Chapter 40
U.S. Unemployment Rate Prediction by Economic Indices in the COVID-19 Pandemic Using Neural Network, Random Forest, and Generalized Linear Regression

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ABSTRACT

Artificial neural network (ANN) has been showing its superior capability of modeling and prediction. Neural network model is capable of incorporating high dimensional data, and the model is significantly complex statistically. Sometimes, the complexity is treated as a Blackbox. However, due to the model complexity, the model is capable of capture and modeling an extensive number of patterns, and the prediction power is much stronger than traditional statistical models. Random forest algorithm is a combination of classification and regression trees, using bootstrap to randomly train the model from a set of data (called training set) and test the prediction by a testing set. Random forest has high prediction speed, moderate variance, and does not require any rescaling or transformation of the dataset. This study validates the relationship between the U.S. unemployment rate and economic indices during the COVID-19 pandemic and constructs three different predictive modeling for unemployment rate by economic indices through neural network, random forest, and generalized linear regression model.

INTRODUCTION

Literature review

In March of 2020, COVID-19 pandemic started to outbreak in the U.S. All industries have been affected dramatically due to the high transmission rate and population movement in the spring. The downgrade of stock market and upgrade of unemployment rate are two sensible evidence to show the serious impact from COVID-19. The Dow Jones Industrial Average has experienced a sharp decrease from almost 30,000 to a point lower than 20,000 in few days. The majority of secondary industry, for examples airline, food, entertainment, were largely affected by the pandemic. Companies like NPC International Inc, Hertz, CMX Cinemas, J.C. Penney, etc. went bankrupt due to COVID-19. In the fourth quarter of 2020, U.S. GPD had fallen over 2 percent for the year, the unemployment rate averaged 6.7 percent according to U.S. department of treasury.

To explore the relationship between stock market index and the unemployment rate, this paper first reviews and summarizes the past studies and researches.

Unemployment rate and stock market are highly correlated because they are all direct outcomes of the country's economic changes. Also, there should be a lag between the changes of stock market and unemployment rate (stock market changes before the movement of unemployment rate). The phenomena are also studied by Quantifying Macroeconomic Expectations in Stock Markets using Google Trends (Bock, 2018) and The Stock Market's Reaction to Unemployment News: Why Bad News Is Usually Good for Stocks (Boyd et al, 2005). There is a clear positive relationship between capacity scrapping and unemployment rate increasing. (Arestis, Baddeley, & Sawyer, 2007)

There are many different factors that could impact unemployment rate, such as adverse demand shocks, when shocks reserve, unemployment may not fall to previous levels due to insufficient capital. (Arestis & Mariscal, 2000) Other economic data such as lagged values show significant effect on unemployment. (Loungani, Rush, & Tave, 1990) Study shows countries experienced the largest slowdown in capital accumulation per labor hour faced the highest unemployment rate in 1990s. (Gordon, 1997) The focus of this study is to model unemployment rate by economic indexes during COVID-19 pandemic. Thus, other factors such as adverse demand shocks, lagged values and capital accumulation slowdown that cannot be quantified with COVID-19 characteristics were not incorporated in this study.

The reason of such relationship is that, negative impact on stock market could cause lower incentives of firms to invest in hiring. During the periods of high risk, stock market valuations are low and unemployment rises. (Kilic & Wachter, 2018) However, the relationship is not perfectly negatively correlated. The information spillover was found significant between the stock market and labor market, but insignificant in the opposite direction, and significant bi-directionally. (Sibande, Gupta, & Wohar, 2019). Also, there is one-way causal direction from stock prices to the unemployment rate in G7 countries. There is a strong bilateral causal relationship between stock prices and unemployment for other advanced countries. (Pan, 2018)

In summary, unemployment rate and stock market should be highly correlated because they are all direct outcome of the country's economy change. Also, there should be a lag between the changes of stock market and unemployment rate (stock market changes before the movement of unemployment rate). This thought has been confirmed after reviewing Quantifying Macroeconomic Expectations in Stock Markets using Google Trends (Bock, 2018) and The Stock Market's Reaction to Unemployment News: Why Bad News Is Usually Good for Stocks (Boyd et al., 2005). Thus, we decided to test whether

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