HIGHWAY LOSS
DATA INSTITUTE

Insurance Report

Motorcycle Antilock Braking System (ABS)

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Highlights

Estimated collision claim frequency of motorcycles equipped with ABS was 23 percent lower than their non-ABS counterparts. Collision overall losses were 21 percent lower with ABS.

Estimated medical payment (MedPay) claim frequency of motorcycles equipped with ABS was 34 percent lower than their non-ABS counterparts. MedPay overall losses for ABS motorcycles were estimated to be 11 percent (p=0.31) lower.

Estimated claim frequency under bodily injury liability coverage was 31 percent lower for motorcycles equipped with ABS. Overall losses were 46 percent lower than non-ABS bikes.

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Contents

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Introduction

According to the National Highway Traffic Safety Administration (NHTSA, 2011) motorcycle registrations more than doubled between 1997 and 2009. 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 108 percent. In comparison to 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 have this outcome (NHTSA, 2005). Therefore, any countermeasure aimed at reducing the likelihood of motorcycle crashes should significantly reduce the risk of injury or death.

One technology designed to reduce the likelihood of motorcycle crashes is antilock braking systems (ABS). Braking a motorcycle is a complicated process, often involving separate controls for the front and rear brakes. Either wheel can lock-up during hard braking and possibly result in a serious fall. ABS has independent braking sensors for each wheel. If the system detects a difference in the rotation speeds of the wheels, it partially releases brake pressure to allow the locked wheel to spin and the tire to retain grip before reapplying the brake. ABS then modulates braking pressure to achieve optimum braking.

The Highway Loss Data Institute (HLDI) initially reported on the effect of motorcycle ABS on collision losses in April 2008 (Vol. 25, No. 1). The model years of the motorcycles studied in that report ranged from 2003 to 2007. The analysis was updated in December 2009 to add the 2008 model year, as well as medical payment and bodily injury liability coverages (A-81). Significant reductions in collision claim frequencies and overall losses were found in both reports for motorcycles equipped with ABS. No significant reductions were found for claim severities. In the 2009 study, significant reductions in claim frequency were also seen for motorcycles equipped with ABS under bodily injury liability and medical payment coverages.

This report updates and improves the previous report by adding 2009-12 model years and adjusting for more covariates. Exposure for collision, bodily injury liability, and medical payment coverages is more than double that of the previous report.

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, three different insurance coverage types were examined: collision, bodily injury liability, and medical payment. Collision insures against physical damage to a motorcycle sustained in a crash when the driver is at fault. Medical payment covers injuries sustained by motorcycle operators, whereas bodily injury liability typically insures against injuries to motorcycle 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 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 (non-standard, or standard) and deductible range (0-100, 101-250, 251-500, or 501+, for collision only) 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 32 pairs of ABS/non-ABS motorcycles. Furthermore, only pairs with at least one claim were included to make it possible to analyze claim severity. A total of 22 pairs of ABS/non-ABS motorcycles were ultimately included in the study.

All of the Honda motorcycles (both ABS and non-ABS) were equipped with combined braking systems (CBS). CBS applies braking force to both wheels when either the rear or front brake control is engaged. Even with CBS, wheel lock still is possible. With or without ABS, CBS may affect collision losses. Due to the small sample of non-CBS motorcycles in the study, the effect of CBS could not be evaluated. This is not expected to bias the results because the motorcycles in the study differed only by whether or not they were equipped with ABS. Each ABS/non-ABS pair either did or did not have CBS. ABS showed a benefit in both the CBS and non-CBS groups, suggesting the presence of CBS on some of the motorcycles did not confound the observed effect of ABS.

Geographic factors

Geographic characteristics included registered vehicle density and garaging state. Registered vehicle density was defined as the number of registered vehicles per square mile (<100, 100-499, and 500+). State and calendar year (2003-11) were used in the analysis to control for their potential impacts on losses, such as state specific training requirements, or economic variation.

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, measured in years (age -1 was grouped with age 0).

An example of the stratified data is a 1-year-old Honda Gold Wing, equipped with ABS, whose rider was a 40-64 year-old single male, classified as non-standard risk with a policy deductible of $250, and garaged in an area in California with a vehicle density of 100-499 vehicles per square mile in 2009. The exposure distributions by coverage type for the variables are listed in the **Appendixes A, E and I**.

Regression analysis was used to quantify the effect of ABS 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 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=2010. The key independent variable in the model, ABS was treated as categorical.

Results

Collision coverage

Summary results of the regression analysis of motorcycle collision claim frequencies using the Poisson distribution are listed in Table 1. 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. Detailed results of the regression analysis using claim frequency as the dependent variable are listed in Table 2. The table shows 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 exponent of the intercept equals 0.0000761 claims per day, or 2.8 claims per 100 insured vehicle years. The intercept outlines losses for the reference (baseline) categories: The estimate 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 2010, and whose rider was a 40-64 year-old married male classified as non-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 female gender equals -0.09, so female rated drivers had estimated claim frequencies 9 percent lower than those for male rated drivers.

The estimate corresponding to motorcycle ABS (-0.26) was highly significant ($p<0.0001$). The estimate corresponded to a 23 percent reduction in claim frequencies for motorcycles equipped with ABS. All make/series estimates were significant at the $p=0.05$ level except for the Honda NT700V, Kawasaki Vulcan 1700 Voyager and Suzuki V-Strom 650. The reference category for the make/series variable was the Honda Gold Wing. Significant predictions for make/series ranged from 1.2 for the Honda ST1300 to 4.2 for the Honda CBR1000RR. Vehicle age significantly affected collision claim frequency. Claim frequencies were estimated to decrease 13 percent ($p<0.0001$) for each one-year increase in vehicle age.

Driver age, marital status, risk, deductible, vehicle density and state significantly predicted motorcycle collision claim frequency. Compared with losses for rated drivers ages 40-64 (reference category), estimated claim frequencies were significantly higher for all 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 non-standard risk was 19 percent higher ($p<0.0001$) than standard risk drivers. Estimated collision claim frequencies decreased as policy deductible increased. Rated driver gender was a nearly significant predictor of collision claim frequencies. Compared with losses for male rated drivers (reference category), estimated claim frequencies were 9 percent lower ($p=0.09$) for rated female drivers. Motorcycle collision claim frequencies increased with vehicle density. Compared with California (reference category), significant collision claim frequency estimates ranged from 65 percent lower ($p=0.0018$) for Delaware to 14 percent lower ($p=0.02$) for Tennessee. Results by state in Table 2 display the 3 states with the lowest estimates, the reference state, and the only state with an estimate greater than the reference category. Complete frequency estimates by state are reported in Appendix B. Calendar year, also in Table 2 has 2010 set as the reference category. Collision claim frequency for 2009 was the only year where claim frequency was significantly different from that of 2010.

Table 1 : Summary results of linear regression analysis of collision claim frequencies			
	Degrees of freedom	Chi-square	P-value
ABS	1	72.05	<0.0001
Vehicle make/series	21	838.65	<0.0001
Vehicle age	1	268.16	<0.0001
Rated driver age	4	189.66	<0.0001
Rated driver gender	2	5.71	0.0577
Rated driver marital status	2	37.31	<0.0001
Risk	1	37.10	<0.0001
Deductible	3	199.13	<0.0001
Vehicle density	2	64.83	<0.0001
State	50	272.50	<0.0001
Calendar year	8	29.92	0.0002

Table 2 : Detailed results of linear regression analysis of collision claim frequencies					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Intercept	-9.4830	7.61E-05	0.0623	23,135.70	<0.0001
ABS					
ABS model	-0.2563	0.7739	0.0308	69.28	<0.0001
Non-ABS model	0	1	0		
Vehicle make/series					
Aprilia Mana 850	1.0471	2.8494	0.2267	21.33	<0.0001
Aprilia Scarabeo 500	0.5706	1.7693	0.1688	11.43	0.0007
Honda CBR1000RR	1.4333	4.1925	0.0791	328.28	<0.0001
Honda CBR600RR	1.3854	3.9964	0.0621	497.85	<0.0001
Honda Gold Wing	0	1	0		
Honda Interceptor 800	0.6946	2.0029	0.0570	148.48	<0.0001
Honda NT700V	0.4036	1.4972	0.2220	3.31	0.0690
Honda Reflex	0.2988	1.3482	0.0649	21.22	<0.0001
Honda Silver Wing	0.5451	1.7248	0.0542	101.14	<0.0001
Honda ST1300	0.2028	1.2248	0.0580	12.22	0.0005
Kawasaki Concours 14	0.7969	2.2187	0.0571	194.49	<0.0001
Kawasaki Vulcan 1700 Voyager	0.1898	1.2090	0.1645	1.33	0.2485
Suzuki Bandit 1250	0.6284	1.8746	0.0946	44.16	<0.0001
Suzuki B-King	0.9620	2.6169	0.1235	60.68	<0.0001
Suzuki Burgman 400	0.9366	2.5513	0.1925	23.68	<0.0001
Suzuki Burgman 650	0.4214	1.5241	0.0521	65.34	<0.0001
Suzuki SV650	0.7941	2.2124	0.0582	186.06	<0.0001
Suzuki V-Strom 650	-0.0496	0.9516	0.0793	0.39	0.5317
Triumph Sprint ST	0.8409	2.3185	0.0750	125.84	<0.0001
Triumph Tiger	0.2324	1.2616	0.0994	5.47	0.0194
Victory Vision	0.4423	1.5563	0.0937	22.30	<0.0001
Yamaha FJR1300	0.2903	1.3368	0.0630	21.27	<0.0001
Vehicle age	-0.1437	0.8661	0.0088	267.07	<0.0001

Table 2 : Detailed results of linear regression analysis of collision claim frequencies					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Rated driver age					
Unknown	0.3010	1.3512	0.0558	29.11	<0.0001
14-24	0.8560	2.3537	0.0634	182.36	<0.0001
25-39	0.2348	1.2647	0.0362	42.02	<0.0001
40-64	0	1	0		
65+	0.1337	1.1430	0.0374	12.80	0.0003
Rated driver gender					
Female	-0.09180	0.9123	0.0542	2.86	0.0906
Male	0	1	0		
Unknown	-0.1164	0.8901	0.0639	3.32	0.0683
Rated driver marital status					
Married	0	1	0		
Single	0.2056	1.2283	0.0349	34.71	<0.0001
Unknown	0.1816	1.1991	0.0626	8.41	0.0037
Risk					
Non standard	0.1726	1.1884	0.0282	37.54	<0.0001
Standard	0	1	0		
Deductible Range					
0-100	0.2963	1.3449	0.0518	32.72	<0.0001
101-250	0.2209	1.2472	0.0274	65.11	<0.0001
251-500	0	1	0		
501+	-0.3261	0.7217	0.0391	69.62	<0.0001
Vehicle density					
0-99	-0.1295	0.8785	0.0306	17.87	<0.0001
100-499	0	1	0		
500+	0.1351	1.1447	0.0281	23.05	<0.0001
State					
Delaware	-1.0476	0.3508	0.3351	9.77	0.0018
Wisconsin	-0.7049	0.4942	0.0814	75.06	<0.0001
Maine	-0.6947	0.4992	0.2451	8.03	0.0046
California	0	1	0		
Louisiana	0.0001	1.0001	0.0901	0.00	0.9991
Calendar year					
2003	-0.2869	0.7506	0.2715	1.12	0.2906
2004	-0.1023	0.9028	0.1316	0.60	0.4371
2005	-0.0615	0.9404	0.0875	0.49	0.4823
2006	-0.0556	0.9459	0.0637	0.76	0.3820
2007	0.0530	1.0544	0.0458	1.34	0.2466
2008	0.0689	1.0713	0.0392	3.09	0.0790
2009	-0.1137	0.8925	0.0368	9.54	0.0020
2010	0	1	0		
2011	-0.0230	0.9773	0.0352	0.43	0.5134

Summary results of the regression analysis of motorcycle collision claim severities using the Gamma distribution are listed in **Table 3**. Six of the variables included in the analysis had p-values less than 0.05. ABS, demographic factors (age, gender and marital status) and calendar year did not significantly affect claim size. Detailed results of the regression analysis using motorcycle collision claim severity as the dependent variable are listed in **Table 4**. The structure of the table, as well as the variables and reference categories, were the same as those used for claim frequency in **Table 2**. The exponent of the intercept equals $10,425. The intercept outlines losses for the reference (baseline) categories: the estimate corresponds to the claim severity for a Honda Gold Wing without ABS, with vehicle age 0, garaged in a medium vehicle density area in California in 2010, and whose rider was a 40-64 year-old married male classified as non-standard risk with a policy deductible of $251-$500.

The estimate corresponding to the ABS effect was a 2 percent increase in claim severity. However, the estimate was not significant (p=0.5), indicating ABS does not affect claim severity. As previously mentioned, vehicle make/series and vehicle age were significant predictors of claim severity. Significant estimates of claim severities for make/series, compared with those for the Honda Gold Wing (reference category), ranged from 23 percent lower for the Honda CBR1000RR to 71 percent lower for the Honda Reflex. As motorcycles aged, their claim severities decreased. The model estimated a 13 percent decrease (p<0.0001) in claim severity per one-year increase in vehicle age.

Risk significantly predicted claim size. Estimated collision claim severity for drivers classified as non-standard risk was 9 percent lower (p<0.0001) than the baseline. Estimated collision claim severity increased as policy deductible increased. Compared with drivers with a deductible of $251-$500 (reference category), estimated claim severity was 18 percent lower (p<0.0001) for drivers with a $0-100 deductible, 5 percent lower (p=0.02) for drivers with $101-$250 deductible, and 7 percent higher (p=0.04) for drivers with deductibles over $500.

Compared with losses in medium vehicle density areas (reference category), estimated claim severities were 6 percent higher (p=0.009) in high-vehicle-density areas. Compared with California (reference category), significant collision claim severities estimates ranged from 34 percent lower (p=0.0008) for New Hampshire to 20 percent higher (p=0.04) for Utah. Complete results by state estimates are reported in **Appendix C**.

Table 3 : Summary results of linear regression analysis of collision claim severities

	Degrees of freedom	Chi-square	P-value
ABS	1	0.42	0.5149
Vehicle make/series	21	1,225.83	<0.0001
Vehicle age	1	26.52	<0.0001
Rated driver age	4	6.67	0.1545
Rated driver gender	2	0.47	0.7912
Rated driver marital status	2	2.20	0.3335
Risk	1	19.71	<0.0001
Deductible	3	32.60	<0.0001
Vehicle density	2	10.26	0.0059
State	50	88.80	0.0006
Calendar year	8	9.46	0.3053

Table 4 : Detailed results of linear regression analysis of collision claim severities					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Intercept	9.2520	1.04E+04	0.0508	33,111.20	<0.0001
ABS					
ABS model	0.0160	1.0161	0.0246	0.42	0.5154
Non-ABS model	0	1	0		
Vehicle make/series					
Aprilia Mana 850	-0.8046	0.4473	0.1851	18.90	<0.0001
Aprilia Scarabeo 500	-1.0405	0.3533	0.1360	58.50	<0.0001
Honda CBR1000RR	-0.2569	0.7734	0.0652	15.53	<0.0001
Honda CBR600RR	-0.5287	0.5894	0.0509	107.81	<0.0001
Honda Gold Wing	0	1	0		
Honda Interceptor 800	-0.6255	0.5350	0.0460	185.19	<0.0001
Honda NT700V	-0.8884	0.4113	0.1820	23.84	<0.0001
Honda Reflex	-1.2390	0.2897	0.0524	558.83	<0.0001
Honda Silver Wing	-0.9672	0.3801	0.0436	492.00	<0.0001
Honda ST1300	-0.3055	0.7368	0.0468	42.57	<0.0001
Kawasaki Concours 14	-0.4425	0.6424	0.0462	91.87	<0.0001
Kawasaki Vulcan 1700 Voyager	-0.2733	0.7609	0.1317	4.31	0.0379
Suzuki Bandit 1250	-0.7891	0.4543	0.0757	108.64	<0.0001
Suzuki B-King	-0.3909	0.6764	0.1004	15.15	<0.0001
Suzuki Burgman 400	-0.8185	0.4411	0.1561	27.51	<0.0001
Suzuki Burgman 650	-0.8097	0.4450	0.0421	369.60	<0.0001
Suzuki SV650	-0.8357	0.4336	0.0471	314.43	<0.0001
Suzuki V-Strom 650	-0.8679	0.4198	0.0640	183.90	<0.0001
Triumph Sprint ST	-0.5660	0.5678	0.0609	86.33	<0.0001
Triumph Tiger	-0.6115	0.5425	0.0801	58.24	<0.0001
Victory Vision	-0.0366	0.9641	0.0763	0.23	0.6313
Yamaha FJR1300	-0.4666	0.6271	0.0507	84.79	<0.0001
Vehicle age	-0.1437	0.8661	0.0088	267.07	<0.0001
Rated driver age					
Unknown	0.0601	1.0619	0.0461	1.70	0.1924
14-24	0.1005	1.1057	0.0515	3.80	0.0511
25-39	0.0147	1.0148	0.0294	0.25	0.6180
40-64	0	1	0		
65+	0.0418	1.0427	0.0304	1.89	0.1696
Rated driver gender					
Female	0.0019	1.0019	0.0438	0.00	0.9650
Male	0	1	0		
Unknown	-0.0352	0.9654	0.0523	0.45	0.5011
Rated driver marital status					
Married	0	1	0		
Single	0.0384	1.0391	0.0282	1.85	0.1735
Unknown	0.0426	1.0435	0.0515	0.68	0.4089
Risk					
Non standard	-0.0995	0.9053	0.0223	19.88	<0.0001
Standard	0	1	0		

Table 4 : Detailed results of linear regression analysis of collision claim severities					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Deductible					
0-100	-0.1990	0.8195	0.0419	22.52	<0.0001
101-250	-0.0529	0.9485	0.0223	5.63	0.0177
251-500	0	1	0		
501+	0.0657	1.0679	0.0314	4.36	0.0367
Vehicle density					
0-99	-0.0185	0.9817	0.0248	0.56	0.4540
100-499	0	1	0		
500+	0.0601	1.0619	0.0231	6.77	0.0093
State					
Delaware	-0.4466	0.6398	0.2666	2.81	0.0939
Wisconsin	-0.1687	0.8448	0.0648	6.77	0.0093
Maine	-0.0221	0.9781	0.1953	0.01	0.9100
California	0	1	0		
Louisiana	-0.06860	0.93370	0.07190	0.91	0.3401
Calendar year					
2003	-0.2664	0.7661	0.2168	1.51	0.2192
2004	-0.0486	0.9526	0.1065	0.21	0.6482
2005	-0.0279	0.9725	0.0718	0.15	0.6972
2006	-0.0242	0.9761	0.0517	0.22	0.6395
2007	-0.0008	0.9992	0.0375	0.00	0.9830
2008	-0.0250	0.9753	0.0320	0.61	0.4349
2009	0.0103	1.0104	0.0298	0.12	0.7294
2010	0	1	0		
2011	0.0645	1.0666	0.0289	4.99	0.0255

Table 5 summarizes the effects of the independent variables on motorcycle collision overall losses, derived from the claim frequency and claim severity models. Overall losses can be calculated by simple multiplication because the estimates for the effect of ABS on claim frequency and claim severity were in the form of ratios relative to the reference (baseline) categories. The standard error for overall losses can be calculated by taking the square root of the sum of the squared standard errors for claim frequency and severity. 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 estimated effect of ABS was a significant 21 percent decrease ($p<0.0001$) in collision overall losses. Estimated overall losses for make/series, compared with those for the Honda Gold Wing (reference category), ranged from 61 percent lower ($p<0.0001$) for the Honda Reflex to 224 percent higher ($p<0.0001$) for the Honda CBR1000RR. Thirteen of the make/series estimates were significantly different from the reference category, and the other estimates were not significant. Vehicle age also had significant effects in reducing collision overall losses. Collision overall losses were estimated to decrease 16 percent ($p<0.0001$) for each one-year increase in vehicle age.

Estimated overall losses by driver age followed the pattern shown for frequency. With the age group 40-64 set as the reference category, estimated overall losses were 160 percent higher ($p<0.0001$) for rated drivers 24 and younger, 28 percent higher ($p<0.0001$) for rated drivers ages 25-39, 19 percent higher ($p=0.0003$) for rated drivers 65 or older, and 44 percent higher ($p<0.0001$) for drivers with unknown age. Rated driver gender was not a significant predictor for overall losses. Estimated overall losses were influenced significantly by rated driver marital status. Compared with losses for married rated riders (reference category), estimated collision overall losses were 28 percent higher ($p<0.0001$) for single drivers and 25 percent higher ($p=0.006$) for drivers with unknown marital status. Risk was

another significant predictor, with standard risk as the reference category. Estimated collision claim frequency for drivers classified as non-standard risk was 8 percent higher (p=0.04) than the baseline. Policy deductible also affected collision overall losses. Compared with drivers with a deductible range of $251-$500 (reference category), estimated overall loss was 18 percent higher (p<0.0001) for drivers with a $101-$250 deductible, and 23 percent lower (p<0.0001) for drivers with a deductible over $500.

Motorcycle collision overall losses were predicted to increase with vehicle density. Compared with losses in medium-vehicle-density areas (reference category), estimated overall losses were 22 percent higher (p<0.0001) in high-vehicle-density areas and 14 percent lower (p=0.0002) in low-vehicle-density areas. Collision overall losses were predicted to vary by state. Compared with California (reference category), significant collision overall losses estimates ranged from 78 percent lower (p=0.0005) for Delaware to 18 percent lower (p=0.03) for Georgia. Complete overall losses estimates by state are listed in **Appendix D**. For calendar year, overall losses for 2009 was an estimated 10 percent lower (p=0.03), the only year with overall losses significantly different from those of 2010 (reference category).

Table 5 : Results for collision overall losses derived from claim frequency and severity models

	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Intercept	-9.4830	0.0623	9.2520	0.0508	-0.2310	0.0804	0.7938	0.0041
ABS								
ABS model	-0.2563	0.0308	0.0160	0.0246	-0.2403	0.0394	0.7864	<0.0001
Non-ABS model	0	0	0	0	0	0	1	
Vehicle make/series								
Aprilia Mana 850	1.0471	0.2267	-0.8046	0.1851	0.2424	0.2927	1.2744	0.4075
Aprilia Scarabeo 500	0.5706	0.1688	-1.0405	0.1360	-0.4699	0.2168	0.6251	0.0302
Honda CBR1000RR	1.4333	0.0791	-0.2569	0.0652	1.1764	0.1025	3.2427	<0.0001
Honda CBR600RR	1.3854	0.0621	-0.5287	0.0509	0.8567	0.0803	2.3554	<0.0001
Honda Gold Wing	0	0	0	0	0	0	1	
Honda Interceptor 800	0.6946	0.0570	-0.6255	0.0460	0.0691	0.0732	1.0716	0.3452
Honda NT700V	0.4036	0.2220	-0.8884	0.1820	-0.4849	0.2870	0.6158	0.0911
Honda Reflex	0.2988	0.0649	-1.2390	0.0524	-0.9402	0.0834	0.3906	<0.0001
Honda Silver Wing	0.5451	0.0542	-0.9672	0.0436	-0.4221	0.0696	0.6557	<0.0001
Honda ST1300	0.2028	0.0580	-0.3055	0.0468	-0.1027	0.0746	0.9024	0.1685
Kawasaki Concours 14	0.7969	0.0571	-0.4425	0.0462	0.3544	0.0735	1.4253	<0.0001
Kawasaki Vulcan 1700 Voyager	0.1898	0.1645	-0.2733	0.1317	-0.0834	0.2107	0.9200	0.6921
Suzuki Bandit 1250	0.6284	0.0946	-0.7891	0.0757	-0.1608	0.1211	0.8515	0.1844
Suzuki B-King	0.9620	0.1235	-0.3909	0.1004	0.5712	0.1592	1.7703	0.0003
Suzuki Burgman 400	0.9366	0.1925	-0.8185	0.1561	0.1181	0.2478	1.1253	0.6337
Suzuki Burgman 650	0.4214	0.0521	-0.8097	0.0421	-0.3883	0.0670	0.6782	<0.0001
Suzuki SV650	0.7941	0.0582	-0.8357	0.0471	-0.0416	0.0749	0.9592	0.5783
Suzuki V-Strom 650	-0.0496	0.0793	-0.8679	0.0640	-0.9175	0.1019	0.3995	<0.0001
Triumph Sprint ST	0.8409	0.0750	-0.5660	0.0609	0.2748	0.0966	1.3163	0.0044
Triumph Tiger	0.2324	0.0994	-0.6115	0.0801	-0.3792	0.1277	0.6844	0.0030
Victory Vision	0.4423	0.0937	-0.0366	0.0763	0.4057	0.1208	1.5003	0.0008
Yamaha FJR1300	0.2903	0.0630	-0.4666	0.0507	-0.1762	0.0808	0.8384	0.0292
Vehicle age	-0.1437	0.0088	-0.0351	0.0068	-0.1787	0.0111	0.8364	<0.0001
Rated driver age								
Unknown	0.3010	0.0558	0.0601	0.0461	0.3611	0.0724	1.4350	<0.0001
14-24	0.8560	0.0634	0.1005	0.0515	0.9565	0.0817	2.6025	<0.0001
25-39	0.2348	0.0362	0.0147	0.0294	0.2495	0.0467	1.2834	<0.0001

Table 5 : Results for collision overall losses derived from claim frequency and severity models								
	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
40-64	0	0	0	0	0	0	1	
65+	0.1337	0.0374	0.0418	0.0304	0.1755	0.0482	1.1919	0.0003
Rated driver gender								
Female	-0.0918	0.0542	0.0019	0.0438	-0.0899	0.0697	0.9141	0.1973
Male	0	0	0	0	0	0	1	
Unknown	-0.1164	0.0639	-0.0352	0.0523	-0.1516	0.0825	0.8593	0.0662
Rated driver marital status								
Married	0	0	0	0	0	0	1	
Single	0.2056	0.0349	0.0384	0.0282	0.2440	0.0449	1.2763	<0.0001
Unknown	0.1816	0.0626	0.0426	0.0515	0.2242	0.0811	1.2513	0.0057
Risk								
Non standard	0.1726	0.0282	-0.0995	0.0223	0.0731	0.0359	1.0758	0.0420
Standard	0	0	0	0	0	0	1	
Deductible								
0-100	0.2963	0.0518	-0.1990	0.0419	0.0973	0.0666	1.1022	0.1444
101-250	0.2209	0.0274	-0.0529	0.0223	0.1680	0.0353	1.1830	<0.0001
251-500	0	0	0	0	0	0	1	
501+	-0.3261	0.0391	0.0657	0.0314	-0.2604	0.0502	0.7707	<0.0001
Vehicle density								
0-99	-0.1295	0.0306	-0.0185	0.0248	-0.1480	0.0394	0.8624	0.0002
100-499	0	0	0	0	0	0	1	
500+	0.1351	0.0281	0.0601	0.0231	0.1952	0.0364	1.2155	<0.0001
State								
Delaware	-1.0476	0.3351	-0.4466	0.2666	-1.4942	0.4282	0.2244	0.0005
Wisconsin	-0.7049	0.0814	-0.1687	0.0648	-0.8736	0.1040	0.4175	<0.0001
Maine	-0.6947	0.2451	-0.0221	0.1953	-0.7168	0.3134	0.4883	0.0222
California	0	0	0	0	0	0	1	
Louisiana	0.0001	0.0901	-0.0686	0.0719	-0.0685	0.1152	0.9338	0.5525
Calendar year								
2003	-0.2869	0.2715	-0.2664	0.2168	-0.5533	0.3474	0.5750	0.1113
2004	-0.1023	0.1316	-0.0486	0.1065	-0.1509	0.1693	0.8600	0.3729
2005	-0.0615	0.0875	-0.0279	0.0718	-0.0894	0.1132	0.9145	0.4295
2006	-0.0556	0.0637	-0.0242	0.0517	-0.0798	0.0820	0.9233	0.3301
2007	0.0530	0.0458	-0.0008	0.0375	0.0522	0.0591	1.0536	0.3772
2008	0.0689	0.0392	-0.0250	0.0320	0.0439	0.0506	1.0449	0.3857
2009	-0.1137	0.0368	0.0103	0.0298	-0.1034	0.0474	0.9018	0.0290
2010	0	0	0	0	0	0	1	
2011	-0.0230	0.0352	0.0645	0.0289	0.0415	0.0455	1.0424	0.3618

Medical payment coverage

Summary results of the regression analysis of motorcycle medical payment claim frequencies using the Poisson distribution are listed in Table 6. Results for the following independent variables: ABS, vehicle make/series, vehicle age, rated driver gender, rated driver marital status and vehicle density had p-values less than 0.05, indicating their effects on claim frequencies were statistically significant. Rated driver age and state were marginally significant while other predictors were not significant.

Detailed results of the regression analysis using claim frequency as the dependent variable are listed in Table 7, which followed the structure initially shown in Table 2. The exponent of the intercept equals 0.000044 claims per day, or 15.9 claims per 1,000 insured vehicle years. The estimate corresponding to motorcycle ABS (-0.42) was highly significant ($p<0.0001$). The estimate corresponded to a 34 percent reduction in medical payment claim frequencies for motorcycles equipped with ABS. Generally speaking, the trends shown within each significant predictor in Table 7 were similar to the corresponding ones in Table 2. Appendix F contains a complete list of frequency estimates by state.

Summary results of the regression analysis of motorcycle medical payment claim severities using the Gamma distribution are listed in Table 8. Eight of the variables included in the analysis had p-values less than 0.05. Vehicle age and calendar year did not significantly affect claim size. Detailed results of medical payment severity analysis are shown in Table 9 and Appendix G. The estimate corresponding to the ABS effect on medical payment claim severity was a highly significant ($p=0.0005$) 35 percent increase in claim severity, indicating ABS increases claim severity. An examination of claim frequency by claim size explains this result. The estimated effects indicate that the reduction of low-severity (≤$3,000) claims was much higher than the reduction for more expensive claims. By removing many of the lowest cost claims, ABS shifted the distribution of claim severity to a higher mean.

Overall losses for medical payment coverage were calculated in the same fashion as collision coverage. ABS was estimated to reduce overall medical payment losses by 11 percent, although the estimate was not statistically significant ($p=0.3$). Detailed parameter estimates are listed in Table 10 and Appendix H.

Table 6 : Summary results of linear regression analysis of medical payment claim frequencies

	Degrees of freedom	Chi-square	P-value
ABS	1	28.23	<0.0001
Vehicle make/series	17	103.20	<0.0001
Vehicle age	1	27.79	<0.0001
Rated driver age	4	9.43	0.0511
Rated driver gender	2	8.54	0.0140
Rated driver marital status	2	9.09	0.0106
Risk	1	0.91	0.3390
Vehicle density	2	18.37	0.0001
Calendar year	7	10.20	0.2514
State	50	65.85	0.0658

Table 7 : Detailed results of linear regression analysis of medical payment claim frequencies					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Intercept	-10.0398	4.36E-05	0.1642	3,739.42	<0.0001
ABS					
ABS model	-0.4195	0.6574	0.0820	26.19	<0.0001
Non-ABS model	0	1	0		
Vehicle make/series					
Aprilia Scarabeo 500	1.0084	2.7411	0.3397	8.81	0.0030
Honda CBR1000RR	1.2565	3.5132	0.2364	28.24	<0.0001
Honda CBR600RR	1.3074	3.6967	0.1651	62.73	<0.0001
Honda Gold Wing	0	1	0		
Honda Interceptor 800	0.1794	1.1965	0.1766	1.03	0.3098
Honda Reflex	0.4505	1.5691	0.1323	11.60	0.0007
Honda Silver Wing	0.3453	1.4123	0.1300	7.05	0.0079
Honda ST1300	0.4584	1.5815	0.1253	13.39	0.0003
Kawasaki Concours 14	0.2174	1.2428	0.1843	1.39	0.2382
Kawasaki Vulcan 1700 Voyager	0.4253	1.5300	0.3894	1.19	0.2748
Suzuki Bandit 1250	0.5422	1.7198	0.2437	4.95	0.0261
Suzuki Burgman 650	0.1968	1.2175	0.1330	2.19	0.1391
Suzuki SV650	0.8723	2.3924	0.1409	38.34	<0.0001
Suzuki V-Strom 650	0.1562	1.1691	0.1802	0.75	0.3860
Triumph Sprint ST	0.6513	1.9181	0.1959	11.05	0.0009
Triumph Tiger	0.4302	1.5376	0.2210	3.79	0.0515
Victory Vision	0.6732	1.9605	0.1909	12.44	0.0004
Yamaha FJR1300	-0.0517	0.9496	0.1743	0.09	0.7667
Vehicle age	-0.1089	0.8968	0.0207	27.79	<0.0001
Rated driver age					
Unknown	-0.0161	0.9841	0.1364	0.01	0.9063
14-24	0.5018	1.6517	0.1704	8.67	0.0032
25-39	-0.0067	0.9933	0.1013	0.00	0.9475
40-64	0	1	0		
65+	0.0445	1.0455	0.0896	0.25	0.6195
Rated driver gender					
Female	-0.3054	0.7369	0.1516	4.05	0.0440
Male	0	1	0		
Unknown	0.2473	1.2805	0.1398	3.13	0.0770
Rated driver marital status					
Married	0	1	0		
Single	0.2671	1.3062	0.0875	9.31	0.0023
Unknown	0.1110	1.1174	0.1352	0.67	0.4114
Risk					
Non standard	-0.0716	0.9309	0.0751	0.91	0.3404
Standard	0	1	0		
Vehicle density					
0-99	-0.1924	0.8250	0.0745	6.67	0.0098
100-499	0	1	0		
500+	0.1640	1.1782	0.0725	5.12	0.0236

Table 7 : Detailed results of linear regression analysis of medical payment claim frequencies					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
State					
Rhode Island	-1.3608	0.2565	1.0067	1.83	0.1764
North Dakota	-1.1441	0.3185	0.7204	2.52	0.1123
Delaware	-0.9852	0.3734	1.0072	0.96	0.3280
California	0	1	0		
Mississippi	0.5490	1.7315	0.2789	3.87	0.0490
Vermont	0.6791	1.9721	0.4259	2.54	0.1108
D.C.	0.7908	2.2051	1.0098	0.61	0.4336
Calendar year					
2003	-4.9593	0.0070	141.6384	0.00	0.9721
2004	-0.3274	0.7208	0.5895	0.31	0.5786
2005	0.0742	1.0771	0.2302	0.10	0.7471
2006	0.2513	1.2857	0.1471	2.92	0.0875
2007	0.1294	1.1382	0.1109	1.36	0.2433
2008	0.0994	1.1045	0.0940	1.12	0.2907
2009	-0.1141	0.8922	0.0894	1.63	0.2020
2010	0	1	0		
2011	-0.0140	0.9861	0.0903	0.02	0.8771

Table 8 : Summary results of linear regression analysis of medical payment claim severities			
	Degrees of freedom	Chi-square	P-value
ABS	1	12.35	0.0004
Vehicle make/series	17	82.97	<0.0001
Vehicle age	1	3.03	0.0820
Rated driver age	4	93.63	<0.0001
Rated driver gender	2	81.92	<0.0001
Rated driver marital status	2	22.55	<0.0001
Risk	1	11.90	0.0006
Vehicle density	2	7.53	0.0231
Calendar year	7	4.62	0.7058
State	50	130.56	<0.0001

Table 9 : Detailed results of linear regression analysis of medical payment claim severities					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Intercept	7.8410	2.54E+03	0.1710	2,103.72	<0.0001
ABS					
ABS model	0.2989	1.3484	0.0865	11.95	0.0005
Non-ABS model	0	1	0		
Vehicle make/series					
Aprilia Scarabeo 500	-0.4211	0.6563	0.3423	1.51	0.2186
Honda CBR1000RR	-0.5384	0.5837	0.2496	4.65	0.0310
Honda CBR600RR	-0.1368	0.8721	0.1855	0.54	0.4609
Honda Gold Wing	0	1	0		
Honda Interceptor 800	-0.7201	0.4867	0.1889	14.53	0.0001
Honda Reflex	-0.4761	0.6212	0.1369	12.10	0.0005
Honda Silver Wing	-0.5807	0.5595	0.1334	18.94	<0.0001
Honda ST1300	-0.5925	0.5529	0.1269	21.80	<0.0001
Kawasaki Concours 14	-0.3675	0.6924	0.1831	4.03	0.0448
Kawasaki Vulcan 1700 Voyager	-0.5167	0.5965	0.4308	1.44	0.2304
Suzuki Bandit 1250	-0.7349	0.4795	0.2367	9.64	0.0019
Suzuki Burgman 650	-0.6707	0.5114	0.1355	24.49	<0.0001
Suzuki SV650	-0.4905	0.6123	0.1514	10.49	0.0012
Suzuki V-Strom 650	-0.0702	0.9322	0.1792	0.15	0.6953
Triumph Sprint ST	-0.8101	0.4448	0.2174	13.89	0.0002
Triumph Tiger	-0.6023	0.5475	0.2213	7.41	0.0065
Victory Vision	0.1265	1.1349	0.1977	0.41	0.5221
Yamaha FJR1300	-0.3820	0.6825	0.1775	4.63	0.0314
Vehicle age	0.0374	1.0381	0.0215	3.04	0.0814
Rated driver age					
Unknown	1.3990	4.0513	0.1532	83.35	<0.0001
14-24	-0.2930	0.7460	0.2001	2.14	0.1431
25-39	0.1193	1.1267	0.1121	1.13	0.2876
40-64	0	1	0		
65+	0.0520	1.0534	0.0910	0.33	0.5678
Rated driver gender					
Female	0.2912	1.3380	0.1507	3.73	0.0533
Male	0	1	0		
Unknown	-1.1900	0.3042	0.1455	66.86	<0.0001
Rated driver marital status					
Married	0	1	0		
Single	0.0411	1.0419	0.0884	0.22	0.6421
Unknown	0.6383	1.8933	0.1398	20.85	<0.0001
Risk					
Non standard	-0.2583	0.7724	0.0740	12.18	0.0005
Standard	0	1	0		
Vehicle density					
0-99	-0.0733	0.9293	0.0772	0.90	0.3421
100-499	0	1	0		
500+	-0.2196	0.8028	0.0797	7.60	0.0058
State					

Table 9 : Detailed results of linear regression analysis of medical payment claim severities					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Rhode Island	0.3369	1.4006	0.8849	0.14	0.7034
North Dakota	0.4251	1.5297	0.6464	0.43	0.5108
Delaware	-0.1010	0.9039	0.9002	0.01	0.9107
California	0	1	0		
Mississippi	-0.3642	0.6947	0.2497	2.13	0.1446
Vermont	0.1809	1.1983	0.4127	0.19	0.6611
D.C.	-0.7583	0.4685	0.8693	0.76	0.3830
Calendar year					
2004	-0.6283	0.5335	0.5217	1.45	0.2284
2005	-0.3138	0.7306	0.2297	1.87	0.1719
2006	0.0782	1.0813	0.1508	0.27	0.6042
2007	-0.0302	0.9703	0.1149	0.07	0.7927
2008	-0.0764	0.9264	0.0964	0.63	0.4280
2009	-0.0399	0.9609	0.0929	0.18	0.6676
2010	0	1	0		
2011	-0.0680	0.9343	0.0938	0.53	0.4684

Table 10 : Results for medical payment overall losses derived from claim frequency and severity models								
	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Intercept	-10.0398	0.1642	7.8410	0.1710	-2.1988	0.2370	0.1109	<0.0001
ABS								
ABS model	-0.4195	0.0820	0.2989	0.0865	-0.1206	0.1191	0.8864	0.3116
Non-ABS model	0	0	0	0	0	0	1	
Vehicle make/series								
Aprilia Scarabeo 500	1.0084	0.3397	-0.4211	0.3423	0.5872	0.4822	1.7990	0.2233
Honda CBR1000RR	1.2565	0.2364	-0.5384	0.2496	0.7182	0.3438	2.0507	0.0367
Honda CBR600RR	1.3074	0.1651	-0.1368	0.1855	1.1706	0.2483	3.2240	<0.0001
Honda Gold Wing	0	0	0	0	0	0	1	
Honda Interceptor 800	0.1794	0.1766	-0.7201	0.1889	-0.5407	0.2586	0.5823	0.0366
Honda Reflex	0.4505	0.1323	-0.4761	0.1369	-0.0256	0.1904	0.9747	0.8929
Honda Silver Wing	0.3453	0.1300	-0.5807	0.1334	-0.2354	0.1863	0.7902	0.2063
Honda ST1300	0.4584	0.1253	-0.5925	0.1269	-0.1341	0.1783	0.8745	0.4520
Kawasaki Concours 14	0.2174	0.1843	-0.3675	0.1831	-0.1501	0.2598	0.8606	0.5634
Kawasaki Vulcan 1700 Voyager	0.4253	0.3894	-0.5167	0.4308	-0.0914	0.5807	0.9126	0.8749
Suzuki Bandit 1250	0.5422	0.2437	-0.7349	0.2367	-0.1927	0.3397	0.8247	0.5706
Suzuki Burgman 650	0.1968	0.1330	-0.6707	0.1355	-0.4739	0.1899	0.6226	0.0126
Suzuki SV650	0.8723	0.1409	-0.4905	0.1514	0.3818	0.2068	1.4649	0.0649
Suzuki V-Strom 650	0.1562	0.1802	-0.0702	0.1792	0.0860	0.2542	1.0898	0.7351
Triumph Sprint ST	0.6513	0.1959	-0.8101	0.2174	-0.1588	0.2927	0.8532	0.5875
Triumph Tiger	0.4302	0.2210	-0.6023	0.2213	-0.1721	0.3127	0.8419	0.5822
Victory Vision	0.6732	0.1909	0.1265	0.1977	0.7997	0.2748	2.2250	0.0036
Yamaha FJR1300	-0.0517	0.1743	-0.3820	0.1775	-0.4338	0.2488	0.6481	0.0813
Vehicle age	-0.1089	0.0207	0.0374	0.0215	-0.0715	0.0298	0.9310	0.0164

Table 10 : Results for medical payment overall losses derived from claim frequency and severity models								
	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Rated driver age								
Unknown	-0.0161	0.1364	1.3990	0.1532	1.3830	0.2051	3.9868	<0.0001
14-24	0.5018	0.1704	-0.2930	0.2001	0.2088	0.2628	1.2321	0.4271
25-39	-0.0067	0.1013	0.1193	0.1121	0.1126	0.1511	1.1192	0.4562
40-64	0	0	0	0	0	0	1	
65+	0.0445	0.0896	0.0520	0.0910	0.0965	0.1277	1.1013	0.4499
Rated driver gender								
Female	-0.3054	0.1516	0.2912	0.1507	-0.0142	0.2138	0.9859	0.9472
Male	0	0	0	0	0	0	1	
Unknown	0.2473	0.1398	-1.1900	0.1455	-0.9427	0.2018	0.3896	<0.0001
Rated driver marital status								
Married	0	0	0	0	0	0	1	
Single	0.2671	0.0875	0.0411	0.0884	0.3082	0.1244	1.3610	0.0132
Unknown	0.1110	0.1352	0.6383	0.1398	0.7494	0.1945	2.1156	0.0001
Risk								
Non standard	-0.0716	0.0751	-0.2583	0.0740	-0.3299	0.1055	0.7190	0.0018
Standard	0	0	0	0	0	0	1	
Vehicle density								
0-99	-0.1924	0.0745	-0.0733	0.0772	-0.2657	0.1072	0.7667	0.0132
100-499	0	0	0	0	0	0	1	
500+	0.1640	0.0725	-0.2196	0.0797	-0.0556	0.1077	0.9459	0.6053
State								
Rhode Island	-1.3608	1.0067	0.3369	0.8849	-1.0239	1.3403	0.3592	0.4449
North Dakota	-1.1441	0.7204	0.4251	0.6464	-0.7190	0.9679	0.4872	0.4576
Delaware	-0.9852	1.0072	-0.1010	0.9002	-1.0862	1.3509	0.3375	0.4213
California	0	0	0	0	0	0	1	
Mississippi	0.5490	0.2789	-0.3642	0.2497	0.1848	0.3743	1.2029	0.6216
Vermont	0.6791	0.4259	0.1809	0.4127	0.8600	0.5930	2.3632	0.1470
D.C.	0.7908	1.0098	-0.7583	0.8693	0.0325	1.3324	1.0330	0.9806
Calendar year								
2003	-4.9593	141.6384						
2004	-0.3274	0.5895	-0.6283	0.5217	-0.9558	0.7872	0.3845	0.2247
2005	0.0742	0.2302	-0.3138	0.2297	-0.2396	0.3252	0.7869	0.4613
2006	0.2513	0.1471	0.0782	0.1508	0.3295	0.2107	1.3902	0.1178
2007	0.1294	0.1109	-0.0302	0.1149	0	0	1	0.5343
2008	0.0994	0.0940	-0.0764	0.0964	0.0230	0.1347	1.0232	0.8646
2009	-0.1141	0.0894	-0.0399	0.0929	-0.1539	0.1289	0.8573	0.2323
2010	0	0	0	0	0.0000	0.0000	1.0000	
2011	-0.0140	0.0903	-0.0680	0.0938	-0.0819	0.1302	0.9213	0.5290

Bodily injury liability coverage

Due to limited exposure, only 13 of the 22 motorcycles used in the collision coverage analysis were used in the analysis of bodily injury liability coverage. Summary results of the regression analysis of motorcycle bodily injury liability claim frequencies using the Poisson distribution are listed in Table 11. Seven of the 10 independent variables had p-values less than 0.05, indicating their effects on claim frequencies were statistically significant.

Detailed results of the regression analysis using claim frequency as the dependent variable are listed in Table 12 and Appendix J. The exponent of the intercept equals 0.000012 claims per day, or 4.4 claims per 1,000 insured vehicle years. The estimate corresponding to motorcycle ABS (-0.37) was significant (p=0.002). The estimate corresponded to a 31 percent reduction in bodily injury liability claim frequencies for motorcycles equipped with ABS. All make/series were estimated as having lower claim frequency than the reference make/series, the Honda Gold Wing. Claim frequencies were estimated to decrease 10 percent (p=0.0002) for each one-year increase in vehicle age. The most significant estimate was that for rated drivers 24 and younger with bodily injury liability frequency nearly 4 times (p<0.0001) that for rated drivers ages 40-64 (reference category).

Rated driver marital status, vehicle density, calendar year, and state were significant predictors of bodily injury liability claim size (Table 13). The estimate corresponding to the ABS effect on bodily injury liability severity was a non-significant (p=0.3424) 21 percent reduction in claim severity. Additional analysis of bodily injury liability claim frequency categorized into three severity ranges indicated that the greatest reduction in claims occurred in the mid-range $3,000 to $25,000 level. Detailed results for these predictors are listed in Table 14 and Appendix K.

ABS was estimated to reduce overall bodily injury liability losses by 46 percent, and this estimate was statistically significant (p=0.03). Detailed estimates for each predictor are listed in Table 15 and Appendix L.

Table 11 : Summary results of linear regression analysis of bodily injury liability claim frequencies

	Degrees of freedom	Chi-square	P-value
ABS	1	10.54	0.0012
Vehicle make/series	12	52.05	<0.0001
Vehicle age	1	14.42	0.0001
Rated driver age	4	28.75	<0.0001
Rated driver gender	2	1.74	0.4185
Rated driver marital status	2	1.68	0.4316
Risk	1	41.65	<0.0001
Vehicle density	2	11.04	0.0040
Calendar year	8	4.65	0.7943
State	50	95.33	0.0001

Table 12 : Detailed results of linear regression analysis of bodily injury liability claim frequencies

Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Intercept	-11.3308	1.20E-05	0.2277	2,477.06	<0.0001
ABS					
ABS model	-0.3743	0.6878	0.1190	9.89	0.0017
Non-ABS model	0	1	0		
Vehicle make/series					
Honda Gold Wing	0	1	0		
Honda Interceptor 800	-0.4996	0.6068	0.2507	3.97	0.0462
Honda Reflex	-1.0579	0.3472	0.3110	11.57	0.0007
Honda Silver Wing	-0.3216	0.7250	0.2140	2.26	0.1329
Honda ST1300	-0.3328	0.7169	0.2039	2.66	0.1027

Table 12 : Detailed results of linear regression analysis of bodily injury liability claim frequencies					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Kawasaki Concours 14	-0.3482	0.7060	0.2690	1.68	0.1956
Suzuki Bandit 1250	-0.1218	0.8853	0.3641	0.11	0.7380
Suzuki Burgman 650	-0.4615	0.6303	0.2108	4.79	0.0285
Suzuki SV650	-0.4437	0.6416	0.2548	3.03	0.0816
Suzuki V-Strom 650	-1.2832	0.2772	0.3676	12.18	0.0005
Triumph Sprint ST	-1.0944	0.3348	0.5082	4.64	0.0313
Triumph Tiger	-0.8989	0.4070	0.4549	3.91	0.0481
Yamaha FJR1300	-1.0359	0.3549	0.3117	11.05	0.0009
Vehicle age	-0.1090	0.8967	0.0288	14.35	0.0002
Rated driver age					
Unknown	0.5000	1.6487	0.2117	5.58	0.0182
14-24	1.3611	3.9005	0.3113	19.11	<0.0001
25-39	0.3364	1.3999	0.1669	4.06	0.0438
40-64	0	1	0		
65+	0.3955	1.4851	0.1162	11.58	0.0007
Rated driver gender					
Female	0.1376	1.1475	0.2036	0.46	0.4991
Male	0	1	0		
Unknown	-0.3237	0.7234	0.2828	1.31	0.2524
Rated driver marital status					
Married	0	1	0		
Single	0.1667	1.1814	0.1315	1.61	0.2048
Unknown	-0.0433	0.9576	0.2772	0.02	0.8758
Risk					
Non standard	-0.7334	0.4803	0.1185	38.33	<0.0001
Standard	0	1	0		
Vehicle density					
0-99	-0.0785	0.9245	0.1156	0.46	0.4971
100-499	0	1	0		
500+	0.3060	1.3579	0.1117	7.51	0.0061
State					
Tennessee	-2.0156	0.1332	0.5951	11.47	0.0007
Massachusetts	-1.5990	0.2021	0.5490	8.48	0.0036
Colorado	-1.4949	0.2243	0.5191	8.29	0.0040
California	0	1	0		
Maine	0.3586	1.4314	0.5960	0.36	0.5474
Idaho	0.5766	1.7800	0.4344	1.76	0.1843
D.C.	1.2561	3.5118	0.7241	3.01	0.0828
Calendar year					
2003	-9.6128	0.0001	244.3235	0.00	0.9686
2004	-0.8512	0.4269	1.0118	0.71	0.4002
2005	-0.1580	0.8539	0.3441	0.21	0.6462
2006	-0.0059	0.9941	0.2242	0.00	0.9791
2007	0.0883	1.0923	0.1616	0.30	0.5849
2008	0.1650	1.1794	0.1374	1.44	0.2297
2009	-0.0243	0.9760	0.1354	0.03	0.8573
2010	0	1	0		
2011	0.0653	1.0674	0.1630	0.16	0.6888

Table 13 : Summary results of linear regression analysis of bodily injury liability claim severities			
	Degrees of freedom	Chi-square	P-value
ABS	1	0.88	0.3482
Vehicle make/series	12	18.95	0.0896
Vehicle age	1	0.02	0.8998
Rated driver age	4	7.64	0.1059
Rated driver gender	2	0.57	0.7538
Rated driver marital status	2	7.60	0.0224
Risk	1	2.26	0.1323
Vehicle density	2	8.58	0.0137
Calendar year	7	15.69	0.0281
State	42	73.98	0.0017

Table 14 : Detailed results of linear regression analysis of bodily injury liability claim severities					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Intercept	10.0478	2.31E+04	0.4835	431.80	<0.0001
ABS					
ABS model	-0.2346	0.7909	0.2470	0.90	0.3424
Non-ABS model	0	1	0		
Vehicle make/series					
Aprilia Scarabeo 500	0	1	0		
Honda CBR1000RR	0.6522	1.9198	0.5580	1.37	0.2425
Honda CBR600RR	-1.1219	0.3257	0.6506	2.97	0.0846
Honda Gold Wing	0.3065	1.3586	0.5571	0.30	0.5822
Honda Interceptor 800	-1.1982	0.3017	0.3922	9.33	0.0023
Honda Reflex	0.0730	1.0757	0.5022	0.02	0.8844
Honda Silver Wing	-0.8908	0.4103	0.7554	1.39	0.2383
Honda ST1300	-0.4852	0.6156	0.4241	1.31	0.2526
Kawasaki Concours 14	-0.2069	0.8131	0.5585	0.14	0.7111
Kawasaki Vulcan 1700 Voyager	-4.6181	0.0099	1.6921	7.45	0.0063
Suzuki Bandit 1250	-0.5156	0.5972	0.6940	0.55	0.4575
Suzuki Burgman 650	-0.5206	0.5942	1.3030	0.16	0.6895
Suzuki SV650	-0.1102	0.8957	0.5800	0.04	0.8493
Vehicle age	-0.0069	0.9932	0.0544	0.02	0.8998
Rated driver age					
Unknown	-0.8528	0.4262	0.4066	4.40	0.0359
14-24	-0.7432	0.4756	0.6673	1.24	0.2654
25-39	-0.6962	0.4985	0.3955	3.10	0.0784
40-64	0	1	0		
65+	-0.2606	0.7706	0.2271	1.32	0.2512
Rated driver gender					
Female	0.2105	1.2343	0.5107	0.17	0.6801
Male	0	1	0		
Unknown	-0.3177	0.7279	0.5607	0.32	0.5711

Table 14 : Detailed results of linear regression analysis of bodily injury liability claim severities					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Rated driver marital status					
Married	0	1	0		
Single	0.6286	1.8751	0.2501	6.32	0.0119
Unknown	0.5589	1.7487	0.5324	1.10	0.2939
Risk					
Non standard	-0.3214	0.7251	0.2114	2.31	0.1284
Standard	0	1	0		
Vehicle density					
0-99	0.6471	1.9100	0.2360	7.52	0.0061
100-499	0	1	0		
500+	0.5113	1.6675	0.2452	4.35	0.0370
State					
Tennessee	0.2495	1.2834	0.7836	0.10	0.7502
Massachusetts	-0.7096	0.4918	1.3099	0.29	0.5880
Colorado	0.6311	1.8797	0.8792	0.52	0.4729
California	0	1	0		
Maine	-3.7235	0.0241	1.1998	9.63	0.0019
Idaho	-0.3157	0.7292	0.9364	0.11	0.7360
D.C.	-2.5014	0.0820	1.2242	4.17	0.0410
Calendar year					
2004	1.9195	6.8176	1.5555	1.52	0.2172
2005	-2.7326	0.0651	0.9166	8.89	0.0029
2006	0.3198	1.3768	0.5135	0.39	0.5335
2007	-0.0818	0.9214	0.3181	0.07	0.7970
2008	0.0477	1.0488	0.2757	0.03	0.8627
2009	-0.5587	0.5719	0.2778	4.05	0.0443
2010	0	1	0		
2011	-0.0736	0.9291	0.3580	0.04	0.8372

Table 15 : Results for bodily injury liability overall losses derived from claim frequency and severity models								
	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Intercept	-11.3308	0.2277	10.0478	0.4835	-1.2831	0.5345	0.2772	0.0164
ABS								
ABS model	-0.3743	0.1190	-0.2346	0.2470	-0.6089	0.2742	0.5440	0.0264
Non-ABS model	0	0	0	0	0	0	1	
Vehicle make/series								
Aprilia Scarabeo 500	0	0	0	0	0	0	1	
Honda CBR1000RR	-0.4996	0.2507	0.6522	0.5580	0.1526	0.6117	1.1648	0.8030
Honda CBR600RR	-1.0579	0.3110	-1.1219	0.6506	-2.1798	0.7211	0.1131	0.0025
Honda Gold Wing	-0.3216	0.2140	0.3065	0.5571	-0.0151	0.5968	0.9850	0.9798
Honda Interceptor 800	-0.3328	0.2039	-1.1982	0.3922	-1.5310	0.4420	0.2163	0.0005
Honda Reflex	-0.3482	0.2690	0.0730	0.5022	-0.2752	0.5697	0.7594	0.6291
Honda Silver Wing	-0.1218	0.3641	-0.8908	0.7554	-1.0126	0.8386	0.3633	0.2272
Honda ST1300	-0.4615	0.2108	-0.4852	0.4241	-0.9467	0.4736	0.3880	0.0456

Table 15 : Results for bodily injury liability overall losses derived from claim frequency and severity models								
	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Kawasaki Concours 14	-0.4437	0.2548	-0.2069	0.5585	-0.6506	0.6139	0.5217	0.2893
Kawasaki Vulcan 1700 Voyager	-1.2832	0.3676	-4.6181	1.6921	-5.9012	1.7316	0.0027	0.0007
Suzuki Bandit 1250	-1.0944	0.5082	-0.5156	0.6940	-1.6099	0.8602	0.1999	0.0613
Suzuki Burgman 650	-0.8989	0.4549	-0.5206	1.3030	-1.4195	1.3801	0.2418	0.3037
Suzuki SV650	-1.0359	0.3117	-0.1102	0.5800	-1.1461	0.6585	0.3179	0.0818
Vehicle age	-0.1090	0.0288	-0.0069	0.0544	-0.1159	0.0616	0.8906	0.0598
Rated driver age								
Unknown	0.5000	0.2117	-0.8528	0.4066	-0.3528	0.4584	0.7027	0.4415
14-24	1.3611	0.3113	-0.7432	0.6673	0.6179	0.7364	1.8551	0.4014
25-39	0.3364	0.1669	-0.6962	0.3955	-0.3598	0.4292	0.6978	0.4019
40-64	0	0	0	0	0	0	1	
65+	0.3955	0.1162	-0.2606	0.2271	0.1349	0.2551	1.1444	0.5971
Rated driver gender								
Female	0.1376	0.2036	0.2105	0.5107	0.3481	0.5498	1.4164	0.5266
Male	0	0	0	0	0	0	1	
Unknown	-0.3237	0.2828	-0.3177	0.5607	-0.6414	0.6280	0.5266	0.3071
Rated Driver Marital								
Married	0	0	0	0	0	0	1	
Single	0.1667	0.1315	0.6286	0.2501	0.7954	0.2825	2.2153	0.0049
Unknown	-0.0433	0.2772	0.5589	0.5324	0.5155	0.6003	1.6746	0.3904
Risk								
Non standard	-0.7334	0.1185	-0.3214	0.2114	-1.0548	0.2423	0.3483	<0.0001
Standard	0	0	0	0	0	0	1	
Vehicle density								
0-99	-0.0785	0.1156	0.6471	0.2360	0.5686	0.2628	1.7658	0.0305
100-499	0	0	0	0	0	0	1	
500+	0.3060	0.1117	0.5113	0.2452	0.8173	0.2694	2.2643	0.0024
State								
Tennessee	-2.0156	0.5951	0.2495	0.7836	-1.7661	0.9840	0.1710	0.0727
Massachusetts	-1.5990	0.5490	-0.7096	1.3099	-2.3086	1.4203	0.0994	0.1041
Colorado	-1.4949	0.5191	0.6311	0.8792	-0.8638	1.0210	0.4216	0.3975
California	0	0	0	0	0	0	1	
Maine	0.3586	0.5960	-3.7235	1.1998	-3.3649	1.3397	0.0346	0.0120
Idaho	0.5766	0.4344	-0.3157	0.9364	0.2609	1.0323	1.2981	0.8005
D.C.	1.2561	0.7241	-2.5014	1.2242	-1.2453	1.4224	0.2879	0.3813
Calendar year								
2003	-9.6128	244.3235						
2004	-0.8512	1.0118	1.9195	1.5555	1.0683	1.8556	2.9103	0.5648
2005	-0.1580	0.3441	-2.7326	0.9166	-2.8905	0.9790	0.0555	0.0032
2006	-0.0059	0.2242	0.3198	0.5135	0.3139	0.5603	1.3688	0.5753
2007	0.0883	0.1616	-0.0818	0.3181	0.0065	0.3568	1.0065	0.9855
2008	0.1650	0.1374	0.0477	0.2757	0.2127	0.3080	1.2370	0.4898
2009	-0.0243	0.1354	-0.5587	0.2778	-0.5831	0.3090	0.5582	0.0592
2010	0	0	0	0	0	0	1	
2011	0.0653	0.1630	-0.0736	0.3580	-0.0083	0.3933	0.9917	0.9832

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Appendix A : Distribution of exposure for independent variables, collision coverage

Make/series	Exposue with ABS	Percent of series	Exposure without ABS	Percent of series
Aprilia Mana 850	46	15%	256	85%
Aprilia Scarabeo 500	574	53%	517	47%
Honda CBR1000RR	196	9%	2,068	91%
Honda CBR600RR	446	8%	5,129	92%
Honda Gold Wing	38,004	21%	138,760	79%
Honda Interceptor 800	3,045	25%	9,284	75%
Honda NT700V	131	20%	510	80%
Honda Reflex	1,752	13%	11,233	87%
Honda Silver Wing	2,531	17%	12,588	83%
Honda ST1300	6,709	36%	11,905	64%
Kawasaki Concours 14	5,519	54%	4,780	46%
Kawasaki Vulcan 1700 Voyager	1,164	66%	590	34%
Suzuki B-King	41	3%	1,349	97%
Suzuki Bandit 1250	778	23%	2,671	77%
Suzuki Burgman 400	42	8%	485	92%
Suzuki Burgman 650	4,072	25%	12,089	75%
Suzuki SV650	540	6%	8,326	94%
Suzuki V-Strom 650	1,782	19%	7,648	81%
Triumph Sprint ST	1,934	38%	3,145	62%
Triumph Tiger	1,210	25%	3,600	75%
Victory Vision	105	3%	4,053	97%
Yamaha FJR1300	8,137	50%	8,020	50%
Total	**78,759**	**24%**	**249,006**	**76%**

Appendix A : Distribution of exposure for independent variables, collision coverage

	Exposure	Percent of total
Vehicle age		
0	27,264	8%
1	55,486	17%
2	63,253	19%
3	57,336	17%
4	44,616	14%
5	34,251	10%
6	24,305	7%

Appendix A : Distribution of exposure for independent variables, collision coverage		
	Exposure	Percent of total
7	14,171	4%
8	7,084	2%
Rated driver age		
Unknown	18,870	6%
14-24	3,354	1%
25-39	33,622	10%
40-64	223,425	68%
65+	48,494	15%
Rated driver gender		
Female	9,684	7%
Male	83,269	56%
Unknown	55,947	38%
Rated driver marital status		
Married	142,810	44%
Single	40,498	12%
Unknown	144,457	44%
Risk		
Non Standard	94,847	29%
Standard	232,918	71%
Deductible		
0-100	14,340	4%
101-250	90,205	28%
251-500	182,949	56%
501+	40,271	12%
Vehicle density		
0-99	101,223	31%
100-499	132,509	40%
500+	94,033	29%
Calendar year		
2003	713	0%
2004	2,729	1%
2005	7,000	2%
2006	16,103	5%
2007	36,039	11%
2008	53,261	16%
2009	65,427	20%
2010	73,622	22%
2011	72,870	22%
State		
Alabama	7,315	2%
Alaska	995	0%
Arizona	7,581	2%
Arkansas	4,768	1%
California	28,085	9%
Colorado	10,337	3%
Connecticut	1,956	1%
D.C.	258	0%

Appendix A : Distribution of exposure for independent variables, collision coverage		
	Exposure	Percent of total
Delaware	697	0%
Florida	22,746	7%
Georgia	9,830	3%
Hawaii	583	0%
Idaho	2,084	1%
Illinois	17,729	5%
Indiana	8,195	3%
Iowa	4,439	1%
Kansas	4,889	1%
Kentucky	3,813	1%
Louisiana	5,414	2%
Maine	1,073	0%
Maryland	4,456	1%
Massachusetts	5,352	2%
Michigan	6,390	2%
Minnesota	14,010	4%
Mississippi	3,586	1%
Missouri	8,529	3%
Montana	1,362	0%
Nebraska	2,426	1%
Nevada	2,471	1%
New Hampshire	1,324	0%
New Jersey	4,371	1%
New Mexico	3,943	1%
New York	6,427	2%
North Carolina	7,005	2%
North Dakota	1,072	0%
Ohio	13,683	4%
Oklahoma	7,331	2%
Oregon	6,419	2%
Pennsylvania	10,464	3%
Rhode Island	397	0%
South Carolina	4,388	1%
South Dakota	1,848	1%
Tennessee	10,207	3%
Texas	18,718	6%
Utah	3,406	1%
Vermont	610	0%
Virginia	8,143	2%
Washington	10,132	3%
West Virginia	2,928	1%
Wisconsin	12,401	4%
Wyoming	1,180	0%

Appendix B : Detailed regression results of collision claim frequencies by state

Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Alabama	-0.2766	0.7584	0.0900	9.44	0.0021
Alaska	-0.3027	0.7388	0.2265	1.79	0.1813
Arizona	-0.1836	0.8323	0.0837	4.82	0.0282
Arkansas	-0.1344	0.8742	0.1040	1.67	0.1961
California	0	1	0		
Colorado	-0.4092	0.6642	0.0784	27.27	<0.0001
Connecticut	-0.4844	0.6161	0.1484	10.66	0.0011
D.C.	-0.1846	0.8314	0.3186	0.34	0.5622
Delaware	-1.0476	0.3508	0.3351	9.77	0.0018
Florida	-0.2944	0.7450	0.0551	28.56	<0.0001
Georgia	-0.1066	0.8989	0.0688	2.40	0.1214
Hawaii	-0.4447	0.6410	0.1899	5.48	0.0192
Idaho	-0.3911	0.6763	0.1602	5.96	0.0146
Illinois	-0.3563	0.7003	0.0623	32.66	<0.0001
Indiana	-0.3331	0.7167	0.0849	15.40	<0.0001
Iowa	-0.5245	0.5919	0.1189	19.46	<0.0001
Kansas	-0.3615	0.6966	0.1045	11.98	0.0005
Kentucky	-0.4174	0.6588	0.1244	11.25	0.0008
Louisiana	0.0001	1.0001	0.0901	0.00	0.9991
Maine	-0.6947	0.4992	0.2451	8.03	0.0046
Maryland	-0.2144	0.8070	0.0913	5.52	0.0188
Massachusetts	-0.5192	0.5950	0.1086	22.86	<0.0001
Michigan	-0.1853	0.8309	0.0825	5.05	0.0247
Minnesota	-0.5343	0.5861	0.0755	50.11	<0.0001
Mississippi	-0.1618	0.8506	0.1208	1.79	0.1805
Missouri	-0.4075	0.6653	0.0843	23.39	<0.0001
Montana	-0.4151	0.6603	0.2171	3.66	0.0558
Nebraska	-0.2933	0.7458	0.1359	4.66	0.0309
Nevada	-0.4647	0.6283	0.1517	9.38	0.0022
New Hampshire	-0.0594	0.9423	0.1567	0.14	0.7045
New Jersey	-0.3677	0.6923	0.1062	11.99	0.0005
New Mexico	-0.2666	0.7660	0.1126	5.61	0.0179
New York	-0.2803	0.7556	0.0824	11.57	0.0007
North Carolina	-0.3481	0.7060	0.0858	16.48	<0.0001
North Dakota	-0.6009	0.5483	0.2462	5.96	0.0147
Ohio	-0.5586	0.5720	0.0718	60.54	<0.0001
Oklahoma	-0.5241	0.5921	0.0968	29.34	<0.0001
Oregon	-0.4025	0.6686	0.0936	18.49	<0.0001
Pennsylvania	-0.4742	0.6224	0.0740	41.07	<0.0001
Rhode Island	-0.6108	0.5429	0.3797	2.59	0.1078
South Carolina	-0.3526	0.7029	0.1136	9.64	0.0019
South Dakota	-0.3451	0.7081	0.1812	3.63	0.0569
Tennessee	-0.1669	0.8463	0.0738	5.11	0.0238
Texas	-0.0245	0.9758	0.0544	0.20	0.6533
Utah	-0.3139	0.7306	0.1154	7.40	0.0065
Vermont	-0.0877	0.9160	0.2323	0.14	0.7058
Virginia	-0.4072	0.6655	0.0791	26.53	<0.0001

Appendix B : Detailed regression results of collision claim frequencies by state

Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Washington	-0.2431	0.7842	0.0715	11.55	0.0007
West Virginia	-0.5926	0.5529	0.1504	15.52	<0.0001
Wisconsin	-0.7049	0.4942	0.0814	75.06	<0.0001
Wyoming	-0.3727	0.6889	0.2221	2.82	0.0933

Appendix C : Detailed regression results of collision claim severities by state

Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Alabama	-0.0455	0.9555	0.0727	0.39	0.5311
Alaska	-0.1194	0.8875	0.1803	0.44	0.5078
Arizona	-0.0014	0.9986	0.0680	0.00	0.9839
Arkansas	-0.0713	0.9312	0.0840	0.72	0.3959
California	0	1	0		
Colorado	-0.0833	0.9201	0.0627	1.77	0.1839
Connecticut	0.0161	1.0162	0.1195	0.02	0.8928
D.C.	0.1983	1.2193	0.2530	0.61	0.4331
Delaware	-0.4466	0.6398	0.2666	2.81	0.0939
Florida	-0.1732	0.8410	0.0454	14.57	0.0001
Georgia	-0.0869	0.9168	0.0560	2.40	0.1212
Hawaii	0.0417	1.0426	0.1536	0.07	0.7859
Idaho	-0.1559	0.8556	0.1273	1.50	0.2209
Illinois	-0.1483	0.8622	0.0510	8.44	0.0037
Indiana	-0.1683	0.8451	0.0691	5.93	0.0149
Iowa	-0.0703	0.9321	0.0956	0.54	0.4620
Kansas	-0.0975	0.9071	0.0848	1.32	0.2503
Kentucky	-0.1232	0.8841	0.0991	1.55	0.2136
Louisiana	-0.0686	0.9337	0.0719	0.91	0.3401
Maine	-0.0221	0.9781	0.1953	0.01	0.9100
Maryland	-0.0683	0.9340	0.0748	0.83	0.3610
Massachusetts	-0.3195	0.7265	0.0957	11.15	0.0008
Michigan	-0.0337	0.9669	0.0676	0.25	0.6181
Minnesota	-0.1215	0.8856	0.0614	3.92	0.0477
Mississippi	-0.1644	0.8484	0.0968	2.88	0.0896
Missouri	-0.0698	0.9326	0.0679	1.06	0.3037
Montana	-0.1905	0.8265	0.1724	1.22	0.2692
Nebraska	-0.3017	0.7396	0.1094	7.61	0.0058
Nevada	0.0121	1.0122	0.1232	0.01	0.9220
New Hampshire	-0.4222	0.6556	0.1260	11.23	0.0008
New Jersey	-0.0417	0.9592	0.0856	0.24	0.6265
New Mexico	-0.1437	0.8661	0.0905	2.52	0.1123
New York	-0.1594	0.8527	0.0667	5.70	0.0169
North Carolina	-0.1722	0.8418	0.0689	6.24	0.0125

Appendix C : Detailed regression results of collision claim severities by state

Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
North Dakota	-0.2533	0.7762	0.1960	1.67	0.1963
Ohio	-0.0958	0.9086	0.0578	2.75	0.0973
Oklahoma	-0.0042	0.9958	0.0785	0.00	0.9572
Oregon	-0.1315	0.8768	0.0754	3.04	0.0811
Pennsylvania	-0.1320	0.8763	0.0600	4.84	0.0278
Rhode Island	-0.2158	0.8059	0.3017	0.51	0.4745
South Carolina	-0.1752	0.8393	0.0911	3.70	0.0544
South Dakota	-0.1953	0.8226	0.1447	1.82	0.1769
Tennessee	-0.1720	0.8420	0.0595	8.35	0.0039
Texas	0.0000	1.0000	0.0451	0.00	1.0000
Utah	0.1859	1.2043	0.0926	4.03	0.0446
Vermont	-0.3269	0.7212	0.1843	3.15	0.0761
Virginia	-0.2027	0.8165	0.0639	10.05	0.0015
Washington	0.0193	1.0195	0.0575	0.11	0.7374
West Virginia	-0.2652	0.7671	0.1207	4.83	0.0280
Wisconsin	-0.1687	0.8448	0.0648	6.77	0.0093
Wyoming	-0.0749	0.9278	0.1771	0.18	0.6724

Appendix D : Derived results for collision overall losses by state

	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Alabama	-0.2766	0.0900	-0.0455	0.0727	-0.3221	0.1157	0.7246	0.0054
Alaska	-0.3027	0.2265	-0.1194	0.1803	-0.4221	0.2894	0.6557	0.1447
Arizona	-0.1836	0.0837	-0.0014	0.0680	-0.1850	0.1078	0.8311	0.0861
Arkansas	-0.1344	0.1040	-0.0713	0.0840	-0.2057	0.1337	0.8140	0.1238
California	0	0	0	0	0	0	1	
Colorado	-0.4092	0.0784	-0.0833	0.0627	-0.4925	0.1003	0.6111	<0.0001
Connecticut	-0.4844	0.1484	0.0161	0.1195	-0.4683	0.1905	0.6261	0.0140
D.C.	-0.1846	0.3186	0.1983	0.2530	0.0137	0.4068	1.0138	0.9732
Delaware	-1.0476	0.3351	-0.4466	0.2666	-1.4942	0.4282	0.2244	0.0005
Florida	-0.2944	0.0551	-0.1732	0.0454	-0.4676	0.0714	0.6265	<0.0001
Georgia	-0.1066	0.0688	-0.0869	0.0560	-0.1935	0.0888	0.8241	0.0293
Hawaii	-0.4447	0.1899	0.0417	0.1536	-0.4030	0.2442	0.6683	0.0989
Idaho	-0.3911	0.1602	-0.1559	0.1273	-0.5469	0.2046	0.5787	0.0075
Illinois	-0.3563	0.0623	-0.1483	0.0510	-0.5045	0.0806	0.6038	<0.0001
Indiana	-0.3331	0.0849	-0.1683	0.0691	-0.5014	0.1095	0.6057	<0.0001
Iowa	-0.5245	0.1189	-0.0703	0.0956	-0.5948	0.1526	0.5517	<0.0001
Kansas	-0.3615	0.1045	-0.0975	0.0848	-0.4590	0.1345	0.6319	0.0006
Kentucky	-0.4174	0.1244	-0.1232	0.0991	-0.5407	0.1591	0.5824	0.0007
Louisiana	0.0001	0.0901	-0.0686	0.0719	-0.0685	0.1152	0.9338	0.5525
Maine	-0.6947	0.2451	-0.0221	0.1953	-0.7168	0.3134	0.4883	0.0222
Maryland	-0.2144	0.0913	-0.0683	0.0748	-0.2827	0.1180	0.7537	0.0166
Massachusetts	-0.5192	0.1086	-0.3195	0.0957	-0.8387	0.1447	0.4323	<0.0001
Michigan	-0.1853	0.0825	-0.0337	0.0676	-0.2190	0.1067	0.8033	0.0400
Minnesota	-0.5343	0.0755	-0.1215	0.0614	-0.6558	0.0973	0.5190	<0.0001

Appendix D : Derived results for collision overall losses by state

	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Mississippi	-0.1618	0.1208	-0.1644	0.0968	-0.3262	0.1549	0.7216	0.0351
Missouri	-0.4075	0.0843	-0.0698	0.0679	-0.4773	0.1082	0.6204	<0.0001
Montana	-0.4151	0.2171	-0.1905	0.1724	-0.6056	0.2772	0.5457	0.0289
Nebraska	-0.2933	0.1359	-0.3017	0.1094	-0.5950	0.1744	0.5516	0.0006
Nevada	-0.4647	0.1517	0.0121	0.1232	-0.4526	0.1955	0.6360	0.0206
New Hampshire	-0.0594	0.1567	-0.4222	0.1260	-0.4816	0.2010	0.6178	0.0166
New Jersey	-0.3677	0.1062	-0.0417	0.0856	-0.4093	0.1364	0.6641	0.0027
New Mexico	-0.2666	0.1126	-0.1437	0.0905	-0.4103	0.1444	0.6635	0.0045
New York	-0.2803	0.0824	-0.1594	0.0667	-0.4397	0.1061	0.6442	<0.0001
North Carolina	-0.3481	0.0858	-0.1722	0.0689	-0.5203	0.1100	0.5944	<0.0001
North Dakota	-0.6009	0.2462	-0.2533	0.1960	-0.8542	0.3147	0.4256	0.0066
Ohio	-0.5586	0.0718	-0.0958	0.0578	-0.6544	0.0921	0.5198	<0.0001
Oklahoma	-0.5241	0.0968	-0.0042	0.0785	-0.5283	0.1246	0.5896	<0.0001
Oregon	-0.4025	0.0936	-0.1315	0.0754	-0.5340	0.1202	0.5863	<0.0001
Pennsylvania	-0.4742	0.0740	-0.1320	0.0600	-0.6062	0.0953	0.5454	<0.0001
Rhode Island	-0.6108	0.3797	-0.2158	0.3017	-0.8265	0.4850	0.4376	0.0883
South Carolina	-0.3526	0.1136	-0.1752	0.0911	-0.5278	0.1456	0.5899	0.0003
South Dakota	-0.3451	0.1812	-0.1953	0.1447	-0.5404	0.2319	0.5825	0.0198
Tennessee	-0.1669	0.0738	-0.1720	0.0595	-0.3389	0.0948	0.7126	0.0004
Texas	-0.0245	0.0544	0.0000	0.0451	-0.0244	0.0707	0.9758	0.7293
Utah	-0.3139	0.1154	0.1859	0.0926	-0.1280	0.1480	0.8798	0.3869
Vermont	-0.0877	0.2323	-0.3269	0.1843	-0.4146	0.2965	0.6606	0.1620
Virginia	-0.4072	0.0791	-0.2027	0.0639	-0.6099	0.1017	0.5434	<0.0001
Washington	-0.2431	0.0715	0.0193	0.0575	-0.2238	0.0918	0.7995	0.0148
West Virginia	-0.5926	0.1504	-0.2652	0.1207	-0.8578	0.1929	0.4241	<0.0001
Wisconsin	-0.7049	0.0814	-0.1687	0.0648	-0.8736	0.1040	0.4175	<0.0001
Wyoming	-0.3727	0.2221	-0.0749	0.1771	-0.4476	0.2840	0.6392	0.1150

Appendix E : Distribution of exposure for independent variables, medical payment coverage

Make/series	Exposue with ABS	Percent of series	Exposure without ABS	Percent of series
Aprilia Scarabeo 500	143	51%	137	49%
Honda CBR1000RR	37	9%	354	91%
Honda CBR600RR	86	7%	1,064	93%
Honda Gold Wing	9,464	20%	38,026	80%
Honda Interceptor 800	634	24%	2,047	76%
Honda Reflex	534	12%	3,782	88%
Honda Silver Wing	798	17%	3,895	83%
Honda ST1300	1,454	33%	2,980	67%
Kawasaki Concours 14	1,240	53%	1,102	47%
Kawasaki Vulcan 1700 Voyager	320	73%	118	27%
Suzuki Bandit 1250	206	25%	618	75%
Suzuki Burgman 650	1,162	25%	3,431	75%
Suzuki SV650	117	5%	2,191	95%

Appendix E : Distribution of exposure for independent variables, medical payment coverage				
Make/series	Exposue with ABS	Percent of series	Exposure without ABS	Percent of series
Suzuki V-Strom 650	422	18%	1,895	82%
Triumph Sprint ST	502	39%	772	61%
Triumph Tiger	257	22%	890	78%
Victory Vision	25	2%	1,194	98%
Yamaha FJR1300	1,935	50%	1,938	50%
Total	**19,335**	**23%**	**66,433**	**77%**

Appendix E : Distribution of exposure for independent variables, medical payment coverage		
	Exposure	Percent of total
Vehicle age		
0	6,459	8%
1	13,664	16%
2	16,126	19%
3	14,936	17%
4	12,067	14%
5	9,637	11%
6	6,889	8%
7	4,110	5%
8	1,880	2%
Rated driver age		
Unknown	8,317	10%
14-24	934	1%
25-39	7,407	9%
40-64	55,544	65%
65+	13,564	16%
Rated driver gender		
Female	4,653	5%
Male	54,835	64%
Unknown	26,279	31%
Rated driver marital status		
Married	43,244	50%
Single	10,757	13%
Unknown	31,767	37%
Risk		
Non Standard	25,446	30%
Standard	60,322	70%
Vehicle density		
0-99	29,087	34%
100-499	34,219	40%
500+	22,461	26%
Calendar year		
2003	1	0%
2004	307	0%
2005	1,630	2%

Appendix E : Distribution of exposure for independent variables, medical payment coverage		
	Exposure	Percent of total
2006	3,996	5%
2007	9,038	11%
2008	14,681	17%
2009	18,311	21%
2010	20,888	24%
2011	16,915	20%
State		
Alabama	1,730	2%
Alaska	220	0%
Arizona	1,087	1%
Arkansas	1,593	2%
California	5,511	6%
Colorado	1,536	2%
Connecticut	442	1%
D.C.	22	0%
Delaware	186	0%
Florida	2,646	3%
Georgia	1,549	2%
Hawaii	103	0%
Idaho	585	1%
Illinois	10,435	12%
Indiana	5,216	6%
Iowa	2,880	3%
Kansas	450	1%
Kentucky	135	0%
Louisiana	779	1%
Maine	1,079	1%
Maryland	570	1%
Massachusetts	2,876	3%
Michigan	2,147	3%
Minnesota	2,925	3%
Mississippi	789	1%
Missouri	4,353	5%
Montana	375	0%
Nebraska	1,616	2%
Nevada	543	1%
New Hampshire	1,045	1%
New Jersey	1,076	1%
New Mexico	913	1%
New York	1,376	2%
North Carolina	280	0%
North Dakota	405	0%
Ohio	3,343	4%
Oklahoma	1,140	1%
Oregon	1,332	2%
Pennsylvania	1,173	1%
Rhode Island	241	0%

Appendix E : Distribution of exposure for independent variables, medical payment coverage		
	Exposure	Percent of total
South Carolina	683	1%
South Dakota	1,075	1%
Tennessee	1,577	2%
Texas	2,165	3%
Utah	806	1%
Vermont	202	0%
Virginia	1,750	2%
Washington	1,714	2%
West Virginia	488	1%
Wisconsin	8,298	10%
Wyoming	310	0%

Appendix F : Detailed regression results of medical payment claim frequencies by state					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Alabama	-0.2607	0.7705	0.2682	0.94	0.3311
Alaska	0.4822	1.6196	0.5155	0.87	0.3496
Arizona	0.3625	1.4368	0.2561	2.00	0.1570
Arkansas	0.0566	1.0582	0.2311	0.06	0.8065
California	0	1	0		
Colorado	-0.1065	0.8989	0.2544	0.18	0.6753
Connecticut	0.3283	1.3886	0.3362	0.95	0.3289
D.C.	0.7908	2.2051	1.0098	0.61	0.4336
Delaware	-0.9852	0.3734	1.0072	0.96	0.3280
Florida	0.0416	1.0425	0.1987	0.04	0.8341
Georgia	0.1270	1.1354	0.2284	0.31	0.5781
Hawaii	0.0934	1.0979	0.5194	0.03	0.8572
Idaho	0.0592	1.0610	0.3526	0.03	0.8666
Illinois	-0.1468	0.8635	0.1459	1.01	0.3144
Indiana	-0.0305	0.9700	0.1653	0.03	0.8537
Iowa	-0.0617	0.9402	0.1961	0.10	0.7531
Kansas	-0.2302	0.7944	0.4617	0.25	0.6181
Kentucky	-0.4862	0.6150	1.0077	0.23	0.6295
Louisiana	-0.1848	0.8312	0.3724	0.25	0.6196
Maine	-0.5222	0.5932	0.3238	2.60	0.1067
Maryland	0.1098	1.1160	0.3216	0.12	0.7328
Massachusetts	-0.3541	0.7018	0.1962	3.26	0.0711
Michigan	0.1017	1.1070	0.1910	0.28	0.5945
Minnesota	-0.4840	0.6163	0.2284	4.49	0.0341
Mississippi	0.5490	1.7315	0.2789	3.87	0.0490
Missouri	-0.1801	0.8351	0.1754	1.05	0.3045
Montana	-0.0864	0.9172	0.5159	0.03	0.8670
Nebraska	-0.5004	0.6063	0.2711	3.41	0.0649
Nevada	0.2224	1.2490	0.3533	0.40	0.5291
New Hampshire	-0.0390	0.9618	0.2585	0.02	0.8802
New Jersey	-0.2563	0.7739	0.2896	0.78	0.3762
New Mexico	0.2731	1.3141	0.2829	0.93	0.3344
New York	-0.1572	0.8545	0.2447	0.41	0.5205

Appendix F : Detailed regression results of medical payment claim frequencies by state

Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
North Carolina	-0.0706	0.9318	0.4659	0.02	0.8796
North Dakota	-1.1441	0.3185	0.7204	2.52	0.1123
Ohio	-0.4281	0.6517	0.2099	4.16	0.0413
Oklahoma	-0.1051	0.9002	0.3009	0.12	0.7269
Oregon	0.1925	1.2122	0.2416	0.63	0.4257
Pennsylvania	-0.2063	0.8136	0.2747	0.56	0.4526
Rhode Island	-1.3608	0.2565	1.0067	1.83	0.1764
South Carolina	-0.2829	0.7536	0.3951	0.51	0.4739
South Dakota	0.0555	1.0571	0.2898	0.04	0.8480
Tennessee	0.2180	1.2436	0.2227	0.96	0.3277
Texas	0.1655	1.1799	0.2061	0.64	0.4220
Utah	0.3140	1.3689	0.2676	1.38	0.2407
Vermont	0.6791	1.9721	0.4259	2.54	0.1108
Virginia	-0.1176	0.8890	0.2176	0.29	0.5889
Washington	-0.0299	0.9705	0.2359	0.02	0.8991
West Virginia	-0.3612	0.6968	0.5149	0.49	0.4829
Wisconsin	-0.3840	0.6811	0.1635	5.52	0.0188
Wyoming	-0.5681	0.5666	0.7182	0.63	0.4290

Appendix G : Detailed regression results of medical payment claim severities by state

Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Alabama	-0.2395	0.7870	0.2454	0.95	0.3291
Alaska	-0.3143	0.7303	0.5180	0.37	0.5440
Arizona	0.3630	1.4376	0.2523	2.07	0.1502
Arkansas	1.5181	4.5634	0.2514	36.45	<0.0001
California	0	1	0		
Colorado	0.1994	1.2206	0.2531	0.62	0.4309
Connecticut	0.0771	1.0802	0.3064	0.06	0.8013
D.C.	-0.7583	0.4685	0.8693	0.76	0.3830
Delaware	-0.1010	0.9039	0.9002	0.01	0.9107
Florida	0.3684	1.4454	0.1840	4.01	0.0452
Georgia	-0.2337	0.7916	0.2422	0.93	0.3347
Hawaii	1.1562	3.1777	0.5300	4.76	0.0292
Idaho	-0.1760	0.8386	0.3155	0.31	0.5769
Illinois	0.2486	1.2822	0.1559	2.54	0.1107
Indiana	0.1955	1.2159	0.1683	1.35	0.2454
Iowa	0.2446	1.2771	0.1911	1.64	0.2005
Kansas	-0.7948	0.4517	0.4057	3.84	0.0501
Kentucky	0.0134	1.0135	0.8872	0.00	0.9879
Louisiana	0.0246	1.0249	0.3319	0.01	0.9410
Maine	0.2604	1.2975	0.3065	0.72	0.3954
Maryland	-0.0626	0.9393	0.3140	0.04	0.8420
Massachusetts	-0.0861	0.9175	0.1991	0.19	0.6656
Michigan	0.6512	1.9179	0.2118	9.45	0.0021
Minnesota	-0.0048	0.9952	0.2242	0.00	0.9829
Mississippi	-0.3642	0.6947	0.2497	2.13	0.1446

Appendix G : Detailed regression results of medical payment claim severities by state					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Missouri	0.0465	1.0476	0.1797	0.07	0.7957
Montana	0.0962	1.1010	0.4764	0.04	0.8400
Nebraska	0.6217	1.8621	0.2787	4.98	0.0257
Nevada	0.2068	1.2298	0.3551	0.34	0.5603
New Hampshire	-0.0200	0.9802	0.2708	0.01	0.9410
New Jersey	0.7758	2.1724	0.2728	8.09	0.0045
New Mexico	0.2888	1.3349	0.2825	1.05	0.3065
New York	-0.5325	0.5871	0.2639	4.07	0.0436
North Carolina	0.4174	1.5180	0.5140	0.66	0.4167
North Dakota	0.4251	1.5297	0.6464	0.43	0.5108
Ohio	0.3965	1.4866	0.2036	3.79	0.0514
Oklahoma	0.3484	1.4168	0.3023	1.33	0.2490
Oregon	0.2966	1.3453	0.2266	1.71	0.1904
Pennsylvania	-0.1018	0.9032	0.2662	0.15	0.7022
Rhode Island	0.3369	1.4006	0.8849	0.14	0.7034
South Carolina	-0.1050	0.9003	0.3565	0.09	0.7683
South Dakota	0.3187	1.3753	0.2778	1.32	0.2513
Tennessee	0.0219	1.0222	0.2244	0.01	0.9222
Texas	0.3028	1.3537	0.2125	2.03	0.1541
Utah	-0.4096	0.6639	0.2644	2.40	0.1214
Vermont	0.1809	1.1983	0.4127	0.19	0.6611
Virginia	0.2490	1.2827	0.2227	1.25	0.2636
Washington	0.1827	1.2004	0.2206	0.69	0.4076
West Virginia	0.2783	1.3209	0.5124	0.30	0.5870
Wisconsin	0.7033	2.0204	0.1678	17.56	<0.0001
Wyoming	0.9329	2.5418	0.8698	1.15	0.2835

Appendix H : Derived results for medical payment overall losses by state								
	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Alabama	-0.2607	0.2682	-0.2395	0.2454	-0.5002	0.3635	0.6064	0.1689
Alaska	0.4822	0.5155	-0.3143	0.5180	0.1679	0.7308	1.1828	0.8183
Arizona	0.3625	0.2561	0.3630	0.2523	0.7254	0.3595	2.0656	0.0436
Arkansas	0.0566	0.2311	1.5181	0.2514	1.5747	0.3415	4.8292	<0.0001
California	0	0	0	0	0	0	1	
Colorado	-0.1065	0.2544	0.1994	0.2531	0.0928	0.3589	1.0973	0.7959
Connecticut	0.3283	0.3362	0.0771	0.3064	0.4054	0.4549	1.4999	0.3728
D.C.	0.7908	1.0098	-0.7583	0.8693	0.0325	1.3324	1.0330	0.9806
Delaware	-0.9852	1.0072	-0.1010	0.9002	-1.0862	1.3509	0.3375	0.4213
Florida	0.0416	0.1987	0.3684	0.1840	0.4100	0.2708	1.5068	0.1300
Georgia	0.1270	0.2284	-0.2337	0.2422	-0.1067	0.3329	0.8988	0.7487
Hawaii	0.0934	0.5194	1.1562	0.5300	1.2496	0.7421	3.4889	0.0922
Idaho	0.0592	0.3526	-0.1760	0.3155	-0.1168	0.4732	0.8898	0.8050
Illinois	-0.1468	0.1459	0.2486	0.1559	0.1018	0.2135	1.1072	0.6335
Indiana	-0.0305	0.1653	0.1955	0.1683	0.1650	0.2359	1.1794	0.4842
Iowa	-0.0617	0.1961	0.2446	0.1911	0.1829	0.2738	1.2007	0.5041

Appendix H : Derived results for medical payment overall losses by state

	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Kansas	-0.2302	0.4617	-0.7948	0.4057	-1.0250	0.6146	0.3588	0.0954
Kentucky	-0.4862	1.0077	0.0134	0.8872	-0.4727	1.3426	0.6233	0.7248
Louisiana	-0.1848	0.3724	0.0246	0.3319	-0.1603	0.4988	0.8519	0.7480
Maine	-0.5222	0.3238	0.2604	0.3065	-0.2618	0.4458	0.7697	0.5571
Maryland	0.1098	0.3216	-0.0626	0.3140	0.0472	0.4495	1.0483	0.9164
Massachusetts	-0.3541	0.1962	-0.0861	0.1991	-0.4401	0.2795	0.6440	0.1154
Michigan	0.1017	0.1910	0.6512	0.2118	0.7529	0.2852	2.1231	0.0083
Minnesota	-0.4840	0.2284	-0.0048	0.2242	-0.4888	0.3200	0.6134	0.1267
Mississippi	0.5490	0.2789	-0.3642	0.2497	0.1848	0.3743	1.2029	0.6216
Missouri	-0.1801	0.1754	0.0465	0.1797	-0.1336	0.2511	0.8749	0.5946
Montana	-0.0864	0.5159	0.0962	0.4764	0.0098	0.7023	1.0099	0.9889
Nebraska	-0.5004	0.2711	0.6217	0.2787	0.1213	0.3888	1.1290	0.7551
Nevada	0.2224	0.3533	0.2068	0.3551	0.4292	0.5009	1.5360	0.3915
New Hampshire	-0.0390	0.2585	-0.0200	0.2708	-0.0590	0.3744	0.9427	0.8748
New Jersey	-0.2563	0.2896	0.7758	0.2728	0.5196	0.3979	1.6813	0.1916
New Mexico	0.2731	0.2829	0.2888	0.2825	0.5620	0.3998	1.7541	0.1598
New York	-0.1572	0.2447	-0.5325	0.2639	-0.6897	0.3599	0.5017	0.0553
North Carolina	-0.0706	0.4659	0.4174	0.5140	0.3468	0.6937	1.4146	0.6171
North Dakota	-1.1441	0.7204	0.4251	0.6464	-0.7190	0.9679	0.4872	0.4576
Ohio	-0.4281	0.2099	0.3965	0.2036	-0.0316	0.2924	0.9689	0.9138
Oklahoma	-0.1051	0.3009	0.3484	0.3023	0.2433	0.4265	1.2755	0.5683
Oregon	0.1925	0.2416	0.2966	0.2266	0.4891	0.3312	1.6308	0.1398
Pennsylvania	-0.2063	0.2747	-0.1018	0.2662	-0.3081	0.3825	0.7348	0.4206
Rhode Island	-1.3608	1.0067	0.3369	0.8849	-1.0239	1.3403	0.3592	0.4449
South Carolina	-0.2829	0.3951	-0.1050	0.3565	-0.3880	0.5322	0.6784	0.4660
South Dakota	0.0555	0.2898	0.3187	0.2778	0.3742	0.4014	1.4539	0.3512
Tennessee	0.2180	0.2227	0.0219	0.2244	0.2399	0.3162	1.2712	0.4479
Texas	0.1655	0.2061	0.3028	0.2125	0.4683	0.2960	1.5972	0.1136
Utah	0.3140	0.2676	-0.4096	0.2644	-0.0956	0.3762	0.9088	0.7994
Vermont	0.6791	0.4259	0.1809	0.4127	0.8600	0.5930	2.3632	0.1470
Virginia	-0.1176	0.2176	0.2490	0.2227	0.1314	0.3114	1.1404	0.6731
Washington	-0.0299	0.2359	0.1827	0.2206	0.1528	0.3230	1.1651	0.6362
West Virginia	-0.3612	0.5149	0.2783	0.5124	-0.0829	0.7264	0.9205	0.9092
Wisconsin	-0.3840	0.1635	0.7033	0.1678	0.3193	0.2343	1.3762	0.1729
Wyoming	-0.5681	0.7182	0.9329	0.8698	0.3648	1.1280	1.4402	0.7464

Appendix I : Distribution of exposure for independent variables, bodily injury liability coverage

Make/series	Exposue with ABS	Percent of series	Exposure without ABS	Percent of series
Honda Gold Wing	34,339	21%	126,511	79%
Honda Interceptor 800	3,355	25%	10,327	75%
Honda Reflex	1,885	13%	12,714	87%
Honda Silver Wing	2,624	16%	13,483	84%
Honda ST1300	6,503	36%	11,813	64%
Kawasaki Concours 14	4,825	51%	4,636	49%
Suzuki Bandit 1250	847	22%	3,026	78%

Appendix I : Distribution of exposure for independent variables, bodily injury liability coverage				
Make/series	Exposue with ABS	Percent of series	Exposure without ABS	Percent of series
Suzuki Burgman 650	3,904	23%	12,853	77%
Suzuki SV650	613	6%	9,890	94%
Suzuki V-Strom 650	1,671	17%	8,444	83%
Triumph Sprint ST	1,875	37%	3,136	63%
Triumph Tiger	1,122	23%	3,735	77%
Yamaha FJR1300	8,243	49%	8,434	51%
Total	**71,806**	**24%**	**229,003**	**76%**

Appendix I : Distribution of exposure for independent variables, bodily injury liability coverage		
	Exposure	Percent of total
Vehicle age		
0	23,012	8%
1	47,800	16%
2	57,535	19%
3	53,655	18%
4	44,003	15%
5	34,098	11%
6	23,126	8%
7	13,126	4%
8	4,453	1%
Rated driver age		
Unknown	19,440	6%
14-24	2,660	1%
25-39	29,400	10%
40-64	202,951	67%
65+	46,359	15%
Rated driver gender		
Female	13,705	5%
Male	165,035	55%
Unknown	122,070	41%
Rated driver marital status		
Married	130,375	43%
Single	38,381	13%
Unknown	132,053	44%
Risk		
Non Standard	91,726	30%
Standard	209,084	70%
Vehicle density		
0-99	92,754	31%
100-499	121,506	40%
500+	86,550	29%
Calendar year		
2003	86	0%
2004	1,304	0%
2005	5,687	2%

Appendix I : Distribution of exposure for independent variables, bodily injury liability coverage		
	Exposure	Percent of total
2006	14,697	5%
2007	36,312	12%
2008	57,824	19%
2009	69,697	23%
2010	75,911	25%
2011	39,291	13%
State		
Alabama	6,833	2%
Alaska	902	0%
Arizona	6,792	2%
Arkansas	4,375	1%
California	26,558	9%
Colorado	8,786	3%
Connecticut	1,868	1%
D.C.	264	0%
Delaware	638	0%
Florida	20,682	7%
Georgia	9,026	3%
Hawaii	520	0%
Idaho	1,884	1%
Illinois	15,280	5%
Indiana	7,101	2%
Iowa	3,850	1%
Kansas	4,196	1%
Kentucky	3,711	1%
Louisiana	5,145	2%
Maine	947	0%
Maryland	4,137	1%
Massachusetts	6,350	2%
Michigan	5,634	2%
Minnesota	11,591	4%
Mississippi	3,353	1%
Missouri	7,542	3%
Montana	1,114	0%
Nebraska	2,015	1%
Nevada	2,032	1%
New Hampshire	1,137	0%
New Jersey	4,302	1%
New Mexico	3,566	1%
New York	6,458	2%
North Carolina	8,690	3%
North Dakota	881	0%
Ohio	12,288	4%
Oklahoma	6,133	2%
Oregon	5,686	2%
Pennsylvania	9,828	3%
Rhode Island	401	0%

Appendix I : Distribution of exposure for independent variables, bodily injury liability coverage		
	Exposure	Percent of total
South Carolina	4,337	1%
South Dakota	1,622	1%
Tennessee	9,614	3%
Texas	18,411	6%
Utah	2,812	1%
Vermont	542	0%
Virginia	7,493	2%
Washington	8,930	3%
West Virginia	2,733	1%
Wisconsin	10,784	4%
Wyoming	1,035	0%

Appendix J : Detailed regression results of bodily injury liability claim frequencies by state					
Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Alabama	-1.3294	0.2646	0.5214	6.50	0.0108
Alaska	0.3031	1.3540	0.7226	0.18	0.6749
Arizona	0.0558	1.0573	0.3052	0.03	0.8550
Arkansas	-0.4747	0.6221	0.4367	1.18	0.2771
California	0	1	0		
Colorado	-1.4949	0.2243	0.5191	8.29	0.0040
Connecticut	-0.0590	0.9427	0.5200	0.01	0.9097
D.C.	1.2561	3.5118	0.7241	3.01	0.0828
Delaware	-9.9232	0.0000	104.7228	0.01	0.9245
Florida	-0.5912	0.5536	0.2384	6.15	0.0132
Georgia	-0.2376	0.7885	0.2873	0.68	0.4083
Hawaii	-9.2719	0.0001	108.4858	0.01	0.9319
Idaho	0.5766	1.7800	0.4344	1.76	0.1843
Illinois	-0.4079	0.6651	0.2496	2.67	0.1023
Indiana	-0.3426	0.7099	0.3241	1.12	0.2904
Iowa	-1.0359	0.3549	0.5971	3.01	0.0828
Kansas	-0.8294	0.4363	0.5206	2.54	0.1111
Kentucky	-0.1644	0.8484	0.4054	0.16	0.6852
Louisiana	0.1356	1.1452	0.3151	0.19	0.6670
Maine	0.3586	1.4314	0.5960	0.36	0.5474
Maryland	-0.4298	0.6506	0.4323	0.99	0.3201
Massachusetts	-1.5990	0.2021	0.5490	8.48	0.0036
Michigan	-0.6408	0.5269	0.3812	2.83	0.0927
Minnesota	-0.5613	0.5705	0.2964	3.59	0.0583
Mississippi	-0.1935	0.8241	0.4744	0.17	0.6833
Missouri	-0.0832	0.9201	0.2968	0.08	0.7792
Montana	0.2244	1.2516	0.6004	0.14	0.7086
Nebraska	-0.8530	0.4261	0.7222	1.40	0.2375
Nevada	0.1546	1.1672	0.4707	0.11	0.7425
New Hampshire	-1.0125	0.3633	1.0111	1.00	0.3167
New Jersey	-0.0332	0.9674	0.3337	0.01	0.9208
New Mexico	-0.5440	0.5804	0.5220	1.09	0.2974

Appendix J : Detailed regression results of bodily injury liability claim frequencies by state

Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
New York	-0.2353	0.7904	0.3200	0.54	0.4622
North Carolina	-0.9357	0.3923	0.3622	6.67	0.0098
North Dakota	0.1661	1.1807	0.7269	0.05	0.8192
Ohio	-0.3408	0.7112	0.2610	1.71	0.1916
Oklahoma	-0.0942	0.9101	0.2976	0.10	0.7516
Oregon	0.0563	1.0579	0.3468	0.03	0.8710
Pennsylvania	-0.0184	0.9818	0.2564	0.01	0.9429
Rhode Island	-0.0910	0.9130	1.0112	0.01	0.9283
South Carolina	-0.3435	0.7093	0.4069	0.71	0.3986
South Dakota	-0.4987	0.6073	0.7253	0.47	0.4917
Tennessee	-2.0156	0.1332	0.5951	11.47	0.0007
Texas	0.1058	1.1116	0.1983	0.28	0.5936
Utah	0.0480	1.0492	0.4031	0.01	0.9051
Vermont	0.0119	1.0119	1.0114	0.00	0.9906
Virginia	-0.2070	0.8130	0.3015	0.47	0.4922
Washington	0.1850	1.2032	0.2626	0.50	0.4812
West Virginia	-0.0907	0.9133	0.4729	0.04	0.8479
Wisconsin	-0.1854	0.8308	0.2861	0.42	0.5170
Wyoming	-0.7963	0.4510	1.0135	0.62	0.4320

Appendix K : Detailed regression results of bodily injury liability claim severities by state

Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Alabama	-4.3345	0.0131	1.2190	12.64	0.0004
Alaska	0.9734	2.6470	1.1985	0.66	0.4167
Arizona	-0.4637	0.6290	0.5990	0.60	0.4389
Arkansas	3.1106	22.4347	0.7489	17.25	<0.0001
California	0	1	0		
Colorado	0.6311	1.8797	0.8792	0.52	0.4729
Connecticut	-2.2039	0.1104	1.2019	3.36	0.0667
D.C.	-2.5014	0.0820	1.2242	4.17	0.0410
Delaware					
Florida	-0.4062	0.6662	0.3932	1.07	0.3016
Georgia	-0.5639	0.5690	0.5030	1.26	0.2622
Hawaii					
Idaho	-0.3157	0.7292	0.9364	0.11	0.7360
Illinois	-0.7302	0.4818	0.4577	2.54	0.1107
Indiana	-0.7091	0.4921	0.5861	1.46	0.2263
Iowa					
Kansas	-1.4833	0.2269	1.2102	1.50	0.2203
Kentucky	-0.7671	0.4644	0.6789	1.28	0.2585
Louisiana	-0.7569	0.4691	0.4883	2.40	0.1212
Maine	-3.7235	0.0241	1.1998	9.63	0.0019
Maryland	-0.5555	0.5738	0.8737	0.40	0.5249
Massachusetts	-0.7096	0.4918	1.3099	0.29	0.5880
Michigan	0.8813	2.4140	0.8815	1.00	0.3175
Minnesota	0.1338	1.1432	0.5154	0.07	0.7952

Appendix K : Detailed regression results of bodily injury liability claim severities by state

Parameter	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Mississippi	0.0149	1.0150	0.7252	0.00	0.9836
Missouri	-0.1240	0.8834	0.4682	0.07	0.7912
Montana					
Nebraska	-2.1961	0.1112	1.1989	3.36	0.0670
Nevada	-0.1867	0.8297	0.7442	0.06	0.8019
New Hampshire					
New Jersey	-1.3105	0.2697	0.9331	1.97	0.1602
New Mexico	0.0529	1.0543	1.2150	0.00	0.9653
New York	1.1609	3.1929	0.6477	3.21	0.0731
North Carolina	-0.3062	0.7362	0.5072	0.36	0.5460
North Dakota					
Ohio	0.2049	1.2274	0.4626	0.20	0.6578
Oklahoma	-1.1401	0.3198	0.4560	6.25	0.0124
Oregon	-0.4698	0.6251	0.6846	0.47	0.4926
Pennsylvania	-0.3365	0.7142	0.4648	0.52	0.4690
Rhode Island	-0.0224	0.9779	1.1907	0.00	0.9850
South Carolina	-0.4699	0.6250	0.6926	0.46	0.4975
South Dakota	-0.1002	0.9047	0.9116	0.01	0.9125
Tennessee	0.2495	1.2834	0.7836	0.10	0.7502
Texas	-0.1334	0.8751	0.3271	0.17	0.6834
Utah	0.2585	1.2950	0.7818	0.11	0.7409
Vermont					
Virginia	0.0216	1.0219	0.5501	0.00	0.9687
Washington	0.1311	1.1401	0.4866	0.07	0.7876
West Virginia	-0.3699	0.6908	0.7486	0.24	0.6212
Wisconsin	-2.8253	0.0593	0.7521	14.11	0.0002
Wyoming					

Appendix L : Derived results for bodily injury liability overall losses by state

	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Alabama	-1.3294	0.5214	-4.3345	1.2190	-5.6639	1.3258	0.0035	<0.0001
Alaska	0.3031	0.7226	0.9734	1.1985	1.2765	1.3995	3.5840	0.3617
Arizona	0.0558	0.3052	-0.4637	0.5990	-0.4079	0.6723	0.6650	0.5440
Arkansas	-0.4747	0.4367	3.1106	0.7489	2.6359	0.8670	13.9562	0.0024
California	0	0	0	0	0	0	1	
Colorado	-1.4949	0.5191	0.6311	0.8792	-0.8638	1.0210	0.4216	0.3975
Connecticut	-0.0590	0.5200	-2.2039	1.2019	-2.2628	1.3095	0.1041	0.0840
D.C.	1.2561	0.7241	-2.5014	1.2242	-1.2453	1.4224	0.2879	0.3813
Delaware	-9.9232	104.7228						
Florida	-0.5912	0.2384	-0.4062	0.3932	-0.9974	0.4598	0.3688	0.0301
Georgia	-0.2376	0.2873	-0.5639	0.5030	-0.8014	0.5792	0.4487	0.1665
Hawaii	-9.2719	108.4858						
Idaho	0.5766	0.4344	-0.3157	0.9364	0.2609	1.0323	1.2981	0.8005
Illinois	-0.4079		-0.7302	0.4577	-1.1380	0.5214	0.3205	0.0291

Appendix L : Derived results for bodily injury liability overall losses by state								
	Claim frequency		Claim severity		Overall loss			
Parameter	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error	Exponent estimate	P-value
Indiana	-0.3426	0.3241	-0.7091	0.5861	-1.0517	0.6697	0.3493	0.1163
Iowa	-1.0359	0.5971						
Kansas	-0.8294	0.5206	-1.4833	1.2102	-2.3126	1.3174	0.0990	0.0792
Kentucky	-0.1644	0.4054	-0.7671	0.6789	-0.9314	0.7907	0.3940	0.2388
Louisiana	0.1356	0.3151	-0.7569	0.4883	-0.6213	0.5812	0.5373	0.2851
Maine	0.3586	0.5960	-3.7235	1.1998	-3.3649	1.3397	0.0346	0.0120
Maryland	-0.4298	0.4323	-0.5555	0.8737	-0.9853	0.9748	0.3733	0.3121
Massachusetts	-1.5990	0.5490	-0.7096	1.3099	-2.3086	1.4203	0.0994	0.1041
Michigan	-0.6408	0.3812	0.8813	0.8815	0.2404	0.9604	1.2718	0.8023
Minnesota	-0.5613	0.2964	0.1338	0.5154	-0.4275	0.5946	0.6521	0.4721
Mississippi	-0.1935	0.4744	0.0149	0.7252	-0.1786	0.8666	0.8364	0.8367
Missouri	-0.0832	0.2968	-0.1240	0.4682	-0.2072	0.5544	0.8129	0.7086
Montana	0.2244	0.6004						
Nebraska	-0.8530	0.7222	-2.1961	1.1989	-3.0492	1.3996	0.0474	0.0294
Nevada	0.1546	0.4707	-0.1867	0.7442	-0.0321	0.8806	0.9684	0.9709
New Hampshire	-1.0125	1.0111						
New Jersey	-0.0332	0.3337	-1.3105	0.9331	-1.3437	0.9910	0.2609	0.1751
New Mexico	-0.5440	0.5220	0.0529	1.2150	-0.4911	1.3224	0.6120	0.7104
New York	-0.2353	0.3200	1.1609	0.6477	0.9257	0.7225	2.5235	0.2001
North Carolina	-0.9357	0.3622	-0.3062	0.5072	-1.2419	0.6233	0.2888	0.0463
North Dakota	0.1661	0.7269						
Ohio	-0.3408	0.2610	0.2049	0.4626	-0.1359	0.5312	0.8729	0.7980
Oklahoma	-0.0942	0.2976	-1.1401	0.4560	-1.2343	0.5445	0.2910	0.0234
Oregon	0.0563	0.3468	-0.4698	0.6846	-0.4135	0.7675	0.6613	0.5900
Pennsylvania	-0.0184	0.2564	-0.3365	0.4648	-0.3549	0.5308	0.7013	0.5038
Rhode Island	-0.0910	1.0112	-0.0224	1.1907	-0.1134	1.5622	0.8928	0.9421
South Carolina	-0.3435	0.4069	-0.4699	0.6926	-0.8134	0.8033	0.4433	0.3112
South Dakota	-0.4987	0.7253	-0.1002	0.9116	-0.5989	1.1649	0.5494	0.6072
Tennessee	-2.0156	0.5951	0.2495	0.7836	-1.7661	0.9840	0.1710	0.0727
Texas	0.1058	0.1983	-0.1334	0.3271	-0.0276	0.3825	0.9728	0.9425
Utah	0.0480	0.4031	0.2585	0.7818	0.3066	0.8796	1.3588	0.7274
Vermont	0.0119	1.0114						
Virginia	-0.2070	0.3015	0.0216	0.5501	-0.1854	0.6273	0.8307	0.7675
Washington	0.1850	0.2626	0.1311	0.4866	0.3160	0.5530	1.3717	0.5676
West Virginia	-0.0907	0.4729	-0.3699	0.7486	-0.4606	0.8855	0.6309	0.6029
Wisconsin	-0.1854	0.2861	-2.8253	0.7521	-3.0106	0.8047	0.0493	0.0002
Wyoming	-0.796	1.014						

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