1-1-2014

Union Carpenter Activity Forecasting

Thomas Potiowsky
Portland State University

Kyle O'Brien
Portland State University

Jeff Renfro
Portland State University

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NeRC

Northwest Economic Research Center
College of Urban and Public Affairs

@nercpdx

Portland State UNIVERSITY

NeRC
Northwest Economic Research Center

Portland State University
College of Urban and Public Affairs
PO Box 751
Portland, OR 97207-0751
503-725-8167
nerc@pdx.edu

www.pdx.edu/NERC

ACKNOWLEDGEMENTS

This research report is produced by the Northwest Economic Research Center (NERC).

NERC is based at Portland State University in The College of Urban and Public Affairs. The Center focuses on economic research that supports public-policy decision-making, and relates to issues important to Oregon and the Portland Metropolitan Area. NERC serves the public, nonprofit, and private sector communities with high quality, unbiased, and credible economic analysis. The Director of NERC is Dr. Thomas Potiowsky, who also serves as the Chair of the Department of Economics at Portland State University. Dr. Jenny Liu is NERC's Assistant Director, as well as an Assistant Professor in the Toulan School of Urban Studies at PSU. The report was researched and written by Dr. Thomas Potiowsky and Kyle O'Brien, Research Assistant. Research support was provided by Jeff Renfro, Senior Economist.

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I. EXECUTIVE SUMMARY

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This study forecasts union carpenter activity for the Trustee of Oregon/SW Washington Carpenters/Employers Taft-Hartly Trusts (Trust). The study uses union carpenter hours data from 1998 to present, as well as general economic indicators to arrive at a forecast for future hours. The report discusses the analysis used to arrive at the forecast, the forecast itself, and recommendations for future work.

As the analysis herein will demonstrate, carpenter hours can be forecasted using historical hours data provided by the Trust, and Oregon construction employment. The ultimate result of the forecasting project is the development of a simple formula which can be used by the Trust to better forecast hours in the future. This formula is given by

$$L_t = \beta_0 + \beta_1 C_t + \rho L_{t-1} + \varepsilon_t$$

where L_t represents labor hours at time t, C_t is Oregon construction employment at time t, β_0 is a constant, β_1 is the estimated coefficient on construction employment, ρ is the estimated

autoregressive parameter, and ε_t is the model error term. Using the econometric analysis and software the estimated coefficients yield the following model:

$$L_t = 958{,}836.2 + 71{,}197.99C_t - .0295L_{t-1}$$

Using this simple formula, the forecasted hours through 2017 can be obtained.

Table 1: Forecasted Hours for Fiscal Years 2014-2017

Fiscal Year	Forecasted Hours
2014	6,321,231
2015	6,488,323
2016	6,726,281
2017	6,919,151

As shown in the table above, the model developed forecasts moderate increases in carpenter hours through the end of the 2017 fiscal year. It would be the recommendation of NERC to continually update the model using the most recent data available. With new information, the forecasted hours will undoubtedly change.

I. INTRODUCTION

The objective of this study is to obtain a model and methodology for forecasting carpenter activity for the purpose of forecasting Trust contributions. Employer contributions into the trust are a function of hours worked by carpenter union members. Therefore, by forecasting the hours worked by carpenters, the Trust can easily obtain an estimate for employer contributions.

In past years, Trustees have been successful in forecasting the cost-side of fund management, however in recent years have misjudged the revenue side. Consequently, the Trust requested the Northwest Economic Research Center (NERC) build a forecasting model for union carpenter hours in the Oregon and SW Washington area. NERC constructed the model based on the results of regression analysis of historical data and current trends. Primary sources of data were

- Trust Data Sources
- Oregon Office of Economic Analysis
- Bureau of Economic Analysis
- Federal Reserve Bank of St. Louis

NERC conducted an extensive review of forecasting literature, with special attention paid to union membership and manpower. This literature, coupled with NERC's expertise, was used to select appropriate predictive variables for the forecasting model.

It was only after careful examination of all the data collected that the ultimate model was obtained. Statistical analysis software packages used to compile and analyze the data were Eviews and Stata. Both these software are commonly used among economists for data analysis and forecasting. Future models can be transferred to Microsoft Excel, eliminating the need for advanced knowledge of statistical software packages.

II. DATA DESCRIPTION

As previously mentioned, the variable of interest for the forecast is the number of hours worked by union members. Employee contributions in to the Trust are a function of the number of hours worked, and does not depend on the age or experience level of the contributor. Because of the linear relationship between hours worked and employee contributions, a forecast for the former can be used by the Trust to determine the latter. With this in mind, hours worked data serves as the dependent variable in the model created. Collecting suitable hours worked data proved to be a challenging aspect of this project, given the time frame allotted.

Qualities of desirable data for hours worked include consistency in reporting across time periods, a monthly breakdown, and the ability to convert to fiscal year rather than calendar year. Not every dataset provided by the Trust possessed these qualities. However, the OWC Historical Work Hours Report from January 1998 – October 2013 was suitable in all areas. Using this data NERC constructed a time series for all time periods reported, thus monthly, going back to January 1998. A significant benefit of using this data is that it includes the past two business cycles.

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A number of publicly available economic time series data was collected and analyzed as possible independent variables.

Table 2: Economic Time Series Data and Sources

Economic Time Series	Frequency	Source
Oregon Real GDP	Annual	FRED
United States Real GDP	Quarterly	FRED
Oregon New Private Housing Units Authorized by Building Permit	Monthly	FRED
United States New Private Housing Units Authorized by Building Permit	Monthly	FRED
Oregon All-Transactions Housing Price Index	Quarterly	FRED
United States All Transactions Housing Price Index	Quarterly	FRED
United States Working Age Population	Monthly	FRED
United States Employed Population	Monthly	FRED
Oregon Unemployment Rate	Monthly	FRED
United States Civilian Unemployment Rate	Monthly	FRED
Oregon Construction Employment	Monthly	FRED and OED
Oregon NonFarm Employment	Monthly	BLS
United States 30-Year Fixed Rate Mortgage Average	Monthly	FRED
United States Inventory Sales Ratio	Monthly	FRED

Note: FRED is the database maintained by the Federal Reserve Bank of St. Louis. OED is the Oregon Employment Department. BLS is the Bureau of Labor and Statistics.

Ultimately, Oregon Construction Employment was determined to be a useful predictor for union labor hours. The Oregon Employment Department (OED) carries out quarterly forecasts of this data series. The availability of this forecast was an important facet influencing its selection as an independent variable. The forecasted values for Oregon Construction Employment were used to determine the future predicted values of labor hours in the forecast.

III. METHODOLOGY

The basic process for generating the forecast model was to complete the following steps:

1.) Literature review
2.) Data gathering (concurrent to literature review)
3.) Data cleaning and compilation
4.) Regression analysis and model specification

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The literature review is a straightforward, although time consuming, process. For the purposes of this forecast, NERC primarily reviewed literature surrounding union membership, as well as labor forecasting.

Data gathering was discussed in some detail in the previous section. The forecast benefited greatly from the widely available economic time series data collected by the United States government. This data can be downloaded with relative ease should the Trust decide to use the methodology provided in this report to forecast in the future, there should not be any issues acquiring the necessary economic data. However, collecting the labor hours data is more complicated. The Trust and Carpenter's Union should implement a process of collecting and maintaining labor data on a monthly basis. NERC will discuss recommendations on collecting data in the "Further Research" section of this report.

Once the data is collected, it is not immediately in a format which can be used for forecasting. Dates need to be formatted and matched across all data in order to merge properly. Keeping a master monthly dataset is essential in order to collapse by year or quarter, depending on the forecast time period frequency. For this forecast, the economic variables were averaged by fiscal year, while the monthly hours were summed. This can be done by quarter for a quarterly forecast. NERC used Stata to perform these operations, however with care they can be done in other Excel or other statistical software packages.

Theory and practicality both played a role determining model specification. NERC's expertise surrounding economic theory and forecasting was used in selecting various economic variables. These variables were analyzed independently for correlation among themselves and with the

dependent variable using Stata and EViews. Examination of correlation between variables is a practical approach to determine which variables may, or may not, be considered as quality independent variables.

It was through careful analysis of variable correlation that Oregon Construction Employment was determined to be a possible independent variable. This data was highly correlated with the union labor hours and could be used as an explanatory variable in the model. The availability of quarterly forecasts for Oregon Construction Employment variable solidified it as a choice for the regression equation.

In addition to construction employment, NERC also experimented with various functional forms for the model specification. Ultimately, the specification chosen this forecast is known as an autoregressive model (AR). Inn this type of model the current level of the dependent variable depends linearly on its previous values. More specific to the model presented here, labor hours in period *t* depends on labor hours in period *t-1*, where *t* is identified with a specific year. Also including Oregon Construction Employment, we can write the model specification as:

$$L_t = \beta_0 + \beta_1 C_t + \rho L_{t-1} + \varepsilon_t$$

where L_t represents labor hours at time t, C_t is Oregon Construction Employment at time t, β_0 is a constant, β_1 is the estimated coefficient on construction employment, ρ is the estimated autoregressive parameter, and ε_t is the model error term.

IV. RESULTS

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Using EViews, NERC used the historical labor hours and Oregon Construction Employment data to complete the necessary regression analysis to obtain a forecast. The estimated model, using the model specification previously discussed, is as follows:

$$L_t = 958{,}836.2 + 71{,}197.99C_t - .0295L_{t-1}$$

To obtain the forecasted hours, one can simply use actual data for C_t and L_t. The result will be the hours which the model predicts. Extending these predicted values into the future, we are able to forecast carpenter labor hours. The following table is a complete look at the forecasted and actual values for labor hours:

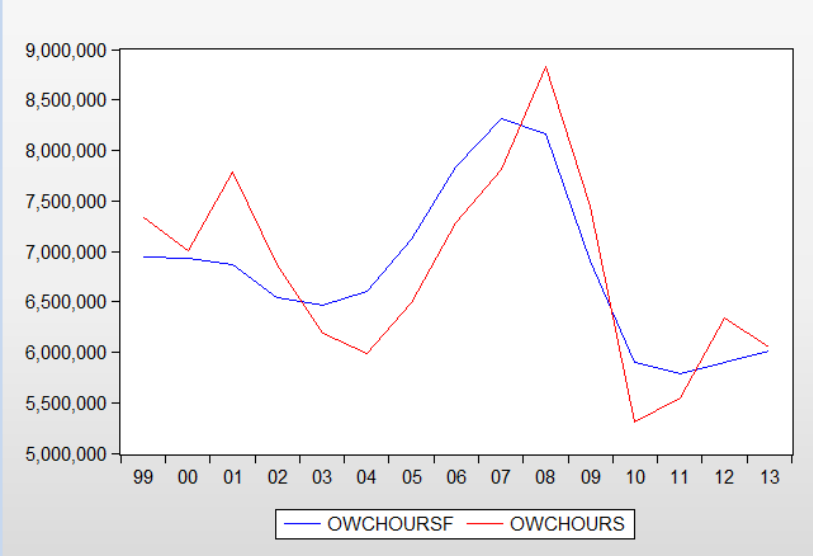
Table 3: Actual and Forecasted Hours for Fiscal Years 1998-2017

Fiscal Year	Actual Hours	Forecasted Hours
1998*	3,477,463.5	3,477,464
1999	7,339,065.9	6,939,311
2000	7,003,404.8	6,929,410
2001	7,783,469.2	6,870,136
2002	6,873,283.5	6,541,349
2003	6,187,675.2	6,469,561
2004	5,990,503.8	6,600,090
2005	6,494,271.2	7,113,309
2006	7,283,731.0	7,830,629
2007	7,813,548.6	8,310,622
2008	8,824,590.0	8,162,293
2009	7,445,836.1	6,903,275
2010	5,305,044.1	5,894,637
2011	5,549,193.0	5,791,993
2012	6,334,948.5	5,904,130
2013	6,049,988.8	6,016,860
2014**	2,235,849.0	6,321,231
2015	n/a	6,488,323
2016	n/a	6,726,281
2017	n/a	6,919,151

*Actual hours data is only for half of the fiscal year

**Actual hours only available for the first 4 months of the fiscal year

The forecast results can be accentuated with a more visual representation.



The red line indicates actual hours while the blue is the forecast.

The forecast behaves well in predicting the actual hours worked. One important aspect of any forecast is capturing changes in direction. This forecast correctly predicts major turning points in the labor hours worked by union members.

V. FURTHER RESEARCH

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The modelling in this report attempts to forecast union carpenter hours that are used in benefit calculations related to pension and health care programs. While the present model assists in determining future hours on a fiscal year basis, there are other modelling approaches that could be explored. These other approaches are currently constrained by data validation and availability.

Further research would be enhanced by moving forward in two broad areas:

Data Validation and Availability. There are discrepancies concerning carpenter hours with various data sources that appear to have been built at different times and by different personnel. A consistent set of hours, for either pension or health care, does not seem to exist. We recommend that this be a coordinated effort between the Council of Carpenters and the William C Earhart Co. to establish a consistent data over time on hours. The goal should be to build a monthly data on total hours going back as far as these organizations feel is possible. This would be the first step. The next would be to disaggregate into industry (NAICS codes), geographically, and public versus private.

Extended Modelling. With the first step completed, that is, a consistent monthly data set on hours, other modelling approaches are possible. This will give the flexibility to build either calendar or fiscal year forecasts. Given other data inputs in the model which are measured quarterly but not monthly, we would move to a quarterly data driven model. The quarterly model would allow recent data to provide signals as to where the calendar or fiscal year totals are headed. So rather than being surprised at the end of the year, tracking and could be done much earlier. Quarterly would also help in identifying turning points, as when a recession hits, to sooner capture this impact.