

1. Introduction

Labour force policies influence the lives of many and tend to directly reflect current and predicted economic growth.

The Australian Bureau of Statistics collects employment data^[1] through the Labour Force Survey encompassing ~60,000 people of diverse demographics. The results are scaled in proportion to Australia's population. For this data, respondents need only work 'one hour or more' for pay or profit to be considered employed^[2], be it full or part-time.

The time series of interest contains monthly estimated counts of working Australians, in thousands.

The intention of this project is to aid in forecasting trends of the complex modern labour market through the development of a linear time series model that predicts the size of the economically active population.

2. The Data

- The recession in the early 1990's^[3] as well as the drastic economic impact of COVID-19 in 2020 led to structural breakpoints in the time series. As such, the original data was truncated for modelling purposes, to contain only the period bordered in blue in Figure 1.

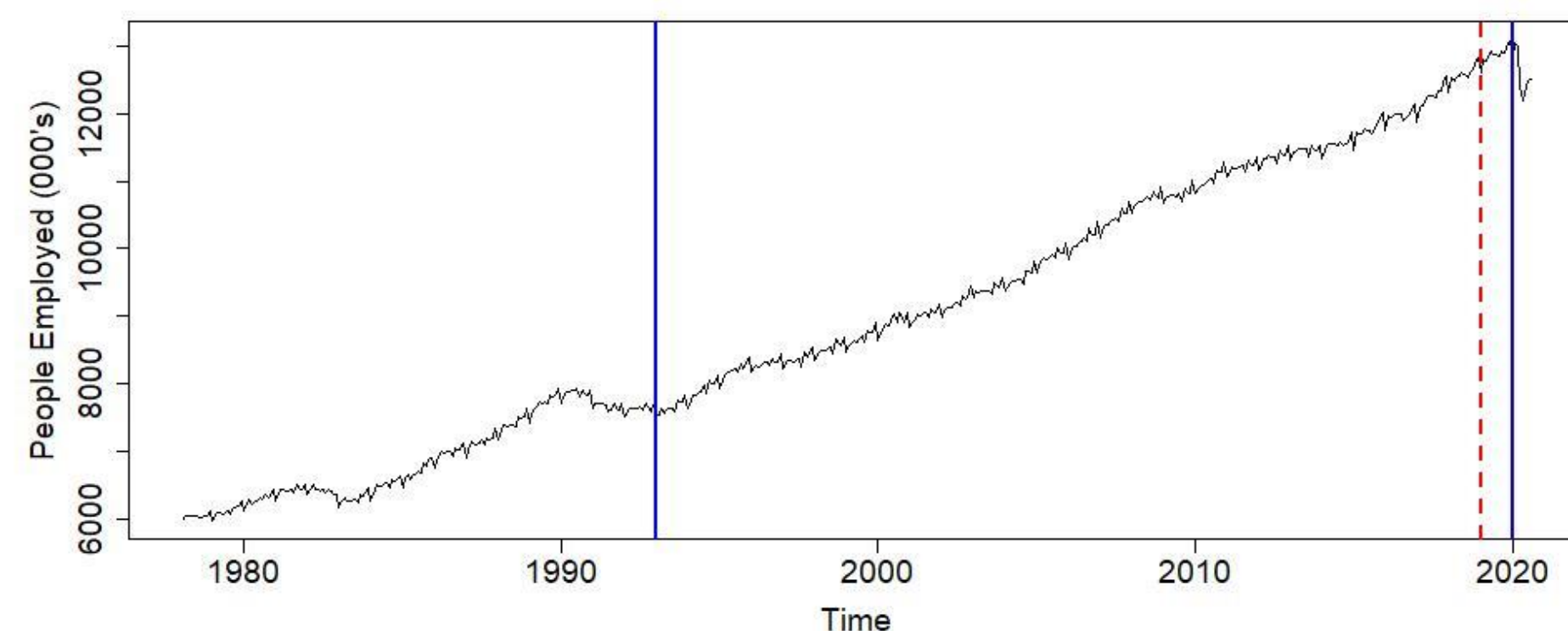


Figure 1: Size of the Australian labour force by month.

- Of the remaining 26 years, January 1993 to December 2018 (inclusive) formed the training data.
- The period January - December 2019 was used to test the accuracy of the model's forecasts.
- Figure 1 shows evidence of a seasonality effect over the time series.

3. Analysis

- The segmented time series X_t is non-stationary, having an increasing trend in mean and fluctuations in variance.
- Applying a logarithmic transformation to the dataset giving $Y_t = \log(X_t)$ and differencing in one lag was sufficient to stabilise the volatility, resulting in the time series $Z_t = Y_t - Y_{t-1}$ as shown in Figure 2.
- The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test was performed on Z_t and returned a p-value of 0.1, providing reasonable evidence of stationarity.

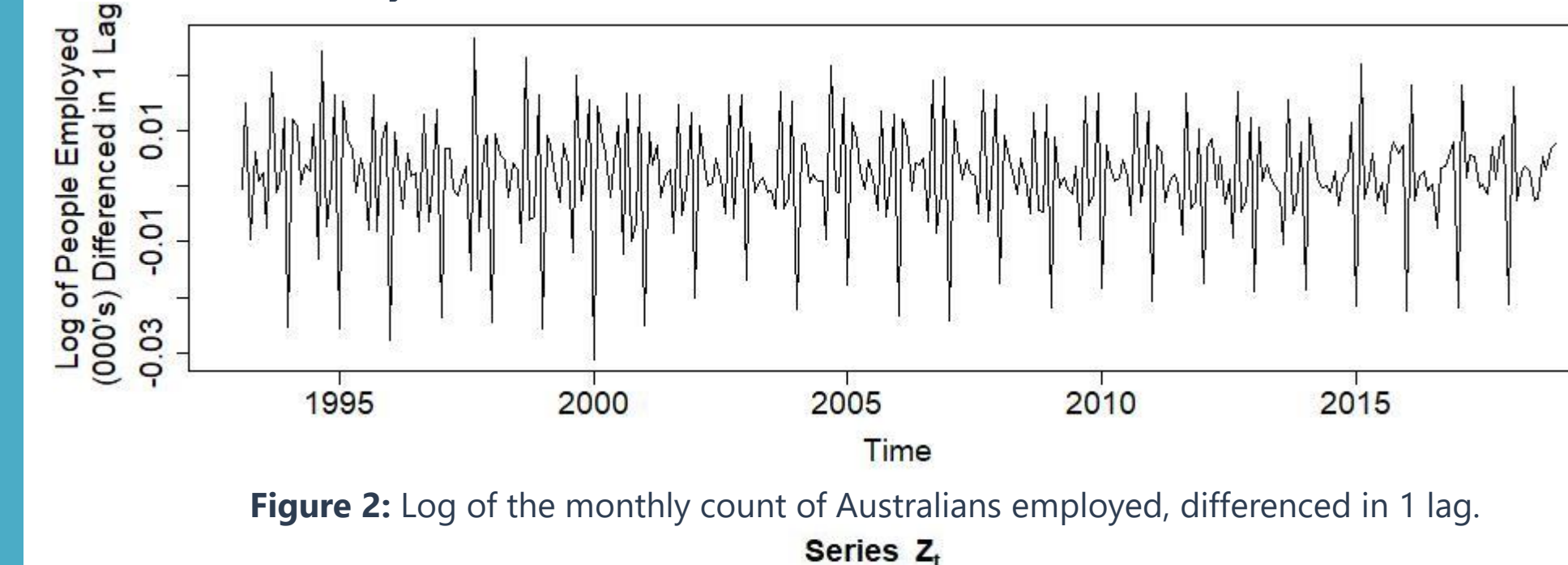


Figure 2: Log of the monthly count of Australians employed, differenced in 1 lag.

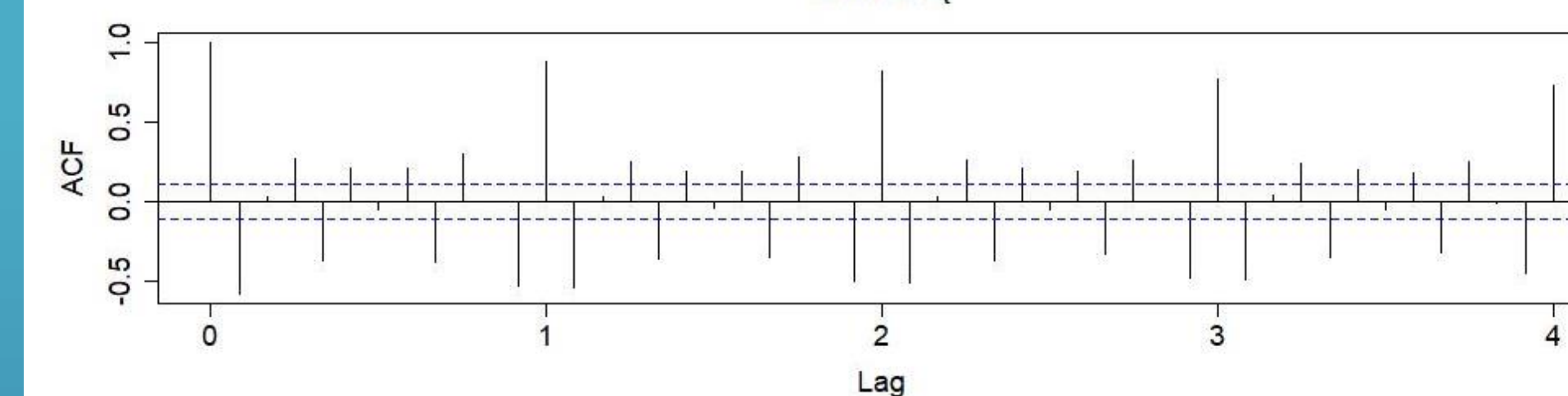


Figure 3: Autocorrelation plot for the differenced log of the monthly employment count.

- Seasonal patterns in the ACF for Z_t (Figure 3) show a slow decay in the dominant lags.
- To mitigate this, the difference in 12 lags was taken yielding $U_t = Z_t - Z_{t-12}$ for which the ACF and PACF are plotted in Figure 4:

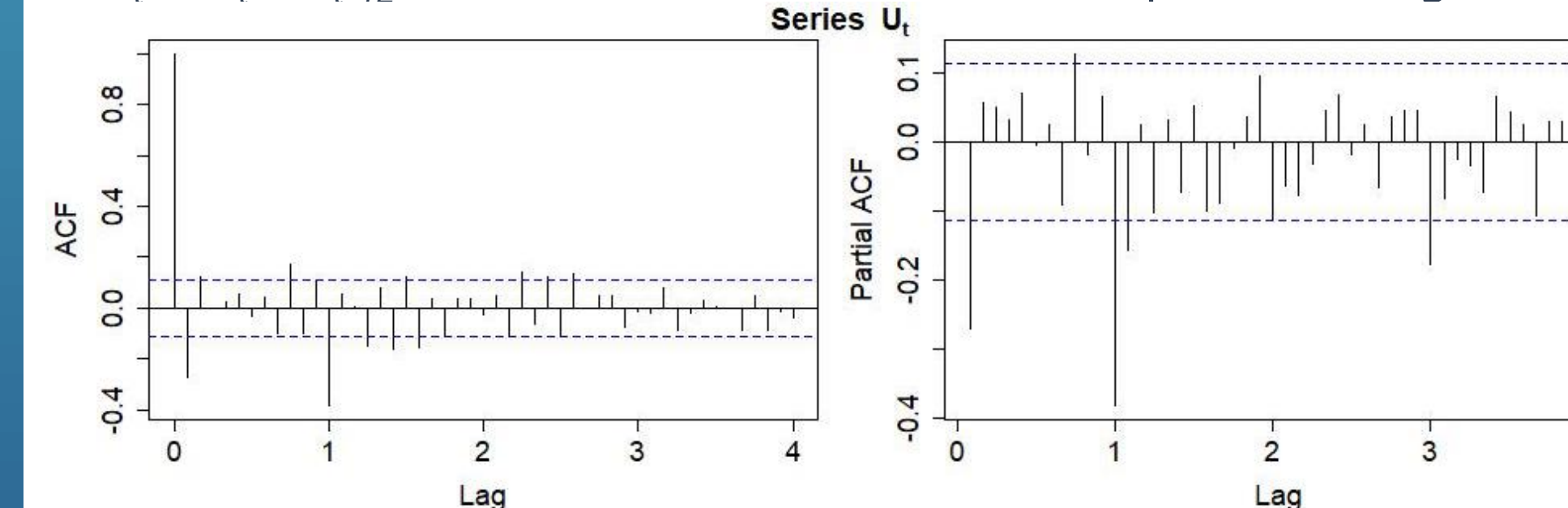


Figure 4: Autocorrelation plot for the seasonally differenced log of the monthly employment count.

- At the seasonal level, there appears to be a cutoff at 1 in the ACF and tailing off in the PACF, possibly indicating $P = 0$ and $Q = 1$.
- Lags 1, 2, ..., 11 suggest several choices, so estimates of $0 \leq p \leq 1$ and $0 \leq q \leq 1$ were made and explored.

4. The Model

Through trimming coefficients and minimizing AIC, the model selected was $SARIMA(1,1,0)(0,1,1)_{12}$, with coefficients to two decimal places:

$$(1 + 0.31B)(1 - B^{12})(1 - B)Y_t = W_t - 0.63W_{t-1}$$

from which X_t is derived through the transformation $X_t = e^{Y_t}$

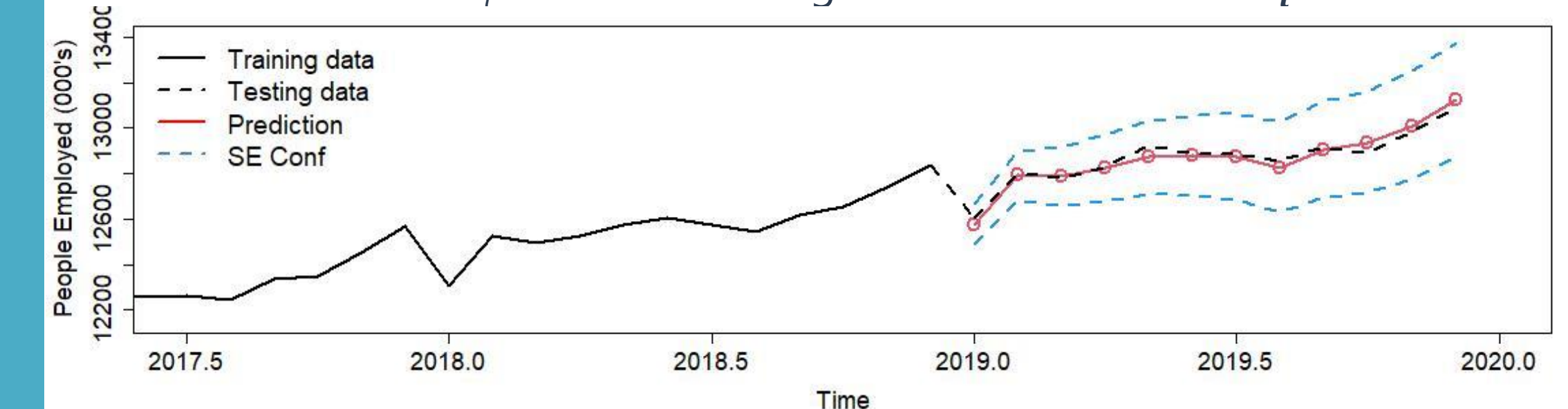


Figure 5: Forecast employment counts for 2019.

Model predictions are plotted against the test data in Figure 5. The calculated MAPE is 0.17%, and our forecasting accuracy is 99.83%.

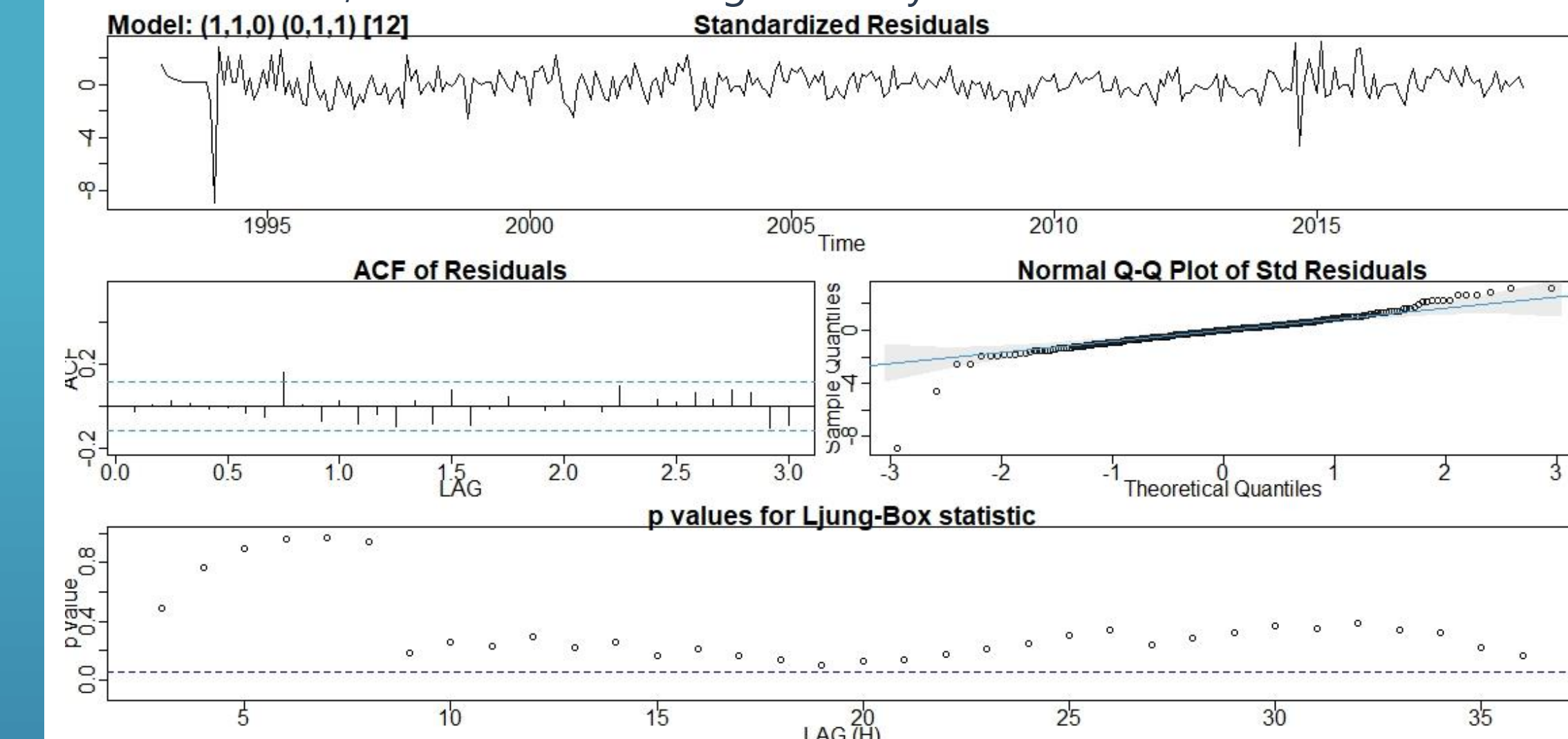


Figure 6: Analysis of model fit and residual diagnostic plots.

The diagnostic plots above confirm normally distributed residuals, with two outlying points clear from the Normal Q-Q plot. Lag 20 of the Ljung-Box statistic confirms that the model does not exhibit lack of fit.

5. Future Work

Given the initial truncation of the dataset due to structural breakpoints, it would be ideal to try and generalise the model to overcome this. A more advanced model like a Regime Switching Model such as a TAR or STAR Model may be appropriate to investigate.

6. References

- [1] Downloaded data on 24/9/2020 from <https://www.abs.gov.au/statistics/labour/employment-and-unemployment/labour-force-australia/latest-release#data-downloads>
- [2] <https://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/6202.0Main%20Features999Dec%202013> accessed 29/10/2020
- [3] <https://www.rba.gov.au/publications/conf/2000/dawkins.html> accessed 09/11/2020