HIGHWAY LOSS DATA INSTITUTE

Bulletin | Vol. 30, No. 9 : April 2013

The effects of Michigan's weakened motorcycle helmet use law on insurance losses

In April of 2012 the state of Michigan changed its motorcycle helmet law. The change allowed motorcyclists 21 years and older to legally ride without a helmet if they carry at least $20,000 in medical payments coverage. The purpose of this study is to quantify the impact of the law change on insurance losses. Losses under medical payments and collision coverage during the 2010 and 2011 riding seasons were compared with the 2012 riding season. Michigan losses were compared with losses in Wisconsin, Illinois, Indiana, and Ohio, where laws regarding helmet use were stable. The study controlled for motorcycle age and class, rider demographic factors, geographic factors, and weather. Overall medical payments costs were 50 percent higher than expected for Michigan after the law change. Some of this increase may reflect increased crash risk as collision claim frequency also increased by about 12 percent. However, most of the increase in medical payments overall losses stemmed from an increase in claim severity of 36 percent. After the law change some motorcyclists increased their medical payments policy limits to the required minimum. When policy limits are taken into account, medical payments claim severity is estimated to have increased 22 percent, consistent with expectation that crashes after the law change resulted in more severe injuries as a result of less helmet use.

Introduction

Motorcycle helmets are designed to cushion and protect a rider's head from impacts during crashes. Helmet use reduces the likelihood of crash fatality by 37 percent, and unhelmeted motorcyclists are 3 times more likely than helmeted riders to suffer traumatic brain injuries in the event of a crash (NHTSA, 2008). Not surprisingly, research has shown large fluctuations in fatal crashes among motorcyclists when states have changed helmet use laws. For example, when Florida weakened its universal law in 2000 to apply only to riders younger than 21, fatal crashes increased by about 21 percent (Ulmer and Northrup, 2005).

In 1967, to increase motorcycle helmet use, the federal government required the states to enact helmet use laws in order to qualify for certain federal safety programs and highway construction funds. The federal incentive worked. By the early 1970s, almost all the states had motorcycle helmet laws that were universal, meaning they covered all riders. In 1976, Congress stopped the Department of Transportation from assessing financial penalties on states without helmet laws. Currently 19 states and the District of Columbia have laws requiring all motorcyclists to wear a helmet, 28 states require only some motorcyclists to wear a helmet, and three states do not have a helmet use law.

Michigan was the first state to repeal its universal helmet law in 1968 but one year later reinstated it. Michigan remained a universal state until April 12, 2012, when a new, weakened law took effect requiring riders younger than 21 years of age to wear a helmet, but allowing those 21 and older to ride without a helmet if they carry at least $20,000 in medical payment (MedPay) insurance and have passed a motorcycle safety course or have had their motorcycle endorsement for at least two years. Motorcycle passengers may ride without a helmet if they are 21 or older and the driver carries additional insurance to cover passenger injuries.

The purpose of this Highway Loss Data Institute (HLDI) bulletin is to determine how the recent weakening of Michigan's universal motorcycle helmet law is affecting medical payment losses. It also looks at collision losses, in part to test the claim by helmet-law opponents that helmets increase fatigue and impede situational awareness, thus making crashes more likely.

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 this study, two different insurance coverage types were examined: collision and medical payment. Motorcycle collision coverage insures against physical damage to a motorcycle sustained in a crash when the rider is at fault. MedPay covers injuries sustained by motorcycle operators.

Insurance measures

Insurance losses are measured as claim frequency, claim severity, and overall losses. Claim frequency is defined as the number of claims for a group of vehicles divided by the exposure for that group, expressed as claims per 100 or 1,000 insured vehicle years. An insured vehicle year is one vehicle insured for one year, two for six months, etc. Claim severity is average loss payment per claim. For a group of vehicles, it is the total dollars paid to settle claims, divided by the number of claims paid. Overall losses for a group of vehicles is the product of claim frequency and claim severity, expressed as dollars per insured vehicle year. Total exposure and claims for motorcycles are shown in Table 1.

Vehicles

The loss data in this study cover calendar years 2010-12. The nine most current model years were included for each calendar year (2003-2011 model years were included for the 2010 calendar year). Losses for Michigan and the control states were determined based on garaging location. Information about where a crash occurred is not available.

Table 1: Motorcycle exposure and claims by coverage type

Coverage	Exposure (insured vehicle years)	Claims
Collision	322,675	8,689
Medical payments	192,189	3,873

Only the Michigan riding season of May through September was included as motorcycle claim frequencies have strong seasonality, especially in northern climates. Two vehicle-related factors served as covariates: motorcycle class and motorcycle age. Motorcycle class included scooter, cruiser, chopper, touring, dual purpose, standard, sport touring, unclad sport, sport, and super sport. Motorcycle age was defined as the difference between the calendar year and model year, with a range of 0 to 7. Motorcycles with a calculated age of -1 (model year 2012 bikes in calendar year 2011) were combined with motorcycles of age 0 (model year 2012 bikes in calendar year 2012).

External data source

Monthly mean temperature and monthly precipitation: Prior HLDI research (Vol. 27, No. 7) showed that temperature and precipitation are highly correlated with motorcycle collision claim frequency. The interaction of temperature and temperature range was also shown to significantly impact motorcycle collision claim frequencies. The temperature ranges utilized in this report are identical to those used in prior research. State monthly mean temperatures, measured in degrees Fahrenheit, were obtained from the National Oceanic and Atmospheric Administration (NOAA) for January 2010 thru September 2012 and were linked to HLDI loss data. Daily mean temperatures for states were unknown. It was possible that, within a given month, there were days with favorable weather conditions for riding, at least in some part of a state, yet the monthly average temperature was less than ideal for riding. Mean monthly temperatures were divided into two ranges: moderate (50-64), and high (65+). NOAA state monthly precipitations, measured in inches, for January 2010 through September 2012 also were linked to HLDI loss data. The type of precipitation and number of days in a given month with measurable precipitation were not available.

Analysis method

Motorcycle data were aggregated by calendar year, model year, month, state, rated driver age, rated driver gender, rated driver marital status, deductible, risk, motorcycle class, and registered vehicle density. The rated driver is the one who 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 vehicle can vary by insurance company and by state, but usually it reflects the driver most likely to operate the vehicle. Information on the actual driver at the time of a collision is not available in the HLDI database. In this study the rated drivers (riders) were limited to those age 21 and older. Information from NOAA on temperature and precipitation were linked to the insurance data using calendar year, month, and state.

Claim frequency was modeled using a Poisson distribution, and claim severity was modeled using a Gamma distribution. Both models used a logarithmic link function. Estimates for overall losses were derived from the claim frequency and claim severity models. The effect of the Michigan helmet law change on collision and MedPay losses was estimated while controlling for other covariates. Covariates were vehicle age, motorcycle class, risk, deductible (collision only), registered vehicle density, time period, state, rated driver age, rated driver gender, rated driver marital status, temperature, temperature range, precipitation, and temperature × temperature range. A second model for MedPay losses was constructed that also included policy limits. Previous HLDI reports have shown these covariates are important predictors of claim frequencies. The primary predictor was state × time period. Reference categories were as follows: state=Michigan, time period=before, motorcycle class=cruiser, rated driver age=40-64, rated driver gender=male, rated driver marital status=unknown, risk=standard, deductible=$ 251-$500 (collision only), temperature range=high, vehicle density=100-499 and policy limit = $5,000-$9,999 (MedPay severity).

To control for other factors not covered by these variables and unrelated to helmet law (e.g., economic situation and change in miles driven), loss data from Illinois, Indiana, Ohio, and Wisconsin were used as controls. Independent variables in the model are listed below.

- State: variable to identify a state, with Illinois, Indiana, Ohio, and Wisconsin serving as controls.
- Time period: categorical variable to indicate whether losses occurred before or after the weakening of Michigan's helmet law.

Illinois, Indiana, Ohio, and Wisconsin were chosen as control states based on several criteria. The control states border Michigan and all had similar seasonality patterns. Motorcycle class is a predictor of crash frequencies and the types of bikes ridden in the control states are similar to those in Michigan. Additionally, their helmet laws remained unchanged during the study time period.

The model includes the interaction of state and time period. This interaction represents the relative change in claim frequency between each control state and Michigan that occurred after the law was changed. The estimates associated with this interaction with p-values less than 0.05 indicate the controls are meaningfully different from Michigan.

HLDI collected insurance claim data through September 2012 and payment information through December 2012. In the regression analysis, May to September 2012 was designed to be the after helmet law change time period, and May to September in 2010 and 2011 was the before helmet law change period.

Weighted averages of the model estimates for individual control states were calculated. The weights in the average were proportional to the inverse variance of the respective estimates, meaning that the estimates with high variance (those with large confidence intervals, typically due to little exposure and/or claims) contributed less than estimates with low variance (those with small confidence intervals). These calculations were estimates of the control states relative to Michigan. Because it is often useful to state the results in terms of Michigan relative to the control states, the inverse was calculated. The weighted averages of the collision frequency estimate for the control states was -0.1133, which means the frequency of the control states was 89 percent (e^(-0.1133)) that of Michigan. After transformation, the estimate was 0.1133 and the collision claim frequency of Michigan was 112 percent of control states. In other words, after the Michigan helmet law change, collision frequency in Michigan was 12 percent higher than the average frequency in control states.

Results

Medical payment coverage

Figures 1-2 illustrate the actual changes in medical payment claim frequency, severity and overall losses in Michigan and the control states after the helmet law was weakened. These results do not control for any of the variables available in the HLDI data. Michigan saw a larger percentage increase in claim frequency (9.6 percent), severity (34.1 percent), and overall losses (47.0 percent) than the four individual control states. When the four control states are combined as in Figure 2, Michigan has larger increases in all measures of loss.

Figure 1: Actual change in medical payment losses after Michigan helmet law, by state

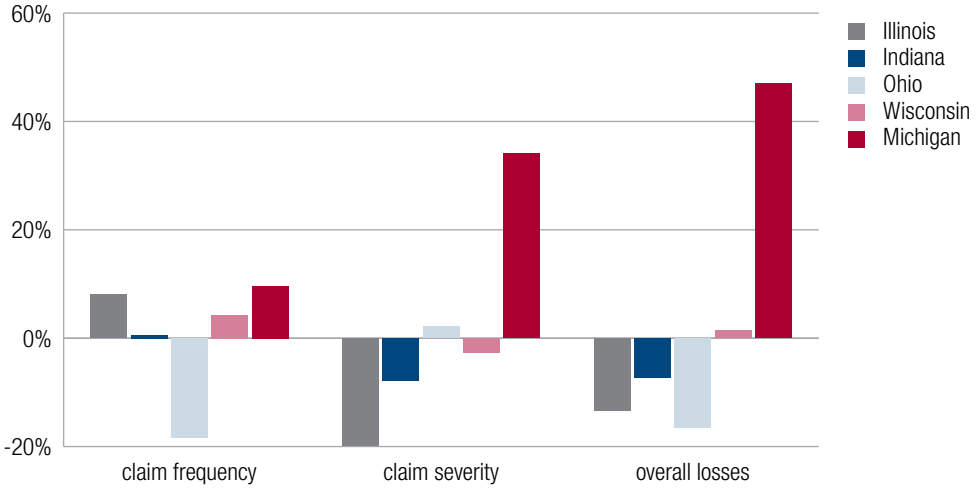
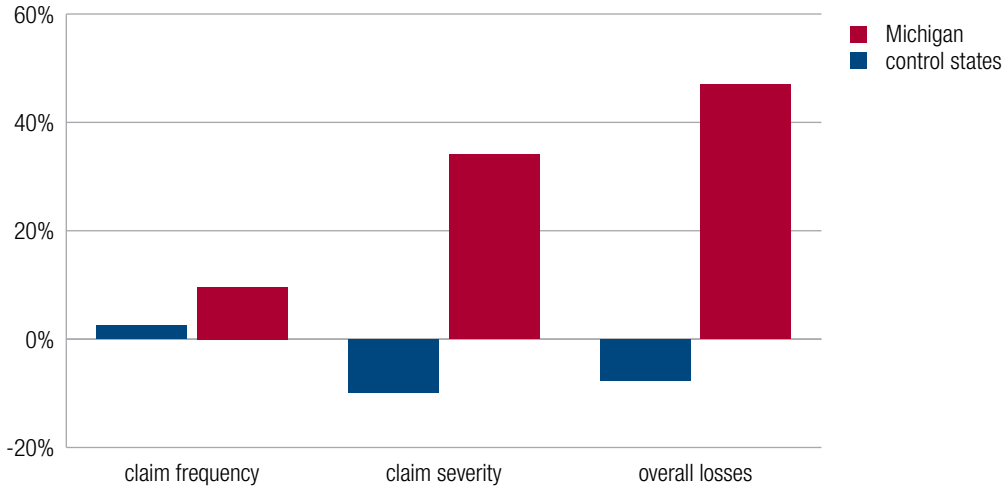


Figure 2: Actual change in medical payment losses after Michigan helmet law versus control states



Summary results of the regression analysis of motorcycle MedPay claim frequencies using the Poisson distribution are listed in Table 2. Nine of the variables included in the analysis had p-values less than 0.05, indicating their effects on claim frequency were statistically significant. Time period, state × time period, gender, precipitation, and temperature did not significantly affect claim frequency.

Table 2: Summary results of linear regression analysis of medical payment claim frequencies for Michigan vs. comparison states

	Degrees of freedom	Chi-Square	P-value
State	4	55.90	<0.0001
Time period	1	0.00	0.9533
State × time period	4	4.90	0.2975
Vehicle age	1	134.22	<0.0001
Motorcycle class	9	194.76	<0.0001
Rated driver age	3	24.27	<0.0001
Rated driver gender	2	1.78	0.4099
Rated driver marital status	2	6.50	0.0388
Risk	1	17.65	<0.0001
Registered vehicle density	2	13.37	0.0012
Temperature range	1	6.73	0.0095
Precipitation	1	0.78	0.3768
Temperature	1	0.00	0.9485
Temperature × temperature range	1	5.55	0.0185

Summary results of the regression analysis of motorcycle medical payment claim severities using the Gamma distribution are listed in Table 3. Seven of the variables included in the analysis had p-values less than 0.05. The model summary indicates that the state by time period interaction is statistically significant with a p-value less than 0.05. However, this is an overall test of the time effect among states, with four degrees of freedom, and is not a direct test of the contrast between the time period effect for Michigan versus the control states. To obtain this test, the time period by state interaction was broken down in the detailed regression analysis into four contrasts between Michigan and each of the control states; these four estimates were then averaged using their respective inverse variances as weights and the result was inverted to yield an estimated increase in injury severity of 36.3 percent (p<0.0001).

Table 3: Summary results of linear regression analysis of medical payment severities for Michigan vs. comparison states

	Degrees of freedom	Chi-Square	P-value
State	4	764.06	<0.0001
Time period	1	0.00	0.9612
State × time period	4	9.90	0.0421
Vehicle age	1	0.48	0.4905
Motorcycle class	9	19.54	0.0209
Rated driver age	3	2.52	0.4711
Rated driver gender	2	517.37	<0.0001
Rated driver marital status	2	183.01	<0.0001
Risk	1	31.42	<0.0001
Registered vehicle density	2	8.98	0.0112
Temperature range	1	0.31	0.5767
Precipitation	1	2.05	0.1522
Temperature	1	1.80	0.1793
Temperature × temperature range	1	0.41	0.5209

Detailed results of the regression analysis for medical payment claim frequency, severity, and overall losses are listed in Table 4. The table shows estimates and significance levels for the individual values of the categorical variables. To make the results more illustrative, a column was added that contains the effect of the estimates. The estimates associated with the state and time period interaction indicate that the change in medical payment losses for each of the comparison states is lower relative to Michigan after the law change. For example, the change in Illinois's claim frequency was 2.5 percent lower than Michigan after the law change, a result that was not significant. Michigan had higher MedPay claim frequencies than all of the control states after the law change. None of the comparisons was significant. Michigan also had higher medical payment claim severities after the law change. This effect was significant for all of the comparison states with the exception of Ohio.

The effects of the independent variables on motorcycle medical payment overall losses, derived from the claim frequency and claim severity models are also displayed in Table 4. Overall losses can be calculated by simple multiplication because the estimates for the effect of Michigan's helmet law 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 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. Michigan had higher overall losses than all the control states after the law change. Only the comparison with Wisconsin was not significant.

Table 4: Results for medical payment claim frequency, claim severity, and overall losses derived from claim frequency and severity models

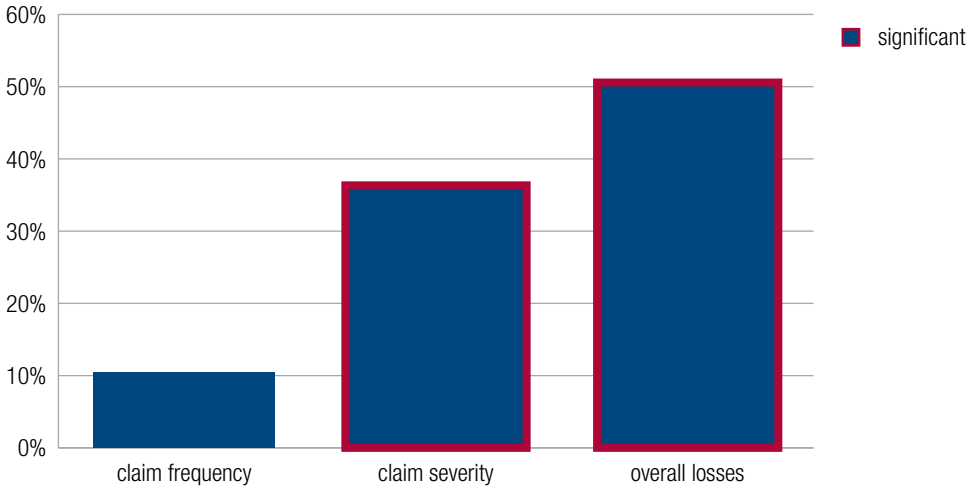
	Claim frequency				Claim severity				Overall loss			
	Estimate	Effect	Standard error	P-value	Estimate	Effect	Standard error	P-value	Estimate	Effect	Standard error	P-value
Intercept	-9.2816		0.3632	<0.0001	9.5425		0.3738	<0.0001	0.2609		0.5212	0.6167
State												
Illinois	-0.2980	-25.8%	0.0726	<0.0001	-1.1953	-69.7%	0.0801	<0.0001	-1.4933	-77.5%	0.1081	<0.0001
Indiana	-0.1363	-12.7%	0.0770	0.0769	-1.3408	-73.8%	0.0829	<0.0001	-1.4771	-77.2%	0.1131	<0.0001
Ohio	-0.3082	-26.5%	0.0908	0.0007	-1.3244	-73.4%	0.0967	<0.0001	-1.6326	-80.5%	0.1326	<0.0001
Wisconsin	-0.3980	-32.8%	0.0794	<0.0001	-0.1037	-9.9%	0.0814	0.2027	-0.5017	-39.4%	0.1137	<0.0001
Michigan	0	0	0		0	0	0		0	0	0	
Time period												
After	0.0972	10.2%	0.0978	0.3200	0.2437	27.6%	0.1103	0.0271	0.3409	40.6%	0.1474	0.0207
Before	0	0	0		0	0	0	.	0	0	0	
State × time period												
After (Illinois)	-0.0255	-2.5%	0.1131	0.8219	-0.3852	-32.0%	0.1250	0.0021	-0.4107	-33.7%	0.1686	0.0148
After (Indiana)	-0.0888	-8.5%	0.1226	0.4690	-0.3050	-26.3%	0.1323	0.0212	-0.3938	-32.6%	0.1804	0.0290
After (Ohio)	-0.2896	-25.1%	0.1512	0.0555	-0.2384	-21.2%	0.1588	0.1333	-0.5280	-41.0%	0.2193	0.0160
After (Wisconsin)	-0.0703	-6.8%	0.1252	0.5745	-0.2797	-24.4%	0.1338	0.0366	-0.3500	-29.5%	0.1832	0.0561
After (Michigan)	0	0	0		0	0	0		0	0	0	
Before (Illinois)	0	0	0		0	0	0		0	0	0	
Before (Indiana)	0	0	0		0	0	0		0	0	0	
Before (Michigan)	0	0	0		0	0	0		0	0	0	
Before (Ohio)	0	0	0		0	0	0		0	0	0	
Before (Wisconsin)	0	0	0		0	0	0		0	0	0	
Vehicle age	-0.0937	-9.0%	0.0081	<0.0001	-0.0055	-0.6%	0.0080	0.4906	-0.0992	-9.4%	0.0114	<0.0001

Table 4: Results for medical payment claim frequency, claim severity, and overall losses derived from claim frequency and severity models (cont'd)

	Claim frequency				Claim severity				Overall loss			
	Estimate	Effect	Standard error	P-value	Estimate	Effect	Standard error	P-value	Estimate	Effect	Standard error	P-value
Motorcycle class												
Chopper	-0.2475	-21.9%	0.2439	0.3102	0.4178	51.9%	0.2287	0.0677	0.1703	18.6%	0.3344	0.6105
Dual purpose	-0.2449	-21.7%	0.1093	0.0251	-0.1562	-14.5%	0.1075	0.1462	-0.4011	-33.0%	0.1533	0.0089
Scooter	-0.5199	-40.5%	0.0826	<0.0001	-0.1588	-14.7%	0.0826	0.0546	-0.6787	-49.3%	0.1168	<0.0001
Sport	0.2978	34.7%	0.0753	<0.0001	-0.0784	-7.5%	0.0785	0.3180	0.2194	24.5%	0.1088	0.0437
Sport touring	-0.4301	-35.0%	0.1486	0.0038	0.0238	2.4%	0.1536	0.8769	-0.4063	-33.4%	0.2137	0.0573
Standard	0.1775	19.4%	0.1468	0.2268	0.0198	2.0%	0.1436	0.8902	0.1973	21.8%	0.2054	0.3367
Super sport	0.5294	69.8%	0.0567	<0.0001	-0.0704	-6.8%	0.0611	0.2494	0.4590	58.2%	0.0834	<0.0001
Touring	0.1606	17.4%	0.0405	<0.0001	0.0763	7.9%	0.0403	0.0583	0.2369	26.7%	0.0571	<0.0001
Unclad sport	0.1637	17.8%	0.1046	0.1176	-0.1398	-13.0%	0.1078	0.1948	0.0239	2.4%	0.1502	0.8736
Cruiser	0	0	0		0	0	0		0	0	0	
Rated driver age												
21-24	0.4003	49.2%	0.0803	<0.0001	-0.1114	-10.5%	0.0843	0.1866	0.2889	33.5%	0.1164	0.0131
25-39	0.0122	1.2%	0.0408	0.7644	-0.0460	-4.5%	0.0425	0.2794	-0.0338	-3.3%	0.0589	0.5662
65+	0.0554	5.7%	0.0677	0.4127	0.0232	2.3%	0.0638	0.7163	0.0786	8.2%	0.0930	0.3981
40-64	0	0	0		0	0	0		0	0	0	
Rated driver gender												
Female	-0.0057	-0.6%	0.0689	0.9335	-0.0778	-7.5%	0.0670	0.2457	-0.0835	-8.0%	0.0961	0.3849
Unknown	0.0769	8.0%	0.0595	0.1961	-1.3158	-73.2%	0.0589	<0.0001	-1.2389	-71.0%	0.0837	<0.0001
Male	0	0	0	.	0	0	0		0	0	0	
Rated driver marital status												
Married	-0.0915	-8.7%	0.0596	0.1250	-0.7330	-52.0%	0.0580	<0.0001	-0.8245	-56.2%	0.0832	<0.0001
Single	0.0454	4.7%	0.0700	0.5164	-0.6999	-50.3%	0.0676	<0.0001	-0.6545	-48.0%	0.0973	<0.0001
Unknown	0	0	0		0	0	0		0	0	0	
Risk												
Nonstandard	0.1885	20.8%	0.0444	<0.0001	-0.2436	-21.6%	0.0428	<0.0001	-0.0551	-5.4%	0.0617	0.3716
Standard	0	0	0		0	0	0		0	0	0	
Registered vehicle density												
<100	-0.0500	-4.9%	0.0427	0.2423	0.0904	9.5%	0.0423	0.0328	0.0404	4.1%	0.0601	0.5015
500+	0.1056	11.1%	0.0376	0.0049	-0.0461	-4.5%	0.0387	0.2336	0.0595	6.1%	0.0540	0.2702
100-499	0	0	0	.	0	0	0		0	0	0	
Temperature range												
Moderate	-1.7920	-83.3%	0.6944	0.0099	-0.3979	-32.8%	0.7120	0.5763	-2.1899	-88.8%	0.9946	0.0277
High	0	0	0		0	0	0				0	
Precipitation	-0.0101	-1.0%	0.0114	0.3774	-0.0165	-1.6%	0.0115	0.1513	-0.0266	-2.6%	0.0162	0.1004
Temperature	0.0003	0.0%	0.0049	0.9485	0.0049	0.5%	0.0051	0.3366	0.0052	0.5%	0.0071	0.4622
Temperature × temperature range												
Moderate	0.0258	2.6%	0.0110	0.0191	0.0072	0.7%	0.0112	0.5204	0.0330	3.4%	0.0157	0.0355
High	0	0	0		0	0	0			0	0	

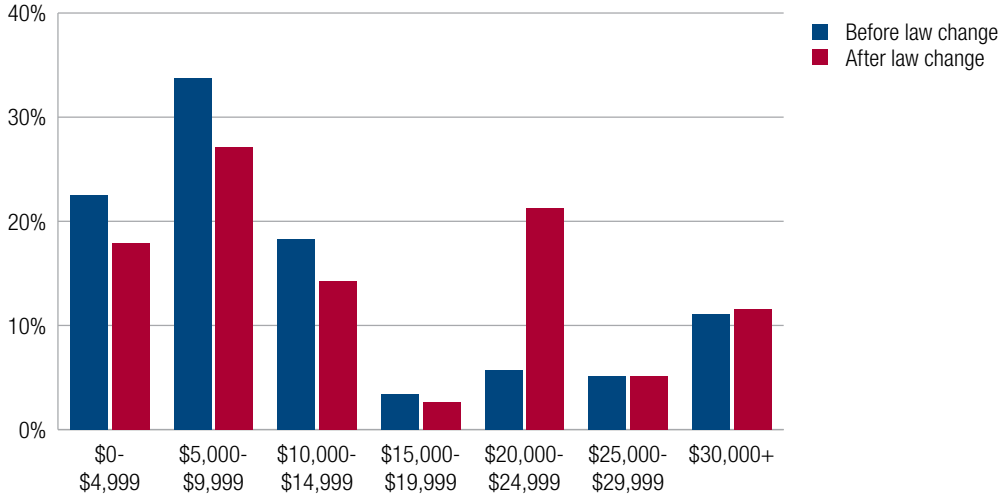
Weighted averages of the model estimates for the interaction of state and time period were calculated. The results of this analysis are similar to the patterns seen in the actual results (Figures 1-2) and are shown in Figure 3. All three measures of loss increased. Medical payment claim frequency increased by 10.4 percent, although that estimate was not significant. Severity increased by 36.3 percent, and overall losses increased by 50.6 percent, both significantly.

Figure 3: Change in medical payment losses after Michigan helmet law versus control states



Michigan's revised helmet law requires motorcyclists who ride without a helmet to have at least $20,000 in MedPay coverage. Figure 4 illustrates the distribution of MedPay policy limits for Michigan before and after the law change. Policy limits were grouped into ranges. In the limit ranges below $20,000 exposure decreased, while in the $20,000 to $24,999 range exposure increased from 5.7 percent of the total before the law change to 21.3 percent after. Changes to limits in the control states were minimal. Due to this shift in insurance coverage in Michigan, additional analysis was performed to attempt to separate the effect on MedPay severity of relaxing the helmet requirement from the accompanying insurance requirement.

Figure 4: Michigan medical payments policy limit distribution



In order to isolate the effect of removing the helmet requirement from the requirement for at least $20,000 in MedPay coverage, an additional model was constructed. This model employed all of the variables used in the first MedPay severity model and added policy limits. These limits were grouped into ranges and treated as a categorical variable. Summary results of the regression analysis of motorcycle medical payment claim severities controlling for policy limits are listed in Table 5. The table indicates that there is a strong relationship between policy limits and MedPay claim severities.

Table 5: Summary results of linear regression analysis of medical payment severities for Michigan vs. comparison states adding policy limits as a control variable

	Degrees of freedom	Chi-Square	P-value
State	4	0.94	0.9190
Time period	1	0.98	0.3226
State x time period	4	6.98	0.1372
Vehicle age	1	0.34	0.5598
Motorcycle class	9	29.25	0.0006
Rated driver age	3	3.30	0.3471
Rated driver gender	2	15.87	0.0004
Rated driver marital status	2	13.42	0.0012
Risk	1	1.45	0.2285
Registered vehicle density	2	0.84	0.6581
Temperature range	1	1.77	0.1830
Precipitation	1	0.54	0.4644
Temperature	1	2.71	0.0999
Temperature x temperature range	1	1.92	0.1657
Policy limits	6	1281.53	<0.0001

Detailed results of the regression analysis for MedPay claim severity controlling for policy limits are listed in Table 6. The table shows estimates and significance levels for the individual values of the categorical variables. The estimates associated with the policy limits are expressed relative to the most populated range — $5,000 to $9,999. In general, as limits increase claim severities increase. For example, the estimated effect of the highest limit range (271.3%) on claim severity indicates that claim severities for policies with limits in this range are expected to be 3.7 times as high as those with policies in the $5,000-$9,999 range. The estimates associated with the state and time period interaction indicate that the change in MedPay claim severity for each of the comparison states was lower relative to Michigan after the law change. For example, the change in Illinois' claim severity was 22.3 percent lower than Michigan after the law change, a result that was significant. Weighted averages of the model estimates for the interaction of state and time period were calculated. Claim severity in Michigan increased by a statistically significant 22.1 percent (p-value = 0.0005).

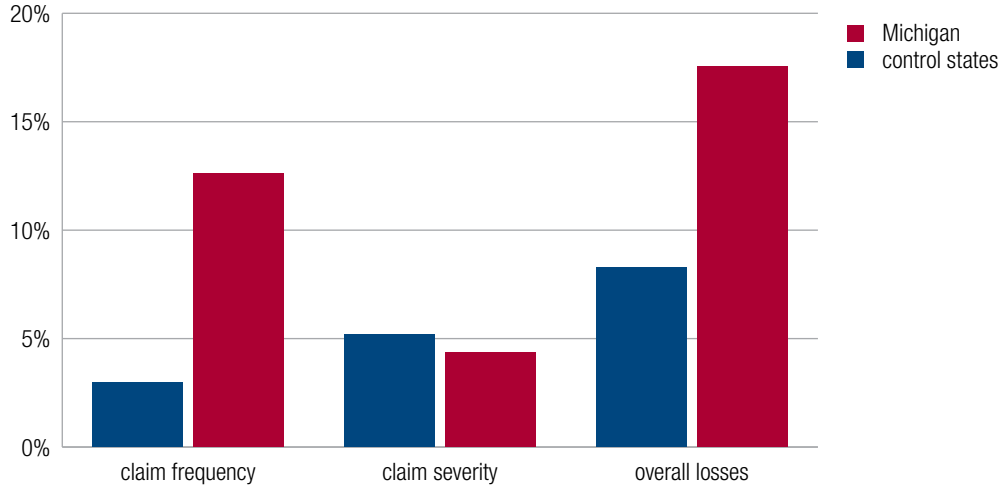
Table 6: Detailed results of linear regression analysis of medical payment severities for Michigan vs. comparison states adding policy limits as a control variable				
Parameter	**Estimate**	**Effect**	**Standard error**	**P-value**
Intercept	8.1438		0.3053	<0.0001
State				
Illinois	0.0856	8.9%	0.0720	0.2340
Indiana	0.0628	6.5%	0.0758	0.4073
Ohio	0.0488	5.0%	0.0843	0.5627
Wisconsin	0.0742	7.7%	0.0812	0.3609
Michigan	0	0	0	
Time period				
After	0.1169	12.4%	0.0943	0.2152
Before	0	0	0	
State x time period				
After (Illinois)	-0.2521	-22.3%	0.1059	0.0173
After (Indiana)	-0.2059	-18.6%	0.1118	0.0655
After (Ohio)	-0.0919	-8.8%	0.1334	0.4907
After (Wisconsin)	-0.2108	-19.0%	0.1135	0.0632
After (Michigan)	0	0	0	
Before (Illinois)	0	0	0	
Before (Indiana)	0	0	0	
Before (Michigan)	0	0	0	
Before (Ohio)	0	0	0	
Before (Wisconsin)	0	0	0	
Vehicle age	0.0038	0.4%	0.0066	0.5597
Motorcycle class				
Chopper	0.1568	17.0%	0.1894	0.4078
Dual purpose	-0.0896	-8.6%	0.0893	0.3158
Scooter	-0.0904	-8.6%	0.0678	0.1822
Sport	-0.1653	-15.2%	0.0645	0.0104
Sport touring	-0.0493	-4.8%	0.1270	0.6977
Standard	-0.0724	-7.0%	0.1189	0.5429
Super sport	-0.1279	-12.0%	0.0492	0.0093
Touring	0.0870	9.1%	0.0330	0.0084
Unclad sport	-0.1278	-12.0%	0.0897	0.1540
Cruiser	0	0	0	
Rated driver age				
21-24	-0.1055	-10.0%	0.0686	0.1244
25-39	0.0151	1.5%	0.0349	0.6647
65+	0.0234	2.4%	0.0525	0.6567
40-64	0	0	0	
Rated driver gender				
Female	-0.0487	-4.8%	0.0554	0.3789
Unknown	-0.2160	-19.4%	0.0548	<0.0001
Male	0	0	0	
Rated driver marital status				
Married	-0.0554	-5.4%	0.0499	0.2669
Single	0.1127	11.9%	0.0594	0.0578
Unknown	0	0	0	

Table 6: Detailed results of linear regression analysis of medical payment severities for Michigan vs. comparison states adding policy limits as a control variable (cont'd)				
Parameter	**Estimate**	**Effect**	**Standard error**	**P-value**
Risk				
Nonstandard	-0.0440	-4.3%	0.0365	0.2274
Standard	0	0	0	
Registered vehicle density				
<100	-0.0068	-0.7%	0.0344	0.8440
500+	0.0244	2.5%	0.0318	0.4430
100-499	0	0	0	
Temperature range				
Moderate	-0.7824	-54.3%	0.5863	0.1820
High	0	0	0	
Precipitation	-0.0069	-0.7%	0.0094	0.4640
Temperature	0.0022	0.2%	0.0041	0.5961
Temperature × temperature range				
Moderate	0.0129	1.3%	0.0093	0.1648
High	0	0	0	
Policy limit ranges				
0 - 4,999	-1.0917	-66.4%	0.0435	<0.0001
5,000 - 9,999	0	0	0	
10,000 - 14,999	0.5689	76.6%	0.0630	<0.0001
15,000 - 19,999	-0.1404	-13.1%	0.2345	0.5493
20,000 - 24,999	0.9312	153.8%	0.1279	<0.0001
25,000 - 29,999	1.2926	264.2%	0.1001	<0.0001
30,000+	1.3119	271.3%	0.1368	<0.0001

Collision coverage

Figure 5 illustrates the actual changes in collision claim frequency, severity, and overall loss in Michigan and the control states after the helmet law was weakened. These results do not control for any of the variables available in the HLDI data. Michigan claim frequency increased by 12.6 percent, while the increase in the control states was just 3 percent.

Figure 5: Actual change in collision losses after Michigan helmet law versus control states



Summary results of the regression analysis of motorcycle collision claim frequencies using the Poisson distribution are listed in Table 7. Nine of the variables included in the analysis had p-values less than 0.05, indicating their effects on claim frequency were statistically significant. Gender, temperature, temperature range, precipitation, state × time period, and temperature × temperature range did not significantly affect claim frequency.

Table 7: Summary results of linear regression analysis of collision claim frequencies for Michigan vs. comparison states

	Degrees of freedom	Chi-Square	P-value
State	4	142.33	<0.0001
Time period	1	3.89	0.0486
State × time period	4	5.29	0.2586
Vehicle age	1	437.81	<0.0001
Motorcycle class	9	823.19	<0.0001
Rated driver age	3	170.75	<0.0001
Rated driver gender	2	5.53	0.0630
Rated driver marital status	2	72.87	<0.0001
Risk	1	81.33	<0.0001
Deducible	3	101.48	<0.0001
Registered vehicle density	2	87.46	<0.0001
Temperature range	1	1.33	0.2493
Precipitation	1	2.89	0.0893
Temperature	1	3.51	0.0611
Temperature × temperature range	1	0.83	0.3623

Summary results of the regression analysis of motorcycle collision claim severities using the Gamma distribution are listed in Table 8. Nine of the variables included in the analysis had p-values less than 0.05, indicating their effects on claim severity were statistically significant. Time period, marital status, temperature range, precipitation, temperature, and temperature × temperature range did not significantly affect claim severity.

Table 8: Summary results of linear regression analysis of collision claim severities for Michigan vs. comparison states

	Degrees of freedom	Chi-Square	P-value
State	4	21.86	0.0002
Time period	1	2.23	0.1355
State × time period	4	9.54	0.0490
Vehicle age	1	8.18	0.0042
Motorcycle class	9	943.29	<0.0001
Rated driver age	3	9.03	0.0289
Rated driver gender	2	17.19	0.0002
Rated driver marital status	2	0.90	0.6365
Risk	1	38.12	<0.0001
Deducible	3	102.34	<0.0001
Registered vehicle density	2	10.23	0.0060
Temperature range	1	0.34	0.5584
Precipitation	1	2.20	0.1379
Temperature	1	1.06	0.3037
Temperature × temperature range	1	0.59	0.4436

Detailed results of the regression analysis for collision claim frequency, severity and overall losses are listed in Table 9. The table shows estimates and significance levels for the individual values of the categorical variables. To make the results more illustrative, a column was added that contains the effect of the estimates. The estimates associated with the state and time period interaction indicate that the change in collision losses for each of the comparison states is lower relative to Michigan after the law change. For example, the change in Ohio's claim frequency was 14.3 percent lower than Michigan after the law change, a result that was significant. Michigan had higher collision claim frequencies than all of the control states after the law change. Only the comparison with Ohio was significant. Collision claim severities in Michigan did not differ significantly from the control states after the law change. The effects of the independent variables on motorcycle collision overall losses, derived from the claim frequency and claim severity models are also displayed in Table 9. Overall losses were calculated the same way as medical payments. Michigan had higher overall losses than all the control states after the law change. Only the comparison with Wisconsin was significant.

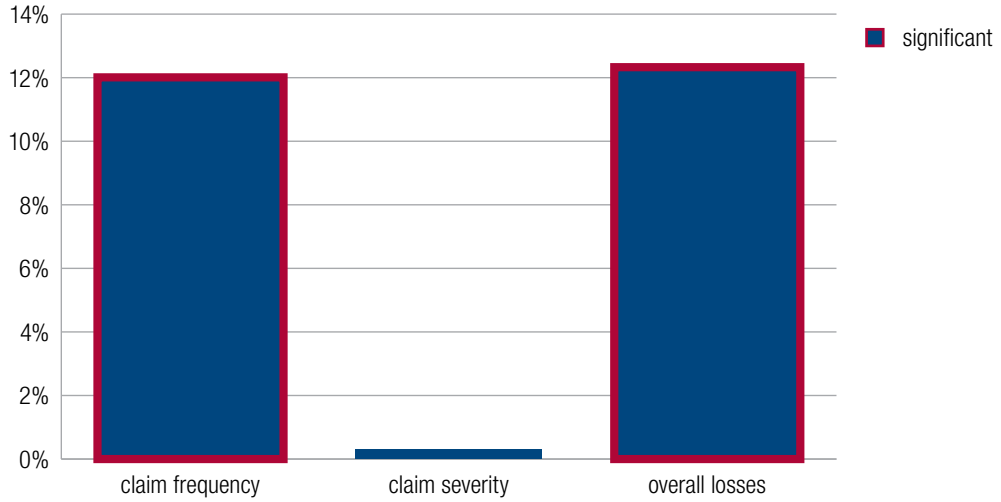
Table 9: Results for collision claim frequency, claim severity, and overall losses derived from claim frequency and severity models

	Claim frequency				Claim severity				Overall loss			
	Estimate	Effect	Standard error	P-value	Estimate	Effect	Standard error	P-value	Estimate	Effect	Standard error	P-value
Intercept	-9.4500		0.2469	<0.0001	8.5211		0.1976	<0.0001	-0.9290		0.3162	0.0033
State												
Illinois	-0.2962	-25.6%	0.0453	<0.0001	0.0659	6.8%	0.0359	0.0663	-0.2303	-20.6%	0.0578	<0.0001
Indiana	-0.2441	-21.7%	0.0515	<0.0001	0.0148	1.5%	0.0405	0.7142	-0.2293	-20.5%	0.0655	0.0005
Ohio	-0.3985	-32.9%	0.0462	<0.0001	-0.0008	-0.1%	0.0366	0.9836	-0.3992	-32.9%	0.0590	<0.0001
Wisconsin	-0.3640	-30.5%	0.0511	<0.0001	0.1862	20.5%	0.0401	<0.0001	-0.1778	-16.3%	0.0649	0.0062
Michigan	0	0	0		0	0	0		0	0	0	
Time period												
After	0.1435	15.4%	0.0581	0.0134	0.0342	3.5%	0.0459	0.4560	0.1777	19.5%	0.0740	0.0163
Before	0	0	0		0	0	0		0	0	0	
State × time period												
After (Illinois)	-0.0734	-7.1%	0.0714	0.3041	0.0250	2.5%	0.0566	0.6583	-0.0484	-4.7%	0.0911	0.5955
After (Indiana)	-0.1487	-13.8%	0.0841	0.0768	0.0600	6.2%	0.0662	0.3648	-0.0887	-8.5%	0.1070	0.4070
After (Ohio)	-0.1548	-14.3%	0.0755	0.0403	0.0160	1.6%	0.0595	0.7881	-0.1388	-13.0%	0.0961	0.1486
After (Wisconsin)	-0.0839	-8.0%	0.0817	0.3047	-0.1198	-11.3%	0.0641	0.0618	-0.2036	-18.4%	0.1039	0.0499
After (Michigan)	0	0	0		0	0	0		0	0	0	
Before (Illinois)	0	0	0		0	0	0		0	0	0	
Before (Indiana)	0	0	0		0	0	0		0	0	0	
Before (Michigan)	0	0	0		0	0	0		0	0	0	
Before (Ohio)	0	0	0		0	0	0		0	0	0	
Before (Wisconsin)	0	0	0		0	0	0		0	0	0	
Vehicle age	-0.1130	-10.7%	0.0054	<0.0001	-0.0117	-1.2%	0.0041	0.0042	-0.1247	-11.7%	0.0068	<0.0001
Motorcycle class												
Chopper	0.1418	15.2%	0.1349	0.2931	0.2692	30.9%	0.1042	0.0098	0.4110	50.8%	0.1704	0.0159
Dual purpose	-0.6510	-47.9%	0.0955	<0.0001	-0.2163	-19.5%	0.0743	0.0036	-0.8673	-58.0%	0.1210	<0.0001
Scooter	-0.4119	-33.8%	0.0605	<0.0001	-0.8141	-55.7%	0.0473	<0.0001	-1.2260	-70.7%	0.0768	<0.0001
Sport	0.5991	82.1%	0.0474	<0.0001	-0.1568	-14.5%	0.0370	<0.0001	0.4424	55.6%	0.0601	<0.0001
Sport touring	0.0422	4.3%	0.0827	0.6098	0.2079	23.1%	0.0638	0.0011	0.2501	28.4%	0.1045	0.0167
Standard	0.0652	6.7%	0.1088	0.5494	-0.2448	-21.7%	0.0848	0.0039	-0.1797	-16.4%	0.1380	0.1928
Super sport	0.8521	134.5%	0.0364	<0.0001	0.0555	5.7%	0.0286	0.0524	0.9075	147.8%	0.0463	<0.0001

Table 9: Results for collision claim frequency, claim severity, and overall losses derived from claim frequency and severity models (cont'd)												
	Claim frequency				Claim severity				Overall loss			
	Estimate	Effect	Standard error	P-value	Estimate	Effect	Standard error	P-value	Estimate	Effect	Standard error	P-value
Touring	0.2622	30.0%	0.0274	<0.0001	0.4586	58.2%	0.0215	<0.0001	0.7208	105.6%	0.0348	<0.0001
Unclad sport	0.2767	31.9%	0.0695	<0.0001	-0.1421	-13.3%	0.0540	0.0085	0.1346	14.4%	0.0880	0.1261
Cruiser	0	0	0		0	0	0		0	0	0	
Rated driver age												
21-24	0.6746	96.3%	0.0496	<0.0001	-0.0997	-9.5%	0.0390	0.0106	0.5749	77.7%	0.0631	<0.0001
25-39	0.1326	14.2%	0.0271	<0.0001	-0.0164	-1.6%	0.0211	0.4366	0.1162	12.3%	0.0344	0.0007
65+	-0.0655	-6.3%	0.0481	0.1730	0.0549	5.6%	0.0376	0.1447	-0.0106	-1.1%	0.0611	0.8623
40-64	0	0	0		0	0	0		0	0	0	
Rated driver gender												
Female	-0.0286	-2.8%	0.0465	0.5383	-0.1511	-14.0%	0.0361	<0.0001	-0.1797	-16.5%	0.0589	0.0023
Unknown	-0.1062	-10.1%	0.0451	0.0185	-0.0046	-0.5%	0.0354	0.8960	-0.1108	-10.5%	0.0573	0.0532
Male	0	0	0		0	0	0		0	0	0	
Rated driver marital status												
Married	-0.1052	-10.0%	0.0444	0.0178	0.0282	2.9%	0.0347	0.4170	-0.0770	-7.4%	0.0564	0.1718
Single	0.1897	20.9%	0.0477	<0.0001	0.0092	0.9%	0.0372	0.8038	0.1989	22.0%	0.0605	0.0010
Unknown	0	0	0		0	0	0		0	0	0	
Risk												
Nonstandard	0.2567	29.3%	0.0281	<0.0001	-0.1345	-12.6%	0.0216	<0.0001	0.1222	13.0%	0.0355	0.0006
Standard	0	0	0		0	0	0		0	0	0	
Deductible												
0-100	0.1229	13.1%	0.0497	0.0133	-0.1352	-12.6%	0.0386	0.0005	-0.0123	-1.2%	0.0629	0.8451
101-250	0.1167	12.4%	0.0259	<0.0001	-0.1184	-11.2%	0.0205	<0.0001	-0.0016	-0.2%	0.0330	0.9607
>500	-0.3145	-27.0%	0.0419	<0.0001	0.2138	23.8%	0.0328	<0.0001	-0.1007	-9.6%	0.0532	0.0583
251-500	0	0	0		0	0	0		0	0	0	
Registered vehicle density												
<100	-0.1015	-9.7%	0.0302	0.0008	-0.0482	-4.7%	0.0236	0.0417	-0.1496	-13.9%	0.0384	<0.0001
500+	0.1692	18.4%	0.0244	<0.0001	0.0301	3.1%	0.0193	0.1175	0.1994	22.1%	0.0311	<0.0001
100-499	0	0	0		0	0	0		0	0	0	
Temperature range												
Moderate	-0.5340	-41.4%	0.4642	0.2500	-0.2141	-19.3%	0.3656	0.5581	-0.7481	-52.7%	0.5909	0.2055
High	0	0	0		0	0	0		0	0	0	
Precipitation	-0.0139	-1.4%	0.0082	0.0899	-0.0095	-1.0%	0.0064	0.1374	-0.0234	-2.3%	0.0104	0.0244
Temperature	0.0062	0.6%	0.0033	0.0611	0.0012	0.1%	0.0027	0.6602	0.0074	0.7%	0.0043	0.0825
Temperature × temperature range												
Moderate	0.0067	0.7%	0.0074	0.3628	0.0044	0.4%	0.0058	0.4432	0.0111	1.1%	0.0094	0.2343
High	0	0	0		0	0	0		0	0	0	

Weighted averages of the model estimates for the interaction of state and time period also were calculated. The results of this analysis are similar to the patterns seen in the actual results (Figure 5) and are shown in Figure 6. Collision claim frequency (12.0 percent) and overall losses (12.3 percent) increased significantly while claim severity remained essentially unchanged (0.3 percent increase).

Figure 6: Effects of helmet law change on Michigan collision losses, estimates of control states pooled



Discussion

The likelihood of having a crash in Michigan increased after the Michigan helmet law was weakened, as evidenced by the increase in collision claim frequency. The likelihood of having a crash that produced an injury also increased, as evidenced by the increase in MedPay claim frequency. Claim severity under medical payments coverage increased by more than 36.3 percent in Michigan compared with control states after Michigan's helmet law was weakened. From an insurance perspective, the weakening of the law is associated with a 50.6 percent increase in overall losses under medical payment coverage and a 12.3 percent increase in overall collision losses.

As implemented, Michigan's revised helmet law presents an analytical challenge to using insurance data to measure the severity of injuries. While the revised law allowed motorcyclists to ride helmetless, which would likely impact the severity of injuries, it also caused some motorcyclists to increase their MedPay policy limits. This increase in limits increased the amount of money that could be spent on a claim. Consequently, in order to gauge the impact of the law on injuries, the effect of the change in helmet requirements must be separated from the new insurance requirement. After controlling for the new insurance requirement, claim severity in Michigan increased by more than 22 percent compared with control states after the helmet law was weakened.

The increase in collision claim frequency merits further discussion. Those who argue against helmet laws often state that requiring helmet use discourages people from riding. It is possible that the increase in collision claim frequency was caused by people traveling more miles on motorcycles. However, opponents of helmet laws also often state that helmets increase the likelihood of crashes because they increase rider fatigue and decrease situational awareness. Assuming fewer riders in Michigan wore helmets after the law change, the increase in collision claim frequency is inconsistent with the notion that helmets increase crash risk.

Limitations

Information about the type of injury associated with a medical payment claim is not available in the HLDI database. Helmets are designed to reduce head injuries, and knowing if a head injury occurred could greatly improve the analysis. It also is unknown whether or not a rider was wearing a helmet at the time of the crash. Observational studies indicate about half of motorcyclists wear helmets even when not required (NHTSA, 2012). It should also be noted that the claims assessed in this study are based on the garaging state of the motorcycle. The claims for collisions occurring in Michigan for motorcycles garaged in another state are categorized in their home state. HLDI's data does not indicate the collision location and thus all claims must be associated with the garaging location of the motorcycle.

References

Highway Loss Data Institute. 2010. Mean temperature and precipitation effects on motorcycle collision claim frequency. HLDI bulletin 27(7). Arlington, VA.

National Highway Traffic Safety Administration. 2008. Traffic safety facts, laws: motorcycle helmet use laws. Report no. DOT-HS-810-887. Washington, DC: Department of Transportation.

National Highway Traffic Safety Administration. 2012. Motorcycle helmet use in 2011 — overall results. Report no. DOT HS-811-610. Washington, DC: U.S. Department of Transportation.

Ulmer, R.G. and Northrup, V.S. 2005. Evaluation of the repeal of the all-rider motorcycle helmet law in Florida. Report no. DOT-HS-809-849. Washington, DC: National Highway Traffic Safety Administration.

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.