AK2281 TIME SERIES ANALYSIS
2ND SEMESTER
2020/2021

THE ANALYSIS OF THE EFFECT OF INCREASING NUMBER OF COVID-19 CASES IN INDONESIA ON THE MOVEMENT OF IHSG

LECTURER : DR.UTRIWENI MUKHAIYAR, S.SI.,M.SI.

MEMBERS :
1. MUHAMMAD NABIL FADHLURRAHMAN (10119065)
2. JOSHIA CAHYADI (10119086)
3. MICHELLE AURELIA (10819006)
4. CORNELIUS FRANCIS JAYADI (10819014)
5. NELSON ALEXANDER OWEN (10819034)

ABSTRACT

Covid-19 a is world wide pandemic started in December 2019 and firstly reported from Wuhan, China. In Indonesia, Covid-19 started to spread in March 2020. Of course, this pandemic affect most all life aspects, including economic sector. This research focus on the impact of Covid-19 pandemic towards Indonesia economic condition. The economic parameter that will be considered in this research is Indonesia Stock Exchange (IDX) Composite .

ANALYSIS PURPOSES

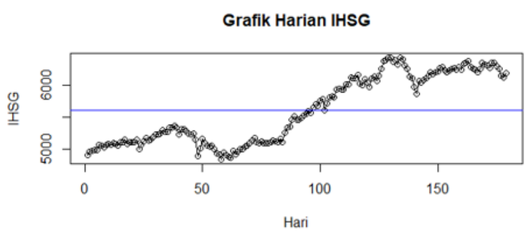
- Modeling the time series of **Composite Stock Price Index (IHSG) and Increasing Number of Covid-19 Cases in Indonesia**
- Understanding the **impact of the COVID-19 Pandemic on the stock index (IHSG) changes**
- Providing additional information to potential investors, esp. **those who just started during the Pandemic.**
- Predicting the Composite Index for the **interval of time of 10 days.**

DATA AND METHODS

The Composite Stock Price Index (IHSG) is an index of all stocks listed on the Indonesia Stock Exchange, IDX. The stock price index data we use is taken from IHSG for July 2020 until April 2021 which contains 179 observations data. The IHSG data then will be compared to Indonesia's COVID-19 new cases. These data are acquired from www.investing.com and www.kaggle.com. The analysis method used is time series analysis (**Box-Jenkins method and heteroskedastic effect modeling**) and visual analysis.

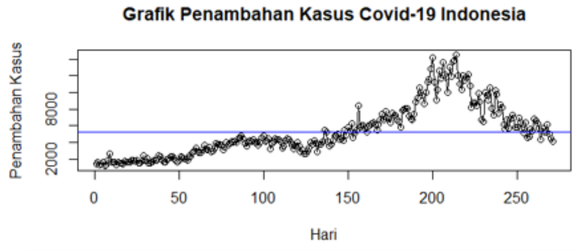
DESCRIPTIVE STATISTICS

a. IHSG



Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
4843	5108	5463	5609	6155	6435

b. COVID-19 New Cases



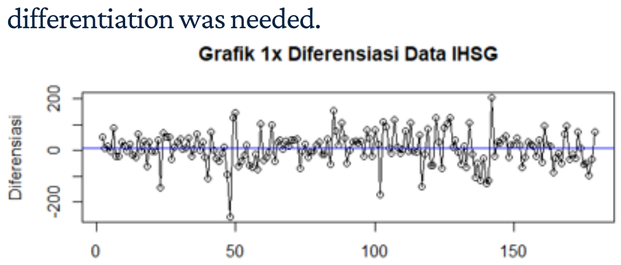
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
1209	3024	4432	5313	6836	14518

TIME SERIES MODELING

I. STATIONARITY TEST

a. IHSG

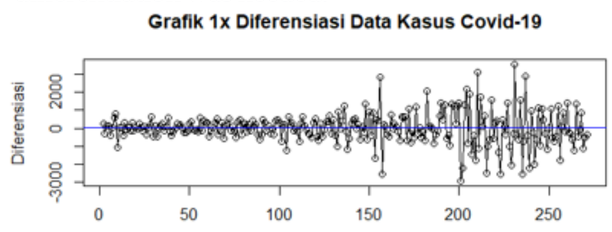
From the ADF Test, it was found that P-Value = 0.6077 for ISHG data, so H0 was not rejected, meaning that the data was not stationary so differentiation was needed.



ADF Test on differentiation data gives P-Value = 0.01 for IHSG data, then H0 is rejected, meaning the data is stationary.

b. COVID-19 New Cases

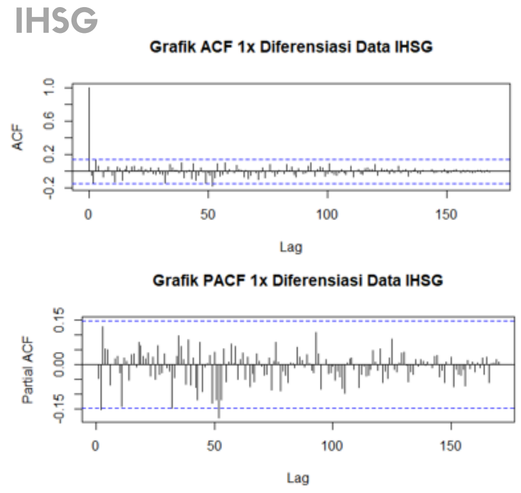
From the ADF Test, it was found that P-Value = 0.99 for COVID-19 data, so H0 was not rejected, meaning that the data was not stationary so differentiation was needed.



ADF Test on differentiation data gives P-Value = 0.01 for COVID-19 data, then H0 is rejected, meaning that the data is stationary.

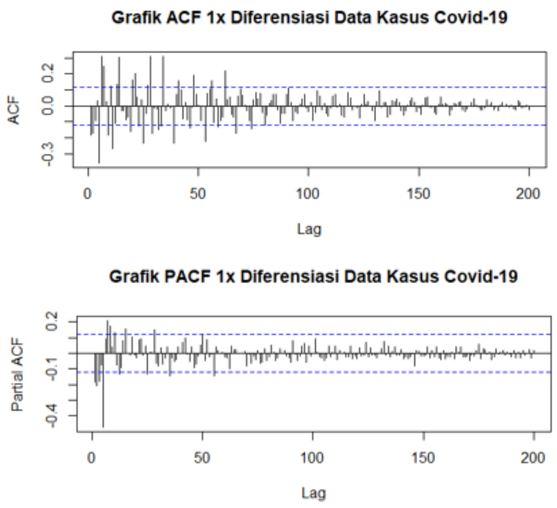
II. Order Identification

a. IHSG



ACF and PACF plot for IHSG data with 1x differentiation show that there is a cut-off on lag 2, so the possible models are ARIMA (2,1,0), ARIMA (0,1,2), and ARIMA (2,1, 2). The model chosen is the best model with the smallest AIC value, namely **ARIMA (2,1,0).**

b. COVID-19 New Cases



From the plot, it can be seen that the ACF cut-off is in lag 2 and 5, while the PACF cut-off is in lag 3 and 5. Therefore, the possible models are ARIMA (3,1,0), ARIMA (0,1,2), ARIMA (5,1,0), ARIMA (0,1,5), ARIMA (3,1,2), ARIMA (3,1,5), ARIMA (5,1,2), ARIMA (5,1,5). The model chosen is the best model with the smallest AIC value, namely **ARIMA (5,1,5).**

III. Parameter Estimation

a. IHSG

```
z test of coefficients:

     Estimate Std. Error z value Pr(>|z|)
ar1 -0.038913   0.074477 -0.5225  0.60133
ar2 -0.138370   0.074268 -1.8631  0.06244 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

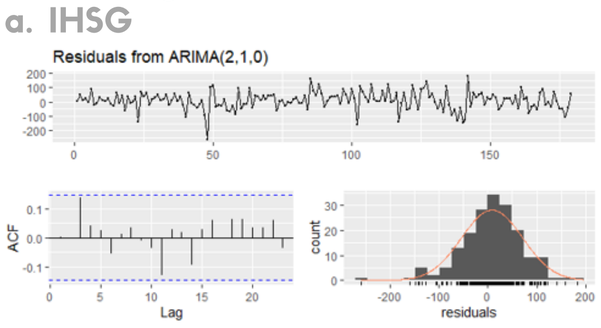
From parameter estimation, it can be seen that all the parameters are not significant, which means IHSG model only consists of white noise (Random Walk).

b. COVID-19 New Cases

```
z test of coefficients:

     Estimate Std. Error  z value  Pr(>|z|)
ar1 -0.233509   0.059878  -3.8998 9.629e-05 ***
ar2 -0.550677   0.060806  -9.0563 < 2.2e-16 ***
ar3 -0.514897   0.064930  -7.9300 2.191e-15 ***
ar4 -0.252899   0.064593  -3.9152 9.031e-05 ***
ar5 -0.802058   0.054569 -14.6982 < 2.2e-16 ***
ma1 -0.101400   0.089319  -1.1353   0.256268
ma2  0.328988   0.102381   3.2134   0.001312 **
ma3  0.245486   0.107311   2.2876   0.022159 *
ma4  0.024148   0.098388   0.2454   0.806115
ma5  0.458965   0.100896   4.5489 5.393e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

IV. Diagnostic Test

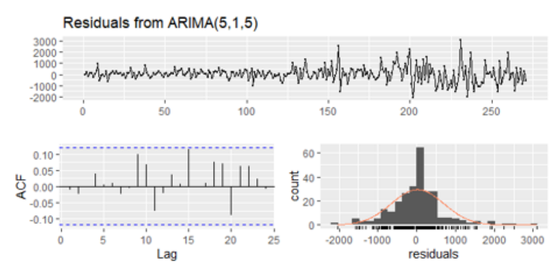
a. IHSG




```
        Ljung-Box test

data:  Residuals from ARIMA(2,1,0)
Q* = 4.9626, df = 8, p-value = 0.7616

Model df: 2.   Total lags used: 10

       ARCH LM-test; Null hypothesis: no ARCH effects

data:  resid
Chi-squared = 9.6056, df = 12, p-value = 0.6505
```

From the diagnostic test, it can be seen that the residuals are close to normal distribution and that the errors are independent. The results of the Ljung-Box test are also supportive because it was found that P-Value = 0.7616> α = 0.05, which means that **the model is quite suitable for the data and the residual is white noise.** From the ARCH LM-test, the P-Value = 0.6505> α = 0.05 is obtained, which means that **the residual does not contain a heteroscedastic effect.**

b. COVID-19 New Cases



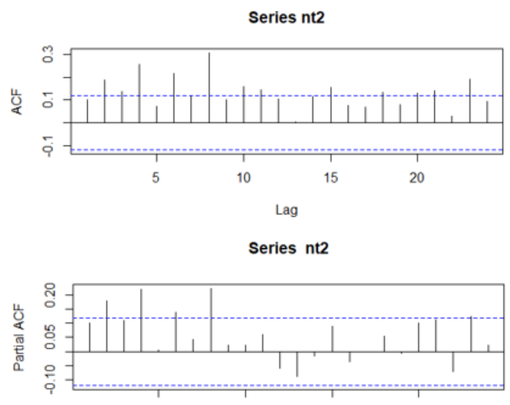

```
        Ljung-Box test

data:  Residuals from ARIMA(5,1,5)
Q* = 6.9389, df = 3, p-value = 0.07387

Model df: 10.   Total lags used: 13

       ARCH LM-test; Null hypothesis: no ARCH effects

data:  resid
Chi-squared = 43.175, df = 12, p-value = 2.109e-05
```

For the COVID-19 data, based on the histogram can be seen that the model residuals are not close enough to the normal distribution and from the ACF plot it can be seen that nothing has crossed the significance limit, means that the errors are independent of each other's lags. The results of the L-jung Box test are also supportive because it was found that P-Value = 0.07387> α = 0.05, so H0 was not rejected, which means that **the model is quite suitable for the data.** But because the residuals plot looks strange and the variance seems getting bigger, then ARCH LM-test was performed to test the presence of heteroscedastic effect. Obtained P-Value = 2.109e-05< α = 0.05 then H0 is rejected, which means that **the residuals contain heteroscedastic effect.**

V. Heteroscedastic Model Identification

a. COVID-19 New Cases

The squared residual sequence is defined as nt2, with stationary test is performed. From the ADF Test for the data, it was found that P-Value = 0.01 < α = 0.05, then H0 is rejected, which means that the residual quadratic sequence data is stationary. Next, we will identify a model for the residual squared sequence by ACF and PACF plot.



The ACF plot's cut-offs are found in lag 2, lag 4, and lag 6, while the PACF plot's cut-offs are in lag 2 and lag 4. Actually, ACF and PACF also have cut-offs on other lags, but they are not significant or can be considered too far. Time series variance was found following several GARCH (p, q) models with the residual squares following the ARMA model (max (p, q), p). Based on the analysis, the possible models are ARMA (2,2), ARMA (2,4), ARMA (4,4), ARMA (2,6), and ARMA (4,6). It is found that the model with the smallest AIC is ARMA (2,2). By estimating the parameters, the GARCH model (2,2) is found, but ω and the parameter for lag 1 is not significant. Therefore, the best model is **GARCH (2,2)**.

```
z test of coefficients:

          Estimate  Std. Error z value  Pr(>|z|)
ar1       7.6195e-02  6.1114e-02  1.2468  0.21248
ar2       8.9114e-01  6.0309e-02 14.7763  < 2e-16 ***
ma1      -7.5615e-02  7.9958e-02 -0.9457  0.34431
ma2      -7.7050e-01  7.7200e-02 -9.9806  < 2e-16 ***
intercept  4.2895e+05  2.3213e+05  1.8479  0.06462 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
```

Furthermore, an ARCH-test was carried out to test whether there was still a heteroscedastic effect on the residuals of the model. Because the P-Value = 0.9994> α = 0.05 then H0 is not rejected, which means that the GARCH model residual (2,2) does not contain heteroscedastic effects.

```
       ARCH LM-test; Null hypothesis: no ARCH effects

data:  residuals(modelnt1)
Chi-squared = 1.9781, df = 12, p-value = 0.9994
```

VI. Final Models

Data IHSG: Random Walk

$$Y_t = e_t$$

$$dengan\ e_t \sim N(0, \sigma_e^2)$$

Data COVID-19: ARIMA (5,1,5)

$$Y_t = 0.7665Y_{t-1} - 0.3172Y_{t-2} + 0.0358Y_{t-3} + 0.262Y_{t-4} - 0.5492Y_{t-5} + 0.8021Y_{t-6} + e_t + 0.3290e_{t-2} + 0.2455e_{t-3} + 0.4590e_{t-5}$$

$$dengan\ e_t = n_t = \sigma_{t|t-1}\varepsilon_t$$

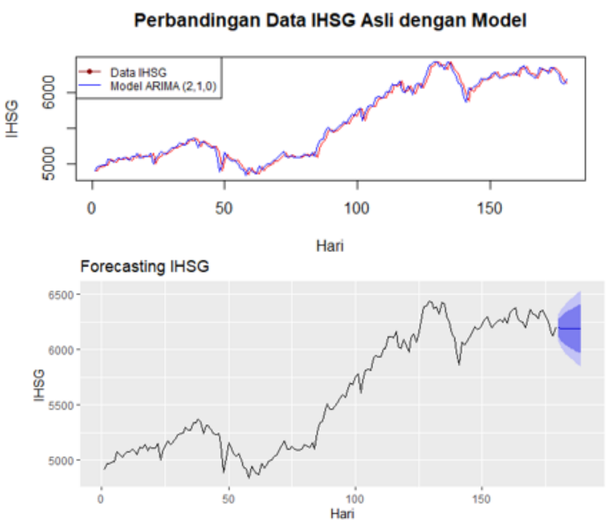
GARCH (2,2)

$$n_t = r_t^2 - \sigma_{t|t-1}^2$$

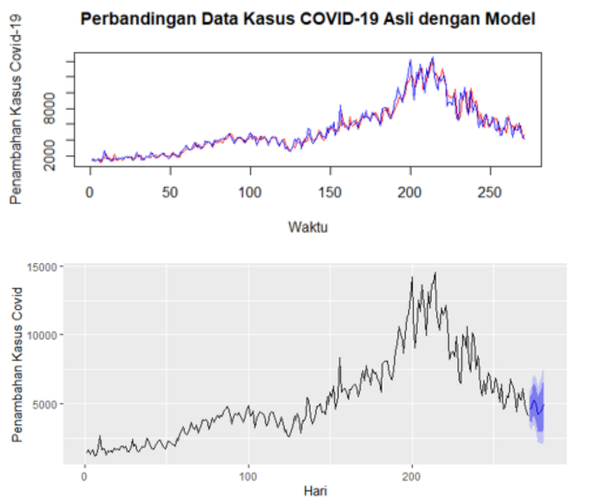
$$\sigma_{t|t-1}^2 = 0.7705\sigma_{t-2|t-3}^2 + 0.1206r_{t-2}^2$$

VI. Comparing and Forecasting

a. IHSG



b. COVID-19 New Cases



CONCLUSIONS & RECOMENDATIONS

CONCLUSIONS

1. The best model for the IHSG data is Random Walk and for the COVID-19 data is ARIMA(5,1,5) with heteroscedastic effect GARCH (2,2).
2. By comparing both the data plot, it's clear that the increasing number of Covid-19 cases in Indonesia had an impact on IHSG movement. In conclusion, Covid-19 is affecting Indonesia's economy for certain moments. However, from Sept 2020, Indonesia's economy is able to recover quickly and grow firmly regardless of the increasing number of Covid-19 cases.

RECOMENDATIONS

We encourage potential investors to take the opportunity and keep calm though the number of Covid-19 cases are still high. Because the models show that Indonesia's economy could stand firmly in Covid-19 pandemic period.