Workers Compensation and the Insurance Cycle

A Major Qualifying Project Report
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By

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Abstract

This project was designed to attempt to predict the insurance cycle, specifically for Workers' Compensation. A process was created which involved regressing premium values against external economic indicators in order to predict future premium values. We tested the data several times using different modifications and groupings of the provided data. Our results were then compared against the unused data points. Finally, we recommended certain possibilities for further analysis or testing.

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Authorship

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Executive Summary

Workers' Compensation is a type of insurance that provides payment to employees who were injured while working. At the same time, the worker must give up their right to sue their employer for negligence. Companies purchase Workers' Compensation policies for their employees and if an employee is injured in the workplace, the policy will pay for both the medical costs of the employee and a portion of their salary if they need to take time off.

There are two types of markets in the insurance cycle: hard and soft. A hard market occurs when insurance companies are leaving the market because prices are decreasing and profits are low, whereas a soft market occurs when insurance companies are joining the market because prices are increasing and profits are high.

The goal of our project was to identify and test the usefulness of economic indicators for predicting the trends in the Worker's Compensation insurance cycle. To obtain this goal, we collected historical data from Hanover Insurance Group and the National Council on Compensation Insurance, NCCI. Hanover data was from March 2004 to January 2010, and we reviewed the Original and Written Premiums for each month. Original Premium is the price of a policy before any adjustments have been made by underwriters. Written Premium is the price of a policy that a customer will have to pay in order to purchase the insurance. The deviation value, Written Premium divided by Original Premium, was computed for each month to determine how the pricing was changing.

Another way we organized Hanover's data was to use three, six, nine, and twelve-month rolling averages. A three-month rolling average would include three months of data; a six-month rolling average would include six months of data, and so on. For example, March 2005 would include the months March, April, and May of 2005; then April 2005 would include the months April, May, and June of 2005. We computed the deviation values for each of these time periods as well. We decided to use this rolling average approach because it is a way to smooth the graph and remove large spikes in the data.

The NCCI data was from 2003 to 2007, but it only provided us with total Original and Written Premiums for each year. We decided that in order to review the NCCI data it needed to be calculated monthly. We were able to determine monthly premiums for NCCI by presuming that both Hanover and NCCI premiums would be distributed in the same fashion. Thus, for each NCCI yearly premium total, we multiplied by the corresponding Hanover monthly percentage for the same year to determine both the Original and Written Premiums. Once we had done this for both Original and Written Premium for each month, we were able to calculate the NCCI monthly deviation values.

We then identified economic factors that were relevant to the Worker's Compensation insurance cycle. The four factors we determined were relevant are as follows: unemployment rate, interest rate, inflation rate, and prime rate. Historical values were found from March 2003 to March 2009 for each economic factor. We computed each of these factors in the following four forms: linear, squared, cubed, and to the fourth power. Given our foresight that these factors may be able to predict future insurance trends, we regressed Hanover data against each individual factor with a lag varying from zero to twelve months, and then chose the one that had the best regression equation.

Once we had determined the best lag for each factor, we combined all sixteen factors (four factors each from power one to four) and regressed it against each data set individually (Hanover monthly, NCCI monthly, Hanover rolling averages monthly) from March 2004 to March 2009. The regression equation that we computed was then reviewed to make sure that each variable was statistically significant. If there were variables not statistically significant, we removed the least significant variable one by one until each variable was statistically significant. Thus, we developed six regression equations, one for each of our data sets. Our best regression equation resulted from the twelve-month rolling average because it had a $R^2 = 0.9755$. The final step we took was to use our regression equation for each data set to predict April 2009 to January 2010, and compare the deviation values our regression equations computed to the actual deviation values that occurred.

As with almost any project, we came across limitations. Some of the limitations we encountered while working on this project included:

• Hanover only had six years (2004-2010) of data; the insurance cycle might not have switched from a soft to a hard market, or vice versa.

• Hanover had undeveloped losses; originally we wanted to focus on the loss side of the insurance equation but due to the incomplete loss data, we were unable to process accurate data.

• NCCI only had five years (2003-2007) of data and it was only computed yearly; we felt that we did not have a large enough sample size to make any notable conclusions about current trends.

• NCCI data also lacked four major Hanover states: Massachusetts, Michigan, New Jersey, and New York; this might result in our NCCI monthly averaging being inaccurate and less credible.

• Recently, the U.S. economy was in a recession; we feel that this might have a large effect on the costs of premiums and the amount of losses paid.

In conclusion, we believe that the process we developed can be very useful to Hanover. It is useful for multiple reasons. The economic factors used are predicted by many different people, such as financial analysts, and depending on each economic factor's corresponding lag, predictions might not be necessary because the time period might have already occurred.

We also feel that this process will allow Hanover to make decisions such as whether or not to stay in a specific market. They will be able to do this by looking for turning points in the deviation values. If the deviation values begin to drop but in a few months it is predicted to rise above the current value, it would be very profitable to stay in the market and enjoy the future profits. On the other hand, if the deviation values begin to rise but in a few months it is predicted to drop below the current value, it would be profitable for Hanover to get out of the market and avoid the future drop in profits.

1.0 Introduction

Injuries occurring at work are very undesirable to both an employee and employer. Without insurance, an employee would have concerns of how they will pay for their medical bills as well as how they will earn money if they are unable to work. An employer would have concerns of his/her employee possibly suing in order to pay for their medical costs and maintain their finances while they were unable to work. Fortunately for both the employee and employer, Workers' Compensation insurance is able to minimize their concerns of medical costs and lost wages.

Workers' Compensation insurance provides payment to those employees who have been injured while performing work for an employer. An employer buys the insurance and pays the monthly premiums to ensure that they can avoid uncertainty in their costs for injury workers, i.e. being sued. An employee enjoys benefits of the insurance because their medical costs are paid for and they will continue to be paid a portion of their salary while they are unable to work.

Insurance companies such as the Hanover Insurance Group provide Workers' Compensation insurance. There are many factors that need to be evaluated before pricing an insurance policy. Some factors that are assessed by insurance companies to determine whether or not they want to offer coverage to an employer are as follows: the state and industry an employer is in and their previous experience with the employer.

For example, an insurance company may want to decrease its riskiness of policies so they would want to stay away from employers in high risk industries, such as mining and construction, because if an injury occurs it will most likely be a serious injury with a high cost to the insurance company. Instead the insurance company should offer policies to employers in low risk industries, such as office jobs and academia, because if an injury occurs it will most likely be less severe and result in a lower cost to the insurance company.

The state in which an employer is located matters to insurance companies because certain states have more competition among insurers than others. In states with high competition, the premiums will be lower to draw consumers whereas the losses will presumably remain the same throughout all states regardless of competition. Thus, profits for the insurance company will be lower in states with high competition among insurers. Knowing about competition in different states is essential information to insurance companies because it would be a waste of time to try and market a policy that is not competitive since no one will want to buy it.

In some cases, insurance companies will have sold policies to the same employers for multiple years in a row thus the insurers will know what range of losses to expect from them. Insurers might learn that certain employers may have more unsafe working areas than others which could lead to more injuries and greater losses to them. With this experience, insurers will increase premiums for these employers in order to account for their poor previous experience. On the other hand, if an employer has very small claims, it would send a message of having a safe workplace. Therefore, insurers may provide discounts to these employers in order to keep these policies with low losses.

The goal of our project was to identify and test the usefulness of economic indicators for predicting the trends in the worker's compensation insurance cycle. To obtain this goal, we collected historical premium data from the National Council on Compensation Insurance (NCCI) and Hanover

Insurance Group. We then identified economic factors that were relevant to the insurance cycle. We conducted a variety of lagging possibilities when analyzing the economic factors. After organizing this data, we compared trends of historical premium data to the economic historical data. We constructed a regression equation for a number of different scenarios we envisioned. Using the regression equation, we predicted short-term changes in pricing. We believe our process will help Hanover foresee turning points in the worker's compensation insurance cycle.

2.0 Background

2.1 Workers' Compensation

Workers' Compensation is a type of insurance that provides payment to employees who were injured while working. At the same time, the worker must give up their right to sue their employer for negligence. Companies purchase Workers' Compensation policies for their employees and if an employee is injured in the workplace, the policy will pay for both the medical costs of the employee and for a portion of their salary if they need to take time off. In this way, Workers' Compensation acts as a safety net to both employer and employee. Workers' Compensation is regulated at both a federal and state level but most states choose to abide by the regulations set by NCCI (see section 2.7).

2.1.1 Types of Loss

Losses in Workers' Compensation can be divided into two main categories: indemnity and medical. Indemnity losses are the costs incurred by paying for the lost time and productivity of an injured employee. When an employee injures themselves or is sick and needs to take time off, Workers' Compensation pays their employer for the lost time. While it depends on the policy, the Workers' Compensation policy pays a percentage of the employee's salary over the days they missed. Because of this, indemnity costs are more predictable and thus easier to price for.

On the other hand, medical losses are much more complicated and can be further divided into separate categories. Depending on the injury or illness, these could include the cost of office visits, physical therapy, radiology, prescription drugs, surgery, etc. While indemnity costs are relatively fixed for a certain policy and therefore easy to price, medical losses are much more random and thus far more difficult to predict for pricing purposes. For example, two employees might both need to take a week off of work (meaning they both incur the insurance company the same indemnity cost), one for a cold and one for a broken leg. While the employee with the cold just needs some time to recuperate, the other will most likely need to go to the doctor, have x-rays taken, possibly have surgery, and undergo physical therapy, which could cost thousands of dollars for the insurance company. Thus the medical costs have a much greater variation and can possibly take up a significant portion of the total losses of a claim.

2.1.2 Reporting Losses

Losses on a specific policy are measured by looking at the frequency and severity of claims. Frequency denotes how often a claim occurs (i.e. its likelihood of happening) while severity measures the cost associated with it. These measures are vital in pricing specific policies. For example, the average injury for a firefighter will be much more severe (and much more likely) than that of someone who works at a desk, thus the price of each policy will differ in accordance with this relationship. This can been seen in Appendix A, where for the year of 2003, over 400,000 policies were written for contracting with a total written premium of over nine billion dollars, whereas over 700,000 policies were written for goods and services, which received roughly the same amount of premiums.

When recording the payment of a claim as a loss, there are four different periods under which an insurance company can file a loss: accident year, reported year, policy year, and calendar year.

Accident year is the year in which the accident from the claim actually occurred. Reported year is the year in which the claim was submitted (while this is generally the same as reported year, if there was a case where an accident occurred at the end of December and was not reported to January, this would differ). Policy year is simply the year in which a given policy was written. Calendar year is used for policies in which the policyholder pays the deductible between January 1st and December 31st and represents the year in which the deductible was paid.

While these different types of 'insurance years' do not affect the total losses incurred, it allows insurance companies to move and spread out the losses between different years, which can be very useful for tax purposes. For example, if an insurance company incurred massive losses one year, but very few the next, they can move some of those losses to the second year so they do not have to pay as many taxes during the better year.

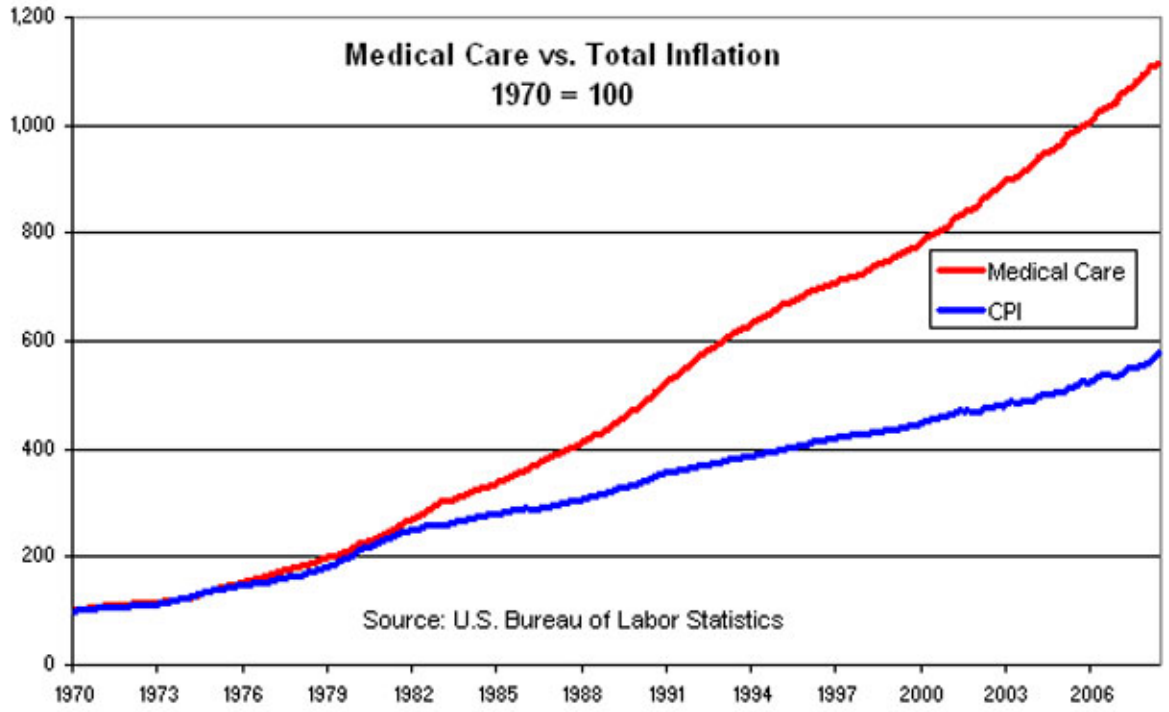
2.1.3 Developing Trends

Over the past couple decades, medical costs of Workers' Compensation have been slowly becoming a greater and greater portion of the total cost of a claim. In 1985, medical costs took up 44% of the total costs, while in 2005 they constituted 58% of the total costs[1]. This is due to the rapid increase in costs associated with medical care, which can be seen by looking at medical cost inflation rates over the past couple decades (see Figure 2.1). On the other hand, indemnity costs are linked to an employee's forgone salary while injured or sick, and increases in salaries (excluding promotions) are generally related to the increased cost of living due to the inflation rate. Since the medical inflation rate is growing far more rapidly than the inflation rate, medical costs are growing at a faster pace than indemnity costs and they are slowly becoming a larger portion of the Workers' Compensation claims being paid out.

At the same time, the frequency of Workers' Compensation claims has been slowly declining. In a 2007 study done by NCCI, they noticed that the average claim frequency had decreased by 21% between 2001 and 2005.[2] NCCI attributes this decrease in claim frequency to stricter safety regulations in the work place, increased emphasis on workplace safety, more and better job training, and improved fraud deterrents.

[1] (Hartwig, 2006)
[2] (DiDonato)

Figure 2.1: Historical Inflation and Medical Inflation Rates [3]



2.2 Cost of Capital: A Decision Making Tool

An important factor in deciding which policies to write and which to ignore is the cost of capital necessary to fund the reserve for the policy. In this case, cost of capital is the cost of keeping money in a reserve. For example, an insurance company can choose between two policies. One insures a manufacturing plant and has a loss range of $0-$200 per claim. The other insures an office building and has a loss range of $90-$110 per claim. While both of these policies have an expected loss per claim of $100 (assuming uniform distribution), the insurance company will have to reserve $200 for the manufacturing policy but only $110 for the office building policy. This means they will have to borrow $90 more for the manufacturing policy. So if the interest rate is 10% and the company sells the manufacturing policy for $25 and the office building policy for $20, then the company will make a profit of $5 [$25 – ($200 * 0.1)] from the manufacturing policy and $9 [$20 - ($110 * 0.1)] from the office building policy. Even though they can charge a higher premium for the manufacturing policy, the cost of capital makes writing the office building policy more profitable.

The smaller variance is another reason why the office building policy is more attractive to an insurance company. A lower variance means that a policy's losses will be more predictable, thus the insurance company will be able to estimate their losses more accurately and will be able to write more policies. In this example (still assuming uniform distribution) the variance of the manufacturing policy is

[3] (Baxter, 2008)

3333.33 [(200-0)^2/12] while the variance of the office building policy is 33.33 [(110-90)^2/12], so the second policy is clearly more predictable and thus safer for the insurance company to write.

2.3 Economic Factors

To predict the future prices of Workers' Compensation insurance, we first must determine what can be used as possible predictors. According to Qin[4], for the general insurance industry of Australia, "inflation rates, interest rates and stock market returns" are all significant factors on the insurance cycle. As this study works with a more precise type of insurance these factors will be considered, but other factors may also need to be included. Another important factor, as pertains to Workers' Compensation, is the unemployment rate. The cycle is not entirely economically driven; however, and this will yield only part of the data necessary to forecast the future prices of the industry.

The inflation rate may be an important factor for several reasons. Payments for indemnity may last for many years and even medical costs may span years, thus making the inflation rate a primary indicator. Also, medical inflation is historically greater than the average inflation rate[5], thus causing an even greater impact. Inflation rates affect the expected present value of claims in two ways. First, it affects indemnity, which would cause the present value of the claim to fall, as indemnity pays out a specific dollar amount, and a positive inflation rate means the same amount of money today will be worth less in the future. Secondly, inflation will affect the present value of medical costs, increased future medical costs due to inflation will cause the present value of the claim to rise, the same amount of money will have less value, and thus more will be needed to cover the same costs. Due to this two-fold effect, we are unsure as to the impact inflation may have on the present value of a claim, and thus pricing needed to cover those claims.

Interest rates may be important and for reasons similar to inflation. Because of the large length claims may last, the present values of those may change greatly due to small changes in economic variables. The way interest rates affect the expected present value of a claim is that, as interest rates rise, the present value of a claim will fall[6] (Harrington), as money will grow at a faster rate, and thus less will be needed to cover future costs.

Stock market returns may be important as some of the investments of insurance companies are made in the form of common stock. According to an Association of California Insurance Companies document from 2004, "property/casualty insurers (including Workers' Compensation insurance carriers) are not heavily invested in the stock market" and "only 18 percent of the insurance industry's investments in 2002 were in common stock". This fact may lead us to believe that a measurement of stock market returns may not be important; however, the stock market is also an economic indicator and therefore may yield a correlation as it may be a predictor of something else. We are unsure as to how the stock market will impact the pricing of Workers' Compensation.

The unemployment rate may be important for many reasons according to the Institute for Work and Health, IWH. IWH has a few suggestions on how unemployment may affect Workers' Compensation:

"1. There are fewer inexperienced workers

[4] (Qin, 2005)
[5] (Alff, 2005)
[6] (Harrington, 2003)

2. The least safe equipment is taken out of use
3. The pace of work is slower
4. Workers fearing job loss may defer filing claims
5. Hazardous industries experience the largest decline in unemployment"

2.4 Economic Cycle

The economic cycle can be defined in many different ways varying by length, cause and/or severity. For the purposes of this project however, we will be focused on the classification of the cycle by Clement Juglar, currently the most widely accepted classification. The Juglar cycle usually lasts anywhere from seven to eleven years, and has four main stages of fluctuation. The first stage of Juglar's cycle is the expansion stage, where everything is growing, production and prices rise and interest rates fall, this discourages consumer spending and encourages increases in consumption. The next stage of this process is the crisis phase, in which stocks plummet and some firms may go bankrupt, this could occur for a number of reasons. Next comes the recession phase, in which the economy is trying to deal with the crisis by lowering prices and production and raising interest rates, to increase consumer savings while attempting to keep consumption relatively similar. The following stage is the recovery stage, where stocks increase, due to the lower prices of goods and services. Juglar's model relates recovery and prosperity with growths of productivity, prices, total demand and the confidence of consumers. The rotations of this cycle can be easily predicted, with the exception of the crisis phase, as through time one will slowly trend to the next, with the exception of the drastic and random effects that cause the crisis phase. This cycle can be clearly seen throughout global and national markets.[7]

2.5 Underwriting Cycle

The underwriting cycle has four stages as well: hard market, buyers market, soft market, and sellers market. The two important stages are the hard and soft markets. A hard market normally occurs after a major global event. As a result of the major event, insurance companies will raise premiums to compensate for the increase in losses. Insurers are usually exiting the market because the losses are becoming too high. On the other hand, a soft market occurs when losses are remaining consistent. Thus, more insurers are entering the market offering lower premiums and providing discounts to customers. This, in turn, forces the current insurance companies to lower their prices as well.[8]

2.6 SNL Website

SNL Financial LC is a business intelligence firm that focuses on financial information relating to specific business sectors. The sectors that SNL covers include the following: banking, financial services, insurance, real estate, energy, and media/communications.[9] SNL "collects, standardizes, and disseminates all relevant corporate, financial, market, and merger & acquisition data" for the previously mentioned sectors.[10] SNL adheres to four core tenets: accuracy, relevance, completeness, and

[7] (Business Cycle)
[8]((Hard markets and Soft markets, 2005)
[9] (SNL)
[10] (SNL)

timeliness.[11] These four tenets made it an obvious choice for our group when it came to finding global information regarding Workers' Compensation.

This data is useful for many reasons. The most compelling reason is SNL's dedication to accuracy in the data they report. Given SNL's track record, we trust that all of their data is complete and accurate. The SNL data has been collected since 1996; this will allow us to see any trends in premiums or losses which may very well help us determine predictors for the insurance cycle.

The SNL data has the same categories that the Hanover data has. This will make it easier to make conclusions and recommendations. The categories that are relevant are premiums (Written and Earned) and losses (paid and incurred). The full definitions of these terms can be found in Appendix B. We will also be able to compare the SNL data with the NCCI data for the same reasons.

2.7 NCCI

2.7.1 History and Purpose

The National Council on Compensation Insurance (NCCI) is a company based in Florida, which gathers and analyzes statistics and data on Workers' Compensation. Since it was founded in 1922, NCCI has been dedicated to collecting and compiling Workers' Compensation data to provide to insurance companies and state governments. Today NCCI works with 39 states and almost one thousand insurance companies in the United States to regulate the workers compensation industry.[12] They help create and maintain legislation to regulate Workers' Compensation standards. NCCI's core services include: rate and advisory loss cost filings, cost analyses of proposed and enacted legislation residual market management, production of experience ratings, statistical and compliance services, and maintenance of the workers compensation infrastructure of classifications, rules, plans, and forms.

The way NCCI works is that that all the insurance companies that operate in NCCI states must report their data to NCCI. This includes data on the losses and premiums of Workers' Compensation policies (for more details see section on WCWS). NCCI then compiles all of this data into a single, industry wide database and uses it to help set acceptable policy rates. NCCI conducts numerous analyses (such as analysis on frequency and severity) on the data as a whole, but it also breaks the data down into a number of categories, so it can determine optimal rates for specific policies. These categories include: the state (and even specifics zip code) that a policy is written in, industry of the policy, and hazard rate (a numerical determination of the inherent danger of a specific job). Any company or state that is a member of NCCI can use the data they have compiled but must also follow the rates and regulations that it sets.[13]

2.7.2 Workers' Compensation Workstation

We primarily used the Workers' Compensation Workstation (WCWS) on NCCI's website, which provides extensive data on the premiums and losses of Workers' Compensation policies. On the WCWS, we gathered industry wide data beginning in 2001 and divided it into categories, to determine whether

[11] (SNL)

[12] The States not on the NCCI database include: California, Delaware, Massachusetts, Michigan, Minnesota, New Jersey, Ney York, North Dakota, Ohio, Pennsylvania, Washington, Wisconsin, and Wyoming. They each have their own separate workers compensation regulations and rates.

[13] (NCCI)

anything out of the ordinary was happening in a specific area. We organized the data into the categories listed above along with numerous other parameters such as: date, policy size, injury type, policy type (new or renewal), deductible type, etc. We mainly organized the data by date, industry, and state.

The WCWS was comprised of two sections: Premium & Loss Reports and Pricing Reports. The premium and loss section allowed us to analyze a number of facts about the premiums and losses of specific policies. The main data we were interested in included the number of policies, Written vs. Original Premiums, exposure, average claim frequency, developed losses (medical and indemnity, and total) and average loss ratio. The pricing section allowed us to analyze data regarding policy prices, such as average reported rates and experience modifications but we did not use this section.

2.8 Hanover Insurance Group

The Hanover Insurance Group provided us with data regarding their Workers' Compensation policies. This data was given to us in eleven Microsoft Excel worksheets. The worksheets were labeled as of the date the data was collected. Each worksheet corresponded to the previous twelve months of policies. For example, the worksheet titled "March 05" referred to the time period of March 2004 through March 2005. This worksheet contained every policy that was in effect as of March 2005. The worksheets given to us are as follows: "March 05", "September 05", "March 06", "June 06", "March 07", "September 07", "March 08", "September 08", "March 09", "September 09", and "January 10".

The data contained many columns of data in which we could sort the policies. In Appendix B, you can find the definitions for each one of the columns in the Excel worksheets. For our group's convenience, we added two columns: "Count" and "Original Premium". In the "Count" column, each policy is given the score of one in order to total the number of policies that are in a specific category. The "Original Premium" column is determined by "WPrem", Written Premium, divided by "Deviation". We created this column so that we would know what price each policy was original priced at before any adjustments were made.

The data provided to us by Hanover was useful for multiple reasons. We were able to compare Hanover data to countrywide data (NCCI). The data can be sorted month-by-month which can be compared to the multiple economic factors that we have identified might be good predictors. We can also sort the data by industry and determine if a specific industry is a possible trend setter for Worker's Compensation as a whole.

3.0 Methodology

3.1 Hanover Data Sorting

Hanover data was arranged in a variety of ways. As said before, the main categories we were interested in were effect date of a policy, type of industry, deviation values average, Written Premium, exposure, number of policies in a specific time period, Original Premium, and the aggregate deviation (Written Premium divided by Original Premium). We had information regarding policies from March 2004 until March 2009.

3.1.1Monthly Data

We decided to determine the monthly averages for each of the categories listed above. For a given month, we totaled the monthly data for Written Premium, exposure, number of policies, and Original Premium, and average the monthly data for deviation value average and aggregate deviation values.

An example of this process is shown for "Manufacturing" for the month "November 2007". The policies that became effective between "November 1, 2007" and "November 31, 2007" would be identified. To determine the deviation value average, we averaged all the deviation values for each policy. In order to determine the Written Premium, exposure, and Original Premium, we totaled each category. We counted the number of "Manufacturing" policies that were issued in November 2007. After the Written Premium and Original Premiums were calculated, the aggregate deviation value would be calculated by Written Premium divided by Original Premium. In Table 3.1, the "Manufacturing November 2007" results are presented.

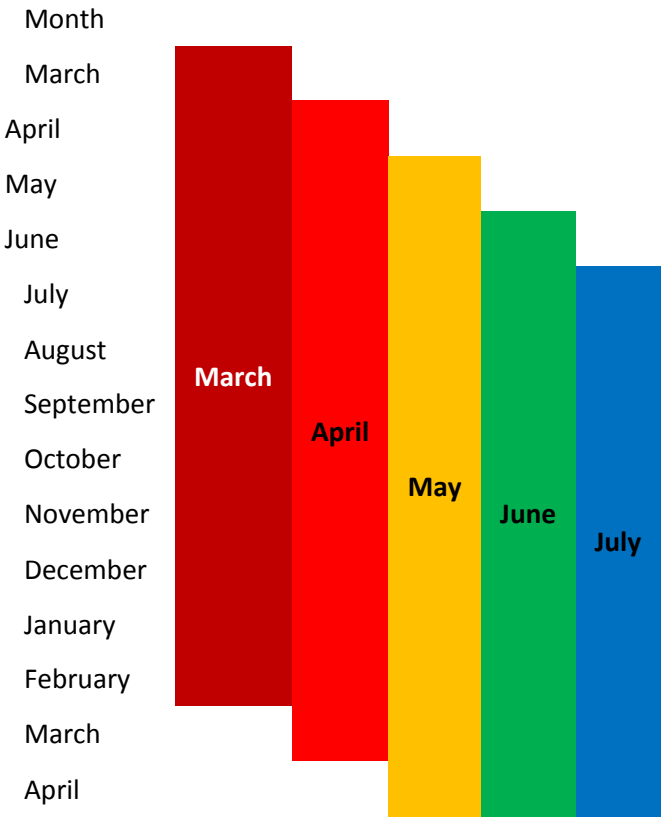
Table 3.1 Manufacturing Data: November 1, 2007 – November 31, 2007

Month	Deviation Value Average	Written Premium	Exposure	# of Policies	Original Premium	Written Premium / Original Premium
November 1, 2007 - November 31, 2007	0.9936486	$1,537,352	$84,442,984	148	$1,625,585.39	0.945722

3.1.2 Rolling Averages

We also determined rolling averages for each of the categories listed above based on the time period and type of industry. We chose to determine three, six, nine, and twelve-month rolling averages. Using rolling averages, we feel that we are able to identify and determine trends more effectively and to be able to predict future premiums more accurately. A visual aid of how a twelve-month rolling average is determined can be found in Figure 3.1. For example, a March 2007 twelve-month rolling average would consist of March 2007 through February 2008. Then an April 2007 twelve-month rolling average would consist of April 2007 through March 2008, and so on.

Figure 3.1: Calculation of Twelve-Month Rolling Averages



3.2 NCCI Data

With the data obtained from NCCI we were able to obtain similar facts about the insurance company as with the Hanover data. While we mainly focused on the deviation values for separate industries and the Workers' Compensation field as a whole, the NCCI losses data was fully developed, which meant that unlike the loss data from Hanover (which was not fully developed) it could provide a meaningful insight to the insurance cycle. Organizing the data from NCCI was much simpler than Hanover's data because the NCCI website allowed the user to filter and organize the data any way they wanted before displaying the data. Even so, there are a number of problems with the process of organizing relevant data and the data itself.

3.2.1 Problems

Firstly, NCCI collects information from only NCCI affiliated states. For example, NCCI does not have data on a number of states including Massachusetts, Michigan, New Jersey, and New York, which are four states in which Hanover does much of its business. Therefore, it should be noted that our prediction of the insurance cycle could vary greatly depending on which data set we use, mainly due to the variances that might be occurring in these three states. Another problem that might stem from NCCI's exclusion of certain states is that companies operating in NCCI states follow NCCI regulations (including pricing regulations) whereas the non-NCCI states each have their own separate rules and regulations. This could lead to all the NCCI states following their own insurance cycle while the other

states each have their own individual cycles. Therefore it is possible for Hanover and NCCI data to give us completely different results.

Another problem with NCCI has to do with the website itself. The premium and loss reports section, where we obtained all of our relevant data, had glitches. When creating a report, you can filter and organize the data by state, industry, period, class code, premium range, hazard group, etc. We were mainly interested in analyzing the data as a whole and that of the specific industries. Unfortunately it was only possible to view the data one state at a time. While investigating for a way to look at the nationwide data or at least groups of states together, we watched the "Getting Started" video. Here it clearly showed the narrator being able to select either the total (nationwide data) up to ten states at once to analyze, which is what we needed. However the button used in the video simply did not exist on the actual application (perhaps it was not implemented yet or was being fixed while we were trying to find it). This meant that we had to download the data one state at a time for every NCCI state and then compile over 30 excel spreadsheets to create a total value. For example, to come up with a total Written Premium for 2005, we had to sum up the Written Premiums in 2005 in over thirty states.

Collecting the data in this method also made us aware of another problem with the NCCI data; not every state has data from all the periods we were looking at. Most states have data for years 2002 to 2007 (although NCCI only allows up to five periods to be grouped at once so we only looked at the most recent years of 2003-2007) but some states are missing data from some of these years. Whether the state just joined NCCI or the data has not been fully compiled yet was not given. Either way, this meant that certain years include data from all NCCI states while others are missing a number of states. For example, the year of 2007 is missing data from Florida, Montana, North Carolina, Nevada, Oregon, Rhode Island, South Carolina, and South Dakota. This can be seen very clearly in the data by simply looking at the policy counts every year. For years 2003-2006, there were over two million policies while it drops drastically to just over seven hundred thousand policies in 2007 (See Appendix A). Even so, we are mostly interested in the deviation value, which is a ratio (Written Premium divided by Original Premium) and therefore not affected by the huge decrease in policies in the 2007 data (although if the deviation values differed significantly in those states, it could have changed the values).

3.2.2 Organization

Besides these issues, collecting the data from NCCI was relatively simply. As previously stated, NCCI's website allows users to filter and organize the data in any number of ways before creating a worksheet. The premium/loss reports section, which is what we mainly used, allowed us to choose seven different premium fields and eleven different loss fields and then organize this information with up to ten different groupings, including: policy period, industry, hazard rate, state, and others, which could then be combined in any number of ways. For our project, we mainly focused on the premium information so we selected all the premium fields and downloaded the data (and as previously mentioned, this had to be done state by state and then aggregated).

We used both industry group and policy period to organize the data. Policy period is straight forward; it separates the policies by the year in which a policy is in force for the policy holder (NCCI). If a policy spans multiple years, then the Written Premium and losses (if there are any) are divided between those years accordingly. The industry group separates the policies into what industry they fall under.

NCCI has five main industry groups, which include: contracting, goods and services, manufacturing, miscellaneous, and office and clerical. There are also several smaller groupings such as F-Class, coal mining, and other but these groups have at most a couple dozen policies so we disregarded them in favor of the main five groups.

Once we had the downloaded data and compiled it, we could calculate the deviation values. Deviation dollars was calculated by subtracting Original Premium from Written Premium. This gives us the difference in dollar amount. Table 3.2 is an example of the relevant information and calculations for the year 2003 with all the industries combined. (For full chart grouped by industry and year see Appendix C).

Table 3.2: All Industries NCCI Data: January 1, 2003 – December 31, 2003

Industry Group	Year	Policy Count	Written Premium	Original Premium	Deviation Value	Deviation Dollars
Total	2003	3,985,795	$67,048,847,352	$63,294,558,316	1.059314563	$3,754,289,036

3.2.3 Month Averaging

As described earlier, we felt that we were unable to compare the NCCI data to Hanover data due to the fact that NCCI data only had five data points (See Appendix D). We decided to estimate NCCI monthly premiums by relating it to Hanover monthly premiums.

The first step in our process involved selecting a specific year of data, for example the year 2005. Figure 3.2 shows the Hanover premium data for 2005 and Figure 3.3 shows NCCI 2005 premium data (notice that only the total for the entire year is known). The next step was to evaluate the percent of premium collected in each month for that specific year. In Figure 3.4, one can see the computed 2005 monthly percentages for Hanover premiums. Once we computed these monthly percentages, we assumed that NCCI monthly percentages would be relatively equal to Hanover monthly percentages. Assuming this, we applied the percentages we found from Hanover 2005 data to NCCI 2005 data by multiplying the 2005 Total by each corresponding monthly percentage. Figure 3.5 displays the estimated NCCI 2005 premium data. The last step in the process for a specific year was to determine the deviation values for each month based on the premiums. Both Figures 3.4 and 3.5 provide the deviation values for each month in 2005.

Figure 3.2: Given Hanover 2005 Premium Data

Given Hanover 2005 Premium Data

Month	Written Premium	Original Premium	Deviation
January	$15,527,718	$15,569,252	0.9973
February	$7,643,837	$7,573,283	1.0093
March	$11,577,755	$11,531,949	1.0040
April	$8,685,666	$8,889,795	0.9770
May	$7,136,089	$7,168,459	0.9955
June	$8,467,373	$8,440,848	1.0031
July	$7,853,892	$7,891,737	0.9952
August	$6,806,284	$6,695,327	1.0166
September	$10,524,017	$10,642,847	0.9888
October	$7,594,799	$7,741,023	0.9811
November	$5,779,533	$5,904,373	0.9789
December	$6,253,044	$ 6,298,827	0.9927
Total	**$103,850,000**	**$104,347,725**	

Figure 3.3: Given NCCI 2005 Premium Data

Given NCCI 2005 Premium Data

Month	Written Premium	Original Premium	Deviation
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			
December			
Total	**$38,169,131,857**	**$36,445,722,343**	

Figure 3.4: Developed Hanover 2005 Premium Data

Developed Hanover 2005 Premium Data

Month	Written Premium	% of Total Written	Original Premium	% of Total Original	Deviation
January	$15,527,718	14.95%	$15,569,252	14.92%	0.9973
February	$7,643,837	7.36%	$7,573,283	7.26%	1.0093
March	$11,577,755	11.15%	$11,531,949	11.05%	1.0040
April	$8,685,666	8.36%	$8,889,795	8.52%	0.9770
May	$7,136,089	6.87%	$7,168,459	6.87%	0.9955
June	$8,467,373	8.15%	$8,440,848	8.09%	1.0031
July	$7,853,892	7.56%	$7,891,737	7.56%	0.9952
August	$6,806,284	6.55%	$6,695,327	6.42%	1.0166
September	$10,524,017	10.13%	$10,642,847	10.20%	0.9888
October	$7,594,799	7.31%	$7,741,023	7.42%	0.9811
November	$5,779,533	5.57%	$5,904,373	5.66%	0.9789
December	$6,253,044	6.02%	$ 6,298,827	6.04%	0.9927
Total	**$103,850,000**		**$104,347,725**		

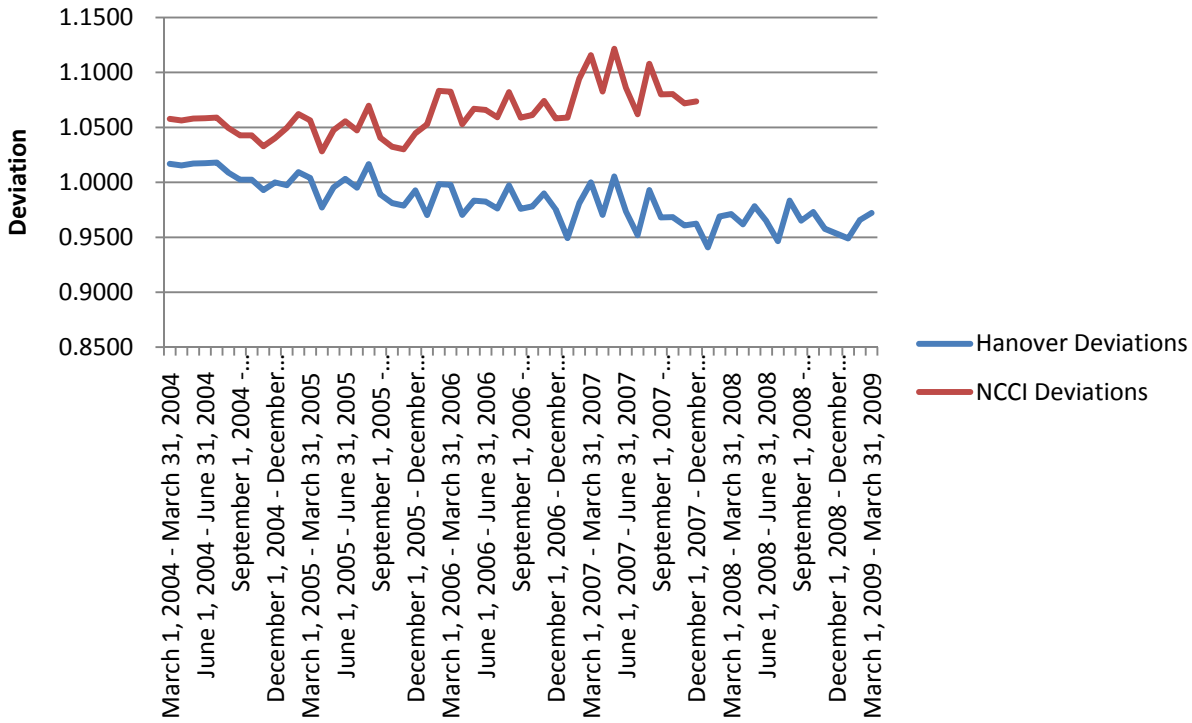
Figure 3.5: Developed NCCI 2005 Premium Data

Developed NCCI 2005 Premium Data

Month	Written Premium	% of Total Written	Original Premium	% of Total Original	Deviation
January	$5,707,072,468	14.95%	$5,437,901,644	14.92%	1.0495
February	$2,809,423,232	7.36%	$2,645,134,621	7.26%	1.0621
March	$4,255,299,253	11.15%	$4,027,785,105	11.05%	1.0565
April	$3,192,338,069	8.36%	$3,104,955,322	8.52%	1.0281
May	$2,622,805,042	6.87%	$2,503,740,948	6.87%	1.0476
June	$3,112,106,449	8.15%	$2,948,150,586	8.09%	1.0556
July	$2,886,627,050	7.56%	$2,756,361,872	7.56%	1.0473
August	$2,501,588,194	6.55%	$2,338,489,397	6.42%	1.0697
September	$3,868,007,371	10.13%	$3,717,246,815	10.20%	1.0406
October	$2,791,399,758	7.31%	$2,703,721,441	7.42%	1.0324
November	$2,124,215,140	5.57%	$2,062,231,493	5.66%	1.0301
December	$2,298,249,830	6.02%	$2,200,003,100	6.04%	1.0447
Total	**$38,169,131,857**		**$36,445,722,343**		

This process was done for each year between 2004 and 2009 (Refer to Appendix C for Hanover monthly data and Appendix E for NCCI monthly data). We were only able to estimate NCCI months between 2004 and 2007 because no data for Hanover 2003 was provided and no data for NCCI after 2007 was available from their website. Figure 3.6 compares the deviation value results of Hanover and NCCI between the years 2004 and 2009.

Figure 3.6: Hanover and NCCI Deviation Value Results



3.3 Regressions

Regressions are used mainly to predict future occurrences based on past similar data. It uses a best fit line to approximate the data points as closely as possible, and based on the results allow for estimates based on that line.[14] We will be using a multivariate regression with multiple powers of each variable. These regressions provide a statistical relationship between the variables in our research. Two of the most important values to identify in our regressions are the R^2 value, which describes the how much of the variance of the data is accounted for by the independent variables, and the p values of the independent variables used. The p-value denotes the likelihood that the coefficient of the variable is significantly different from 0, and therefore useful to the equation. Another important value of a regression is the significance of F, which speaks to the significance of the line as a whole.

Over the course of analysis, many different measures of fluctuation were looked at. First, the average reported, which is the average of the percent of payroll charged to a company for Workers' Compensation insurance, was evaluated; this would tell how the average pricing was shifting from

[14] (Copas, 1983)

period to period. Next, the deviation value average, the adjustments on the Original Premium, were looked at; this would tell us how actual prices were shifting relative to what was expected, the Original Premium (See deviations column in Appendix C for more information). Further analysis of deviation values included averaging it with a dollar-weighting to determine a more accurate average. Lastly, rolling averages were looked at to obtain smoother curves and to better observe any trends (See Appendix F for example). All data was accumulated on a monthly basis.

For each test of an dependent variable, whether it be the average reported rate, the dollar-weighted average deviation value for an industry or overall, or the dollar-weighted average deviation value for a rolling three, six, nine and twelve-month period for an industry or overall, the same steps were taken to determine a statistically significant formula based on the four independent variables: Dow Jones Industrial Average Close, Inflation rate, Prime rate, and the Unemployment rate.

The first step was to determine the lag factor of each variable independently. To determine the most likely lag that was experienced, the dependent variable, y, was regressed against a quintnomial of the independent variable, x, in the form of $a + b*x + c*x^2 + d*x^3 + e*x^4 = y$, thirteen times, once for the independent data and dependent data being from the same month, and then lagging the independent data one month at a time up to one year.

Then the lag with the greatest R^2 was chosen to be used in the overall equation, this was done for all four independent variables. The results from that process were then combined into one regression, a septendecanomial in the form $a + b*w + c*w^2 + d*w^3 + e*w^4 + f*x + g*x^2 + h*x^3 + i*x^4 + j*y + k*y^2 + l*y^3 + m*y^4 + n*z + o*z^2 + p*z^3 + q*z^4 = u$.

The resulting regression then had to be reduced so that each coefficient of an independent variable was statistically significant. This was accomplished by removing the least significant coefficient, re-running the regression without it, and repeating the process until each coefficient was significant. The resulting R^2 value could then be taken as a statistically significant measure of how much variance of the dependent variable could be reliably measured by the independent variables. (See Appendices G, H, I, and J for visual example of process)

4.0 Results

4.1 Average Reported Rate

The first round of testing was done on the average reported rate. The analytical process yielded the results of a septanomial consisting of the DJIA powers of 1-4 and unemployment powers of 1-2. This regression gave a R^2 value of 0.77734, significance of 3.133E-12, and with all independent variables significant. This was a promising start with the analysis.

4.2 Average Deviations by Industry

The next round of testing was on the averaged deviations by industry. The results for this were less promising, all regressions and independent variables were significant, but R^2 values ranged from .409 to only .614. Various combinations of predictors resulted, and they was no discernable pattern in predictors used, or the lags associated with predictors.

4.3 Rolling Weighted Average Deviations

The final analysis was on the rolling weighted average deviations. This produced quite amazing results. Again, all regressions and independent variables in the final regressions were significant. Each regression ended using a slightly different set of independent variables, but each independent variable uses the same or very similar lag in each rolling period, a very promising event in relating how accurate observations may be.

4.3.1 3-Month Rolling Average

For the 3-month rolling, the R^2 was 0.8917. The 3-month rolling used DJIA powers of 2-4, inflation powers 2-4, and the 3rd power of the unemployment rate. Lags for this regression were 9 months for DJIA, 12 months for both unemployment and prime rate, and a 0 month lag on inflation.

Table 4.1: 3-Month Rolling Final Results

Variable	Intercept	$DJIA^2$	$DJIA^3$	Inf^2	Inf^3	Inf^4	$Unemp^3$
Coefficient	1.12113	-0.00331	0.00017	0.00634	-0.00248	0.00025	0.00014

4.3.2 6-Month Rolling Average

For the 6-month rolling the R^2 was 0.9663. The 6-month rolling used DJIA powers of 2-4, unemployment powers of 1-4, and the 2nd prime rate power. Lags for the 6-month data are as follows: DJIA-9 months, Unemployment and Prime-12months, and no lag on inflation,

Table 4.2: 6-Month Rolling Final Results

Variable	Intercept	$DJIA^2$	$DJIA^3$	$DJIA^4$	Unemp	$Unemp^2$	$Unemp^3$	$Unmp^4$	$Prime^2$
Coefficient	-25.6022	0.0106	-0.0014	5.01×10^{-5}	20.6514	-6.0042	0.7703	-0.0368	-0.0002

4.3.3 9-Month Rolling Average

For the 9-month rolling the R^2 was 0.9650. The 9-month rolling used DJIA powers of 1-3, inflation powers of 2-4, and unemployment powers of 2-4. Lag rates were 8 months for DJIA, 12 months for both prime and unemployment, with no lag on inflation.

Table 4.3: 9-Month Rolling Final Results

Variable	Intercept	DJIA	$DJIA^2$	$DJIA^3$	Inf^2	Inf^3	Inf^4	$Unemp^2$	$Unemp^3$	$Unemp^4$
Coefficient	0.5579	0.2664	-0.0250	0.0008	0.0027	-0.0012	0.0001	-0.1071	0.0265	-0.0018

4.3.4 12-Month Rolling Average

For the 12-month rolling the R^2 was 0.9755. The 12-month rolling used DJIA powers of 2-4 and unemployment powers of 1-4. Lag rates for this period we the same as the lag rates for the 9 month rolling average.

Table 4.4: 12-Month Rolling Final Results

Variable	Intercept	$DJIA^2$	$DJIA^3$	$DJIA^4$	Unemp	$Unemp^2$	$Unemp^3$	$Unemp^4$
Coefficient	-7.7255	0.0097	-0.0012	4.13×10^{-5}	6.9091	-2.0781	0.2751	-0.0135

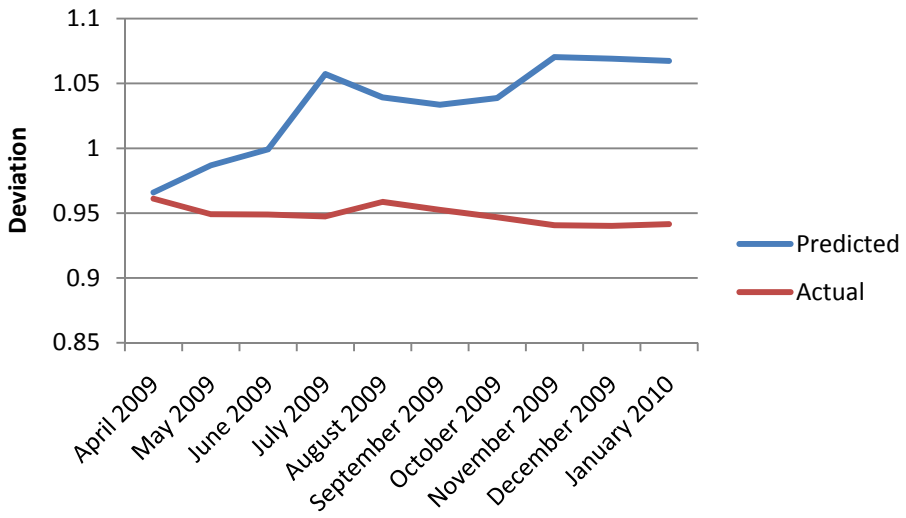
4.4 Predicting Months April 2009 – January 2010

We then decided to test how accurate our predictions would be using data points that occurred after our test data was collected. To do this we used the appropriate lags, variables and coefficients for each type of regression to compute a predicted rolling weighted-average deviation for 3, 6, 9, and 12 month periods, we then graphed these predictions against the actual averages that occurred. It is important to note that as the time from the original testing increases, the possible accuracy of predicted values decreases.

4.4.1 Using 3-Month Rolling Average

For the 3-month period as seen in Figure 4.1, the initial predictions are quite accurate, but unfortunately, due to numerous effects listed in the limitations section, the rest of the predictions were quite inaccurate. The worst result of this is that values above one are predicted, while actual values were below one (See Appendix L).

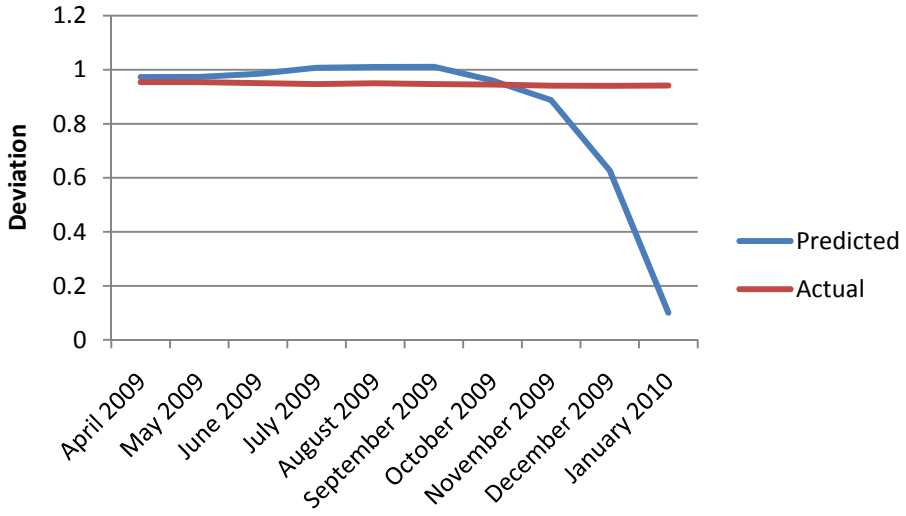
Figure 4.1: 3-Month Rolling Predicted vs. Actual Deviation Results



4.4.2 Using 6-Month Rolling Average

The 6-month rolling average, as seen in Figure 4.2, was perhaps the most accurate set of predictions in the short term, though due to large coefficients on some variables, it became wildly skewed in the long run. As can be seen in Appendix M, for the short-term, the predictions only differed by less than 0.1.

Figure 4.2: 6-Month Rolling Predicted vs. Actual Deviation Results

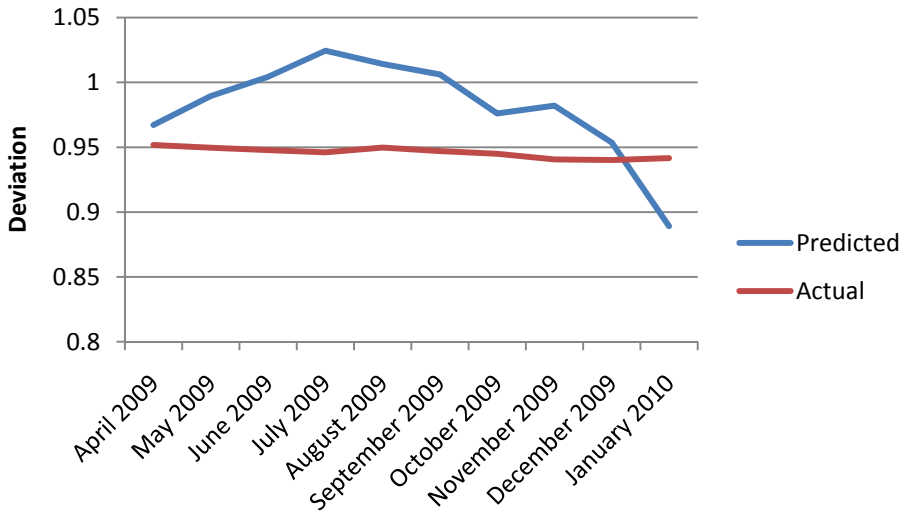


4.4.3 Using 9-Month Rolling Average

Though the predictions for the 9-month rolling average, as seen in Figure 4.3, are almost all greater than predicted values, it can be seen that a best-fit line drawn through the predictions will have a slope

similar to the slope of the actual values, showing that predictions may be higher, but are trending a similar way.

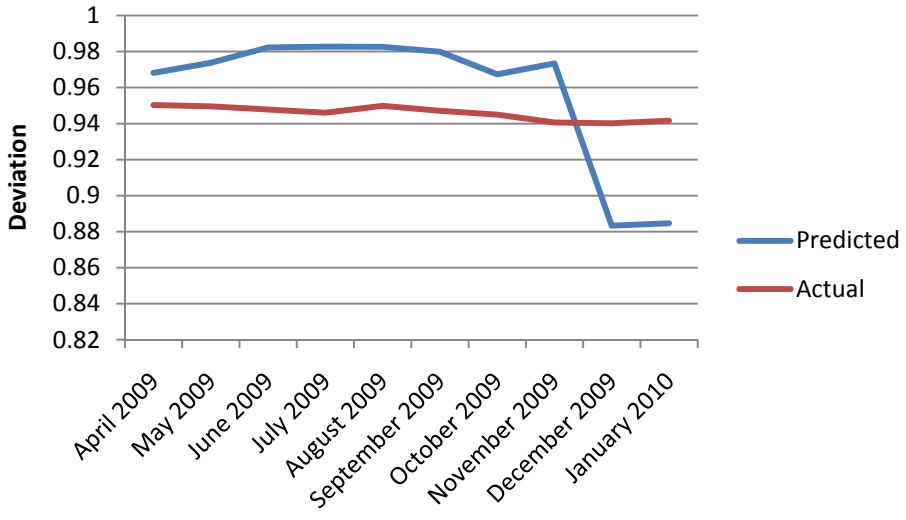
Figure 4.3: 9-Month Rolling Predicted vs. Actual Deviation Results



4.4.4 Using 12-Month Rolling Average

The 12-month rolling average, as seen in Figure 4.4, is a quite accurate prediction in the short-term, and only becomes inaccurate in the later data points. It is also similar to the 9-month rolling average in that the slope of a best fit line on the predictors seems to closely match the slope of the actual data points.

Figure 4.4: 12-Month Rolling Predicted vs. Actual Deviation Results



5.0 Conclusion

5.1 Continued Analysis

We believe that the results from the data analysis done over the course of this project show very promising predictions of pricing based on external economic factors. However, to produce the best possible predictions from this process, we recommend that it be repeated every 1, 2, 3, or 6, months, depending on desired accuracy. This would keep the tests close to the time of desired prediction, for a more accurate result. Also, repeating the process would be beneficial, because over time more and more data would be added to the regressions, and therefore would provide more and more reliable regression results. These factors combined should, over time, allow for either better predictions, more significant equations, or in a worst-case scenario, though quite unlikely, could ultimately show that results found by this project to be purely coincidence. Most likely, we believe it will produce better and better results, relating the economic and insurance cycles, and could allow for very accurate predictions.

5.2 Limitations

Our project had numerous limitations, which either forced us to follow a different path or limited the usefulness of our results. Without these limitations, we believe that the process we developed through this project could be even more accurate in predicting trends in Workers' Compensation Insurance, and would help to increase the long term profitability of the Workers' Compensation industry. Below is an overview of these limitations and recommendations of how our project could be expanded upon if they can be overcome.

5.2.1 Ways to Analyze the Data

There are a number of different ways in which we could group the data in order to analyze micro trends. We began grouping deviation values by hazard rates, state, and industry but were not able to make any conclusions due to time constraints. By organizing data into these categories, it would be possible for insurance companies to make even more informed decisions about whether to stay in or enter a specific market so this could be a very useful route to continue the work we have done so far. For example, applying our process to state data would help Hanover determine if one state might be more profitable than another. When analyzing these different categories, it is also important to consider that certain economic indicators might be more applicable or useless for each category. For example, when dividing the data by state, using state unemployment rates would make more sense that the national rate, which we used. Similarly, if looking at specific industries, an industry-specific stock index might be more insightful that using the Dow Jones Industrial Average.

5.2.2 Losses

When we began working on our project, we started by analyzing losses instead of premiums. Insurance companies base their prices based off of expected losses and individual expenses so we thought by predicting losses, we could in turn predict the insurance cycle. The two main problems we encountered were as follows: not knowing that losses are assumed and dealing with undeveloped losses.

The first problem stems from the fact that NCCI calculates an assumed loss cost based on industry, location, hazard rate, and a number of other variables for all the states it operates in. Insurance companies then add their own expenses on top of this to determine their premium rates. While losses may vary drastically from year to year, individual insurers do not have much power to change the base rates of their policies based on their own losses.

The second limitation when focusing on losses was dealing with undeveloped losses. If a worker is injured badly enough that they can no longer work, their policy could be paying their wages and medical bills for years to come. This means that Workers' Compensation losses can take a long time to fully develop (finish paying a claim) depending on the type of injury. While looking at Hanover's losses, we noticed that their loss ratios were much lower that the NCCI average (see Appendix K) and they were seemingly making a huge profit from their current premiums. After inquiring about this, we were notified that these losses were only the losses paid in the claim year. On average, fully developed loss ratios tended to increase by roughly twenty percent, making Hanover's losses much more realistic. However this meant that the loss data we were analyzing was incomplete and thus not useful for accurately predicting future losses.

On the other hand, NCCI did have the option of showing only developed losses. However, we felt that without the complete loss data from Hanover to compare it with, combined with the numerous other NCCI limitations (see section 5.2.5), this data would not be of much use so in the end we decided to focus on analyzing premiums primarily.

The data from SNL also had fully developed loss, expense, and combined ratios, for the largest one hundred insurance companies in the world. Unfortunately, by the time we found this, we had already abandoned analyzing losses and we believed that it would not produce meaningful results without similar Hanover data to compare it to.

The combination of predicted premiums and losses would allow Hanover to predict their profitability, which would be much more insightful than just knowing premiums or losses alone. For this reason, we believe using the method we derived could be used on Hanover's fully developed loss data, to provide another perspective from which to view the insurance cycle.

5.2.2.1 Loss Frequency and Severity

Within the losses we were examining a number of sub-trends. The main concepts we explored were: claim frequency over time, claim severity over time, and medical inflation rates. We looked at the developing trends of claim frequency and severity (see section 2.1.3) to determine whether there was a link between either of these statistics and the insurance cycle. We believed that these might be useful indicators because some of the most noticeable and sudden historical shifts into a hard market occurred right after a period of extremely high losses such as a natural disaster (See Appendix P).

5.2.2.2 Medical and Indemnity Losses

The rapid rise in medical inflation (which in turn causes increased severity) was also something we examined before abandoning analyzing losses. We thought there might be a link to the insurance cycle within the fact that medical costs are becoming a larger portion of Workers' Compensation losses (see Appendix Q) but we were not able to determine a link. In fact, medical inflation rates have been growing at faster and faster rates over the last few decades (see Figure 2.1) and there seemed to be no

cyclical trends in its growth, which suggests that it might not affect the insurance cycle (besides increasing average costs over time) but once again, we did not conclude anything.

5.2.3 Qualitative Factors

These are factors which have been known to have a significant effect on the insurance cycle, but as their name suggests it is difficult if not impossible to predict this impact in any meaningful way.

5.2.3.1 Random Acts of God

Random acts of God such as hurricanes, floods, earthquakes, and other natural disasters have been known to affect insurance cycles. Due to massive losses incurred as a result of these events, insurance companies must raise their rates dramatically afterwards, which leads to a hard cycle. While the effects of these disasters are well known and documented (See Appendix P). , they are, as the name suggests, completely random and thus impossible to predict For this reason we ignored the effects of random acts of God on the insurance cycle in our analysis in order to focus on something more predictable.

5.2.3.2 Governmental Regulations

Governmental regulations and laws regarding workplaces can also have a dramatic effect on the insurance cycle. New laws or regulations can change anything from conditions in the insured workplace to procedure for reporting claims, and this can affect the Workers' Compensation insurance industry (and thus the cycle) in some way. For example over the past few decades, more stringent regulations on safety in the workplace have caused frequency of claims to go down (See section 2.1.3). The current healthcare bill could also have a significant impact on the insurance cycle. If it decreases healthcare costs (as it is supposed to), this would lead to lower medical losses and therefore greater overall profits on Workers' Compensation policies, which would create a hard market and draw in new firms to benefit from the gains. However there are numerous factors that make hard to predict the effect that laws and regulations will have on the insurance cycle. The constant fluctuation of politics means that it is hard to determine whether any given law will even be passed. On top of this, many regulations that are passed do not always have the desired effect. These variables mean the effect of laws and regulations on the insurance cycle are difficult to predict. For this reason, we decided not to analyze the connection between laws and the insurance cycle.

5.2.4 Length of Data

Another serious limitation stemmed from the amount of data we had to work with. From Hanover's data we obtained deviation values from 2004 to 2010 and NCCI gave us access to data from 2002 to 2007. The first issue with this stems from the fact that we are only able to see a small section of the insurance cycle with the data we have. For example, the deviation values we obtained from NCCI show that national insurance prices were (for the period we looked at) trending upwards (see figure 3.7) but we were not able to see a turning point, making it hard to draw any useful conclusions.

Another issue is that the data we have from Hanover in particular is from the period leading up to and during the current economic crisis. The economic indicators that we used, particularly the Dow Jones Industrial Average and unemployment rate, have been fluctuating far outside of their normal ranges over the last few years. This could very easily have caused our regressions, which were based on

these abnormal points, to be useless for predicting the insurance cycle in a more normal economy. While this means that our current results could be flawed, the method which we used could and should be easily applied again once the economy stabilizes in order to come up with a formula based on more normal values.

A final issue with the length of data relates to how rolling averages were calculated. As rolling averages approached the later points in the data set, they became less and less accurate due to the incomplete data for the rolling period, ending with all rolling periods have the same final data point, as it only has one month of data to draw from. This limitation caused an effect on the regressions, but it was mostly mitigated by the number of data points in each regression. However, it had a great impact on the prediction values due to the fact that the inaccurate data points were such a large percentage. This effect could lead the slightly different predicted values as compared to the actual values.

5.2.5 NCCI

There were also several limitations to the usefulness of comparing NCCI's data to Hanover's data.

5.2.5.1 Example of Deviation Value Misinterpretation

Hanover Original Premiums might initially be higher than NCCI Original Premiums. Thus the discounting effect by Hanover might not necessarily result in lower prices than the NCCI. For example, if Hanover Original Premium is $100 for a specific policy and NCCI Original Premium is $90 for the same policy, then both NCCI and Hanover selling the policy at $95 would result in two differing deviations. Hanover's deviation value would be 0.95 [$95/$100], whereas NCCI's deviation value would be 1.05 [$95/$90]. Looking only at the deviation values, one might assume that Hanover is providing lower prices because a deviation value less than one means that the policy has been discounted from the initial price. Accordingly, one might assume that NCCI is charging higher prices because a deviation value greater than one means that the policy has been marked up.

5.2.5.2 Hanover Offers Discounts/ NCCI Marks Up

Another way one might misinterpret this data is to say that Hanover advises their potential customers that the price they are given initially is the highest price that they could be asked to pay, and thus they are able to bring down the prices and give discounted rates. On the other hand, one might misinterpret NCCI as showing its potential customers the lowest price that they will offer just to get the customer in the door. After the customer is in the door, other charges might be layered on due to customer's inability to still qualify for the lowest priced policy.

521.5.3 Hanover has States that NCCI does not cover

Another problem with trying to compare the NCCI data to the Hanover data is that the NCCI does not cover states that Hanover does most of its business in. Hanover's largest states include Michigan, Massachusetts, New Jersey, and New York, which are all non-NCCI affiliated states, thus it is difficult to compare the results. When we remove these states from the Hanover, we are removing the majority of Hanover data. We feel that the remaining data does not truly represent how Hanover acts in the market.

5.2.5.4 No Actual Monthly Data

As previously, mentioned in section 3.2, NCCI only provided five actual data points, one for each year. While we were able to derive monthly deviation values, they were based on the assumption that most insurance companies write their policies at the same time Hanover does. While most companies do renew policies based on financial quarters (as was seen in Hanover's data), any inconsistencies could cause the deviation values that we calculated to be significantly off from what they truly are. Despite the fact that NCCI deviation values might not be exact, they are still very useful for determining where the premiums are trending.

5.3 Turning Points

We feel that this process will allow Hanover to make decisions such as whether or not to stay in a specific market. They will be able to do this by looking for turning points in the deviation values. If our process projects the deviation value to drop for a few months but also projects the deviation value to rise above the current value immediately after the short decrease, then it would be very profitable for Hanover to endure the short time period of loses in order to enjoy the future profits when the deviation value rises. Hanover will be able to enjoy future profits because as the rates decrease insurers will stop offering policies in order to maintain their profits.

On the other hand, if our process projects the deviation value to rise for a few months but also projects the deviation value to drop below the current value immediately after the short increase, then it would be profitable for Hanover to keep their rates at the current level and allow customers to shop around if they wanted to receive better rates. Hanover would be able to foresee the expected decrease in premiums and thus avoid the diminishing profits and possible losses.

5.4 Further Research

After finalizing the project, we have some possible considerations for further research in the area and improvements to our process. Many of these recommendations stem from the limitations of the project and can be read about in section 5.2.

There were a couple of flaws in our regression method, which could also be improved. One minor flaw in our project design has to deal with our method of reducing the regressions; it appears that it is common practice to keep the primary type of term in a regression if one is using a modified version of the variable. This would require more analysis on the regressions to determine new significant and more correct regressions.

A recommendation for the process in this project would be to calculate all possible combinations of regressions (a very lengthy task) because as the removal or non-removal of a variable from a regression effectively leads one down a different path in the decision tree, and this could lead to a non-optimal regression; it is also the case with our analysis that this could have occurred, but we believe our process produces a closely related answer. To do this for the project would require running 6,304 separate regressions, and we currently lack the time to explore this possibility. The next step in the process would be to remove any of those regressions in which any coefficient is not significant, then to choose the regression with the greatest R^2 value.

Appendix A: NCCI Data by Industry

Industry Group	Year	Policy Count	Written Premium	Original Premium	Deviation Value	Deviation Dollars
Contracting	2003	438,274	9,028,755,600	8,221,345,610	1.098208983	807,409,990
Contracting	2004	451,474	9,893,248,007	9,003,567,412	1.098814232	889,680,595
Contracting	2005	473,477	10,812,286,047	9,940,336,325	1.087718332	871,949,722
Contracting	2006	491,787	11,296,984,070	10,273,233,534	1.099652221	1,023,750,536
Contracting	2007	157,304	3,216,447,161	2,900,845,751	1.108796343	315,601,410
Goods & Services	2003	704,966	9,559,234,496	9,716,277,617	0.983837111	-157,043,121
Goods & Services	2004	708,655	10,113,016,240	10,262,653,955	0.985419199	-149,637,715
Goods & Services	2005	715,356	10,607,468,834	10,768,321,503	0.98506242	-160,852,669
Goods & Services	2006	713,197	10,798,031,053	10,729,740,106	1.006364641	68,290,947
Goods & Services	2007	224,086	3,255,507,781	3,176,698,400	1.024808581	78,809,381
Manufacturing	2003	137,483	5,770,371,478	5,441,817,868	1.060375709	328,553,610
Manufacturing	2004	135,526	6,116,828,318	5,735,687,257	1.066450809	381,141,061
Manufacturing	2005	135,306	6,371,653,972	5,932,622,368	1.074002958	439,031,604
Manufacturing	2006	133,330	6,378,002,489	5,877,848,932	1.085091257	500,153,557
Manufacturing	2007	43,911	2,100,102,642	1,911,540,457	1.098644098	188,562,185
Miscellaneous	2003	138,061	5,100,586,055	4,831,156,135	1.055769243	269,429,920
Miscellaneous	2004	138,207	5,529,353,820	5,254,794,129	1.052249372	274,559,691
Miscellaneous	2005	140,333	5,813,660,477	5,498,821,539	1.057255711	314,838,938
Miscellaneous	2006	140,789	5,973,385,397	5,533,409,098	1.0795127	439,976,299
Miscellaneous	2007	48,223	2,144,189,815	1,934,471,390	1.108411231	209,718,425
Office & Clerical	2003	705,840	4,061,957,879	3,847,551,125	1.055725511	214,406,754
Office & Clerical	2004	719,241	4,261,271,290	4,016,179,537	1.061026095	245,091,753

Office & Clerical	2005	743,727	4,564,062,527	4,305,620,608	1.060024313	258,441,919
Office & Clerical	2006	759,688	4,726,512,702	4,369,664,255	1.081664958	356,848,447
Office & Clerical	2007	236,672	1,403,396,826	1,263,704,068	1.110542303	139,692,758
Total	2003	2,124,624	33,520,905,508	32,058,148,355	1.045628248	1,462,757,153
Total	2004	2,153,103	35,913,717,675	34,272,882,290	1.047875617	1,640,835,385
Total	2005	2,208,199	38,169,131,857	36,445,722,343	1.047287018	1,723,409,514
Total	2006	2,238,791	39,172,915,711	36,783,895,925	1.064947438	2,389,019,786
Total	2007	710,196	12,119,644,225	11,187,260,066	1.083343388	932,384,159

Appendix B: Glossary

Glossary for Hanover Data

ID-Number	A number used to identify each policy from year to year. (Created exclusively for WPI use)
State	State of insured's main location
State Rank	Hanover used ranking system for each state
Company	Company within Hanover Insurance Group that policy is written
Branch	Office where policy is processed
EffDate	First day that current policy took effect, will change from year to year 1/1/09 will be 1/1/10 on renewal
New Renewal	Whether policy is new to Hanover (one year or less) or has been renewed with Hanover (over 1 year)
NAICS	Industry used code to classify each company
NAICS Desc	Description of NAICS
Industry	Industry corresponding to NAICS
Risk Grade	Risk ranking system based on Industry
Credit_Debit	Deviation from manual premium; < 1 is a reduced premium while > 1 is an increase premium Based on Underwriting judgment
IRPM Dollars	Amount increased or decreased from manual premium, corresponds to Credit_Debit
IRPMDesc	Grouping of Credit_Debit percentages
ExpMod	A factor used to increase/decrease premium amount based solely on insured's experience
ExpModGroup	Grouping of ExpMod percentages
DevDollars	Dollar amount of deviation relative to base company (Company utilization tool)
Deviation	Relative factor of Company to base company (Company Utilization tool)
PolSizeDesc	Grouping by WPrem
WPrem	Dollar amount of written premium
TotDevDol	IRPM Dollars + DevDollars
IF EP	Amount of premium earned over life of the current policy; Earned Premium
IF Losses	Amount in losses
Region	Geographic region of Branch

%TtlDev	(TotalDevDollars) / (WPrem - TotalDevDollars)
Exception	Policies that fall outside of Hanover's Underwriting criteria; Based on underwriting judgment
Exposure	Estimated payroll of insured
Loss Ratio	Losses / EP; Key ratio used in analysis

Glossary for NCCI Data

Industry Group	Industry which the policy insures (can be contracting, goods and services, manufacturing, miscellaneous, and office and clerical)
Policy Count	Number of policies written in given period
Manual Premium	Same as written premium in Hanover data
Standard Premium	Same as original premium in Hanover data
Exposure	Same as exposure in Hanover Data

Glossary for SNL Financial Data

Direct Premiums Written

Premiums written including gross premiums booked, adjusted for additional or return premiums, on policies where the company is the primary or direct carrier, as it relates to a specific line of business. State Fund direct premiums written are included where applicable.

Losses Paid Less Salvage: Direct Business

Claims paid on direct business written net of salvage and subrogation. State Fund direct losses paid are included where applicable.

Direct Premiums Earned

Direct premiums earned less returning premiums.

Direct Losses Incurred

Direct losses incurred

Direct Defense & Cost Containment Exp Incurred

Direct Defense & Cost Containment Expense Incurred

Commissions & Brokerage Exp

Commissions & Brokerage Expenses

State Direct Premiums & Annuity Considerations

State Direct Premiums & Annuity Considerations

Dividends Paid on Direct Business

Dividends paid to policyholders on direct business

Taxes, Licenses, Fees on Direct Business

Taxes, Licenses, Fees on Direct Business

Direct Losses Paid

Losses paid on a direct basis before reinsurance

Direct Paid Loss Ratio (%)

Direct losses paid excluding salvage as a percent of direct premiums written

Direct Incurred Loss Ratio (%)

Direct losses incurred as a percent of direct premiums earned

Direct Adj. Incurred Loss Ratio (%)

Direct losses incurred as a percent of direct premiums earned less dividends paid or credited to policyholders on direct business

Direct Loss and Loss Adj. Exp Ratio (%)

Direct losses incurred plus direct defense and cost containment expense incurred as a percent of direct premiums earned

Direct Expense Ratio (%)

Commissions and brokerage expenses plus taxes, licenses and fees as a percent of direct premiums written

Direct Simple Combined Ratio (%)

Direct loss and LAE ratio plus direct expense ratio. Dividends are not a part of this version of the combined ratio.

Appendix C: All Industry Data for Hanover by Month

Month	Deviation Value Average	WPrem	# of Policies	Original Premium	WPrem / Original
March 1, 2004 - March 31, 2004	1.03229	$ 541,047	70	$ 532,094	1.01683
April 1, 2004 - April 31, 2004	1.02012	$ 5,389,893	912	$ 5,308,042	1.01542
May 1, 2004 - May 31, 2004	1.01276	$ 5,017,014	1014	$ 4,932,484	1.01714
June 1, 2004 - June 31, 2004	1.01169	$ 6,696,256	981	$ 6,581,584	1.01742
July 1, 2004 - July 31, 2004	1.01610	$ 6,412,739	1058	$ 6,299,339	1.01800
August 1, 2004 - August 31, 2004	1.00741	$ 7,854,685	1392	$ 7,785,479	1.00889
September 1, 2004 - September 31, 2004	1.00359	$ 10,183,861	1533	$ 10,158,914	1.00246
October 1, 2004 - October 31, 2004	1.00739	$ 8,928,044	1641	$ 8,906,127	1.00246
November 1, 2004 - November 31, 2004	1.00676	$ 6,150,552	1248	$ 6,194,165	0.99296
December 1, 2004 - December 31, 2004	1.00772	$ 8,230,475	1319	$ 8,230,464	1.00000
January 1, 2005 - January 31, 2005	1.00545	$ 15,527,718	2224	$ 15,569,253	0.99733
February 1, 2005 - February 31, 2005	1.00657	$ 7,643,837	1527	$ 7,573,283	1.00932
March 1, 2005 - March 31, 2005	1.00933	$ 11,577,755	1777	$ 11,531,949	1.00397
April 1, 2005 - April 31, 2005	0.98421	$ 8,685,666	1717	$ 8,889,796	0.97704
May 1, 2005 - May 31, 2005	1.00218	$ 7,136,089	1542	$ 7,168,459	0.99548
June 1, 2005 - June 31, 2005	1.00024	$ 8,467,373	1523	$ 8,440,848	1.00314
July 1, 2005 - July 31, 2005	1.00653	$ 7,853,892	1543	$ 7,891,738	0.99520
August 1, 2005 - August 31, 2005	1.00520	$ 6,806,284	1313	$ 6,695,328	1.01657
September 1, 2005 - September 31, 2005	1.00178	$ 10,524,017	1394	$ 10,642,847	0.98883
October 1, 2005 - October 31, 2005	1.00455	$ 7,594,799	1463	$ 7,741,023	0.98111
November 1, 2005 - November 31, 2005	1.00473	$ 5,779,533	1134	$ 5,904,374	0.97886
December 1, 2005 - December 31, 2005	1.00555	$ 6,253,044	1150	$ 6,298,828	0.99273
January 1, 2006 - January 31, 2006	0.99835	$ 14,650,814	2109	$ 15,100,006	0.97025
February 1, 2006 - February 31, 2006	1.00273	$ 7,036,104	1401	$ 7,047,864	0.99833
March 1, 2006 - March 31, 2006	1.00408	$ 9,782,405	1647	$ 9,804,579	0.99774
April 1, 2006 - April 31, 2006	0.98558	$ 9,500,810	1647	$ 9,790,567	0.97040
May 1, 2006 - May 31, 2006	0.99841	$ 7,273,070	1487	$ 7,396,280	0.98334
June 1, 2006 - June 31, 2006	0.99777	$ 8,577,111	1441	$ 8,730,564	0.98242
July 1, 2006 - July 31, 2006	1.02468	$ 8,981,605	1551	$ 9,200,218	0.97624
August 1, 2006 - August 31, 2006	1.01809	$ 7,209,201	1286	$ 7,229,023	0.99726
September 1, 2006 - September 31, 2006	1.00921	$ 10,464,051	1355	$ 10,721,658	0.97597
October 1, 2006 - October 31, 2006	1.02217	$ 7,734,918	1501	$ 7,907,897	0.97813
November 1, 2006 - November 31, 2006	1.01751	$ 5,837,048	1127	$ 5,896,191	0.98997
December 1, 2006 - December 31, 2006	1.01482	$ 7,970,233	1195	$ 8,172,117	0.97530
January 1, 2007 - January 31, 2007	1.01232	$ 16,124,385	2217	$ 16,986,999	0.94922
February 1, 2007 - February 31, 2007	1.01047	$ 7,400,037	1462	$ 7,544,631	0.98083
March 1, 2007 - March 31, 2007	1.01823	$ 9,279,702	1638	$ 9,279,491	1.00002

April 1, 2007 - April 31, 2007	0.99905	$ 9,648,490	1646	$ 9,942,072	0.97047
May 1, 2007 - May 31, 2007	1.01941	$ 7,265,483	1450	$ 7,226,765	1.00536
June 1, 2007 - June 31, 2007	1.01134	$ 8,693,385	1457	$ 8,930,314	0.97347
July 1, 2007 - July 31, 2007	1.00669	$ 9,319,219	1532	$ 9,789,664	0.95194
August 1, 2007 - August 31, 2007	1.00311	$ 7,362,681	1294	$ 7,414,756	0.99298
September 1, 2007 - September 31, 2007	1.00039	$ 10,518,178	1381	$ 10,864,944	0.96808
October 1, 2007 - October 31, 2007	1.00835	$ 8,993,633	1580	$ 9,287,508	0.96836
November 1, 2007 - November 31, 2007	1.00014	$ 6,877,584	1220	$ 7,158,349	0.96078
December 1, 2007 - December 31, 2007	0.99807	$ 8,700,615	1248	$ 9,041,064	0.96234
January 1, 2008 - January 31, 2008	1.00041	$ 16,754,108	2234	$ 17,808,428	0.94080
February 1, 2008 - February 31, 2008	0.99003	$ 7,868,362	1445	$ 8,121,078	0.96888
March 1, 2008 - March 31, 2008	0.99773	$ 8,942,583	1622	$ 9,207,829	0.97119
April 1, 2008 - April 31, 2008	0.98897	$ 9,781,314	1649	$ 10,169,791	0.96180
May 1, 2008 - May 31, 2008	1.01050	$ 7,311,212	1458	$ 7,473,201	0.97832
June 1, 2008 - June 31, 2008	0.99638	$ 9,362,300	1491	$ 9,703,589	0.96483
July 1, 2008 - July 31, 2008	1.00179	$ 10,290,180	1589	$ 10,871,745	0.94651
August 1, 2008 - August 31, 2008	1.00244	$ 7,410,595	1308	$ 7,536,281	0.98332
September 1, 2008 - September 31, 2008	0.99900	$ 11,099,644	1434	$ 11,500,455	0.96515
October 1, 2008 - October 31, 2008	1.00732	$ 10,030,708	1542	$ 10,309,220	0.97298
November 1, 2008 - November 31, 2008	0.99980	$ 6,616,914	1220	$ 6,908,555	0.95779
December 1, 2008 - December 31, 2008	0.99850	$ 8,107,181	1238	$ 8,503,588	0.95338
January 1, 2009 - January 31, 2009	0.99662	$ 14,750,625	2157	$ 15,543,781	0.94897
February 1, 2009 - February 31, 2009	0.99130	$ 7,239,934	1429	$ 7,496,986	0.96571
March 1, 2009 - March 31, 2009	0.99409	$ 8,750,047	1662	$ 9,062,780	0.96549
April 1, 2009 - April 31, 2009	0.98180	$ 9,350,818	1676	$ 9,780,590	0.95606
May 1, 2009 - May 31,2009	0.99772	$ 7,177,800	1437	$ 7,403,108	0.96957
June 1, 2009 - June 31, 2009	0.98680	$ 9,669,182	1555	$ 10,073,737	0.95984
July 1, 2009 - July 31, 2009	0.98260	$ 11,161,506	1597	$ 12,029,906	0.92781
August 1, 2009 - August 31, 2009	0.98394	$ 7,352,688	1370	$ 7,595,114	0.96808
September 1, 2009 - September 31, 2009	0.97853	$ 10,540,780	1481	$ 11,042,969	0.95452
October 1, 2009 - October 31, 2009	0.98010	$ 10,261,680	1554	$ 10,730,004	0.95635
November 1, 2009 - November 31, 2009	0.97144	$ 5,848,550	1263	$ 6,205,572	0.94247
December 1, 2009 - December 31, 2009	0.97369	$ 7,733,262	1289	$ 8,246,680	0.93774
January 1, 2010 - January 31, 2010	0.97130	$ 13,146,189	2030	$ 13,961,771	0.94158

Appendix D: NCCI Yearly Data

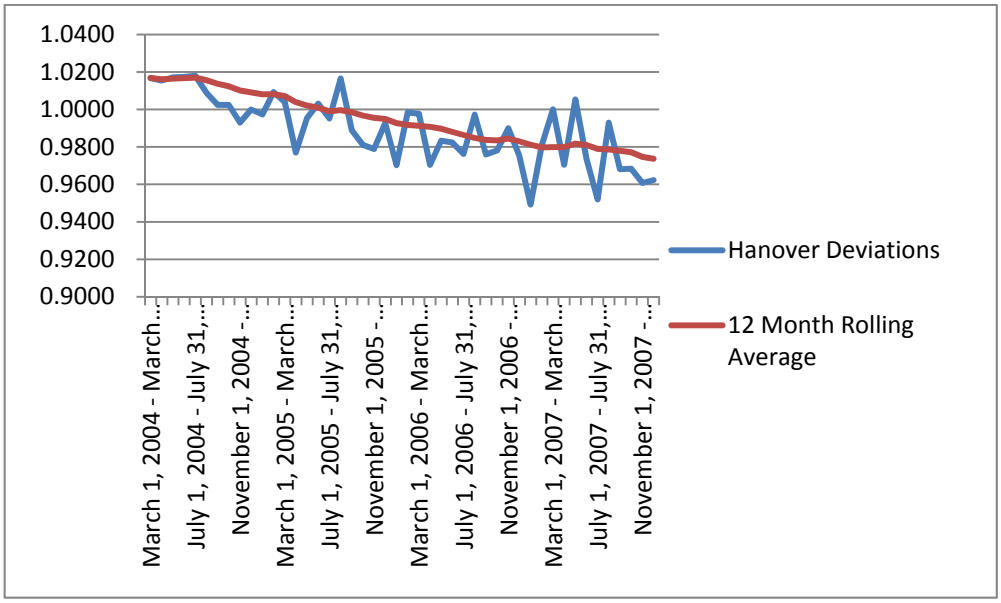
Year	Written Premium	Original Premium
2003		
2004	$ 35,913,717,675	$ 34,272,882,290
2005	$ 38,169,131,857	$ 36,445,722,343
2006	$ 39,172,915,711	$ 36,783,895,925
2007	$ 12,119,644,225	$ 11,187,260,066

Appendix E: NCCI Monthly Averaging Data

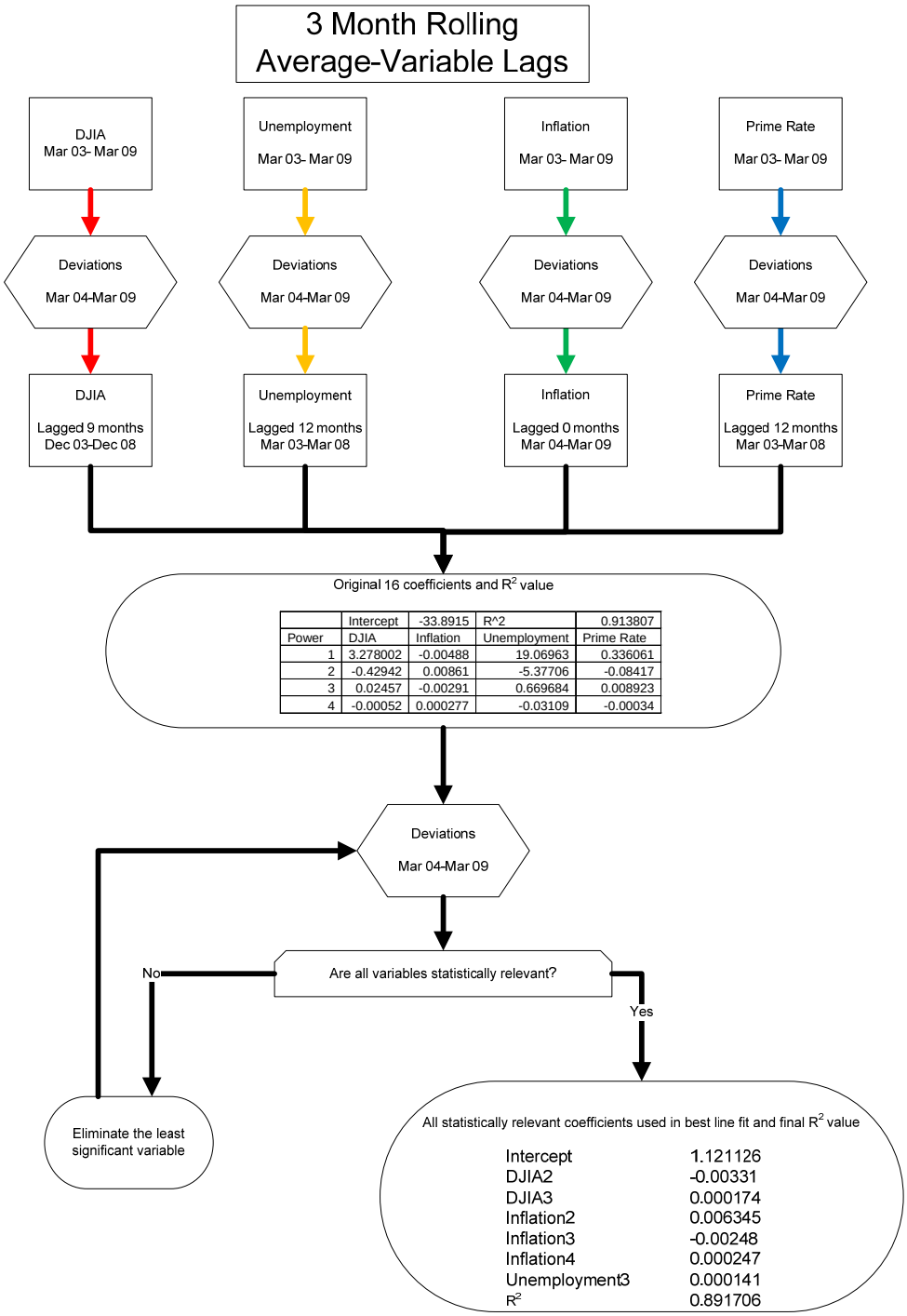
Month	Wprem	% of Wprem	Original Premiums	% of Original	Deviation Value
March 1, 2004 - March 31, 2004	$ 297,089,491	0.83%	$ 280,868,074	0.82%	1.0578
April 1, 2004 - April 31, 2004	$ 2,959,596,055	8.24%	$ 2,801,872,000	8.18%	1.0563
May 1, 2004 - May 31, 2004	$ 2,754,847,794	7.67%	$ 2,603,632,268	7.60%	1.0581
June 1, 2004 - June 31, 2004	$ 3,676,921,386	10.24%	$ 3,474,116,547	10.14%	1.0584
July 1, 2004 - July 31, 2004	$ 3,521,241,896	9.80%	$ 3,325,132,724	9.70%	1.0590
August 1, 2004 - August 31, 2004	$ 4,313,015,998	12.01%	$ 4,109,597,766	11.99%	1.0495
September 1, 2004 - September 31, 2004	$ 5,591,969,050	15.57%	$ 5,362,425,612	15.65%	1.0428
October 1, 2004 - October 31, 2004	$ 4,902,398,582	13.65%	$ 4,701,136,652	13.72%	1.0428
November 1, 2004 - November 31, 2004	$ 3,377,274,731	9.40%	$ 3,269,615,935	9.54%	1.0329
December 1, 2004 - December 31, 2004	$ 4,519,362,692	12.58%	$ 4,344,484,711	12.68%	1.0403
2004 Totals	$ 35,913,717,675		$ 34,272,882,290		
January 1, 2005 - January 31, 2005	$ 5,707,072,468	14.95%	$ 5,437,901,644	14.92%	1.0495
February 1, 2005 - February 31, 2005	$ 2,809,423,232	7.36%	$ 2,645,134,621	7.26%	1.0621
March 1, 2005 - March 31, 2005	$ 4,255,299,253	11.15%	$ 4,027,785,105	11.05%	1.0565
April 1, 2005 - April 31, 2005	$ 3,192,338,069	8.36%	$ 3,104,955,322	8.52%	1.0281
May 1, 2005 - May 31, 2005	$ 2,622,805,042	6.87%	$ 2,503,740,948	6.87%	1.0476
June 1, 2005 - June 31, 2005	$ 3,112,106,449	8.15%	$ 2,948,150,586	8.09%	1.0556
July 1, 2005 - July 31, 2005	$ 2,886,627,050	7.56%	$ 2,756,361,872	7.56%	1.0473
August 1, 2005 - August 31, 2005	$ 2,501,588,194	6.55%	$ 2,338,489,397	6.42%	1.0697
September 1, 2005 - September 31, 2005	$ 3,868,007,371	10.13%	$ 3,717,246,815	10.20%	1.0406
October 1, 2005 - October 31, 2005	$ 2,791,399,758	7.31%	$ 2,703,721,441	7.42%	1.0324
November 1, 2005 - November 31, 2005	$ 2,124,215,140	5.57%	$ 2,062,231,493	5.66%	1.0301
December 1, 2005 - December 31, 2005	$ 2,298,249,830	6.02%	$ 2,200,003,100	6.04%	1.0447
2005 Totals	$ 38,169,131,857		$ 36,445,722,343		
January 1, 2006 - January 31, 2006	$ 5,464,954,054	13.95%	$ 5,191,147,877	14.11%	1.0527
February 1, 2006 - February 31, 2006	$ 2,624,563,050	6.70%	$ 2,422,946,344	6.59%	1.0832
March 1, 2006 - March 31, 2006	$ 3,648,970,894	9.32%	$ 3,370,662,077	9.16%	1.0826
April 1, 2006 - April 31, 2006	$ 3,543,932,107	9.05%	$ 3,365,844,881	9.15%	1.0529
May 1, 2006 - May 31, 2006	$ 2,712,954,610	6.93%	$ 2,542,726,342	6.91%	1.0669
June 1, 2006 - June 31, 2006	$ 3,199,379,743	8.17%	$ 3,001,432,421	8.16%	1.0660
July 1, 2006 - July 31, 2006	$ 3,350,261,539	8.55%	$ 3,162,892,295	8.60%	1.0592
August 1, 2006 - August 31, 2006	$ 2,689,130,599	6.86%	$ 2,485,225,861	6.76%	1.0820

September 1, 2006 - September 31, 2006	$ 3,903,234,178	9.96%	$ 3,685,939,575	10.02%	1.0590
October 1, 2006 - October 31, 2006	$ 2,885,230,232	7.37%	$ 2,718,612,408	7.39%	1.0613
November 1, 2006 - November 31, 2006	$ 2,177,298,758	5.56%	$ 2,027,018,900	5.51%	1.0741
December 1, 2006 - December 31, 2006	$ 2,973,005,947	7.59%	$ 2,809,446,944	7.64%	1.0582
2006 Totals	$ 39,172,915,711		$ 36,783,895,925		
January 1, 2007 - January 31, 2007	$ 1,773,604,951	14.63%	$ 1,674,836,860	14.97%	1.0590
February 1, 2007 - February 31, 2007	$ 813,968,549	6.72%	$ 743,864,593	6.65%	1.0942
March 1, 2007 - March 31, 2007	$ 1,020,722,676	8.42%	$ 914,913,495	8.18%	1.1156
April 1, 2007 - April 31, 2007	$ 1,061,287,586	8.76%	$ 980,240,730	8.76%	1.0827
May 1, 2007 - May 31, 2007	$ 799,168,255	6.59%	$ 712,524,478	6.37%	1.1216
June 1, 2007 - June 31, 2007	$ 956,230,621	7.89%	$ 880,486,219	7.87%	1.0860
July 1, 2007 - July 31, 2007	$ 1,025,069,357	8.46%	$ 965,214,078	8.63%	1.0620
August 1, 2007 - August 31, 2007	$ 809,859,568	6.68%	$ 731,059,457	6.53%	1.1078
September 1, 2007 - September 31, 2007	$ 1,156,949,091	9.55%	$ 1,071,231,541	9.58%	1.0800
October 1, 2007 - October 31, 2007	$ 989,256,459	8.16%	$ 915,703,884	8.19%	1.0803
November 1, 2007 - November 31, 2007	$ 756,501,227	6.24%	$ 705,779,022	6.31%	1.0719
December 1, 2007 - December 31, 2007	$ 957,025,886	7.90%	$ 891,405,711	7.97%	1.0736
2007 Totals	$ 12,119,644,225		$ 11,187,260,066		
January 1, 2008 - January 31, 2008	$ -	14.75%	$ -	15.08%	
February 1, 2008 - February 31, 2008	$ -	6.93%	$ -	6.88%	
March 1, 2008 - March 31, 2008	$ -	7.87%	$ -	7.80%	
April 1, 2008 - April 31, 2008	$ -	8.61%	$ -	8.61%	
May 1, 2008 - May 31, 2008	$ -	6.44%	$ -	6.33%	
June 1, 2008 - June 31, 2008	$ -	8.24%	$ -	8.22%	
July 1, 2008 - July 31, 2008	$ -	9.06%	$ -	9.20%	
August 1, 2008 - August 31, 2008	$ -	6.52%	$ -	6.38%	
September 1, 2008 - September 31, 2008	$ -	9.77%	$ -	9.74%	
October 1, 2008 - October 31, 2008	$ -	8.83%	$ -	8.73%	
November 1, 2008 - November 31, 2008	$ -	5.83%	$ -	5.85%	
December 1, 2008 - December 31, 2008	$ -	7.14%	$ -	7.20%	
2008 Totals					
January 1, 2009 - January 31, 2009	$ -	50.68%	$ -	51.20%	
February 1, 2009 - February 31, 2009	$ -	24.87%	$ -	24.69%	
March 1, 2009 - March 31, 2009	$ -	24.45%	$ -	24.11%	
2009 Totals					

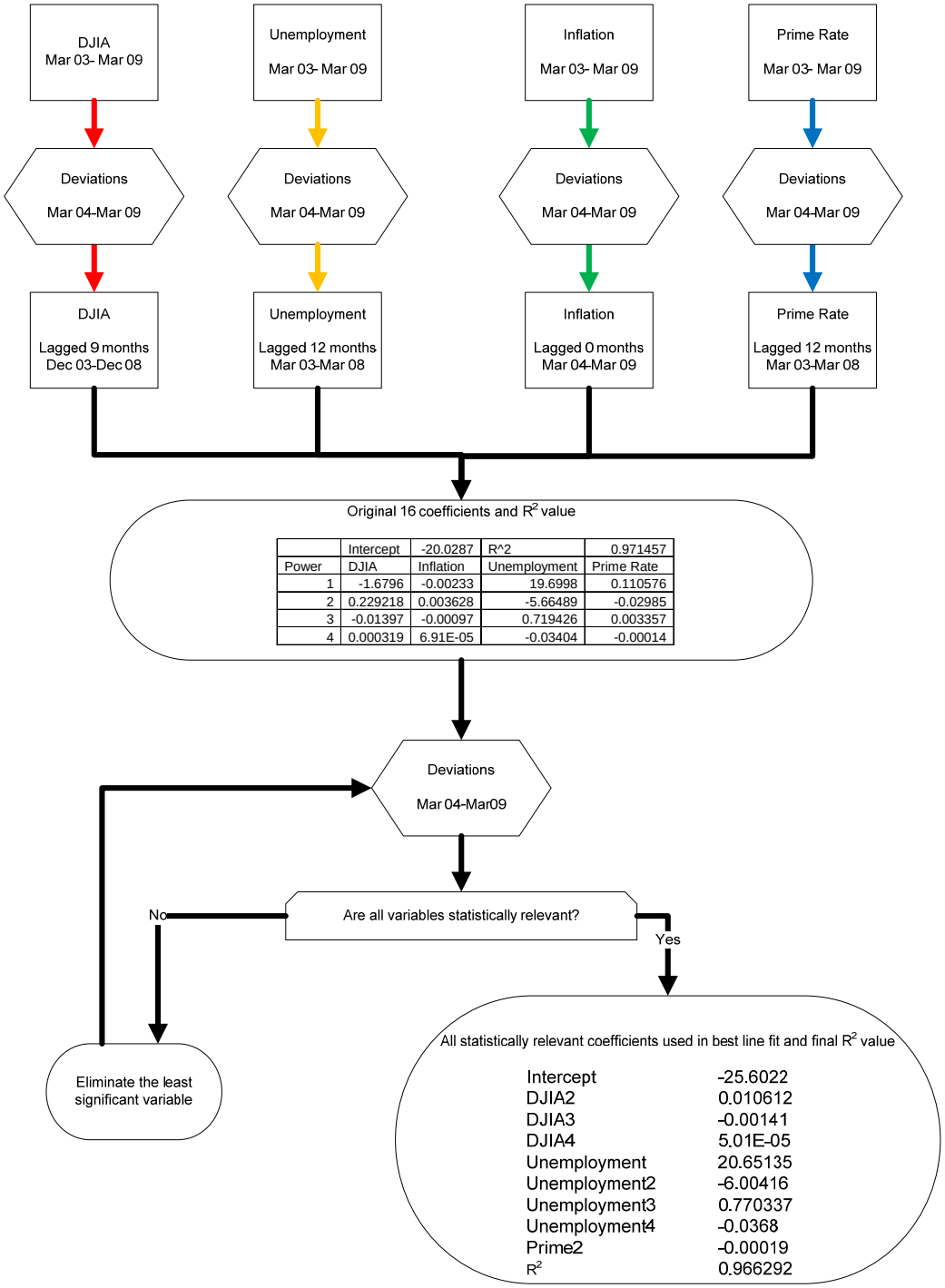
Appendix F: Smoothing the Data by using Rolling Averages



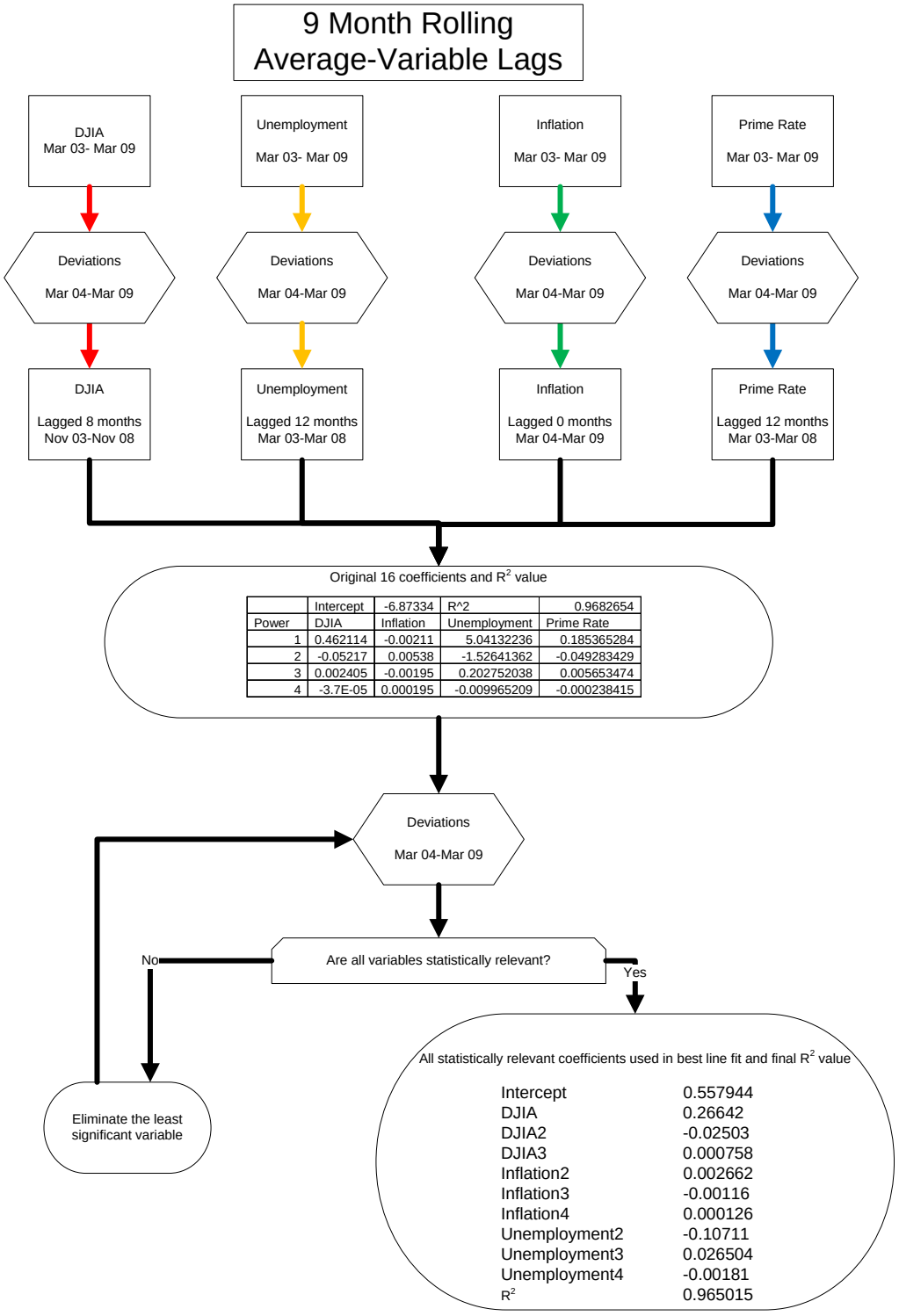
Appendix G: 3 Month Rolling Average Flowchart



Appendix H: 6 Month Rolling Average Flowchart

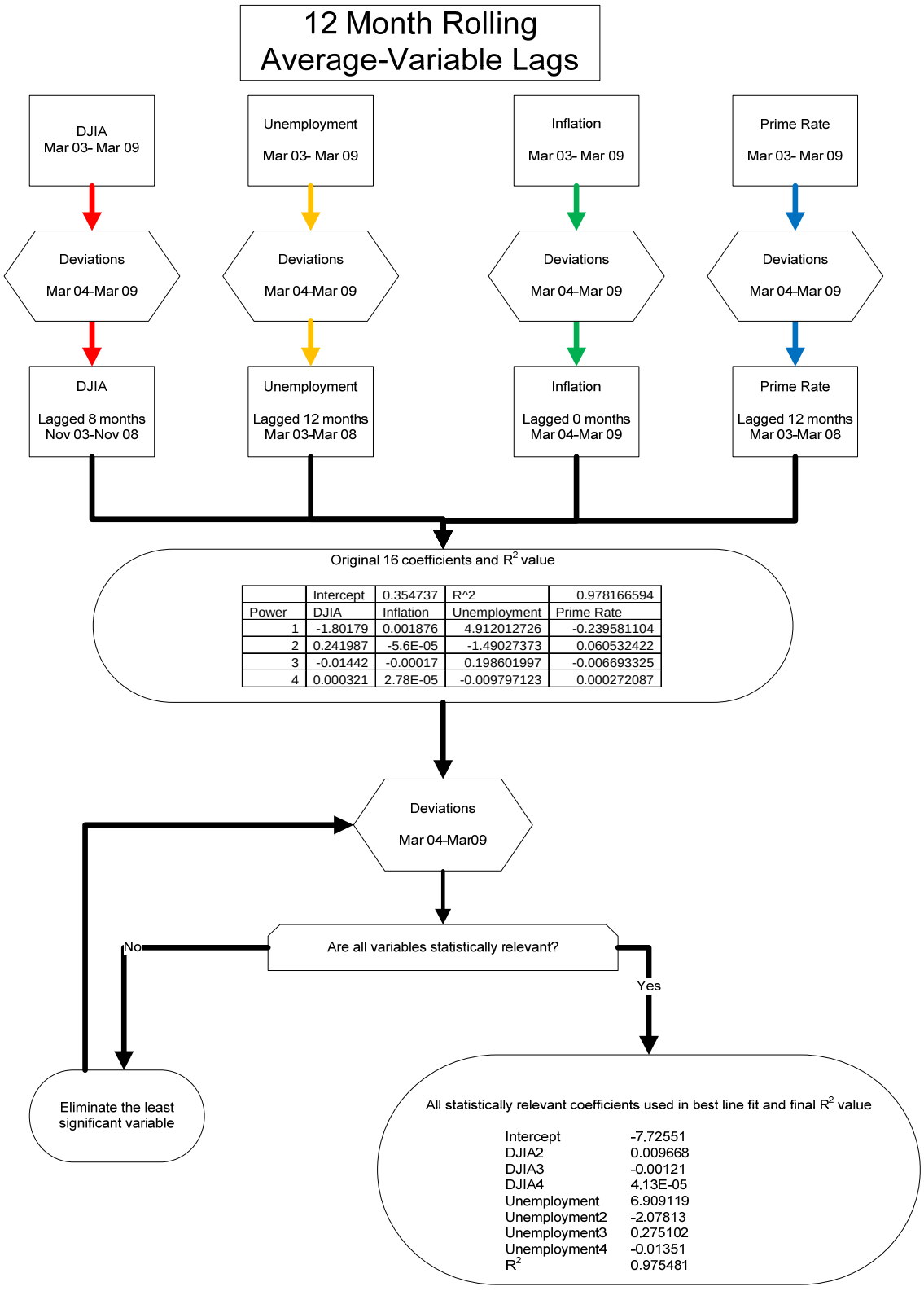


Appendix I: 9 Month Rolling Average Flowchart

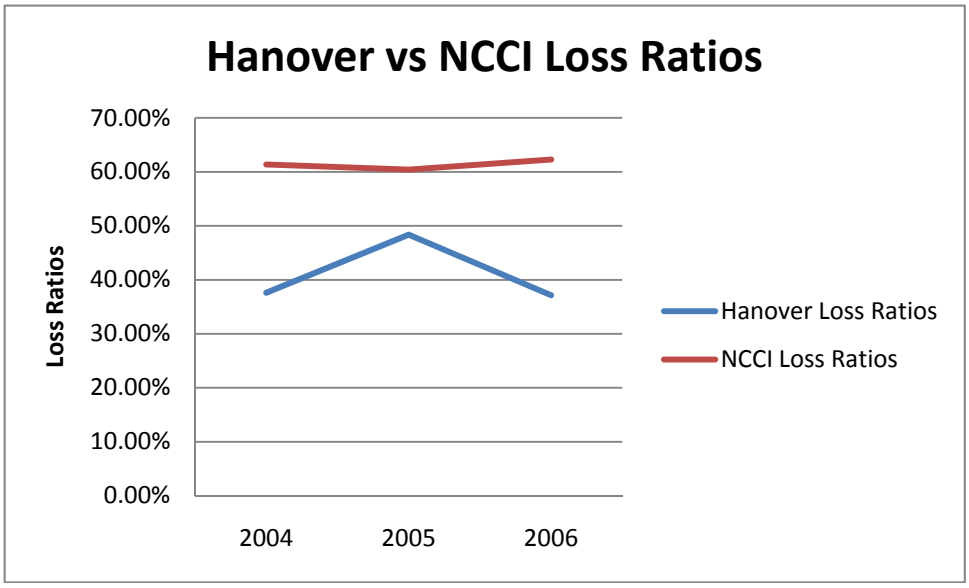


	Intercept	-6.87334	R^2	0.9682654
Power	DJIA	Inflation	Unemployment	Prime Rate
1	0.462114	-0.00211	5.04132236	0.185365284
2	-0.05217	0.00538	-1.52641362	-0.049283429
3	0.002405	-0.00195	0.202752038	0.005653474
4	-3.7E-05	0.000195	-0.009965209	-0.000238415

Appendix J: 12 Month Rolling Average Flowchart



Appendix K: Hanover vs. NCCI Loss Ratios



Appendix L: 3-Month Rolling Averages Predicted vs. Actual Deviation Results

Month	Predicted	Actual	Difference
April 2009	0.965926	0.961125	**0.004801**
May 2009	0.986756	0.949223	**0.037533**
June 2009	0.999140	0.948975	**0.050165**
July 2009	1.057230	0.947404	**0.109826**
August 2009	1.039208	0.958699	**0.080509**
September 2009	1.033595	0.952552	**0.081043**
October 2009	1.038811	0.946837	**0.091974**
November 2009	1.070288	0.940662	**0.129626**
December 2009	1.069088	0.940158	**0.128930**
January 2010	1.067315	0.941585	**0.125730**

Appendix M: 6-Month Rolling Averages Predicted vs. Actual Deviation Results

Month	Predicted	Actual	Difference
April 2009	0.972724	0.953860	**0.018864**
May 2009	0.973642	0.953950	**0.019692**
June 2009	0.984720	0.950710	**0.034010**
July 2009	1.007240	0.947148	**0.060092**
August 2009	1.010432	0.949829	**0.060603**
September 2009	1.010682	0.947067	**0.063615**
October 2009	0.959636	0.944964	**0.014672**
November 2009	0.887764	0.940662	**-0.052898**
December 2009	0.626722	0.940158	**-0.313436**
January 2010	0.100922	0.941585	**-0.840663**

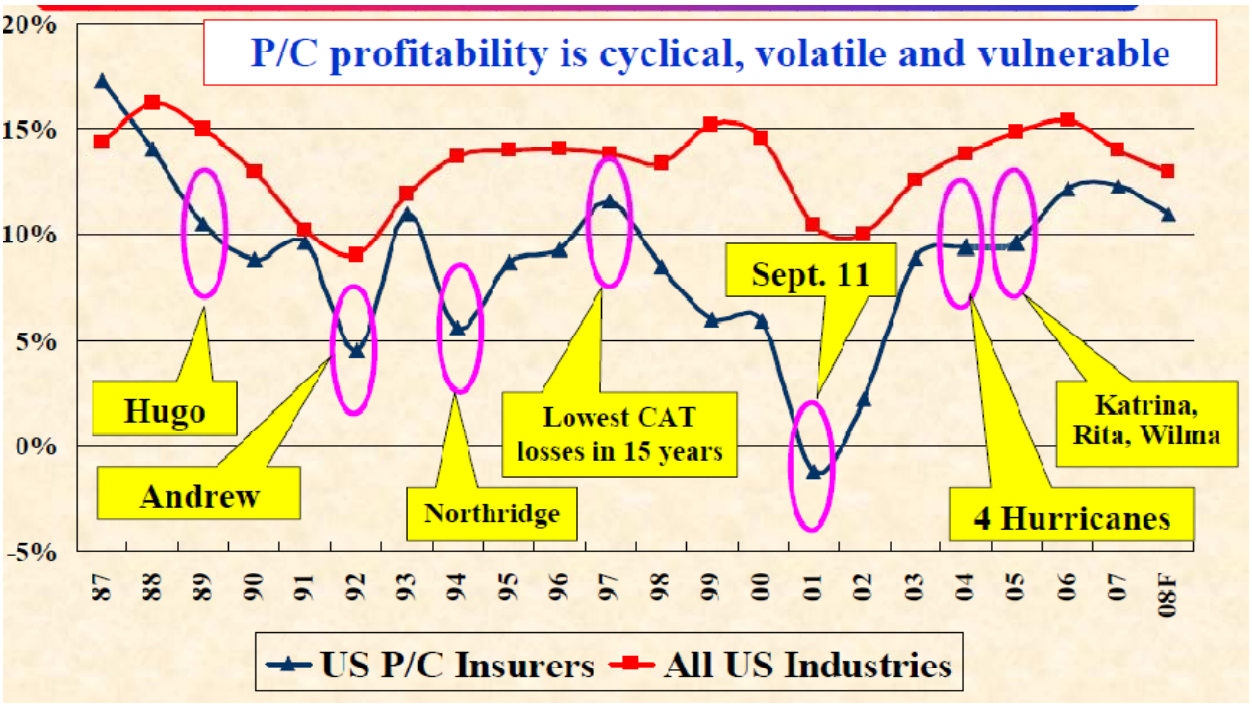
Appendix N: 9-Month Rolling Averages Predicted vs. Actual Deviation Results

Month	Predicted	Actual	Difference
April 2009	0.967193	0.951732	**0.015461**
May 2009	0.989547	0.949624	**0.039923**
June 2009	1.004321	0.947776	**0.056545**
July 2009	1.024352	0.946036	**0.078316**
August 2009	1.014222	0.949829	**0.064393**
September 2009	1.006191	0.947067	**0.059124**
October 2009	0.976104	0.944964	**0.031140**
November 2009	0.982058	0.940662	**0.041396**
December 2009	0.953776	0.940158	**0.013618**
January 2010	0.889227	0.941585	**-0.052358**

Appendix O: 12-Month Rolling Averages Predicted vs. Actual Deviation Results

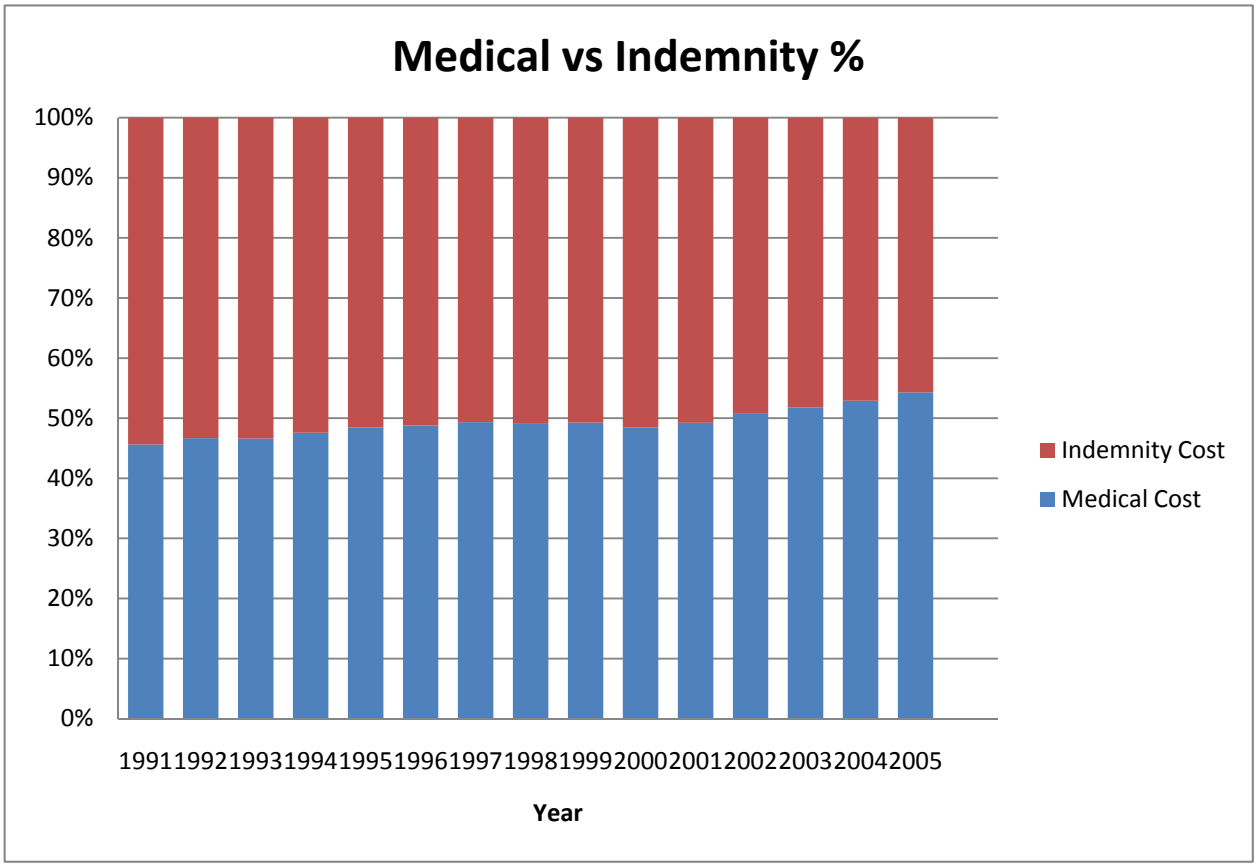
Month	Predicted	Actual	Difference
April 2009	0.968178	0.950273	**0.017905**
May 2009	0.973713	0.949624	**0.024089**
June 2009	0.982248	0.947776	**0.034472**
July 2009	0.982688	0.946036	**0.036652**
August 2009	0.982647	0.949829	**0.032818**
September 2009	0.979888	0.947067	**0.032821**
October 2009	0.967351	0.944964	**0.022387**
November 2009	0.973439	0.940662	**0.032777**
December 2009	0.883340	0.940158	**-0.056818**
January 2010	0.884640	0.941585	**-0.056945**

Appendix P: Effects of Natural Disasters on Insurance Cycle[15]



[15] (Hartwig, 2006)

Appendix Q: Medical vs. Indemnity portion of WC losses[16]



[16] (Hartwig, 2006)

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