Net Job Creation Using Time Series Forecasting

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Abstract
This study focuses on forecasting net job creation across the economy and by sector annually. Data from the United States Census Bureau's Business Dynamic Statistics database for years 1977-2010 as well as forecasting method ARMAX were used to develop forecasting models for net job creation by nine different sectors: agriculture, forestry, and fishing; mining; construction; manufacturing; transportation, communication, and public utilities; wholesale trade; retail trade; finance, insurance, and real estate; and services. Net job creation was forecasted through 2023. Overall, the forecast points to a positive outlook for the American job market. The results of the study as well as time series forecasting techniques will benefit macroeconomic, labor economics, and applied econometrics literature.

Keywords: *ARMAX, Forecasting, Net Job Creation, SAS*

INTRODUTION

In the United States, the cycle of high unemployment and limited job creation are consequences of lagging economic growth resulting from what is considered the great recession or long recession that began in December, 2007 and reportedly ended in June, 2009. The global impact continues to be studied and a plethora of reports continue to indicate a very long journey to true recovery from the job crisis. The International Monetary Fund (IMF) warned in 2010 that "America and Europe face the worst jobs crisis since the 1930s and risk 'an explosion of social unrest'"(Evans-Pritchard, 2010). "The weak economic performance since 2000 has seen the percentage of working age adults actually employed drop from 64% to 58% (a number last seen in 1984), with most of that drop occurring since 2007" (eM, 2012).

Net job creation has been debated and studied for decades, with a focus on firm formation, entrepreneurship, small business hypotheses, real exchange rates and oil shock rates to name a few. Kirchoff and Green (1998) postulated that many policymakers act as though small businesses are the solution to all job creation problems; while Kirchoff and Phillips (1988) examined the effects of firm formation and growth on job creation; thus, providing rigorous support for the professed "entrepreneurship belief." Historically, employment growth is considered larger in the United States than in other developed countries because of small businesses, entrepreneurship, deregulation, firm entry, expansion, exit and contraction; thus, positively influencing employment growth (Kirchoff and Phillips, 1988). However, the current lack of job creation in the United States has had a devastating effect on a global scale.

The objective of this study was to develop forecasting models focusing on U.S. job creation to provide guidance to policy makers and government agencies, such as state agencies. Since state governments are responsible for disbursing unemployment benefits, accurate forecast of job creation would allow for more accurate budgeting of necessary unemployment funds. Unemployment is a major concern for voters, and politicians, particularly those running for election need to have a policy plan to cope with the current job crisis. Industry firms can also plan for growth or size reduction more appropriately with the knowledge of how many additional jobs will need to be created to accommodate growth. The forecasting models developed were based upon United States Census data, 1977-2010 and forecasted through 2023. The results of the study as well as the time series forecasting techniques will benefit macroeconomic, labor economics, and applied econometrics literature.

RESEARCH METHODOLOGY

The purpose of this research is to forecast net job creation through 2023. We used the autoregressive moving average with exogenous inputs model (ARMAX) (Franses, 1991; Greene, 2000) to analyze the data in this study. The ARMAX model focuses on using past values and exogenous variables to forecast future values. ARMAX is the Box-Jenkins autoregressive moving average (ARMA) model (Box and Jenkins, 1970) with explanatory exogenous variables (X).

Gross Domestic Product (GDP) data for 1977-2012 was obtained from the Federal Reserve Economic Data (FRED) managed by the Federal Reserve Bank of St. Louis. FRED is an online database with time series economic data from international, national, public and private sources (FRED, 2013). The budget and economic outlook GDP growth projections were obtained from the United States Congressional Budget Office (CBO) and used to forecast GDP for 2013-2023 (CBO, 2013). The change in GDP growth was calculated for years 1977-2023, resulting in a new variable, delta. GDP and change in GDP were used as exogenous variables in the forecasting model. SAS PROC ARIMA was used for the ARMAX model to get the forecast for net job creation.

The ARMAX model was fit in SAS using PROC ARIMA. The first step of PROC ARIMA is the identify step, which checks the stationarity of the data series being forecasted, while using information criteria to optimize the values of *p* and *q*. A common test for stationarity is the augmented Dickey-Fuller (1979, 1981) (ADF) unit root test. The augmented Dickey-Fuller tests use the data generation process that follows:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{t-p+1} \Delta y_{t-p+1} + u_t$$

The ADF test assumes the null hypothesis that $\beta = 1$, or that there is a unit root in the series of the first difference of the data. The ADF test uses a lag operator and a lagged difference variable to estimate the regression. A rejection of the null (based on the critical values of the ADF tests) implies that the data is suited to forecasting with ARMA-type models (Sperrazza, 2012).

The SAS PROC ARIMA identify step then selects *p* and *q* to minimize the Bayesian Information Criterion (BIC)**,** followed by testing up to *p*=5 and *q=5*. If the estimates did not converge, then the process was expanded to consider up to *p*=7 and *q=7*. The estimate step is next and estimates the autocorrelation functions (ACF), partial autocorrelation functions (PACF), and fit statistics of the model supplied; thus, estimating the ARMAX (Sperrazza, 2013) The final step of SAS PROC ARIMA is the forecast step. This step is used to forecast the time series and net job creation. PROC ARIMA was used to forecast the economy across all nine sectors as defined by the U.S. Census Bureau. This procedure was followed by forecasting each of the nine sectors: agriculture, forestry, and fishing; mining; construction; manufacturing; transportation, communication, and public utilities; wholesale trade; retail trade; finance, insurance, and real estate; and services.

EMPIRICAL ANALYSES

The time series data used for forecasting in this study was based upon the U.S. Department of Commerce, United States Census Bureau, Center for Economic Studies, Business Dynamics Statistics job creation data (U.S. Department of Commerce, 2012). In this forecast, the Augmented Dickey-Fuller (1979, 1981) unit root test was used to test for stationarity. The data rejected the unit root hypothesis at the 1% significance level, indicating that the series is stationary. The identify step then selects *p* and *q* to minimize the BIC, followed by testing up to *p*=5 and *q=5*. The minimum value of BIC was for the ARMAX(1,1) model, when BIC=28.84.

The next step in the SAS PROC ARIMA procedure is the estimate step. The estimate step estimates the ACFs, PACFs, and fit statistics of the model supplied; thus, estimating the ARMA(1,1) model. The ACFs and PACFs for all lags greater than 0 were within the confidence interval. The residuals were nearly normally distributed around 0. The third and final step in SAS's PROC ARIMA is the forecast step.

The forecasts were carried out for thirteen periods, through 2023. The last ten years of the data were used as a holdout period. All economy-wide forecast models are presented in Figure 1. The forecasts by sector are presented in Figures 2-10. All modeling was performed in SAS. Figure 1 shows an ARMAX forecast through 2023 for net job creation across the entire U.S. economy, using real GDP and change in real GDP as exogenous variables. The line represents the forecast from 2001 to 2023. Actual data is included on the graph for 2001 to 2010. It is worth noting that all actual data falls within the confidence interval for the forecast. This forecast predicts positive net job creation for the rest of the period, though negative values are also included in the confidence interval for every year. Overall, the forecast shows potential for modest annual job gains.

In all nine sectors, the data rejected the unit root null hypothesis at the 1% significance level, indicating that the series are stationary. Table 1 presents the values of p and q, which minimized BIC in each sector. The ACFs and PACFs for all lags greater than 0 were within the confidence interval. The residuals were nearly normally distributed around 0. In the final step, the forecast for each sector is generated and presented in Figures 2-10. Overall, most industries were forecasted to stay fairly consistent in number of jobs. The exceptions were services, where large net gains were forecasted, and manufacturing, where losses were forecasted.

ARMAX was an appropriate modeling technique because it incorporates past values as well as past errors in forecasting. Moreover, the data was irregular and oscillated between positive and negative values at no discernible pattern; therefore, requiring a more sophisticated forecasting technique such as ARMAX. Due to

the stationarity and irregularity of the time series, ARMAX was the most appropriate method for creating forecasts. Using ARMAX, forecasts were created that can be used by state governments and firms for planning and budgeting purposes.

Table 1 – Identify Step Model Selection

Sector	ARMAX (p, q)	BIC
Agriculture, Forestry, Fishing	ARMAX (1,1)	20.52
Construction	ARMAX (1,3)	24.97
Fire (Finance, Insurance and Real Estate)	ARMAX (1,2)	23.46
Manufacturing	ARMAX (2,1)	25.84
Mining	ARMAX (1,1)	21.26
Retail Trade	ARMAX (1,1)	25.58
Services	ARMAX (7,6)	25.21
Transportation, Communication and Public Utilities	ARMAX (1,1)	23.44
Wholesale Trade	ARMAX (6,3)	-19.37

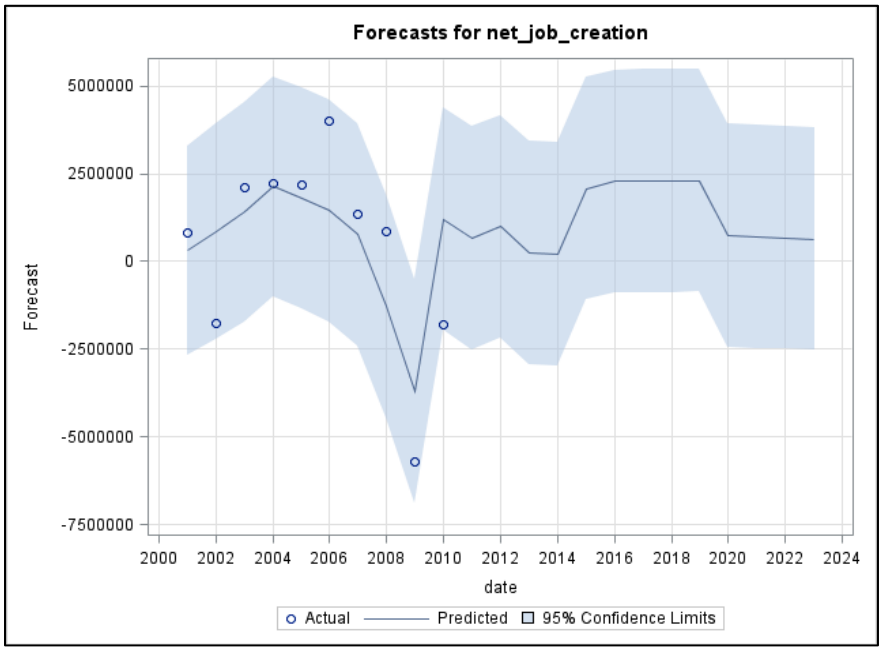

Figure 1. Net Job Creation: Economy-wide Forecast

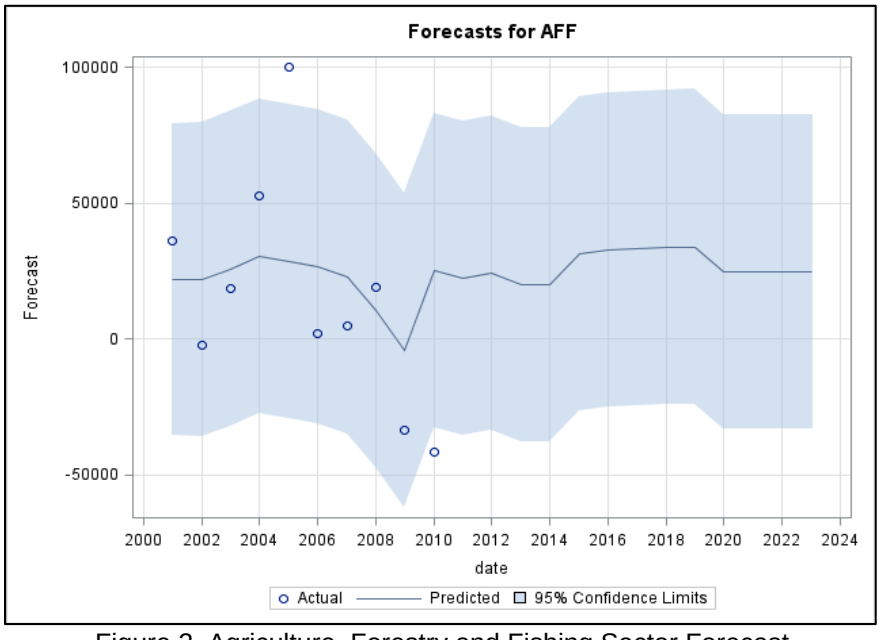

Figure 2. Agriculture, Forestry and Fishing Sector Forecast

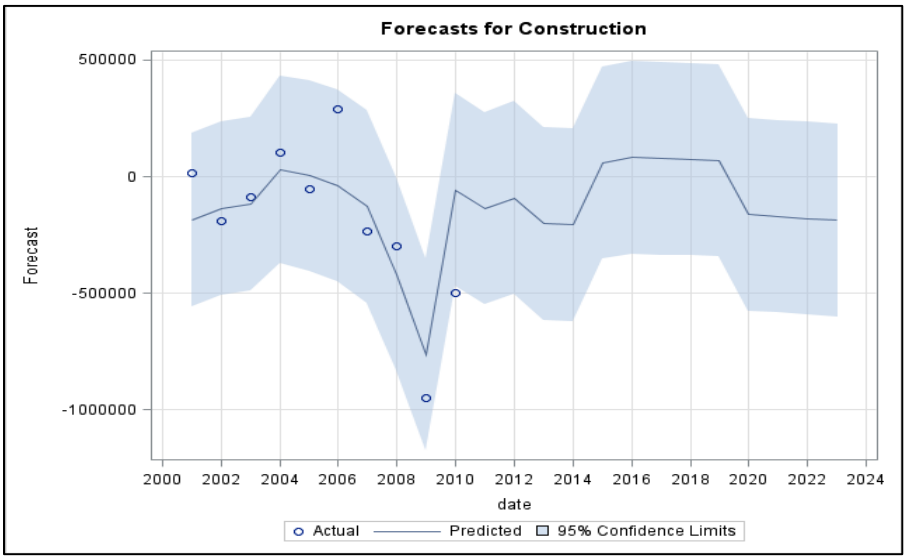

Figure 3. Construction Sector Forecast

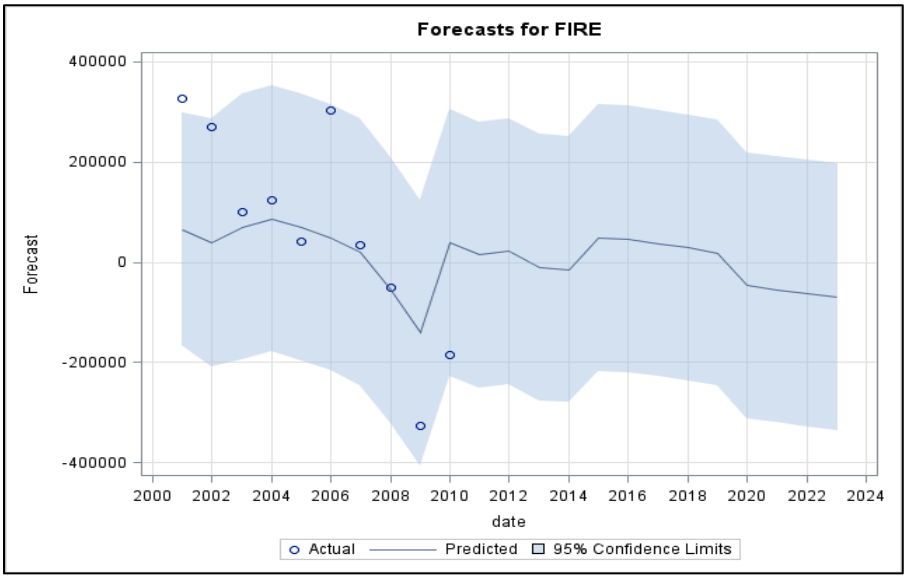

Figure 4. Finance, Insurance, Real Estate Sector Forecast

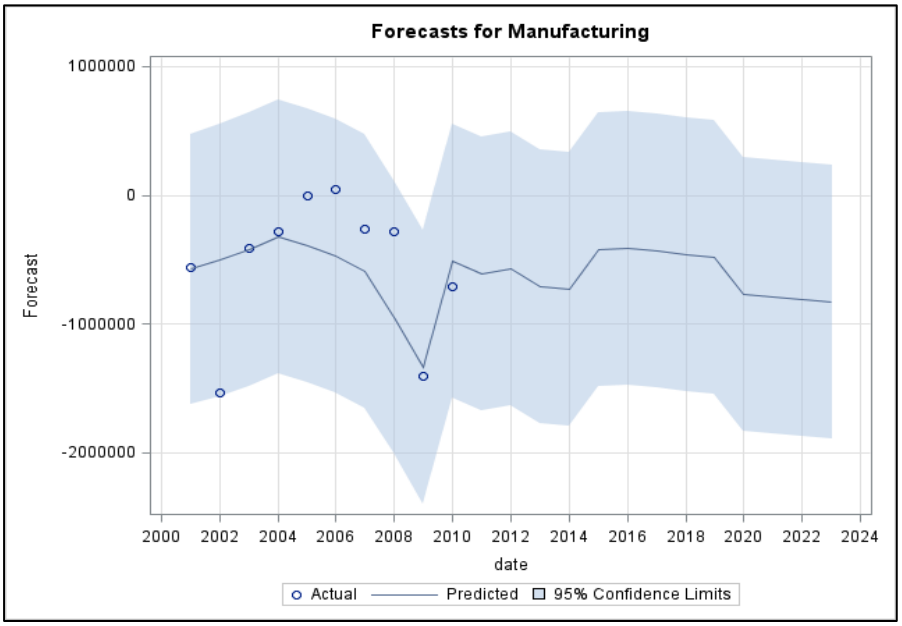

Figure 5. Manufacturing Sector Forecast

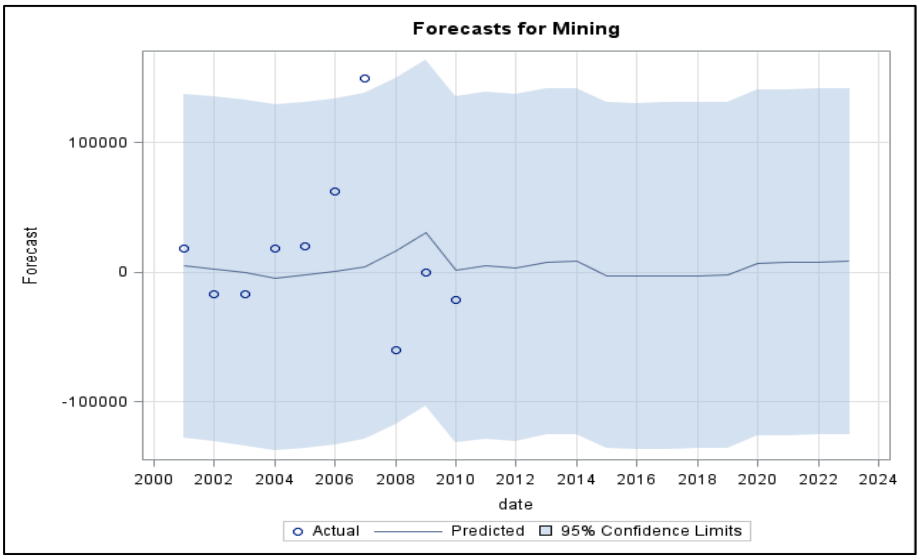

Figure 6. Mining Sector Forecast

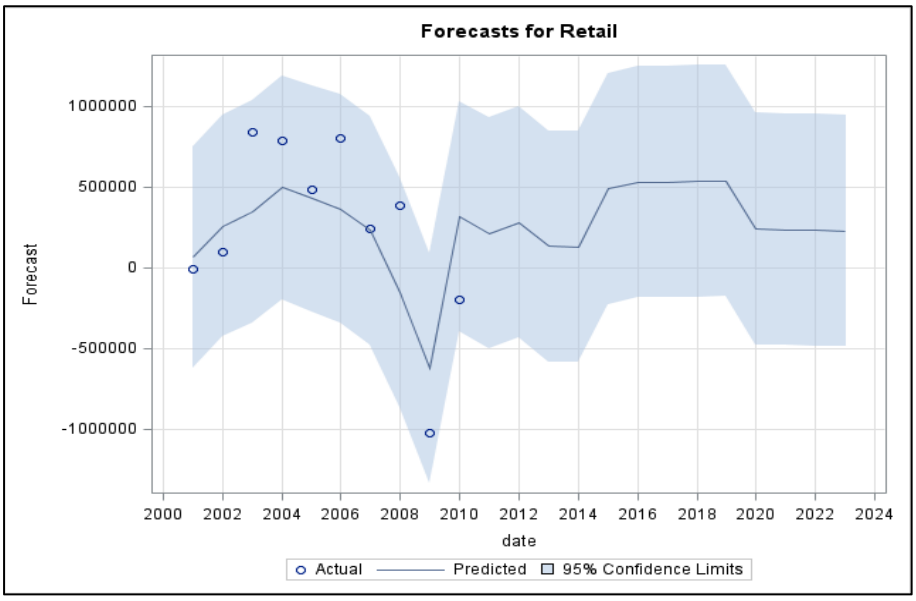

Figure 7. Retail Trade Sector Forecast

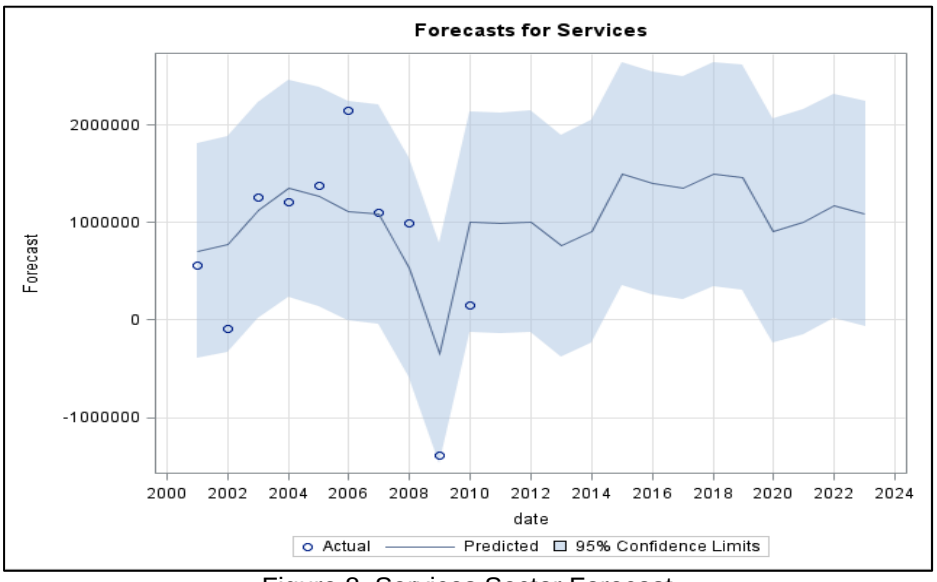

Figure 8. Services Sector Forecast

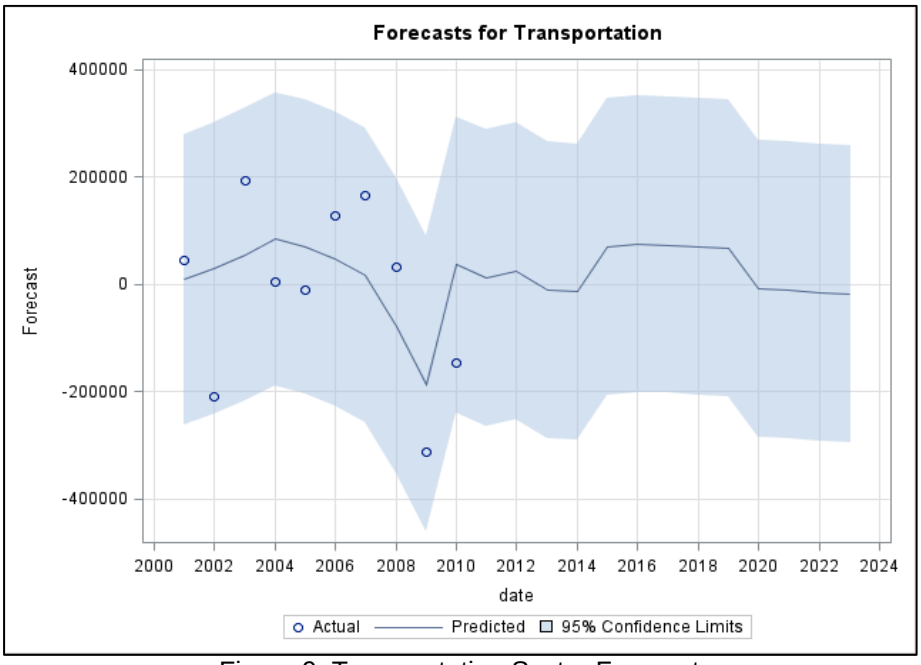

Figure 9. Transportation Sector Forecast

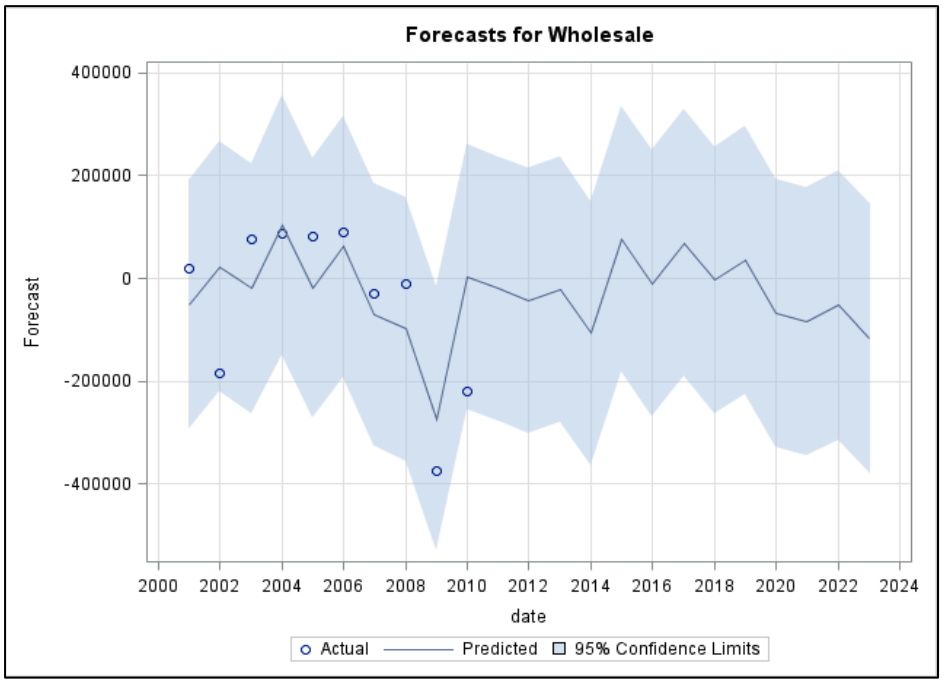

Figure 10. Wholesale Sector Forecast

CONCLUSION

The prediction of modest job growth in the forecast is useful to multiple groups. One is state governments, who are responsible for the disbursement of unemployment benefits. The modest growth forecast in the model will lead to an increase in overall employment, so state governments can expect to slightly reduce spending on unemployment benefits. The forecast is also of interest to firms, who can prepare for capital investment and expansion as a response to predicted job growth.

High unemployment and limited job creation since 2007 have led government agencies and corporate organizations on a long journey to recovery. Forecasting net job creation through 2023 across the economy and by sector annually provides valuable information to breaking the cycle of the Great Recession. Overall, the forecast points to a positive outlook for the American job market, which also has a positive impact on the global market. This is a welcome change for the United States and the world.

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