

UNDERSTANDING AND FORECASTING SELECTED PHILIPPINE STOCK MARKET PRICES FROM DIFFERENT COMPANIES BEFORE AND DURING COVID-19 PANDEMIC USING MULTIPLE LINEAR REGRESSION AND ARIMA MODEL

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ABSTRACT

The COVID-19 pandemic has emerged as one of the most devastating events in history, impacting not only lives but also global economies, resulting in job losses and business closures. This study delves into the economic repercussions of the pandemic, focusing on the effectiveness of investing in the stock market as a potential income source amidst the financial crisis. Against the backdrop of widespread negative effects, the central question addressed by this research is: Can investing in the stock market serve as a viable means of income during a period of financial upheaval? To investigate this, a cluster sampling method was employed to select representative companies from various sectors within the Philippine Stock Exchange Index (PSEi). The chosen companies—PLDT, JFC, MPI, BPI, and MEG—underwent a thorough analysis. Specifically, the study examined each company's stock prices both before the pandemic (2016-2019) and during the pandemic (2020-2021). These stock prices were then correlated with key economic indicators, including GDP, Inflation Rate, and Unemployment, using multiple linear regression analysis. Through this approach, the research aims to unveil the intricate relationships between stock prices and economic indicators, shedding light on the potential of stock market investments as a resilient source of income during challenging economic times. Moreover, the research employs ARIMA modeling to predict 30-day stock prices for December 2019 and March 2021. To enhance the data forecast, the study incorporates performance indicators spanning a 5-year period for each company, offering additional insights for a comprehensive investment analysis. Notably, the research reveals substantial returns for the stock prices of each corporation, as indicated by the Mean Absolute Percentage Error (MAPE), both before and during the pandemic. The forecasted models are below 10% MAPE except for MPI's before the pandemic model. Forecasting the stock prices of these companies can help investors to buy low and sell high, which is taking advantage of the situation to earn higher returns while alleviating businesses as well as the economy to recover.

Keywords: COVID-19, ARIMA, Multiple Linear Regression, Stock Market, PSEi

INTRODUCTION

In 2019, the COVID-19 allegedly started in an outbreak at Huanan Seafood Market in Wuhan, China. The pneumonia-like disease that has distinguishable fever, dry cough, and fatigue

spread to neighboring countries Japan, Philippines, and even United States (Chan, et al. 2020). Statistics from the World Health Organization (WHO) show that today, there are over 500 million confirmed cases and over 6 million deaths globally. Starting at 2021, where the study is

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being accomplished and at the height of the pandemic, in the Philippine setting, the total number of COVID-19 cases recorded stands at around 2,843,979 with a total death toll of over 51,504 as of December 2021. To add more to that, out of 30,526 tests made in December, DOH records a 10.3% positivity rate which is the highest daily rate since October 2021. Despite these large numbers, recorded recoveries is around 2,778,242 (Macaraeg, 2021). Aside from its health effects, the COVID-19 has also given rise to fears of an impending economic recession because of the uncertainty of the end of pandemic. In addition to that, the target year for herd immunity will be 2023 as stated by DOH (Inquirer.net, 2022) thus, businesses will have trouble in recovering from the unanticipated back and forth lockdowns. Given its adverse effects on the lives of the Filipinos and the entire world, it is imperative that studies be conducted to determine the advantage and disadvantage changes the COVID-19 has brought about, particularly in the stock market. Stock Market and Economy Globally, March 2020 of the pandemic gave one of the most dramatic stock market crashes in history as it took only less than four trading days for the Dow Jones Industrial Average (DJIA) to drop 6,400 points – a 26% decrease that was attributed to the government’s reaction to the Covid-19 (i.e., lockdowns and social distancing), causing many businesses to shut down temporarily or even permanently and lose revenue for an indefinite period of time. In the Philippines, a 2020 survey conducted by Sergio Ortiz-Luis Jr. of the ABS-CBN Investigative and Research Group revealed that business owners encountered increased challenges in sustaining operations amid the enhanced community quarantine. These difficulties were attributed to government-imposed restrictions, a shortage of public transportation, logistical constraints, and disruptions in the supply of raw materials.

On that note, the National Economic Development Authority discussed how a simultaneous decline and mitigation effects on the supply and demand, it would reduce the Philippines’ real GDP growth to 0.6 or 4.3% in 2020 from a 6.4% in Q4 of 2019. Furthermore, there will be an increase in unemployment rate because of the COVID-19 pandemic and this could be seen in the data from Philippine Statistics Authority (2019) wherein the unemployment rate from the Labor Force Survey during 2019 is around 5.1% but during the year 2020, unemployment doubled to 10.3%. As such, the Philippine government has imposed several mitigating measures including promoting the availability of credit to productive sectors of the economy with emphasis on those from rural areas through reducing lending rates of interest and reserve requirements of lending organizations; giving preference to programs by relevant government agencies such as the “Tulong Hanapbuhay sa Ating Disadvantaged/Displaced Workers and COVID-19 Adjustment Measures Program” by the Department of Labor and Employment, the Rice Farmers Financial Assistance Program by the Department of Agriculture, and the Assistance to Individuals in Crisis Situations (AICS), livelihood assistance grants by the Department of Social Welfare and Development (International Monetary Fund, 2020). The government has also sought to soften the impact of income instability during the COVID-19 crisis by providing welfare aids and mandating a minimum of thirty-day grace period on residential rents during the enhanced community quarantine as well as loan payments and other cash deliverables (TMF Group, 2020). In 2021, the prevailing consensus among economists is that a robust vaccination rollout offers the Philippines a significant opportunity to return to normal business operations. With this, understanding the pattern of stock prices before the pandemic might help in



understanding how the stock prices of Philippine Stocks Exchange-listed companies will recover in the pandemic. There are different stock price patterns that can be observed and these help investors and analysts predict and understand the movement of the stock prices. Another is, investing in the stock market can help different people earn and secure savings for emergencies that can happen during this pandemic and for the years to come even after the pandemic. An economic recession will happen during a pandemic, thus, because of investors withdrawing their money from stock markets companies will lower their stock prices (AIA Group, 2020). This will help people to look into investing in the stock market because the prices will be cheaper. Additionally, this will help the companies to still continue functioning because of the investments from the investors. Furthermore, we study industry- level patterns to determine how the pandemic caused stock market crashes in the best performing industries in the Philippines as well as the sectors that experienced either positive monthly returns or rapid descent of their market capitalizations and investigate the reasons behind such behavior.

OBJECTIVES OF THE STUDY

The main objectives of this study are the following: 1) to determine the before and during the pandemic PLDT stock price vs economic indicators; 2) to know the before and during pandemic JFC stock price vs economic indicators; 3) to evaluate the before and during pandemic MPI stock price vs economic indicators.

RESULTS AND DISCUSSION

Analyses of the 3-year and 2-year data involved the use of multiple linear regression to reveal the relationship between stock prices and economic indicators such as inflation rate, unemployment rate, and GDP. The analysis of the

data was pursued to understand the patterns of stock prices before and during the pandemic. Information about the relationship between stock prices and certain economic indicators would have been advantageous for investors recognizing the economic situation of the country and how it affected the stock prices of some companies. To interpret the results, the researchers observed the p-value of each multiple linear regression in accordance with the hypothesis testing, where the null hypothesis (Ho) was tested: the p-value is greater than 0.05. After establishing the relationship, the researchers further interpreted the results by examining the f-statistic, an indicator of a better model, and R², which shows how well the model fits the data or the goodness of fit.

1. Before and During Pandemic PLDT Stock Price vs Economic Indicators

Table 1
Before and During regression PLDT Stock Price vs Economic Indicators

	PLDT	
	Before	During
p-value	0.00286	0.921
f-statistic	8.85	0.146
R ²	0.707	0.305

The results of the multiple regression for before and during pandemic stock prices show that only the p-value before the pandemic (2016-2019) is 0.00286 which is less than the null hypothesis (p-value < .05) therefore, we reject the null hypothesis thus, the stock prices of PLDT before the pandemic is statistically significant for the economic indicators.

2. Before and During the Pandemic JFC Stock Price vs Economic Indicators



Table 2

Before and During regression of JFC stock price to economic indicators

JFC		
	Before	During
p-value	0.0368	0.56
f-statistic	4.03	172
R ²	0.524	0.998

The results of the multiple regression for before and during pandemic stock prices shows that only the p-value before the pandemic (2016-2019) is 0.0368 which is less than the null hypothesis ($p\text{-value} < .05$) therefore, we reject the null hypothesis thus, the stock prices of JFC before the pandemic is statistically significant for the economic indicators.

3. Before and During Pandemic MPI Stock Price vs Economic Indicators

4.

Table 3

Before and During regression of MPI stock price to economic indicators

MPI		
	Before	During
p-value	0.00439	0.462
f-statistic	7.88	2.08
R ²	0.682	0.862

The results of the multiple regression for before and during pandemic stock prices show that only the p-value before the pandemic (2016-2019) is 0.00439 which is less than the null hypothesis ($p\text{-value} < .05$) therefore, we reject the null hypothesis thus, the stock prices of MPI before the pandemic is statistically significant for the economic indicators.

5. Before and During Pandemic BPI Stock Price vs Economic Indicators

Table 4

Before and During regression of BPI stock price to economic indicators

BPI		
	Before	During
p-value	0.319	0.16
f-statistic	1.31	20.7
R ²	0.264	0.984

The results of the multiple regression for before and during pandemic stock prices shows that both p-values of the multiple regression are greater than .05 therefore, do not reject the null hypothesis thus, the stock prices of BPI before and during the pandemic is not statistically significant for the economic indicators.

6. Before and During Pandemic MEG Stock Price vs Economic Indicators

Table 5

Before and During regression of MEG stock price to economic indicators

MEG		
	Before	During
p-value	0.0538	0.137
f-statistic	3.48	28.2
R ²	0.487	0.988

The results of the multiple regression for before and during pandemic stock prices shows that both p-values of the multiple regression are greater than .05 therefore, accept the null hypothesis thus, the stock prices of MEG before and during the pandemic is not statistically significant for the economic indicators.

7. Arima Model

The process of the ARIMA modelling can be summarized as follows:

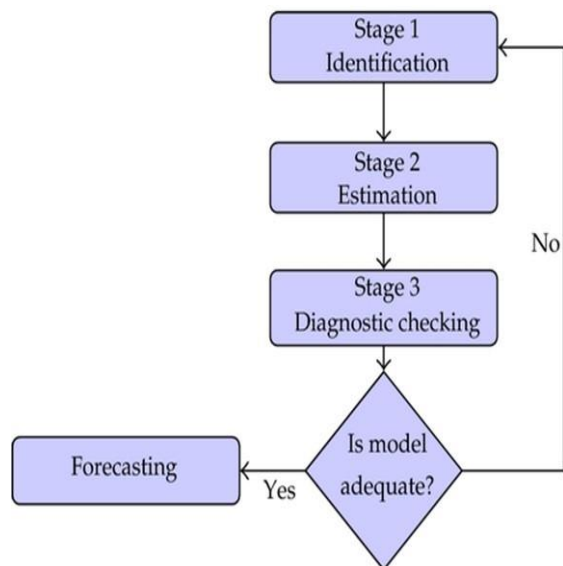


Figure 1. Box-Jenkins Model

From figure 1, the Box-Jenkins (1994) method, the first step was to identify if the time series is stationary and initial ARIMA orders (p, d, q) as guide to the exploratory analysis of the models. In table 6, the stock prices of the chosen companies were tested using the Augmented Dickey Fuller test to check if the time series is stationary. All of the time series underwent differencing once. Therefore, order d must be equal to 1 or ARIMA (p,1,q). Due to the fact that the stock price was unpredictable especially because of the pandemic, seasonal ARIMA was excluded and therefore, the researchers chose ARIMA for forecasting. After stationarity and seasonality have been dealt, the next step is to identify orders p and q in the ARIMA model. The PACF and ACF plots of the time series are generated to determine the AR or p order and the MA or q order. Once all of the initial ARIMA models are identified, the method can proceed to stage 2.

8. Dickey Fuller test hypothesis comparison

Table 6

Dickey Fuller test hypothesis comparison

Company	P-value after differencing	Conclusion
PLDT	1.00E-03	Reject H_0 , Stationary
JFC	1.00E-03	Reject H_0 , Stationary
MPI	1.00E-03	Reject H_0 , Stationary
BPI	1.00E-03	Reject H_0 , Stationary
MEG	1.00E-03	Reject H_0 , Stationary

As for stage 2, estimation is performed using several ARIMA models that were built using the Econometric Modeler in MATLAB. ARIMA models are tested in comparison to the initial ARIMA model (2,1,2) which is based on the exploratory analysis in the previous stage. Stage 3 diagnostic checking is done by verification and validation of the best fit ARIMA model that would be used in forecasting. According to Pankratz (1983) there are several characteristics of a good ARIMA model. A few of which are: the model is parsimonious, stationary (has AR coefficients), invertible (has MA coefficients), and most importantly it forecasts the future adequately due to its relatively small errors. The model is parsimonious when it is simple and has no unnecessary coefficients. In this regard, AR (p) and MA (q) orders greater than 2 are not part of the possible ARIMA models in forecasting. The ARIMA models with the lowest AIC, BIC, standard error of regression, and MAPE are chosen to be the best fit ARIMA models to forecast the stock prices. After that, forecasting is facilitated in MATLAB following a 10% margin of error.

9. Summary of ARIMA models for PLDT

Initial model identification of table 7 for PLDT, the table shows before the pandemic, the model ARIMA (1,1,1) has the lowest MAPE. During the pandemic, the table also shows that ARIMA (1,1,2) has the lowest MAPE. Therefore, both models are used to forecast the stock prices for



the whole month of December 2019 and March 2021.

Table 7
Summary of ARIMA models for PLDT

PLDT	ARIMA (p,d,q)	AIC	BIC	MAPE
Before	ARIMA (1,1,1)	8.68E+03	8.70E+03	0.0538
	ARIMA (1,1,2)	8.67E+03	8.70E+03	0.0543
	ARIMA (2,1,1)	8.67E+03	8.70E+03	0.0541
	ARIMA (2,1,2)	8.67E+03	8.70E+03	0.0542
During	ARIMA (1,1,1)	2.27E+03	2.29E+03	0.2268
	ARIMA (1,1,2)	2.27E+03	2.29E+03	0.0278
	ARIMA (2,1,1)	2.27E+03	2.29E+03	0.0280
	ARIMA (2,1,2)	2.27E+03	2.30E+03	0.0281

10. Before and During Actual vs Predicted PLDT stock price

Table 8
Before and During Actual vs Predicted PLDT stock price

PLDT	Date	Actual	Predicted ARIMA (1,1,1)	Absolute Percentage Error
Before	12/2/2019	1064	1080.298445	1.51%
	12/3/2019	1085	1079.371439	0.52%
	12/4/2019	1072	1078.444467	0.60%
	12/5/2019	1042	1077.517551	3.30%
	12/6/2019	1052	1076.590721	2.28%
	12/9/2019	1035	1075.664028	3.78%
	12/10/2019	1000	1074.737552	6.95%
	12/11/2019	1003	1073.811418	6.59%
	12/12/2019	998	1072.885824	6.98%
	12/13/2019	1001	1071.961085	6.62%
	12/16/2019	990	1071.037694	7.57%
	12/17/2019	994.5	1070.116436	7.07%
	12/18/2019	1000	1069.198546	6.47%
	12/19/2019	999	1068.285978	6.49%
	12/20/2019	1000	1067.381818	6.31%
	12/23/2019	1020	1066.490943	4.36%
	12/26/2019	999.5	1065.621056	6.20%
12/27/2019	988	1064.784331	7.21%	
PLDT	Date	Actual	Predicted ARIMA (1,1,2)	Absolute Percentage Error
During	3/1/2021	1297	1267.629028	2%
	3/2/2021	1300	1268.84417	2%
	3/3/2021	1291	1270.059303	2%
	3/4/2021	1290	1271.274454	1%
	3/5/2021	1299	1272.489572	2%
	3/8/2021	1297	1273.704751	2%
	3/9/2021	1296	1274.919815	2%
	3/10/2021	1328	1276.135096	4%
	3/11/2021	1309	1277.349969	2%
	3/12/2021	1311	1278.56561	3%
	3/15/2021	1266	1279.779803	1%
	3/16/2021	1291	1280.996728	1%
	3/17/2021	1313	1282.208498	2%
	3/18/2021	1290	1283.429993	1%
	3/19/2021	1195	1284.633141	7%
	3/22/2021	1220	1285.870904	5%
	3/23/2021	1226	1287.04336	5%
	3/24/2021	1250	1288.339025	3%
	3/25/2021	1248	1289.402244	3%
	3/26/2021	1251	1290.903997	3%
3/29/2021	1267	1291.57841	2%	
3/30/2021	1268	1293.813686	2%	
3/31/2021	1221	1293.104231	6%	

From the tables above, PLDT’s actual stock prices and the predicted stock prices are depicted for the months December 2019 and March 2021. Additionally, table 8 also shows the absolute percentage error (APE) between the actual and predicted prices.

11. Summary of ARIMA models for JFC

Table 9
Summary of ARIMA models for JFC

JFC	ARIMA (p,d,q)	AIC	BIC	MAPE
Before	ARIMA (1,1,1)	5.19E+03	5.21E+03	0.0620
	ARIMA (1,1,2)	5.19E+03	5.21E+03	0.0620
	ARIMA (2,1,1)	5.19E+03	5.21E+03	0.0620
	ARIMA (2,1,2)	5.19E+03	5.22E+03	0.0648
During	ARIMA (1,1,1)	1.42E+03	1.43E+03	0.0339
	ARIMA (1,1,2)	1.42E+03	1.44E+03	0.0347
	ARIMA (2,1,1)	1.42E+03	1.44E+03	0.0344
	ARIMA (2,1,2)	1.42E+03	1.44E+03	0.0318

Initial model identification of table 9 for JFC, the table shows before the pandemic, the model ARIMA (1,1,1) has one of the lowest BIC and one of the lowest MAPE. During the pandemic, the table also shows that ARIMA (2,1,2) has the lowest MAPE. Therefore, both models are used to forecast the stock prices for the whole month of December 2019 and March 2021.

12. Before and During Actual vs Predicted JFC stock price

From the table 10, JFC’s actual stock prices and the predicted stock prices are depicted for the months December 2019 and March 2021. Additionally, table 10 also shows the APE between the actual and predicted prices.



Table 10
Before and During Actual vs Predicted JFC stock price

JFC	Date	Actual	Predicted ARIMA (1,1,1)	Absolute Percentage Error
Before	12/2/2019	197.9	199.2434293	0.67%
	12/3/2019	192	199.206071	3.62%
	12/4/2019	198	199.1686366	0.59%
	12/5/2019	205	199.1310841	2.95%
	12/6/2019	202	199.0933488	1.46%
	12/9/2019	206.6	199.0553297	3.79%
	12/10/2019	201	199.0168709	1.00%
	12/11/2019	207.6	198.9777301	4.33%
	12/12/2019	216	198.9375318	8.58%
	12/13/2019	221.2	198.8956939	11.21%
	12/16/2019	223.6	198.8513138	12.45%
	12/17/2019	225	198.8029917	13.18%
	12/18/2019	225	198.7485576	13.21%
	12/19/2019	216	198.6846464	8.71%
12/20/2019	213	198.6060406	7.25%	
12/23/2019	220	198.5046502	10.83%	
12/26/2019	216.2	198.3679312	8.99%	
12/27/2019	216	198.1764338	8.99%	
JFC	Date	Actual	Predicted ARIMA (2,1,2)	Absolute Percentage Error
During	3/1/2021	178.8	174.8838641	2.24%
	3/2/2021	186	174.8973325	6.35%
	3/3/2021	186	174.9287833	6.33%
	3/4/2021	189.9	174.9387853	8.55%
	3/5/2021	186.8	174.9744179	6.76%
	3/8/2021	181.9	174.9795053	3.96%
	3/9/2021	183	175.0211387	4.56%
	3/10/2021	184	175.0192981	5.13%
	3/11/2021	180.9	175.0696115	3.33%
	3/12/2021	181.9	175.0581266	3.91%
	3/15/2021	180	175.1212034	2.79%
	3/16/2021	181.3	175.0966691	3.54%
	3/17/2021	185	175.1791399	5.61%
	3/18/2021	185.6	175.1381233	5.97%
	3/19/2021	176	175.2519135	0.43%
	3/22/2021	175.9	175.1938511	0.40%
	3/23/2021	181	175.3635106	3.21%
	3/24/2021	176.9	175.3008011	0.91%
	3/25/2021	178.2	175.5843662	1.49%
	3/26/2021	174.9	175.5749458	0.38%
	3/29/2021	175.7	176.1254413	0.24%
3/30/2021	176.9	176.3746992	0.30%	
3/31/2021	176.9	177.6247048	0.41%	

Table 11
Before and During Actual vs Predicted MPI stock price

MPI	Date	Actual	Predicted ARIMA (1,1,1)	Absolute Percentage Error	
Before	12/2/2019	4.37	4.30789034	1.44%	
	12/3/2019	4.39	4.306240203	1.95%	
	12/4/2019	3.92	4.304592643	8.93%	
	12/5/2019	3.8	4.302949536	11.69%	
	12/6/2019	3.66	4.301314126	14.91%	
	12/9/2019	3.54	4.299692018	17.67%	
	12/10/2019	3.67	4.298092896	14.61%	
	12/11/2019	3.19	4.296533499	25.75%	
	12/12/2019	2.69	4.295042753	37.37%	
	12/13/2019	3.01	4.293670649	29.90%	
	12/16/2019	3.05	4.292503578	28.95%	
	12/17/2019	3.19	4.291690839	25.67%	
	12/18/2019	3.49	4.291490446	18.68%	
	12/19/2019	3.4	4.292348293	20.79%	
	12/20/2019	3.26	4.295034958	24.10%	
	12/23/2019	3.42	4.300882135	20.48%	
	12/26/2019	3.58	4.312191218	16.98%	
	12/27/2019	3.48	4.32393941	19.69%	
	MPI	Date	Actual	Predicted ARIMA (1,1,2)	Absolute Percentage Error
	During	3/1/2021	4.16	4.062345823	2.40%
3/2/2021		4.05	4.066304617	0.40%	
3/3/2021		4.09	4.070229795	0.49%	
3/4/2021		4.13	4.074200427	1.37%	
3/5/2021		4.11	4.078109597	0.78%	
3/8/2021		4	4.082101875	2.01%	
3/9/2021		3.96	4.085981776	3.08%	
3/10/2021		4.01	4.0901363	1.96%	
3/11/2021		3.95	4.093840018	3.51%	
3/12/2021		3.962	4.09744231	3.32%	
3/15/2021		3.78	4.101672777	7.84%	
3/16/2021		3.78	4.105909289	7.94%	
3/17/2021		3.86	4.109458945	6.07%	
3/18/2021		3.93	4.113937347	4.47%	
3/19/2021		3.86	4.117159926	6.25%	
3/22/2021		3.78	4.122080592	8.30%	
3/23/2021		3.78	4.124705154	8.36%	
3/24/2021		3.74	4.13043444	9.45%	
3/25/2021	3.73	4.131965611	9.73%		
3/26/2021	3.72	4.139173349	10.13%		
3/29/2021	3.76	4.138705399	9.15%		
3/30/2021	3.69	4.148616289	11.05%		
3/31/2021	3.74	4.144493218	9.76%		

From the table 11, MPI's actual stock prices and the predicted stock prices are depicted for the months December 2019 and March 2021. Additionally, table 11 also shows the APE between the actual and predicted prices.

13. Summary of ARIMA models for MPI

Initial model identification of table 10 for MPI, the table shows before the pandemic, the model ARIMA (1,1,1) has one of the lowest AIC, lowest BIC, and the lowest MAPE. During the pandemic, the table shows that ARIMA (1,1,2) has one of the lowest AIC, and the lowest MAPE. Therefore, both models are used to forecast the stock prices for the whole month of December 2019 and March 2021.

14. Before and During Actual vs Predicted MPI stock price

15. Summary of ARIMA models for BPI

Table 12
Summary of ARIMA models for BPI

BPI	ARIMA (p,d,q)	AIC	BIC	MAPE
Before	ARIMA (1,1,1)	3.19E+03	3.21E+03	0.0209
	ARIMA (1,1,2)	3.19E+03	3.22E+03	0.0206
	ARIMA (2,1,1)	3.19E+03	3.22E+03	0.0205
	ARIMA (2,1,2)	3.19E+03	3.22E+03	0.0200
During	ARIMA (1,1,1)	1.02E+03	1.04E+03	0.0390
	ARIMA (1,1,2)	1.03E+03	1.04E+03	0.0400
	ARIMA (2,1,1)	1.03E+03	1.04E+03	0.0400
	ARIMA (2,1,2)	1.01E+03	1.03E+03	0.0381



Initial model identification of table 12 for BPI, the table shows before the pandemic, the model ARIMA (2,1,2) has one of the lowest AIC and the lowest MAPE. During the pandemic, the table shows that ARIMA (2,1,2) has the lowest AIC, BIC, and MAPE. Therefore, both models are used to forecast the stock prices for the whole month of December 2019 and March 2021.

16. Before and During Actual vs Predicted BPI stock price

From the table above, BPI's actual stock prices and the predicted stock prices are depicted for the months of December 2019 and March 2021. Additionally, table 13 also shows the APE between the actual and predicted prices.

Table 13
Before and During Actual vs Predicted BPI stock price

BPI	Date	Actual	Predicted ARIMA (2,1,2)	Absolute Percentage Error
	3/1/2021	87.3	86.08980895	1.41%
	3/2/2021	86	86.14840622	0.17%
	3/3/2021	88.8	86.27430853	2.93%
	3/4/2021	88.1	86.28402942	2.10%
	3/5/2021	86.5	86.20340972	0.34%
	3/8/2021	82.1	86.25160934	4.81%
	3/9/2021	82.1	86.41853964	5.00%
	3/10/2021	82.3	86.44436903	4.79%
	3/11/2021	81.5	86.31678562	5.58%
	3/12/2021	80.2	86.34157707	7.11%
	3/15/2021	80.2	86.56180219	7.35%
During	3/16/2021	82.5	86.62025312	4.76%
	3/17/2021	83.8	86.4327552	3.05%
	3/18/2021	85.95	86.41342417	0.54%
	3/19/2021	84	86.70031108	3.11%
	3/22/2021	82.1	86.81709961	5.43%
	3/23/2021	83.4	86.55629498	3.65%
	3/24/2021	84.8	86.46121458	1.92%
	3/25/2021	84.05	86.8276341	3.20%
	3/26/2021	82.5	87.04113086	5.22%
	3/29/2021	84.6	86.69560119	2.42%
	3/30/2021	84.2	86.47813776	2.63%
	3/31/2021	81.5	86.93345403	6.25%
BPI	Date	Actual	Predicted ARIMA (2,1,2)	Absolute Percentage Error
	12/2/2019	86.4	86.87628772	0.55%
	12/3/2019	87.25	86.85914505	0.45%
	12/4/2019	89	86.86341089	2.46%
	12/5/2019	89.95	86.89036851	3.52%
	12/6/2019	89	86.91211808	2.40%
	12/9/2019	89	86.89441205	2.42%
	12/10/2019	86.5	86.83861524	0.39%
	12/11/2019	89	86.79674267	2.54%
	12/12/2019	90.5	86.82711079	4.23%
	12/13/2019	91	86.92075812	4.69%
	12/16/2019	87.3	86.98141585	0.37%
	12/17/2019	84.6	86.91062928	2.66%
	12/18/2019	83.1	86.73597521	4.19%
	12/19/2019	83.8	86.63441884	3.27%
	12/20/2019	87	86.77059291	0.26%
	12/23/2019	87.5	87.07484135	0.49%
	12/26/2019	86.9	87.22394392	0.37%
	12/27/2019	87.9	86.94560824	1.10%

Initial model identification of table 13 for MEG, the table shows before the pandemic, the model

ARIMA (2,1,2) has one of the lowest AIC and the lowest MAPE.

Table 14
Summary of ARIMA models for MEG

MEG	ARIMA (p,d,q)	AIC	BIC	MAPE
Before	ARIMA (1,1,1)	-1.65E+03	-1.64E+03	0.0554
	ARIMA (1,1,2)	-1.65E+03	-1.63E+03	0.0561
	ARIMA (2,1,1)	-1.65E+03	-1.63E+03	0.0561
	ARIMA (2,1,2)	-1.65E+03	-1.62E+03	0.0553
During	ARIMA (1,1,1)	-4.86E+02	-4.72E+02	0.0553
	ARIMA (1,1,2)	-4.87E+02	-4.69E+02	0.0581
	ARIMA (2,1,1)	-4.86E+02	-4.68E+02	0.0575
	ARIMA (2,1,2)	-4.97E+02	-4.76E+02	0.0725

During the pandemic, the table shows that ARIMA (2,1,2) has the lowest AIC and BIC. Therefore, both models are used to forecast the stock prices for the whole month of December 2019 and March 2021.

18. Before and During Actual vs Predicted MEG stock price

Table 15
Before and During Actual vs Predicted MEG stock price

MEG	Date	Actual	Predicted ARIMA (2,1,2)	Absolute Percentage Error
	12/2/2019	4.43	4.400809073	0.68%
	12/3/2019	4.35	4.40128124	1.16%
	12/4/2019	4.18	4.40167256	5.04%
	12/5/2019	4.3	4.402105288	2.32%
	12/6/2019	4.27	4.402536123	3.01%
	12/9/2019	4.18	4.402970381	5.06%
	12/10/2019	4.25	4.40340577	3.48%
	12/11/2019	4.31	4.403839427	2.13%
	12/12/2019	4.25	4.404270364	3.50%
	12/13/2019	4.3	4.404724628	2.38%
	12/16/2019	4.11	4.405167452	6.70%
	12/17/2019	4.04	4.405609228	8.30%
	12/18/2019	4.07	4.406046117	7.63%
	12/19/2019	4.1	4.4064940751	6.96%
	12/20/2019	4	4.407842006	9.25%
	12/23/2019	4.03	4.40951359	8.63%
	12/26/2019	4.09	4.412345969	7.31%
	12/27/2019	4.01	4.418470652	9.24%
MEG	Date	Actual	Predicted ARIMA (2,1,2)	Absolute Percentage Error
	3/1/2021	3.75	3.820495453	1.83%
	3/2/2021	3.8	3.8191929	0.50%
	3/3/2021	3.71	3.819300683	2.86%
	3/4/2021	3.67	3.821045728	3.95%
	3/5/2021	3.73	3.823435948	2.44%
	3/8/2021	3.59	3.82458626	6.13%
	3/9/2021	3.59	3.822881101	6.09%
	3/10/2021	3.66	3.818365941	4.19%
	3/11/2021	3.61	3.813430312	5.33%
	3/12/2021	3.54	3.811399935	7.12%
	3/15/2021	3.35	3.813035503	12.19%
	3/16/2021	3.42	3.823253825	10.55%
	3/17/2021	3.48	3.831024624	9.16%
	3/18/2021	3.51	3.82175529	8.66%
	3/19/2021	3.46	3.821951939	9.47%
	3/22/2021	3.38	3.805187736	11.17%
	3/23/2021	3.5	3.791950117	7.70%
	3/24/2021	3.38	3.79391506	10.91%
	3/25/2021	3.45	3.815091286	9.57%
	3/26/2021	3.56	3.845496167	7.43%
	3/29/2021	3.67	3.864696841	5.04%
	3/30/2021	3.67	3.852289067	4.73%
	3/31/2021	3.58	3.806158684	5.94%

From the table 15 above, MEG's actual stock prices and the predicted stock prices are depicted for the months December 2019 and March 2021. Additionally, table 15 also shows the APE between the actual and predicted prices.

19. Company Performance Indicators



Table 16

Performance indicators of different companies

YEAR	PLDT		BPI		MEG		JFC		MPI	
	EPS	BVPS	EPS	BVPS	EPS	BVPS	EPS	BVPS	EPS	BVPS
2016	101.73	553.01	5.60	41.94	0.35	3.94	5.75	31.89	0.38	4.82
2017	61.61	531.62	5.33	44.61	0.41	4.38	6.58	39.24	0.42	5.12
2018	87.28	535.27	5.35	55.20	0.48	5.08	7.66	45.85	0.45	5.50
2019	103.96	542.05	6.39	59.81	0.55	5.53	6.68	47.80	0.76	6.05
2020	112.12	583.79	4.74	62.01	0.30	5.81	-10.45	62.49	0.15	5.91
2021	121.75	625.00	5.29	64.94	0.42	6.24	5.29	56.13	0.33	6.34

The performance of each company will be also analyzed and interpreted to improve the data's relevance. Using the chosen performance indicators namely: (Earnings per share, EPS and Book Value per share, BVPS) the indicators before the pandemic will be compared to the most recent one which is during the pandemic to give additional information on the viability of investing.

To supplement our forecast models, in Table 16, The researchers have summarized some performance indicators of each company that aids in proving the viability of investing in these companies. From the chosen performance indicators Earnings Per Share (EPS) and Book Value Per Share (BVPS), a high EPS indicates that the company is more profitable and has more profits to distribute to its shareholders. For the BVPS, comparing this value to the stock price will show that when the stock is below the BVPS then the stock price is undervalued. According to myaccountingcourse.com when a stock is undervalued, they are projected to increase rapidly thus, will be a good opportunity to invest.

Investing on a product should be backed by evidences like forecasted stock prices and overall performances on their stock or financials. Out of all these companies, the best ARIMA model with an improved MAPE is ARIMA (1,1,2) of PLDT where the MAPE before was reduced to 2.78 making a more accurate forecast.

From the performance indicators of the said companies, investing using these indicators during the pandemic could guide investors to know what companies are profitable or not.

These statistics are a way to support the study's results to reduce the risk of financial loss.

CONCLUSIONS

Among the five companies, only three (PLDT, JFC, MPI) exhibit statistical significance to economic indicators, and all significant p-values are from the data before the pandemic. Out of the three significant regression models, only PLDT and MPI show parameters under the before-pandemic data, with PLDT having the best model and fit, indicated by the largest f-statistic and R2. Conversely, BPI and MEG seem unaffected by the chosen economic indicators.

The best-fitted ARIMA models before the pandemic are ARIMA (1,1,1) for PLDT, JFC, and MPI, and ARIMA (2,1,2) for BPI and MEG. During the pandemic, the best-fitted ARIMA models are ARIMA (1,1,2) for PLDT and MPI, and ARIMA (2,1,2) for JFC, BPI, and MEG. These models, assessed by MAPE, show accuracy within the 10% margin of error, with more than 90% accuracy in predicting stock prices.

Most ARIMA models have satisfactorily predicted stock prices in a short period, suggesting that investing in the stock market during uncertainty can be profitable. Additionally, checking performance indicators of these stocks boosts confidence in investing in the companies used in the study.

RECOMMENDATIONS

The researchers recommend to enhance data consistency, it is advisable to focus primarily on the years directly impacted by the pandemic, excluding data from before the pandemic. Secondly, despite the efficiency of the ARIMA model, the exploration and testing of alternative forecasting models are recommended to minimize the mean absolute percentage error. Thirdly, the study suggests exploring other resilient trade-listed companies that have demonstrated stability during the pandemic. Lastly, to ensure the study's long-term applicability in predicting stock prices, future researchers are encouraged to explore and employ forecasting techniques over several months. Additionally, the researchers advocate for



considering both technical and fundamental analyses when analyzing financial markets. Technical analysis, which examines stock price movements, can aid in predicting future movements, while fundamental analysis considers economic and financial factors influencing a business.

REFERENCES

ABS-CBN Research and Investigative Group, (2020, April 30). *Labor Day: Impact of COVID-19 on employment.* ABS. <https://news.abs-cbn.com/spotlight/05/01/20/labor-day-impact-of-covid-19-on-employment>

Adebiyi, A. A., Adewumi, A. O. & Ayo. C. K. (2014). *Stock price prediction using the ARIMA model.* <https://ijssst.info/Vol-15/No-4/data/4923a105.pdf>

AIA Group (2020). *Here's why you should start investing during a pandemic.* <https://www.bpiphilam.com/en/bancassurance/finance-and-insurance/heres-why-you-should-start-investing-during-a-pandemic.html>

Ahmadi, H., Katzis, K., Shakir, M. Z., Arvaneh, M., & Gatherer, A. (2020, June 4). *Wireless communication and the pandemic: The story so far.* The UWS Academic Portal. <https://research-portal.uws.ac.uk/en/publications/wireless-communication-and-the-pandemic-the-story-so-far>

Ashraf, B. (June 01, 2020). *Economic impact of government actions to control COVID-19 pandemic: evidence from financial markets.* <https://ssrn.com/abstract=3628693> or <http://dx.doi.org/10.2139/ssrn.3628693>

Asian Development Bank. (2021, November 29). *Food inflation and food and nutrition security situation in developing Asia during the COVID-19 pandemic.* Asian Development Bank. <https://www.adb.org/news/features/food-inflation-food-nutrition-security-situation-developing-asia-covid-19-pandemic>

Asmelash, L., & Cooper, A. (2020, April 9). *Nearly 80% of hotel rooms in the US are empty, according to new data.* CNN. <https://edition.cnn.com/2020/04/08/us/hotel-rooms-industry-coronavirus-trnd/index.html>

Boon, L., Haugh, D., Pain, N., & Salins, V. (2020). *Tackling the fallout from COVID-19. In Economics in the Time of COVID-19.* London, UK: CEPR Press. <https://voxeu.org/content/economics-time-covid-19>

Chan, Y. et al (2020). *The outbreak of COVID-19: An overview : Journal of the Chinese Medical Association.* LWW. https://journals.lww.com/jcma/fulltext/2020/03000/the_outbreak_of_covid_19_an_overview.3.aspx

Dela Cruz, E., & Morales, N. J. (2020, August 6). *Philippines suffers first recession in 29 years, braces for Grim Year on virus woes.* Reuters. <https://www.reuters.com/article/us-philippines-economy-gdp-idUSKCN25208>

Donthu, N., & Gustafsson, A. (2020). *Effects of COVID-19 on business and research. Journal of Business Research,* 117, 284-289. <https://reader.elsevier.com/reader/sd/pii/S0148296320303830?token=701DCB9CF1F07646E6F691885AC67CE64979385EE1D8E194072288D0DBC158B29A93E91E26A368C2D30F57B59B5CBDB3&originRegion=us-east-1&originCreation=20220413011401> or doi:10.1016/j.jbusres.2020.06.008

Guiao, J. (2019). *Forecasting Philippine stock market prices using ARIMA-GARCH Models.* www.dlsu.edu.ph/wp-content/uploads/pdf/conferences/research-congress-proceedings/2019/ebm-l-007.pdf

Grashuis, J., Skevas, T., & Segovia, M. S. (2020, July 2). *Grocery shopping preferences during the COVID-19 pandemic.* MDPI. <https://www.mdpi.com/2071-1050/12/13/5369/htm>

Höhler, J., & Lansink, A. O. (2020, December 9). *Measuring the impact of Covid-19 on stock prices and profits in the Food Supply Chain.* Wiley Online Library.

<https://onlinelibrary.wiley.com/doi/10.1002/agr.21678>

<https://link.springer.com/article/10.1007/s00521-020-05434-0> or doi:10.1007/s00521-020-05434-0

INQUIRER.net (2020, November 10). *Jollibee slowly recovering from covid-19, narrowed loss in Q3*. INQUIRER.net. <https://business.inquirer.net/311430/jollibee-slowly-recovering-from-covid-19-narrowed-loss-in-q3>

Musulini, J., et al. (2020). *Impact of covid-19 on forecasting stock prices: An integration of stationary wavelet transform and bidirectional long short-term memory*. Complexity, 2020, 1-12. <https://www.hindawi.com/journals/complexity/2020/1846926/> or doi:10.1155/2020/1846926.

INQUIRER.net (2021, February 9). *Philippines targets to reach herd immunity by 2023*. <https://newsinfo.inquirer.net/1393512/philippines-goals-to-reach-herd-immunity-by-2023>

Nasution, B. I., Tarigan, A. B., & Siregar, S. I. (2020). *Investment and unemployment reduction: An empirical study of Indonesia using panel data regression*. <https://scitepress.org/Papers/2020/93562/93562.Pdf>

International Bank for Reconstruction and Development. (2020). *Building a resilient recovery*. <http://documents1.worldbank.org/curated/en/983051607354214738/pdf/Philippines-Economic-Update-Building-a-Resilient-Recovery.pdf>

Philippine Statistics Authority. (2019). *Preliminary results of the 2019 annual estimates of labor force survey (LFS)*. <https://psa.gov.ph/statistics/survey/labor-and-employment/labor-force-survey/title/Preliminary%20Results%20of%20the%202019%20Annual%20Estimates%20of%20Labor%20Force%20Survey%20%28LFS%29>

International Labor Organization (2020). *Covid-19 labour market impact in the Philippines: Assessment and national policy responses*. (2020, November 27). https://www.ilo.org/manila/publications/WCMS_762209/lang-en/index.htm

Philippine Statistics Authority. (2020). *Highlights of the April 2020 labor force survey. Employment Situation in April 2020*. <https://psa.gov.ph/content/employment-situation-april-2020>

International Monetary Fund. (2020, June 17). *Policy responses to COVID-19: Philippines*. *International Monetary Fund: Policy Tracker*. <https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19#P>

Philippine Statistics Authority. (2020). *2020 Annual preliminary estimates of labor force survey (LFS)*. <https://psa.gov.ph/statistics/survey/labor-and-employment/labor-force-survey/title/2020%20Annual%20Preliminary%20Estimates%20of%20Labor%20Force%20Survey%20%28LFS%29>

Loyola, J. A. (2020, December 30). *PSE marks major milestones despite COVID-19 impact*. Manila Bulletin. <https://mb.com.ph/2021/01/01/pse-marks-major-milestones-despite-covid-19-impact/>

Pankratz, A. (1983, August 30). *Forecasting with Univariate Box - Jenkins Models: Concepts and cases*. Google Books, *Forecasting with Univariate Box-Jenkins Models, Concept and Cases* (bayanbox.ir)

Macaraeg, P. (2021). *PH coronavirus cases hit 2-month high of 2,961 on New Year's Eve*. <https://www.rappler.com/nation/coronavirus-cases-philippines-december-31-2021/>

Prabhakaran, S. (2021, March 22). *ARIMA model - complete guide to time series forecasting in*

Malki, Z., Atlam, E., et al. (2020, October 23). *ARIMA models for predicting the end of COVID-19 pandemic and the risk of second rebound Neural Computing and Applications*.

python. ML+.

<https://www.machinelearningplus.com/time-series/arima-model-time-series-forecasting-python/>

Quandt, A. K. (2020, December 28). *Stock market correlations to economic indicators*. <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1293&context=honorsthesis>

Smith, T. (2021, March 4). *Random walk theory*. investopedia. <https://www.investopedia.com/terms/r/randomwalktheory.asp#:~:text=Random%20walk%20theory%20suggests%20that,to%20predict%20its%20future%20movement>

Switlyk, V., & Shang, J. (2019). *Model comparison for the prediction of stock prices in the NYSE*. https://www.researchgate.net/publication/338031344_Model_Comparison_for_the_Prediction_of_Stock_Prices_in_the_NYSE

TMF Group. (2020, July 7). *Government support schemes for COVID-19*. TMF Group: <https://www.tmf-group.com/en/news-insights/coronavirus/government-support-schemes/>

United Nations (2022), *Global Unemployment*. <https://unstats.un.org/sdgs/report/2021/goal-08/>

Wren-Lewis, S. (2020). *The economic effects of a pandemic*. In: *Economics in the Time of COVID-19*. London, UK: CEPR Press. <https://voxeu.org/content/economics-time-covid-19>

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