Advanced Time Series Analysis [D0M63a]

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Data

Source: OECD

Time Series: Business Confidence Index (BCI) and Consumer Confidence Index (CCI) for Belgium

Time Frame: Monthly data starting from January, 2014

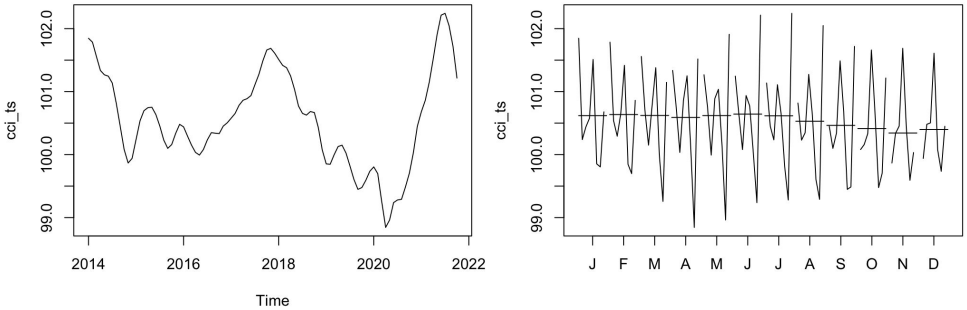
Univariate analysis: done both on ΔCCI (shown on slides) and ΔBCI (in R script only, results used in slides)

Research question (for multivariate analysis part): How are ΔBCI and ΔCCI related?

BCI provides information on future developments, based upon opinion surveys on developments in production, orders and stocks of finished goods in the industry sector. Numbers above 100 suggest an increased confidence in near future business performance, and numbers below 100 indicate pessimism towards future performance.

CCI provides an indication of future developments of households' consumption and saving, based upon answers regarding their expected financial situation, their sentiment about the general economic situation, unemployment and capability of savings. An indicator above 100 signals a boost in the consumers' confidence towards the future economic situation, as a consequence of which they are less prone to save, and more inclined to spend money on major purchases in the next 12 months. Values below 100 indicate a pessimistic attitude towards future developments in the economy, possibly resulting in a tendency to save more and consume less.

Univariate Analysis for ΔCCI

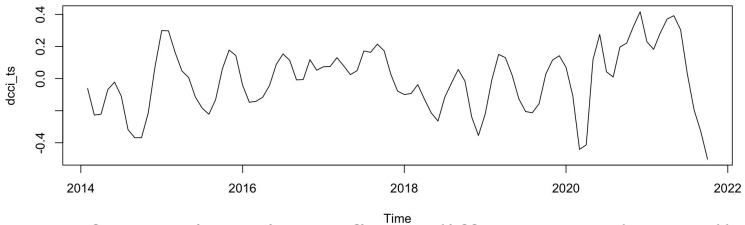


Series seems to be persistent with no seasonal effects.

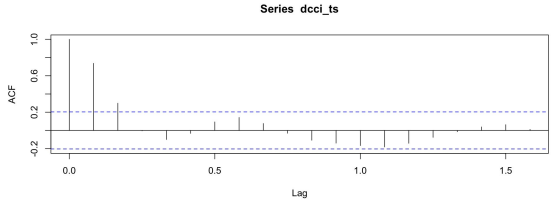
Dickey-Fuller Unit Root Test suggests that there is a unit root, which means that the TS is non stationary. The series are made stationary by going into first differences.

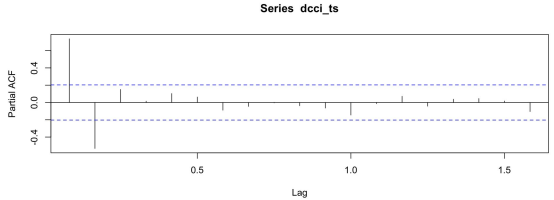
ACF and Partial ACF plots show many significant (partial) autocorrelations. In particular, this may mean that the differenced TS are NOT white noise. The Q-test confirms that they indeed are NOT white noise.

According to ACF plot, MA(2) model can be used. Partial ACF suggests using AR(2) model.

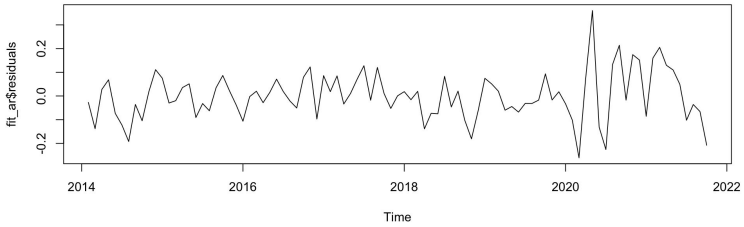


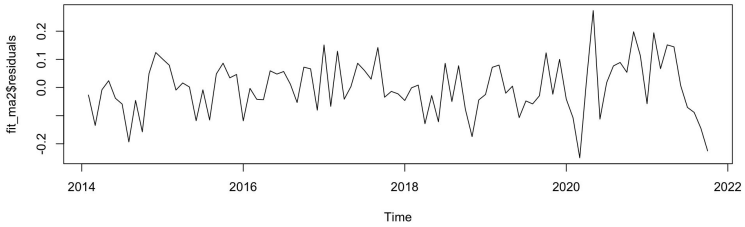
After going into first differences, the null hypothesis of the Unit Root test is rejected and consequently now the TS are stationary.

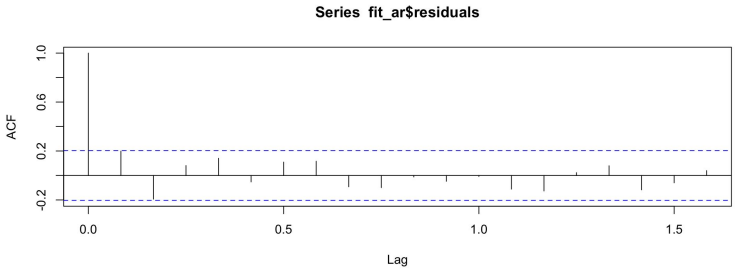


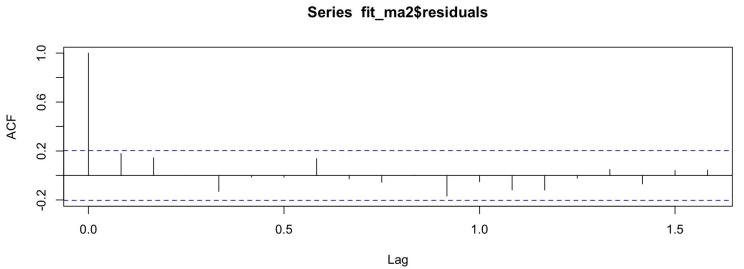


Univariate Analysis for ΔCCI: AR(2) and MA(2) models









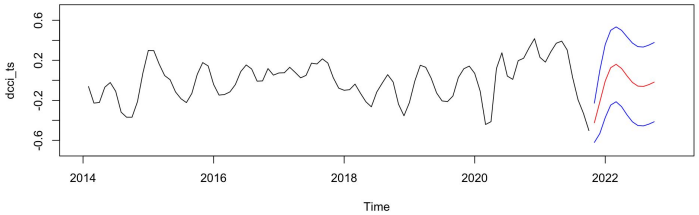
The ACF plots of residuals from both AR(2) and MA(2) models show no significant autocorrelations.

The Q-test on residuals does NOT reject the null hypothesis of residuals being white noise (p-value=0.136>5% and p-value=0.5097>5% for AR(2) and MA(2) respectively), consequently residuals are indeed white noise and both models are formally validated. Since both of the models are validated, there is no need for using other, more complex models.

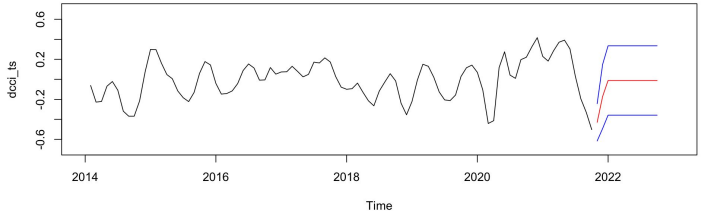
The in-sample performance of MA(2) is better than that of AR(2) according to both Akaike and Schwarz Information Criteria (AIC=-163 vs AIC=-154 and SIC=-153 vs SIC=-144 accordingly).

Univariate Analysis for ΔCCI: Forecasts for 12 months

Forecast by AR(2)



Forecast by MA(2)



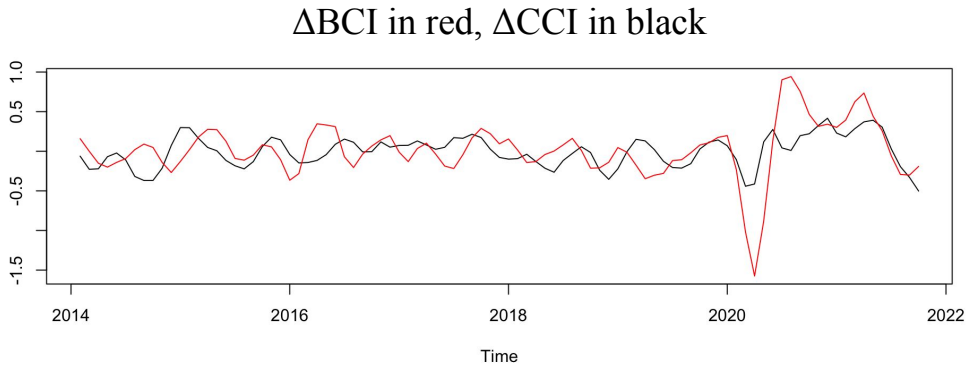
Both plots show that the further away the forecasts are done, the more uncertain they will be. This explains why the prediction interval widens over time.

The out-of sample model comparison for horizons 1, 2 and 3 using mean absolute errors (MAE) yields the following results:

- For h=1, MAE=0.14 and 0.115 for AR(2) and MA(2) models respectively, suggesting no significant difference between forecasting performances of the 2 models according to Diebold-Mariano Test (p-value=0.09583).
- For h=2, MAE=0.258 and 0.238 for AR(2) and MA(2) models respectively, again suggesting no significant difference between forecasting performances of the 2 models according to Diebold-Mariano Test (p-value=0.4558).
- For h=3, the key inferences are analogous to the ones from h=1 and h=2.

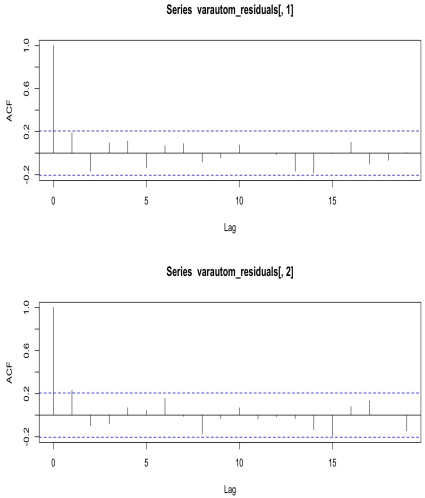
Although the forecasting performances of the two models are not significantly different by the absolute value loss, it is evident that for all 3 horizons the MA(2) model has performed slightly better than the AR(2).

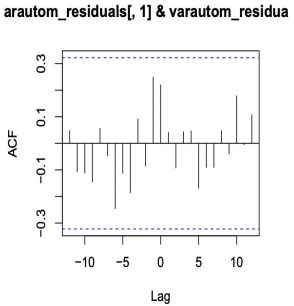
Multivariate Analysis: How are ΔBCI and ΔCCI related?



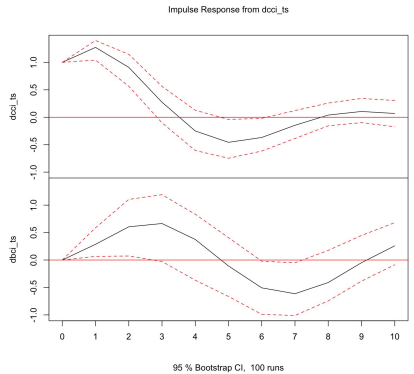
- Both time series are integrated of order one, since these series in differences are stationary, whereas in levels they were NOT stationary.
- VAR(2) model is chosen for this part of assignment due to attaining the lowest SIC value from automatic lag selection procedure.
- According to estimation results for ΔCCI, the $R^2 = 0.76$, thus almost 76% of the variance of ΔCCI is explained by the lagged observations of ΔCCI and of ΔBCI at lag 2. The F-statistic has p-value = 0.00 < 5%, thus the null hypothesis is rejected and it is concluded that the regressors are jointly significant.
- Estimation results for ΔBCI show that the $R^2 = 0.83$ and thus, almost 83% of the variance of ΔBCI is explained by the lagged observations of ΔBCI and of ΔCCI at lag 2. The F-statistics has p-value = 0.00 < 5%, thus the null hypothesis is rejected and it is concluded that the regressors are jointly significant.

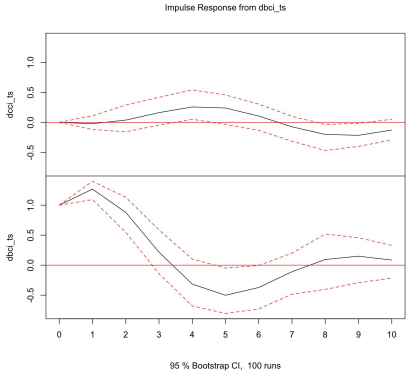
Multivariate Analysis: Model validation and IRFs





The residuals look like multivariate white noise, which signifies the validation of the model.





Given a unitary impulse in ΔCCI at time t, we observe a significant negative response in ΔBCI at times t + 6 and t + 7.

Given a unitary impulse in ΔCCI at time t, we observe a significant negative response in ΔCCI at time t + 5.

Given a unitary impulse in ΔBCI at time t, we observe a significant positive response in ΔCCI at time t + 4.

Multivariate Analysis: Cointegration and Granger Causality

- From the Engle-Granger test for NO cointegration the obtained test statistic (-4.07) is smaller than the Engle-Granger ADF test statistic for one explanatory variable (−3.41). This means that the null hypothesis of NO cointegration is rejected and thus, it is concluded that ΔBCI and ΔCCI are cointegrated.
- As Johansen's trace test has now become the standard test for NO cointegration, it was also interesting to try that test as well. The results show that, for example, for r=0, the test statistic is larger than then the critical value (105.19 > 19.96), which, on its turn, signifies that there is at least one cointegrating relation.
- The null hypothesis of NO Granger Causality is rejected on a 10% significance level leading to a conclusion that ΔBCI indeed has incremental explanatory power in predicting ΔCCI.

Multivariate Analysis: Final remarks

Given the aggregated nature of data and the fact of working in differences, the analysis results may come at the expense of interpretability.

Domain knowledge and inclusion of additional external factors may be beneficial in terms of improving the model performance and better interpreting the results.

Since the VAR(2) model has proved its viability by passing a number of tests and has passed the validation, there was no need for looking at other models. But this does NOT mean that the current model should be considered as the most promising one.

Overall, the model suggests that there is indeed a certain type of relationship between these 2 time series and shocks in one of them lead to lagged responses in the other either in negative or positive direction depending on the coming impulse. This can also be considered coherent with common sense, since the increased confidence in business performance may lead to increased confidence in economy, which may result in consumers spending more and saving less. The opposite logic also can be a workable assumption, again coherent with the model.