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Development of a predictive index for the logistics and distribution industry.

Erin Lynn Gerber
University of Louisville

DEVELOPMENT OF A PREDICTIVE INDEX FOR THE LOGISTICS AND DISTRIBUTION INDUSTRY

By

Erin Lynn Gerber

B.S.I.E., University of Louisville, 2008

M.Eng.I.E., University of Louisville, 2009

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By the following Dissertation Committee:

____

Sunderesh Heragu, Dissertation Co-Advisor

____

Gail DePuy, Dissertation Co-Advisor

____

William Biles

____

J.P. Mohsen

ABSTRACT

DEVELOPMENT OF A PREDICTIVE INDEX FOR THE LOGISTICS AND DISTRIBUTION INDUSTRY

Erin Lynn Gerber

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Indices are popular in many sectors of the US economy and are commonly used by businesses when making important decisions. In this research, two new indices are developed; a regional index for the Greater Louisville area and a national index for the United States. Both indices predict changes in the level of the logistics and distribution activity (as measured by employment values) and can be used by various organizations to plan expenditures that effect their logistics and distribution operations.

This analysis utilizes two types of data; raw tonnage and economic factors. Local railway and local barge data are reported by the Ports of Indiana. Airway data for the Greater Louisville area is collected from the Regional Airport Authority. Both local and national roadway data come from the American Trucking Association. National data for air transit is collected from the Bureau of Transportation Statistics while barge data is provided by the Army Corps of Engineers. National railway data is provided by the Association of American Railroads. Both local and national employment data is collected from the Bureau of Labor Statistics. Additional organizations provided secondary data including: the Purchasing Manager's Index (PMI) [y-charts.com], Gross Domestic

Product [y-charts.com], crude oil prices [the Energy Information Administration], and the exchange rate of the US Dollar [International Monetary Fund].

Linear regression models are utilized to predict a response variable that is then converted into an index value for both the regional and the national indices. The regression models are tested against historical data to ensure their predictions are valid. Resulting index values are also tested to confirm the changes they indicate coincide with actual changes in employment data. A comparative analysis is completed which verifies that the national index is as useful as (if not more useful than) existing indicators. The regional regression was found to make predictions within 3% of the regional employment values 81% of the time. The national model falls within 3% of the national employment values 67% of the time. These indices are found to be valid, leading indicators of future activity in the logistics and distribution industry, for their specified regions.

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CHAPTER 1

INTRODUCTION

The purpose of an index is to gage the level of activity in a particular sector. Indices have been utilized for many years in numerous sectors of the economy. There are many different economic indicators in use today. Some examples include: the Consumer Confidence Index (CCI), the Consumer Price Index (CPI), and the Producer Price Index (PPI). These indices indicate growth or decline within a particular region.

The majority of current indices relate directly to the economy, or a portion thereof. Very few of these indices are predictive in nature and those which are predictive are prone to bias due to their use of subjective survey response data. One such index is the Consumer Confidence Index (CCI). The CCI is a measure of how confident consumers are in the US economy. This measure is used by various companies to make important operating decisions such as when to roll out a new product line. When consumers are lacking confidence in the economy, they are less likely to spend money on unnecessary items. It is unwise for a company to introduce a new product (that is not an item of necessity) when consumer confidence is low.

The Consumer Price Index (CPI) is a measure of the overall cost of household goods. The CPI is often used as a cost-of-living estimate and therefore can instigate major changes in many important government factors. For instance, the government utilizes this index when regulating social security payments and federal retirement expenditures as well as when adjusting tax brackets and inflation values (Greenlees, 2008).

Regression analysis is an incredibly useful technique which allows raw data to be combined and utilized to predict a response variable. Current indicators utilize a myriad of techniques to analyze data and create an index for general use. Regression analysis is a tool that is occasionally used during one portion of current index calculations but has yet to be utilized to take raw data and directly create a predictive indicator.

Predictive indicators are incredibly useful to both private companies as well as government bodies. The information provided by these indicators allow these organizations to determine whether, when, where and how much of their capital and operating budget to invest in a specified area of the market. It also alerts users to when these markets are expected to experience a decline, therefore potentially savings investors large sums of money.

This research strives to answer the question of whether regression analysis can be implemented as a primary means to calculate a predictive indicator for the logistics and distribution industry based on raw tonnage data from the industry.

CHAPTER 2

LITERATURE REVIEW

Indices are a heavily utilized source of information both in the United States as well as across the globe. These index values alert the public to changes, both good and bad, within a specific industry or the economy as a whole. Not only do consumers themselves rely upon this data to formulate their own decisions, but companies and government-run agencies also rely on many indices to determine changes in policy and expenditures.

Related Economic Indices

Although there currently are a plethora of indices measuring various areas of the economy and industry, the most well-known and commonly utilized indexes are those which measure the health of the economy as a whole. One of these indices is called the Consumer Confidence Index (CCI) which is developed by an organization known as the Conference Board. The Conference Board is an independent research association which aims to provide useful information to the business industry. The Conference Board completes in depth research in order to make important data pertaining to the economy available to the public (Conference Board, 2011).

The CCI is based on the Index of Consumer Sentiment (ICS) which was first released at the University of Michigan in 1978 (Van Oest and Franses, 2008). Both the CCI and the ICS measure consumers' level of confidence in the US economy each month. These measures, along with their counterparts, the University of Michigan's measure of consumer expectations (UME) and the Conference Board's Consumer Buying Expectations Survey (CBE) are calculated utilizing answers to survey questions which are gathered from randomly selected individuals on a monthly basis.

The University of Michigan's Index of Consumer Sentiment (ICS) uses the Michigan Survey of Consumers for their data. This survey contains questions asking consumers how they feel they are faring financially both now and a year from now as well as how they think the country will be doing over the next 5 years. Choices offered as answers to these questions are generally *better off* or *worse off* and *good* or *bad*. The ICS is calculated based on the answers provided by randomly polled households. For each question in the survey, a percentage of encouraging responses is calculated and from that percentage they subtract the percentage of discouraging responses. A value of one hundred is then added to this number. The total must then be scaled by its base year. Finally, a small factor is added in order to correct for past changes (Van Oest and Franses, 2008). In addition to the ICS, the University of Michigan utilizes these survey answers in a second index known as the Index of Consumer Expectations (ICE). The main difference in the calculation of the ICE is that only the survey questions which ask about future expectations are utilized with relative scores. Thus the ICE is based solely on the future expectations of consumers and therefore represents a predictive indicator of expected changes in the US economy (Kwan and Cotsomitis, 2004).

Many other indices have been created from the CCI and ICS, especially at regional levels. Many states and regions have begun taking it upon themselves to create confidence indices pertaining solely to their area. This increasing trend to compile indices at the state or regional level has been shown especially important with Van Oest and Franses' (2008) research on the ability (or lack thereof) to utilize national confidence indicators on the state level. Most of these regional indicators, such as the Consumer Confidence Index of Florida (CCIF) and the Consumer Confidence Index of Ohio (OCCI) utilize the exact same methods as the ICS (Dunn and Mirzaie, 2006).

Indices in other areas have also begun to play an important role in the business world. They are utilized by individual companies to make investment decisions and by governmental agencies for changes in the calculation of benefits as well as tax systems. One of the other large contributors is the Consumer Price Index (CPI) which is used to measure the changes in consumer prices throughout the US. The CPI is compiled by Bureau of Labor Statistics (BLS) and is sometimes used as a cost-of-living index. However, the BLS emphasizes that the CPI is an incomplete cost-of-living index as it does not directly take into account changes in the government and/or environment which could alter the overall well-being of consumers (Consumer Price Index, 2010). This is an important distinction and will be discussed in the following section along with other disadvantages of the CPI.

The CPI is calculated much differently than most consumer confidence indices. Since it is a measure of cost changes, the CPI is based on actual prices of goods and services throughout the United States. To collect this cost data, the BLS deploys hundreds of employees every month for the sole purpose of collecting prices. Data is collected from approximately 20,000 retail centers located in 45 large urban areas (Klenow and Kryvtsov, 2008). The data collected by these employees represents approximately 70% of the information in the CPI. Locations for data collection are selected from household surveys gathering point-of-purchase information (Klenow and Kryvtsov, 2008).

It is important for the CPI to take into consideration the fact that over time the list of available goods will undergo changes as new products come into the market and old ones are discontinued. For this reason, the CPI rotates products through the model every two years (Hazlett and Hill, 2003). Additional data is collected through the Consumer Expenditure Survey (CEX). The data is combined using a modified Laspeyres algorithm (additions and changes to this method are discussed in the next section) to form various portions of the CPI, mainly the CPI for all Urban Consumers (CPI-U) and the CPI for Urban Wage Earners and Clerical Workers (CPI-W). The CPI-U encompasses approximately 87% of the population whereas the CPI-W is a direct subset of the CPI-U containing about 32% of the total population of the US (Moulton and Stewart, 1999).

Though the CPI-U and the CPI-W are the main indices produced by the BLS under the CPI moniker, there are many other versions of the CPI that are considered experimental but are currently being researched and developed by the BLS. The Chained Consumer Price Index for all urban consumers (C-CPI-U) is meant to more closely approximate a true cost-of-living index (Gage and Jackman, 2003). The Consumer Price Index Research Series (CPI-U-RS) incorporates improvements made to the calculation methods of the CPI over all historical CPI values, allowing for improved comparison between current and historical CPI index data (Stewart and Reed, 2000). The experimental Consumer Price Index for Elderly Americans (CPI-E) is a version of the CPI which focuses on the US's elderly population, namely those 62 years and older (Stewart, 2008).

The CPI, especially the CPI-W and the CPI-U are important indices used in determining many factors important to the US economy. As outlined by Greenlees (2008), cost-of-living adjustments made to social security payments as well as federal retirement payments are both based on the CPI-W, which is also used in collective bargaining agreements when determining wage increases. Greenlees (2008) also notes that the CPI-U is utilized in many important venues as well, such as adjustments to tax brackets and inflation adjustments such as TIPS (Treasury Inflation-Protected Securities).

Related Industrial Indices

Another Index that is highly utilized is the Producer Price Index (PPI). The PPI is similar to the CPI however, the PPI measures changes in prices of goods and services as seen by commercial and industrial producers. Unlike the CPI, the PPI does not include taxes on the prices it collects as taxes do not add to the actual revenue received for a good or service (Klemmer and Kelley, 1998). As with many indices, the data used to calculate the PPI has evolved over time. The BLS originally collected data based on major commodity groupings, but changed to collecting data based on the stage-of-processing various products had reached (crude goods, intermediate goods, and finished goods) in the 1980's (Clem, 1989). Along with this change in groupings, the number of data points collected was also altered. Prior to the 1980's, "3,000 producers reported prices on 10,000 items in 2,800 product areas" (Early, 1979). The revisions released in 1983, increased the pool of respondents from 3,000 to 30,000 producers and the collection of products from 10,000 to 140,000 spanning 10,000 product areas (as compared to the original 2,800). Probability sampling techniques were also introduced to obtain variance measures such as standard deviation data (Early, 1979).

Originally called the "Wholesale Price Index", the BLS felt this name confused many of the general populous as the prices collected were not wholesale prices at all, but were prices reported by production managers. The name was changed to the "Producer Price Index" in 1978. In 1987 the 1972 census values were replaced with the newly available 1982 census values. The following year, the reference base was also altered and 1982 became equivalent to 100 as opposed to the year 1967 (Clem, 1989). Due to changes in prices of goods as well as technological advancements, weight revisions must be considered on a fairly regular basis. One such revision was undertaken in 1996, at which time weights for all areas of the PPI were found to have undergone a 20 percent increase in the aggregate value of shipments. This means that each item's revised "relative importance" value when recalculated would be 20% less than the value before the revision (Sager, 1992).

The Purchasing Managers Index (PMI) is another index of importance within manufacturing industry. Maintained and reported by the Institute of Supply Chain Management (ISM), the PMI is based on subjective survey responses, much like the CCI. Due to the nature of the surveys, the PMI is one of the few indices considered to be a leading indicator. Surveys are distributed to over 40,000 respondents who are in supply chain or manufacturing related purchasing positions. The surveys ask for information in five areas: deliveries from suppliers, inventory levels, production levels, equipment levels and new orders. Respondents pick from three predetermined options: *the same*, *better* or *worse* (Barnes, 2013).

Responses from the purchasing manager's survey are then converted into numerical values depending on which of the three responses was chosen. This allows all responses to be combined mathematically. A weight is placed on each area: 15% for supplier deliveries, 10% for inventory levels, 25% for production levels, 20% for equipment levels and 30% for new orders. These weights and numerical response equivalents allow a simple equation to calculate an overall level for the "health" of the manufacturing sector (Barnes, 2013).

Related Transportation Indices

Other indices do currently exist, which measure the transportation industry, either in part of as a whole. The most notable of these indices would be the Transportation Service Index (TSI). The TSI is the only previously existing index that comes close to measuring that which the LoDI Index measures. The TSI measures volume moved by five methods of transit: inland waterway, [for hire] trucking, [freight] railroad, air [freight], and pipeline. The TSI exists in three parts; freight only, passenger only, and combined freight and passenger (BTS, January 2013).

The TSI is a lagging indicator which comes available approximately three months after the period it measures. As a lagging indicator, the TSI uses the Fisher Ideal Index Method to convert raw data into an index value. This method is essentially a geometric mean of the Laspeyres and Paache algorithms. By taking the geometric mean of these two methodologies, the Fisher method resolves the substitution bias of the Laspeyres method and the tendency of the Paache algorithm to underestimate actual growth. The TSI also utilizes a value-added component to weight parts of the index input as well as an index chaining method to create a "time-series" of indices (BTS, April 2013).

In addition to the TSI, many indices pertaining to one area of the transportation industry are also available. One of the first transportation related index was the ATA

Truck Tonnage Index put out by the American Trucking Association (ATA). This index was first developed in the 1970's and measures changes in tonnages shipped by truck throughout the US. The ATA builds this index off of data provided directly from private companies throughout the country. Data is aggregated and a comparison is made between output from the current month and the previous month to gauge what level of growth or decline was observed.

There is very little information available as to exactly what data and how much is collected in order to calculate the ATA's Truck Tonnage Index. This information is considered proprietary and makes it difficult to gauge the index's overall effectiveness. However, it is still widely trusted and utilized within the industry (EconomicPerspectives.com, 2012). In fact, the TSI utilizes the ATA Truck Tonnage Index as one of its [for hire] trucking inputs.

One reason the ATA Index is utilized for the TSI is the abundant lack of available truck tonnage data. This absence leads the way for an influx of additional trucking "indicators" to be marketed. For example, Cass Information Systems, a private business which caters heavily to trucking companies, began releasing their own index dubbed the Cass Freight Index in the early 1990's. Cass has the upper-hand as they are able to utilize trucking information from their own client base to create their index. The Cass Freight Index has been found to be a very reliable indicator of volume trends in the US trucking sector, and has even been shown to occasionally lead the ATA Truck Tonnage Index "at turning points" (Berman, 2012).

Disadvantages of Current Economic Indices

Constant growth in a field also brings constant changes in preferred methodologies and continued reliability testing of past values. The area of indices is no different and has received additional scrutiny. Problems of calculation bias are some of the most common issues brought to light with commonly used indices. Other issues such as using subjective data in calculating indices have also been discussed.

Desroches and Gosselin (2004) find in their research that uncertainty can cause drops in sentiment indices. They show that even in times when a person's actual income has not changed, if there is uncertainty in the economy that person becomes less likely to consume and therefore his or her sentiment as a consumer drops. This is an interesting phenomenon, and as Desroches and Gosselin (2004) point out, this can mean that a drop in a sentiment index can itself be cause for many families to alter their spending habits and change their overall level of confidence in the marketplace.

Many researchers have analysed the true predictive power of the ICS and the CCI. Because both indices claim to be a leading economic indicator, it is important to test whether or not they have the power to predict future spending habits of the American populous. Garrett, et al. (2005) tested just this issue in their study along with the question of whether or not these two indices are able to predict spending at the state-level or only at the national-level. Their findings suggest that both the ICS and the CCI do contain predictive power at the national level. They found high correlation in their study of the index values and the overall retail spending trends the following month. It was also found however, that the national indices do not translate directly to a state-level. Fluctuations between states are thought to compound when aggregated to the national-level, causing the national data to be predictive as a national indicator, but since the data specific to each state cannot be disaggregated directly out of the national index, it should not be used in an attempt to predict state-level consumer spending trends (Garrett et al., 2005). It was not researched whether or not the discrepancy between the national and state-levels can be accounted for consistently by utilizing a factor of change. Further research may be able to add to that completed by Garrett et al.

Another issue relating to the calculation of the ICS utilizing random sampling was discussed by Van Oest and Franses (2008). This pertained to comparing monthly releases of confidence indices which utilize random sampling of consumers. Their concern arises from the fact that one month of a confidence index cannot be compared to another month as the pool of respondents changes from month to month. Van Oest and Franses (2008) use simulation techniques to estimate the percentage of changes in responses but found that the changes occurring between months were not statistically significant.

The need for state and regional-based indices is also explored by Dunn and Mirzaie (2006). This study examines the link between the manufacturing sector and leading confidence indices. In this research it was found that states with large manufacturing sectors also had regional confidence indices which more closely mirrored leading indicators (namely the CCI). States with very little manufacturing were found to have confidence indicators which showed a tendency to lag predictive indicators. Dunn and Mirzaie (2006) therefore concluded that manufacturing indicators can be used to help predict future consumer confidence. This also means that states with smaller manufacturing industries may not be able to fully rely on predictive indicators that represent the US as a whole, thus calling for the need to have state/regional indices available as well (Dunn et al., 2006).

Problems that have been researched with respect to the CPI are many and varied. Most address the various levels and areas of bias that are believed present in the indicator. Some researchers focus on methods of bringing the CPI closer to a true cost-of-living index. Even the issue of rounding the CPI has been researched. According to Elliot Williams (2006), the rounding that takes place both in the calculation of the CPI and before the index is released can cause error in calculations carried out with the rounded version of the CPI, but this is not found to be a source of long-term bias.

As Moulton and Stewart (1999) discuss in their overview of experimental U.S. consumer price indices, the BLS has taken steps to bring the CPI towards a closer approximation of a true cost-of-living index by integrating the use of the geometric mean formula into the early stages of calculation. The use of the geometric mean helps to bring the CPI closer to a true cost-of-living index by fixing the issue of substitution bias (Abraham, 1998). Substitution bias occurs when the CPI calculations do not take into account the fact that as one version of a good becomes increasingly expensive, a consumer can generally switch to a different variety of the same good with relatively little change in overall utility. Thus, the consumer does not suffer from decreased quality of good once they switch (Hazlett, 2003).

Klenow and Kryvtosov (2008) note in their research that the BLS utilizes a combination of monthly and bimonthly data in its collection and calculation of the CPI. Goods in the categories of food and fuel are collected monthly for all areas; monthly data is also collected in all categories within the three major cities (New York, Los Angeles, and Chicago). However, data for all other categories and in all other cities are only collected bimonthly (Klenow and Kryvtosov estimate this data to be about 30% of the sample). In research presented by Eppright et al. (1998), it is mentioned that conflicting results in testing of the CPI could be caused by the combination of data aggregated at varying levels (monthly and bimonthly).

In addition to substitution bias, there is also outlet bias. This occurs when an item is discontinued at one store, but is picked up and begins to be sold by another store. The formulation of the CPI does not allow for this same item to be treated as a single item, but rather the item at the original store is taken out of the collection rotation while the same item at the new store is added as though it is a completely new item. Hausman (2003) finds that use of price data in conjunction with data on quantity sold, is necessary to fix this problem. Hausman (2003) also shows that by utilizing quantity data, the quality change issue may also be fixed. This issue deals with changes in quality of a good from one month to another and how that quality change is measured in combination with a change (or lack of change) in price. With the use of readily available quantity data (which is commonly collected by store scanners), a demand function could be incorporated into the CPI to help handle the outlet bias and the quality change problem (Hausman, 2003).

Along with the use of quantity data, the use of hedonic statistical techniques has also been suggested to aid in problems such as the quality problem. It was reported by Abraham et al., (1998) that the BLS began integrating a hedonic model into the category of personal computers and peripheral equipment within the CPI as of January 1998. Many researchers are still sceptical about the use of the hedonic model for the CPI.

Hausmann (2003) claims that the hedonic method does not fully capture consumer preferences and reiterates the need for combining price and quantity data.

Many people may not fully understand the impact that these biases could have on the index as a whole. However, in 1996 a study by the Boskin commission reported that the CPI biases cause an overestimation of the cost-of-living by approximately 1.1% (Hazlett, 2003). This means that any decisions made, personal or governmental, which are based on the CPI are affected by the overestimate. The CPI is used to make adjustments to tax brackets as well as Social Security payments. Thus an overstatement of 1.1% could end up costing the country a substantial amount of money every year (Hazlett, 2003). Because the 1996 study predates the previously mentioned "fixes" to the varying areas of bias, the overestimate of the CPI has decreased in the past few years. The use of geometric means instead of the Laspeyres index is said to have decreased the overestimate by 0.2% alone (Silver and Heravi, 2006).

Another important change made to the CPI was its treatment of home-ownership in the index. Originally, an asset approach was used, in which the cost of buying or renting a home was taken into account in the calculation of the CPI. This may seem like a good approach to some, but problems arose when it was realized that home ownership is more of an investment and the CPI is not meant to include investments such as stocks, bonds and other assets. The new method that was implemented is referred to as the "rental equivalence" method. This approach focuses on the amount of money "given up" by a consumer in order to reside in their home. For renters this value is pretty straight forward as the renter gives up the cost of rent in order to utilize the home in which they live. It becomes a bit trickier when dealing with homeowners. As Greenlees (2008) states it "For homeowners, it means the amount they lose by not renting out their house." Although this may seem counter-intuitive to some, it is easy to justify the change when looking at the problem this way; unlike the cost of consumable goods, it is considered beneficial to homeowners when the cost of houses increases instead of decreases. This cost-benefit reversal shows that home prices cannot be input into the CPI in the same manner as the prices of general goods (Greenlees, 2008).

Updates to the CPI are not uncommon. In fact, according to Greenlees (1998), an updating of the index is done every ten years to maintain its accuracy. Many changes are considered during these updates. For example, a new "fixed basket of goods" is determined for the next time period. This is important because as time changes, new trends and technologies are introduced into the market and the old ones are phased out. Other issues that arise during these revisions include reselection and reclassification of areas, items and outlets (Greenlees et al., 1998).

Disadvantages of Current Industrial Indices

The PPI also has faced scrutiny, mostly about its applicability in additional areas. Dasgupta and Lahiri (1992) tested the Carlson-Parkin (1975) procedure used to analyze qualitative survey responses which are used in part of the PPI. Their findings showed that the Carlson-Parkin (1975) method was very useful and stood up to various tests. Additionally, Klemmer and Kelley (1998) found that the PPI's energy indices are comparable to other sources of energy data, showing they are a good indicator of the energy sector as a whole.

The PMI, as any other index, also has its limitations. Due to the subjective nature of survey responses, the PMI lends itself to biases of perception, just as with the CCI.

This is due to the fact that answers to the response questions depend entirely upon the respondent's point of view (Barnes, 2013). There is then the chance that a low PMI could itself alter the perceptions of the respondents in a negative manner, which would then lead them to respond more negatively on the next month's PMI survey. This type of bias is common with indicators based on subjective survey responses.

Disadvantages of Current Transportation Indices

The Transportation Services Index (TSI) has a few shortcomings as well. Firstly, the TSI does not include data for 100% of the market it is measuring (for-hire transportation). This is due to lack of available data (BTS, January 2013). Secondly, the TSI is a national indicator that is not easily applicable at the regional level. Though some national indicators of this type can be used as a general guide for regions which maintain a high level of manufacturing (Dunn et al., 2006) it could prove problematic to utilize the TSI in this manner unless the region in question utilizes all methods of transit covered by the index. In the case of the Freight TSI, this includes pipeline transit which is not nearly as commonplace as other methods. Thirdly, although the TSI includes a passenger-only version, it can only be used to measure for-hire passenger transit. This neglects to cover a large portion of personal transportation that may otherwise be useful for infrastructure planning applications. Lastly, it can be said the lag of the TSI is an additional limitation. As with most current indicators, the TSI measures what has already occurred and does not give any indication of what is expected to happen in the coming months. This type of measurement requires additional time as all data necessary for the calculation must first be collected and reported to the BTS before they can complete the actual TSI calculations.

As with the TSI, data availability is also an issue with trucking indicators. Both the ATA Truck Tonnage Index as well as the Cass Freight Index only utilize data provided directly from their members/customers. This means each index is built only on a sample of companies and may or may not be representative of the national trucking industry as a whole. Both are also lagging indicators, though the Cass Freight Index has been shown to lead the ATA Truck Tonnage Index in the past (Berman, 2012).

The proposed indices fill a void left by the current indices; a predictive indicator of the logistics and distribution industry. These indices do not contain subjective survey data which has been shown to cause bias in other predictive indicators. Instead, regression analysis is be the foundation of these indices predictive abilities. Data utilized for these indices is the most comprehensive data possible for each factor, ensuring the indices thoroughly cover their intended regions. These predictive indicators will inform the users of what is expected to happen instead of notifying them of what has already come to pass. This is the true benefit of these indices. The ability to plan ahead will help many companies diminish their level of uncertainty and make well-informed decisions ahead of schedule.

Regression Analysis

Regression analysis serves are the primary tool used to develop the predictive index in this research. Regression analysis is a statistical technique which can utilize multiple input variables to predict future changes in a response variable (Montgomery, 2003). There are many forms of regression analysis, including but not limited to; simple linear regression, multiple linear regression, least squares method, hedonic regression, and logistics regression. This section will focus on some forms of linear regression with examples of how regression can be used successfully in a multitude of applications. This section is not inclusive of all methods or uses of regression techniques, but is designed to give the reader a general understanding of the breadth of regression analysis research.

Regression analysis is a technique developed in the late 1800's. The initial idea of regression analysis was discovered by Sir Francis Galton, cousin to Charles Darwin, after he conducted an experiment with sweet pea seeds. Knowledge of regression analysis was furthered by Galton's colleague Karl Pearson in the 1890's when he developed equations for calculating both the slope of the regression equation and the correlation factor (Stanton, 2001). This early work was built upon by many other mathematicians. To this day improvements and additional techniques for regression analysis are undergoing constant research.

Hedonic regression techniques are commonly used in many areas including the calculation of the Consumer Price Index (CPI). It has also been used extensively in the area of housing market pricing. Redfearn (2009) presents a study involving an application of hedonic regression. He discusses faults in the use of a hedonic regression alone in the analysis of amenity effects (specifically proximity to light rail transit in Los Angeles County) on housing markets. The author then outlines an alternate technique which utilizes a combination of locally weighted regression and hedonic regression. Weights are determined using a tri-cubic kernel. It was determined that this technique was much more useful that the standard hedonic regression alone, although the author states that it is not necessarily the optimal method.

Work by Chakravarty et al., (2006) on market prices also utilizes hedonic regression. They make use of hedonic regression techniques to measure the effects of several attributes on the overall market-share of word processing software. Many versions of the hedonic regression analysis were tested in this study, as they encountered multicollinearity as well as low degrees of freedom. Once a proper hedonic model was determined, it was found that factors which affect the sale of spreadsheet software do not necessarily affect word processing software (formatting, macros addition, import/export ability, etc). It was found that the brand name of software as well as the overall size of the network affected the price of the selected software.

Huang and Lee (2010) approach the issue of combination of information versus combination of forecasts by utilizing regression analysis. Although many researchers have stated that it is better to combine the base data when available, there are many times when this is not possible. Huang and Lee (2010) utilize various regression equations in their analysis to prove that in instances where each lower level forecast is given ("close to") equal weights, combination of forecasts can actually outperform the combination of information version.

Applications of Regression Analysis

Regression techniques are adaptable and varied. Due to this, many researchers use regression analysis to test a multitude of problems in a variety of subject areas. Tian and Tibshirani (2010) use three regression-based models (linear regression, logistic regression, and Cox regression) to test the use of a bio-marker index's predictability in medical applications. Their regression analysis showed that their bio-marker index had no significant effect on determining whether or not a patient would survive their diagnosis as the treatment showed a significant interaction within the analysis which had to be corrected (Tian and Tibshirani, 2010).

Peng and Huang (2011) investigate methods for using non-concave penalized least squares methods to develop single index models. The authors find that their methods are applicable to many "high-dimensional single index models" but issues of dimensionality keep it from being applicable to many other models (Peng and Huang, 2011). Meanwhile, Zhu et al, (2011) use least squares methods and a kernel function along with other analytical techniques to more accurately select variables for single-index models with some success.

Kallberg and Pasquariello (2008) utilized regression analysis to investigate the underlying reasons for co-movement in stock indices. They found that although the regression analysis provided a good fit and good estimation of certain factors, the model was unable to explain all causes of co-movement. The authors surmised that some of the unexplained reasons stem from one of three areas; decisions made by investors when rebalancing portfolios, shocks within the product market, or the lack of standardized information endowments.

Bai and Ng (2009) study the use of boosting in predictor selection within factor-augmented autoregressions. The method of "boosting" requires the use of stage-wise regression equations and has the ability to estimate the value of an unknown function. This method is superior to many previous methods because "it can handle high dimensional data well with low computational cost, and when the data truly have a sparse structure it can produce models that do not tend to overfit" (Bai and Ng, 2009). This technique is used in the areas of machine learning, biostatistics, and economic analysis.

Regression analysis has been useful in the testing and calculation of indices. For example, Laing et al. (2011) develop a new heat-stress index called index-equivalent temperature (index-ET). The purpose of this index is to measure a worker's ability to complete work safely at high levels of heat and humidity. This new index is created using Cox regression which is the most commonly utilized regression technique in the area of survival analysis. Not only were the authors able to use this regression technique to develop an index which correlates to its intended use, they were also able to justify the practicality of the index through additional testing.

Chelgani et al. (2011) use the least squares regression model (in addition to artificial neural networks) to determine whether or not the free-swelling index (FSI) used in the production of coal, can itself be predicted by the particular coal used. They found positive results from this method and were able to determine many additional underlying factors which add to, or take away from the coal's FSI value, which had previously not been identified. In related work completed by Khorami et al. (2011), a non-linear regression analysis and Adaptive Neuro Fuzzy Inference System (ANFIS) were utilized to test for factors contributing to the predictability of the free-swelling index (FSI). It was found that the ANFIS method obtained more accurate results that the regression analysis.

Another index which has utilized regression analysis testing techniques is the Leaf Area Index (LAI). Sea et al. (2011) completed a study measuring improvements in methods for calculating the leaf area index for a region of the Australian Savannahs. The authors found through analytical testing and linear regression analysis, that the use of MODIS data (images taken from satellites and translated into digital images containing pixelated cells) can be as accurate, if not more, than the use of ground estimates when calculating the leaf area index for those regions. This index is used in many environmental calculations. Research pertaining to more readily available environmental calculation methods could help substantially in the area of environments research.

Chiu et al (2010) studied the use of analysis-of-covariance regression techniques to produce a health index for a freshwater ecosystem. This method was not previously utilized for this application and was found not only effective but superior to other methods as it provided unbiased data. The authors also outlined the usefulness of this method for all fields of research when an overall health factor is desired.

Gabauer and Gabler (2008) used binary logistic regression to compare current indices and metrics designed to predict the incidents and severity of injuries from car crashes. Their analysis showed that the simpler metrics (delta-V) were more helpful with this prediction than the computationally complex indices (OIV and ASI).

The calculation of the International Roughness Index (IRI), which is used to measure pavement smoothness, utilizes regression analysis techniques (Wang and Li, 2011). Opponents to this method have voiced their concern, which is the reason Wang and Li (2011) completed research on other regression techniques designed to fix these issues, namely the fuzzy regression method, with positive results.

Contributions of this Research

The literature reviewed in this section has been most enlightening on the topics of current indices as well as research utilizing regression analysis. The articles discussed have shown that indices are important tools, used by many in the business world when making decisions based on monetary risk and reward. It is also clear that although there are some current indices related to the transportation sector, none are predictive in nature. This leads to the conclusion that the creation of the proposed index will greatly benefit companies with a vested interest in the logistics and distribution industry. This is a niche that is in definite need of fulfilment; a problem which this research will resolve.

On the topic of regression analysis techniques, the research is vast and wide-ranging. The literature reviewed is believed to be representative of the breadth and variety of available regression analysis research. Although this section by no means covers all varieties of regression analysis or all areas for which it is applicable, areas of importance as pertaining to the intended research were mentioned. No research was found that showed regression analysis techniques being utilized as the primary calculation methodology for a predictive index application.

The purpose of the proposed research is to create predictive indices that predict changes in the level of activity within the logistics and distribution industry. Though there are many indices currently in existence, many of which were discussed in this section, none fulfil the intended purpose of the proposed indices. Regression analysis has been utilized in the development and testing of much research and its uses continue to grow. It is a fitting method for this research and its use for these indices will further extend its current applications.

Issues with past indices are taken into consideration during the testing phase of this project. An attempt is made to correct for potential biases, although this will be less of a problem in this case as the majority of factors utilized will not have a tendency towards bias (i.e. raw data). Upon completion of this project, an important role is fulfilled and many businesses as well as individuals will benefit from the information it will provide.

CHAPTER 3

PROBLEM DESCRIPTION

Although the indices that currently exist are very helpful in various industries, there is currently no predictive index specifically designed for the logistics and distribution industry. The purpose of this research is to fill this void and investigate the use of regression analysis as a main calculation method for the creation of such a predictive indicator. Two indices are created; one regional index pertaining to the Greater Louisville area, and one national index covering the whole of the United States. Both indices will be continually calculated and reported by the Logistics and Distribution Institute (LoDI) out of the University of Louisville and thus are referred to as the LoDI Indices.

Logistics and distribution activity is often characterized by the volume of goods transported through four physical modes of transit; truck, barge, rail and air. Tonnage shipped from each of these areas can be used to develop an index to represent the industry as a whole. Each of these methods of transit is used to some extent throughout the United States. Statistics gathered from the Bureau of Transportation Statistics for 2006 (updated in 2009) and reported in American Commercial Lines July 2011 Industry Overview, state that 49.8% of freight ton miles in the United States is moved by rail, 15.1% by barge, 0.4% by air, and 34.7% is moved by truck.

In addition to the primary factors of tonnage shipped by rail, barge, truck and airplane, it is also necessary to include additional secondary factors when developing a predictive index. These additional inputs serve as indicators of logistics and distribution activity and are included to increase the quality of the index's predictive power. Examples of potential secondary factors (for the national index) are; the exchange rate of the US Dollar, Crude Oil Prices, Purchasing Managers Index (PMI), and gross domestic product. Monthly employment numbers are utilized as a response variable in the analysis.

The logistics and distribution industry has witnessed significant growth in the last few years. According to the Bureau of Labor Statistics the truck transportation and warehousing industry is expected to grow 11% between the years 2008-2018 (BLS, 2009). Although this represents only one part of the logistics and distribution industry, this data shows that the industry is growing rapidly and companies may want to invest resources in these systems to improve their net profit. Additional investments will bring about future growth and the need for a logistics and distribution index will become vastly beneficial to this developing field. These companies will have the ability to use the proposed indices to help them determine when to invest in logistics and distribution systems.

The closest currently available index is the Transportation Services Index (TSI) which measures volume of people and cargo moving through the transportation industry inside the US. The TSI is different from the proposed national index in two main ways. (1) It considers both cargo and passenger transit. (2) It is a lagging indicator, built using past data. It should also be noted that the TSI is only calculated at the national level.

The proposed indices, on the other hand, are leading indicators and do not take any passenger transit into account. The proposed indices are also different from many other current predictive indices in that the calculations will be driven primarily by raw data, as opposed to subjective data. Another point that sets this research apart from that of previous indices is the calculation methodology. Regression analysis is used to make predictions based on raw data. Predictions from the regression model are then converted into index values. Though regression analysis has been utilized in portions of index calculations in the past, it has not been utilized as the sole calculation methodology in order to create a predictive indicator.

As per the issue of selecting an appropriate region for the initial index; there are many reasons that combine to make Louisville a prime choice as it is considered to be a significant logistics and distribution hub. According to a 2003 report from Greater Louisville Inc. (GLI), companies related to logistics and distribution in the Greater Louisville area (Transportation & Warehousing, Manufacturing, Wholesale, and Retail) represent roughly 38% of all companies in the area. These same companies employ 47% of the Greater Louisville workforce (ranked 2^{nd} in most logistic employees amongst competing cities) and bring in 81% of the revenue for the area (Greater Louisville Inc., 2003).

Louisville has three major highways and two major highway bypasses, two major railroad lines, access to the Ohio River for barge transit and is home to the UPS Worldport hub. These factors combine to make Louisville a crucial location for large scale freight transit. Also it is notable that 35% of the US population is within 500 miles of Louisville (Greater Louisville Inc., 2003) and thus can receive same day shipments by truck. In addition, 60% of the population is close enough to receive one-day shipments by air from the Louisville area (Greater Louisville Inc., 2011).

On a population-density map, Louisville is only 40 miles from center of the contiguous United States and is within a four-hour flight of 95% of the nation (Konrad, 2010). All of these factors combine to make Louisville a prime location for any company to build or invest in logistics and distribution facilities and systems.

There are two main goals of the proposed project. First, a local index is created to fulfill this niche for the greater Louisville area. As a major logistics and distribution hub, the greater Louisville area provides a suitable region in which to cultivate a preliminary index. Developing an index for a limited geographic area will provide the opportunity for improvement of index methodologies before a broader national index is developed. The second goal of this project is to develop a more comprehensive logistics and distribution index which encompasses the entire United States.

Just as there is a great need for a regional index, a national index would be of even greater value. The majority of current indices are national level indicators. Indices are generally built on this level in order to provide a single measure that can be utilized across the entire country and not just on a state-by-state basis. Although regional indices are useful to the regions they measure, it is much more common for companies to do business across state-lines and often across the entire nation.

The regional index will serve local companies well; but as those companies work to expand their business, a broader indicator will be of greater use to them. Similarly, a national indicator will be of use to a much larger range of businesses. Finally, the creation of a national indicator is of added importance to governmental agencies which measure growth in various sectors of the economy at the national level.

The indices created from this research are already in use by logistics and distribution companies in the area. The indices utilize raw tonnage data from the industry to predict future growth or decline. Just as current economic indices aid companies and government bodies when making important economic decisions, an index which measures the health of the logistics and distribution industry provides a yardstick by which companies and individuals could measure the potential significance of their investments in this particular field.

CHAPTER 4

METHODOLOGY

A predictive index is created to estimate changes in the level of activity within the logistics and distribution industry. Regression analysis is used to build this index from raw tonnage data as well as economic variables and acts as an indicator of logistics and distribution activity for the upcoming month. The regional index covers the Greater Louisville area and the national index covers the entire United States. In order to create the regional index, data pertaining to the traffic originating, terminating or flowing through the greater Louisville area is collected. Similar data for the United States as a whole is collected for the national index. Instead of utilizing subjective data from surveys, as many predictive indicators do, these indices are primarily based upon raw data representing tonnage shipped through various modes of transit. Data pertaining to the economy is also considered for inclusion in the national index model.

Many logistics and distribution related organizations recognize six main areas of the industry. Referred to as the six R's by Greater Louisville Inc, these areas include: Rail, River, Road, Runway, Real Estate and Router. Data is collected from each of the four physical transportation modes utilized by the industry. These four modes are: rail, runway (air), road (truck) and river (barge). Tonnage shipped in each of the four modes, aggregated monthly, is used as a primary data input.

Data Collection

Local companies and governmental agencies are the main sources of data. Publicly available data is utilized whenever available. Tonnage shipped is the main factor as it can be considered universal across all transportation modes. This is important when combining the data to form a regression equation. All four modes of transportation are incorporated into both the local and national indices. It should be noted that many regions do not have access to a major waterway and therefore cannot utilize barge as a primary method of shipment. Unlike these regions, the greater Louisville area has direct access to the Ohio River and therefore has a large stake in barge transit.

Data for the Greater Louisville index is provided by the following organizations. The Ports of Indiana provides data on both barge and railway transit. The Ports of Indiana controls the majority of rail shipments through the Louisville area and therefore no other rail data is needed. The vast majority of shipments transported via barge passes through the Ports of Indiana as well. This data therefore also provides a good representation of all barge data in the Greater Louisville area. Barge data is provided as a tonnage shipped value; however, rail data is collected as “carloads shipped”. The Ports of Indiana reported that the industry standard conversion factor from carloads to tonnage is 80 tons per carload. Thus all rail data was converted from carloads shipped to estimated tonnage shipped for the analysis. Air data is provided by the Louisville Regional Airport Authority which compiles and publicly reports information on all commercial and non-commercial flights and shipments which pass through the Louisville area. Tonnages shipped by truck are not tracked for the Louisville area (or at the national level). Because it is not feasible to collect this data for the project from each and every private trucking company on a monthly basis, a different factor had to be found. The American Trucking Association's (ATA) Truck Tonnage Indicator is utilized for the trucking variable. As previously mentioned, Dunn and Mirzaie (2006) found that regions with large manufacturing sectors can utilize national indicators such as this as a regional indicator. Thus the ATA Truck Tonnage Indicator is a fair substitute for raw tonnage data from the trucking industry for this application.

The final piece of data needed for the regional regression analysis is a response variable. This is the variable that the regression equation predicts. The response variable should represent changes in the logistics and distribution industry as that is the goal of the index. Many options are considered for the response variable, but in the end, employment data is selected. As the logistics and distribution industry grows, additional workers must be added to the industry to account for the extra workload, making employment data a good benchmark to measure the industry's level of growth. This data is also publicly available on a monthly basis through the Bureau of Labor Statistics (BLS).

Upon completion of the local index, a second index for the entire United States is developed. This national index provides much needed information to businesses with a national reach as well as government agencies. Similar to the regional index, the national index is released on a monthly basis. The data collected for the national index is provided by the following organizations. National rail data is gathered from the Association of American Railroads (AAR) weekly rail traffic summary. This is a report published each week that includes the total carloads shipped throughout the US. Carload data is then converted utilizing the same conversion factor utilized in the regional LoDI Index. This data is also aggregated by month to match all other data in the model. National Air data is obtained through the Bureau of Transportation Statistics (BTS). The BTS publicly reports total tonnage shipped by air each month. Trucking data was again found to be unavailable. Because it is even more difficult to collect this data on a national scale, the ATA Truck Tonnage Index is once again utilized for the national model. Barge data, much like trucking data, was found to be lacking. Though it is very likely that the Army Corps of Engineers has much of this data, they only publish a monthly tonnage indicator. This indicator is utilized as the barge tonnage factor for the National Index in the same way that the ATA Index is utilized for the truck tonnage factor. The National Index also utilizes employment data as the response variable.

In addition to this data, data pertaining to the economy is considered for inclusion in the national model. Though Gross Domestic Product (GDP) is only calculated on a quarterly or annual basis, a group called the "Macroeconomic Advisors" calculates an estimated monthly value for the GDP which is published on ycharts.com. This is the first economic indicator considered for inclusion. Additionally, monthly crude oil prices ($/barrel) are collected from the U.S Energy Information Administration (EIA). The exchange rate of the US Dollar is published daily by the International Monetary Fund. Daily values are collected and aggregated to monthly values before consideration. Finally, the Purchasing Managers Index (PMI) is collected monthly and considered for inclusion in the national model as well.

It is the goal of the data collection stage to implement a method by which monthly data will be easily and continuously obtained as soon as it is available. For much data, this means finding organizations that publish the necessary data online every month in a timely fashion. Where data cannot be obtained publicly, relationships are cultivated with private companies who have the ability to provide this data. It is the hope that these companies will submit their data to the research team at the same time each month so that once the research project is complete, the index release schedule can be maintained.

Analysis Methods

Once the data collection process is completed, statistical software is utilized for the development of a regression model. The main goal is to utilize regression analysis to predict changes in the level of logistics and distribution activity for the upcoming month. The regression equation must be such that it will continue to utilize the input data (updated each month) to predict the increase or decrease in the employment values (response) for the following month.

A time series plot of tonnage data is used to determine whether or not seasonality and lagged data should be considered in the model. Best subsets analysis is then utilized to select the necessary factors for inclusion in the regression model. The technique of best subsets allows all combinations of variables to be tested by the software at once, and the best possible combinations are reported with additional statistical output allowing the user to select the best overall model from the choices. This helps the user determine which combination of factors should be included in the regression model.

After the best subsets analysis is completed, a linear regression model is built using the selected factors as inputs and the employment values as a response variable. Regression analysis finds relationships that allow the factors (inputs) to be utilized in predicting the response (output). A regression equation is supplied by the statistical software, which will predict future values of the response variable when the appropriate data is entered for each variable. The statistical software also provides information on the goodness of fit for the regression model. The two factors considered of importance for this analysis are the R^2 (adjusted) value and the *p*-value.

The R^2 (adjusted) value is the main goodness of fit measure for this regression analysis. The closer the R^2 (adjusted) is to 100%, the better the fit of the model. The *p*-value is a measure which tells the user whether or not to reject the regression model based on the significance between the terms within the model and the response variable. A *p*-value greater than 0.05 is considered too high and means the model should be rejected.

Once a suitable regression equation is developed, back-testing of the regression equation, is completed. This step requires historical data to be run through the equation in order to determine how accurately the regression model predicts the increase or decrease in activity for the following month. Only historical data that is not used in the calculation of the regression analysis is utilized during the back-testing stage.

Index Conversion Methods

Output from the selected regression model must be converted into an index value. Though many methods exist for calculating index values, there are few that convert one already calculated number into an index value. The majority of index calculation techniques transform a large amount of raw data directly to an index value. Two methods are investigated for this conversion. First an arithmetic-based method is tested where two points of conversion are set to calculate a conversion factor.

First, the minimum and maximum estimated employment values are found. It is determined that over this period of time, it is likely that the index covers a range of 50 points. This is due mostly to the economic downturn prevalent in 2008 and the growth throughout the following years. Therefore, the minimum estimated employment value is given a corresponding index value of 25, while the maximum value is set to correspond to an index value of 75. Simple arithmetic is used to calculate how many employment units (jobs) corresponded to an index value of one as well as an index value of zero. With these values known, it is possible to convert all estimated employment values to index values.

The second conversion method investigated is the base year conversion method. As previously described, the majority of indices currently available are converted directly from raw data to index values. The only commonly utilized method of converting a calculated value (such as the regression's output) into an index value is the base year conversion method. This method requires the selection of a base period which is given a value of 100 (%.) All future data points are then compared to this base value. To make this comparison, the predicted employment value for the new month is divided by the employment value from the base period. The resulting value is a percentage that relates the new estimate to the base period.

This is a very simplistic but effective way of creating an index value. However, it may not be as easily interpreted by the general public as desired by the research team. Therefore, all index values are divided by a value of 2, in an attempt to maintain a range of 1-100. These halved values are then reported to the public on a monthly basis by the Logistics and Distribution Institute, run out of the University of Louisville.

The creation of these two indices is of use to the greater Louisville community as well as the entire nation. The logistics and distribution industry is rapidly growing and in need of a specialized indicator. The creation of a predictive indicator is highly useful to interested parties. Businesses, individuals, and governmental-bodies will be able to utilize the index values to make investment, expansion or other business decisions as they pertain to this industry.

CHAPTER 5

REGIONAL INDEX ANALYSIS AND RESULTS

Regional Index Analysis

After collection, regional data is combined into tables in Microsoft Excel for aggregation. It is important that all data be aggregated to the same level. A monthly level is selected so that the index can estimate changes to occur from one month to the next. This also allows the index to be released once each month.

Data for each factor is collected for every month from January 2005 to December 2011. Any data requiring conversion (rail) is converted before it is aggregated to the monthly level. Table 1 shows a sample of the data collected. To see a full listing of data utilized for the regional analysis, see Appendix A.

Table 1

Sample of Raw Regional Data

Period	Air total	Rail	River	ATA Index	Total Employment
Jan - 2008	92,106	95,280	219,027	117.5	615.2
Feb - 2008	85,981	106,320	183,611	116.7	615.6
Mar - 2008	89,068	116,320	156,353	115.6	617.8
Apr - 2008	93,111	116,160	150,408	114.5	623.2
May -2008	93,862	83,680	98,289	114.7	633.0
June - 2008	87,581	92,880	71,591	116.4	631.7
July - 2008	92,687	91,840	53,260	114.4	619.5
Aug - 2008	91,279	66,320	66,535	112.7	624.4
Sept - 2008	90,637	83,120	80,178	112.1	619.5
Oct - 2008	96,529	97,840	88,208	109.3	618.4
Nov - 2008	83,081	79,120	73,012	109.9	621.5
Dec - 2008	92,428	93,360	144,641	105.7	615.5
Jan - 2009	80,727	86240	166833	104.1	592.0
Feb - 2009	76,920	59680	196655	105.9	591.4
Mar - 2009	84,053	46800	121497	101.4	593.0
Apr - 2009	87,057	67680	106731	100.2	597.4
May -2009	85,945	35840	109965	101.5	599.6
June - 2009	87,941	58880	77934	100.9	599.0
July - 2009	92,350	42240	28317	102.0	592.6
Aug - 2009	88,810	57360	21586	105.1	595.0
Sept - 2009	95,538	60560	92998	103.8	595.1
Oct - 2009	100,029	67200	129613	103.8	596.0
Nov - 2009	88,918	42560	153957	106.1	597.4
Dec - 2009	106,206	84160	144670	107.5	595.3

A time series plot is completed for the three categories of data represented by raw tonnage values. The plot allows the user to view potential patterns amongst the factors. This plot is shown below in Figure 1. It can be seen that not only are cyclical patterns present, but also that the cycles of each transit method do not move together. There seem to be two probable explanations for the cycle variations. First, the method of transit could be a factor. For example, barge transit may be more highly utilized in February while rail transit may be more highly favored during the month of March. A second possible cause involves the lag time between increased demand of goods and distribution of those goods via different modes of transit. That is, goods shipped via rail may not show heavy gains until after those same gains are already experienced by barge transit. This could be due to the fact that a large quantity of goods are actually multi-modal and are shipped by rail only after first being shipped by barge. Either way, it is clear that additional lags as well as seasonal indicators should be considered for inclusion in the regression model.

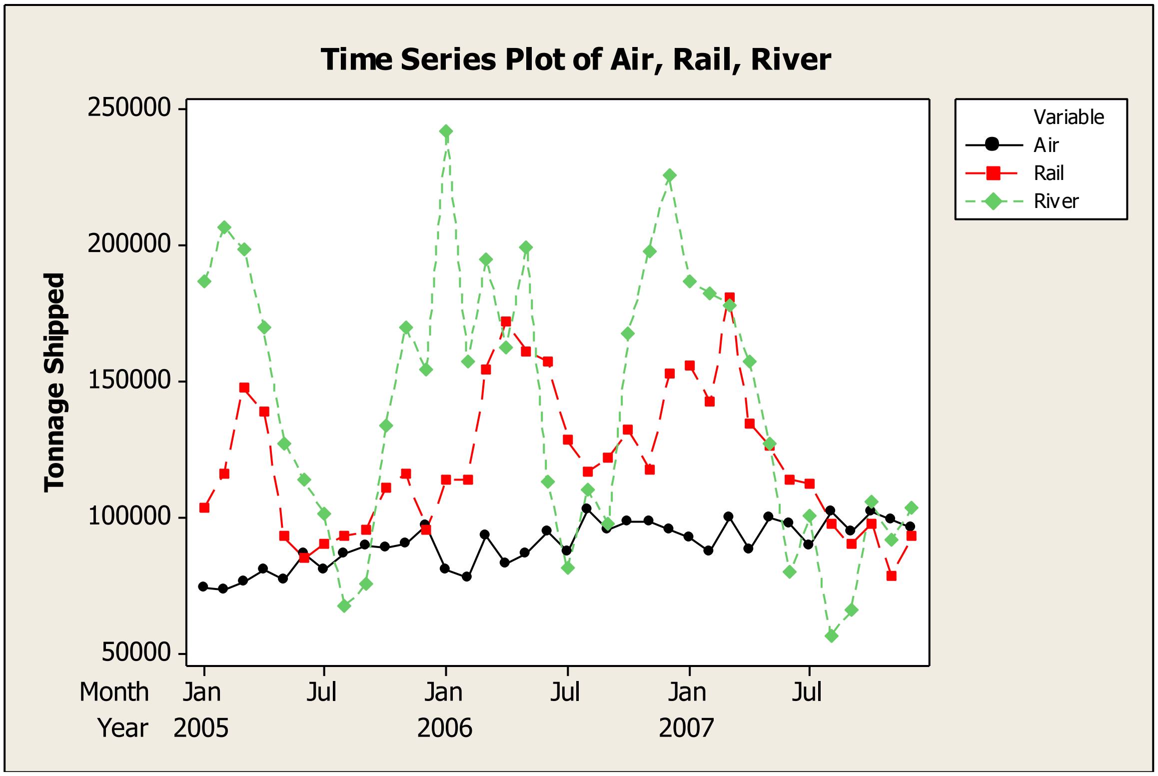


Figure 1. Time Series plot for air, rail and river transport

Because it appears that lagged figures may be of some importance, data with additional lags are added to the analysis to find the combination with the best fit and most statistical significance. The original data already requires a lag of three months since it takes time for raw data to be collected and reported. Lags of one or two additional months (4 and 5 months total) are considered for each primary factor (air tonnage, river tonnage, rail tonnage, and the ATA Truck Tonnage Index). The likelihood that a lag of significance would extend beyond five months (total) is considered to be small.

Seasonal indicators are also included in the regression model. These indicators allow the model to correct for changes in the level of activity that are due to seasonality and not due to growth itself. For example, if truck tonnage values increase every December by 10% due to the holiday season, then immediately recede back to their original level, that 10% increase should not be counted as overall growth in the industry and is thus removed. Each indicator, (M2, M3,…M12) is represented by a unique combination of zeros and ones corresponding to a specific month. The value of one is assigned to the month that is being predicted by the regression equation. Table 2 shows the indicator matrix.

Table 2

Indicator Matrix

Month	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
January	0	0	0	0	0	0	0	0	0	0	0
February	1	0	0	0	0	0	0	0	0	0	0
March	0	1	0	0	0	0	0	0	0	0	0
April	0	0	1	0	0	0	0	0	0	0	0
May	0	0	0	1	0	0	0	0	0	0	0
June	0	0	0	0	1	0	0	0	0	0	0
July	0	0	0	0	0	1	0	0	0	0	0
August	0	0	0	0	0	0	1	0	0	0	0
September	0	0	0	0	0	0	0	1	0	0	0
October	0	0	0	0	0	0	0	0	1	0	0
November	0	0	0	0	0	0	0	0	0	1	0
December	0	0	0	0	0	0	0	0	0	0	1

Another factor that required additional testing is the response variable. As previously stated, monthly employment data has been selected as the regression's response variable. However, a decision that still remains whether to use total employment numbers for the region, or the numbers pertaining to a specific sector. There are eleven categories of regional employment data reported by the Bureau of Labor Statistics (BLS) on a monthly basis. These categories include: Total Non-Farm; Mining, Logging and Construction; Manufacturing; Trade, Transportation and Utilities; Information; Financial

Activities; Professional and Business Services; Education and Health Services; Leisure and Hospitality; Other Services; and Government.

Many of these categories do not directly correlate to the logistics and distribution industry and thus are not considered for the analysis. The following categories are considered: Total Non-Farm; Manufacturing; and Trade, Transportation and Utilities. When these three options for employment data are graphed and compared to the tonnage data, it is found that the Total Non-Farm employment data is a much closer fit to changes seen in the tonnage values. It is not surprising that the Total non-farm employment data should be used for a regional indicator pertaining to the Greater Louisville area. This is due to the fact that a large portion of Louisville's business is directly related to the manufacturing or distribution of goods.

The amount of historical data used to build the regression model must also be evaluated. Seven years of data are collected. Analysis is performed on the various models based on five years of data, four years of data and three years of data separately. It is found that utilizing three years of data points produced regression results of greater statistical significance than four or five years of data. In most regression analyses, including more data points gives better results. The opposite is seen here, most likely due to the specific period of time this analysis utilizes (beginning January 2005). During this time period, the nation underwent a substantial recession followed by many ups and downs in the economy. Therefore three years of data provided enough of a timeline to account for yearly trends, but not too much to affect the analysis with frequently changing data which may or may not directly pertain to the growth rate of the industry as it currently stands.

Best subsets analysis is utilized to determine which combination of factors should be included in the regression model. For this best subsets analysis, three versions of each of the main factors, air tonnage, rail tonnage, barge tonnage, and the ATA Truck Tonnage Index are given as possible inputs. These three versions included (1) the data with its minimum lag of three months, (2) the data lagged by four months (one additional month), and (3) the data lagged by five months (two additional months). The best subsets technique shows that the models with the best overall results contain each factor multiple times, both with and without an additional lag.

The combination of factors with the best overall measures of fit is then selected. Factors included in this model are: Air (lag = 3), Rail (lag=3), River (lag=3), ATA Index (lag=3), Air (lag = 4), Rail (lag=4), River (lag=4), ATA Index (lag=4), Air (lag = 5), Rail (lag=5), and ATA Index (lag=5). Seasonal indicators (M2, M3,…M12) are also included in this model. This regression model achieved an R^2 (adjusted) value of 93.9% and a *p*-value of 0.000. This relatively high R^2 (adjusted) value indicates that this regression equation is a good fit to the data. The *p*-value is also accepted as it is below the target value of 0.05. The selected regression model is shown in Equation (1) below.

Total Employment = 508 + 0.000501 Air - 0.000104 Rail + 0.000031 River + 0.745 ATA - 1.90 M2 + 1.95 M3 + 12.3 M4 + 26.4 M5 + 35.3 M6 + 15.1 M7 + 23.5 M8 + 25.0 M9 + 20.4 M10 + 21.9 M11 + 19.9 M12 + 0.000515 Air (Lag = 1) + 0.000075 Rail (Lag = 1) + 0.000025 River (Lag = 1) - 0.456 ATA (Lag=1) + 0.000340 Air (Lag=2) - 0.000091 Rail (Lag=2) - 0.479 ATA (Lag=2) **(1)**

This equation is chosen for three main reasons. (1) It achieved the highest R^2 (adjusted) value (93.9%) representing that this model is a good fit to the data. (2) Each factor is incorporated into the model once with the minimum lag of three months, and at least once with an additional lag, allowing all factors to be given adequate representation in the model. (3) Upon reviewing the residuals graphs (shown below in Figure 2), the normal probability plot shows a good fit and the residuals versus fit plot shows a fairly random distribution of residuals, further supporting the overall fit and significance of the model.

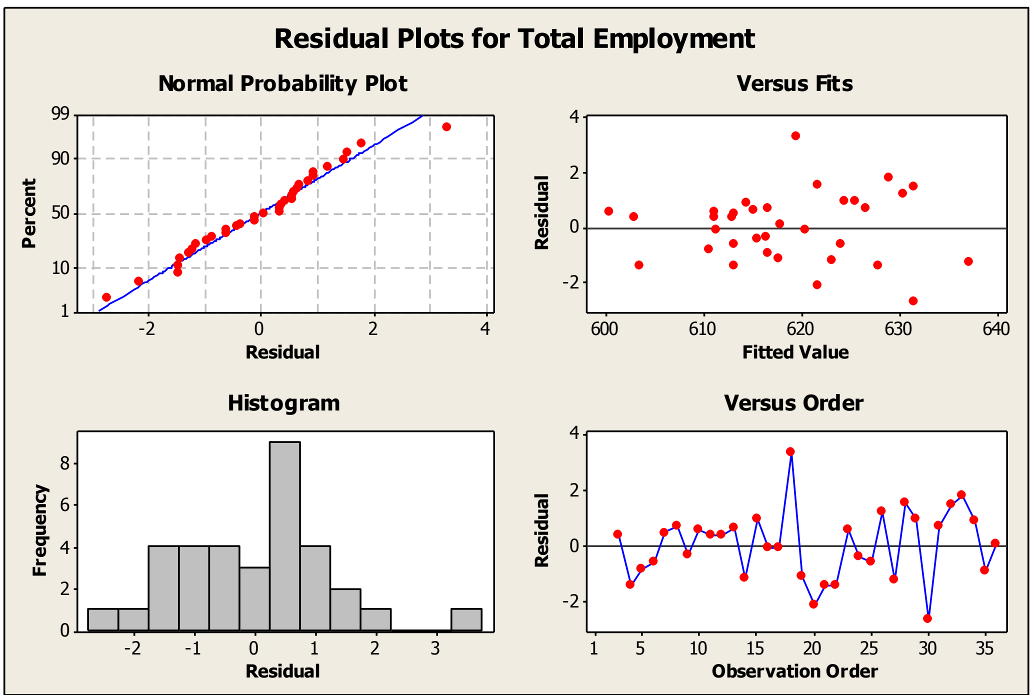


Figure 2. Four-in-one Residuals plots for Equation (2)

Next the regression output must be converted into an index value. The arithmetic-based method is completed first. The minimum and maximum estimated employment values are found, for all estimated months from April 2008 through December 2011. The minimum estimated employment value is 573.99 and is set to correspond to an index value of 25.The maximum value is 619.79 and is given an index value of 75. Simple arithmetic can be used to find that 0.9159 employment units (jobs) correspond to an index value of one. An index value of zero is equivalent to 551.09 jobs. Table 3 shows the conversion from regression output to index value for the April 2008 through March 2012 predictions. Actual employment values for these months are also included in the table. Though shown to three decimal places, index values are rounded to the nearest whole number before being reported to the public.

Table 3

Regression Output to Index Conversion Table

Month	Actual Employment	Regression Equation	Index Value
Apr - 2008	623.2	629.5982932	85.714
May -2008	633.0	629.0312879	85.095
June - 2008	631.7	643.144122	100.504
July - 2008	619.5	626.6061689	82.447
Aug - 2008	624.4	634.1698614	90.705
Sept - 2008	619.5	633.6233474	90.109
Oct - 2008	618.4	630.9452745	87.185
Nov - 2008	621.5	636.5523496	93.307
Dec - 2008	615.5	630.5590408	86.763
Jan - 2009	592.0	608.6838609	62.879
Feb - 2009	591.4	598.36119	51.609
Mar - 2009	593.0	599.2254471	52.552
Apr - 2009	597.4	603.390398	57.100
May -2009	599.6	623.6681773	79.239
June - 2009	599.0	630.4222579	86.614
July - 2009	592.6	607.2944214	61.362
Aug - 2009	595.0	618.7227722	73.840
Sept - 2009	595.1	618.7737998	73.896
Oct - 2009	596.0	621.5191106	76.893
Nov - 2009	597.4	625.8658356	81.639
Dec - 2009	595.3	621.2440786	76.593
Jan - 2010	579.0	610.3906088	64.743
Feb - 2010	573.7	606.6420126	60.650
Mar - 2010	584.5	609.1162363	63.351
Apr - 2010	593.3	616.1274567	71.006
May -2010	599.9	636.6249862	93.386
June - 2010	600.0	648.8608115	106.745
July - 2010	589.4	631.9202785	88.249
Aug - 2010	592.8	638.460657	95.390
Sept - 2010	594.4	639.6975263	96.741
Oct - 2010	594.5	638.2589633	95.170
Nov - 2010	596.0	643.9387351	101.371
Dec - 2010	593.7	637.1921781	94.005
Jan - 2011	582.3	623.5466911	79.107
Feb - 2011	583.9	621.9029109	77.312
Mar - 2011	593.3	627.6390664	83.575
Apr - 2011	601.0	636.9508407	93.742
May -2011	602.4	638.8926112	95.862
June - 2011	607.0	647.6335049	105.405
July - 2011	598.8	634.7153391	91.301
Aug - 2011	604.4	634.8497571	91.448
Sept - 2011	607.3	640.0473347	97.123
Oct - 2011	611.6	632.1414265	88.491
Nov - 2011	611.5	636.9139329	93.701
Dec - 2011	613.9	636.082314	92.793
Jan - 2012	599.1	616.4365553	71.344
Feb - 2012	601.1	616.5912375	71.513
Mar - 2012	612.2	632.2220066	88.579

Regional Index Results

Though the selected regression model obtained strong goodness of fit values, additional testing is needed. To further test the model, additional data points (not utilized in the model's calculation) are used as inputs in the regression equation and the output (estimated employment) is compared to actual employment data from those months. This tests the model's ability to predict the response variable (employment numbers) over the following months. Because data from January 2005 through December 2007 are utilized to calculate the regression model, data starting January 2008 is used in the model's testing phase. When data from January 2008 is utilized, the regression output predicts the employment value for April 2008 (3 months out). Figure 3 shows a graph comparing the output of the regression model to the actual employment numbers.

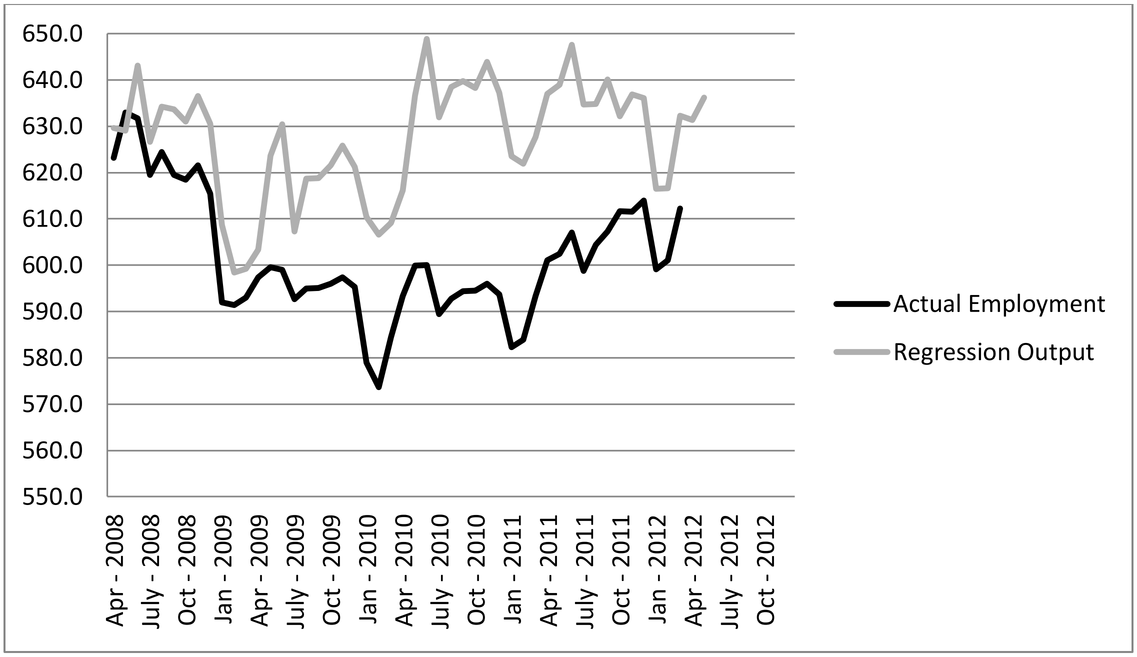
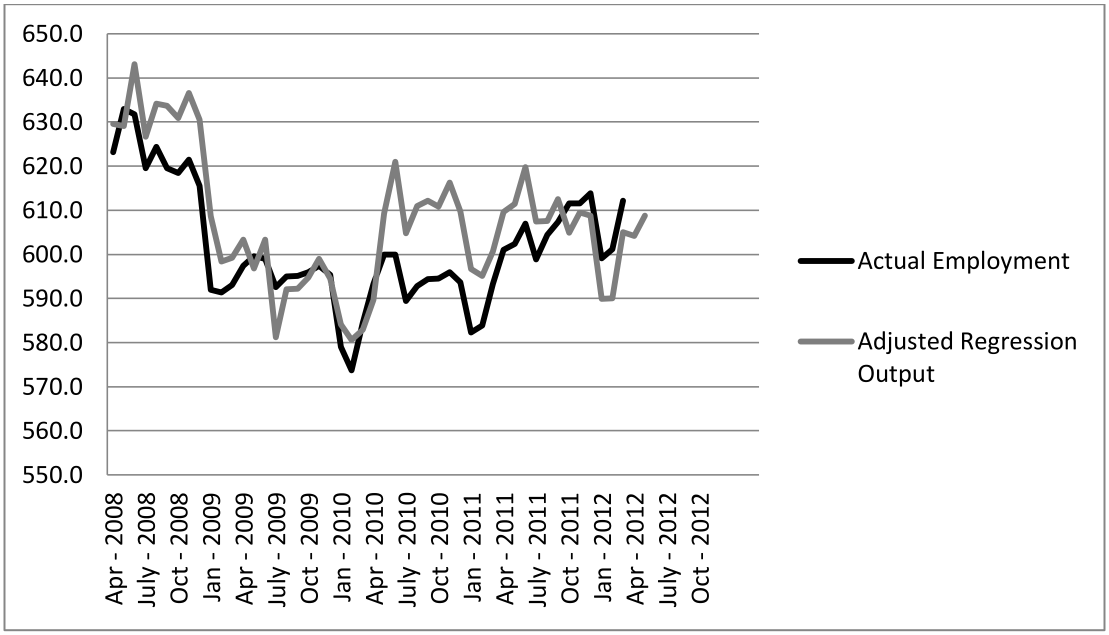


Figure 3. Regional Regression Output versus Actual Employment Numbers

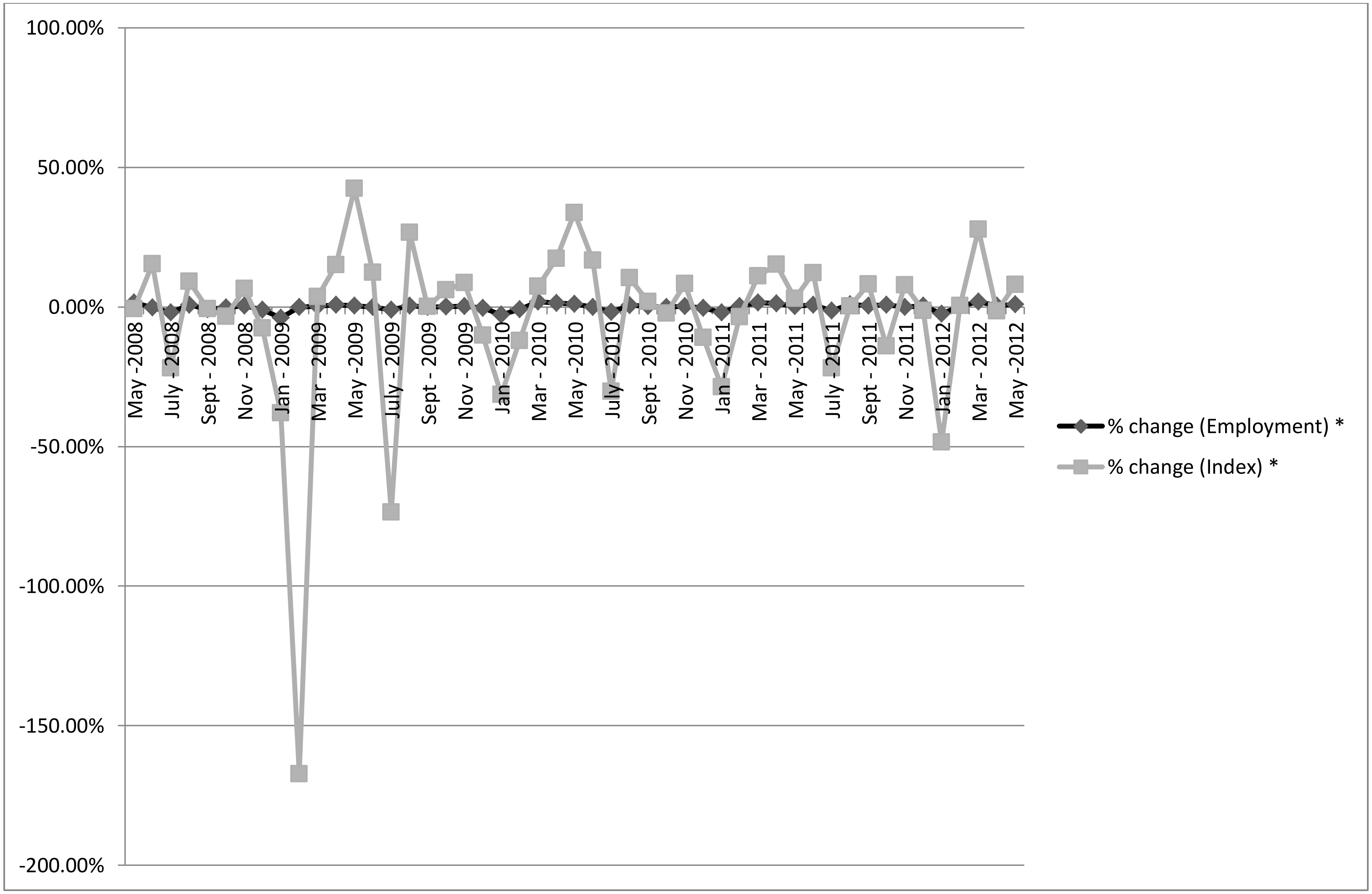
Figure 3 shows that the regression equation starts off as a very good prediction of the actual employment values. Then in early 2009, the employment values failed to rebound after a substantial drop. After this, the regression equation becomes a constant overestimate of the actual employment values. There are two ways to fix this issue. The best option is to recalculate the regression model. However, there is not yet sufficient data points after the drop to complete this recalculation. Therefore, an adjustment factor is calculated (0.043) and applied to all regression output values after the discrepancy (beginning May 2009) to correct for the gap. The value of 0.043 is found by comparing the differences of the regression outputs (after May 2009) to the actual employment values. It is determined that after the unexpected shift, the regression output is off by an average of 4.3%. Thus a factor of 0.043 is used to adjust the output to a more appropriate approximation of the employment values. This means that all estimated employment values from May 2009 onward, are reduced by 4.3% until the regression model can be recalculated. Figure 4 shows a graph of the adjusted regression output versus the actual employment values.



<u>Figure 4.</u> Adjusted Regional Regression Output versus Actual Employment Numbers

Figure 4 shows that the regression output, once adjusted, is a very good predictor of changes in the employment values for the Greater Louisville area. Even with the adjustment factor, there still remain a few larger drops in actual employment numbers that are not predicted by the regression equation. It takes some length of time for the regression model to catch up to the actual employment values after these drops. This leads to the belief that there are other factors not included in the model which would help predict some changes not predicted by tonnage variables, such as economic factors. Overall it can be stated that the model (with the adjustment factor) is a good predictor as it provides estimates within 3% of the regional employment values, 81% of the time.

Even though the adjusted model appears to be a good indicator, it is important to also check the results of the index values. Since the index values range from (approximately) 0-100, and employment values fall in the 570-650 (thousands) range, the two are not easily compared. To analyze results for the index values, a percentage of change is calculated from one month to the next for both the index values and the actual employment data. Figure 5 shows the comparison of these values.



<u>Figure 5.</u> Percentage change of index values versus percentage change of employment values

It can be seen in Figure 5 that though the index values tend to correctly predict the *direction* of change experienced by the employment numbers, they do a very poor job of predicting the *magnitude* of change. To further investigate the reasoning behind this issue, the same graph is constructed to compare the percentages of change between the regression output and the actual employment data (see Figure 6 below).

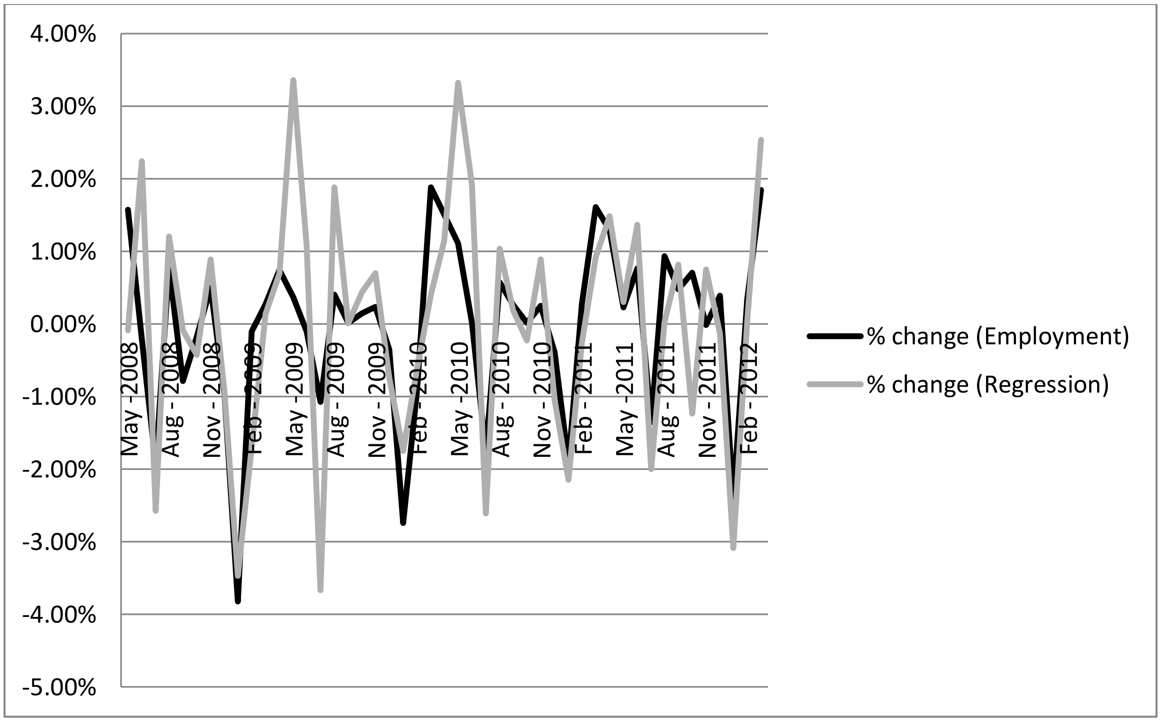


Figure 6. Percentage change of regression output versus percentage change of actual employment values

Figure 6 once again proves that the regression model is a good estimator of actual employment numbers for the upcoming month. Graphing these percentage change values illustrations that the regression output shows the proper direction of change and is also a good indicator of the magnitude of change seen in future employment numbers. This leads to the conclusion that there is a problem with the method used to convert the regression output to an index value. To fix this issue, the base year conversion method is tested.

To select a base period, measures of central tendency for the employment values are calculated. The calculations resulted in the following values: mean = 608.1; median = 610.4; mode = 619.5. Using the mean as the guiding measure, a base period of May 2005 is selected. During this month, the employment level was 608.2. Table 4 shows a sample of the values obtained through the base year conversion method alongside those found by the previous method. For a full listing see Appendix B. Figure 7 shows the percentage changes for the actual employment numbers versus the percentage changes of the updated index values.

Table 4

Regional Index Values – Base Year Conversion

Month	Index Value	Base Year - Index Value
Apr - 2008	85.71	103.52
May -2008	85.10	103.43
June - 2008	100.50	105.75
July - 2008	82.45	103.03
Aug - 2008	90.71	104.27
Sept - 2008	90.11	104.18
Oct - 2008	87.18	103.74
Nov - 2008	93.31	104.66
Dec - 2008	86.76	103.68
Jan - 2009	62.88	100.08
Feb - 2009	51.61	98.38
Mar - 2009	52.55	98.52
Apr - 2009	57.10	99.21
May -2009	79.24	102.54
June - 2009	86.61	103.65
July - 2009	61.36	99.85
Aug - 2009	73.84	101.73
Sept - 2009	73.90	101.74
Oct - 2009	76.89	102.19
Nov - 2009	81.64	102.90
Dec - 2009	76.59	102.14
Jan - 2010	64.74	100.36
Feb - 2010	60.65	99.74
Mar - 2010	63.35	100.15
Apr - 2010	71.01	101.30
May -2010	93.39	104.67
June - 2010	106.75	106.69
July - 2010	88.25	103.90
Aug - 2010	95.39	104.98
Sept - 2010	96.74	105.18
Oct - 2010	95.17	104.94
Nov - 2010	101.37	105.88
Dec - 2010	94.01	104.77

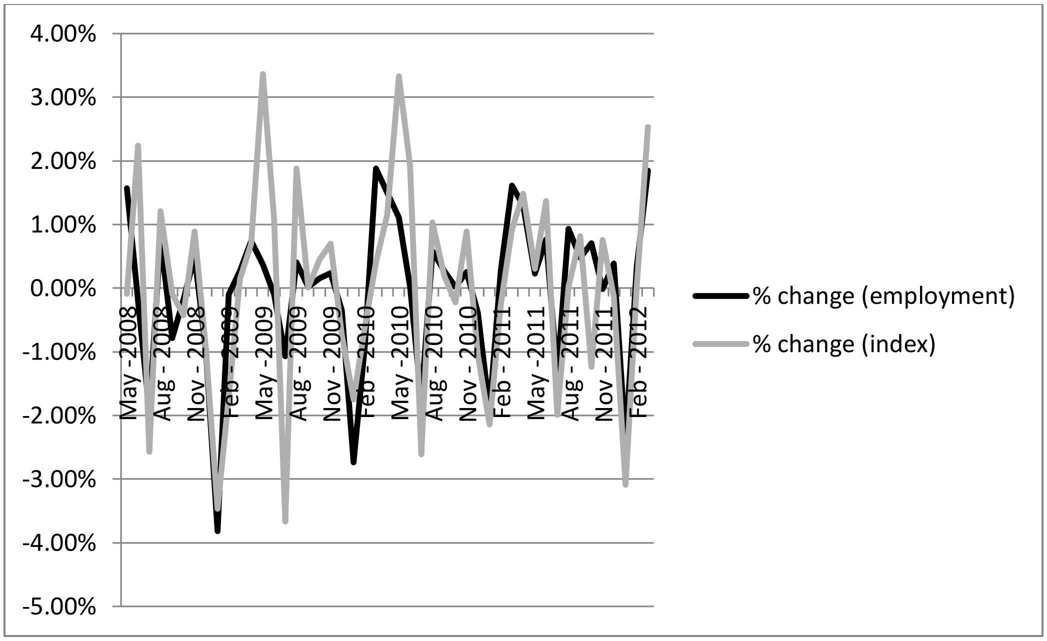


Figure 7. % Change of (Updated) Index Values versus % Change of Employment Values

It can be seen from Figure 7 that the base year conversion method does a much better job of maintaining the magnitude and direction of change predicted by the regression model than the previous method. Index values obtained through the base year method are considered as a percentage of the base period value. In other words, an index with a value of 103% means that the employment number for that month was 103% of the employment value from the base period. All index values are divided by a value of 2, before being reported to the public. This is thought to allow the users of the index to more easily interpret the overall level of activity in the logistics and distribution industry by maintaining an approximate range of 1-100 for the index values.

CHAPTER 6

NATIONAL INDEX ANALYSIS AND RESULTS

National Index Analysis

The first task that must be completed prior to developing the national index regression model is to determine which category or categories of employment data should be utilized as the response variable at the national level. There are over 100 categories and sub-categories of national employment data reported by the Bureau of Labor Statistics (BLS). The following categories are tested for use in this model: Total Non-Farm; Service Providing; Goods Producing; Manufacturing; Trade, Transportation, and Utilities; Transportation and Warehousing. Combinations of some categories are also considered. These combinations are (1) Manufacturing + Trade, Transportation and Utilities; and (2) Manufacturing + Transportation and Warehousing. The three categories cannot all be considered together because Transportation and Warehousing is a subset of Trade, Transportation and Utilities.

A separate best subsets analysis is run for each category (or group of categories) once with only primary (tonnage) factors, and a second time with both primary (tonnage) factors and secondary (economic) factors. Tables 5 and 6 show the measures of fit variables (provided by best subsets) of the best options found for each employment category. The measure of R^2 (adjusted) has been previously explained. A variable called "Mallows" is also reported by the Best Subsets analysis.

This is a value that measures precision of a potential model. Ideally the Mallows value should be close to the number of variables included in the model.

Table 5

Results with Primary (tonnage) Factors Only

Employment Category	Best of Feasible Solutions			
	R^2	R^2 (adjusted)	# of Variables	Mallows
Total Non-Farm	89.9	76.2	8.0	17.1
Service Providing	90.4	77.5	8.0	17.2
Goods Producing	75.7	19.9	12.0	24.0
Manufacturing	91.4	78.3	9.0	18.9
Trade, Transportation and Utilities	90.0	76.4	8.0	17.2
Transportation and Warehousing	92.1	81.4	8.0	16.8
Manfacturing + Trade, Trans, & Util	83.9	64.6	7.0	14.8
Manufact + Trans & Warehousing	87.8	71.3	8.0	16.8

Table 6

Results with Both Primary (tonnage) and Secondary (economic) Factors

Employment Category	Best of Feasible Solutions			
	R^2	R^2 (adjusted)	# of Variables	Mallows
Total Non-Farm	99.5	98.8	8	13.4
Service Providing	99.7	99.3	9	16.8
Goods Producing	93.1	77.2	12	20.6
Manufacturing	99.3	97.0	14	24.7
Trade, Transportation and Utilities	99.5	98.2	12	22.5
Transportation and Warehousing	99.1	97.5	10	16.3
Manfacturing + Trade, Trans, & Util	97.2	92.9	9	15.3
Manufact + Trans & Warehousing	96.5	88.6	12	21.3

The three categories; Total Non-Farm, Service Providing, and Goods Producing, are highlighted in gray. These categories are run for comparison purposes only. It is believed that utilizing such broad-ranging data for the response of a national model focused only on the logistics and distribution industry would not be advisable. This is due to the fact that large changes in areas completely unrelated to logistics and distribution could cause large shifts in the index which are not indicative of actual changes within the industry.

Cells that are highlighted in red indicate options where the Mallows are considered too high. A high Mallows value indicates that the model is not as precise as other options and could be biased. For both runs of the best subsets analysis, the best option found is the analysis that utilized transportation and warehousing employment data as the response variable.

With the transportation and warehousing employment data selected as the response for the regression model, it is necessary to determine the factors to be included in the model. The best subsets analyses used to select the response variable in the tables above can also serve to select factors, but it must first be determined whether or not to include secondary factors. It is clear from the two best subsets analyses that the model which includes secondary factors is a much better option than the model without secondary factors. This is clear as the R^2 (adjusted) value is higher when secondary factors are included, and the Mallows value is closer to the number of variables included in the model.

In order to keep the economic factors secondary to the primary factors, they will only be considered for inclusion in the model with the minimum lag of 4 months. This will allow the primary factors to have more bearing on the model (as they should) as they can be chosen for inclusion in the model up to three times each with different lags. The minimum lag for the national model is one month longer than that of the regional model. The additional month is simply due to longer data release schedules of the national data.

Using the results of the best subsets analysis from Table 6 for transportation and warehousing employment data, the following factors have been selected to build the national regression model: Air (lag=4), Rail (lag=4), River (lag=4), ATA Index (lag=4), Air (lag=5), Rail (lag=5), Air (lag=6), GDP, PMI, Oil. As previously described, secondary factors considered for inclusion are: Estimated Monthly Gross Domestic Product (GDP), the Purchasing Manager's Index (PMI), Monthly Crude Oil Prices (Oil), and the Average Monthly Exchange Rate of the US Dollar. All but the exchange rate have been selected for this model, and again, all of these secondary factors are included only with the minimum possible lag of 4 months. Appendix C shows all the data utilized for the national model.

The selected factors are used to build a regression model. Equation (2) shows this models regression equation. Again, the seasonal indicators are present in this model. The model obtained an R^2 (adjusted) value of 97.46% with a *p*-value of 0.000. Figure 8 shows the output of this national regression model versus the actual employment data later reported for the transportation and warehousing sector.

T&W Employment = 1798.26 + 0.000262804 Air (L=4) + 1.35889e-005 Rail (L=4) + 2.34543 River (L=4) + 1.07647 ATA Index (L=4) + 0.000419478 Air (L=5) - 1.94537e-005 Rail (L=5) + 0.000291222 Air (L=6) + 111.706 GDP for US - 2.01882 PMI - 0.570218 Oil - 39.1072 M2 - 38.8363M3 - 57.2115 M4 - 20.7476 M5 + 73.519 M6 + 62.1725 M7 + 14.9594 M8 - 9.87084 M9 + 7.92066 M10 + 10.7903 M11 - 12.328 M12 **(2)**

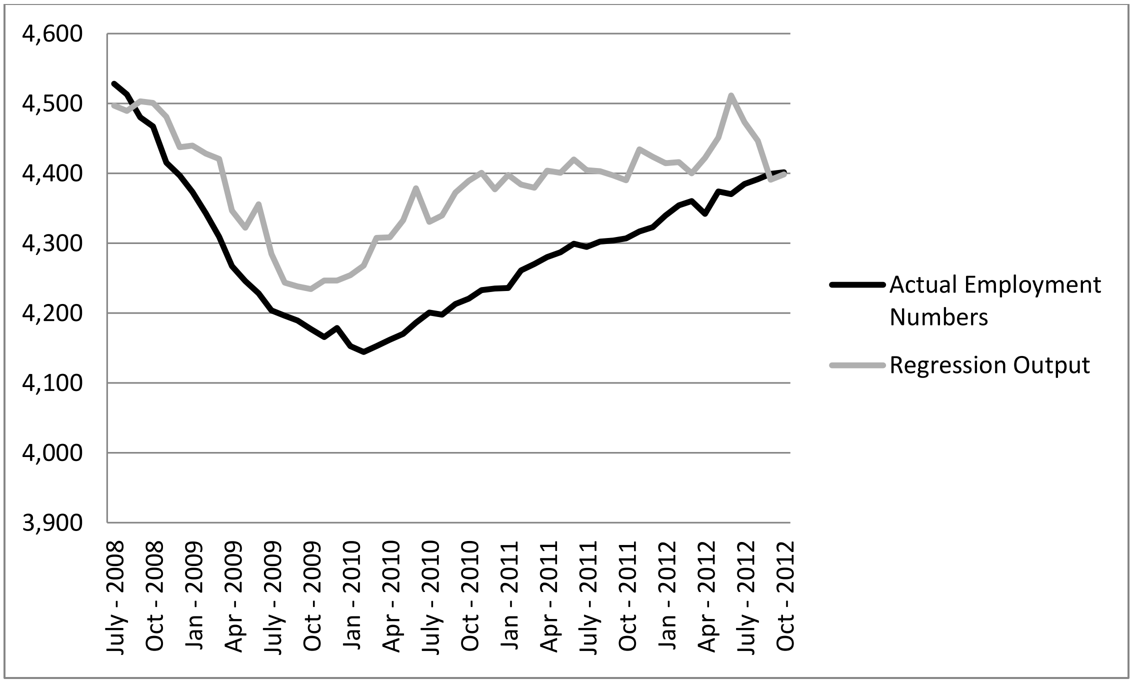


Figure 8. National (Static) Regression Output versus Actual Employment Numbers

Figure 8 shows that the national regression model is a constant overestimate of the actual employment values for the transportation and warehousing sector. This leads to the belief that the national regression model does not make strong predictions based on static data. A new method of calculation has been devised which was dubbed the “Monthly Moving Regression” technique. This technique begins with the same three years of data (January 2005 – December 2007) and calculates a regression model. The next available data point (January 2008) is input into the regression equation to make one prediction four months out (May 2008). Then, as a new month of data becomes available (February 2008), the oldest month (January 2005) is dropped from the regression model’s data pool and the next newest month (January 2008) is added. The regression model is then rerun with the “newest” three years of data (February 2005 – January 2008), and utilizes the value of February 2008 to make the next prediction (June 2008).

It is also easily noticeable in Figure 8 that the national data does not contain the same seasonal pattern as the regional data. For this reason, the Monthly Moving Regression Analysis was run twice, once with seasonal indicators and once without seasonal indicators. Both analyses utilize the same primary and secondary factors as the previous national regression model. Equations (3) and (4) show these Monthly Moving Regression Equations for the first possible calculation, predicting May 2008 (for a full table of regression equations see Appendices D and E) and Figure 9 shows both their outputs compared to the actual employment data for the transportation and warehousing sector. Equation (3) corresponds to the model with seasonal predictors included and Equation (4) to the model without seasonal predictors.

T&W Employment = 1798.26 + 0.000262804 Air (L=4) + 1.35889e-005 Rail (L=4) + 2.34543 River (L=4) + 1.07647 ATA Index (L=4) + 0.000419478 Air (L=5) - 1.94537e-005 Rail (L=5) + 0.000291222 Air (L=6) + 111.706 GDP for US - 2.01882 PMI - 0.570218 Oil - 39.1072 M2 - 38.8363M3 - 57.2115 M4 - 20.7476 M5 + 73.519 M6 + 62.1725 M7 + 14.9594 M8 - 9.87084 M9 + 7.92066 M10 + 10.7903 M11 - 12.328 M12 **(3)**

T&W Employment = 2708.79 - 1.64519e-005 Air (L=4) + 1.76987e-005 Rail (L=4) + 0.655678 River (L=4) - 0.230156 ATA Index (L=4) + 5.53457e-005 Air (L=5) + 3.11192e-006 Rail (L=5) + 3.09447e-005 Air (L=6) + 132.957 GDP for US - 0.5871 PMI - 1.20091 Oil **(4)**

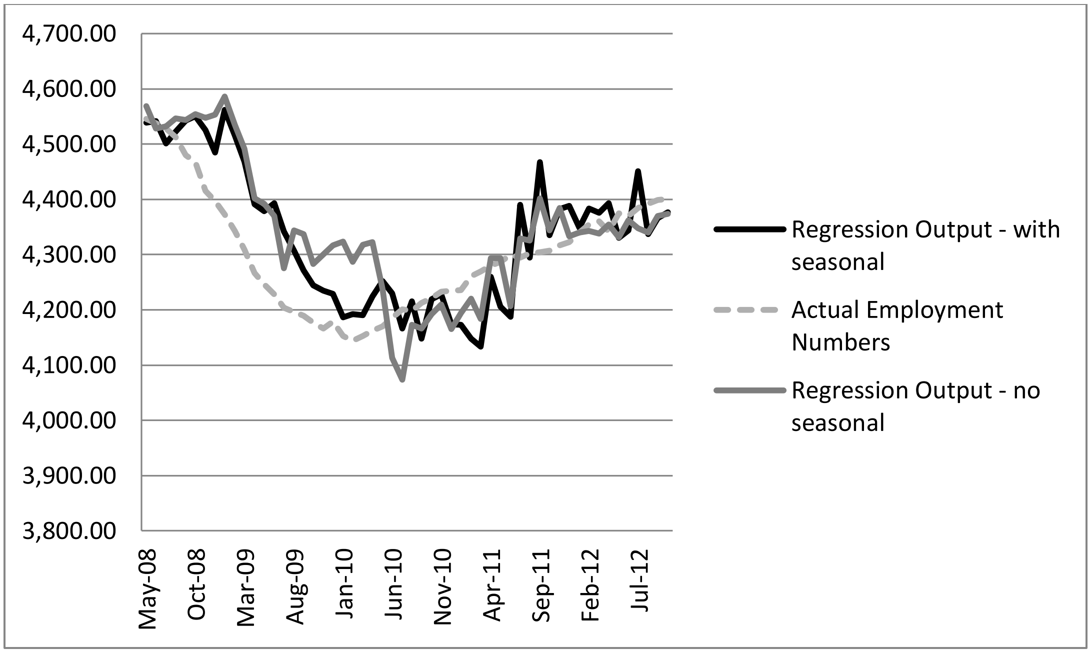


Figure 9. Monthly Moving Regression Outputs (seasonal and non-seasonal) versus Actual Employment Numbers

Both monthly moving regression models are slightly more jagged in nature that the static regression model. However, this is to be expected as the regression equation is being recalculated before each new prediction. One model does not seem overtly superior to the other, however subtle differences can be seen. There is one period of time around May 2009 – May 2010 where the model with seasonal factors remains a better prediction of the actual values, however over the whole of the graph the non-seasonal model tends to be slightly less jagged, resulting in a more "stable" model. Because either model appears to be a good fit and each have their own merits, the more simplistic model is selected in order to avoid unintentional bias that can occur with extraneous data. When averaged across all equations, this model has an average R^2 (adjusted) value of 91.12. This model is also found to make predictions within 3% of the national employment values 67% of the time.

As was discussed in the chapter on the regional index, the national regression output must also be converted into an index value. It is not necessary to test multiple conversion methods on the national index. The base year conversion method was found to work best for the regional index so it is safe to assume it will do the same for the national index. The same technique is utilized to find the base period for the national model as was used for the regional model. Measures of central tendency for the transportation and warehousing data are calculated as follows: mean= 4373.9, median = 4374.2 and mode = 4538. The month of July 2005 is selected as the base period as it has an employment value of 4374 which is very close to both the mean and median of the data. Table 7 shows a sample of National Index Values found through the base year conversion method. For full table see Appendix F.

Table 7

National Index Values

Month	Actual Employment Numbers	Regression Output	Base Year = Jul 2005	Index Value
May-08	4,546.00	4,568.55	104.45%	52.22
Jun-08	4,538.00	4,528.14	103.52%	51.76
Jul-08	4,528.00	4,532.02	103.61%	51.81
Aug-08	4,513.00	4,546.63	103.95%	51.97
Sep-08	4,480.00	4,543.62	103.88%	51.94
Oct-08	4,467.00	4,553.84	104.11%	52.06
Nov-08	4,415.00	4,547.76	103.97%	51.99
Dec-08	4,397.00	4,553.62	104.11%	52.05
Jan-09	4,373.00	4,585.68	104.84%	52.42
Feb-09	4,343.00	4,534.90	103.68%	51.84
Mar-09	4,309.00	4,491.39	102.68%	51.34
Apr-09	4,267.00	4,402.14	100.64%	50.32
May-09	4,246.00	4,392.39	100.42%	50.21
Jun-09	4,228.00	4,370.11	99.91%	49.96
Jul-09	4,204.00	4,275.36	97.74%	48.87
Aug-09	4,196.00	4,343.51	99.30%	49.65
Sep-09	4,189.00	4,337.44	99.16%	49.58
Oct-09	4,177.00	4,282.90	97.92%	48.96
Nov-09	4,166.00	4,300.56	98.32%	49.16
Dec-09	4,179.00	4,316.77	98.69%	49.35

National Index Results

It has already been show in Figure 9 that the monthly moving regression model selected (that with no seasonal indicators) is a good predictor of the employment data for the transportation and warehousing sector. This is reiterated in Figure 10 which shows only the employment numbers estimated by the selected national model against the actual employment numbers. The selection of this model is further solidified when comparing it to the static model originally tested for the national level (Figure 11).

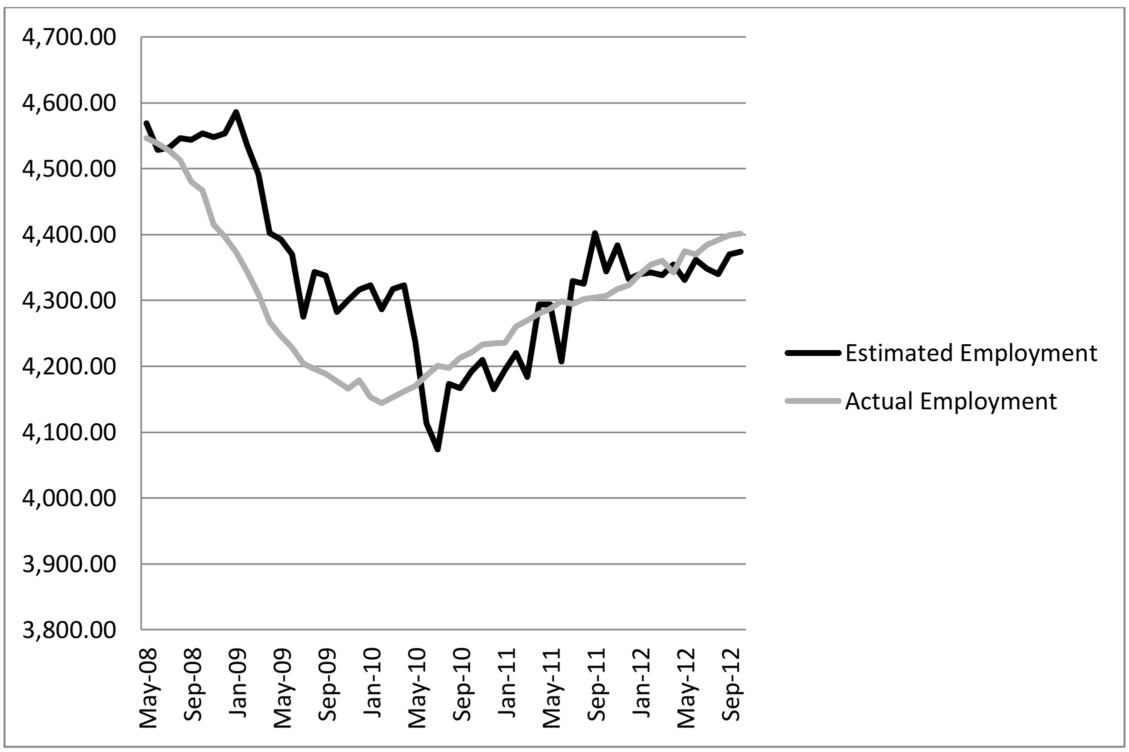


Figure 10. Estimated Employment (National) versus Actual Employment

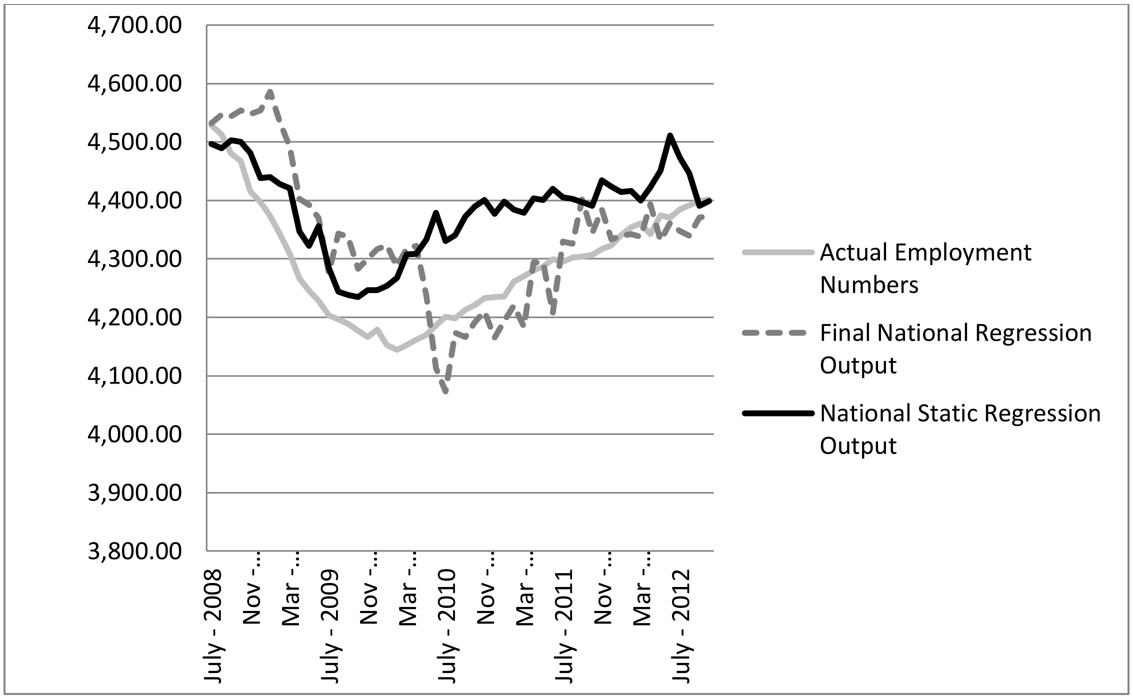


Figure 11. National Moving Model versus National Static Model versus Actual Employment Numbers

To check the index values calculated from the final regression model (through the base year conversion method), the percentage of change of index values from one month to the next is graphed against the percentage of change in the actual employment data (Figure 11).

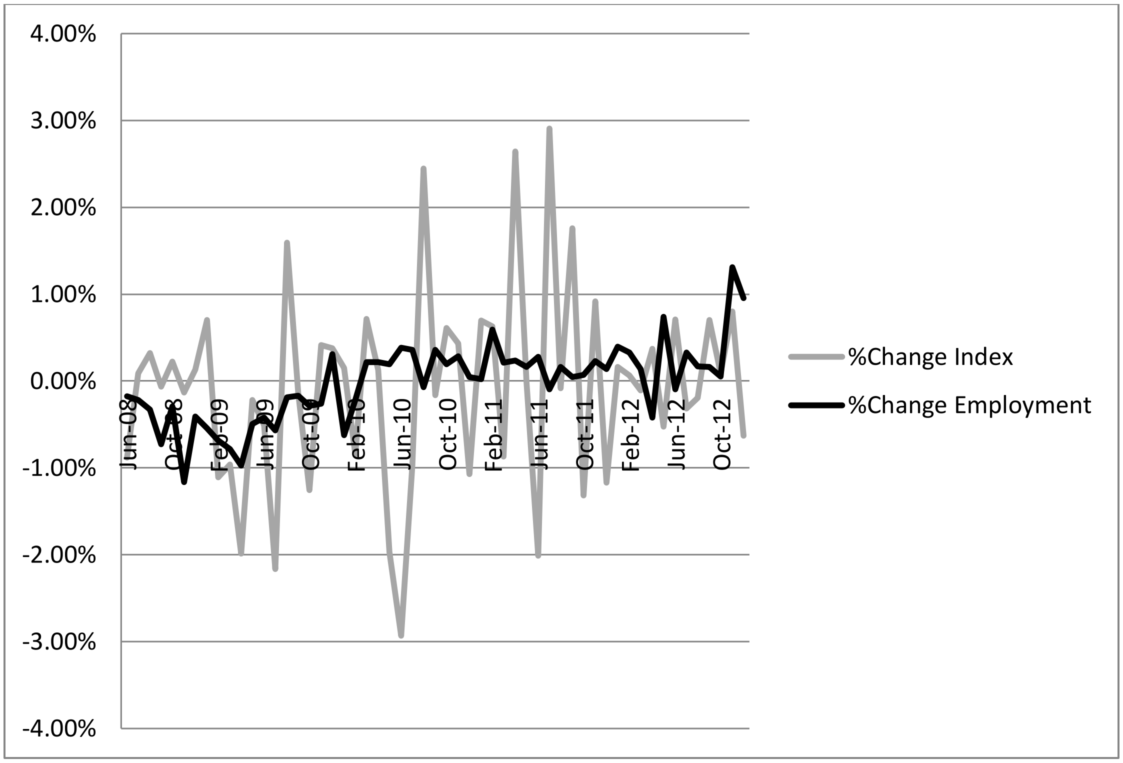


Figure 12. % Change of National Index versus % Change of Employment Numbers

Figure 12 shows that the National LoDI Index overstates the magnitude of change somewhat, but is often a close prediction. Also, the index predicts the direction of change reasonably well. The more erratic behavior shown by the percentages of change in this index can be attributed to the constant recalculation of the regression model. Figure 13 shows the same information comparing the employment numbers to the regression output. It proves that the base year conversion method maintains the proper magnitude and direction of change from the regression equation to the index value. The monthly moving regression predictions from July 2008 – October 2012 fall within 3% of the actual employment values 67% of the time. This shows that the National LoDI Index is a strong estimator of changes in future employment values.

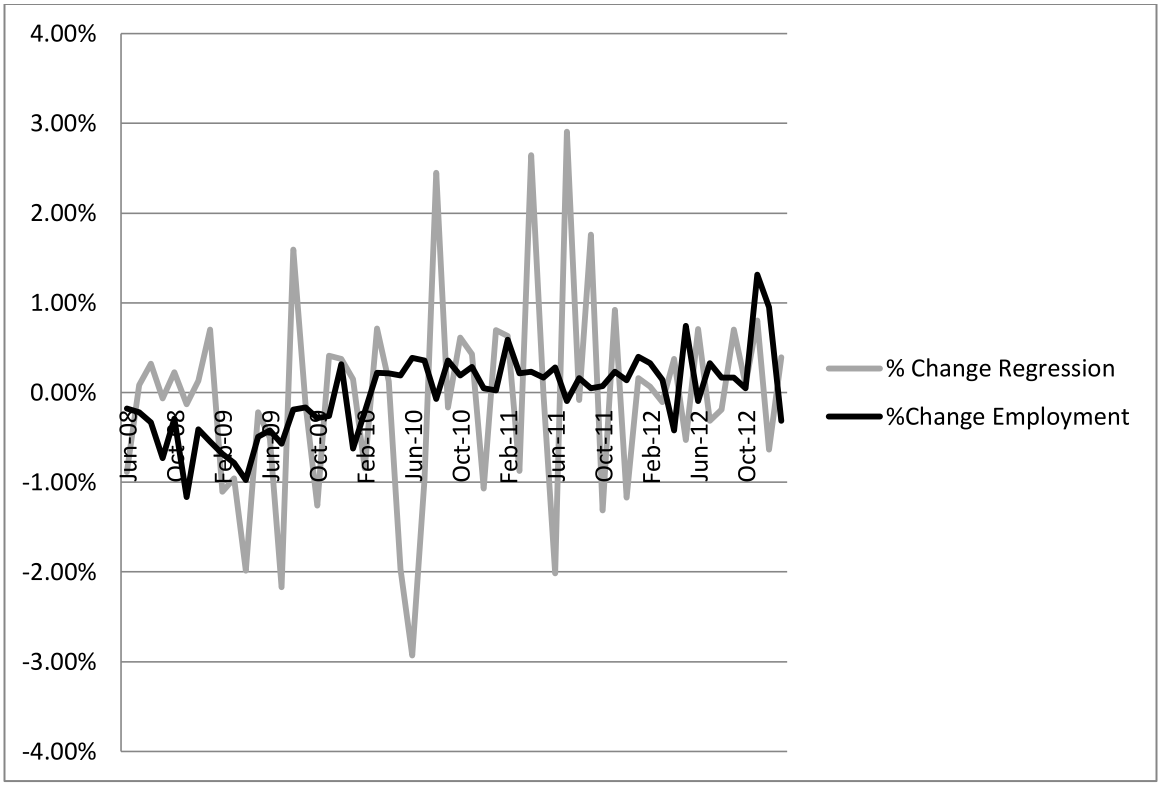


Figure 13. % Change of National Regression Output versus % Change of Employment Numbers

Comparative Analysis

The National LoDI Index is expected to fulfill a niche and serve as a predictive indicator for the logistics and distribution industry. Regression analysis is utilized in order to give the model the desired predictive capabilities. In order to show the full advantages of this index, a comparative analysis has been completed. The first phase of this analysis aims to compare the use of regression modeling against the geometric mean method (as utilized by the Fisher Ideal Index Method). The Fisher Ideal Index method is used to calculate the Transportation Services Index (TSI).

The geometric mean calculations rely on both quantity and cost data. Some quantity data (tonnage shipped) utilized in the regression analysis is also utilized in the geometric mean analysis. Cost data for each mode of transit is also compiled. The following variables are utilized for the geometric mean analysis: tonnage shipped by air [quantity], jet fuel cost ($/gallon) [cost], ton-miles shipped by rail [quantity], rail shipment cost ($/mile) [cost], tonnage shipped by barge [quantity], barge shipment cost ($/ton) [cost], ATA Truck Tonnage Index [quantity], trucking shipment cost ($/mile) [cost]. Data is converted to necessary units as needed. All data is also utilized at the monthly level, just as with the regression analysis. Figure 14 shows the results of this analysis.

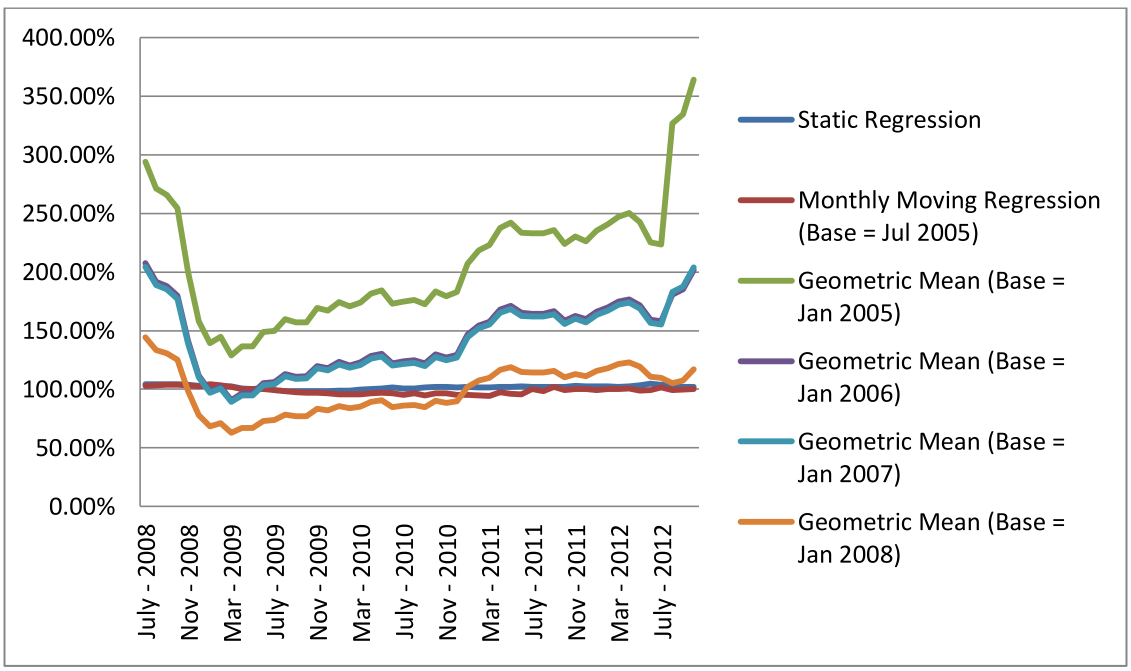


Figure 14. Comparison of Index Values Using: Static Regression, Monthly Moving Regression, and Geometric Mean

For this phase of the comparative analysis, four geometric mean calculations are completed with varying base values. Figure 14 shows how the selection of the base value changes the outcome of this type of model. It should be noted that the geometric mean results are lagging values while the regression results are predictive values. The graph shows that the geometric mean model that is closest to the selected national regression model is that with a base period of January 2008. Figure 15 shows only this model and the national regression model together for a closer comparison.

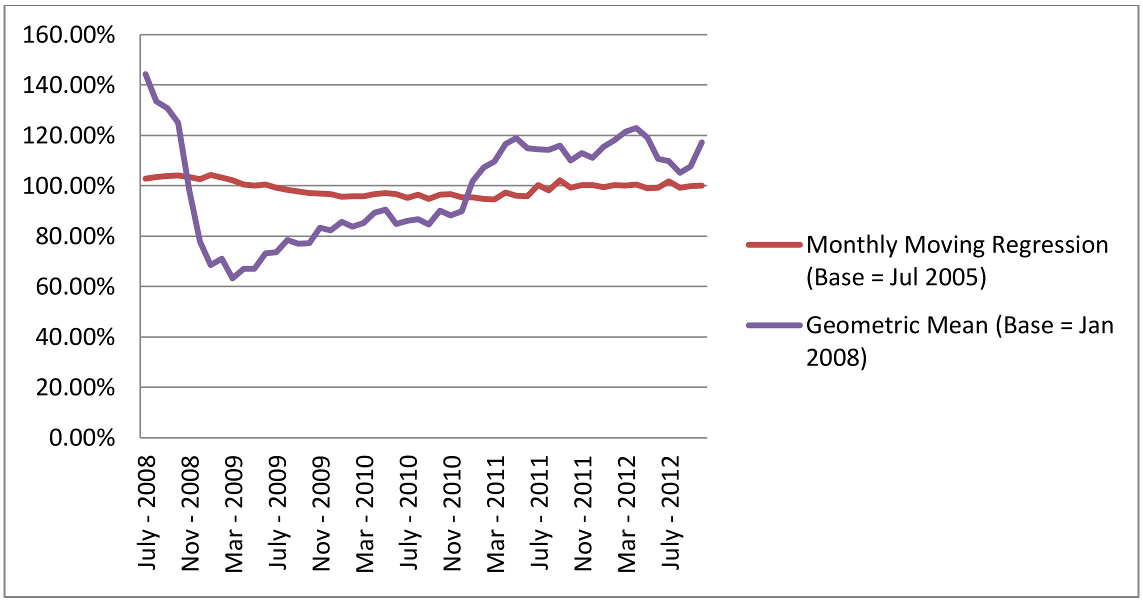


Figure 15. Monthly Moving Regression Index Values versus Geometric Mean Index Values

The line for the geometric mean model spans a much larger range with much more pronounced peaks than the Monthly Moving Regression. Though cost data may be beneficial to this type of analysis in many areas, it is detrimental in this case (as used in the geometric mean analysis). Shipment costs are based primary on fuel prices. This could be the main reason the geometric mean model seems incredibly volatile as fuel prices in the US are constantly fluctuating, sometimes with substantial shifts in cost per gallon. This first phase of the comparative analysis proves that the regression analysis utilized to develop the National LoDI Index is far superior to the results of a geometric mean analysis applied to the same (or related) data.

The second phase of the comparative analysis deals with comparing the National LoDI Index to other currently existing indicators. The goal of the National LoDI index is to predict changes in the level of activity for the logistics and distribution industry. To measure changes in the activity level of this industry it is important to consider both the actual volume of goods moved as well as the level of business (economic) activity. The following indicators are included in this phase of analysis: National LoDI Index, Transportation Services Index (TSI), Purchasing Managers Index (PMI), ATA Truck Tonnage Index (ATA), Dow Jones Transportation Average (DJT), and estimated monthly Gross Domestic Product for the US (GDP).

These factors have been selected as they are thought to represent various types of indicators that could be considered helpful in the planning of business expenditures for the logistics and distribution sector. Due to their very different methods of measurement, a percentage of change from one month to the next is calculated for each variable and used for comparison. The goal of this analysis is to show that not only is the National LoDI Index a strong predictive index, but that it is also just as useful, if not more useful than all of these currently existing indicators. The analysis begins with a graph comparing the percentages of change in all the variables considered. This portion of analysis compares percentages of change, however, for simplicity of explanation variables will only be identified by their indicator name (i.e. LoDI Index, TSI, etc). Figure 16 shows all of the variables when graphed together.

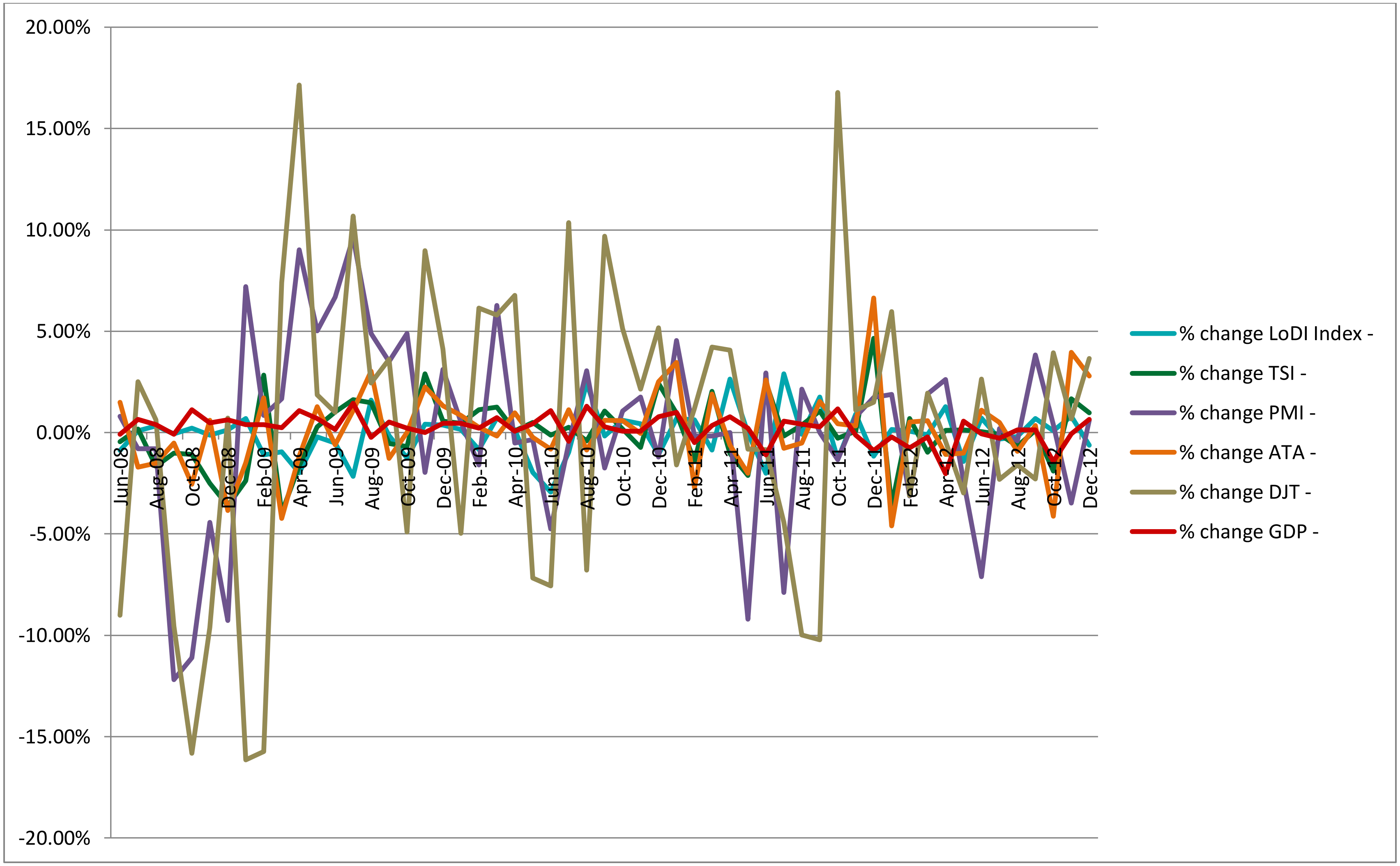


Figure 16. Comparative Analysis: All variables

From Figure 16, it is clear that the most volatile indicator, and therefore the least reliable for this application, is the Dow Jones Transportation Average (DJT). The DJT is a stock price indicator. As discussed in the previous stage of the comparative analysis, while cost variables may be helpful in many models, they should not be a main component in this industry. This is because transportation costs fluctuate far too frequently and at a high magnitude of change. This is especially true for the DJT. Stock prices fluctuate at an even more rapid pace than simple transportation costs. In fact, the DJT is itself recalculated every two seconds during stock market trading hours. It is clear that the DJT is not an ideal indicator to use when measuring the changes in activity of the logistics and distribution industry. For this reason, the DJT is removed from the graph, making further comparisons more straightforward.

Figure 17 shows the same graph with the DJT data removed. In this graph, it becomes clear that the PMI is also a very unpredictable measure. Part of this may be due to its nature as a predictive indicator that is based on subjective data. The PMI is designed to measure changes in the manufacturing industry. Although it is a highly utilized index, it seems to be most useful when used in conjunction with other indicators (Barnes, 2013). Therefore it makes a good addition to the National LoDI index when included as a factor, but should not be utilized on its own when measuring logistics and distribution activity. Therefore the PMI is the next factor taken out of the graph before further analyzing the remaining variables (See Figure 18).

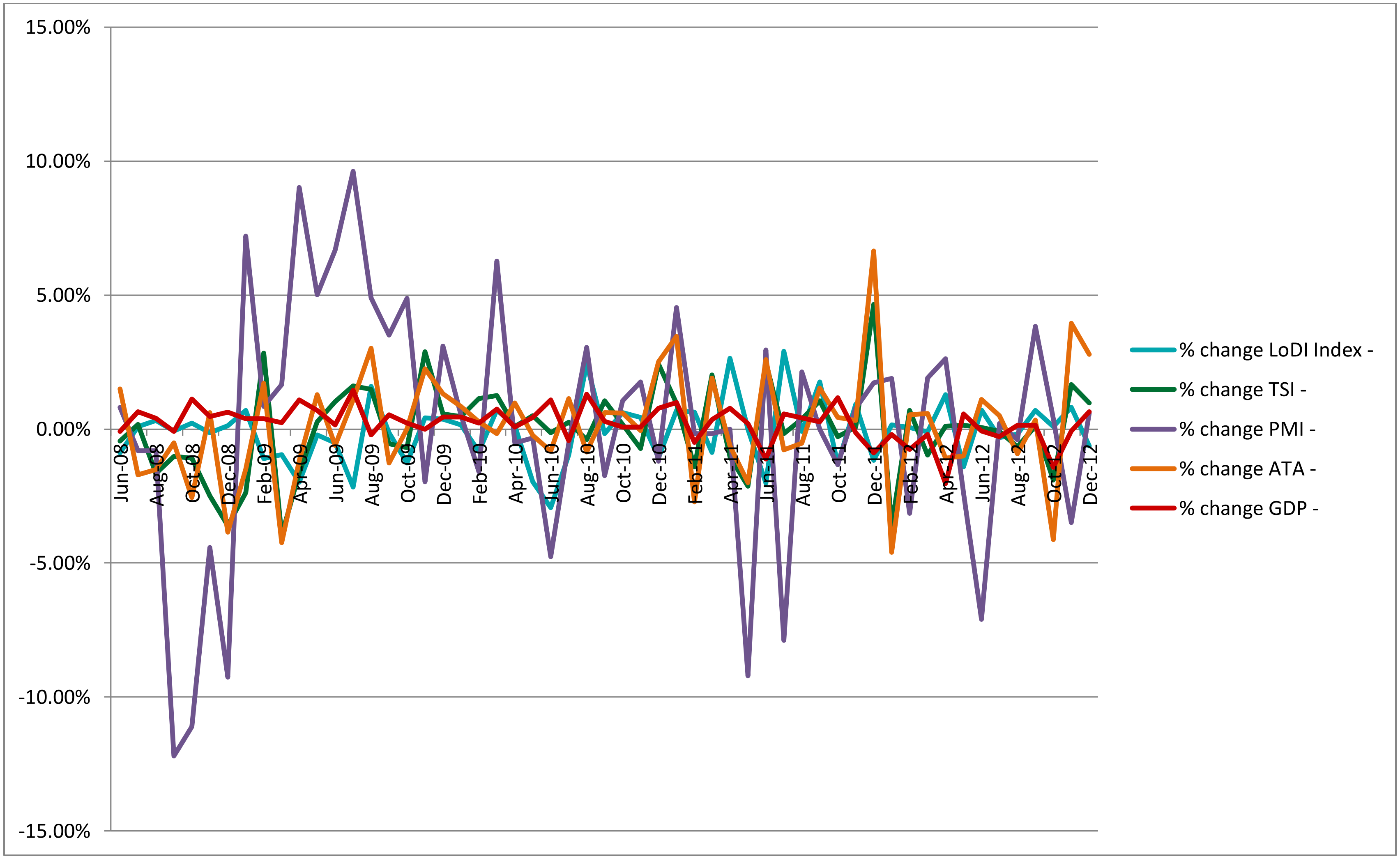


Figure 17. Comparative Analysis: All variables, except DJT

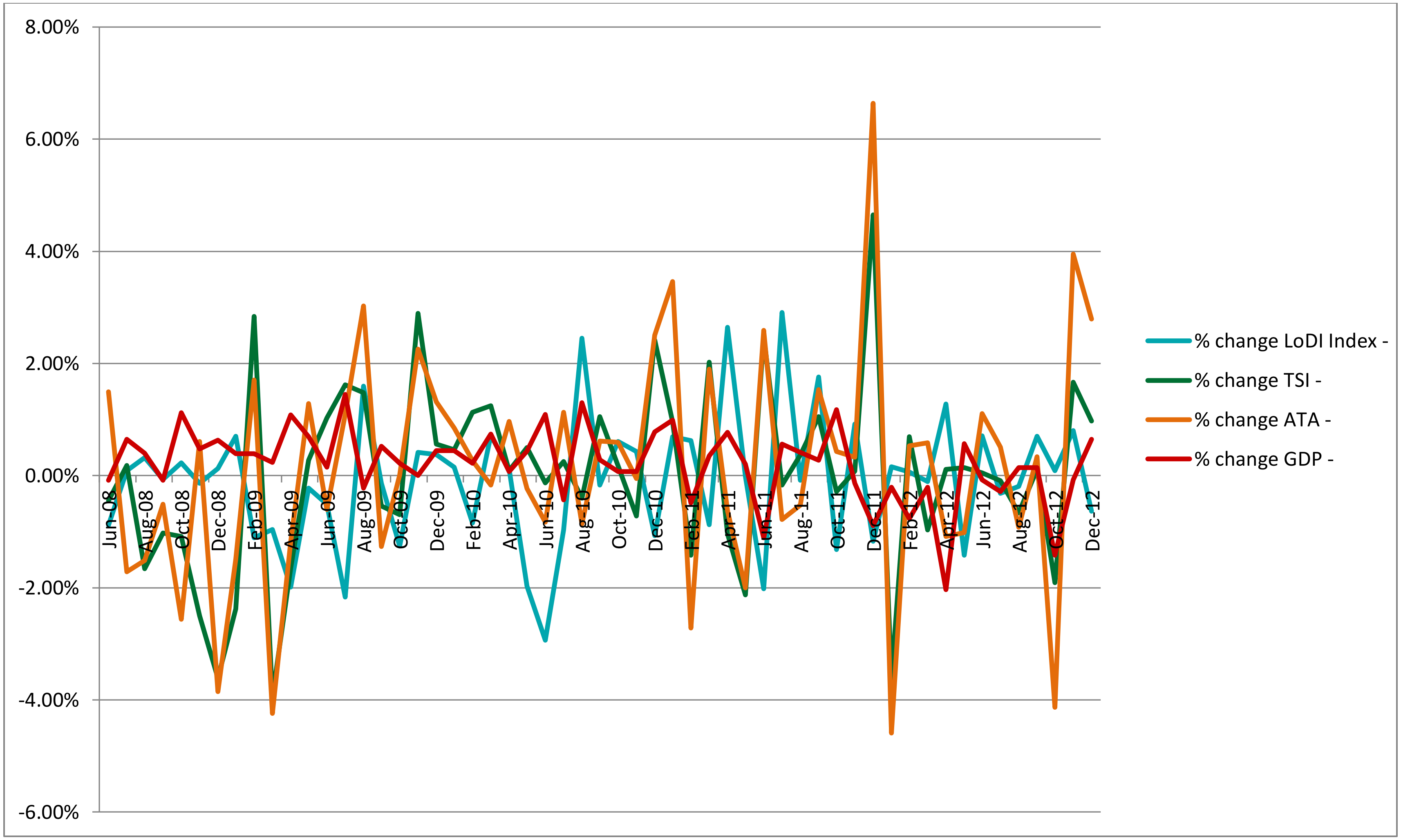
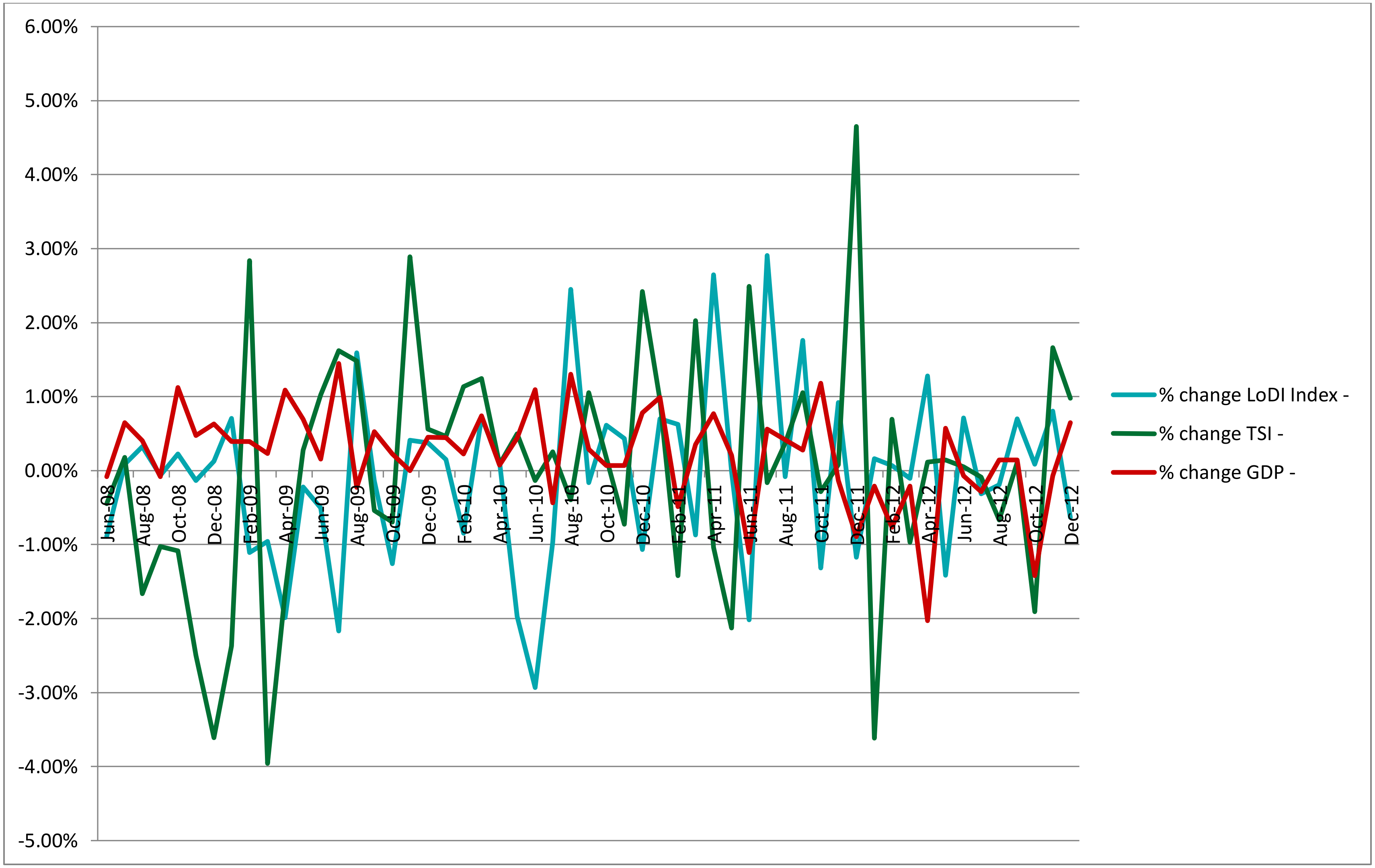


Figure 18. Comparative Analysis: All variables, except DJT and PMI

Once the PMI data is removed, the remaining factors begin to consolidate into a more consistent range. Though it is not extensively different than the TSI, the ATA Index does show a greater tendency, however slight, toward larger shifts. The ATA Index only covers the trucking industry, and only a representative sample of that industry. While it has been found fairly reliable as a trucking indicator, it cannot be expected to act as a guide for the logistics and distribution industry as a whole. What this analysis does support is its validity as a factor of the National LoDI Index. This graph shows that the ATA Index tracks well with other transportation indicators. This is expected as 67% of all freight tonnage transported domestically through the US moves by truck (United States Department of Commerce, 2013). It is not a surprise that both the TSI and National LoDI Index follow some of the same patterns as the ATA Index as the ATA Index is used as a factor in the calculation of both of these indices. The ATA Index data is the next factor removed from the graph for the final step of this analysis (Figure 19).

What remains in Figure 19 is a graph of the National LoDI Index, the TSI and the GDP. This graph shows that the TSI is slightly more volatile than the National LoDI Index as it has "extreme" values more frequently. Table 8 shows the number of times the National LoDI and the TSI each deviate from the GDP at varying levels. It can be seen that the National LoDI Index has a tendency to diverge by lesser percentages than the TSI. Looking at the range of all of these deviations also supports use of the National LoDI Index. The National LoDI Index diverges from the GDP measures by a range of 7.39 percentage points while the TSI diverges by a range of 9.79 percentage points. It is expected that the National LoDI Index tracks more closely to the GDP as the GDP is a secondary factor of the National LoDI Index.



<u>Figure 19.</u> Comparative Analysis: LoDI, TSI and GDP only

Table 8

Divergence of National Index Values and TSI versus GDP

	National LoDI	TSI
difference <1%	33	31
difference between 1%-2%	15	10
difference between 2%-4%	6	11
difference >5%	1	3
total range of divergence	7.39%	9.79%

CHAPTER 7

SUMMARY AND CONCLUSIONS

Discussion

The findings of the research show that as hoped, regression analysis is a suitable means of creating a predictive index when appropriate data is utilized. The regional index results reported in Chapter 5 show that the regional regression analysis (once adjusted) does an excellent job of predicting changes in the regional employment numbers for the upcoming month (predictions within 3% of actual 81% of the time). The utilization of an adjustment factor for the regional regression model will be remedied once enough data is present to recalculate the model. In the meantime the adjustment factor is show to correct for the discrepancy.

The Regional LoDI Index for the Greater Louisville area is a strong indicator of changes in the local logistics and distribution sector. This index will be extremely helpful to any local businesses or government organizations with a stake in the logistics and distribution industry. As a leading indicator, it will give these organizations a leg up in any investment decisions related to this sector. The Regional LoDI Index is the first of its kind, and will put Louisville even more solidly on the national stage as the logistics hub it is.

The national regression analysis is slightly more complex than the regional analysis, and has a more difficult task at hand as there are so many factors effecting the logistics and distribution industry on the national level. Even with these added difficulties the national regression model does a fine job of predicting changes in national employment numbers for the transportation and warehousing sector (within 3% of actual 67% of the time). It is very likely that the regional regression analysis performs better than the national due to the size of the region. Changes happening on the national level are magnified since they cover and much larger area and population than at the regional level. Additionally, the logistics and distribution industry within Louisville represents a much larger portion of the region's revenue than that of the national logistics and distribution industry.

The National LoDI Index is a solid predictor of changes expected in the logistics and distribution industry on a national scale. This is the first national leading indicator related to the logistics and distribution industry and will be helpful for national organizations in the same way that the Regional LoDI Index is to the Greater Louisville area. This index also brings to the foreground the use of regression analysis as a primary calculation tool for predictive indicators.

The comparative analysis shows that the use of regression analysis aids in the reliability of this indicator over the use of geometric mean analysis. This can be explained by the volatility of transportation costs. Since the cost to transport goods is highly dependent upon fuel costs, and fuel costs are highly unstable, the transportation costs themselves cause increased instability to the geometric mean model. The analysis further shows that the national index follows trends of other closely related indices (such as the TSI) and factors (such as the GDP) well, however the National LoDI index is predicting these changes, whereas the other indices are measuring the changes after the fact. The ability to effectively predict these changes could prove most helpful to organizations and government bodies throughout the US.

Summary

The goal of this research is to create two indices (one regional and one national) that predict changes in the level of activity within the logistics and distribution industry. Data is collected on both freight transportation (tonnage) and economic factors (national index only). Best subsets analysis is utilized to select which factors should be included in the models for each index. Lagged factors and seasonal indicators are utilized where deemed necessary. Factors selected through the best subsets analyses are used to build linear regression models that predict the employment values for an upcoming month. The regional regression was found to make predictions within 3% of the regional employment values 81% of the time. The national model falls within 3% of the national employment values 67% of the time. The output from the regression models are then converted to an index value. It was found that the base year conversion method is the best technique to complete this conversion for both the regional (Greater Louisville) and national indices.

Calculated index values and regression outputs are put through rigorous testing to prove each model's validity. Changes are then made to the models where necessary and the resulting indices are both found to be good indicators of future employment values. These employment predictions allow inferences to be made on expected levels of growth and decline within the logistics and distribution industry.

A comparative analysis is also completed to show not only the usefulness of the National LoDI index as compared to other related indices but also to compare the methodologies used in its calculation to another widely used method, a geometric mean calculation, as utilized by the Fisher Ideal Index method. This analysis demonstrated that the regression techniques utilized for this research provide a superior metric for the intended purpose of this index than the geometric mean method.

In addition to these findings, the National LoDI Index is graphically shown to not only convey trends shown by other widely accepted transportation indicators, but is also found capable of tracking well with (included) economic factors, setting this index apart from others on the market. On the graphical analysis comparing the National LoDI Index to other common indicators, the national index diverges from the GDP measures by a range of only 7.39 percent. The factor with the next closest range was the TSI which diverged by a range of 9.79. This analysis further solidified the use of certain factors included in the national model's calculations including the ATA Truck Tonnage Index and the GDP.

Research Contributions

This research has answered the question set forth and has shown that regression analysis can in fact be utilized as the primary calculation method of a predictive index most successfully. This method of index calculation will open the door for the creation of additional predictive indices covering a myriad of applications.

In addition to the use of regression analysis, this research has also shown that the combination of raw (tonnage) data and other (economic) indicators can be of great use when calculating an industry specific index. Finally, the most tangible contributions of this research are in fact the two new indicators it provides. The Regional LoDI Index and National LoDI Index will provide important data pertaining to a rapidly growing industry. Companies throughout the nation will benefit from these indices.

Limitations

As with any emerging research, it is important to understand the limitations of the final product. The regional model is limited by the age of data used to build the model. As discussed in Chapter 5, the regional model utilizes an adjustment factor for predictions after May 2009. It would be best to recalculate the regression model (utilizing the same factors) once sufficient data is available to build and test the new model. To ensure that these same issues do not arise in the future one of two paths must be taken: 1. A set of rules should be developed to determine how frequently to recalculate the model or 2. The regional model should be reworked to utilize the Monthly Moving Regression analysis method.

There are limitations for the national model as well; namely, the fact that the model slightly overestimates the magnitude of actual change in the employment numbers. This is true for the index values as well. This overestimate is minor allowing the model to still be considered valid.

It should be noted that the results of this research are also limited to their intended regions. The regional index only measures the logistics and distribution industry within the Greater Louisville area, and the national index is a measure of this industry within the United States.

Finally, it can be stated that these indices are limited in the fact that they measure the logistics and distribution industry (of their respective areas) as a whole, and cannot be used to measure portions of the industry. For example, the regional index cannot be used to determine trends specific to the trucking industry (or any other specific mode of transit) within Louisville. Some of these limitations provide motivation for additional related research.

Future Research

Though the goals of this research were fulfilled, there are possible extensions to this project that may also be beneficial. First, additional regional indicators for other areas could be developed utilizing the methodologies set forth in this research. Also, there could be many uses for sub-indicators pertaining directly to each specific method of transit. These sub-indices would allow companies with a stake in only one segment of the logistics and distribution industry to better predict short-term changes in their specific areas of interest. Sub-indices would also be exceedingly helpful in the area of infrastructure planning. For instance, a sub-index for the trucking industry could predict large increases in truck transit, signaling the need for additional highway capacities at major trucking junctures.

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APPENDIX A

TABLE OF REGIONAL DATA

Month	Air	Rail	River	ATA Index	Air (Lag = 4)	Rail (Lag = 4)	River (Lag = 4)	ATA (Lag=4)	Air (Lag = 5)	Rail (Lag = 5)	River (Lag = 5)	ATA (Lag=5)	Total Employment
Jan - 2005	73,903.95	103,280	186,543.39	121.6	-	-	-	-	-	-	-	-	591.4
Feb - 2005	73,288.71	116,080	206,681.80	116.1	73,903.95	103280	186,543.39	121.6	-	-	-	-	594.4
Mar - 2005	76,127.62	147,280	198,124.85	113.3	73,288.71	116080	206,681.80	116.1	73,903.95	103280	186,543.39	121.6	598.1
Apr - 2005	80,714.88	138,800	169,345.55	116.3	76,127.62	147280	198,124.85	113.3	73,288.71	116080	206,681.80	116.1	604.2
May -2005	76,960.27	92,720	127,242.90	113.7	80,714.88	138800	169,345.55	116.3	76,127.62	147280	198,124.85	113.3	608.2
June - 2005	86,579.19	84,720	113,863.84	114.0	76,960.27	92720	127,242.90	113.7	80,714.88	138800	169,345.55	116.3	613.2
July - 2005	80,739.15	90,400	101,072.96	114.6	86,579.19	84720	113,863.84	114.0	76,960.27	92720	127,242.90	113.7	601.9
Aug - 2005	86,645.92	92,720	66,917.00	114.1	80,739.15	90400	101,072.96	114.6	86,579.19	84720	113,863.84	114.0	609.7
Sept - 2005	89,464.78	95,040	75,255.00	114.8	86,645.92	92720	66,917.00	114.1	80,739.15	90400	101,072.96	114.6	612.5
Oct - 2005	88,448.87	110,720	133,378.12	115.7	89,464.78	95040	75,255.00	114.8	86,645.92	92720	66,917.00	114.1	613.6
Nov - 2005	90,063.45	115,920	169,683.22	117.0	88,448.87	110720	133,378.12	115.7	89,464.78	95040	75,255.00	114.8	617.2
Dec - 2005	96,757.84	94,960	154,144.14	117.0	90,063.45	115920	169,683.22	117.0	88,448.87	110720	133,378.12	115.7	615.9
Jan - 2006	80,410.81	113,440	241,911.78	117.0	96,757.84	94960	154,144.14	117.0	90,063.45	115920	169,683.22	117.0	600.9
Feb - 2006	77,357.75	113,280	157,088.14	115.2	80,410.81	113440	241,911.78	117.0	96,757.84	94960	154,144.14	117.0	603.3
Mar - 2006	92,975.63	153,920	194,474.36	112.4	77,357.75	113280	157,088.14	115.2	80,410.81	113440	241,911.78	117.0	611.4
Apr - 2006	82,710.87	171,680	162,209.04	114.8	92,975.63	153920	194,474.36	112.4	77,357.75	113280	157,088.14	115.2	615.7
May -2006	86,021.76	160,720	199,180.57	114.5	82,710.87	171680	162,209.04	114.8	92,975.63	153920	194,474.36	112.4	621.8
June - 2006	94,208.77	157,360	112,944.72	114.5	86,021.76	160720	199,180.57	114.5	82,710.87	171680	162,209.04	114.8	625.3
July - 2006	86,935.19	128,720	80,965.00	115.1	94,208.77	157360	112,944.72	114.5	86,021.76	160720	199,180.57	114.5	611.1
Aug - 2006	102,920.97	116,240	110,056.73	110.0	86,935.19	128720	80,965.00	115.1	94,208.77	157360	112,944.72	114.5	620.3
Sept - 2006	95,344.92	121,680	97,467.00	113.7	102,920.97	116240	110,056.73	110.0	86,935.19	128720	80,965.00	115.1	622.7
Oct - 2006	97,991.52	132,400	167,257.75	112.5	95,344.92	121680	97,467.00	113.7	102,920.97	116240	110,056.73	110.0	616.5
Nov - 2006	98,048.23	117,680	197,566.90	109.7	97,991.52	132400	167,257.75	112.5	95,344.92	121680	97,467.00	113.7	619.5
Dec - 2006	95,315.63	152,480	225,365.35	113.9	98,048.23	117680	197,566.90	109.7	97,991.52	132400	167,257.75	112.5	626.4
Jan - 2007	92,595.03	155,440	186,571.38	111.8	95,315.63	152480	225,365.35	113.9	98,048.23	117680	197,566.90	109.7	611.6
Feb - 2007	87,178.54	142,240	182,503.81	113.2	92,595.03	155440	186,571.38	111.8	95,315.63	152480	225,365.35	113.9	611.7
Mar - 2007	99,302.86	181,040	177,441.77	114.1	87,178.54	142240	182,503.81	113.2	92,595.03	155440	186,571.38	111.8	615.0
Apr - 2007	87,899.04	134,400	157,215.54	112.5	99,302.86	181040	177,441.77	114.1	87,178.54	142240	182,503.81	113.2	623.4
May -2007	99,271.69	125,840	126,605.99	110.8	87,899.04	134400	157,215.54	112.5	99,302.86	181040	177,441.77	114.1	631.6
June - 2007	97,158.42	113,600	79,368.00	110.2	99,271.69	125840	126,605.99	110.8	87,899.04	134400	157,215.54	112.5	635.8

July - 2007	89,248.37	112,400	100,107.15	110.5	97,158.42	113600	79,368.00	110.2	99,271.69	125840	126,605.99	110.8	623.1
Aug - 2007	101,981.00	97,280	56,206.00	110.7	89,248.37	112400	100,107.15	110.5	97,158.42	113600	79,368.00	110.2	626.3
Sept - 2007	94,670.61	89,920	65,443.00	111.3	101,981.00	97280	56,206.00	110.7	89,248.37	112400	100,107.15	110.5	628.8
Oct - 2007	101,746.66	97,600	105,663.12	111.4	94,670.61	89920	65,443.00	111.3	101,981.00	97280	56,206.00	110.7	627.2
Nov - 2007	99,068.10	78,320	91,837.00	112.5	101,746.66	97600	105,663.12	111.4	94,670.61	89920	65,443.00	111.3	633.0
Dec - 2007	95,648.92	93,200	103,021.01	115.5	99,068.10	78320	91,837.00	112.5	101,746.66	97600	105,663.12	111.4	630.7
Jan - 2008	92,106.39	95,280	219,027.21	117.5	95,648.92	93200	103,021.01	115.5	99,068.10	78320	91,837.00	112.5	615.2
Feb - 2008	85,980.89	106,320	183,611.24	116.7	92,106.39	95,280	219,027.21	117.5	95,648.92	93200	103,021.01	115.5	615.6
Mar - 2008	89,068.08	116,320	156,353.08	115.6	85,980.89	106,320	183,611.24	116.7	92,106.39	95,280	219,027.21	117.5	617.8
Apr - 2008	93,111.45	116,160	150,407.69	114.5	89,068.08	116,320	156,353.08	115.6	85,980.89	106,320	183,611.24	116.7	623.2
May -2008	93,861.77	83,680	98,289.00	114.7	93,111.45	116,160	150,407.69	114.5	89,068.08	116,320	156,353.08	115.6	633.0
June - 2008	87,581.41	92,880	71,591.00	116.4	93,861.77	83,680	98,289.00	114.7	93,111.45	116,160	150,407.69	114.5	631.7
July - 2008	92,686.88	91,840	53,260.00	114.4	87,581.41	92,880	71,591.00	116.4	93,861.77	83,680	98,289.00	114.7	619.5
Aug - 2008	91,279.49	66,320	66,535.00	112.7	92,686.88	91,840	53,260.00	114.4	87,581.41	92,880	71,591.00	116.4	624.4
Sept - 2008	90,637.35	83,120	80,178.00	112.1	91,279.49	66,320	66,535.00	112.7	92,686.88	91,840	53,260.00	114.4	619.5
Oct - 2008	96,529.36	97,840	88,208.00	109.3	90,637.35	83,120	80,178.00	112.1	91,279.49	66,320	66,535.00	112.7	618.4
Nov - 2008	83,080.70	79,120	73,012.00	109.9	96,529.36	97,840	88,208.00	109.3	90,637.35	83,120	80,178.00	112.1	621.5
Dec - 2008	92,427.79	93,360	144,641.00	105.7	83,080.70	79,120	73,012.00	109.9	96,529.36	97,840	88,208.00	109.3	615.5
Jan - 2009	80,726.76	86,240	166,833.00	104.1	92,427.79	93,360	144,641.00	105.7	83,080.70	79,120	73,012.00	109.9	592.0
Feb - 2009	76,919.94	59,680	196,655.00	105.9	80,726.76	86,240	166,833.00	104.1	92,427.79	93,360	144,641.00	105.7	591.4
Mar - 2009	84,052.99	46,800	121,496.98	101.4	76,919.94	59,680	196,655.00	105.9	80,726.76	86,240	166,833.00	104.1	593.0
Apr - 2009	87,056.89	67,680	106,731.06	100.2	84,052.99	46,800	121,496.98	101.4	76,919.94	59,680	196,655.00	105.9	597.4
May -2009	85,944.62	35,840	109,965.46	101.5	87,056.89	67,680	106,731.06	100.2	84,052.99	46,800	121,496.98	101.4	599.6
June - 2009	87,940.95	58,880	77,934.28	100.9	85,944.62	35,840	109,965.46	101.5	87,056.89	67,680	106,731.06	100.2	599.0
July - 2009	92,350.06	42,240	28,317.10	102.0	87,940.95	58,880	77,934.28	100.9	85,944.62	35,840	109,965.46	101.5	592.6
Aug - 2009	88,810.13	57,360	21,586.50	105.1	92,350.06	42,240	28,317.10	102.0	87,940.95	58,880	77,934.28	100.9	595.0
Sept - 2009	95,537.76	60,560	92,997.91	103.8	88,810.13	57,360	21,586.50	105.1	92,350.06	42,240	28,317.10	102.0	595.1
Oct - 2009	100,028.81	67,200	129,613.12	103.8	95,537.76	60,560	92,997.91	103.8	88,810.13	57,360	21,586.50	105.1	596.0
Nov - 2009	88,917.52	42,560	153,956.76	106.1	100,028.81	67,200	129,613.12	103.8	95,537.76	60,560	92,997.91	103.8	597.4
Dec - 2009	106,206.25	84,160	144,669.50	107.5	88,917.52	42,560	153,956.76	106.1	100,028.81	67,200	129,613.12	103.8	595.3
Jan - 2010	91,662.10	113,440	244,685.66	108.4	106,206.25	84,160	144,669.50	107.5	88,917.52	42,560	153,956.76	106.1	579.0
Feb - 2010	89,121.97	108,000	178,692.40	108.7	91,662.10	113,440	244,685.66	108.4	106,206.25	84,160	144,669.50	107.5	573.7
Mar - 2010	101,502.06	117,280	238,455.29	108.5	89,121.97	108,000	178,692.40	108.7	91,662.10	113,440	244,685.66	108.4	584.5
Apr - 2010	100,044.86	105,920	174,017.92	109.6	101,502.06	117,280	238,455.29	108.5	89,121.97	108,000	178,692.40	108.7	593.3
May -2010	97,580.15	72,480	104,564.64	109.3	100,044.86	105,920	174,017.92	109.6	101,502.06	117,280	238,455.29	108.5	599.9
June - 2010	101,588.82	84,400	88,311.08	108.4	97,580.15	72,480	104,564.64	109.3	100,044.86	105,920	174,017.92	109.6	600.0

July - 2010	101,300.10	78,800	81,395.09	109.6	101,588.82	84,400	88,311.08	108.4	97,580.15	72,480	104,564.64	109.3	589.4
Aug - 2010	99,561.93	70,240	34,374.11	108.7	101,300.10	78,800	81,395.09	109.6	101,588.82	84,400	88,311.08	108.4	592.8
Sept - 2010	102,168.40	85,200	98,745.24	109.4	99,561.93	70,240	34,374.11	108.7	101,300.10	78,800	81,395.09	109.6	594.4
Oct - 2010	103,946.17	91,360	143,151.81	110.0	102,168.40	85,200	98,745.24	109.4	99,561.93	70,240	34,374.11	108.7	594.5
Nov - 2010	99,060.69	79,360	147,370.69	110.0	103,946.17	91,360	143,151.81	110.0	102,168.40	85,200	98,745.24	109.4	596.0
Dec - 2010	106,831.80	92,960	174,700.98	112.7	99,060.69	79,360	147,370.69	110.0	103,946.17	91,360	143,151.81	110.0	593.7
Jan - 2011	91,402.81	97,920	189,659.78	116.6	106,831.80	92,960	174,700.98	112.7	99,060.69	79,360	147,370.69	110.0	582.3
Feb - 2011	89,539.15	92,240	172,537.63	113.5	91,402.81	97,920	189,659.78	116.6	106,831.80	92,960	174,700.98	112.7	583.9
Mar - 2011	108,071.32	136,240	218,735.78	115.6	89,539.15	92,240	172,537.63	113.5	91,402.81	97,920	189,659.78	116.6	593.3
Apr - 2011	97,631.95	121,040	130,772.74	114.9	108,071.32	136,240	218,735.78	115.6	89,539.15	92,240	172,537.63	113.5	601.0
May -2011	96,227.85	101,760	104,638.28	112.6	97,631.95	121,040	130,772.74	114.9	108,071.32	136,240	218,735.78	115.6	602.4
June - 2011	103,807.33	77,440	62,422.43	115.5	96,227.85	101,760	104,638.28	112.6	97,631.95	121,040	130,772.74	114.9	607.0
July - 2011	96,649.94	80,480	32,484.21	114.6	103,807.33	77,440	62,422.43	115.5	96,227.85	101,760	104,638.28	112.6	598.8
Aug - 2011	102,452.97	75,280	54,798.90	114.0	96,649.94	80,480	32,484.21	114.6	103,807.33	77,440	62,422.43	115.5	604.4
Sept - 2011	101,458.10	81,360	48,955.74	115.8	102,452.97	75,280	54,798.90	114.0	96,649.94	80,480	32,484.21	114.6	607.3
Oct - 2011	98,660.79	106,560	119,878.97	116.3	101,458.10	81,360	48,955.74	115.8	102,452.97	75,280	54,798.90	114.0	611.6
Nov - 2011	103,311.21	115,040	125,863.00	116.6	98,660.79	106,560	119,878.97	116.3	101,458.10	81,360	48,955.74	115.8	611.5
Dec - 2011	116,946.66	122,880	142,394.00	124.4	103,311.21	115,040	125,863.00	116.6	98,660.79	106,560	119,878.97	116.3	613.9

APPENDIX B

REGIONAL INDEX VALUES

Month Predicting	Index Value - Arithmetic Method	Index Value - Base Year Method
Apr - 2008	85.71	103.52
May -2008	85.10	103.43
June - 2008	100.50	105.75
July - 2008	82.45	103.03
Aug - 2008	90.71	104.27
Sept - 2008	90.11	104.18
Oct - 2008	87.18	103.74
Nov - 2008	93.31	104.66
Dec - 2008	86.76	103.68
Jan - 2009	62.88	100.08
Feb - 2009	51.61	98.38
Mar - 2009	52.55	98.52
Apr - 2009	57.10	99.21
May -2009	79.24	102.54
June - 2009	86.61	103.65
July - 2009	61.36	99.85
Aug - 2009	73.84	101.73
Sept - 2009	73.90	101.74
Oct - 2009	76.89	102.19
Nov - 2009	81.64	102.90
Dec - 2009	76.59	102.14
Jan - 2010	64.74	100.36
Feb - 2010	60.65	99.74
Mar - 2010	63.35	100.15
Apr - 2010	71.01	101.30
May -2010	93.39	104.67
June - 2010	106.75	106.69
July - 2010	88.25	103.90
Aug - 2010	95.39	104.98
Sept - 2010	96.74	105.18
Oct - 2010	95.17	104.94
Nov - 2010	101.37	105.88
Dec - 2010	94.01	104.77
Jan - 2011	79.11	102.52
Feb - 2011	77.31	102.25
Mar - 2011	83.57	103.20
Apr - 2011	93.74	104.73
May -2011	95.86	105.05
June - 2011	105.41	106.48
July - 2011	91.30	104.36
Aug - 2011	91.45	104.38
Sept - 2011	97.12	105.24
Oct - 2011	88.49	103.94
Nov - 2011	93.70	104.72
Dec - 2011	92.79	104.58
Jan - 2012	71.34	101.35
Feb - 2012	71.51	101.38
Mar - 2012	88.58	103.95
Apr - 2012	87.66	103.81
May -2012	92.88	104.60

APPENDIX C

TABLE OF NATIONAL DATA

Month Actual	Air total (L=4)	Rail (L=4)	River (L=4)	ATA Index (L=4)	Air (L=5)	Rail (L=5)	River (L=5)	ATA (L=5)	Air (L=6)	Rail (L=6)	River (L=6)	ATA (L=6)	GDP for US	PMI	Crude Oil Price ($/barrel)	T&W Employment
Jan-05	974,655	102,022	41.0	121.6	-	-	-	-	-	-	-	-	12.36	56.6	45.2188	4,309
Feb-05	951,293	107,987	41.5	116.1	974,655	102,022	41.0	121.6	-	-	-	-	12.35	54.8	47.7299	4,322
Mar-05	1,153,697	135,585	51.0	113.3	951,293	107,987	41.5	116.1	974,655	102,022	41.0	121.6	12.43	54.9	54.8389	4,333
Apr-05	1,080,299	109,427	51.0	116.3	1,153,697	135,585	51.0	113.3	951,293	107,987	41.5	116.1	12.48	52.5	54.1956	4,348
May-05	1,027,549	132,092	54.7	113.7	1,080,299	109,427	51.0	116.3	1,153,697	135,585	51.0	113.3	12.47	51.0	51.5641	4,360
Jun-05	1,122,855	106,782	49.3	114.0	1,027,549	132,092	54.7	113.7	1,080,299	109,427	51.0	116.3	12.61	52.6	58.5939	4,359
Jul-05	1,079,548	101,367	50.5	114.6	1,122,855	106,782	49.3	114.0	1,027,549	132,092	54.7	113.7	12.67	54.0	62.3240	4,374
Aug-05	1,132,801	134,637	47.1	114.1	1,079,548	101,367	50.5	114.6	1,122,855	106,782	49.3	114.0	12.75	51.6	68.9645	4,379
Sep-05	1,144,140	107,823	36.7	114.8	1,132,801	134,637	47.1	114.1	1,079,548	101,367	50.5	114.6	12.80	56.5	68.8488	4,381
Oct-05	1,155,379	106,478	44.8	115.7	1,144,140	107,823	36.7	114.8	1,132,801	134,637	47.1	114.1	12.85	57.2	64.5880	4,387
Nov-05	1,158,416	131,017	44.9	117.0	1,155,379	106,478	44.8	115.7	1,144,140	107,823	36.7	114.8	12.88	56.5	58.1987	4,400
Dec-05	1,211,130	98,996	43.2	117.0	1,158,416	131,017	44.9	117.0	1,155,379	106,478	44.8	115.7	13.02	54.9	59.0946	4,404
Jan-06	992,131	106,156	41.1	117.0	1,211,130	98,996	43.2	117.0	1,158,416	131,017	44.9	117.0	13.11	55.0	64.8686	4,420
Feb-06	928,705	105,830	39.9	115.2	992,131	106,156	41.1	117.0	1,211,130	98,996	43.2	117.0	13.13	55.5	61.1940	4,429
Mar-06	1,219,050	140,404	50.0	112.4	928,705	105,830	39.9	115.2	992,131	106,156	41.1	117.0	13.32	54.7	63.9380	4,430
Apr-06	1,087,720	108,380	47.1	114.8	1,219,050	140,404	50.0	112.4	928,705	105,830	39.9	115.2	13.29	55.8	71.8943	4,445
May-06	1,079,882	137,326	48.9	114.5	1,087,720	108,380	47.1	114.8	1,219,050	140,404	50.0	112.4	13.36	53.5	73.9499	4,459
Jun-06	1,158,395	110,556	48.1	114.5	1,079,882	137,326	48.9	114.5	1,087,720	108,380	47.1	114.8	13.39	52.4	73.0351	4,465
Jul-06	1,064,208	111,422	47.7	115.1	1,158,395	110,556	48.1	114.5	1,079,882	137,326	48.9	114.5	13.39	53.2	77.4398	4,479
Aug-06	1,200,044	1,360,524	45.8	110.0	1,064,208	111,422	47.7	115.1	1,158,395	110,556	48.1	114.5	13.45	52.8	75.5630	4,480
Sep-06	1,147,168	108,173	46.6	113.7	1,200,044	1,360,524	45.8	110.0	1,064,208	111,422	47.7	115.1	13.51	51.8	65.1385	4,487
Oct-06	1,168,698	108,407	46.0	112.5	1,147,168	108,173	46.6	113.7	1,200,044	1,360,524	45.8	110.0	13.54	50.5	60.2457	4,496
Nov-06	1,189,991	129,794	44.9	109.7	1,168,698	108,407	46.0	112.5	1,147,168	108,173	46.6	113.7	13.64	50.4	60.2352	4,509
Dec-06	1,219,094	101,326	44.1	113.9	1,189,991	129,794	44.9	109.7	1,168,698	108,407	46.0	112.5	13.65	52.0	62.7218	4,529
Jan-07	1,044,864	124,228	41.7	111.8	1,219,094	101,326	44.1	113.9	1,189,991	129,794	44.9	109.7	13.71	49.2	56.2743	4,530
Feb-07	981,403	101,073	36.2	113.2	1,044,864	124,228	41.7	111.8	1,219,094	101,326	44.1	113.9	13.86	51.9	60.8338	4,530
Mar-07	1,188,800	104,796	47.9	114.1	981,403	101,073	36.2	113.2	1,044,864	124,228	41.7	111.8	13.80	51.2	63.4792	4,535
Apr-07	1,064,889	132,270	48.1	112.5	1,188,800	104,796	47.9	114.1	981,403	101,073	36.2	113.2	13.98	52.9	67.8256	4,538
May-07	1,144,168	104,663	50.0	110.8	1,064,889	132,270	48.1	112.5	1,188,800	104,796	47.9	114.1	14.02	52.6	68.8395	4,541
Jun-07	1,138,253	107,529	48.4	110.2	1,144,168	104,663	50.0	110.8	1,064,889	132,270	48.1	112.5	14.03	53.2	72.7736	4,538
Jul-07	1,081,756	104,084	46.1	110.5	1,138,253	107,529	48.4	110.2	1,144,168	104,663	50.0	110.8	14.04	52.1	78.8807	4,539
Aug-07	1,190,076	107,721	42.1	110.7	1,081,756	104,084	46.1	110.5	1,138,253	107,529	48.4	110.2	14.15	50.5	75.9166	4,535
Sep-07	1,110,633	107,217	40.5	111.3	1,190,076	107,721	42.1	110.7	1,081,756	104,084	46.1	110.5	14.29	50.4	80.1561	4,560
Oct-07	1,185,907	134,946	47.1	111.4	1,110,633	107,217	40.5	111.3	1,190,076	107,721	42.1	110.7	14.22	49.9	86.6563	4,555
Nov-07	1,158,505	105,838	45.1	112.5	1,185,907	134,946	47.1	111.4	1,110,633	107,217	40.5	111.3	14.27	50.7	93.9180	4,551
Dec-07	1,136,850	121,029	43.6	115.5	1,158,505	105,838	45.1	112.5	1,185,907	134,946	47.1	111.4	14.38	48.7	91.0303	4,548
Jan-08	1,024,934	125,302	41.4	117.5	1,136,850	121,029	43.6	115.5	1,158,505	105,838	45.1	112.5	14.41	50.5	92.5140	4,551
Feb-08	965,862	103,821	36.9	116.7	1,024,934	125,302	41.4	117.5	1,136,850	121,029	43.6	115.5	14.25	48.7	94.9743	4,552
Mar-08	1,057,134	104,679	38.0	115.6	965,862	103,821	36.9	116.7	1,024,934	125,302	41.4	117.5	14.33	49.1	104.9203	4,557

Apr-08	1,091,169	133,468	41.4	114.5	1,057,134	104,679	38.0	115.6	965,862	103,821	36.9	116.7	14.39	48.9	112.8277	4,561
May-08	1,068,661	105,231	44.8	114.7	1,091,169	133,468	41.4	114.5	1,057,134	104,679	38.0	115.6	14.43	49.6	124.9946	4,546
Jun-08	984,573	103,613	39.1	116.4	1,068,661	105,231	44.8	114.7	1,091,169	133,468	41.4	114.5	14.60	50.0	134.7052	4,538
Jul-08	1,018,050	128,550	45.1	114.4	984,573	103,613	39.1	116.4	1,068,661	105,231	44.8	114.7	14.58	49.6	134.8328	4,528
Aug-08	1,002,647	107,231	45.3	112.7	1,018,050	128,550	45.1	114.4	984,573	103,613	39.1	116.4	14.45	49.2	117.2400	4,513
Sep-08	964,284	102,255	36.6	112.1	1,002,647	107,231	45.3	112.7	1,018,050	128,550	45.1	114.4	14.42	43.2	101.9770	4,480
Oct-08	1,041,170	131,163	44.2	109.3	964,284	102,255	36.6	112.1	1,002,647	107,231	45.3	112.7	14.31	38.4	76.1741	4,467
Nov-08	896,036	95,159	42.8	109.9	1,041,170	131,163	44.2	109.3	964,284	102,255	36.6	112.1	14.28	36.7	53.1141	4,415
Dec-08	964,656	103,859	36.8	105.7	896,036	95,159	42.8	109.9	1,041,170	131,163	44.2	109.3	13.99	33.3	38.6568	4,397
Jan-09	807,135	85,114	33.5	104.1	964,656	103,859	36.8	105.7	896,036	95,159	42.8	109.9	14.07	35.7	40.0630	4,373
Feb-09	749,414	88,495	34.1	105.9	807,135	85,114	33.5	104.1	964,656	103,859	36.8	105.7	14.06	36.0	41.9708	4,343
Mar-09	819,222	87,668	37.2	101.4	749,414	88,495	34.1	105.9	807,135	85,114	33.5	104.1	14.02	36.6	50.0074	4,309
Apr-09	825,591	81,422	37.1	100.2	819,222	87,668	37.2	101.4	749,414	88,495	34.1	105.9	14.04	39.9	53.8020	4,267
May-09	827,353	79,708	37.4	101.5	825,591	81,422	37.1	100.2	819,222	87,668	37.2	101.4	14.06	41.9	61.4779	4,246
Jun-09	832,392	102,360	41.2	100.9	827,353	79,708	37.4	101.5	825,591	81,422	37.1	100.2	13.86	44.7	71.6949	4,228
Jul-09	876,928	86,245	42.2	102.0	832,392	102,360	41.2	100.9	827,353	79,708	37.4	101.5	13.85	49.0	68.2968	4,204
Aug-09	858,892	89,296	42.7	105.1	876,928	86,245	42.2	102.0	832,392	102,360	41.2	100.9	13.94	51.4	73.0761	4,196
Sep-09	907,764	110,467	33.3	103.8	858,892	89,296	42.7	105.1	876,928	86,245	42.2	102.0	13.97	53.2	72.4131	4,189
Oct-09	982,902	88,058	36.5	103.8	907,764	110,467	33.3	103.8	858,892	89,296	42.7	105.1	14.14	55.8	76.8965	4,177
Nov-09	919,206	87,096	42.1	106.1	982,902	88,058	36.5	103.8	907,764	110,467	33.3	103.8	14.08	54.7	79.2438	4,166
Dec-09	1,073,599	103,954	37.4	107.5	919,206	87,096	42.1	106.1	982,902	88,058	36.5	103.8	14.04	56.4	77.3008	4,179
Jan-10	831,441	84,535	32.8	108.4	1,073,599	103,954	37.4	107.5	919,206	87,096	42.1	106.1	14.20	56.7	79.8246	4,153
Feb-10	793,651	87,210	35.7	108.7	831,441	84,535	32.8	108.4	1,073,599	103,954	37.4	107.5	14.27	55.8	78.3700	4,144
Mar-10	934,726	115,517	40.6	108.5	793,651	87,210	35.7	108.7	831,441	84,535	32.8	108.4	14.36	59.3	81.5972	4,153
Apr-10	937,536	94,322	39.5	109.6	934,726	115,517	40.6	108.5	793,651	87,210	35.7	108.7	14.46	59.0	85.1785	4,162
May-10	917,531	92,316	44.7	109.3	937,536	94,322	39.5	109.6	934,726	115,517	40.6	108.5	14.48	58.8	75.7114	4,170
Jun-10	937,246	113,250	44.9	108.4	917,531	92,316	44.7	109.3	937,536	94,322	39.5	109.6	14.45	56.0	76.4669	4,186
Jul-10	934,969	89,785	43.3	109.6	937,246	113,250	44.9	108.4	917,531	92,316	44.7	109.3	14.54	55.7	77.7932	4,201
Aug-10	927,773	94,356	42.8	108.7	934,969	89,785	43.3	109.6	937,246	113,250	44.9	108.4	14.55	57.4	77.9337	4,198
Sep-10	939,101	119,001	41.2	109.4	927,773	94,356	42.8	108.7	934,969	89,785	43.3	109.6	14.64	56.4	77.4588	4,213
Oct-10	977,787	95,717	44.6	110.0	939,101	119,001	41.2	109.4	927,773	94,356	42.8	108.7	14.71	57.0	81.3040	4,221
Nov-10	927,679	90,995	42.2	110.0	977,787	95,717	44.6	110.0	939,101	119,001	41.2	109.4	14.69	58.0	84.6292	4,233
Dec-10	1,074,314	108,627	41.7	112.7	927,679	90,995	42.2	110.0	977,787	95,717	44.6	110.0	14.81	57.3	89.7965	4,235
Jan-11	835,069	91,496	37.3	116.6	1,074,314	108,627	41.7	112.7	927,679	90,995	42.2	110.0	14.72	59.9	91.9183	4,236
Feb-11	781,781	90,924	37.0	113.5	835,069	91,496	37.3	116.6	1,074,314	108,627	41.7	112.7	14.74	59.8	95.4635	4,261
Mar-11	994,289	93,579	40.4	115.6	781,781	90,924	37.0	113.5	835,069	91,496	37.3	116.6	14.99	59.7	106.2747	4,270
Apr-11	906,309	118,680	38.5	114.9	994,289	93,579	40.4	115.6	781,781	90,924	37.0	113.5	15.04	59.7	116.7921	4,280
May-11	868,693	114,621	35.2	112.6	906,309	118,680	38.5	114.9	994,289	93,579	40.4	115.6	15.04	54.2	111.1730	4,287
Jun-11	921,231	92,436	41.3	115.5	868,693	114,621	35.2	112.6	906,309	118,680	38.5	114.9	14.93	55.8	108.1521	4,299
Jul-11	872,492	112,378	46.6	114.6	921,231	92,436	41.3	115.5	868,693	114,621	35.2	112.6	15.13	51.4	108.4520	4,295
Aug-11	908,280	117,934	45.7	114.0	872,492	112,378	46.6	114.6	921,231	92,436	41.3	115.5	15.21	52.5	101.1503	4,302
Sep-11	889,963	95,648	41.5	115.8	908,280	117,934	45.7	114.0	872,492	112,378	46.6	114.6	15.14	52.5	103.0732	4,304
Oct-11	900,542	97,250	44.3	116.3	889,963	95,648	41.5	115.8	908,280	117,934	45.7	114.0	15.38	51.8	104.0929	4,307
Nov-11	905,846	118,131	42.7	116.6	900,542	97,250	44.3	116.3	889,963	95,648	41.5	115.8	15.29	52.2	109.6715	4,317
Dec-11	1,027,483	90,766	41.5	124.4	905,846	118,131	42.7	116.6	900,542	97,250	44.3	116.3	15.29	53.1	108.3133	4,323

Jan-12	788,469	91,585	38.7	118.7	1,027,483	90,766	41.5	124.4	905,846	118,131	42.7	116.6	15.43	54.1	106.6905	4,340
Feb-12	827,274	114,374	40.1	119.3	788,469	91,585	38.7	118.7	1,027,483	90,766	41.5	124.4	15.56	52.4	109.3877	4,354
Mar-12	949,960	89,800	43.9	120.0	827,274	114,374	40.1	119.3	788,469	91,585	38.7	118.7	15.47	53.4	112.2200	4,361
Apr-12	751,873	89,048	43.6	118.7	949,960	89,800	43.6	120.0	827,274	114,374	40.1	119.3	15.57	54.8	109.7594	4,342
May-12	819,986	111,388	43.9	117.5	751,873	89,048	43.9	118.7	949,960	89,800	43.6	120.0	15.61	53.5	104.3409	4,374
Jun-12	804,086	91,185	39.5	118.8	819,986	111,388	39.5	117.5	751,873	89,048	43.9	118.7	15.66	49.7	93.0277	4,370
Jul-12	762,917	88,299	40.6	119.4	804,086	91,185	40.6	118.8	819,986	111,388	39.5	117.5	15.83	49.8	93.8840	4,385
Aug-12	841,634	100,887	40.1	118.3	762,917	88,299	40.6	119.4	804,086	91,185	40.6	118.8	15.76	50.7	97.8368	4,392
Sep-12	790,238	89,257	37.0	118.7	841,634	100,887	40.1	118.3	762,917	88,299	40.6	119.4	15.86	51.6	102.0425	4,399
Oct-12	833,475	113,812	41.7	113.8	790,238	89,257	37.0	118.7	841,634	100,887	40.1	118.3	15.84	51.7	101.4300	4,401
Nov-12	853,018	90,462	40.3	118.3	833,475	113,812	41.7	113.8	790,238	89,257	37.0	118.7	15.84	49.9	98.8000	4,459
Dec-12	877,336	86,959	39.5	121.6	853,018	90,462	40.3	118.3	833,475	113,812	41.7	113.8	15.96	50.2	94.3700	4,502

APPENDIX D

TABLE OF MONTHLY MOVING REGRESSION EQUATION COEFFICIENTS - WITH SEASONAL VARIABLES

Month Predicting	Constant	Air (L=4) Coeff	Rail (L=4) Coeff	River (L=4) Coeff	ATA (L=4) Coeff	Air (L=5) Coeff	Rail (L=5) Coeff	Air (L=6) Coeff	GDP Coeff	PMI Coeff	Oil Coeff
May-08	1798.26	0.000263	1.36E-05	2.345	1.07647	0.000419	-1.95E-05	0.000291	111.706	-2.019	-0.5702
Jun-08	1784.57	0.000261	1.53E-05	2.272	1.61275	0.000383	-1.89E-05	0.000262	114.741	-2.137	-0.6136
Jul-08	1780.33	0.000287	1.76E-05	2.006	1.89685	0.000396	-1.32E-05	0.000262	111.824	-2.700	-0.5344
Aug-08	2373.2	0.000143	2.34E-05	-0.798	0.85472	0.000339	1.72E-06	0.000171	111.531	-3.283	-0.6212
Sep-08	2558.93	0.000194	2.16E-05	-1.234	0.68934	0.000272	5.18E-06	0.000192	104.187	-4.521	-0.4454
Oct-08	2584	0.000191	2.19E-05	-1.253	0.63093	0.000272	5.20E-06	0.000183	103.961	-4.567	-0.4417
Nov-08	2682.86	0.000190	2.35E-05	-1.237	0.71369	0.000245	3.80E-06	0.000152	103.902	-5.135	-0.5908
Dec-08	2845.57	0.000155	2.68E-05	-1.282	0.81175	0.000210	2.87E-06	0.000095	104.777	-5.647	-0.7802
Jan-09	3088.04	0.000073	2.91E-05	-1.271	0.70257	0.000151	2.60E-06	0.000005	109.242	-5.866	-1.0859
Feb-09	2499.46	0.000163	1.26E-05	0.146	0.33113	0.000299	1.10E-05	0.000140	107.308	-3.736	-0.3736
Mar-09	2405.17	0.000192	6.53E-07	0.980	-0.20719	0.000344	2.01E-06	0.000241	99.127	-3.413	0.0788
Apr-09	2688.93	0.000248	-1.07E-05	1.407	-2.54544	0.000379	-1.65E-06	0.000281	84.902	-3.857	0.6321
May-09	2654.61	0.000258	-9.32E-06	0.669	-2.03927	0.000351	-2.93E-07	0.000249	87.268	-3.060	0.4993
Jun-09	2640.91	0.000252	-9.99E-06	0.677	-1.72366	0.000350	-1.56E-06	0.000254	85.707	-3.016	0.5020
Jul-09	2408.56	0.000299	-7.35E-06	-0.151	-0.34442	0.000366	-1.20E-06	0.000238	91.242	-3.201	0.3736
Aug-09	2241.04	0.000363	-7.94E-06	0.073	1.29477	0.000292	-8.94E-06	0.000184	93.376	-2.486	0.2231
Sep-09	2322.79	0.000368	-9.78E-06	0.814	1.65979	0.000399	-1.84E-05	0.000179	80.630	-4.717	0.4327
Oct-09	2483.36	0.000347	-1.68E-05	1.849	0.98213	0.000420	-2.10E-05	0.000253	69.719	-6.199	0.6743
Nov-09	2459.53	0.000379	-1.95E-05	1.647	1.93092	0.000415	-2.39E-05	0.000250	65.748	-6.946	0.6185
Dec-09	2601.26	0.000372	-2.37E-05	1.936	1.66766	0.000455	-2.66E-05	0.000284	55.652	-8.324	0.7805
Jan-10	2662.27	0.000416	-7.93E-05	1.959	1.02023	0.000472	-2.50E-05	0.000295	54.173	-9.402	0.9030
Feb-10	2764.06	0.000396	3.95E-04	0.470	0.39002	0.000473	8.22E-04	0.000282	49.176	-9.310	0.7242
Mar-10	2847.46	0.000390	3.96E-04	0.775	0.49500	0.000471	7.88E-04	0.000295	42.566	-9.688	0.7846
Apr-10	2668.89	0.000382	3.93E-04	0.825	0.64690	0.000474	9.92E-04	0.000286	54.258	-9.706	0.6404
May-10	2659.15	0.000336	4.10E-04	0.987	0.44368	0.000495	9.97E-04	0.000325	56.197	-10.038	0.6243
Jun-10	3134.33	0.000408	4.51E-04	1.447	1.39826	0.000414	9.63E-04	0.000343	17.678	-11.550	0.8481
Jul-10	3588.12	0.000491	5.18E-04	0.556	2.98520	0.000477	9.20E-04	0.000200	-20.717	-13.072	1.0562
Aug-10	3915.98	0.000552	-4.73E-05	1.978	5.93851	0.000411	6.67E-04	0.000183	-60.414	-13.705	1.2034
Sep-10	4217.8	0.000585	-8.05E-05	2.026	4.67728	0.000405	5.37E-04	0.000195	-74.186	-14.341	1.5439
Oct-10	3909.38	0.000595	-4.23E-05	1.752	5.06878	0.000439	3.29E-04	0.000144	-52.409	-14.328	1.4077
Nov-10	4136.3	0.000542	4.55E-05	0.967	4.85897	0.000461	3.36E-04	0.000177	-66.374	-14.368	1.5770
Dec-10	4219.92	0.000558	8.14E-05	1.260	4.46099	0.000435	3.28E-04	0.000171	-69.443	-14.563	1.7509

M2 Coeff	M3 Coeff	M4 Coeff	M5 Coeff	M6 Coeff	M7 Coeff	M8 Coeff	M9 Coeff	M10 Coeff	M11 Coeff	M12 Coeff	Regression Output - with seasonal
-39.107	-38.836	-57.212	-20.748	73.519	62.173	14.959	-9.871	7.921	10.790	-12.328	4,539.07
-37.077	-36.884	-55.886	-15.378	70.985	53.655	12.508	-8.659	6.101	10.970	-13.064	4,542.03
-34.683	-35.667	-56.282	-12.383	79.851	56.652	14.714	-2.925	8.156	12.906	-12.562	4,501.03
-2.920	-8.109	-24.290	-9.676	55.733	81.954	27.608	28.609	32.863	32.879	7.038	4,522.88
-6.293	-8.248	-26.733	-3.044	52.443	70.436	50.326	26.744	29.969	36.620	-1.991	4,543.00
-5.187	-7.543	-25.537	-2.395	53.098	70.210	49.269	28.634	30.140	36.664	-1.456	4,550.30
-4.188	-6.741	-24.113	-0.755	51.258	62.105	46.035	29.961	27.905	35.543	-3.740	4,525.22
0.750	-2.907	-18.171	-0.475	44.913	52.087	38.442	32.327	27.099	37.392	-3.754	4,484.97
9.698	4.236	-6.387	-1.551	31.223	36.501	24.670	34.381	24.216	33.557	0.812	4,561.76
8.904	4.939	-8.244	12.918	76.510	82.462	49.686	36.409	35.200	42.880	25.228	4,515.80
-18.752	-13.780	-27.050	-0.492	72.518	84.173	48.339	13.870	20.484	25.144	16.517	4,467.96
-26.514	-34.560	-33.248	4.627	86.304	88.204	49.640	4.225	13.915	16.862	9.756	4,391.15
-20.907	-30.111	-26.296	6.376	81.897	81.622	47.493	9.262	15.352	20.781	10.443	4,378.31
-21.176	-30.153	-26.812	5.774	78.351	80.461	46.594	7.527	14.017	19.218	10.371	4,392.72
-17.267	-27.325	-27.728	8.798	65.696	81.568	47.814	15.390	18.048	27.237	14.624	4,341.63
-22.645	-27.918	-31.350	14.520	65.211	58.242	34.933	8.384	8.885	22.156	5.390	4,306.75
-27.142	-36.395	-35.212	12.630	81.902	75.202	35.079	9.509	9.597	21.516	11.522	4,271.92
-38.849	-43.601	-42.995	9.023	81.722	81.694	43.011	0.383	6.106	13.490	10.269	4,244.90
-42.041	-45.428	-48.688	8.471	81.392	79.591	45.583	4.175	9.714	15.845	11.888	4,234.50
-46.872	-49.870	-53.404	5.414	84.006	87.515	52.056	7.438	13.694	12.301	14.959	4,229.03
-49.884	-51.760	-56.329	9.717	93.188	92.079	57.577	10.171	18.624	18.016	9.629	4,186.04
-47.284	-63.225	-57.998	0.191	83.328	101.930	59.234	12.854	32.499	26.963	17.335	4,192.51
-53.477	-66.436	-62.221	-2.823	80.227	99.076	57.893	10.105	29.601	23.867	15.651	4,190.77
-54.485	-83.048	-63.254	-5.783	77.359	99.897	57.373	7.945	32.151	25.279	15.560	4,224.47
-53.172	-85.920	-80.588	-14.110	69.513	103.772	59.331	6.924	31.217	24.510	17.154	4,251.74
-63.340	-84.788	-94.696	-31.247	60.764	80.669	53.791	-2.827	24.817	15.578	10.046	4,230.26
-59.004	-82.137	-90.824	-25.667	54.757	73.940	39.747	5.473	27.635	25.238	14.017	4,165.86
-62.209	-91.087	-102.077	-19.394	46.236	58.650	30.677	-11.580	13.011	10.385	-3.908	4,215.46
-64.723	-86.669	-103.772	-9.610	52.842	61.603	18.027	-13.327	8.977	6.476	-4.197	4,148.13
-61.445	-83.738	-100.517	-10.449	60.149	61.079	13.020	-8.444	12.466	14.189	0.412	4,219.48
-53.618	-77.759	-95.914	-14.512	54.540	68.184	20.788	-1.825	2.154	17.638	6.843	4,228.35
-57.059	-76.300	-95.914	-8.555	57.253	64.169	18.004	-4.143	-1.735	1.808	3.715	4,174.40

Jan-11	4079.95	0.000706	2.04E-04	-2.265	3.50829	0.000399	2.13E-04	0.000263	-55.483	-14.346
Feb-11	3882.95	0.000713	2.10E-04	-1.205	3.08710	0.000373	2.23E-04	0.000235	-37.672	-14.439
Mar-11	3703.51	0.000717	-3.85E-04	1.457	4.33470	0.000280	2.88E-04	0.000219	-30.802	-14.641
Apr-11	3127.82	0.000884	-5.71E-04	0.749	3.20979	0.000176	5.19E-05	0.000146	23.904	-15.243
May-11	3161.52	0.001040	-6.49E-04	-2.879	10.85550	-0.000437	6.52E-04	0.000168	-1.377	-15.426
Jun-11	3153.94	0.000955	-5.84E-04	-3.062	13.07270	-0.000412	5.66E-04	0.000093	-8.272	-15.499
Jul-11	3174.33	0.000790	-4.90E-04	-3.411	14.23690	-0.000727	8.27E-04	0.000302	-6.098	-15.076
Aug-11	3248.08	0.000357	9.37E-04	-3.348	5.35066	-0.000249	1.12E-03	0.000246	38.864	-14.421
Sep-11	3264.31	0.000193	8.05E-04	-3.013	3.99316	-0.000306	1.58E-03	0.000254	56.740	-14.352
Oct-11	3372.68	0.000317	-3.05E-04	1.836	5.74365	-0.000032	2.96E-04	0.000127	26.827	-14.980
Nov-11	3395.28	0.000315	1.45E-04	3.670	3.44758	-0.000074	5.20E-04	0.000069	38.755	-14.824
Dec-11	3455.93	0.000404	-3.03E-05	2.571	3.57563	-0.000077	9.10E-04	0.000077	28.760	-14.077
Jan-12	3393.75	0.000211	-3.66E-04	-1.746	11.74390	-0.000089	-4.47E-04	0.000194	2.518	-12.640
Feb-12	3305.86	0.000134	3.88E-04	-3.497	14.82570	-0.000272	-6.49E-04	0.000155	1.912	-10.891
Mar-12	3188.23	0.000088	4.27E-04	-4.568	10.41710	-0.000127	2.51E-04	-0.000050	42.916	-9.159
Apr-12	3176.29	0.000096	-9.71E-06	-4.113	8.14215	-0.000016	1.16E-04	0.000014	51.613	-9.375
May-12	3060.39	0.000001	-1.64E-04	-4.004	0.89496	0.000076	-2.14E-05	-0.000160	115.789	-6.827
Jun-12	3248.71	-0.000153	-4.67E-04	-2.561	-2.00477	-0.000054	5.32E-05	-0.000086	125.417	-4.929
Jul-12	3313.29	0.000057	-6.79E-04	-1.374	-3.59182	-0.000166	-2.14E-05	-0.000172	129.843	-3.487
Aug-12	3346.96	-0.000133	-5.83E-04	-1.249	-4.86051	-0.000117	2.41E-05	-0.000347	137.551	-1.030
Sep-12	3379.89	-0.000165	-5.32E-04	-0.927	-4.87386	-0.000168	6.93E-05	-0.000333	134.181	-0.151
Oct-12	3464.15	-0.000073	-6.36E-04	0.550	-3.14677	-0.000255	-3.04E-05	-0.000142	98.974	-0.633
Nov-12	3205.18	-0.000054	-5.14E-04	-0.712	-1.24598	-0.000147	-2.24E-04	-0.000124	98.037	-0.448
Dec-12	2377.74	-0.000055	-3.60E-04	-2.861	1.50099	-0.000117	-3.21E-04	-0.000170	150.600	1.632

1.2964	-54.629	-51.158	-110.625	2.370	63.087	78.313	42.919	27.261	29.283	37.453	57.739	4,172.53
1.3720	-67.523	-61.868	-115.557	0.262	59.979	63.182	26.411	10.468	13.191	18.123	39.271	4,147.93
1.5564	-57.493	-74.525	-112.892	8.714	51.730	49.935	14.706	-13.617	-2.527	-8.269	13.309	4,133.61
1.8124	-64.880	-26.809	-102.912	43.290	79.769	36.598	8.059	-10.338	2.869	-6.563	19.052	4,259.97
1.7729	-55.069	30.868	-144.517	99.671	39.265	-16.117	17.874	15.694	28.066	0.484	45.680	4,205.46
1.8244	-46.282	29.653	-131.484	92.956	36.184	-18.301	12.555	16.837	26.381	2.278	44.044	4,187.67
2.1753	-28.979	55.414	-123.060	116.793	-22.072	-30.919	40.775	26.142	23.879	-2.469	51.703	4,389.86
2.6268	-7.453	44.386	-46.987	64.459	10.607	-3.237	46.875	40.331	18.260	13.928	59.744	4,294.50
2.9435	-5.051	40.609	-23.910	52.371	-15.613	-13.516	16.004	34.195	13.236	4.205	52.653	4,467.70
2.7033	-27.462	-17.725	-52.980	24.044	11.131	-15.712	-6.655	-33.097	-18.286	-21.907	6.323	4,335.47
2.7447	-38.917	-16.787	-47.244	43.705	29.020	-27.537	-17.192	-37.434	-50.414	-32.279	-0.708	4,382.06
2.3249	-47.087	-19.130	-59.289	38.435	36.148	-23.075	-12.289	-31.382	-41.040	-56.691	3.889	4,387.89
1.0151	4.164	-10.039	-70.379	-13.980	-56.743	-24.972	7.331	-28.576	-21.097	-22.473	-15.045	4,348.24
-0.0607	54.289	47.381	-39.558	24.904	-56.007	-22.871	37.688	4.928	10.329	20.027	17.679	4,383.53
-0.5100	14.884	49.141	3.795	6.955	-4.280	-5.875	10.085	9.311	25.911	21.775	27.070	4,376.00
-0.2009	4.718	13.631	-3.987	-9.857	-8.582	5.863	8.208	-0.592	22.120	14.141	20.454	4,393.44
0.0624	-3.957	7.707	13.477	-21.953	30.091	9.127	-20.983	-5.430	25.868	9.866	16.650	4,330.63
0.6184	-9.315	3.835	36.662	-17.492	-19.115	0.766	-17.552	-18.088	14.160	-1.175	4.289	4,343.44
1.1223	-20.540	0.938	28.107	8.913	-7.610	-36.642	-26.409	-15.078	6.789	-8.931	-2.568	4,450.56
1.3847	-20.392	-0.830	49.046	-4.609	13.940	-49.829	-68.221	-8.352	10.273	-9.667	-2.367	4,336.71
1.5094	-19.598	0.248	52.029	-0.820	3.407	-56.311	-69.709	-13.138	8.661	-9.750	-3.851	4,366.08
2.1425	-24.832	-8.339	17.395	13.419	-28.441	-64.419	-49.206	-23.579	-17.394	-15.225	-11.957	4,376.29
1.8961	-19.902	-11.066	5.667	-10.694	-28.333	-55.467	-54.550	-21.934	-12.737	-21.880	-4.186	4,385.82
-1.8043	-80.136	13.421	16.666	-9.873	-1.751	-28.297	-35.663	-2.805	2.890	-8.630	7.563	4,390.90

APPENDIX E

TABLE OF MONTHLY MOVING REGRESSION EQUATION COEFFICIENTS - WITHOUT SEASONAL VARIABLES

Month Predicting	Constant	Air (L=4) Coeff	Rail (L=4) Coeff	River (L=4) Coeff	ATA (L=4) Coeff	Air (L=5) Coeff	Rail (L=5) Coeff	Air (L=6) Coeff	GDP Coeff	PMI Coeff	Oil Coeff
May-08	2,708.79	-1.65E-05	1.77E-05	0.6557	-0.2302	5.53E-05	3.11E-06	3.09E-05	132.96	-0.587	-1.2009
Jun-08	2,799.16	-9.77E-06	1.54E-05	0.6551	-1.0627	6.21E-05	3.16E-06	3.46E-05	130.95	-0.310	-1.2384
Jul-08	2,859.78	-1.90E-05	1.58E-05	0.3506	-0.7194	4.64E-05	3.90E-06	2.43E-05	129.67	-1.000	-1.1314
Aug-08	2,979.33	-1.69E-05	1.40E-05	0.0576	-0.8317	2.50E-05	4.23E-06	5.06E-06	126.94	-1.430	-0.9907
Sep-08	3,041.89	-1.91E-05	1.53E-05	0.0352	-0.6149	2.95E-05	2.37E-06	-1.75E-05	124.78	-2.104	-0.9657
Oct-08	3,095.81	-2.86E-05	1.51E-05	0.2481	-0.6559	2.99E-05	1.93E-06	-1.52E-05	122.61	-2.538	-0.9463
Nov-08	3,225.62	-3.08E-05	1.45E-05	0.4049	-0.6714	2.21E-05	5.88E-07	-2.36E-05	118.57	-3.533	-1.0369
Dec-08	3,279.86	-3.57E-05	1.58E-05	0.4504	-0.4497	3.02E-05	-1.77E-06	-3.68E-05	116.44	-4.175	-1.1371
Jan-09	3,286.75	-1.61E-05	1.53E-05	0.3884	0.0307	3.50E-05	-3.39E-06	-1.97E-05	111.58	-4.890	-1.1500
Feb-09	2,129.17	2.57E-05	2.16E-05	0.9544	1.7941	4.32E-05	4.54E-06	3.46E-05	145.80	1.831	-1.2546
Mar-09	1,930.78	5.90E-05	1.67E-05	-0.1739	1.0987	5.17E-05	8.46E-06	5.06E-05	150.28	5.407	-1.0434
Apr-09	2,005.97	1.21E-04	6.14E-06	-1.2123	0.2615	4.44E-05	9.00E-06	7.24E-05	140.88	7.057	-0.6866
May-09	2,003.42	1.80E-04	1.37E-06	-1.8979	1.7740	5.37E-05	2.79E-06	6.73E-05	128.85	6.217	-0.6230
Jun-09	1,982.33	1.81E-04	1.20E-06	-1.9118	2.8222	7.36E-05	-1.84E-06	7.68E-05	120.97	5.767	-0.5644
Jul-09	1,984.26	1.91E-04	-1.16E-07	-1.9990	3.0709	8.38E-06	-3.50E-06	8.21E-05	117.26	5.658	-0.5077
Aug-09	1,878.12	2.22E-04	-1.85E-06	-1.9154	4.1825	5.11E-05	-6.20E-06	6.77E-05	117.02	5.823	-0.6148
Sep-09	1,669.14	2.24E-04	3.93E-06	-1.5072	6.7828	8.15E-05	-1.26E-05	6.69E-05	112.19	4.638	-0.6888
Oct-09	1,511.20	2.26E-04	7.46E-06	-0.9549	8.6907	9.02E-05	-1.54E-05	9.42E-05	108.12	3.303	-0.7238
Nov-09	1,364.71	2.59E-04	8.84E-06	-1.1055	10.5340	8.72E-05	-1.96E-05	7.39E-05	106.72	2.633	-0.8565
Dec-09	1,254.53	2.83E-04	1.52E-05	-1.3282	11.5513	1.23E-04	-2.04E-05	8.28E-05	107.45	0.966	-0.8471
Jan-10	1,358.39	3.39E-04	4.07E-04	-2.4102	10.6435	1.34E-04	-1.20E-05	1.21E-04	104.47	-0.755	-0.6968
Feb-10	1,555.30	2.89E-04	-2.91E-04	1.1194	12.6286	1.94E-04	-2.08E-04	1.50E-04	77.20	-4.054	-0.3247
Mar-10	2,446.87	2.29E-04	-5.31E-04	2.9569	14.4794	2.38E-04	-7.16E-04	2.01E-04	3.18	-6.948	0.3384
Apr-10	3,152.75	3.02E-04	1.33E-04	1.4583	13.7926	1.91E-04	-7.80E-06	1.90E-04	-43.58	-9.028	0.7038
May-10	5,002.73	3.18E-04	-2.49E-04	1.4157	14.3450	3.17E-04	5.76E-04	1.30E-04	-179.16	-12.862	1.7943
Jun-10	6,666.07	3.37E-04	1.62E-05	0.8996	13.4040	3.83E-04	5.21E-04	1.65E-04	-293.97	-15.533	2.6862
Jul-10	5,645.12	3.49E-04	-1.25E-04	2.2994	13.5528	3.49E-04	2.03E-04	1.41E-04	-220.85	-14.725	2.2616
Aug-10	4,791.65	4.15E-04	-2.49E-04	3.4420	17.5175	2.41E-04	7.50E-05	4.44E-05	-182.54	-13.588	1.5596
Sep-10	4,666.84	4.47E-04	-5.05E-04	2.9806	15.5224	2.03E-04	1.58E-04	1.08E-04	-160.21	-13.810	1.7396
Oct-10	4,541.73	4.43E-04	-4.51E-04	2.4052	15.7326	2.52E-04	-1.79E-04	6.61E-05	-148.99	-14.087	1.7959
Nov-10	4,385.56	4.31E-04	-2.90E-04	1.1082	13.7928	2.19E-04	9.29E-05	1.07E-04	-123.08	-14.170	1.9610
Dec-10	4,078.84	4.55E-04	-7.72E-05	-0.4329	13.2886	1.85E-04	2.14E-04	7.42E-05	-92.19	-14.490	2.0102

Jan-11	3,888.47	3.85E-04	1.49E-04	-0.2983	12.8893	2.07E-04	2.31E-04	5.97E-05	-74.13	-14.417	2.0423
Feb-11	3,947.37	3.11E-04	4.93E-04	0.2594	13.4872	7.11E-05	7.57E-04	8.31E-05	-79.66	-14.226	2.1511
Mar-11	3,826.23	2.91E-04	2.45E-04	-0.2869	16.0568	5.30E-05	7.37E-04	6.88E-07	-78.58	-14.523	2.1819
Apr-11	3,470.33	2.42E-04	2.32E-04	-0.6638	18.2799	3.38E-05	2.96E-04	-5.99E-05	-56.76	-14.815	2.1733
May-11	3,730.96	1.39E-04	4.99E-04	-0.7477	18.2682	3.61E-06	7.34E-04	-7.82E-05	-71.59	-14.641	2.3742
Jun-11	3,767.27	2.11E-04	1.64E-04	-0.8749	15.5411	-6.83E-05	8.03E-04	-4.90E-05	-53.62	-15.100	2.7063
Jul-11	3,511.64	1.81E-04	1.42E-04	-0.9893	13.4015	-7.80E-05	5.98E-04	-3.71E-05	-16.45	-15.305	2.9432
Aug-11	3,452.12	6.59E-05	7.65E-04	-0.5732	6.8801	3.18E-05	8.47E-04	4.55E-05	22.32	-14.824	3.0625
Sep-11	3,419.19	5.85E-05	2.55E-04	0.0366	4.3242	-2.17E-05	1.16E-03	1.46E-04	39.75	-14.521	3.0663
Oct-11	3,647.97	1.08E-04	-1.24E-04	1.5521	9.1382	1.77E-05	3.93E-04	7.35E-05	-7.99	-14.558	2.7114
Nov-11	3,662.95	9.89E-05	7.82E-05	1.5480	8.2005	4.52E-05	3.25E-04	8.09E-05	-4.85	-14.293	2.5827
Dec-11	3,823.47	1.47E-04	-9.62E-06	0.1616	8.7320	1.27E-05	6.98E-04	8.70E-05	-20.86	-13.459	2.2589
Jan-12	3,532.46	1.63E-04	-3.39E-07	-1.2562	8.9708	3.05E-05	2.00E-04	4.87E-05	6.70	-12.704	1.4371
Feb-12	3,406.11	1.28E-04	2.94E-04	-0.9590	8.5994	1.66E-05	1.77E-04	2.70E-05	19.42	-11.529	0.7449
Mar-12	3,358.54	8.41E-05	1.81E-04	-1.5668	8.3517	-1.13E-05	3.43E-04	-6.13E-06	30.21	-10.164	0.2332
Apr-12	3,333.64	8.73E-05	8.22E-05	-1.9848	7.4128	-2.21E-05	2.21E-04	-5.28E-05	40.60	-9.696	0.1773
May-12	3,266.32	1.35E-05	1.09E-04	-2.1657	3.3894	-6.84E-06	7.99E-05	-9.95E-06	75.84	-8.341	0.1461
Jun-12	3,332.62	6.67E-07	-3.25E-05	-1.7422	2.9369	-4.30E-05	-9.99E-05	-1.60E-05	74.79	-7.676	0.4568
Jul-12	3,380.85	1.84E-05	-2.40E-04	-1.3891	1.1813	-4.05E-05	-1.36E-04	-3.13E-05	80.14	-7.107	0.9271
Aug-12	3,396.25	2.34E-05	-3.64E-04	-1.0392	0.5701	-3.55E-05	-1.70E-04	-3.22E-05	79.43	-6.604	1.2462
Sep-12	3,425.40	1.96E-05	-3.64E-04	-0.6646	0.5952	-3.24E-05	1.75E-04	-2.07E-05	73.39	-6.356	1.4499
Oct-12	3,334.43	1.61E-05	-3.47E-04	-1.2230	0.3856	-5.45E-05	-2.16E-04	-3.01E-05	86.80	-6.327	1.1528
Nov-12	3,269.24	1.91E-05	-3.58E-04	-1.1940	0.4075	-5.41E-05	-1.70E-04	-2.43E-55	88.46	-5.852	1.1384
Dec-12	3,099.73	3.23E-05	-2.87E-04	-1.4416	0.5934	-3.87E-05	-2.18E-04	-1.55E-05	94.29	-5.098	1.0687

APPENDIX F

NATIONAL INDEX VALUES

Month Predicting	Actual Employment Numbers	Regression Output	Base Year = Jul 2005	Index Value
May-08	4,546.00	4,568.55	104.45%	52.22
Jun-08	4,538.00	4,528.14	103.52%	51.76
Jul-08	4,528.00	4,532.02	103.61%	51.81
Aug-08	4,513.00	4,546.63	103.95%	51.97
Sep-08	4,480.00	4,543.62	103.88%	51.94
Oct-08	4,467.00	4,553.84	104.11%	52.06
Nov-08	4,415.00	4,547.76	103.97%	51.99
Dec-08	4,397.00	4,553.62	104.11%	52.05
Jan-09	4,373.00	4,585.68	104.84%	52.42
Feb-09	4,343.00	4,534.90	103.68%	51.84
Mar-09	4,309.00	4,491.39	102.68%	51.34
Apr-09	4,267.00	4,402.14	100.64%	50.32
May-09	4,246.00	4,392.39	100.42%	50.21
Jun-09	4,228.00	4,370.11	99.91%	49.96
Jul-09	4,204.00	4,275.36	97.74%	48.87
Aug-09	4,196.00	4,343.51	99.30%	49.65
Sep-09	4,189.00	4,337.44	99.16%	49.58
Oct-09	4,177.00	4,282.90	97.92%	48.96
Nov-09	4,166.00	4,300.56	98.32%	49.16
Dec-09	4,179.00	4,316.77	98.69%	49.35
Jan-10	4,153.00	4,323.23	98.84%	49.42
Feb-10	4,144.00	4,286.71	98.00%	49.00
Mar-10	4,153.00	4,317.35	98.70%	49.35
Apr-10	4,162.00	4,322.64	98.83%	49.41
May-10	4,170.00	4,237.58	96.88%	48.44
Jun-10	4,186.00	4,113.35	94.04%	47.02
Jul-10	4,201.00	4,073.60	93.13%	46.57
Aug-10	4,198.00	4,173.37	95.41%	47.71
Sep-10	4,213.00	4,166.51	95.26%	47.63
Oct-10	4,221.00	4,191.95	95.84%	47.92
Nov-10	4,233.00	4,210.00	96.25%	48.13
Dec-10	4,235.00	4,164.97	95.22%	47.61
Jan-11	4,236.00	4,194.01	95.88%	47.94
Feb-11	4,261.00	4,220.31	96.49%	48.24
Mar-11	4,270.00	4,183.49	95.64%	47.82
Apr-11	4,280.00	4,294.08	98.17%	49.09
May-11	4,287.00	4,293.65	98.16%	49.08
Jun-11	4,299.00	4,207.15	96.19%	48.09

Jul-11	4,295.00	4,329.43	98.98%	49.49
Aug-11	4,302.00	4,325.78	98.90%	49.45
Sep-11	4,304.00	4,401.97	100.64%	50.32
Oct-11	4,307.00	4,344.07	99.32%	49.66
Nov-11	4,317.00	4,384.04	100.23%	50.11
Dec-11	4,323.00	4,332.80	99.06%	49.53
Jan-12	4,340.10	4,339.79	99.22%	49.61
Feb-12	4,354.40	4,342.64	99.28%	49.64
Mar-12	4,360.50	4,337.97	99.18%	49.59
Apr-12	4,342.20	4,354.18	99.55%	49.77
May-12	4,374.40	4,331.19	99.02%	49.51
Jun-12	4,370.30	4,361.90	99.72%	49.86
Jul-12	4,384.50	4,348.17	99.41%	49.70
Aug-12	4,391.80	4,339.82	99.22%	49.61
Sep-12	4,399.00	4,370.18	99.91%	49.96
Oct-12	4,401.20	4,374.05	100.00%	50.00
Nov-12	4,459.00	4,409.20	100.80%	50.40
Dec-12	4,501.50	4,381.28	100.17%	50.08

CURRICULUM VITAE

NAME: Erin Lynn Gerber

EMAIL: elgerber13@gmail.com

EDUCATION: Doctorate in Industrial Engineering…………………………...July 2013
University of Louisville, Louisville, KY

Masters of Engineering in Industrial Engineering…………….May 2009
University of Louisville, Louisville, KY

Bachelors of Science in Industrial Engineering……………August 2008
University of Louisville, Louisville, KY

HONORS AND
AWARDS: Speed School Alumni Scholarship……...…………………August 2004
University of Louisville Honors Program…August 2004 – August 2008
MHEFI Scholarship……………………………………..August 2008
GEMS Mathematics Fellowship…...………….August 2008 - May2009

PROFESSIONAL
SOCIETIES: Executive Board member Golden Key International Honour Society
Member of Society of Women Engineers U of L Chapter
Member of National Society of Collegiate Scholars
Member of Institute of Industrial Engineers
Member of Tau Beta Pi Engineering Honor Society
Member of Alpha Pi Mu Industrial Engineering Honor Society

PUBLISHED

WORKS: 1. Jackson, Erin, Gail W DePuy, and Gerald W. Evan, 2008. “Logistics Skills Management Heuristics,” Proceedings of the 2008 Industrial Engineering Research Conference, May 17-21, Vancouver, Canada, 6 pages.

2. Gerber, Erin, Sunderesh Heragu, and Gail DePuy, 2013. “Logistics and Distribution Index for Greater Louisville Area” Proceedings of the 2013 Industrial and Systems Engineering Research Conference, May 18-22, San Juan, Puerto Rico, 7 pages.

CONFERENCE

PRESENTATIONS:

1. Jackson, Erin, DePuy, Gail W., and Evans, Gerald W. (May, 2008). *Logistics Skills Management Heuristics*. **Paper presented at** the Industrial Engineering Research Conference 2008, Vancouver, Canada.
2. Gerber, Erin, Heragu, Sunderesh, and DePuy, Gail W. (May, 2013). *Logistics and Distribution Index for Greater Louisville Area*. **Paper presented at** the Industrial and Systems Engineering Research Conference 2013, San Juan, Puerto Rico.