Auto Loss Costs: Personal Injury Protection

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When all of the PIP states are analyzed together, frequency is positively related to vehicle miles traveled over land area of the state. When broken up even further into the states that have a verbal threshold, we see that the percentage of male licensed drivers over 75 has the greatest effect on frequency. For monetary threshold states, interstate travel has the greatest effect. For severity and loss cost, all of the PIP states were analyzed and had similar results. For both, the state of Michigan was a large outlier. The main driver of both severity and loss cost turned out to be the percentage of interstates in the state with both having a negative relationship.

Introduction

Personal Injury Protection (PIP) pays for post-collision medical expenses regardless of who was at fault. It is only available in certain states. Some states require it, while in others it is optional. In some states there is a monetary threshold to sue instead of filing a PIP claim (once the claim reaches a certain amount), other states have a verbal threshold, meaning it is only legal to sue for certain types of injuries such as disfigurement. The only states considered in this report are those which have PIP insurance (optional or required).

We collected data describing two areas: insurance claims costs (frequency, severity, and loss costs) and environmental factors that could potentially influence the insurance claim costs. The insurance claims costs come from the project sponsors. All other data was collected from government agencies like the Federal Highway Administration and the Federal Bureau of Investigation. The data goes from the first quarter of 2010 to the last quarter of 2018. Here is a list of the most important variables used:

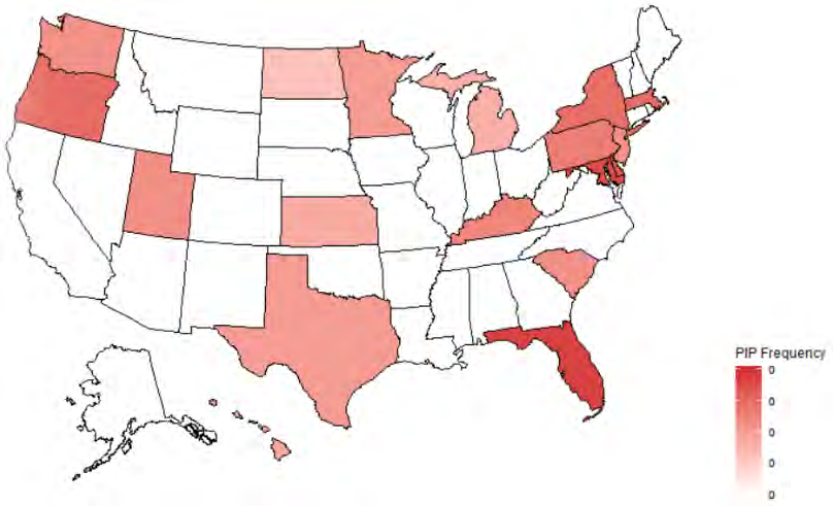
- The number of lawyers per 10 thousand people
- Percentage of licensed male drivers younger than 25
- Percentage of licensed male drivers older than 75
- Percentage of licensed male drivers between 25 and 75, inclusive
- Percentage of licensed female drivers younger than 25
- Percentage of licensed female drivers older than 75
- Percentage of licensed female drivers between 25 and 75, inclusive
- Percentage of road miles on rural roads
- Percentage of road miles on urban roads
- Vehicle miles traveled over land area in square kilometers for each state
- Percentage of vehicle miles traveled on the interstate
- Percentage of vehicle miles traveled on other freeways
- Percentage of vehicle miles traveled on principal arterial roads
- Percentage of vehicle miles traveled on minor arterial roads

- Percentage of vehicle miles traveled on major collector roads
- Percentage of vehicle miles traveled on minor collector roads
- Percentage of vehicle miles traveled on local roads
- Total industry GDP per capita
- Vehicle miles traveled over total road miles
- Urban vehicle miles traveled over total urban road miles
- Rural vehicle miles traveled over total rural road miles
- Total road miles over total land area

Frequency

When looking at frequency on a state by state basis, Florida and Maryland consistently have the highest frequency, while North Dakota comes in as the lowest. Most states do not offer PIP, as can be seen in the map in Figure 1, where these states are white. This lack of comprehensive data is something to keep in mind when looking at PIP trends.

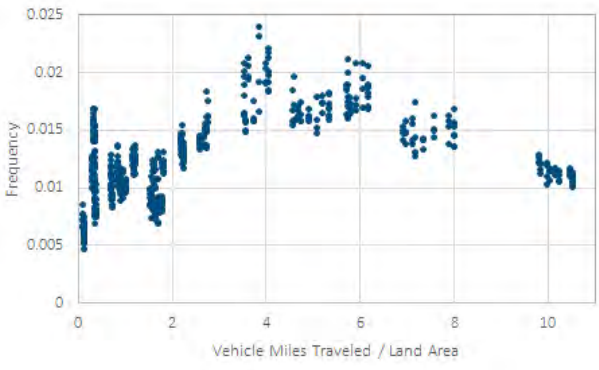
Figure 1
Personal Injury Protection Frequency by State



Vehicle Miles Traveled per Square Kilometer

All of the data was fit to a random forest model which indicated that the most significant factor affecting frequency is vehicle miles traveled per square kilometer of state land area. This has a positive correlation with frequency under 4 miles traveled per square kilometer, but becomes negative beyond that. It is presently unclear what causes the downturn as the ratio of miles traveled to land area increases, but this is probably greatly impacted by the small number of PIP states. The positive correlation indicates that more people driving in a smaller area increases PIP claim frequency. Following vehicle miles traveled per square kilometer for most important factors in the random forest model are total road length divided by land area, and congestion (Vehicle miles traveled per road mile), both of which have a positive correlation with PIP frequency.

Figure 2
Frequency by Vehicle Miles Traveled per Square Kilometer

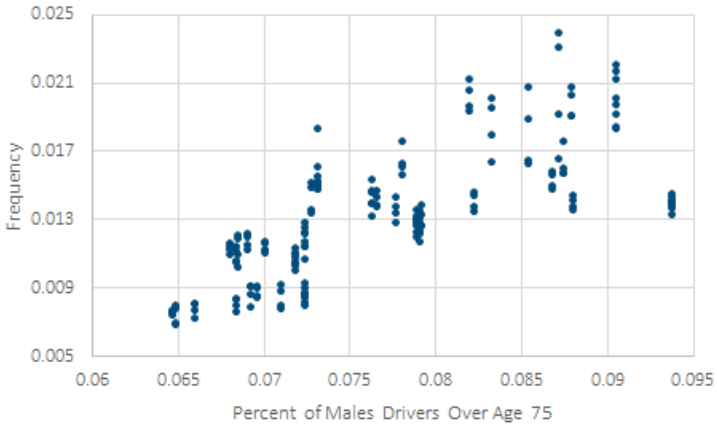


Verbal Threshold

Since PIP is divided into two different types of legal thresholds, verbal and monetary, it is important to look at the differences between the two. The states with a verbal threshold were put into one random forest. The random forest showed that the percentage of the male population over 75 was the top factor influencing frequency. Older male populations and frequency are positively correlated (Figure 3).

Figure 3

Frequency by Percent of Male Drivers Over Age 75



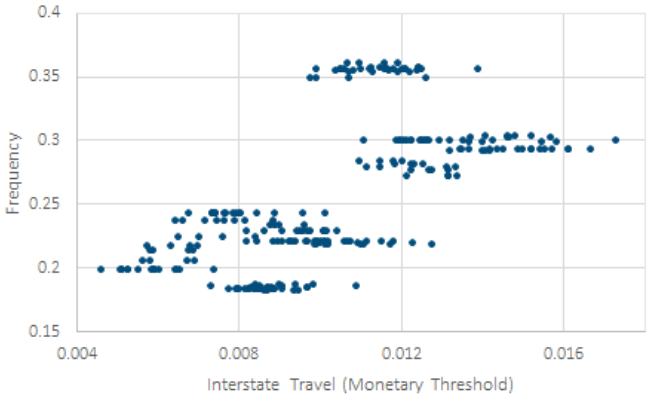
Monetary Threshold

When fitting a random forest for the monetary threshold states, the percentage of vehicle miles traveled on interstates was positively correlated with frequency (Figure 4).

PIP frequency seems to mostly be driven by an increase in miles traveled in smaller areas and by congestion. However, because of the two types of legal thresholds within PIP states, there are different factors that impact each threshold. For verbal threshold states, an aging driver population impacts frequency. In monetary threshold states, we see an increase in frequency with an increase in interstate travel.

Figure 4

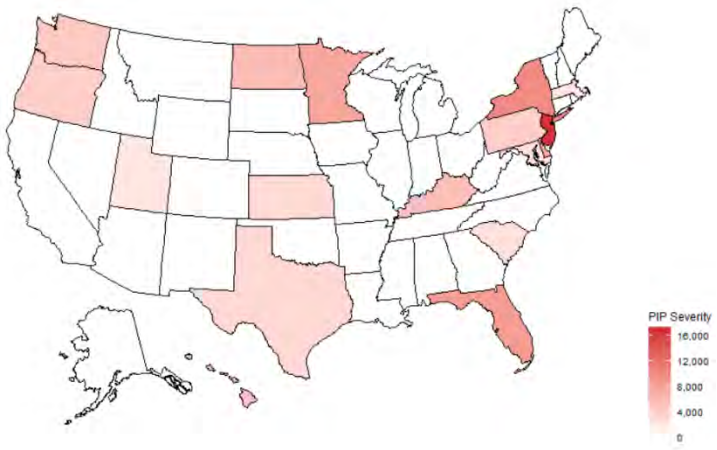
Frequency by Interstate Travel (Monetary Threshold)



Severity

An overview of the data revealed that Michigan is a clear outlier for PIP severity. Michigan has a unique mandate in its no-fault insurance law that requires the insurance company of an injured driver to pay for "all reasonable charges incurred for reasonably necessary products, services and accommodations for an injured person's care, recovery, or rehabilitation" (Michigan Insurance Code Act of 1956, section 500.3183). This increases the severity for PIP claims. Since Michigan has a much greater severity than all other states, it was not included in any of our analyses. Once Michigan was excluded from the analysis, the graph in Figure 5 shows PIP severity by state.

Figure 5
Personal Injury Protection Severity by State



The results for severity and loss costs will be limited by the fact that we do not have access to the average coverage limit by state.

Interstate Percentage

A random forest, with Michigan excluded, determines which variables are most significant for PIP severity. The results show that the percent of interstate roads is the most important factor in determining PIP severity. The graph in Figure 6 displays a negative correlation between the severity variable and the interstate percentage.

The next biggest factors affecting severity, as indicated from the random forest model, are the percent of other freeways, miles traveled divided by land area, and male drivers greater than 75 years old. The graph in Figure 7 shows how other freeways affect the severity of PIP. Figure 7 indicates a positive relationship between the percent of other freeways and the severity. This means that as the percent of other freeways decreases, so does the severity.

Other Freeways

Surprisingly, other freeway percentage is positively correlated with the PIP severity while the interstate percentage is negatively correlated. The correlation between other freeways and interstate percentages is slightly negative. Based on this information, it appears that interstate percentage and other freeway percentage are not strongly correlated. Hence, other freeways are an important factor at play.

When examining PIP severity, it appears that the road type is most important when determining severity. This could be due to faster speed limits or the types of crashes that occur along different types of roads.

Figure 6
Interstate Percentage Added-Variable Plot

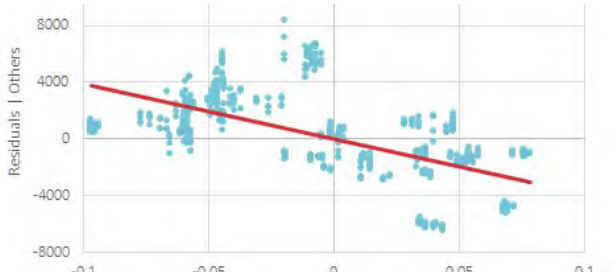


Figure 7
VMBFS Other Freeways Percentage Added-Variable Plot

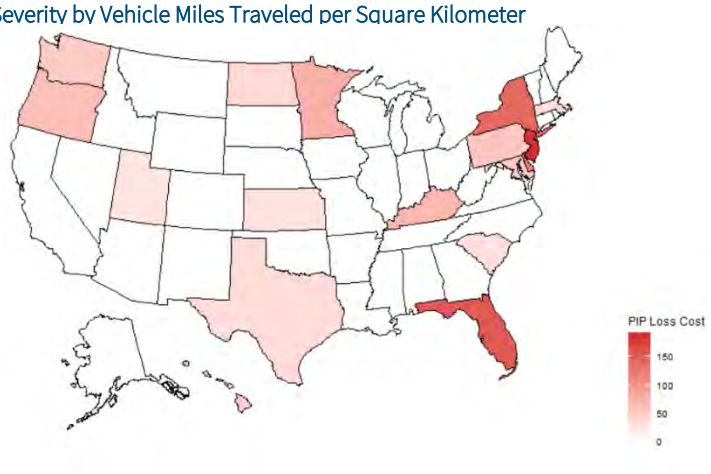
Loss Costs

As with severity, Michigan is an outlier with loss costs, so the analysis will be completed without Michigan. As can be seen in the map in Figure 8, New Jersey and Florida have the highest loss costs in the U.S. in the absence of Michigan.

To analyze the data, a random forest model was fit to predict which variables have the biggest effect on loss costs. In order to negate the effects of inflation over time, a linear model was run on the natural log of loss cost by time, the residuals from this linear model were then used in the random forest model as the response variable. The model identified the percentage of vehicle miles based on functional system on the interstate and the percentage of licensed drivers that are males over age 75 as the largest drivers of loss costs.

Figure 8

Severity by Vehicle Miles Traveled per Square Kilometer



Interstate Percentage

As can be seen in the added-variable plot for the percentage of vehicle miles on the interstate (Figure 9) there is a strong negative correlation with loss costs. A possible explanation for this is that because on interstates, people drive in the same direction and generally the same speed. This could lead to fewer accidents and therefore less loss costs as driving is more predictable on these roads.

Males over 75

On the added-variable plot for the percentage of licensed drivers that are males over age 75 (Figure 10), there is a positive correlation between loss costs. Older males may have slower reaction times behind the wheel and are more susceptible to serious injury.

Figure 9

VMBFS Interstate Percentage Added-Variable Plot

Figure 11

Percent of Male Drivers Over 75 Added-Variable Plot

Conclusion

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Additional Tables

Parameter	Severity Linear Model			
	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	15589.57	1009.33	15.445	< 2e-16
VMBFS Minor Arterial Percentage	6902.38	3592.71	1.921	0.05517
VMBFS Interstate Percentage	-38529.47	1982.63	-19.434	< 2e-16
VMBFS Major Collector Percentage	-28478.58	4640.64	-6.137	1.52E-09
VMBFS Other Freeways Percentage	9850.45	2649.83	3.717	0.00022
VMTM Land Area	297.20	49.69	5.981	3.8E-09

Parameter	Loss Cost Linear Model			
	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-3.19871	13.89139	-0.230	0.818
Percentage of Male Drivers Over 75	1908.56528	149.27238	12.786	< 2e-16
VMBFS Interstate Percentage	-260.95201		27.93136	< 2e-16
Lawyers per 10000	0.33698	0.08247	4.086	0.0000497
VMTM Land Area	16.13271	1.19101	13.545	< 2e-16
Roads to Land	-21.39313	2.61296	-8.187	1.58E-15