PREDICTION OF COVID-19 CASES IN PHILIPPINES USING ARTIFICIAL NEURAL NETWORKS

*Dr. Smartson. P. NYONI[1], Thabani NYONI[2], Tatenda. A. CHIHOHO[3]

[1]*ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe*
[2]*Department of Economics, University of Zimbabwe, Harare, Zimbabwe*
[3]*Department of Economics, University of Zimbabwe, Harare, Zimbabwe*
**Corresponding Author*

ABSTRACT

Philippines continues to be affected by the COVID-19 pandemic, and this calls for forecasting and control models to be put in place in order to enhance planning and strategizing by ministry of health in the country. In this research article, the ANN approach was applied to investigate COVID-19 cases in Philippines. The employed data covers the period January 30, 2020 to October 31, 2020 and the out-of-sample period ranges over the period November 2020 to April 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting daily COVID-19 cases in Philippines. The results of the study generally suggest that the pandemic is "there to stay" in the Philippines but the good news is that daily case volumes are likely to slowly decline over the out-of-sample period, characterized by a range of 1000 to 6000 cases per day. The study recommends strict adherence to prevention and control measures in order to manage the pandemic in Philippines.

Keywords: - *ANN, COVID-19, Forecasting*

INTRODUCTION

The index case of COVID-19 occurred in late December 2019 in Wuhan in China (Zhu *et al*., 2020). Since then, cases have been exported to other Chinese cities, as well as internationally, highlighting concern of a global outbreak (Wu *et al*., 2020). COVID-19 symptoms include dry cough, fever, difficulty of breathing, and in some cases diarrhoea (Huang *et al*., 2020). The first suspected case of COVID-19 in Philippines was initially investigated on January 22, 2020 and officially reported on January 30, 2020 (Department of Health, 2020). COVID-19 modeling in the country is generally scanty; barely characterized by few papers such as Torres *et al*. (2020) and Medina (2020). Using SEIR, O-U and ARIMA models, Torres *et al*. (2020) predicted a surge in cases in the country and concluded that the ARIMA (1, 2, 1) model was the best model for analyzing COVID-19 cases in the Philippines. Based on a Simple Linear Regression, Medina (2020), revealed that the case fatality of COVID-19 in the Philippines at the few weeks of the outbreak was 4.35%, and is higher than estimates in mainland China and Italy as well as the global estimate. However, Medina (2020) did not forecast future trends of the pandemic. There is need for a latest predictive model for the pandemic in Philippines in order to enhance planning and strategizing by public health policy makers in the country. In an attempt to help the

Philippians government in better managing the pandemic, the study seeks to model and forecast daily COVID-19 cases in the country.

METHODOLOGY

This paper applies the multi-layer perceptron neural network type of the ANN approach in order to predict daily new COVID-19 infections in Philippines. The study particularly applies the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function. The research is based on daily new COVID-19 cases (referred to as series, F, in this study) for all age groups in the Philippines. The data covers the period 30 January 2020 to 31October 2020 while the out-of-sample forecast covers the period November 2020 to April 2021. All the data employed in this research paper was gathered from John Hopkins University (USA).

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
1379.5	621.00	0.00000	6725.0
Std. Dev.	C.V.	Skewness	Ex. kurtosis
1511.2	1.0955	1.0384	0.24971
5% Perc.	95% Perc.	IQ range	Missing obs.
0.00000	4276.7	2223.8	0

As shown in the table above, the maximum number of daily cases over the study period is 6725 while the average daily case volume is approximately 1380 cases per day. These are alarming figures and therefore strict control and prevention meausres are needed to be put in place.

ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN PHILIPPINES

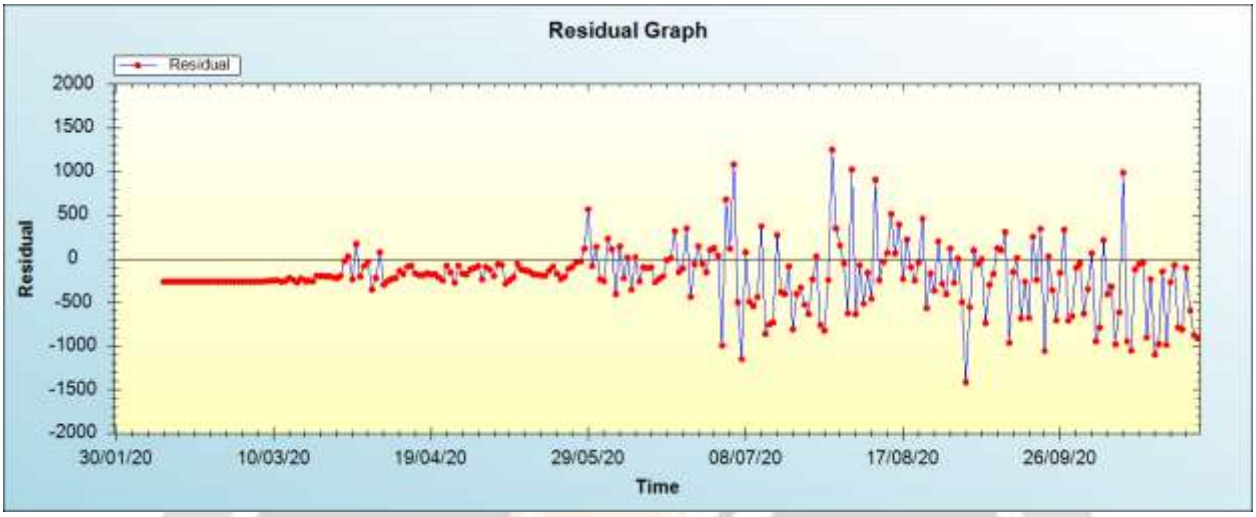
Table 2: ANN model summary

Variable	F
Observations	264 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning:	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.110905
MSE	171689.926871
MAE	310.904638

Table 2 presents the summary of the architecture model applied.

Residual Analysis for the ANN model

Figure 1: Residual analysis



The applied model is stable and acceptable as shown in the residual diagnostics in figure 1 above.

In-sample Forecast for F

Figure 2: In-sample forecast for the F series

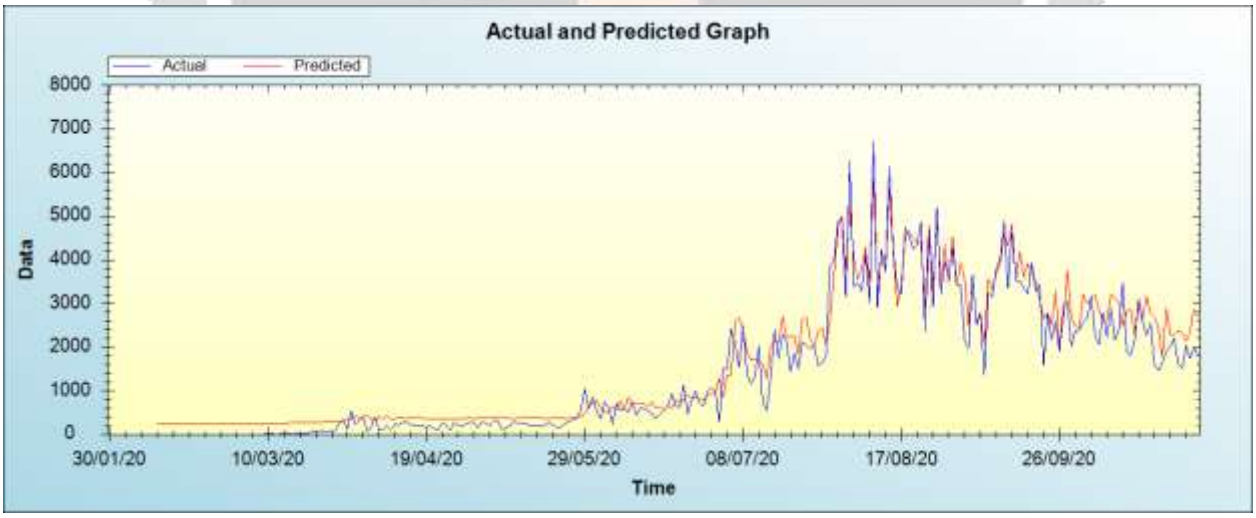
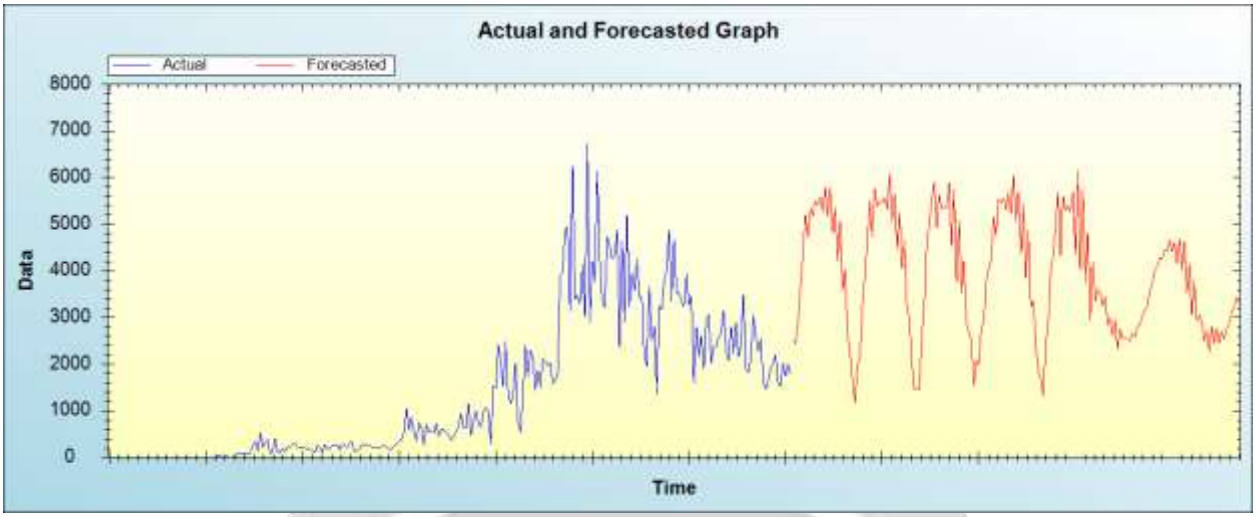


Figure 2 shows the in-sample predictions of the employed model.

Out-of-Sample Forecast for F: Actual and Forecasted Graph

Figure 3: Out-of-sample forecast for F: actual and forecasted graph



Out-of-Sample Forecast for F: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	2523.1168
02/11/20	2441.9364
03/11/20	2920.0908
04/11/20	3619.4575
05/11/20	4343.3641
06/11/20	5195.9913
07/11/20	4708.4386
08/11/20	5340.0019
09/11/20	5173.5948
10/11/20	5517.6631
11/11/20	5413.1944
12/11/20	5600.7729
13/11/20	5268.8273
14/11/20	5786.2349
15/11/20	5168.6370

16/11/20	5818.5920
17/11/20	4823.0972
18/11/20	5365.8048
19/11/20	4205.8923
20/11/20	5063.9421
21/11/20	3585.5672
22/11/20	4036.7557
23/11/20	2647.3505
24/11/20	2243.5095
25/11/20	1661.0099
26/11/20	1172.2387
27/11/20	1980.1006
28/11/20	2114.9887
29/11/20	3247.3036
30/11/20	3905.6053
01/12/20	4661.5815
02/12/20	5507.6649
03/12/20	4739.7434
04/12/20	5770.7457
05/12/20	5391.8418
06/12/20	5488.9459
07/12/20	5451.1668
08/12/20	5577.7305
09/12/20	5325.5718
10/12/20	6073.4161
11/12/20	5045.8433

12/12/20	5647.6650
13/12/20	4482.4584
14/12/20	5246.4856
15/12/20	4039.8761
16/12/20	4658.8092
17/12/20	3146.5099
18/12/20	3005.7839
19/12/20	2012.9765
20/12/20	1448.4221
21/12/20	1497.6302
22/12/20	1456.2748
23/12/20	2592.2793
24/12/20	3299.0569
25/12/20	4604.4631
26/12/20	5015.6252
27/12/20	5529.8208
28/12/20	5906.8586
29/12/20	4926.7873
30/12/20	5640.2169
31/12/20	5313.2786
01/01/21	5364.6590
02/01/21	5352.4961
03/01/21	5905.2201
04/01/21	4529.2838
05/01/21	5739.2102
06/01/21	3767.4719

07/01/21	5099.7077
08/01/21	3516.9013
09/01/21	4205.7883
10/01/21	2894.5999
11/01/21	2672.0088
12/01/21	2522.8908
13/01/21	1535.0288
14/01/21	2081.5479
15/01/21	1982.0843
16/01/21	2779.0935
17/01/21	2935.0977
18/01/21	3782.8116
19/01/21	4045.5428
20/01/21	4246.2549
21/01/21	5180.0356
22/01/21	4761.1096
23/01/21	5534.9884
24/01/21	5473.2948
25/01/21	5557.0120
26/01/21	5307.7676
27/01/21	5680.9526
28/01/21	5234.4503
29/01/21	6054.1053
30/01/21	5062.4565
31/01/21	5703.8130
01/02/21	4356.7133

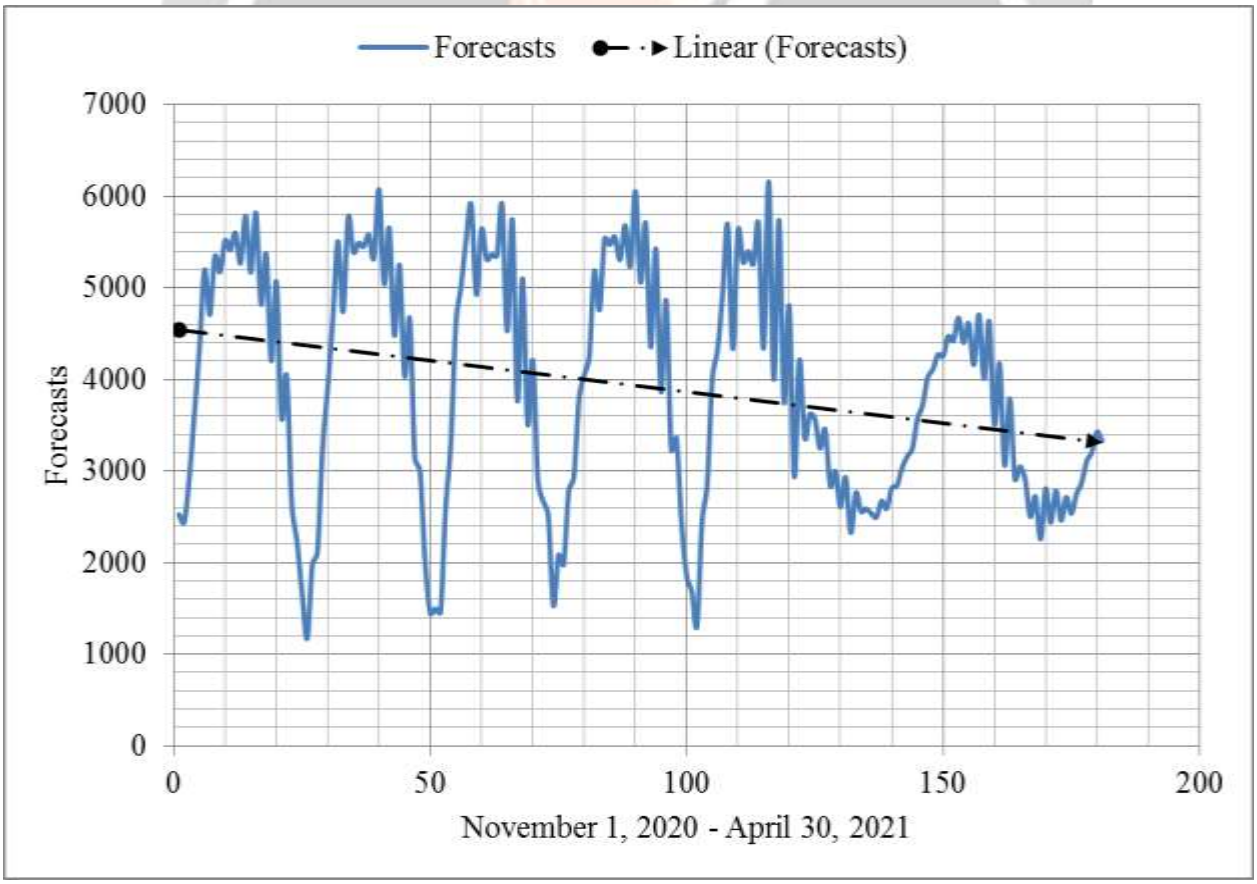
02/02/21	5422.8270
03/02/21	3867.0528
04/02/21	4861.5756
05/02/21	3234.4108
06/02/21	3361.6400
07/02/21	2427.0077
08/02/21	1854.3372
09/02/21	1684.0152
10/02/21	1311.7481
11/02/21	2449.6150
12/02/21	2851.4648
13/02/21	4008.0718
14/02/21	4311.6007
15/02/21	4925.3536
16/02/21	5690.0747
17/02/21	4336.0804
18/02/21	5620.4274
19/02/21	5278.9333
20/02/21	5398.7880
21/02/21	5262.0197
22/02/21	5698.0863
23/02/21	4343.1348
24/02/21	6158.6065
25/02/21	4000.7827
26/02/21	5737.7576
27/02/21	3753.9129

28/02/21	4799.3826
01/03/21	2941.7577
02/03/21	4212.1790
03/03/21	3365.0402
04/03/21	3618.8578
05/03/21	3568.6234
06/03/21	3247.8532
07/03/21	3450.8777
08/03/21	2843.0614
09/03/21	2997.2231
10/03/21	2607.6005
11/03/21	2929.8873
12/03/21	2327.4573
13/03/21	2763.2985
14/03/21	2559.3260
15/03/21	2589.1511
16/03/21	2536.2837
17/03/21	2496.2792
18/03/21	2672.5870
19/03/21	2588.8448
20/03/21	2814.5294
21/03/21	2840.9850
22/03/21	3032.4150
23/03/21	3159.1000
24/03/21	3243.7867
25/03/21	3566.9207

26/03/21	3717.4804
27/03/21	4018.3108
28/03/21	4109.1359
29/03/21	4272.3072
30/03/21	4255.8824
31/03/21	4469.4926
01/04/21	4424.4546
02/04/21	4672.6019
03/04/21	4402.9100
04/04/21	4612.7147
05/04/21	4161.0999
06/04/21	4705.6061
07/04/21	4007.9981
08/04/21	4630.6628
09/04/21	3507.7031
10/04/21	4170.5154
11/04/21	3062.0429
12/04/21	3789.3255
13/04/21	2916.6978
14/04/21	3049.0697
15/04/21	2910.7019
16/04/21	2502.9487
17/04/21	2722.0942
18/04/21	2258.1455
19/04/21	2808.2456
20/04/21	2439.1005

21/04/21	2785.8723
22/04/21	2461.7351
23/04/21	2713.7130
24/04/21	2536.2210
25/04/21	2746.7951
26/04/21	2871.6577
27/04/21	3105.0181
28/04/21	3205.7029
29/04/21	3426.9769
30/04/21	3327.2574

Figure 4: Graphical presentation of out-of-sample forecasts



Figures 3 and 4 as well as table are out-of-sample projections produced by the model. Generally, COVID-19 daily cases are likely to decline over the period November 2020 to April 2020, but

the prevalence of the pandemic will still remain very high; characterized by daily cases ranging between 1000 and 6000 cases per day.

CONCLUSION & RECOMMENDATIONS

Declared as a pandemic by WHO, early this year, COVID-19 is currently the most troublesome disease in the globe, affecting everyone. Philippines also, just like other countries around the world, was not able to escape from the scourge. Today, the virus is now a major threat in the country, affecting thousands of people on a daily basis. It has become essential for us to model and forecast the trends of the pandemic in the country in order to inform policy. The study relied on an ANN model and established that the pandemic may not end anytime soon in the country even-though daily cases are most likely to be, generally, following a downwards trajectory. The government of the Philippines should continue to enforce sanitary rules postulated by the WHO. We also encourage people in the country to always behave responsibly with regards to face-mask wearing, social distancing and so on., in order to stop avoidable infections in the country.

REFERENCES

[1] COVID-19 Repository By the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University.

[2] Department of Health (2020). 2019-NCOV Case Tracker, *Department of Health*, Manila.

[3] Dong, E., *et al*. (2020). An Interactive Web-based Dashboard to Track COVID-19 in Real Time, *Lancet Infectious Diseases*, 20 (5): 533 – 534.

[4] Huang, C., *et al*. (2020). Clinical Features of Patients With 2019 Novel Coronavirus in Wuhan, China, *The Lancet*, 395 (10223): 497 – 506.

[5] Medina, M. A. P. (2020). Preliminary Estimates of COVID-19 Case Fatality Rate in the Philippines Using Linear Regression Analysis, *SSRN*, pp: 1 – 6.

[6] Torres, M. C., *et al*. (2020). Forecasting COVID-19 Cases in the Philippines Using Various Mathematical Models, *medRxiv*, pp: 1 – 18.

[7] Wu, J. T., Leung, K., & Leung, G. M. (2020). Nowcasting and Forecasting the Potential Domestic and International Spread of the 2019-nCoV Outbreak Originating in Wuhan, China: A Modeling Study, *The Lancet*, 6736 (20): 1 – 11.

[8] Zhu, N., *et al*. (2020). A Novel Coronavirus From Patients With Pneumonia in China, 2019, *New England Journal of Medicine*, pp: 1 – 8.