MEDICAL MALPRACTICE INSURANCE AND ITS PREMIUM

JING YANG
SPRING 2014

A thesis
submitted in partial fulfillment
of the requirements
for baccalaureate degrees
in Mathematics and Statistics
with honors in the Mathematics

Reviewed and approved* by the following:

Ron Gebhardtsbauer
Clinical Associate Professor
Thesis Supervisor

Mark Levi
Professor
Honors Advisor

* Signatures are on file in the Schreyer Honors College.
ABSTRACT

Medical malpractice insurance (medical professional liability insurance) is an insurance protecting medical professionals from lawsuit by patients. As other insurances, medical malpractice insurance is a business contract, helping to alleviate the conflict between patients and medical providers. In general, if the medical professionals lose the litigation with the patients, the insurance companies who insure the medical professionals pay the claims to patients. The insurance providers insure the liability of medical professionals and the medical professionals pay the premiums to them. In the early part of the last decade, medical malpractice insurance premiums have increased a lot, so physicians and hospitals nationwide were very concerned.

This paper examines the variables that may contribute to the increasing medical malpractice insurance premiums. To achieve this goal, this paper first explores the historical background of malpractice insurance, as well as the reasons that may cause the growth of the medical malpractice insurance premiums. Then, Chapter 2 will employ qualitative and quantitative techniques to analyze what variables increase the medical malpractice insurance premiums. The results of the qualitative and quantitative analysis are given in Chapter 3. Chapter 4 provides the implication of the findings and possible recommendations for limiting or controlling the future increase of the premiums in the United States.
# TABLE OF CONTENTS

List of Figures ........................................................................................................ iii

List of Tables ........................................................................................................ iv

Acknowledgements ............................................................................................... v

Chapter 1 Introduction ......................................................................................... 1

  Introduction ........................................................................................................ 1
  Background ........................................................................................................ 2
  Current Situation of Premium Malpractice Insurance ..................................... 3
  Research Questions ............................................................................................ 8

Chapter 2 Methods ............................................................................................... 9

  Previous Studies ............................................................................................... 9
  Methods for Analyzing Premiums of Malpractice Insurance .......................... 11

Chapter 3 Results ................................................................................................. 12

  Qualitative Analysis .......................................................................................... 12
    Medical Variables ........................................................................................... 12
    Economic Variables ....................................................................................... 13
    Legal Variables ............................................................................................. 13
  Quantitative Analysis ....................................................................................... 14
    Variable 1 Licensed or Non-admitted Market Premium Written .................. 14
    Variable 2 Direct Losses Incurred ................................................................ 16
    Variable 3 Direct Defense And Cost Containment Expense Incurred .......... 18
    Analysis of Regression ................................................................................... 19

Chapter 4 Discussion .......................................................................................... 26

  Discussion .......................................................................................................... 26
  Recommendation .............................................................................................. 27
  Conclusion ......................................................................................................... 29

Appendix A SAS Code for regression analyses of variables and medical malpractice insurance premiums in Missouri ......................................................... 30

Appendix B Regression output of variables and medical malpractice insurance premiums in Missouri ................................................................. 31

BIBLIOGRAPHY ................................................................................................. 41
LIST OF FIGURES

Figure 1. Direct premium written in US from 1991 to 2012 (Unit: Dollar) ......................... 4
Figure 2: Direct premium earned in US from 1991 to 2012 (Unit: Dollar) ......................... 4
Figure 3: Direct premium written in Missouri from 1991 to 2012 (Unit: Dollar) ............... 5
Figure 4: Direct premium earned in Missouri from 1991 to 2012 (Unit: Dollar) ............... 5
Figure 5: Market division of medical malpractice insurance applicants in 2012 (Unit:Dollar) ........................................................................................................................................ 7
Figure 6: Licensed market premium written and non-licensed in Missouri from 2000 to 2012(Unit: Dollar) ......................................................................................................................................................... 16
Figure 7: Direct losses incurred in US from 1991 to 2012 (Unit: Dollar) ......................... 17
Figure 8: Direct losses incurred in Missouri from 2000 to 2012 (Unit: Dollar) ............... 18

Figure 9: Direct defense and Cost Containment expenses incurred in US (Unit: Dollar) ...... 19
Figure 10: Direct defense and Cost Containment expenses incurred in Missouri (Unit: Dollar) ........................................................................................................................................ 20
Figure 11: Regression analysis of variable 1 and medical malpractice insurance premiums in Missouri (Unit: Dollar) ............................................................................................................................. 21
Figure 12: the Pearson Correlation Coefficients Analysis Between Variable2 And Variable3 ......................................................................................................................................................... 23
Figure 13: Regression analysis of variable 2 and medical malpractice insurance premiums in Missouri (Unit: Dollar) ............................................................................................................................. 24
Figure 14: Regression analysis of variable 3 and medical malpractice insurance premium in Missouri (Unit: Dollar) ........................................................................................................................................ 25
ACKNOWLEDGEMENTS

I would like to thank my thesis advisor, Professor Ron Gebhardtsbauer for valuable advice and directions. I would like to thank Professor Mark Levi, my honors advisor, and Laurie Allen for taking the time out to review my thesis and provide support throughout this entire process. My thesis cannot be completed without their efforts.
Chapter 1

INTRODUCTION

Introduction

Medical malpractice insurance (medical professional liability insurance) is an insurance protecting medical professionals from lawsuit by patients who feel that they were improperly treated (NAIC 2014). In the United States, the approach to solving medical malpractice problems is to sue the doctor who committed malpractice. If the defendant (generally a health care provider) loses, and the complainant (usually patients) wins, the insurance companies take the responsibility of paying the medical negligence damage in the range of the contractual insurance.

Medical malpractice insurance is a combination of laws, medical systems, and insurance policies. Once a medical malpractice incident takes place and a conflict between doctors and patients occurs, a lawsuit will arise. Lawyers who represent patients will launch the lawsuit. According to legal procedure in the US, the patient authorizes a lawyer to send a letter to the defendant doctor, then the defendant doctor will transfer the letter to his or her insurance agency. The insurance company will spend a large amount of money to investigate the validity of the malpractice incident. If the medical professional’s negligence is proven to be true, the lawyer who represents the insurance company may claim that the incident is not covered by the insurance policy and bargain for less compensation. Usually, the lawyer who represents the doctor will not accept the offer, and then the dispute will be transferred from patients versus doctors into insurance companies versus doctors. The lawsuit procedure is very long and the attorney fees are extremely high, while the interest earned on the premiums of insurance companies is low. To
offset the costs, the insurance companies have to increase the medical malpractice insurance premiums. If the insurance companies raise the premiums, the medical professionals need to raise their medical fees as well to pay the increasing premiums, or the medical professionals have to stop buying the medical malpractice insurance, which would be a real problem because a malpractice claim could then bankrupt them.

Every step within this procedure will change the cost of the malpractice insurance and then lead to the fluctuations of its premium. But what factors have significant effect on it? This paper will discuss the factors that have significant effect on premium of the medical malpractice insurance in America.

**Background**

Since the mid-1970s, the United States has experienced three significant medical crises due to the growth of medical malpractice insurance premiums. In the mid 1970s, federal government required all the states to change their medical malpractice policies and required insurance companies states to pay for medical negligence losses. (Stuart L. Weinstein) Cost of malpractice insurance increased dramatically. Insurance companies raised premium rates for medical liability insurance by 15% to 30%. For this reason, healthcare providers were unable to pay the extremely high premiums, so the medical service market shrunk. The second stage was in the 1980s, when the National Association of Insurance Commissioners (NAIC) banned insurance companies from raising premiums. (Eric Nordman, Davin Cermak and Kenneth McDaniel) The insurance companies could not make a profit based on the premium rate anymore, so they could do nothing but just exit the market. The third medical crisis occurred at the beginning of the 21st century, when insurance companies suffered losses because of poor pricing decisions and the lack of policyholders. (Stuart L. Weinstein)
Insurance companies calculate the premiums of malpractice insurance based on healthcare providers’ specialty, geographic location of the medical professionals, scope of the insurance coverage, claims severity, claims frequency, and laws in corresponding areas. It is very complex for insurance companies to estimate the price of medical malpractice.

**Current Situation of Medical Malpractice Insurance**

As demonstrated in Figure 1, direct premiums written for medical malpractice insurance in the United States rose a lot in the early part of the last decade and then declined after 2006. The premiums written in 1991 were $5,041,116,742. Then the premium written began to increase gradually until 2000 ($6,428,278,303). The following six years, the premium written increased dramatically. The premium written in 2006 ($12,332,430,917) doubled from that in 2000 ($6,428,278,303). After 2006, the premium written decreased to $10,019,229,369 (2012), which is a lot when considering that inflation increased costs by double digits over that period. The trend of premium earned is similar to the trend of premium written as discussed above (See Figure 2). The first one is based on cash accounting, and the second is according to accrual accounting. The trends of individual states are similar to the trends of the whole country. For example, direct premiums written and direct premium earned in Missouri have similar development trend as that in the whole country from 1991 to 2006 (See Figure 3 and Figure 4). After 2006, its decreasing rate is a little higher than the whole United States.
Figure 1: Direct premium written in the United States from 1991 to 2012 (Unit: Dollar)

Source: National Association Insurance Commissioners

Figure 2: Direct premium earned in the United States from 1991 to 2012 (Unit: Dollar)

Source: National Association Insurance Commissioners
Figure 3: Direct premium written in Missouri from 1991 to 2012 (Unit: Dollar)

Source: National Association Insurance Commissioners

Figure 4: Direct premium earned in Missouri from 1991 to 2012 (Unit: Dollar)

Source: National Association Insurance Commissioners
According to recent data about market division of malpractice insurance applicants (See Figure 5), the largest percentage of insurance applicants are physicians and surgeons (69.67%), who account for nearly 70% of the whole market. The second largest insurance applicant is hospitals (20.71%), followed by dentists (3.09%), nurses (0.29%) and all other medical professionals (6.24%).

The loss ratio for each division discussed above is as follows:

The largest market insurance applicant, the physicians and surgeons, had a 17.8% loss ratio while hospitals had the highest loss ratio (33.80%). Nurses had a 21.70% loss ratio, ranking second among the five groups of applicants. Dentists and all other providers generated a negative loss ratio of -84.90% and -60.80% respectively. The loss ratio is equal to amount of losses divided by premiums (Donald J. Riggin). The negative loss ratio means that insurance companies made profits (ignoring the investment income on the premium). It implies that the insurance for dentists and all other providers can produce positive profits while the insurance for the other healthcare providers didn’t.
Figure 5: Market division of medical malpractice insurance applicants in 2012 (Unit: Dollar)

<table>
<thead>
<tr>
<th></th>
<th>Physicians &amp; Surgeons</th>
<th>Hospitals</th>
<th>Dentists</th>
<th>Nurses</th>
<th>All Other Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss Ratio</td>
<td>17.80%</td>
<td>33.80%</td>
<td>-84.90%</td>
<td>21.70%</td>
<td>-60.80%</td>
</tr>
<tr>
<td>Direct Incurred Losses</td>
<td>16,426,167</td>
<td>9,127,742</td>
<td>-3,430,038</td>
<td>80,779</td>
<td>4,468,479</td>
</tr>
<tr>
<td>Direct Paid Losses</td>
<td>29,093,806</td>
<td>7,454,710</td>
<td>371,931</td>
<td>11,860</td>
<td>1,931,649</td>
</tr>
<tr>
<td>Loss Adjustment Expense</td>
<td>20,989,427</td>
<td>2,757,243</td>
<td>1,407,461</td>
<td>36,462</td>
<td>1,009,801</td>
</tr>
<tr>
<td>Direct Premium Earned</td>
<td>92,038,687</td>
<td>27,023,744</td>
<td>4,040,694</td>
<td>372,591</td>
<td>8,139,433</td>
</tr>
<tr>
<td>Direct Premium Written</td>
<td>90,030,972</td>
<td>26,758,217</td>
<td>3,992,620</td>
<td>373,509</td>
<td>8,066,454</td>
</tr>
</tbody>
</table>

Source: National Association Insurance Commissioners
Research Questions

Increasing premiums for malpractice insurance nationwide have been a disturbing problem from 1991 to 2006. When costs increase a lot, the availability of insurance services is curtailed. (Stuart L. Weinstein MD)

Based on such background, this paper aims to:

1) Discuss the possible variables (economic and non-economic) that increase the premiums and the reasons why the variables increase the premiums;

2) Test a hypothesis for malpractice insurance premium that the licensed or non-admitted market premium written, the direct losses incurred, and the defense and cost containment expense have significant effects on the amount of direct premiums written;

3) Give recommendations to decrease malpractice insurance premiums.
Chapter 2

METHODS

Previous Studies

In order to determine the variables that influence the increasing trend of premiums, it is necessary to critically review existing empirical studies and how the research was carried out.

Frank (2005) suggests that placing a cap on non-economic damages is one of the most effective short-term methods to stop the rising trend of premiums. He mainly uses the qualitative and narrative methods to demonstrate the “non-economic” damages, which include subjective claims, such as pain compensation, suffering compensation, and psychic trauma. Frank’s findings imply that non-economic factors increase the number of claims and the amount of paid medical negligence compensation per claim.

The Missouri Department of Insurance (2012) uses two methods to collect claim information for malpractice insurance. One is to collect the claim information per defendant. With this method, no matter how many claims a policyholder has, he or she would only be counted once. The other method is to collect the claim information of each claim. In this way, some people would be counted more than once.

The United States General Accounting Office (2003) utilizes annual surveys and questionnaires to collect data on medical malpractice insurance. Respondents include individual insurers and medical specialists (internal medicine, general surgery, and obstetrics/gynecology). Premium rates collected through the survey are base rates, which do not reflect discounts or additional charges. Therefore, the actual premium rates are different from the premium rates
collected from the survey. Unfortunately, the difference between base rates and actual rates is unpredictable.

Carlton (2005) adopts the risk-adjusted malpractice performance score (RAMPS) measurement in target hospitals and indicates the hospital structure has influence on medical costs and medical malpractice insurance. This study presents a simple and inexpensive way to explore the factors that affect medical malpractice insurance.

Carlton and David (2011) state that the possible variables that influence the medical malpractice insurance claims are the number of licensed practical nurses (LPNs), the number of registered nurses (RNs), the number of physician residents, and the number of employed physicians. They use the AHA (American Hospital Association) dataset to test their hypothesis. Since the distributions of these variables are skewed to the right, the researchers apply the logarithmic transformation to normalize them (Newton & Rudestam, 1999). Carlton and David (2011) find that hospitals with more employed physicians have lower medical malpractice claims, while hospitals with more physician residents have higher medical malpractice claims. The number of licensed practical nurses and registered nurses do not evidently change the claim costs of hospitals.
Methods for Analyzing Premiums of Malpractice Insurance

Most of the previous studies use both qualitative and quantitative methods to analyze premiums of malpractice insurance. The qualitative method measures non-numerical variables including the economic situation in the United States, laws and the medical system in the United States. When measuring continuous variables such as the medical malpractice insurance claims, premium rates, etc., the quantitative methods such as classification analysis, RAMPS models, and other statistical methods are applied.

This essay is attempting to determine the variables that lead to the growing medical malpractice insurance premiums, both the qualitative ones and the quantitative ones. In the qualitative analysis, medical variables, economic variables and legal variables will be discussed. In the quantitative analysis, the hypothesis: licensed or non-admitted market premium written, direct losses incurred and defense and cost containment expense may have a significant effect on the amount of direct premiums written (see Chapter 3) will be tested.
Chapter 3

RESULTS

Qualitative Analysis

Medical Variables

Since the mid-1970’s, medical technologies have made big advances in the United States. However, the development of medical technologies is a double-edged sword. On one hand, medical technologies bring better medical treatments and new hopes to patients. On the other hand, these new medical technologies may have side effects, which lead to an increase in medical incidents.

Furthermore, patients believe medical professionals should respond accurately to the patients’ illness, but actually, doctors do not always treat the patients correctly for a lot of reasons. And sometimes, even though the doctors provide correct treatments, the patients are still unable to recover. Even though this situation is not medical malpractice by the definition, patients and families tend to blame the medical professionals and ask for compensation. The incorrect understanding of medical malpractice will result in future disputes.

Because of the high expectation of medical services from patients, the healthcare providers have a higher chance of performing medical malpractice. If the number and the frequency of medical malpractice incidents rise, the premiums for the medical malpractice insurance will increase.
Economic Variables

From the economic perspective, the growth of medical malpractice lawsuits increased the compensation in the early part of the last decade. In addition, the United States has been experiencing an economic depression, and the investment income of insurance companies has decreased. In order to offset the financing gap of medical insurance, insurance companies had to increase medical malpractice insurance premiums. (Weinstein) Secondly, medical malpractice insurance premiums reflect the national economic situation, therefore the instability of the national economic situation increase the uncertainty of premium rates of malpractice insurance. In this situation, insurance companies have to increase the risk charge to avoid bankruptcy, which leads to the increase of premiums. Furthermore, the variables that determine the cost of insurance, such as the number of lawsuits, the final judgments, and compensation of medical malpractice, do not synchronize by time. The many variables make it harder for insurance companies to price the premiums. Since insurance companies cannot predict the total cost of medical malpractice correctly, the safest way for insurance companies is to charge more than they estimate. In addition, the medical malpractice insurance has a relatively smaller market scale and the number of insurers is much smaller than the number of life or health insurers. Therefore the risk charge for malpractice insurance will be larger, which directly leads to the growth of premiums for malpractice insurance.

Legal Variables

The legal and judicial environments in the United States are more supportive for patients to launch lawsuits. Under American laws, a jury that lacks medical background or any formal medical knowledge is more likely to support the vulnerable patients and be unfair to healthcare
providers. Besides, medical lawyers usually take 30% to 50% of the compensation paid to patients, so they are highly motivated to help patients to win their lawsuits. For instance, a medical lawyer may amplify the non-economic loss to recover higher compensation. The high attorney’s fee also leads to higher premiums for the medical malpractice insurance. It is reported that only 3% to 30% of the lawsuits about medical malpractice have valid evidence.

Quantitative Analysis

After reviewing several datasets and reports, we tested whether licensed or non-admitted market premium written, direct losses incurred, and defense and cost containment expenses, have a significant effect on the amount of direct premiums written.

The equations related to these variables are:

\[
\text{Total Annual Premium Written} = \text{Licensed Market Premium Written} + \text{Non-Admitted Market Premium Written};
\]

\[
\text{Total Annual Premium Written} = \text{Direct Losses Incurred} + \text{Direct Defense and Cost Containment} + \text{Risk Charge} + \text{Insurer’s Profit}.
\]

Variable 1: Licensed or Non-admitted Market Premium Written

The licensed market and unlicensed market refer to the insurers rather than the policyholder. The licensed insurers hold the license from the same state as the policyholders; therefore, they have to follow the regulations of that state. However, the non-admitted insurers, who are also called the surplus line producer, are not licensed in the policyholder's state. Since
the non-admitted insurers are not regulated in the policyholder's states, their policies and premium rate are more flexible than the licensed insurers.

Figure 6 illustrates that the medical malpractice insurance market is divided into two parts: the licensed market and the non-admitted market. The licensed market premium written has the biggest percentage (83.3%) of direct premium written in 2004, suggesting that the licensed market premium written has more influence on the whole value of direct premium written. By contrast, the non-admitted market premium written, which contributes only 16.7% of the direct premium written, does not have the same influence as the licensed market.

From Figure 6, it is easy to observe that the increasing rate of direct premium written is consistent with the increasing rate of the licensed market premium written. Both reached their peaks in 2004 and then decreased from 2004 to 2006. However, the non-admitted market premium written had an increase from 2000 to 2006, which is not consistent with the changing rate of the direct premium written.

Moreover, the direct premium written and the licensed market premium written changed dramatically in some years, while the non-admitted market premium written was relatively stable. Therefore, the scale of licensed market premium written may, to some extent, determine the direct premium written.
Figure 6: Licensed market premium written and non-licensed in Missouri from 2000 to 2012 (Unit: Dollar)

Source: National Association Insurance Commissioners

Variable 2: Direct Losses Incurred

Figure 7 shows that direct losses incurred in the United States were generally stable from 1991 to 1998. Then they increased dramatically during the period of 1998 to 2003, followed by a decrease from 2003 to 2010. After 2010, the direct losses incurred increased a little. When comparing Figure 7 with Figures 1 and 2, we can see that the trend of direct losses incurred are similar but precede the trends of premiums in the United States from 1991 to 2012. For instance, as shown in Figure 7, the direct losses incurred reached the vertex in 2003, while the direct premium written and direct premium changes earned reached their peaks in 2006. The direct losses incurred in United States experienced a downward trend until 2010, when the trend rebounded a slight extent, while the direct premium written and direct premium earned in the
United States continued decreasing from 2006. Based on Figure 8, the change of direct losses incurred in Missouri from 2000 to 2012 also preceded the changes of direct premium written and direct premium. This suggests that premiums were increased in response to the high losses incurred.

As the general trends of direct losses are similar but precede premiums, this paper sets direct losses incurred two years ago as one of the variables to predict the premium written. This is reasonable because the insurance companies need time to change the premium based on the losses.

Figure 7: Direct losses incurred in the United States from 1991 to 2012 (Unit: Dollar)

Source: National Association Insurance Commissioners
**Variable 3: Direct Defense and Cost Containment Expense Incurred**

Direct defense and cost containment expense incurred refer to the costs that are used to control the volume of compensation to patients and other directly related costs. For example, these costs include investigation costs of insurance companies and the defense costs of doctors and insurance companies. From Figure 9, the direct defense and cost containment expenses incurred in the United States seem to have the same trend as the direct premium written and earned. Both the cost containment expenses incurred and the direct premium written increased, followed by stable trends for two years, and then a decrease.

However, both the cost containment expenses incurred and the direct premium written did not reach their peaks in the same year. The defense and containment expenses went through a
wavy growth before the vertex reached $2,847,849,045 in 2004, while the medical malpractice insurance premiums experienced a significant increase before the peak in 2006 (See Figure 1 and 2). The defense and containment expenses incurred in Missouri had the same trend as that in the whole country. Both of the containment expense and premium written shared the same trends. However, the containment expense is around 2 to 3 years ahead of premium written.

In order to test whether defense and containment expenses have significant effect on premiums, this paper makes defense and containment expenses two years ago as one of the variables to predict the premium written for malpractice insurance in the regression test.

Figure 9: Direct defense and cost containment expenses incurred in the United States (Unit: Dollar)

Source: National Association Insurance Commissioners
Regression Analysis Result

We ran regression analyses to test the hypothesis. This thesis use SAS to operate the data analysis. All of the codes and outputs are provided in the appendixes.

When doing regression analysis, we first build the equation for the explanatory and response variables and then use analysis of variance (ANOVA) table to test whether this equation, or model, fits the data. If the Pr > F value is less than the significant level (0.05), it means that the model fits the data, therefore, we can continue to look at the parameter estimates for the explanatory variables from the equation. If the Pr > F value for an explanatory variable is less than significant level (0.05), we can conclude that that variable have effect on the response variable, vice versa.
Variable 1, whether licensed or non-admitted market premium written, is tested according to the equation:

\[ \text{Total Annual Premium Written} = \text{Licensed Market Premium Written} + \text{Non-Admitted Market Premium Written}. \]

In Figure 12, the ANOVA table shows that the value Pr > F of this model is less than 0.0001, which means that the model is perfect for the dataset. The following parameter estimates indicate that variable 1’s Pr>|t| value is less than 0.0001. It means that variable 1 (licensed premium written) has a significant effect on the direct premium written.

**Figure 11: Regression analysis output of variable 1 and medical malpractice insurance premiums in Missouri**

![Analysis of Variance Table]

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1</td>
<td>1.918694E16</td>
<td>1.918694E16</td>
<td>499.86</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error</td>
<td>11</td>
<td>4.222343E14</td>
<td>3.838493E13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>12</td>
<td>1.960918E16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Parameter Estimates Table]

| Variable     | DF | Parameter Estimate | Standard Error | t Value | Pr > |t| |
|--------------|----|--------------------|----------------|---------|------|-----|
| Intercept    | 1  | 8249805            | 8585159        | 0.96    | 0.3572|     |
| variable1    | 1  | 1.19380            | 0.05340        | 22.36   | <.0001|     |

Source: Self-produced form
Variables 2 and 3, the direct losses incurred and the direct defense and cost containment expenses, are in the equation:

\[
\text{Total Annual Premium Written} = \text{Direct Losses Incurred} + \text{Direct Defense and Cost Containment} + \text{Risk Charge} + \text{Insurer’s Profit}.
\]

Before operating the regression analysis, we need to check the correlation between these two variables. If these two variables are highly correlated to each other, we should not place them in the same regression model.

From Figure 12, the Pearson Correlation Coefficient between variable 2 and variable 3 are 0.71598. The Pearson Correlation Coefficient measures the strength of the linear relationship between two variables. The values of it range from -1 to 1. -1 indicates that these two variables are highly negative correlated; 0 means that they are not correlated at all; and +1 shows that they are highly positive correlated. The 0.71598 in this analysis indicates that these two variables are positive correlated.

And the value of Pr > F of the Pearson Correlation Coefficient is 0.0132. This p-value tests the null hypothesis that there is no correlation between these two variables (the Pearson Correlation Coefficient=0). The 0.0132 is less than 0.05; therefore, we can conclude that these variable 2 and variable 3 are correlated and we should not place them in the same regression model.
Figure 12: Pearson correlation coefficients analysis between variable2 and variable3

Then we evaluate variables 2 and 3 separately. From Figure 13, the p-value of this model (0.0036) from the ANOVA table indicates that this model is acceptable. According to the parameter estimates table, the Pr>|t| values of variable 2 is 0.0036. It means that variable 3 has a significant effect on the direct premium written.
Figure 13: Regression analysis of variable 2 and medical malpractice premiums in Missouri

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1</td>
<td>4.345339E15</td>
<td>4.345339E15</td>
<td>15.18</td>
<td>0.0036</td>
</tr>
<tr>
<td>Error</td>
<td>9</td>
<td>2.577069E15</td>
<td>2.86341E14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>10</td>
<td>6.922408E15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Variable      | DF | Parameter Estimate | Standard Error | t Value | Pr > |t| |
|---------------|----|--------------------|----------------|---------|------|-----|
| Intercept     | 1  | 174257984           | 16391205      | 16.77   | <.0001|
| variable2     | 1  | 0.36194            | 0.09291       | 3.90    | 0.0036|

Source: Self-produced form

According to Figure 14, the p-value of this model (0.0252) from the ANOVA table indicates that this model is suitable. The Pr>|t| values of variable 3 is 0.0036 from the parameter estimates tables. Therefore, variable 3 has a significant effect on the direct premium written.
Figure 14: Regression analysis of variable three and premiums of medical malpractice premium in Missouri

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1</td>
<td>3.073917E15</td>
<td>3.073917E15</td>
<td>7.19</td>
<td>0.0252</td>
</tr>
<tr>
<td>Error</td>
<td>9</td>
<td>3.848491E15</td>
<td>4.276101E14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>10</td>
<td>6.922408E15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Variable        | DF | Parameter Estimate | Standard Error | t Value | Pr > |t| |
|-----------------|----|---------------------|----------------|---------|------|---|
| Intercept       | 1  | 161558978           | 18944405       | 8.53    | <0001|
| variable3       | 1  | 0.92772             | 0.34602        | 2.68    | 0.0252|

Source: Self-produced form

In conclusion, the licensed premium written, the direct losses incurred, and the variable direct defense and cost containment expense incurred, have significant effects on the direct premium written.
Chapter 4

DISCUSSION

DISCUSSION

In conclusion, medical, economic and legal variables from the qualitative analysis and the licensed or non-admitted market premium written, the cost incurred from qualitative analysis may be explanatory variables to the medical malpractice insurance premiums. The reforms corresponding to these variables may be the critical factors to control the premiums.

Since the first medical risk in the 1970’s, many reforms have been implemented but the results are not always obvious. The federal government required the states to establish a fund for every medical organization that buys medical malpractice insurance, assisting doctors in acquiring the insurance. (Eric Norman, Davin Cermak and Kenneth McDaniel) However, this solution did not reduce the premiums the doctors were buying. The reform was implemented to establish a fund for doctors, with the hope that it would help patients ultimately. From a legal standpoint, some reforms, generally refer to the several solutions states have introduced to change the legal environment for compensating claimants, are implemented to limit the quantity of medical malpractice lawsuits so that the premiums can be lowered. In the 1970’s, many states in the United States decreased the rule of investigating the malpractice insurance and limited the action of the patients. Some states set limitations on the attorney fees, reducing the lawyers’ payments on the compensations for the patients. Some states established auditing committees to audit medical malpractice incidents, preventing patients from defrauding the system. In some states, limited compensation is regulated for the insurance companies and
doctors. In addition, medical organizations and medical professionals could be required to share the responsibility with the insurance companies by the laws and regulations. Some insurance companies are allowed to pay the compensations in several installments and a lump sum is not needed at one time. All these reforms belong to the reforms of tort law in the 1970s and they did not have much effect on the reduction of premiums before 2006. However, after 2007, these reforms did decrease the premiums of insurance companies. (Eric Norman, Davin Cermark, Kenneth McDaniel) Therefore, it is reasonable to conclude that these reforms are useful, but the malpractice insurance system needs a long time to change.

**Recommendation**

From the discussion above, it is recommended to review the historical reforms of medical malpractice and give examples of reforms which alter and control the medical malpractice insurance premiums.

Reforms of the legal system in medical malpractice are recommended in the following parts:

1. Medical Reform

Changing the punishment methods of malpractice for the medical professionals is the first choice. (Kristin & Erik, 2011) For example, judges punish medical professionals by revoking their licenses rather than charging compensation only. Then, the cost the insurance companies need to pay will be lower, which leads to the decrease of the premiums for the medical malpractice insurance.
In addition, the government should improve the current laws and regulations for malpractice and limit the non-economic compensation. Then, only the patients who do suffer from valid malpractice can get compensation.

Furthermore, these patients should not be allowed to ask for unreasonable compensations using noneconomic evidence, so that the cost for malpractice decreases. Limiting compensation policy for both economic compensation and noneconomic compensation is necessary. (Eric, Davin and Kenneth)

2. Legal Reform

Changing the laws and process of the malpractice lawsuit would also help. Lawyers take a huge amount of the compensation in lawsuits and it is not beneficial to either the patients or the medical professionals. If the United States government could introduce a professional institution that could handle malpractice lawsuits, the patients could get more of the compensation and the cost for malpractice lawsuit could also decrease. Additionally, the patients, healthcare providers, and insurance companies could negotiate the compensation outside of court; thus, the legal processing fees and the payment for lawyer could decrease.

4. Insurance Reform

To make the market stable, the American Insurance Regulatory Commission could limit the change rate of premiums every year. If premiums increase moderately each year, healthcare providers will become accustomed to a steady increase and continue to pay their premiums. But insurers might get out of the system if they can’t charge enough, in which case premiums will go up if there is less supply.
CONCLUSION

In conclusion, it is necessary to think about what influences the increasing insurance premiums and how to address the problems of malpractice insurance. Costs incurred explain the increases in medical malpractice insurance premiums as shown in our regression analysis. The Federal government has taken several actions to decrease the insurances costs in order to help control the high premiums. Thanks to these actions, the malpractice insurance premiums have dropped for six years. Karls, a principal and consulting actuary for Milliman said: "Premium costs are lower than what they were a decade ago. However, it doesn't necessarily mean that they shouldn't be lower." (Robert, Lowes) To continue to decrease the premium, each area of the many increases in malpractice insurance premiums should be addressed including the lack of the medical system responsibility, legal fees, the regulation of economic and noneconomic compensation, and the insurance companies themselves. Until these critical factors are addressed as a group the problem with insurance premiums in the United States will continue.
Appendix A

SAS Code for regression analyses of variables and medical malpractice insurance premiums in Missouri

```
data malpractice;
   infile 'C:\Desktop\malpractice.prn' firstobs=2;
   input premium variable1 variable2 variable3;
run;
proc print;
run;
proc reg data=malpractice;
   model premium=variable1;
run;
proc reg data=malpractice;
   model premium=variable2 variable3 variable2*variable3;
run;
proc reg data=malpractice;
   model premium=variable2;
run;
proc reg data=malpractice;
   model premium=variable3;
run;
proc corr data=malpractice;
   var variable2 variable3;
run;
```

Source: Self-produced form
## Appendix B

Regression Analysis Outputs from SAS

<table>
<thead>
<tr>
<th>Obs</th>
<th>premium</th>
<th>variable1</th>
<th>variable2</th>
<th>variable3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>113578169</td>
<td>9238702</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>2</td>
<td>133683918</td>
<td>109081420</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>3</td>
<td>205019484</td>
<td>171916338</td>
<td>75241729.04</td>
<td>39580796.58</td>
</tr>
<tr>
<td>4</td>
<td>226961038</td>
<td>186479369</td>
<td>102474068.30</td>
<td>36504150.05</td>
</tr>
<tr>
<td>5</td>
<td>246655563</td>
<td>205581129</td>
<td>205636190.40</td>
<td>65063144.01</td>
</tr>
<tr>
<td>6</td>
<td>232504144</td>
<td>190032878</td>
<td>187225315.70</td>
<td>80388177.81</td>
</tr>
<tr>
<td>7</td>
<td>238513370</td>
<td>189392764</td>
<td>126564208.70</td>
<td>59531213.71</td>
</tr>
<tr>
<td>8</td>
<td>216599280</td>
<td>169414624</td>
<td>114712341.90</td>
<td>81206100.02</td>
</tr>
<tr>
<td>9</td>
<td>206807164</td>
<td>164271453</td>
<td>72600183.80</td>
<td>63734814.82</td>
</tr>
<tr>
<td>10</td>
<td>202725118</td>
<td>155867385</td>
<td>28585982.30</td>
<td>38779433.35</td>
</tr>
<tr>
<td>11</td>
<td>191048974</td>
<td>145448052</td>
<td>38511149.52</td>
<td>39352923.28</td>
</tr>
<tr>
<td>12</td>
<td>176510951</td>
<td>138335771</td>
<td>67817727.39</td>
<td>36345428.75</td>
</tr>
<tr>
<td>13</td>
<td>161399270</td>
<td>129221773</td>
<td>52380591.63</td>
<td>26013063.65</td>
</tr>
</tbody>
</table>
1) Regression analysis of variable 1 and medical malpractice premiums in Missouri

The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: premium

<table>
<thead>
<tr>
<th>Number of Observations Read</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Observations Used</td>
<td>13</td>
</tr>
</tbody>
</table>

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1</td>
<td>1.918694E16</td>
<td>1.918694E16</td>
<td>499.86</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error</td>
<td>11</td>
<td>4.222343E14</td>
<td>3.838493E13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>12</td>
<td>1.960918E16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Root MSE 6195558
R-Square 0.9785
Dependent Mean 196308188
Adj R-Sq 0.9765
Coeff Var 3.15604

Parameter Estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>DF</th>
<th>Parameter Estimate</th>
<th>Standard Error</th>
<th>t Value</th>
<th>Pr &gt;</th>
<th>t</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1</td>
<td>8249805</td>
<td>8585159</td>
<td>0.96</td>
<td>0.3572</td>
<td></td>
<td></td>
</tr>
<tr>
<td>variable1</td>
<td>1</td>
<td>1.19380</td>
<td>0.05340</td>
<td>22.36</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: premium

Fit Diagnostics for premium

Observations 13
Parameters 2
Error DF 11
MSE 384E+11
R-Square 0.9785
Adj R-Square 0.9765
Source: Self-produced form
2) Regression analysis of variable 2 and medical malpractice premiums in Missouri

**The SAS System**

The REG Procedure  
Model: MODEL1  
Dependent Variable: premium

<table>
<thead>
<tr>
<th>Number of Observations Read</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Observations Used</td>
<td>11</td>
</tr>
<tr>
<td>Number of Observations with Missing Values</td>
<td>2</td>
</tr>
</tbody>
</table>

**Analysis of Variance**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1</td>
<td>4.345339E15</td>
<td>4.345339E15</td>
<td>15.18</td>
<td>0.0036</td>
</tr>
<tr>
<td>Error</td>
<td>9</td>
<td>2.577069E15</td>
<td>2.86341E14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>10</td>
<td>6.922408E15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Root MSE</th>
<th>16921613</th>
<th>R-Square</th>
<th>0.6277</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Mean</td>
<td>209522214</td>
<td>Adj R-Sq</td>
<td>0.5864</td>
</tr>
<tr>
<td>Coeff Var</td>
<td>8.07629</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Parameter Estimates**

| Variable    | DF | Parameter Estimate | Standard Error | t Value | Pr > |t|  |
|-------------|----|--------------------|----------------|---------|------|---|
| Intercept   | 1  | 174257984           | 10391206       | 16.77   | < .0001 |
| variable2   | 1  | 0.36194            | 0.09291        | 3.90    | 0.0036 |
The SAS System
The REG Procedure
Model: MODEL1
Dependent Variable: premium

Source: Self-produced form
Source: Self-produced form
3) Regression analysis of variable 3 and premiums of medical malpractice premium in Missouri

The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: premium

Number of Observations Read 13
Number of Observations Used 11
Number of Observations with Missing Values 2

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1</td>
<td>3.073917E15</td>
<td>3.073917E15</td>
<td>7.19</td>
<td>0.0252</td>
</tr>
<tr>
<td>Error</td>
<td>9</td>
<td>3.848491E15</td>
<td>4.276101E14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>10</td>
<td>6.922408E15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Root MSE 20678736
R-Square 0.4441
Dependent Mean 209522214
Adj R-Sq 0.3823
Coeff Var 9.86947

Parameter Estimates

| Variable | DF  | Parameter Estimate | Standard Error | t Value | Pr > |t| |
|----------|-----|--------------------|----------------|---------|------|---|
| Intercept| 1   | 161558978          | 18944405       | 8.53    | <.001|
| variable3| 1   | 0.92772            | 0.34602        | 2.68    | 0.0252|
Source: Self-produced form
BIBLIOGRAPHY


Young, C. C. (2005), Premium Non Nocere: Measuring and Benchmarking Hospital Malpractice Performance, ProQuest Information and Learning Company


<https://www.casact.org/pubs/proceed/proceed58/58063.pdf> [Accessible at 20th February 2014]


Duenwald, M.; Sample B. (2013). *Do Big Malpractice Awards Really Increase Medical Costs?* [Online]. *Bloomberg.* Available at: 


<http://www.naic.org/cipr_topics/topic_med_mal.htm> [Accessible at 18th February 2014]


<http://www.policyalmanac.org/health/archive/medical_malpractice.shtml>. [Accessible at 22nd February 2014]


The National Institute on Aging (2014). *Do Medical Malpractice Costs Affect the Delivery of Health Care.* [Online]. The National Institute on Aging. Available at:

<http://www.nber.org/bah/fall04/w10709.html>. [Accessible at 24th February 2014]


ACADEMIC VITA

Jing Yang
jvy5104@psu.edu

Education

The Pennsylvania State University, University Park, University Park 2010 – present
Eberly College of Science
  Majors: General Mathematics and Actuarial Statistics
  Minor: Natural Science
The University of California, Berkeley 2011, summer
The Nanking University, China 2012, summer
Passed P/Probability Theory and FM/Financial Mathematics for Actuarial Science

Honors

Scholar of Schreyer Honors College 2012 – present
Dean’s List Fall, 2010 - Fall, 2012
  Fall, 2013
Member of Mu Sigma Rho, National Statistical Honor Society March, 2013- Present

Extracurricular Activities

Penn State Learning Center November 2012- present
Schreyer Consulting Club Fall 2012- Present
THON-For the Kids Activity January-March, 2013
Deloitte Case Competition February 2013
China Life Insurance intern May 2012

Skills

C++, SAS, R, MATLAB