MINISTRY OF EDUCTION AND TRAINING

NATIONAL ECONOMIC UNIVERSITY

PROJECT TIME SERIES

TIME SERIES ANALYSIS

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CLASS: DSEB 62

Group 2

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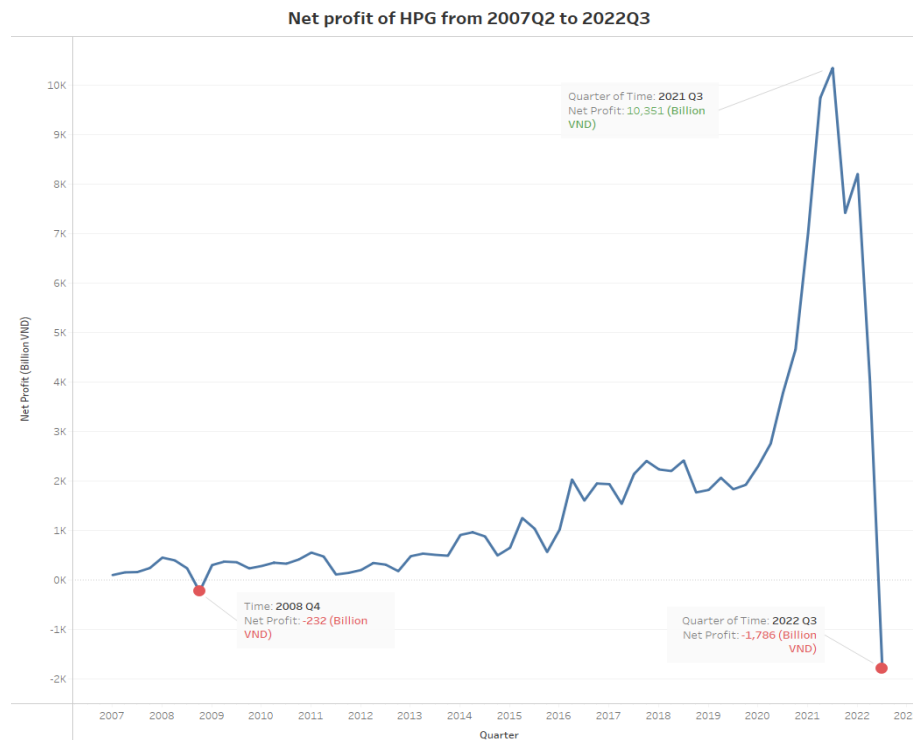| No	ID	Full Name	Contribution	Score
1	11204971	Nguyen Tuan Duy	35%	
2	11204838	Nguyen Minh Duc	35%	
3	11203096	Le Huy Phong	30%	
Sum			100%	

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1. INTRODUCTION

Steel is the most important engineering and construction material as it is used in many aspects of our lives from home appliances such as refrigerators and washing machines to cargo ships and buildings. In Vietnam, the steel industry plays a particularly important role in the process of developing the country towards industrialization and modernization as steel is the input materials for important economic sectors of the country like mechanical engineering, construction... Vietnam steel industry has witnessed a strong growth in terms of quantity as well as quality of output in recent years, evidently, it was ranked as the 14th biggest steel producing country in 2020. As a result, the steel stock market has been attracting more and more attention from investors, thus, the problem of forecasting the accurate future stock price is becoming increasingly important. This study will analyze the performance of the three leaders in Vietnam steel industry namely Hoa Phat Group, Hoa Sen Group and Nam Kim Group using different indexes in the groups' quarterly financial report such as gross revenue or net profit and forecast the daily closing stock price of these businesses for the first 10 days in 2023. Additionally, the relationships between the three stock codes will also be considered to develop a multivariate model for forecasting.

2. TIME SERIES ANALYSIS WITH STEEL STOCK PRICE – INDIVIDUAL

2.1 Hoa Phat Group – Gross Sale Revenue and Stock price analyzation – Nguyen Tuan Duy

2.1.1. 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.

Net profit of HPG from 2007Q2 to 2022Q3

2.1.2 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.

Visually, 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.

By regressing Net profit on trend and seasonality, some insights can be interpreted from the coefficients of the models:
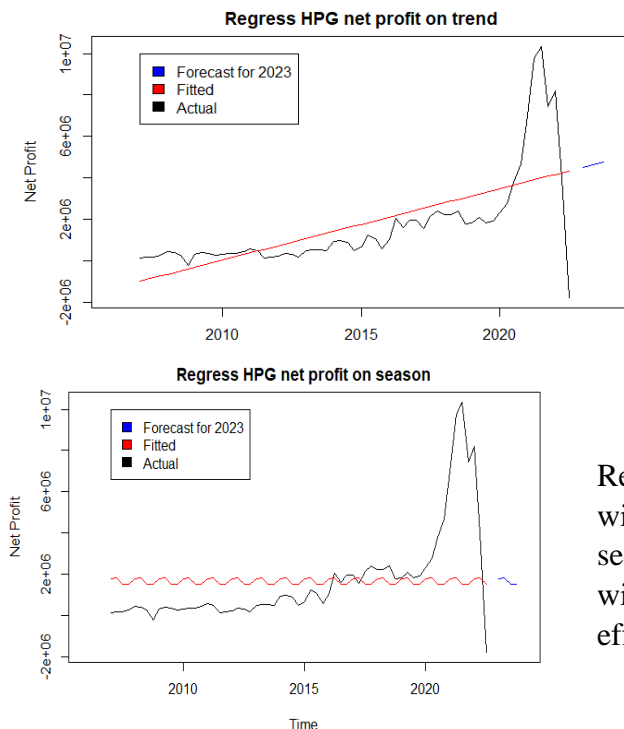
Regress on linear trend:

$$Netp = -1094272 + 86074t$$

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.

Regressing net profit on seasonality:

$$Netp = 1510591 + 268039\,Q_1 + 314060\,Q_2 + 6558\,Q_3$$

Regressing net profit on seasonality, it can be seen 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.

From regression results, only trend component is statistically significant whereas for seasonal components, they are insignificant suggesting that the net profit's trend is not cyclical. To examine the relationship between trend and seasonality on the HPG's quarterly net profit, the decomposition of the series can be used:

Decomposition of additive time series
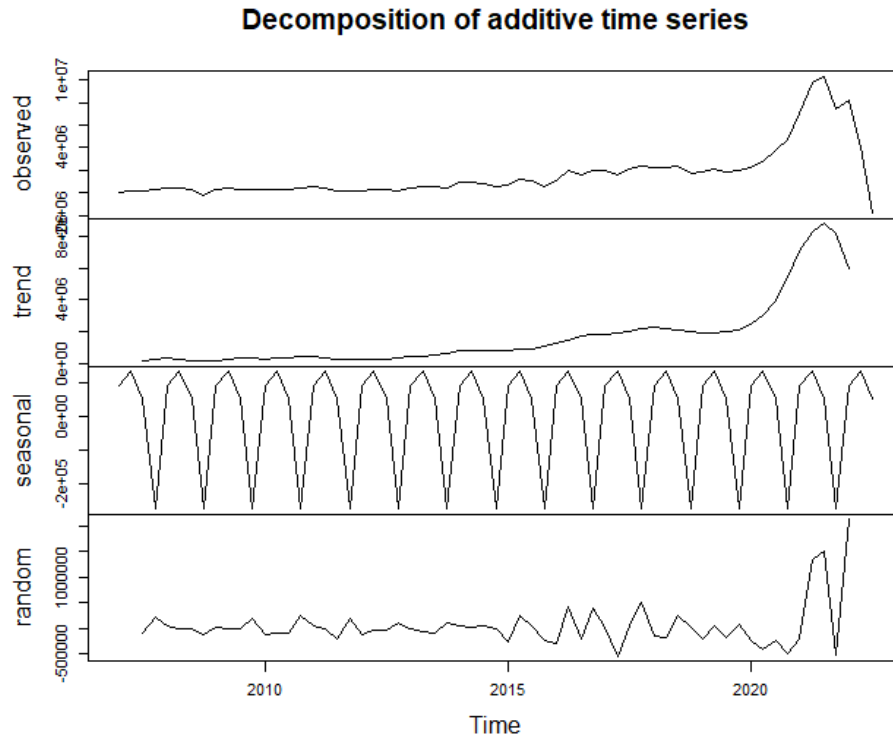
The seasonal series suggests that Hoa Phat tends to make the least profit on the fourth quarter of the year, and recover in the first two quarters of the year. The trend component, on the other hand, shows a significant impact the net profit of HPG as the regression result showed. The growth of HPG is an upward trend but it began to decline from third quarter of 2022. The effect of randomness becomes more and more significant overtime, suggesting the net profit deviates more from trend and seasonality as time goes on. Addtionally, Holt-winters models can also be utilized to forecast future profit for HPG:
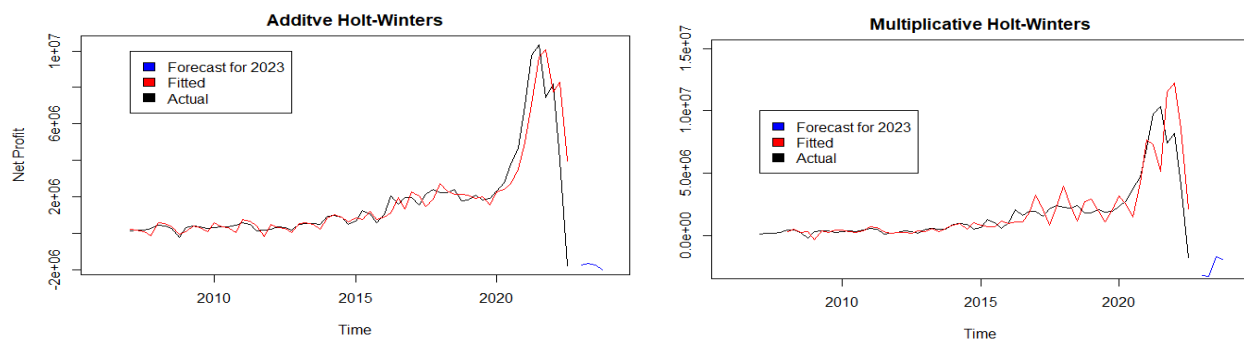
	RMSE (Whole data)	RMSE (Last 4 observations)	MAPE (Whole data)	MAPE (Last 4 observations)	Forecasted Average profit 2023
Linear-Linear trend	1713286	403271	148%	111%	4629640
Linear-Log trend	1997210	4262831	233%	104%	298660
Log-Linear trend	2853247	595316	100%	100%	627909.4
Seasonality	2316076	4795025	278%	99%	1657755
Seasonal + Trend	1702693	393046	143%	108%	4638811
Seasonal * Trend	1689016	359762	147%	99%	4651495
Additive Holt-Winters	1107052	3819690	45%	117%	-1796685
Multiplicative Holt-Winters	2327727	5741293	74%	101%	-2529453

Table 2.1.1. All models RMSE&MAPE

The evaluation on eight models indicates that the Holt-Winter models provide a better forecast than regressions on trend and seasonality. Additionaly, the two model groups provide contradict forecasts, regressing 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.

2.1.3. 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.
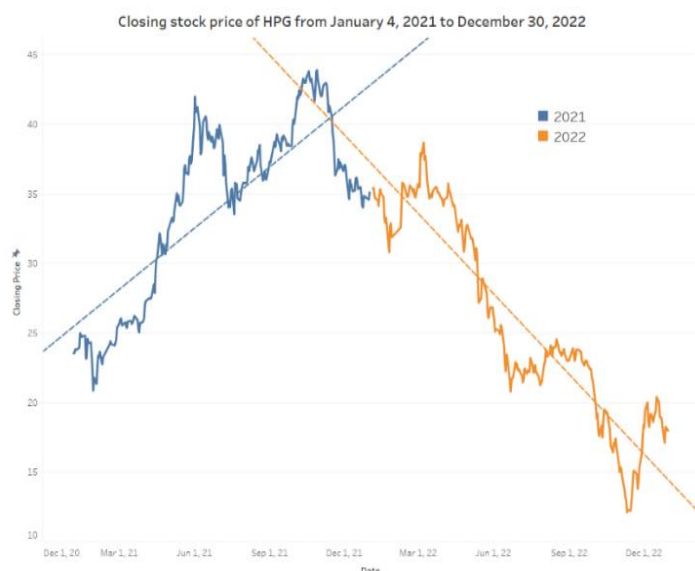
Consequently, the stock price of HPG also reflect the opposite trends between two years as in 2021, the stock price has a positive trend whereas in 2022, it is negative.

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:
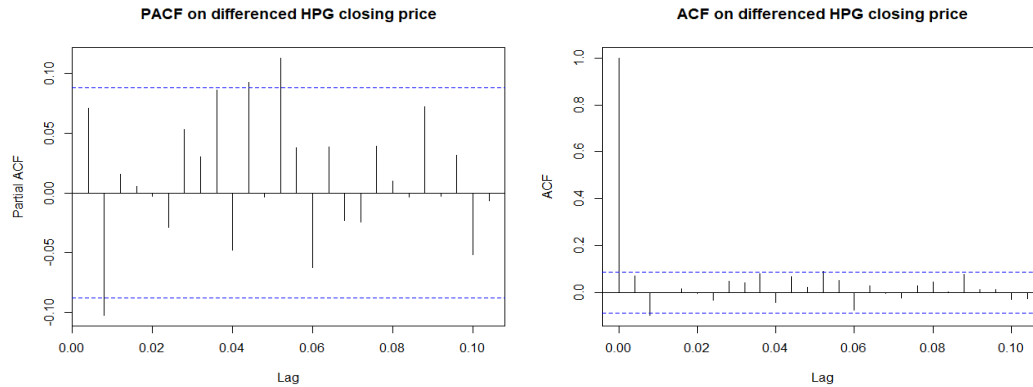

The plots suggests that an AR(1) model fits here due to a clear cut off after lag 1 in the PACF plot and only one autocorrelation that is significantly non-zero at a lag of 0, . To provide comparision, a few more ARIMA model was fitted on the HPG stock price series:

	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%

Table 2.1.2. ARIMA Comparison

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.

Figure 2.1.7
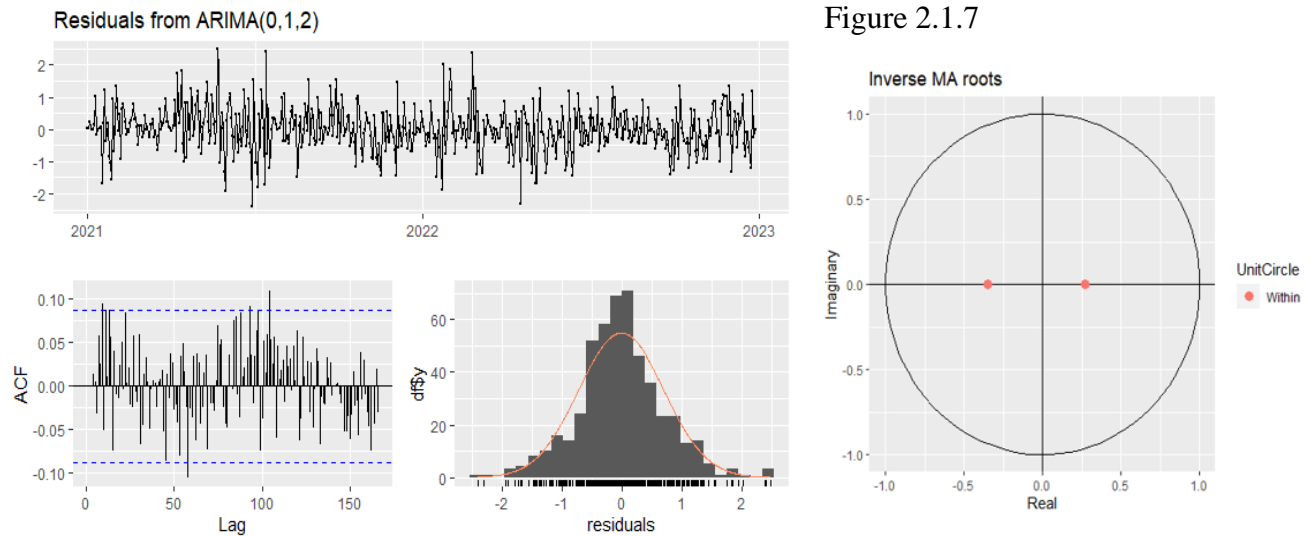
To evaluate the ARIMA(0, 1, 2) model, inverse roots are inside the unit circle and a p-value of 0.1474 from Ljung-box test says that the model's residuals are whitenoise, therefore, the model is valid. Finally, the forecast result of ARIMA(0, 1, 2) model on stock price of HPG is presented below:


Forecasts from ARIMA(0,1,2)
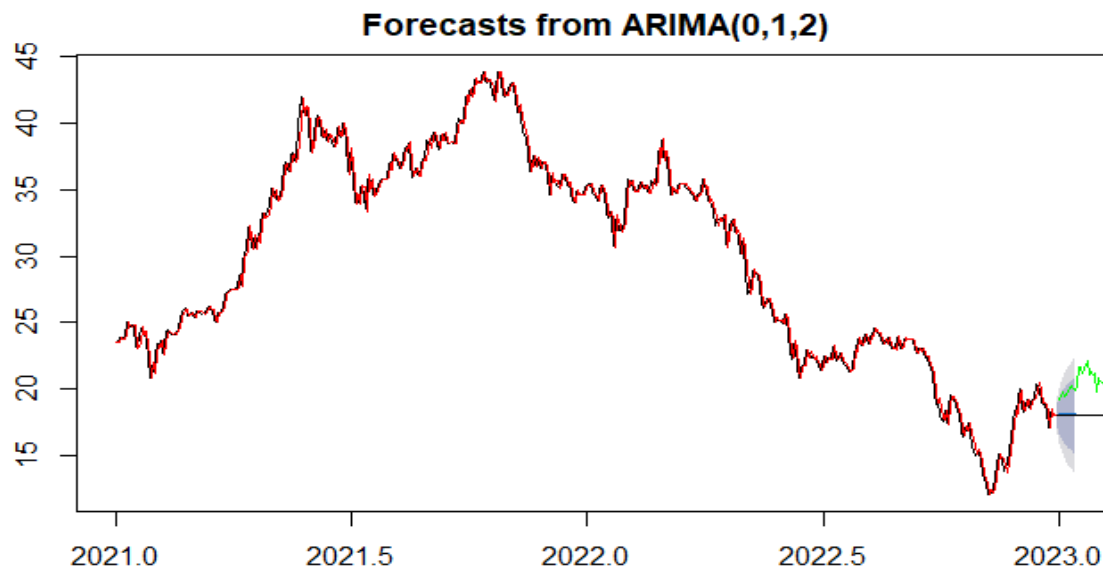
2.2 Hoa Sen group – Gross Sale Revenue and Stock price analyzation – Nguyen Minh Duc

2.2.1. 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.

2.2.2 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.
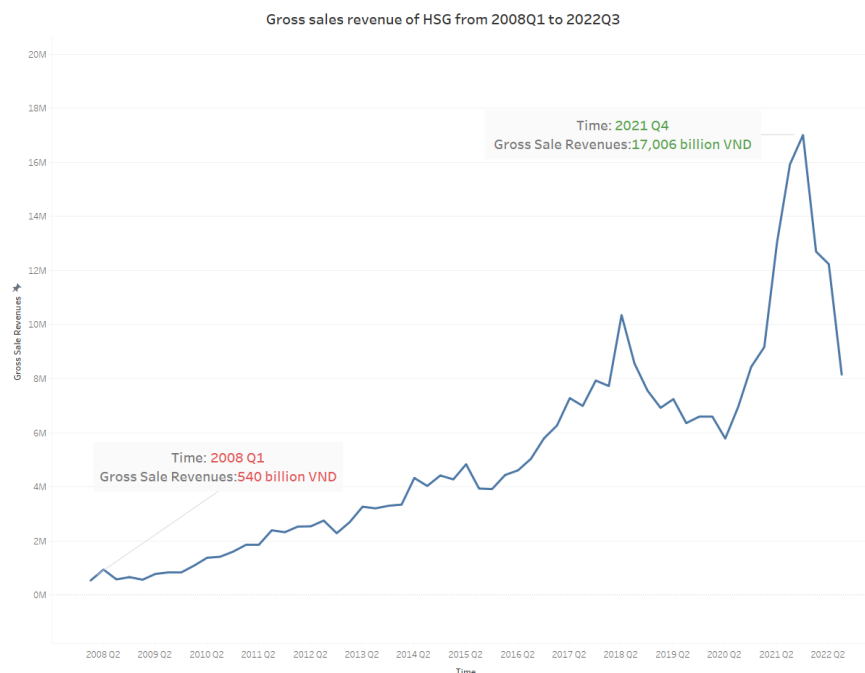
This time series line shows the gross sales revenue of Hoa Sen Group over a period of 14 years, from 2008 to the third quarter of 2022. The data indicates that the company has experienced fluctuations in revenue, with some years showing significant growth while others experiencing declines. Overall, 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%

Table 2.2.1: Trend models RMSE & MAPE

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 the case of all datasets, 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.

On the other hand, when we compare the MAPE of these models in the 4 last observations, there is a huge difference. 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.

Forecast by 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%

Table 2.2.2 Holt-Winter model RMSE&MAPE

Considering 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.
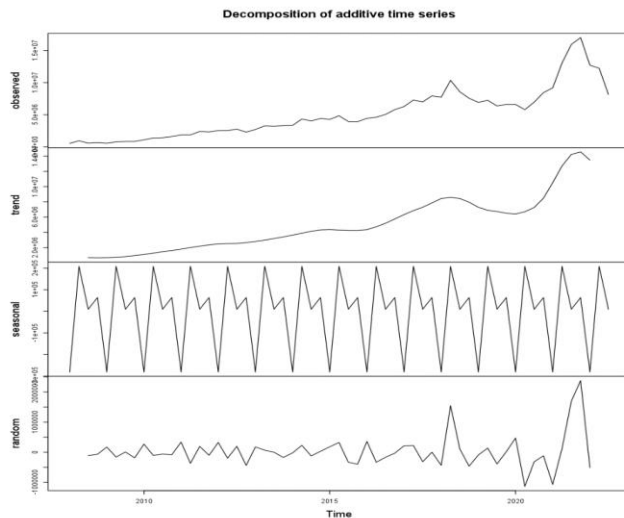
The seasonal series highlights that the gross sales revenue is heavily influenced by Q1 and Q2, with Q1 showing a significant decrease of around 281879 and Q2 indicating a sharp increase of approximately 208681. This suggests that there is a substantial drop in demand during Q1, followed by a substantial 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 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%

Table 2.2.3. Additive model RMSE & MAPE

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.

Time Series Stock Analysis Project

2.2.3. 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 8,152 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 price showed a positive trend, while in 2022, it exhibited a downward trend.
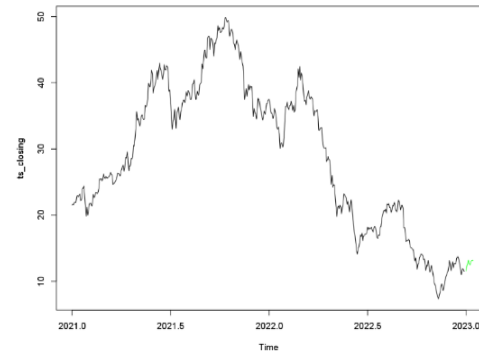
The series was tested for a unit root by Dickey-Fuller Unit root test, and it was discovered that it was stationary with a drift after taking the first-order difference. Therefore, the value of "d" in the ARIMA (p, d, q) model is 1. Additionally, to determine the two remaining orders of the ARIMA model, PACF and ACF plots can be used.
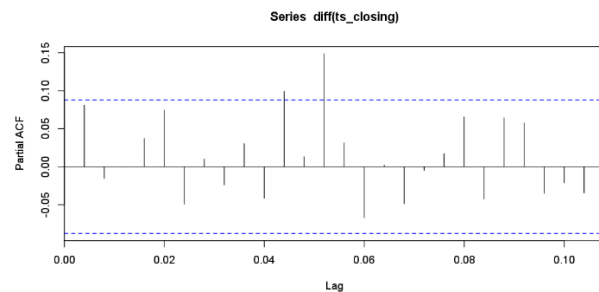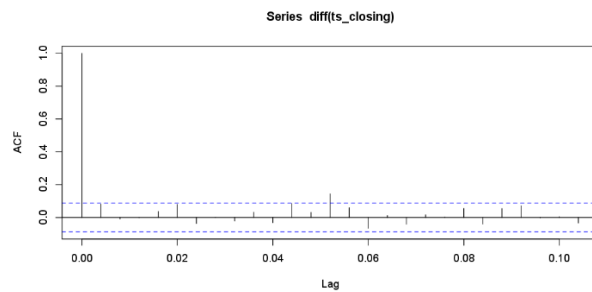

Upon examining the PACF and ACF plots, it becomes evident that there is no dependence on error terms, and there is no dependence on past values. To draw a comparison, a few additional ARIMA models were fitted to the HPG stock price series:

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%

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| 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%

Table 2.2.4 ARIMA Comparison

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.
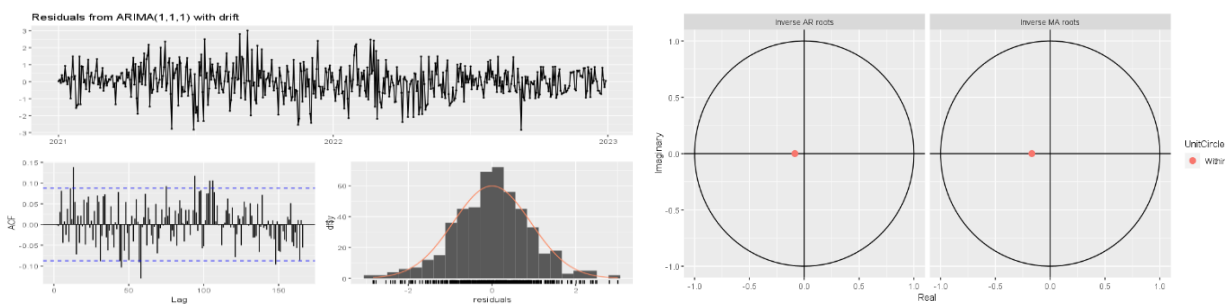
To evaluate the ARIMA (1,1,1) model, inverse roots are inside the unit circle and a p-value of 0.00 says that the model's residuals exhibit serial correlation. Upon examining the residuals of the other models, we have found evidence of serial correlation in those models as well. As the result, forecast 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:

Forecasts from ARIMA(1,1,1) with drift
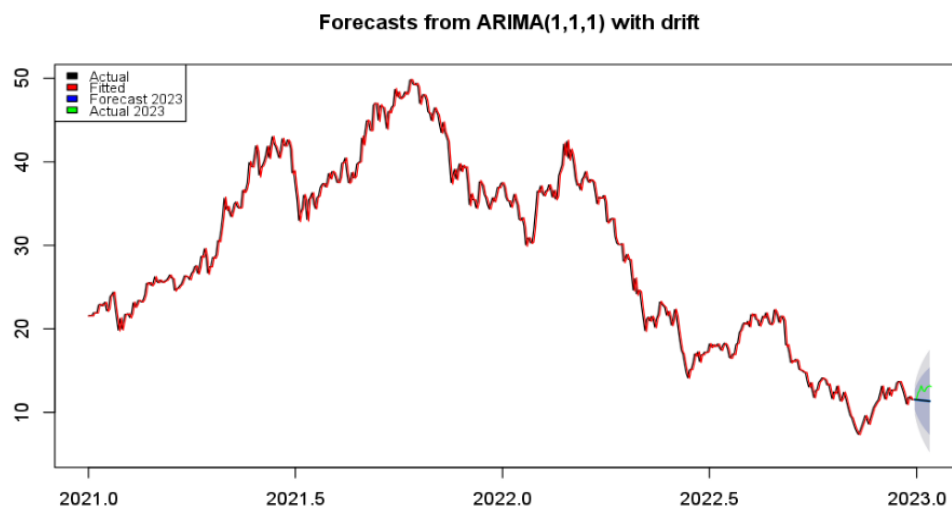
2.3. Nam Kim Group – Gross Sale Revenue and Stock price analyzation – Le Huy Phong

2.3.1. 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.

2.3.2. Quarter – Gross Sale Revenue

Gross revenue of NKG from 2010 Q1 to 2022 Q3
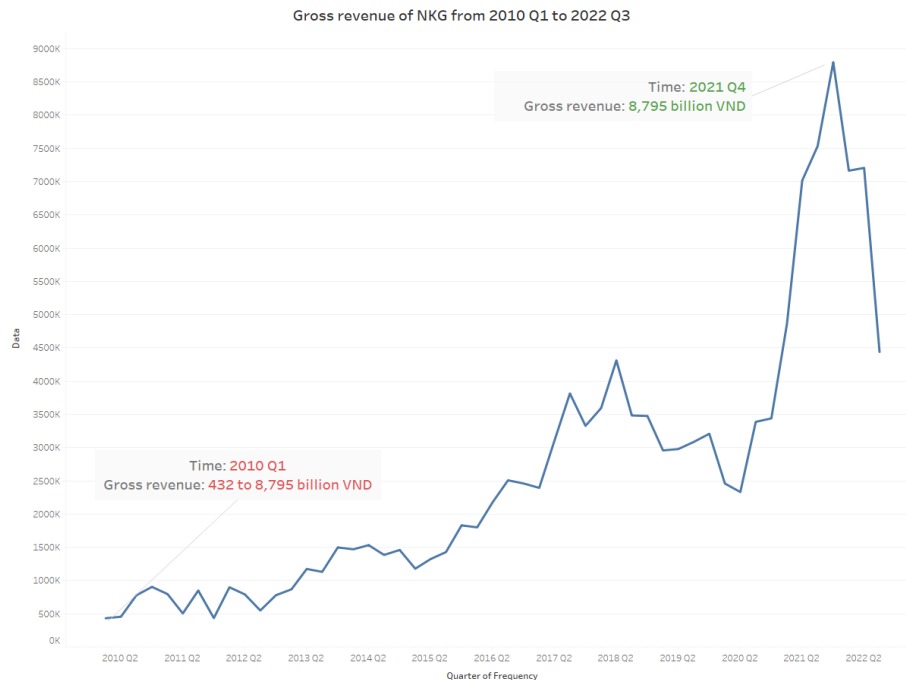
The time series data I analyze is the Gross Sale Revenue price of a corporation called NKG (CTCP Thép Nam Kim) from 2010 to 2022. The graph tells us that the company has gone through many states from steadily increasing until 2020 and experienced a rocket boost in GSR in 2022 to continually decrease 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 model 1 to model 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 shows 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:

	RMSE (Whole data)	RMSE (Last 4 observations)	MAPE (Whole data)	MAPE (last 4 observations)
Linear-Linear trend	1041127	2299360	37.2 %	29.2%

|				
Linear-Log trend	1441906	3274554	71%	37.4%
Log-Linear trend	3277096	7076182	99.9%	99.9%
Seasonality	2013084	4597940	111%	60%
Seasonal + Trend	1038149	2273173	37.1%	28.7%
Seasonal * Trend	1028837	2169625	37.5%	26.9%
Additive Holt-Winters	681672.7	1724813	21.2%	25.5%
Multiplicative Holt-Winters	2467798	6358366	60.9%	88.4%

Table 2.3.1 All models RMSE&MAPE

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 suggests that in the 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.
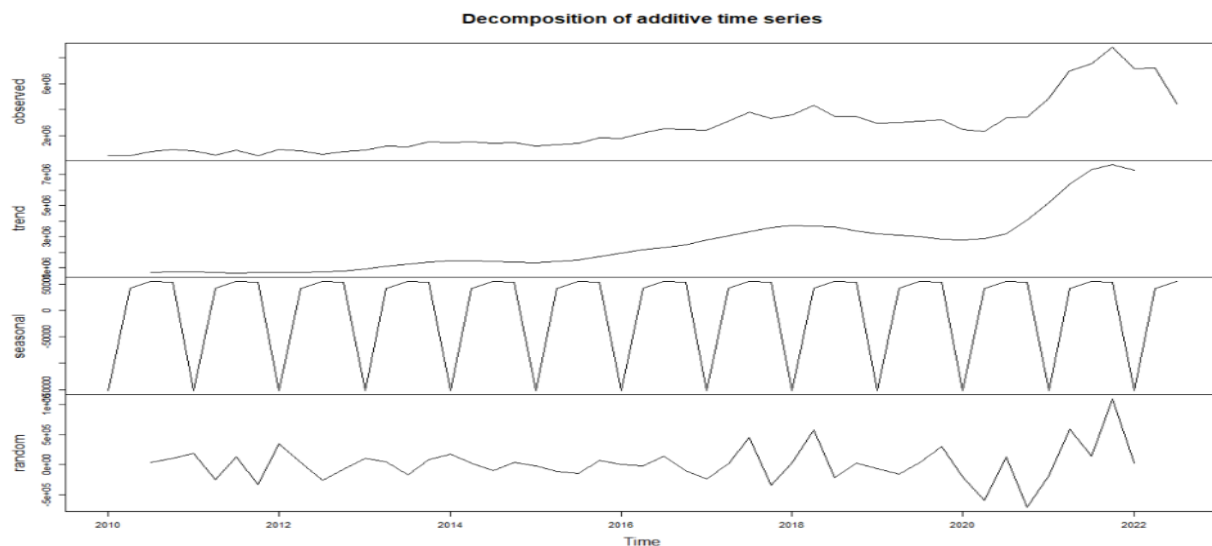
2.3.3 Daily – Stock price of NKG:

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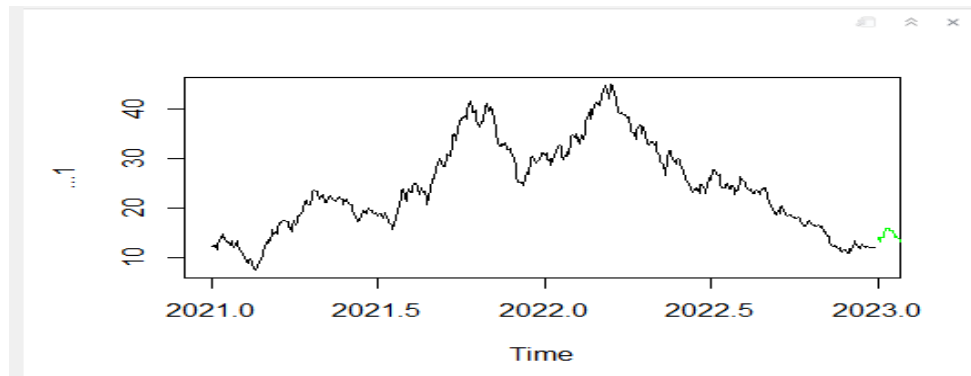
After that, we will Test with trend and constant (H1: stationary around trend)

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 plot 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.
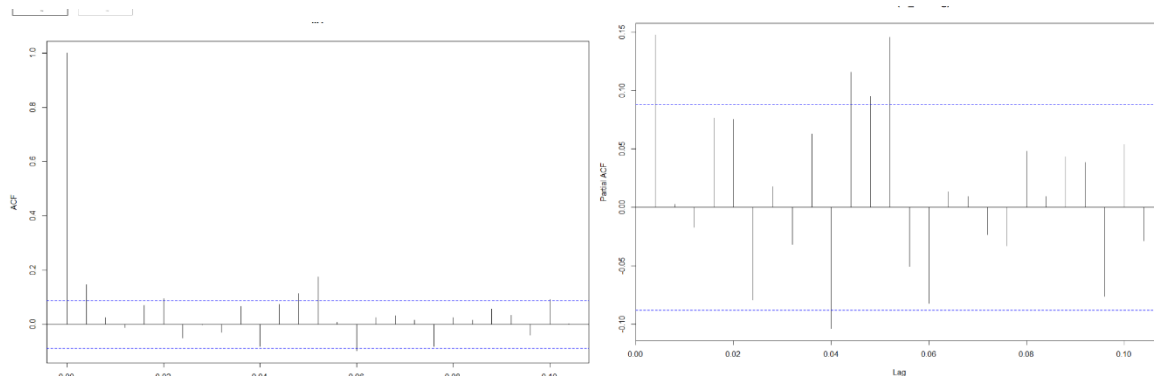

To provide comparison, we will move on to fitting and evaluating models a few more ARIMA model was fitted on the NKG stock price series.

	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 observations)	0.297	0.303	0.305	0.302	0.322
MAPE (last 10 observations)	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%

Table 2.3.2. ARIMA Comparison

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 has the lowest AIC and BIC values. In conclusion, when it comes 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 has a decent result in other fields compared to other models.
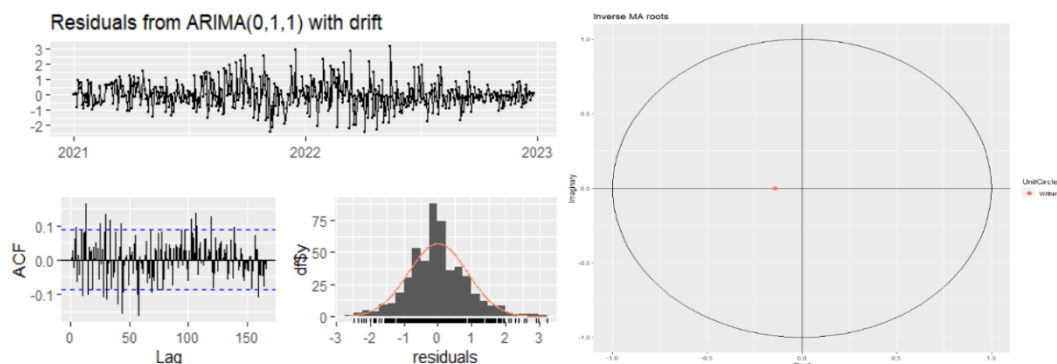
Here is the forecast model:
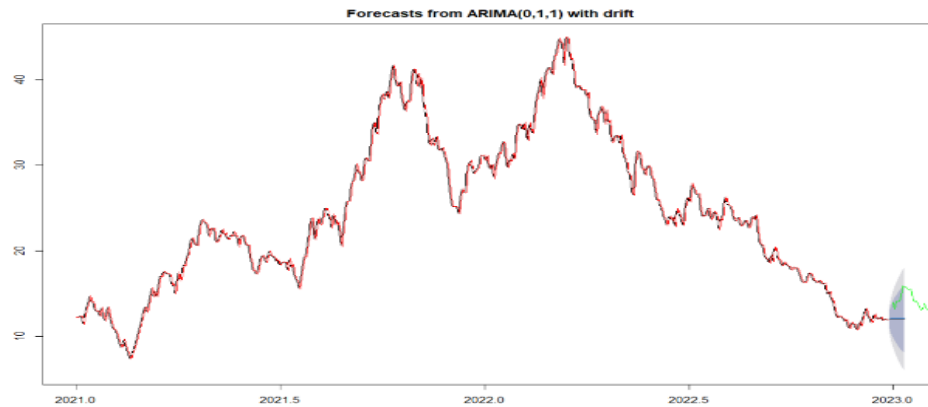
3. COINTEGRATE ANALYSIS

Spurious regression refers to a situation where two or more time series variables appear to be related or correlated, even though they are not causally related. Since the three groups operate in the same industry of manufacturing steel, the cointegration relationship can be explained by underlying economic theory rather than being a spurious regression.

3.1 Spurious regression analysis:

We estimate the equation to see if there is a long-run equilibrium that will occur.

Figure 3.1. Spurious regression result

From the regression result, all three series depend on each other as all coefficients are significant at 5% level, which arises due to the same trend in three series. To determine the long-run equilibrium, we need to check whether the residual is white noise or not.

By testing the stationary residual using Augmented Dickey-Fuller unit root test, there is enough evidence to show that the residuals are stationary at 5% level for model HPG ~ HSG + NKG and model HSG ~ HPG + NKG and residuals are stationary at 10% level for model NKG ~ HSG + HPG. These results suggest there exists a long-run equilibrium and a steady state.

3.2 Cointegration:

Daily closing price of HPG, HSG, NKG from 2021 to 2023
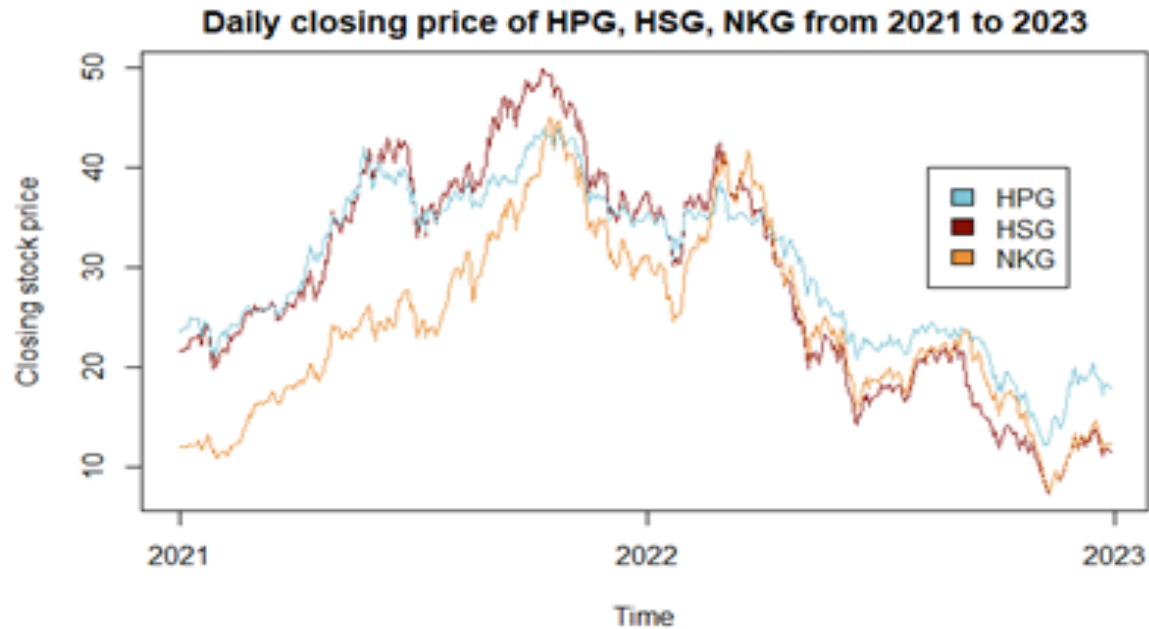
Take a closer look at all three series following a common trend: increase in the year 2021 and decrease in 2022. Additionally, stock prices of all three groups peaked in October of 2021 and hit their bottoms in November of 2022, which is an indication that they may be cointegrated.

Johansen test (Type = "max eigen")	Test	10pct	5pct	1pct
r <= 2	2.79	6.50	8.18	11.65
r <= 1	13.04	12.91	14.90	19.19
r = 0	20.35	18.90	21.07	25.75

Table 3.1 Johansen test result

The first hypothesis r = 0 tests for the presence of cointegration. As can be seen from the test result, the test statistic did not exceed the 5% level, therefore there is not enough evidence to reject the null hypothesis of no cointegration relationship between the series. Based on the test results, the three series don't have cointegration relationships and they are stationary in residuals, thus, there is no need to develop an error correction model (ECM).

4. VAR MODEL

4.1 Granger causality test

To decide whether the three stock price series have causality relationship on each other, the Granger causality test gave following result:

X		Y	P-value
ΔHPG		ΔHSG	0.8941
ΔHPG	Is cause of	ΔNKG	0.3634
ΔHSG		ΔHPG	0.5539
ΔHSG		ΔNKG	0.1216
ΔNKG		ΔHSG	0.7537
ΔNKG		ΔHPG	0.8018

Table 4.1. Granger test results

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:

4.2 Var model

	ΔHPG $= \beta_{10} + \beta_{11}\Delta HPG_{t-1}$ $+ \beta_{12}\Delta HSG_{t-1}$ $+ \beta_{13}\Delta NKG_{t-1} + u_{1t}$		ΔHSG $= \beta_{20} + \beta_{21}\Delta HPG_{t-1}$ $+ \beta_{22}\Delta HSG_{t-1}$ $+ \beta_{23}\Delta NKG_{t-1} + u_{2t}$		ΔNKG $= \beta_{30} + \beta_{31}\Delta HPG_{t-1}$ $+ \beta_{32}\Delta HSG_{t-1}$ $+ \beta_{33}\Delta NKG_{t-1} + u_{3t}$	
	est. coefficients	P_value	est. coefficients	P_value	est. coefficients	P_value
ΔHPG_{t-1}	0.049576	0.488	-0.006957	0.940	0.019175	0.824
ΔHSG_{t-1}	0.068379	0.329	0.105173	0.248	0.107953	0.204
ΔNKG_{t-1}	-0.054868	0.415	-0.025657	0.769	0.041052	0.614

Table 4.2. VAR results

From the results table, at 5% significance level, all coefficients are not statistically significant. Also, after conducting serial test, p-value = 0.009, so there is a serial correlation. Therefore, the evaluation of the statistical significance of the coefficient estimates of the model is not reliable, so the team suggests that the model should not be used to evaluate the impact and predict the confidence interval.

4.3 Impulse response function

An impulse response function (IRF) of a time series mode measures the changes in the future responses of all variables in the system when a variable is shocked by an impulse. With HPG, HSG and NKG, Impulse response function is shown below:
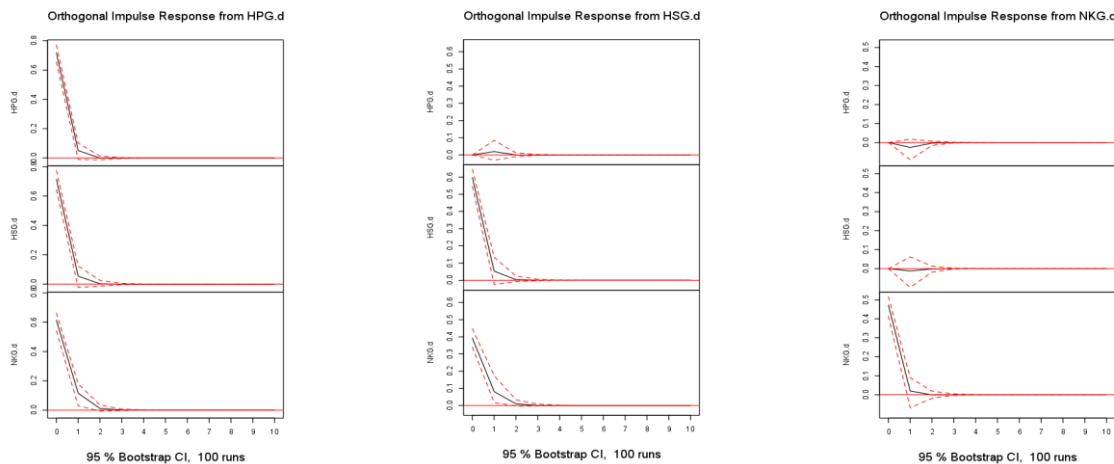

Figure 4.3. IRF plot results

When 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. 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 price movement after one period, there was only a slight upward correction. 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, the shock in the past of price movement of the HPG stock directly and significantly affects the price movement of the other two stocks. The shock in the past of 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 past shock 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 shock in the price movement of HPG has a significant impact on the shock in the price movements of the other stocks. The shock in price movement of

NKG, in contrast, largely has no impact on the shock of price movement of the remaining stocks and only influences it internally.

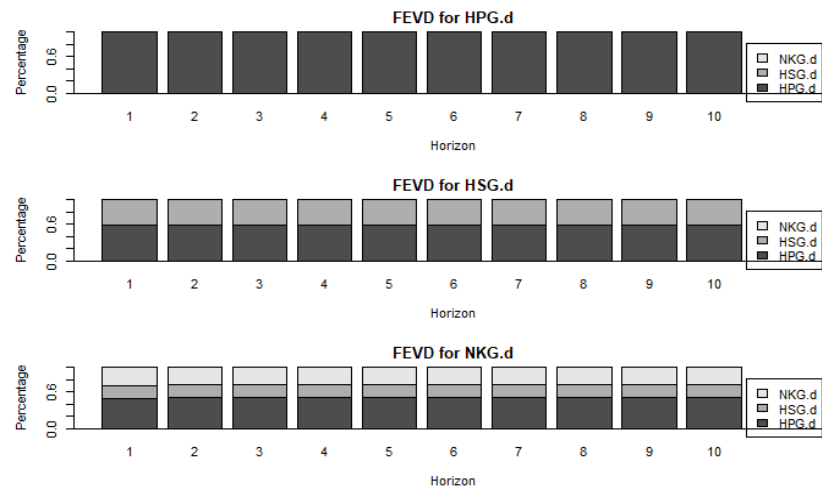## 4.4 Forecast error variance decomposition - FEVD

Figure 4.4. FEVD

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.

5. FORECAST RESULT

	HPG		HSG		NKG	
Model	VAR (1)	ARIMA (0, 1, 2)	VAR (1)	ARIMA (1, 1, 1)	VAR (1)	ARIMA (0,1,1)
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%

Table 5.1. VAR & ARIMA forecast summary.

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.

6. CONCLUSION & RECOMENDATION

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. However, we need to notice that the task of prediction is hard, and we can't make it with 100 % accuracy, we must take in real-life data and consider the real accuracy requirement in real life.

Fourth, we can infer from impulse response function that the shock in the price movement of HPG has a significant impact on the shock in the price movements of the other stocks. The shock in price movement of NKG, in contrast, largely has no impact on the shock of price movement of the remaining stocks and only influences it internally. This can easily be explained because HPG is a large steel corporation that has a huge effect on other companies in the same section.

Fifth, Through the above report, we can see that most of the forecast results of the models for the closing price of the stock as well as the business situation of the corporation are tending to increase, but the forecast results are not too accurate, difficult to apply these models into practice and real-life situation. The business situation of the steel industry is strongly influenced by several macro factors related to industries such as industry, construction, and real estate (The business situation of these industries is very unpredictable due to various micro and macro factors). In the long term, investors can consider the volatility of macro and micro price chains to come up with reasonable investment strategies. Along with that, investors can go through and use the forecast results of the chains to come up with an appropriate investment plan.

7. REFERENCES

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Data 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)) from 2011 till the end of 2022