

**Comparative Analysis
of Wisconsin and National
Business Cycle**

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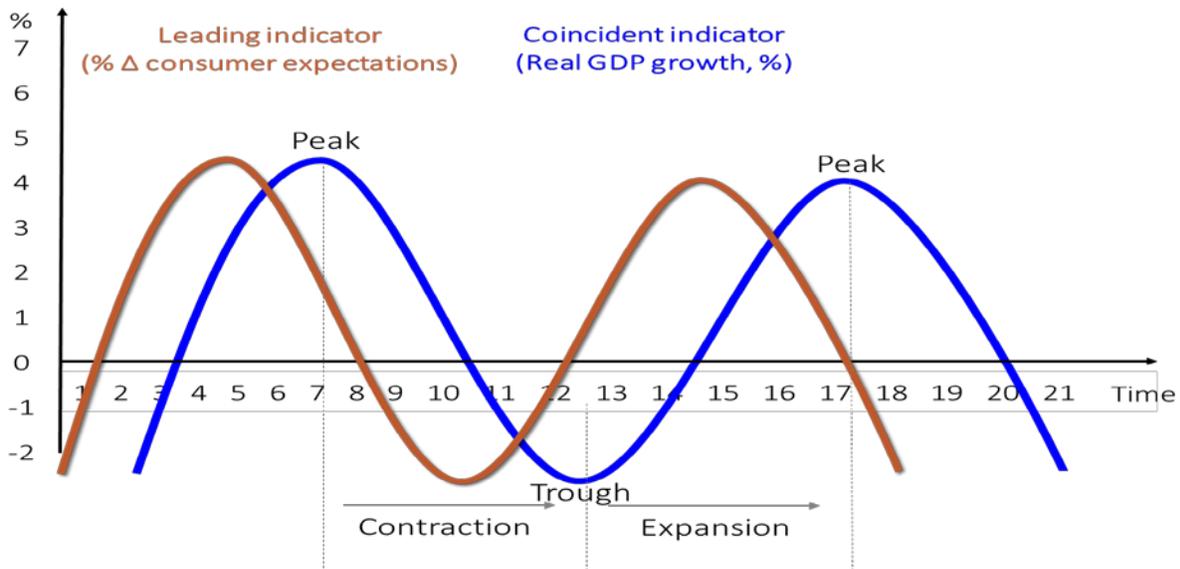
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Abstract

The objective of this study was to examine and forecast the Wisconsin business cycle. The motivation for this project is that little research has been done on state-level business cycles. The study aims to address two key research questions: How does the Wisconsin business cycle compare to the national business cycle? What does this tell us about the state's business cycle? To answer these research questions, leading economic indicators were used to forecast the state's coincident economic indicators. The coincident economic indicators were then utilized to determine the recessionary periods in Wisconsin between 1970 to present. Lastly, the state's recessionary periods were compared to the national recessionary periods.

Introduction

National business cycle and forecasting of associated economic indicators is a widely studied topic. Studying state-level business cycles, however, is a less common topic, as there are fewer applications for such research, and data is more difficult to find on a state level. This report aims to date the Wisconsin's business cycle and compare it to the national business cycle.



Business cycle, as illustrated above, is normally studied using the coincident, leading, and lagging economic indicators. In this study, lagging indicators were not utilized, therefore, the above image is indicative only of the coincident and leading indicators. The purpose for using the coincident economic indicators is to gauge the current economic conditions, as measured by real gross domestic product (GDP) growth, nonagricultural employment, and similar indicators. These are the real time indicators that tell us how the economy is currently functioning. When the business cycle turns from peak to trough, this contractionary period is considered a recession. When the business cycle turns from trough to peak, this expansionary period is considered a boom. While coincident economic indicators are used to date the business cycle, they usually take time to collect and therefore are not really available to gauge the current economic

conditions. Fortunately, leading economic indicators, such as changes in business inventories, building permits, and consumer expectations, can be used to predict the business cycle, as such indicators often precede the changes in coincident economic indicators. For example, if we see an up or a down trend in the leading index, we can expect to see the same pattern in the coincident indicators two or three quarters later.

To study the state business cycle of Wisconsin, I will use state level (micro) and national level (macro) indicators to forecast the Wisconsin's coincident indicators and date the state's business cycle. The coincident indicators will be used as dependent variables and leading indicators will serve as independent variables.

Wisconsin's Economy at a Glance

According to the current Bureau of Labor Statistics data, Wisconsin has a population of 5.76 million and a civilian labor force of 3.14 million. Wisconsin has an unemployment rate of 4.5%, which is about 0.5 percentage points lower than the national unemployment rate. Wisconsin's growth in employment is largely attributed to the private sector growth, even though the public sector accounts for around 20% of employment. Recently, construction exhibited some of the largest gains in employment (JEC Senate, 2016). Even with this increase in the labor force in areas of higher wages, such as construction, Wisconsin's average earnings per week have fallen by \$23.73 since last year. The state's poverty rate is lower than the US average though, at 10.9% at the state level, compared to 14.8% at the national level. Wisconsin's economy also relies heavily on manufacturing, agriculture and healthcare. These industries are different from the main national industries, which may explain any differences between the national and state business cycles that get identified later. Wisconsin's GDP growth is currently lower than the US average and stands at 1%, compared to the national GDP growth of 2% per year.

Literature Review

Business Cycle Indicators Handbook

The Business Cycle Indicators Handbook, published by The Conference Board, is designed to track all indicators that can map the business cycle. The indicators are meant to track the national business cycle, but many can be also applied to the state business cycle. The Conference Board separates the leading, lagging, and coincident indexes and breaks down each component, such as employment, wages, unemployment, etc. Leading indicators are designed to predict what the economic conditions will be in the future. Leading indicators identified in the Business Cycle Indicators Handbook and that are used in this study include unemployment claims, building permits, interest rate spread and the index of consumer expectations. The coincident indicator that is included in the Business Cycle Indicators Handbook and in this report is employees on nonagricultural payrolls. The lagging indicators that are in the Business Cycle Indicators Handbook and in this report are average duration of unemployment and average prime rate.

Economic Indexes for States in the Third District

In 2000, The Philadelphia Federal Reserve released a report mapping the business cycles of Pennsylvania, New Jersey and Delaware. The Federal Reserve created business cycles for these three states and compared them to the business cycle of the US. They touch on the industries in each state and how these specific industries can influence when and how long a business cycle on a state level lasts. The Philadelphia Federal Reserve used many of the indicators found in the Business Cycle Indicator Handbook but they also added their own variables to each index. I used one leading indicator and one coincident indicator from the Philadelphia Federal Reserve's report in this study, which were not previously identified in the Business Cycle Indicators Handbook. The leading indicator used is the state's leading economic activity index, which is

based on the state-level housing permits (1 to 4 units), state unemployment insurance claims, delivery times from the Institute for Supply Management (ISM) manufacturing survey, and the interest rate spread between a 10-year Treasury bond and a 3-month Treasury bill. The coincident indicator used is the unemployment rate.

The Philadelphia Federal Reserve uses a basic Stock and Watson model to construct the coincident indexes for each of the three states in their district. The Stock and Watson model was developed as a model that estimates changes in the economy. The Philadelphia Federal Reserve uses this model and imports the state data to get the standing of the state's economy. Their findings suggest that the state recessions correlate with the national recessions, but that state recessions often have leads or lags compared to the national recessions. For example, the report states that there was a US recession that spanned from 1974 to the second quarter of 1975. All three states also experienced this recession, but Delaware's recession began in the first quarter of 1973 and New Jersey's recession began in the second quarter of 1974. This is generally attributed to the different industries that play a major role in each state's economy.

Business Cycle Phases in the US States

In this article published in *The Review of Economics and Statistics*, Michael Owyang, Jeremy Piger and Howard Wall explore the differences in state growth, analyzing the recession growth rates and expansion growth rates. They used a Markov-Switching model with monthly state coincident indices that were first introduced and described in Crone (2002). Their findings suggested that different states have different growth rates, primarily due to differences in their key industries. In states, like Alaska and Maine, during recessions, there was a small negative change in growth; while during expansions, there was a large positive change in growth rates. In North Dakota and Wyoming, the changes in growth were the opposite of Alaska and Maine:

large negative changes during a recession and small positive changes during an expansion. They concluded that even though most state-level recessions are usually associated with the national recessions, their peaks and troughs differ greatly and do not always coincide with the national peaks and troughs. Further, these state recessions can often be attributed to the national economic changes, but states' main industries tend to control the duration of such recessions.

Measuring State and Regional Business Cycles

In this report published by the *University of Chicago Press* in 1947, Rutledge Vining attempts to measure the state and regional business cycles and studies what indicators work best to predict a recession or a boom. Vining conducted an extensive literature review on previous business cycle research but turned out to be the first scholar to study the state and regional-level business cycles. Even though the article is dated, the content is still relevant, and Vining's findings still hold true today. Vining attributes the lack of data on state and regional business cycles to be due to the lack of importance that single state economies have on the nation as a whole. To analyze these local economies, Vining focuses mostly on cyclical economic changes, which can be tied to unemployment rate, unemployment claims, building permits (construction is often thought of as seasonal cyclicity due to weather constraints). Vining concluded that states' economies are often more volatile in their business cycle patterns and measures than the nation as a whole. This parallels with all prior literature conducted on this topic. The national economy has many industries that perform well, whereas the states' industries are often limited to their geographic characteristics.

Methodology

To develop the empirical model, this study drew on economic indicators from the BCI Handbook and the Philadelphia Federal Reserve report. The dependent variables that were available on a

state level for Wisconsin were total non-agriculture employment, unemployment rate, and the coincident economic index indicator. The coincident economic index indicator is comprised of four coincident indicators, which include total employees on non-agricultural payroll, personal income less transfer payments, index of industrial production and manufacturing, and trade sales.

Dependent Variables	Description	Source
nonag_emp_state	Total Nonfarm Employment	FRED, MN DEED
Coinc_index_state	Average of Four Coincident Indicators	FRED
unrate_state	Unemployment Rate	FRED

The next step in constructing the model was deciding on which leading indicators would be included as explanatory variables. From the BCI handbook, unemployment claims, new housing and building permits, and an index of consumer expectations were used. From the Philadelphia Federal Reserve report, each of the states' leading economic activity indices were used. This leading index, like the coincident indicator index, is comprised of four different leading economic indicators which are then averaged out. The leading index includes new housing/building permits, initial unemployment insurance claims, delivery times (from the Institute for Supply Management), and the interest rate spread between 10-year and 3-month treasury bills.

Independent Variables	Description	Source
lead_index_state	Average of Four Leading Indicators	FRED
unemp_claims_state	New Unemployment Claims	USDOL
permits_state	New Private Housing Permits Authorized	FRED, Census
Insp500	Natural Log Transformation of S&P 500 Stock Index	FRED
cons_sentim	University of Michigan Consumer Sentiment Survey	FRED
qdummy1-qdummy4	Quarterly Dummies for Quarters 1 through 4	Generated

The S&P 500 stock index and the University of Michigan Consumer Sentiment Survey were also included, but are limited only to national level data. The S&P 500 stock index, which is used as a leading indicator, was transformed using a natural log transformation in order to capture the non-linear correlation with the dependent variables. For the independent variables, four dummy variables were also included, each corresponding to the four quarters of the year, in order to capture the seasonal variations in the data.

Dependent Variablet

$$= a + \beta_1 lead_{index_{state}_{it}} + \beta_2 unemp_{claims_{state}_{it}} + \beta_3 permits_{state}_{it} + \beta_4 \ln sp500_{it} + \beta_5 cons_{sentim}_{it} + Xf_{it} + e_{it}$$

To evaluate and forecast the Wisconsin business cycle, two approaches were used: an ARIMA model and a multiple linear regression model. The equation listed above shows the regression model that aims to explain the variations in dependent variables: non-agriculture employment, the coincident index indicator, and the unemployment rate. On the right hand side of the equation, a is a constant term. $lead_index_state$ is the lead index, which is computed by the Federal Reserve Economic Database. This, as explained earlier, is an indicator that tracks the new housing/building permits, initial unemployment insurance claims, delivery times (from the Institute for Supply Management), and the interest rate spread between 10-year and 3-month treasury bills. It was originally theorized that there would be correlation issues between $lead_index_state$ and the other independent variables but, as shown below, no two independent variables exhibited correlations of 0.70 or greater, signifying that there are no severe multicollinearity issues.

	lead_i~e	unemp_~e	permit~e	cons_s~m	lnsp500
lead_index~e	1.0000				
unemp_clai~e	-0.5109	1.0000			
permits_st~e	0.1561	-0.4399	1.0000		
cons_sentim	0.4224	-0.4630	0.5513	1.0000	
lnsp500	-0.2479	0.1454	-0.1221	0.0297	1.0000

unemp_claims_state is the quarterly unemployment claims variable. Originally, this variable was reported weekly, so the sum of the 13 weeks within a quarter were used to transform the data from weekly to quarterly. Using unemployment claims for Wisconsin as an independent variable does two things: it tracks seasonality within the data and it is a predictor for the dependent variables, unemployment rate in particular. If the number of unemployment claims for a particular quarter is lower than the prior quarter, it is expected that the unemployment rate would drop in the next 1-2 quarters. *permits_state* is a transformed variable for building permits authorized per month converted to quarterly data. Knowing the amount of new building permits issued per quarter gives an idea of how the non-agriculture employment and unemployment rate will change. $\ln sp500$ is the natural log transformation of the S&P500 stock index, which was included to capture the national (macro) economic effects

cons_sentim is the consumer sentiment variable, which is based on a survey conducted monthly by the University of Michigan. This gauges the expectations of consumers across the nation. Unfortunately, there is no consumer sentiment survey conducted specifically in Wisconsin. Hence, using the national survey gives a general idea of how the nation feels about current and future economic conditions.

Xf represents the set of quarterly dummy variables, which are $qdummy1$, $qdummy2$, $qdummy3$, and $qdummy4$. The values for these variables were 1 if the economy was currently in that quarter, 0 otherwise. These variables allow us to track seasonality within Wisconsin's business cycle.

Data was gathered from many sources, as was listed in tables above. Multiple agencies were used to gather data, including the Federal Reserve Economic Database (FRED), US Department of Labor (USDOL), Minnesota Department of Economic Development (DEED), and the US Census Data. Unlike the national business cycle, state business cycle data is not tracked as closely. This limited the periods in which data was available, with new building permits being the latest variable available beginning in the first quarter of 1988, which brought the regression model to 113 observations, as opposed to the maximum number of observations of 185. However, these 113 observations is still a large enough sample size for statistical significance.

Data Analysis

The table below shows the results of three regression analyses, with a different dependent variable in each regression. In this section, only relationships of statistical significance will be covered, with the findings subject to ceteris paribus assumption.¹

Regression Analysis for the Wisconsin Business Cycle			
Wisconsin Bus Cycle Variable	nonag_emp_state	coinc_index_state	unrate_state
qdummy1	-36133.22**	1.887592	-0.7515368***
qdummy2	-23844.76**	-0.5375525	0.2356534
qdummy4	11565.1	0.4895576	-1.936831***
lead_index_state	-22527.9***	-1.258924***	0.5770177***
unemp_claims_state	0.3138**	-1.57e-06**	0.0000251***
permits_state	54.35232***	0.0013965**	-0.0005769***
cons_sentim	-1103.389**	-0.2175992***	-0.0413637***
Insp500	364640.1***	34.45818***	-0.0747799
_cons	161017.6***	-0.2175992***	6.760552***
Prob > F	.000	.000	.000
Adj R-squared	.9739	.9708	.8693

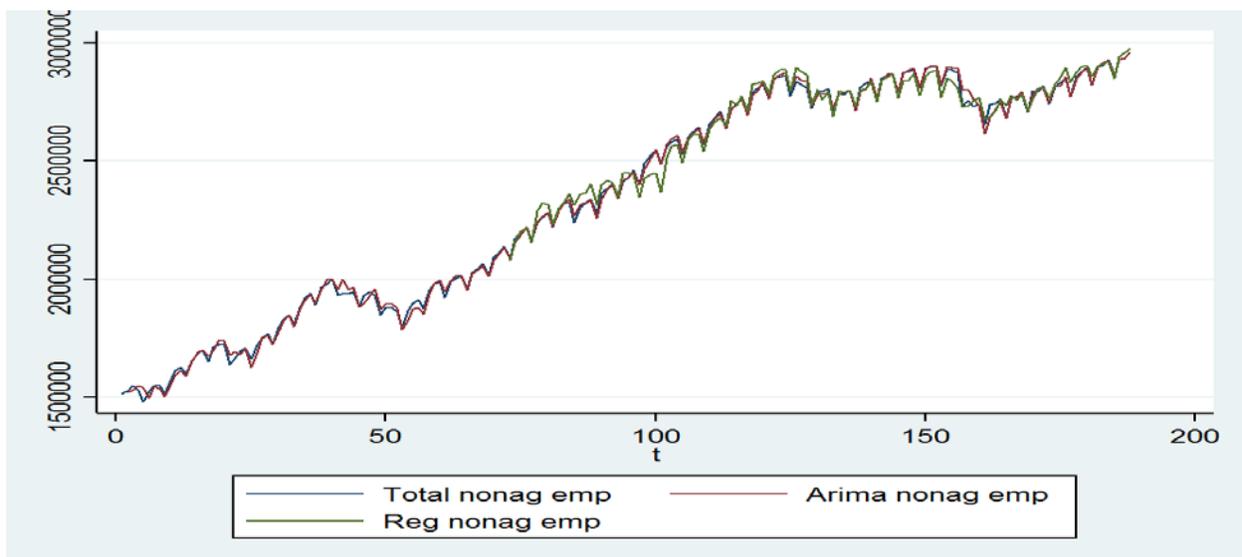
Non-agriculture Employment

The first column shows the regression results for the non-agricultural employment. The model's F-test came back as statistically significant at 1%, which suggests that the model as a whole is statistically significant. The adjusted r-squared is .9739, which means that the model accounts for 97.39% of variation in nonagricultural employment. The coefficient for the quarter 1 dummy suggests that nonagricultural employment is (on average) 36,133 people less than in quarter 3, which is omitted. The 2nd quarter dummy also suggests that nonagricultural employment is (on average) lower in quarter 2 than in quarter 3.

¹ *** indicates statistical significant at 1%, ** statistical significance at 5%, * statistical significance at 10%. Coefficients with no stars suggest that the coefficient is not statistically significant.

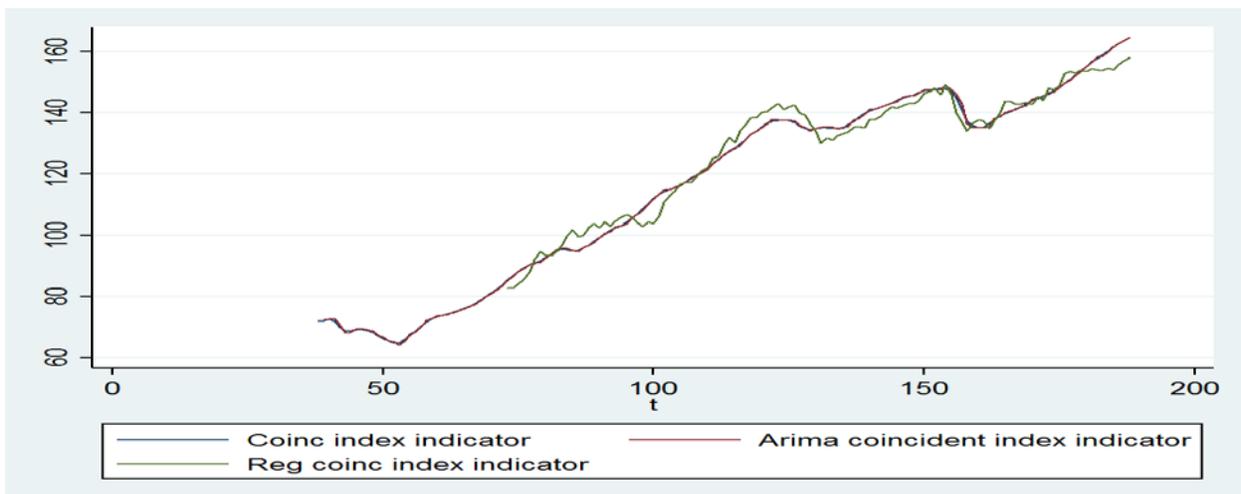
The lead index indicator, or β_1 , suggests that a one point increase in the lead index indicator will lead to an average decrease in nonagricultural employment of 22,528. The unemployment claims for Wisconsin, or β_2 , show that on average, a 1 point increase will lead to a 0.3 point increase in the non-agricultural labor force. The housing permits for Wisconsin, or β_3 suggests that for every 1 increase in housing permits, nonagricultural employment increases by 54 people. Consumer sentiment, or β_4 suggests that for every point increase, nonagricultural employment decreases by 1,103 people. The natural log of the S&P500, or β_5 suggests that for every one point increase, nonagricultural employment will increase by 364,640 people. This is because $\ln sp500_i$ has a range from 4.5 to 7.7. If we divide this by 1000, every .001 point increase in $\ln sp500_i$ will lead to a 364 person increase in nonagricultural employment.

The graph below shows the actual total nonagricultural employment (blue), an ARIMA forecast of nonagricultural employment (red), and a regression forecast of the nonagricultural employment (green). The ARIMA and regression forecasts both do a great job of fitting the model, but I believe that the regression model best follows the seasonality and variation of nonagricultural employment while better forecasting future nonagricultural employment.



Coincident Index Indicator

The model's F-test came back as statistically significant at 1%, which shows that the model is statistically significant. The adjusted r-squared is .9708, which means that the model accounts for 97.08% of variation in the coincident index indicator. The lead index indicator, or β_1 suggests that a point increase in the lead index indicator will lead to an average decrease in the coincident indicator index of 1.26. The unemployment claims for Wisconsin, or β_2 , show that on average, a point increase will lead to a very minute decrease in the coincident index indicator. Housing permits for Wisconsin, or β_3 suggests that for every point increase in housing permits, the coincident index indicator decreases by 0.001. Consumer sentiment, or β_4 suggests that for every point increase, the coincident indicator index decreases by 0.22. The natural log of the S&P500, or β_5 suggests that for every point increase, the coincident index indicator will increase by 34.46. This is because $\ln sp500_i$ has a range from 4.5 to 7.7. If we divide this by 1000, every .001 point increase in $\ln sp500_i$ will lead to an increase of 0.034 in the coincident index indicator.



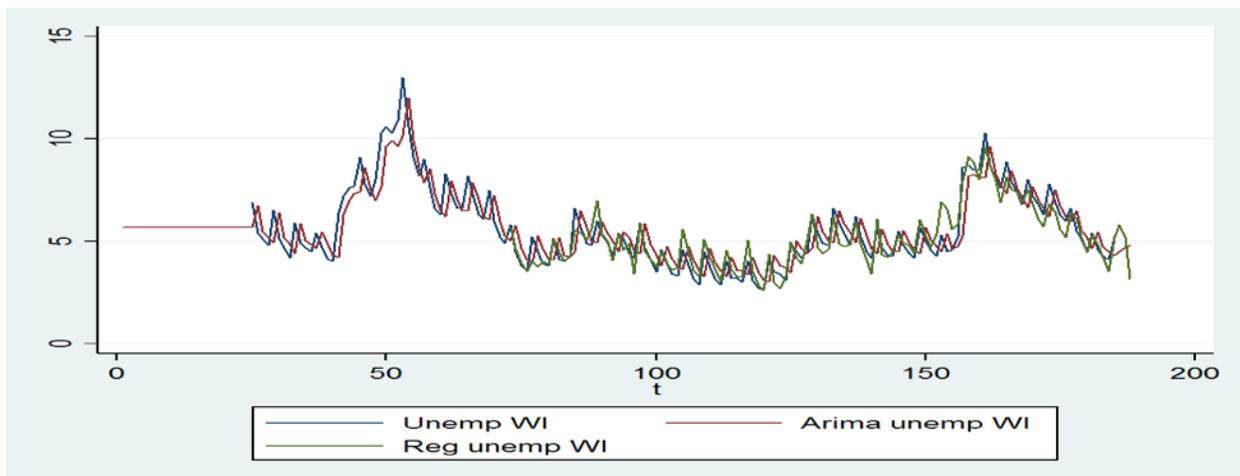
The coincident indicator index graph above shows the actual coincident indicator, the ARIMA forecast of the coincident index, and the regression forecast of the coincident index. The ARIMA forecast is almost identical to the level variable, showing that it has a great predictive

ability in the coincident index. The regression model does not do a great job of following the trend of the coincident index, which is because the coincident index is seasonally adjusted, whereas the regression model uses non-seasonally adjusted variables. This explains the variation in the regression forecast and this is why the ARIMA forecast is best fit for the coincident index.

Unemployment Rate

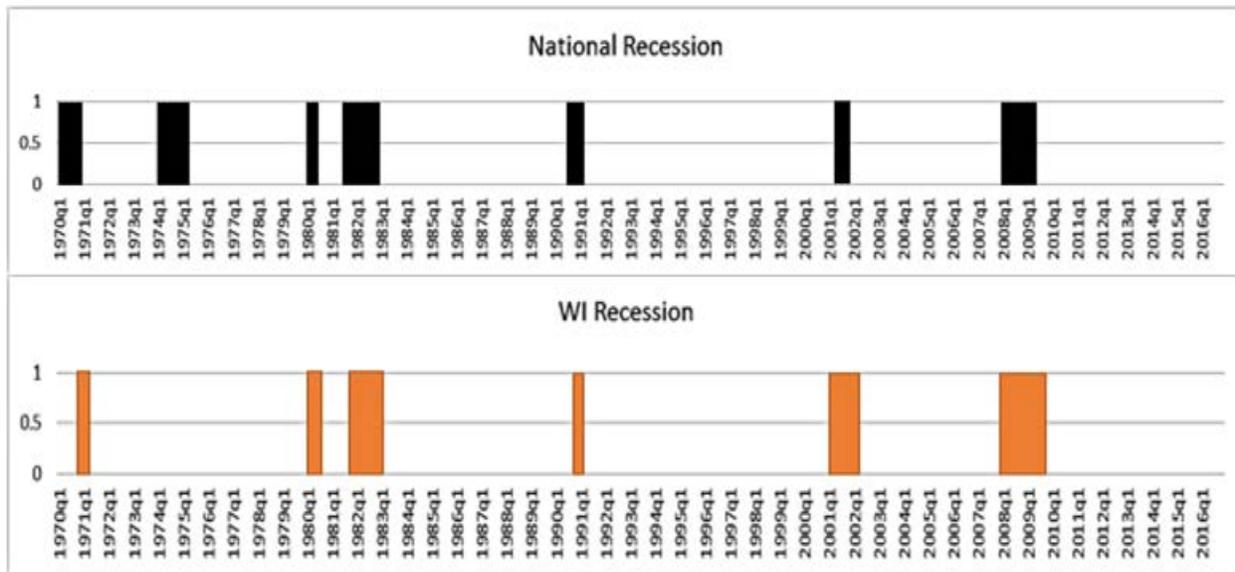
The model's F-test came back as statistically significant at 1%. The adjusted r-squared is .8693, which means that the model accounts for 86.93% of variation in the unemployment rate. The coefficient for the quarter 1 dummy suggests that the unemployment rate is (on average) 0.75 points less than in quarter 3, which is omitted. The fourth quarter dummy also suggests the unemployment rate is (on average) 1.94 percentage points lower in quarter 4 than it is in quarter 3. The lead index indicator, or β_1 suggests that a one point increase in the lead index indicator will lead to an average increase in the unemployment rate of 0.58 percentage points. The unemployment claims for Wisconsin, or β_2 , show that on average, a 1 point increase will lead to a 0.00003 point increase in the unemployment rate. Housing permits for Wisconsin, or β_3 suggests that for every one increase in housing permits, the unemployment rate decreases by 0.0006. Consumer sentiment, or β_4 suggests that for every point increase, the unemployment rate decreases by 0.04 percentage points.

The graph below shows the actual unemployment rate, the ARIMA forecast of unemployment rate, and the regression forecast of the unemployment rate. The ARIMA forecast does a great job of following the trend of the unemployment rate. The regression is more volatile but it is a better predictor due to a flat future ARIMA forecast.



Analysis of Recessionary Periods

The below graph illustrates the US and Wisconsin's recessionary periods. The determinant for a recessionary period is one where at least two of the coincident indicators trended downwards for at least two quarters. As we can see, there are periods where the state's recessions lag, lead, and replicate, the US recessions, with the state recession durations often being different from the national recession durations. There are also points in time where the US has a recession and but the state does not exhibit one. In 1974, the US experienced a recessionary period, whereas Wisconsin did not experience a recessionary period at all. Overall, Wisconsin experienced 6 recessions between 1970s and 2015, whereas the US experienced 7.



Conclusion

The examination and forecasting of the Wisconsin business cycle was primarily conducted in this study using an ARIMA forecasting approach and a regression analysis. For the nonagricultural employment of Wisconsin, it was found that the regression forecast was the best predictor. The regression model generally forecasts better than the ARIMA approach because it can pick up seasonality and follow the trend. For the coincident index indicator of Wisconsin, the ARIMA forecast best predicted the future values. This is because the coincident index indicator is seasonally adjusted and the regression used the independent variables that were not seasonally adjusted. This creates seasonal variation in the regression model when predicting the coincident index indicator, while the ARIMA model did not show this seasonal variation. The unemployment rate of Wisconsin is best forecasted using a regression forecasting approach. The ARIMA model does a good job of picking up the seasonal variation but loses the general trend when forecasting.

A comparison of the Wisconsin and the national recessionary periods revealed that Wisconsin has experienced fewer recessions since 1970 than the US economy. According to literature, this can be attributed to the state's geography, demographics, and most importantly, main industries that make up the state's economy. With these industries differing from the main national industries, there is also a difference in the starting and ending points of recessions. When Wisconsin experienced recessionary periods, they generally began either one quarter before or one quarter after the national recession.

This study has some limitations. The main limitation is mainly the lack of business cycle data on a state level. When data on state level was available, it was generally scattered across many different agencies and incomplete. This made it difficult to gather the consistent data that was needed to forecast the state business cycles.

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