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| MINISTRY OF EDUCTION AND TRAINING  NATIONAL ECONOMIC UNIVERSITY |
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| PROJECT TIME SERIES  TIME SERIES ANALYZATION  LECTURER: MR.BUI DUONG HAI  Group 2 |
| |  |  |  |  | | --- | --- | --- | --- | | No | ID | Full Name | Contribution | | 1 | 11204838 | Nguyen Minh Duc |  | | 2 | 11204971 | Nguyen Tuan Duy |  | | 3 | 11203096 | Le Huy Phong |  | |  |  | Sum |  | |
|  |
| Ha Noi, 04/04/2023 |

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1. INTRODUCTION

Data points collected over time may have internal structures (like autocorrelation, trend, or seasonal variation) that need to be taken into account. Time series analysis takes this into account. Forecasting the behavior of time series variables, like exchange rates, is irrational because they exhibit inconsistent behavior. Despite these claims, a large number of multinational corporations, foreign exchange dealers, exporters, importers, and speculators still base their hedging decisions on forecasted rates and ex-post data.

These hedging decisions are based on the assumption that patterns in the ex-post data exist and that these patterns, at least in the short term, provide an indication of future movement of exchange rates. Modern mathematical techniques such as ARIMA model could theoretically be used to identify such patterns if they exist.

1. PROJECT BACKGROUND
2. Intended model use

A.1 ARMA

The Autoregressive AR and the Moving Average MA are the two processes that make up the ARMA model. If we have a series Xt, we can model the relationship between the level of the current observations and the level of the lag observations. The AR model can serve as a representation of this way of thinking. Additionally, we can simulate how shocks that occurred before time t also have an impact on the observations of a random variable at time t. The MA model can serve as a representation of this way of thinking.

A.2 ARIMA

Using linear relationships with their previous values, autoregressive integrated moving average (ARIMA) models aim to describe the current behavior of variables. It has an Integrated (I) component (d) that indicates how much differencing needs to be done on the series in order for it to become stationary. The second part of the ARIMA is an ARMA model for the series that has been differentiated stationary. The ARMA component is further divided into the previously discussed AR and MA components. The values of the orders of the AR and MA processes are estimated using the autocorrelation function (ACF) and partial autocorrelation function (PACF), respectively. The statistical package R is used to analyze the data

A.3 Log time trend (series ~ log(time))

A.4 Linear time trend (series ~ time)

A.5 Log-linear time trend (log(series) ~ time)

A.6 Seasonal (series ~ s2 + s3 +s4)

A.7 Linear trend + seasonal (series ~ time + seas)

A.8 Linear time trend \* seasonal (series ~ time \* seas)

A.9 Holt-winters additive

A.10 Holt-winters multiplicative

A.11 Decomposition (hard)

1. Objective

The purpose of this study is to conduct a statistical analysis on the stock series of the Viet Nam Steel corporations. Basic time series techniques are used on the data while the details about the data are described. Some of the graphical tools used to analyze the series include series plots, autocorrelation functions, and partial autocorrelation functions. In order to generate reliable forecasts from the model, we also aim to fit a model (ARMA, ARIMA) to the data.

For each of the model above, we will go through 5 steps:

1. Fit + summarize model

2. Explain coefficients if possible

3. Graph actual, fitted value, forecast value

4. Model evaluation: F-test (overall significant), coefficients' significance, R-square

5. Comments on RMSE, MAPE

1. DATA OVERLOOK & ANALYZATION

## A. Sources

The data used for this analysis is the open and close price of three Viet Nam steel corporations : HPG ( Hoa Phat ), HSG ( Hoa sen ), NKG ( Nam Kim ). The data was downloaded and exported from the stock website ([Chứng Khoán, Cổ Phiếu, Tin Chứng Khoán, Thị Trường Chứng Khoán, Chứng Khoán Việt Nam (cophieu68.vn)](https://www.cophieu68.vn/)) from 2011 till the end of 2022

## B. Hoa Phat Group – Gross Sale Revenue and Stock price analyzation

1. About Hoa Phat Group:

Founded in August 1992 as a company in the trade of building equipment and pieces of machinery, Hoa Phat Group is now the leading industrial manufacturing group in Vietnam operates in five sectors: Iron and steel, Steel Products, Agriculture, Real Estate, Home appliances. Since November 15, 2007, Hoa Phat has been officially listed on the Stock Exchange under the stock ticker symbol “HPG” and is currently holding the highest market share in Vietnam for construction steel and steel pipes. This study will analyze and forecast the quarterly profit after corporate income tax (Net profit) of HPG, which will provide some insight into the business’s health and helps predict the stock price of the company.

1. Net profit of Hoa Phat Group:

This study collected data about net profit in 63 quarters (from 2007 to the third quarter of 2022) from the group’s financial report.

Chart, line chart

Description automatically generatedVisually, this time series exhibits a positive time trend as it increases in the long run. The year 2021 was the most successful year for HPG in terms of profit as it reached 10,351 billion VND, the highest in the group’s history despite the impact of Covid-19. However, throughout the period, HPG experienced losses twice in the fourth quarter of 2008 and second quarter of 2022 with the latter being more severe. The reason for the lowest profit point is reported to be the decrease in both domestic and international demand, the increase in input material’s price, exchange rate and interest rate.

Chart, line chart

Description automatically generatedBy regressing Net profit on trend and seasonality, some insights can be interpreted from the coefficients of the models:

Regress on linear trend:

Overall, the net profit series has a positive trend. Based on the model, when other factors remain constant, after one quarter, net profit is expected to increase 86 billion VND.

Chart, line chart

Description automatically generated Applying log on time, we have following model:

Even though the parameter for trend cannot be interpreted, the model still has value in prediction. In the first quarter of 2023, when only trend is considered, Hoa Phat group will make 2,957 billion VND in profit.

Chart

Description automatically generatedRegressing net profit on seasonality:

Regressing net profit on seasonality, it can be see that within a year, net profit average the highest in the second quarter and in the fourth quarter, it is the lowest with 314 billion VND between them, although the effect may not be statistically significant.

Chart

Description automatically generatedAdding trend to seasonal model:

Additive form:

Mixed form:

Chart, histogram

Description automatically generatedIn additive seasonal model, the magnitude of the seasonal fluctuations does not vary with the level of time series, which means after accounting for trend, net profit in the first quarter will average 354 billion VND higher than the fourth quarter.

In mixed form, the multiplicative elements makes the seasonal fluctuations increase or decrease proportionally with the level of series.

Chart, line chart, histogram

Description automatically generatedChart, line chart, histogram

Description automatically generatedAddtionally, Holt-winters models can also be utilized

to forecast future profit for HPG:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Linear-Linear trend | Linear-Log trend | Log-Linear trend | Seasonality | Seasonal + Trend | | Seasonal \* Trend | Additive Holt-Winters | Multiplicative Holt-Winters |
| RMSE  (whole data) | 1713286 | 1997210 | 2853247 | 2316076 | | 1702693 | 1689016 | 1107052 | 2327727 |
| RMSE  (last 4 observation) | 4032712 | 4262831 | 5953164 | 4795025 | | 3930466 | 3597627 | 3819690 | 5741293 |
| MAPE  (whole data) | 148% | 233% | 100% | 278% | | 143% | 147% | 45% | 74% |
| MAPE  (last 4 observation) | 111% | 104% | 100% | 99% | | 108% | 99% | 117% | 101% |
| Forecasted  average profit 2023 | 4629640 | 2986602 | 627909.4 | 1657755 | | 4638811 | 4651495 | -1796685 | -2529453 |

Chart, line chart

Description automatically generatedRegressing the net profit series on trend gives a positive forecast, which suggest that on a long run trend HPG will make profit in the future. On the other hand, Holt-Winters models forecast a negative profit in 2023 suggesting Hoa Phat group will suffer loss in 2023.

1. Stock price of HPG:

As the analysis on quarterly net profit pointed out that in 2021, Hoa Phat group experienced record high profit in the third quarter whereas in the third quarter of 2022, the record loss hit. Consequently, the stock price of HPG also reflect the opposite trends between two years as in 2021, the stock price has a positive trend whereas in 2022, it is negative.

After testing for unit root, the series was found to be stationary with drift after first order difference, therefore the order of d in ARIMA(p, d, q) is 1. Furthermore, to identify two remaining orders of ARIMA model, PACF and ACF plots can be utilized:

Chart

Description automatically generatedChart

Description automatically generated

The plots suggests that an AR(1) model fits here due to a clear cut off after lag 1 in the PACF plot and only one autocorrelation that is significantly non-zero at a lag of 0. To provide comparision, a few more ARIMA model was fitted on the HPG stock price series:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | ARIMA  (1,1,0) | ARIMA  (2,1,1) | ARIMA  (1,1,1) | ARIMA  (4,2,1) | ARIMA  (0,1,2) |
| AIC | 1084.76 | 1082.82 | 1080.74 | 1087.61 | 1079.01 |
| BIC | 1110.02 | 1103.87 | 1097.58 | 1112.86 | 1091.64 |
| RMSE  (whole data) | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 |
| MAPE  (whole data) | 1.9% | 1.9% | 1.9% | 1.9% | 1.9% |
| RMSE  (last 10 observation) | 0.694 | 0.646 | 0.656 | 0.64 | 0.651 |
| MAPE  (last 10 observation) | 2.6% | 2.5% | 2.6% | 2.5% | 2.6% |
| RMSE  (first 10 days of 2023) | 1.866 | 1.85 | 1.913 | 2.05 | 1.795 |
| MAPE  (first 10 days of 2023) | 9.2% | 9.1% | 9.5% | 10.08% | 8.9% |

The ARIMA(4,2,1) fits best on the last 10 days of 2022, however, it provided the worst prediction on the first 10 days of 2023. On the other hand, the ARIMA(0, 1, 2) model have minimum AIC, BIC as well as smallest forecast error on the whole series and 10 first days of 2023.

Chart

Description automatically generatedGraphical user interface, chart, histogram

Description automatically generated

To evaluate the MA(2) model, inverse roots are inside the unit circle and a p-value of 0.1474 from Ljung-box test says that the model’s residuals are whitenoise, therefore, the model is valid. Finally, the forecast result of MA(2) model on first order difference on stock price of HPG is presented below:

Chart, line chart, histogram

Description automatically generated

## C. Hoa Sen group – Gross Sale Revenue and Stock price analyzation

### 1. About Hoa Sen Group

Hoa Sen Group is a prominent Vietnamese firm that focuses on producing and selling steel items. Since its establishment in 2001, the company has expanded considerably and is now one of the most significant steel manufacturers in Vietnam, operating in both local and global markets. Hoa Sen Group has gained recognition for its exceptional standards, inventive approaches, and effective practices, and has diversified its operations to include other sectors such as real estate, renewable energy, and logistics. The purpose of this study is to assess and predict Hoa Sen Group's quarterly gross sales revenue, which will offer valuable insights into the company's performance and assist in forecasting its stock price.

### 2. Gross sales Revenue

This study collected data about gross sales revenue in 59 quarters (from 2008 to the third quarter of 2022) from the group’s financial report

Chart, line chart

Description automatically generated

This time series line shows the gross sales revenue of Hoa Sen Group over a period of 14 years, from 2008 to the third quarter of 2022. The data indicates that the company has experienced fluctuations in revenue, with some years showing significant growth while others experiencing declines. Overall, the trend appears to be positive, with revenue increasing steadily until 2017, and then experiencing a slight dip in the following years before rebounding to a new high in 2021. The decline in overall sales was attributed to lower demand both domestically and internationally, as well as rising costs of materials, exchange rates, and interest rates. Despite the negative impact of the Covid-19 pandemic, HSG experienced its most successful year in terms of gross revenue in 2021, reaching VND 17,005 trillion, the highest amount in the history of the company.

Forecast by trend model:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | RMSE | MAPE | RMSE (4 last obs) | MAPE (4 last obs) |
| Model 1: Linear time trend (series ~ time) | 1678583 | 26.67% | 3856930 | 25.72% |
| Model 2: log-linear time trend (log(series) ~ time) | 1787341 | 24.65% | 4383221 | 36.14% |
| Model 3: linear trend + seasonality (additive form) (series ~ time + seas) | 1668207 | 30.81% | 3794262 | 24.92% |
| Model 4: log-linear trend + seasonality (additive form) (log(series) ~ time + seas) | 1773465 | 24.4% | 4313139 | 35.41% |
| Model 5: linear trend + seasonality (multiplicative form) (series ~ time \* seas) | 1647871 | 29.95% | 3515962 | 23.66% |

Overall, all five models have relatively high R-squared values, indicating a good fit to the data. However, the RMSE and MAPE values differ between the models. Model 2: (log-linear time trend) has a low MAPE value in case of all dataset, indicating the smallest average percentage error between actual and predicted values. However, it has the highest RMSE value among all the models. Model 4: (log-linear trend + seasonality) has the lowest MAPE value and a lower RMSE value compared to Model 2, indicating that it is a good choice for forecasting gross sales revenue.

In other hand, when we compare MAPE of these models in 4 last observations, there is huge different. Model 5 (linear trend + seasonality in multiplicative form) has the lowest RMSE (3515962) and MAPE (23.66%) values, indicating that it is the most accurate model among all other models in predicting the series values for the last four observations. Following up, Model 3 (linear trend + seasonality in additive form) also performs well, with an RMSE of 3794262 and an MAPE of 24.92%, which is very close to the performance of Model 5. To conclude, model 4 appears to have the best overall fit for the dataset, but when considering only the last 4 observations, model 5 exhibits the highest level of accuracy.

Holt-Winter model:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | RMSE | MAPE | RMSE (4 last obs) | MAPE (4 last obs) |
| Model 6: Holt-Winter Additive form | 1138826 | 15.73% | 2935848 | 23.78% |
| Model 7: Holt-Winter Multiplicative form | 1027275 | 15.77% | 2593691 | 17.77% |

Consider at the MAPE values, we see that both models have similar performance, with the Holt-Winter Additive form having a slightly lower MAPE (15.73%) compared to the Holt-Winter Multiplicative form (15.77%). This indicates that both models are equally good at predicting the percentage error in the time series. Furthermore, we can also look at the performance of the models on the last 4 observations of the time series. In this case, the Holt-Winter Multiplicative form performs better, with a lower MAPE (17.77%) compared to the Holt-Winter Additive form, which has MAPE of 23.78%. This suggests that the Holt-Winter Multiplicative form is better suited for predicting the recent values of the time series

Decomposition of Gross Sale Revenue series (additive):

In general, we can see that the gross sale revenue has increased over time, with some fluctuations along the way. From 2008 to 2010, the values increased steadily, followed by a sharp increase from 2011 to 2017. After a dip in 2018 and 2019, the values increased again in 2020 and 2021.

|  |  |
| --- | --- |
| Chart, histogram  Description automatically generated | The seasonal series highlights that the gross sales revenue is heavily influenced by Q1 and Q2, with Q1 showing a significant decrease of around 281879 and Q2 indicating a sharp increase of approximately 208681. This suggests that there is a substantial drop in demand during Q1, followed by a substantial surge in demand in Q2.  We remove the seasonal impact from the time series and retain only the trend and random factors. This will yield a Seasonal Adjustment series, which we can use to construct a regression model. Since the model model is a seasonally adjusted model, |

it is necessary to incorporate the decomposed seasonal factor when making predictions or computing metrics such as RMSE and MAPE.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | RMSE | MAPE | RMSE (4 last obs) | MAPE (4 last obs) |
| Model 8: Additive seasonal adjustment ~ time | 1671357 | 30.74% | 3857107 | 25.79% |

After conducting tests on 8 different models, it is evident that the Holt-Winter model performs better than trend models. Hence, we could consider utilizing the Holt-Winter model either in its Additive form or Multiplicative form to predict the gross sales revenue of HSG.

3. Stock Price of HSG:

|  |  |
| --- | --- |
| The quarterly analysis of gross sales revenue revealed that Hoa Sen Group had achieved an all-time high profit of 17,005 billion in Q4 of 2021. Nonetheless, 2022 saw a reduction in gross sales revenue, starting at 12697837 billion in Q1 and declining to 8152489 billion in Q3, which is almost half of what was recorded in the same period last year, which was 15,922 billion in Q3 of 2021. As a result, the stock price of HSG reflected opposite trends between the two years. In 2021, the stock | Chart, line chart  Description automatically generated |

price showed a positive trend, while in 2022, it exhibited a downward trend.

The series was tested for a unit root by Dickey-Fuller Unit root test, and it was discovered that it was stationary with a drift after taking the first-order difference. Therefore, the value of "d" in the ARIMA(p, d, q) model is 1. Additionally, to determine the two remaining orders of the ARIMA model, PACF and ACF plots can be used.

|  |  |
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Upon examining the PACF and ACF plots, it becomes evident that there is no dependence on error terms, and there is no dependence on past values. To draw a comparison, a few additional ARIMA models were fitted to the HPG stock price series:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Model | AIC | BIC | RMSE | MAPE | RMSE (10 last obs) | MAPE (10 last obs) | RMSE (first 10 obs 2023) | RMSE (first 10 obs 2023) |
| ARIMA (1,1,1) | 1345.41 | 1362.25 | 0.925 | 2.7% | 0.489 | 3.3% | 1.379 | 9.86% |
| ARIMA (2,1,1) | 1347.4 | 1368.45 | 0.925 | 2.7% | 0.489 | 3.3% | 1.379 | 9.86% |
| ARIMA (0,1,1) | 1343.44 | 1356.07 | 0.925 | 2.7% | 0.489 | 3.3% | 1.381 | 9.88% |
| ARIMA (2,2,1) | 1347.9 | 1364.74 | 0.926 | 2.7% | 0.48 | 3.3% | 1.67 | 11.95% |
| ARIMA (5,2,3) | 1351.41 | 1389.28 | 0.919 | 2.7% | 0.46 | 2.9% | 1.589 | 11.33% |

The ARIMA(5,2,3) model was most suitable for modeling the data of the final 10 days of 2022, but it performed poorly in predicting the first 10 days of 2023. On the contrary, the ARIMA(0,1,1) model had the lowest AIC and BIC values. However, surprisingly, the ARIMA(1,1,1) model had the best performance overall and also yielded the smallest forecast error for the entire time series as well as the first 10 days of 2023.

|  |  |
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| Graphical user interface  Description automatically generated | Chart, diagram  Description automatically generated |

. To evaluate the ARIMA(1,1,1) model, inverse roots are inside the unit circle and a p-value of 0.00 says that the model’s residuals exhibit serial correlation. Upon examining the residuals of the other models, we have found evidence of serial correlation in those models as well. As the result, forecast value of these models might not be reliable for predict HSG stock price

Forecast result of ARIMA(1,1,1) model on stock price of HSG is presented below:

Chart, line chart

Description automatically generated

## D. Nam Kim Group – Gross Sale Revenue and Stock price analyzation

### 1. About Nam Kim Group

Ton Nam Kim, a leading business in Vietnam, founded in 23/12/2002, that specializes in the production of galvanized steel sheets, has always been a leader in technology investment to give both domestic and foreign customers products that meet the highest quality standards. Currently, Ton Nam Kim products are respected across the country and exported to more than 50 nations.

### 2. Quarter – Gross Sale Revenue

Chart, line chart, histogram

Description automatically generated

The time series data I analyze is the Gross Sale Revenue price of a corporation called NKG (CTCP Thep Nam Kim) from 2010 to 2022. The graph tells us that the company has gone through many states from steadily increasing until 2020 and experienced a rocket boost in GSR in 2022 to continually decrease from then. Overall, the graph shows a positive trend with only a slight downfall in 2022.

As for the models, all the results formats are the same and for the limitation of our length in this report I will only summarize the MAPE, RMSE of the full data and last 4 observations as well as show the graph of it.

From Figure 1 – 6, they all are trend models, each has their own meaning. With linear time trend, it shows that the net profit series has a positive trend, and with seasonality, it show the average of net profit within a year (second quarter was the highest and fourth quarter the lowest)

Moreover, Holt-winters model can be used to forecast future profit:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Linear time trend | Log time trend | Log-linear time trend | Seasonality | Linear trend + seasonal | Linear time trend \* seasonal | Holt-winters additive | Holt-winters multiplicative |
| RMSE  (whole Data) | 1041127 | 1441906 | 3277096 | 2013084 | 1038149 | 1028837 | 681672.7 | 2467798 |
| RMSE  (last 4 obs) | 2299360 | 3274554 | 7076182 | 4597940 | 2273173 | 2169625 | 1724813 | 6358366 |
| MAPE  (whole data) | 0.3722754 | 0.7101393 | 0.9999898 | 1.11608 | 0.3714209 | 0.3756195 | 0.212125 | 0.6093436 |
| MAPE  (last 4 obs) | 0.2923381 | 0.3744985 | 0.9999976 | 0.6002338 | 0.2873729 | 0.2690645 | 0.2552807 | 0.8844114 |

We can notice that the predicted data from Holt-Winters model clearly points out that it has a good value of MAPE (0.21) and a good RMSE compared to training set. It also evidence that the Holt-Winter model performs better than trend models.

Regressing the net profit series on trend gives a positive forecast, which suggest that on a long run trend NKG will make profit in the future. The results also show us the positive prediction value, suggesting that the corporation will have a slight improvement compared to last quarter.

Decomposition of Gross Sale Revenue series (additive):

In general, we can see that the gross sale revenue has increased over time, with some fluctuations along the way. From 2010 to 2018, the values increased steadily, followed by a sharp increase from 2018 to 2022. After that was a slight decrease.

Chart

Description automatically generated

1. Daily – Stock price of NKG:

Next, we will go through daily data with dickey-fuller test and ARIMA model but before that we need to check for stationary in the data using figure below:

Chart, line chart, histogram

Description automatically generated

After that, we will Test with trend and constant (H1: stationary around trend)

if trend is insignificant: Test with constant (H1: stationary around constant)

if constant is insignificant: Test without constant (H1: stationary around 0)

Lastly, before fit in the model, we will be using auto function to try and select the most optimize (p,d,q) for ARIMA also the order for AR and MA

Auto regressive (AR) process (p): Order p is the lag value after which PACF plot crosses the upper confidence interval for the first time.

Moving average (MA) process(q): Order q of the MA process is obtained from the ACF plot, this is the lag after which ACF crosses the upper confidence interval for the first time.

The plots suggests that there is a MA(1) model fits here due to a clear cut off after lag 1 in the ACF plot and only one autocorrelation that is significantly non-zero at a lag of 0.

Chart

Description automatically generatedChart, box and whisker chart

Description automatically generated

To provide comparision, we will move on to fitting and evaluating models a few more ARIMA model was fitted on the NKG stock price series

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | ARIMA  (0, 1, 1) | ARIMA  (1, 1, 1) | ARIMA  (2, 1, 1) | ARIMA  (1, 1, 0) | ARIMA  (4, 2, 1) |
| AIC | 1274.62 | 1276.26 | 1278.21 | 1274.27 | 1280.56 |
| BIC | 1287.25 | 1293.1 | 1299.25 | 1286.89 | 1305.8 |
| RMSE (Full data) | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 |
| MAPE (Full data) | 2.8% | 2.8% | 2.8% | 2.8% | 2.8% |
| RMSE (last 10 obs) | 0.297 | 0.303 | 0.305 | 0.302 | 0.322 |
| MAPE (last 10 obs) | 1.7% | 1.8% | 1.8% | 1.8% | 1.9% |
| RMSE (first 10 days of 2023) | 2.827 | 2.826 | 2.821 | 2.826 | 3.23 |
| MAPE (first 10 days of 2023) | 17.8% | 17.8% | 17.8% | 17.8% | 20.3% |

The ARIMA (0,1,1) model was the best to use for modelling data of the last 10 observations, but when predicted, the model does a quite off job compared to ARIMA (2,1,1). However, the ARIMA(1,1,0) model have the lowest AIC and BIC values. In conclusion, when it come to overall performance the model ARIMA(0,1,1) is outstanding with good MAPE and RMSE for the whole data and last 10 observations, it also have a decent result in other fields compare to other model.

Graphical user interface, chart

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Here is the forecast model.

Chart, line chart, histogram

Description automatically generated

1. USING VAR MODEL

The tests suggest that the series have no Granger causality effect on each other, however, for forecasting purposes, a VAR(1) model can still be developed:

Where is the lagged difference of stock price of Hoa Phat Group, similar denotations for Hoa Sen Group (HSG) and Nam Kim Group (NKG).

From the VAR model, the impulse response function is shown below:

Chart, line chart

Description automatically generatedWhen there is a shock in the price movement of HPG in the past, HPG, HSG, and NKG all have a strong impact right away, followed by a strong downward trend after one period. that, after two periods, gradually stabilized

Chart, line chart

Description automatically generated When the price movement of HSG is past-shocked, HSG and NKG's price movements are strongly impacted right away, followed by a strong downward trend after one period, and then gradually. stayed steady after two periods. Even though this shock had no immediate impact on HPG's price movement after one period, there was only a slight upward correction.

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Chart

Description automatically generated The price movement of HPG and HSG was almost nonexistent when there was a shock to NKG's price movement in the past; this effect was only slightly reduced after 1 period and then gradually decreased. stayed steady after two periods. However, this shock directly affects the movement of NKG's price, with the impact sharply decreasing after one period and stabilizing after two.

Overall, it can be seen that the price movement of the HPG stock directly and significantly affects the price movement of the other two stocks. The price movement of NKG shares, in contrast, largely has no impact on the price movement of the other two stocks and only has an internal impact. On the other hand, while HSG's price movement affects NKG's intrinsic value and price movement, HPG's price movement is unaffected by HSG's price movement. We can infer from this that the price movement of HPG has a significant impact on the price movements of the other stocks. The price movement of NKG, in contrast, largely has no impact on the price movement of the remaining stocks and only influences it internally.

Timeline

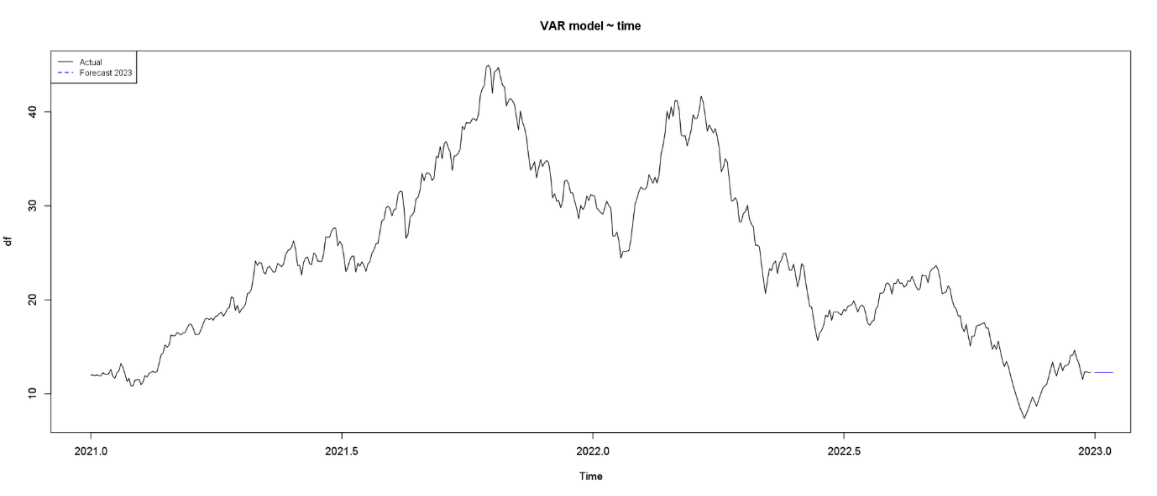
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The forecast error variance decomposition shows how much a shock to one variable impacts the forecast error of a different one. In this case, a shock to HPG stock price affects around 60% of the forecast error of HSG and 50% of NKG. 20% of the forecast error variance of NKG is also explained by a shock to HSG’s stock price. On the other hand, forecast error variance of HPG is not explained by the shock on the other two stock prices.

Chart, line chart

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|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | HPG | | HSG | | NKG | |
| Model | VAR(1) | ARIMA  (0, 1, 2) | VAR(1) | ARIMA  (1, 1, 1) | VAR(1) | ARIMA  (0,1,1) |
| RMSE  (whole data) | 0.714 | 0.71 | 0.927 | 0.925 | 0.865 | 0.867 |
| MAPE  (whole data) |  | 1.9% |  | 2.7% |  | 2.8% |
| RMSE  (last 10 observation) |  | 0.651 |  | 0.489 |  | 0.3 |
| MAPE  (last 10 observation) |  | 2.6% |  | 3.3% |  | 1.7% |
| RMSE  (first 10 days of 2023) | 1.865 | 1.795 | 1.38 | 1.379 | 1.49 | 2.83 |
| MAPE  (first 10 days of 2023) | 10.2% | 8.9% | 11.2% | 9.86% | 11.5% | 17.8% |

Overall, the VAR(1) model gives a decent forecast on the stock prices as RMSE on the forecast for the first 10 days of 2023 is relatively low, however, ARIMA models’ forecast is still more accurate. Moreover, the VAR(1) suffers from serial correlation in the residuals, which makes the forecast less reliable.

# CONCLUSION

After the analyzation of NKG, HPG and HSG stocks which all belong to steel sections on stock market base on their GRS (Gross Sale Revenue) and Closed stock price, we can come up with these results

First, most of the companies belong to steel section all have a steady increase in GRS until the near end of 2020 and then they will have a rocket boost in 2021 and 2022, which mean their market have a huge increase in the pandemic time ( COVID – 19 ), from the last quarter of 2022, they had a slight decrease.

Second, the ARIMA model that is being used in all three stocks are well-fitted and can have a good prediction, especially in the first 10 days of 2023, most of the model resulted in outstanding MAPE and good RMSE.

Third, after applying the VAR model, we can see that model gives a decent forecast on the stock prices as RMSE on the forecast for the first 10 days of 2023 is relatively low, however, ARIMA models’ forecast is still more accurate. Moreover, the VAR(1) suffers from serial correlation in the residuals, which makes the forecast less reliable.

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