



**15TH NATIONAL
CONVENTION
ON STATISTICS**

03-05 OCTOBER 2022



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DYNAMIC REGRESSION ANALYSIS ON THE PHILIPPINE INFLATION RATE

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Price Statistics and Inflation
Crowne Plaza Galleria Manila
10:30 AM to 12:00 PM, October 4, 2022

Dynamic Regression Analysis on the Philippine Inflation Rate



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INTRODUCTION

- PURPOSE OF REGRESSION ANALYSIS
 - Description
 - Control
 - Prediction
- PURPOSE OF TIME SERIES REGRESSION
 - Extraction
 - Forecast

INTRODUCTION

- DYNAMIC REGRESSION
 - Allows the exploration of the time-lagged association between dependent and independent variables
- Some inflation rate forecasts are disregard independent variables on the time series data. Most of the models and forecasting in business and economics, particularly in the inflation rate, are based on the historical series using methods
 - GARCH (Ramon, 2008)
 - ARIMA (Olajide, Ayansola, Odusina, & Oyenuga, 2012; Medalla & Fermo, 2013; Gikungu, Witutu, & Kihoro, 2015; dela Cruz, Pamaylaon, & Largo, 2016)
 - Neural Network (dela Cruz, Pamaylaon, & Largo, 2016)

INTRODUCTION

- In dynamic regression analysis, forecast of inflation can include information on the independent variables such as foreign exchange rates and oil prices in the world market.

OBJECTIVES

- Demonstrate the use of dynamic regression analysis in modeling the inflation rate and its relationship with other economic variables in the Philippines.
- Develop an appropriate dynamic regression model to forecast the inflation rate for which forex and oil price will be used as regressors.

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SIGNIFICANCE OF THE STUDY

- Economic Managers

METHODS

- Data Sources
 - Philippine Statistics Authority, Department of Energy, and Bangko Sentral ng Pilipinas
- Software
 - R with the following packages
 - ‘fpp’
 - ‘urca’
 - ‘ggplot2’

METHODS

- Procedure
 - Identification of ARIMA Structure
 - Determining the Possible Dynamic Regression Models
 - Model Estimation and Diagnostics
 - Forecast Evaluation



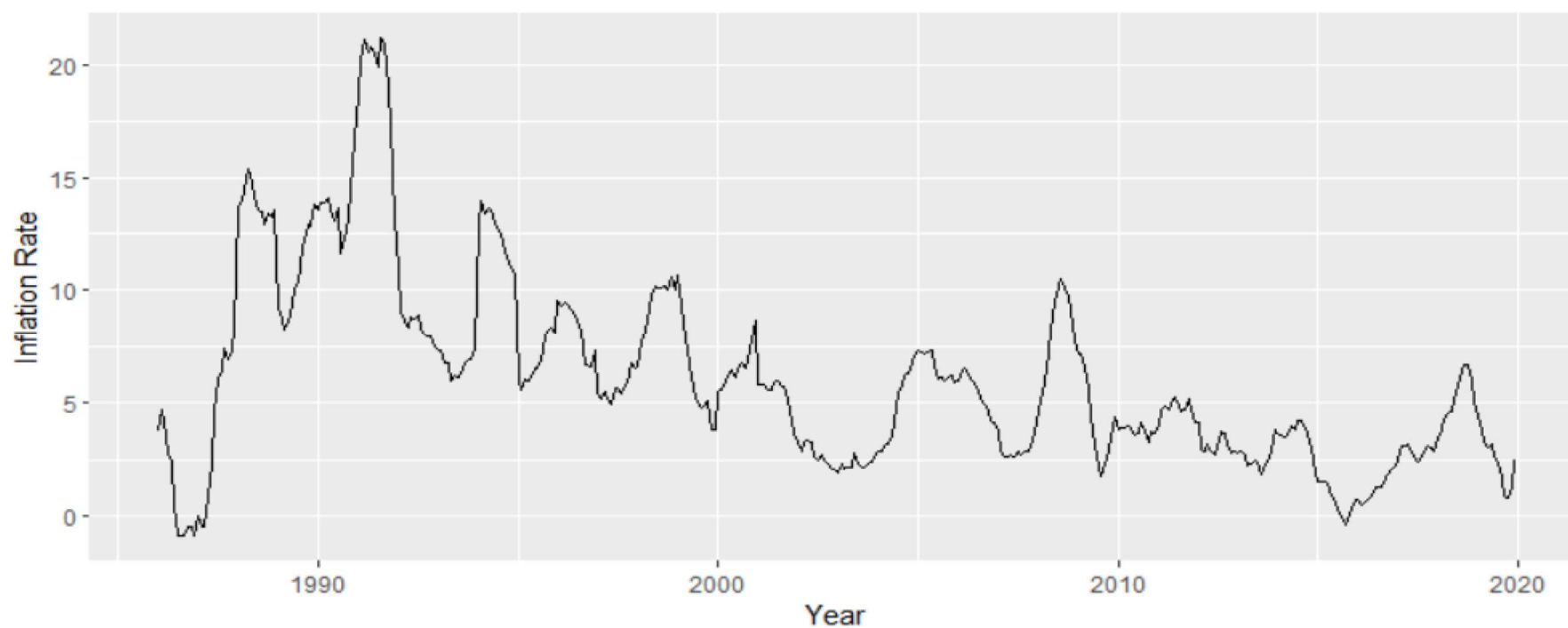
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RESULTS



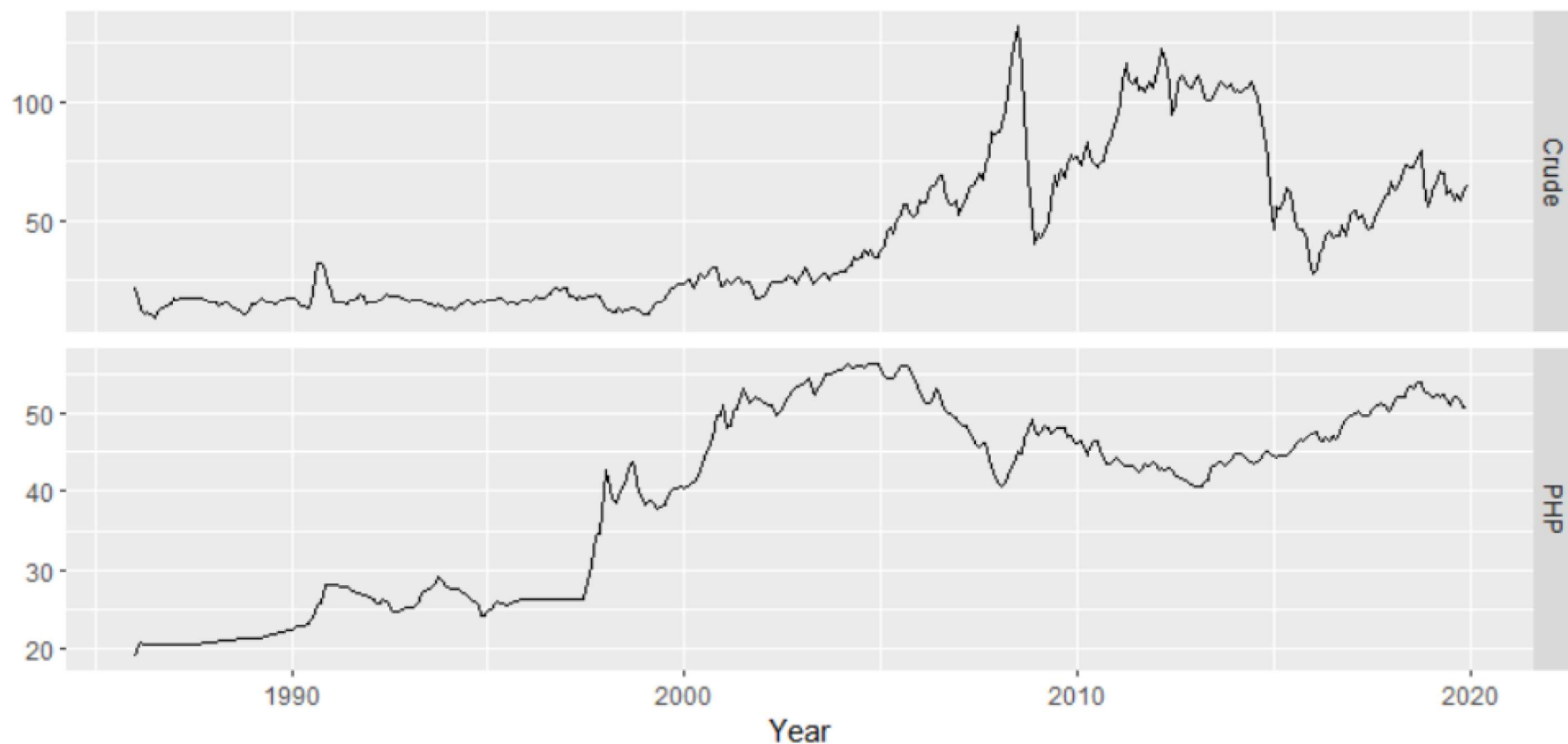


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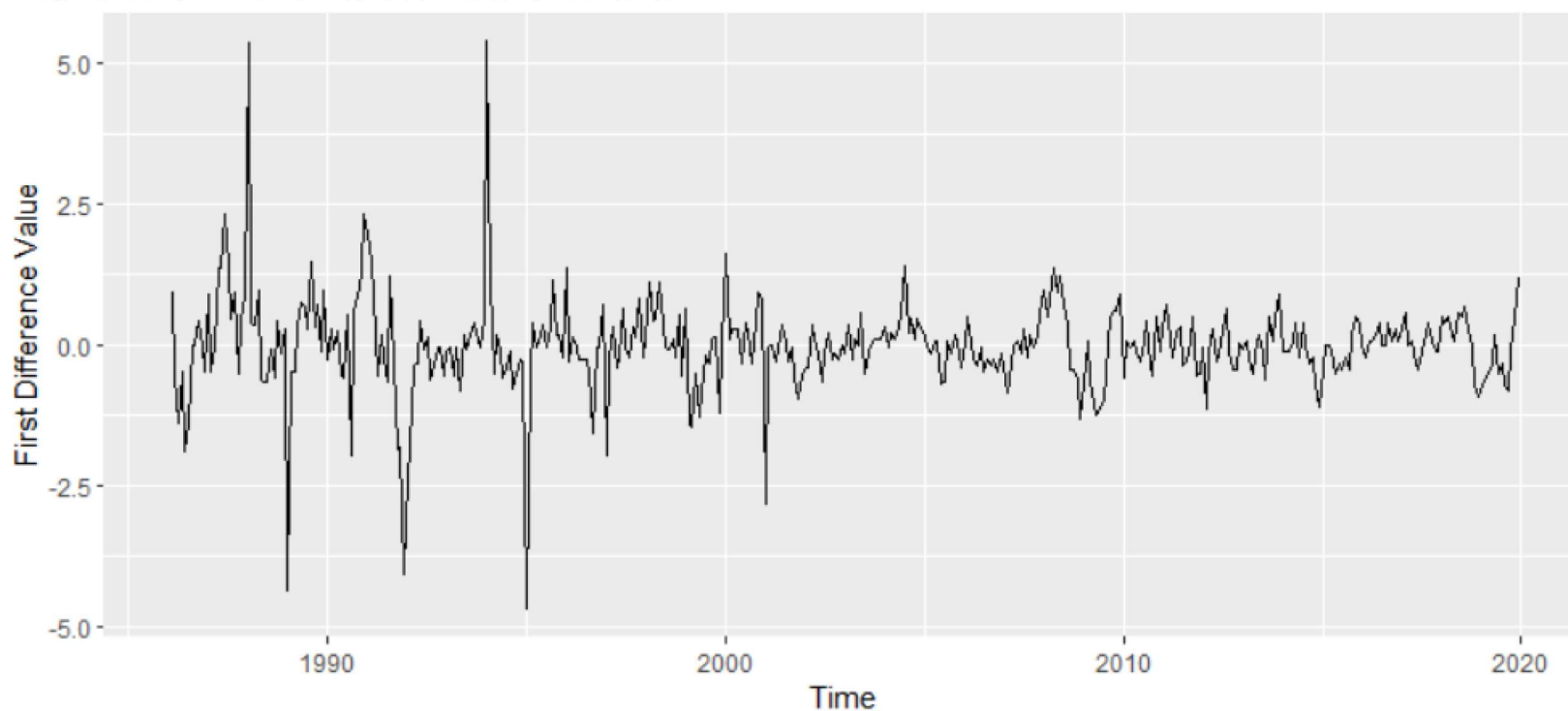
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TRANSFORMATION



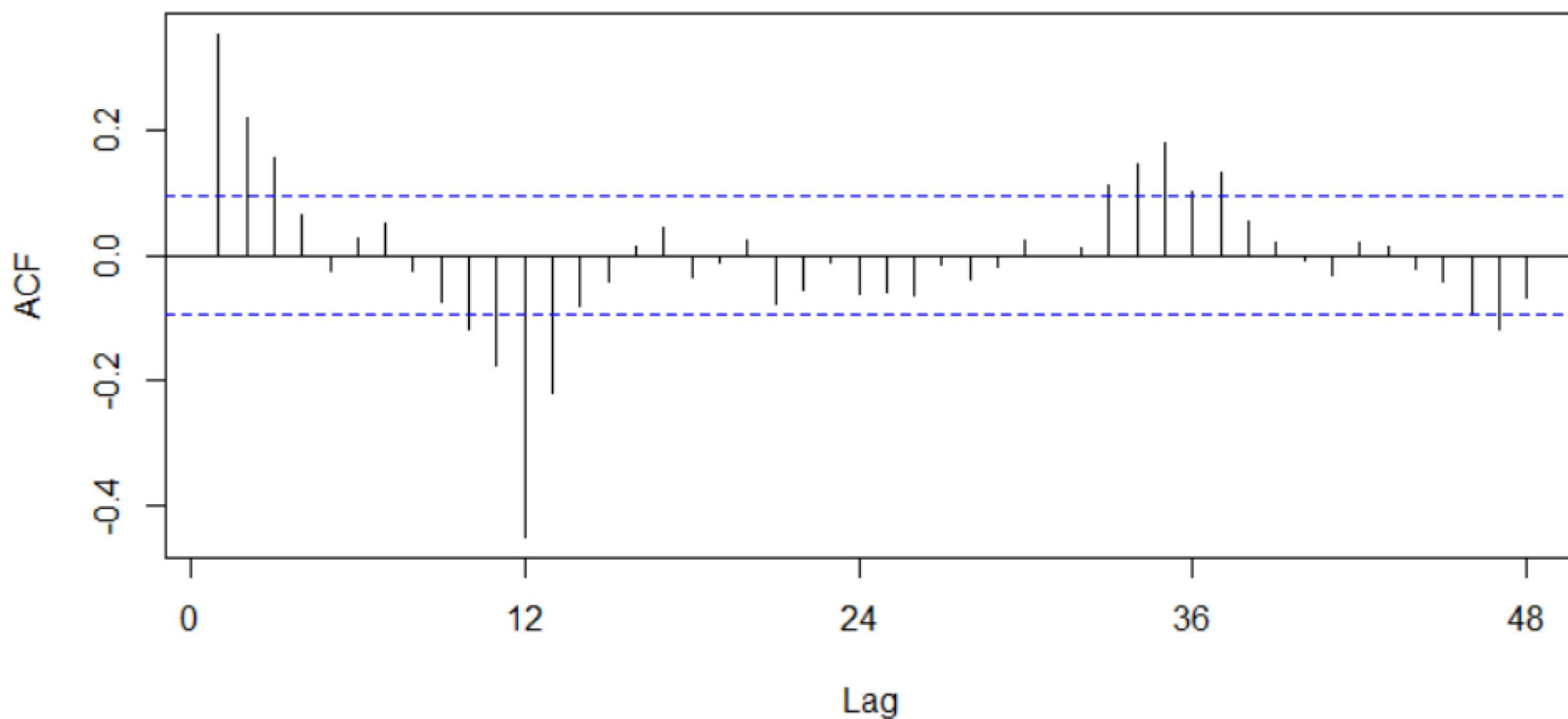


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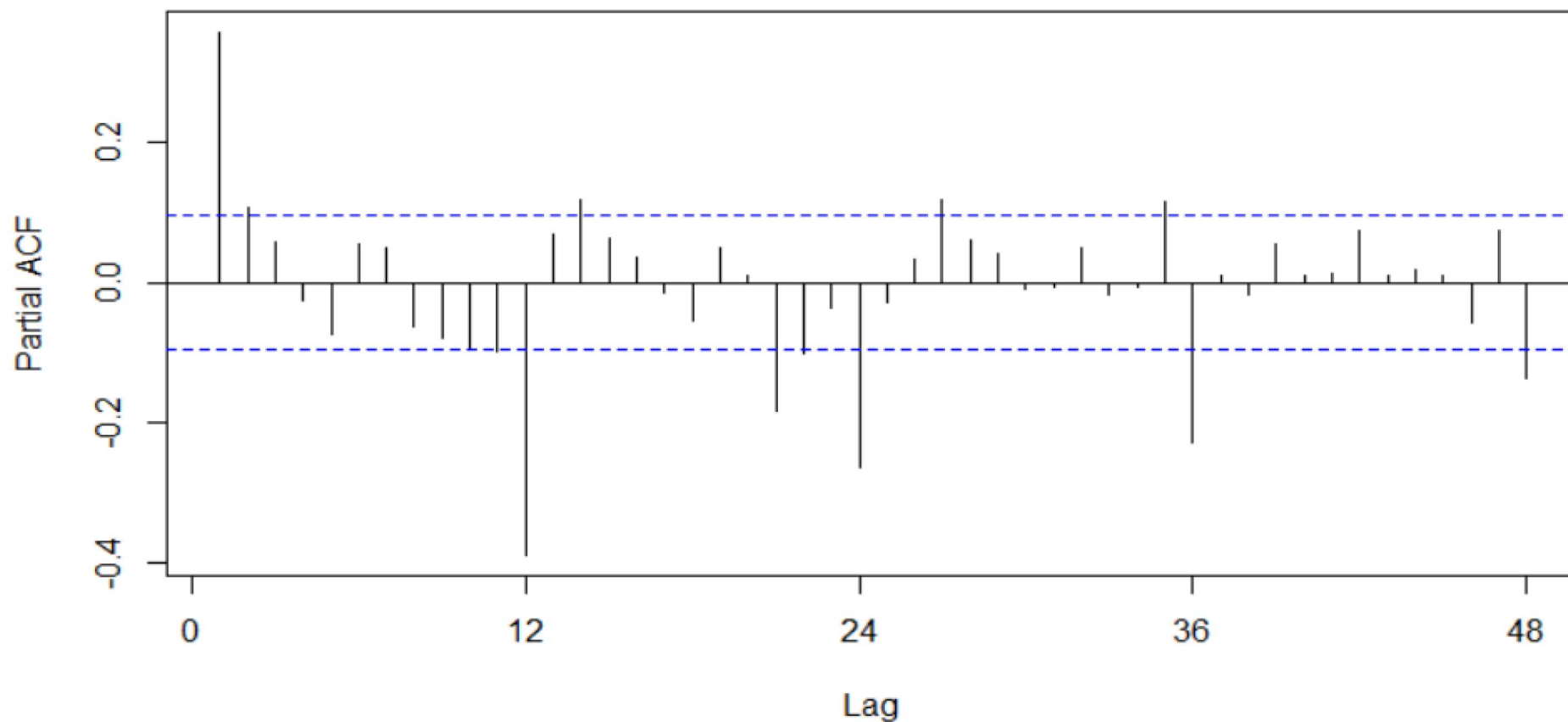


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Tentative Model (ARIMA Structure)	AIC
$ARIMA (2, 1, 0) \times (0, 0, 1)_{12}$	763.16
$ARIMA (2, 1, 3) \times (0, 0, 1)_{12}$	762.21
$ARIMA (3, 1, 3) \times (0, 0, 1)_{12}$	763.93
Tentative Model (Dynamic Regression)	
$ARIMA (2, 1, 0) \times (0, 0, 1)_{12}$ with regressor Crude Oil	764.29
$ARIMA (2, 1, 3) \times (0, 0, 1)_{12}$ with regressor Crude Oil	763.07
$ARIMA (3, 1, 3) \times (0, 0, 1)_{12}$ with regressor Crude Oil	753.78
$ARIMA (2, 1, 0) \times (0, 0, 1)_{12}$ with regressor US\$ Foreign Exchange Rate against Philippine Peso	760.78
$ARIMA (2, 1, 3) \times (0, 0, 1)_{12}$ with regressor US\$ Foreign Exchange Rate against Philippine Peso	761.02
$ARIMA (3, 1, 3) \times (0, 0, 1)_{12}$ with regressor US\$ Foreign Exchange Rate against Philippine Peso	752.20
$ARIMA (2, 1, 0) \times (0, 0, 1)_{12}$ with combination of two regressors	761.89
$ARIMA (2, 1, 3) \times (0, 0, 1)_{12}$ with combination of two regressors	761.79
$ARIMA (3, 1, 3) \times (0, 0, 1)_{12}$ with combination of two regressors	745.75



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Model Term	Estimate	Standard Error	z	p-value
<i>AR</i> (1)	0.5835	0.0787	-7.4163	1.204×10^{-13}
<i>AR</i> (2)	-0.8658	0.0143	-60.4020	$< 2.2 \times 10^{-16}$
<i>AR</i> (3)	0.7506	0.0799	9.6317	$< 2.2 \times 10^{-16}$
<i>MA</i> (1)	-0.3193	0.1069	-2.9862	0.0028
<i>MA</i> (2)	0.9341	0.0194	48.0487	$< 2.2 \times 10^{-16}$
<i>MA</i> (3)	-0.4620	0.1078	-4.2860	1.82×10^{-5}
<i>SMA</i> (1)	0.8321	0.0305	-27.2784	$< 2.2 \times 10^{-16}$
Crude Oil	0.0050	0.0042	1.1923	0.2332
Foreign Exchange Rate	0.0480	0.0216	-2.2204	0.0264



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Model Term	Estimate	Standard Error	z	p-value
AR (1)	0.8304	0.0874	9.4964	$< 2.2 \times 10^{-16}$
AR (2)	-1.0386	0.0155	-67.0025	$< 2.2 \times 10^{-16}$
AR (3)	0.7379	0.0841	8.7769	$< 2.2 \times 10^{-16}$
MA (1)	-0.5784	0.1188	-4.8695	1.12×10^{-6}
MA (2)	1.0521	0.0183	57.4479	$< 2.2 \times 10^{-16}$
MA (3)	-0.4667	0.1185	-3.9384	8.20×10^{-5}
SMA (1)	-0.8570	0.0271	-31.5794	$< 2.2 \times 10^{-16}$
Foreign Exchange Rate	-0.0374	0.0217	-1.7262	0.0843

$$\hat{y} = -0.0374x + \eta_t, \quad (1 - 0.8304B + 1.0386B^2 - 0.7379B^3)(1 - B)\eta_t \\ = (1 - 0.8570B^{12})(1 - 0.5784B + 1.0521B^2 - 0.4667B^3)\epsilon_t$$



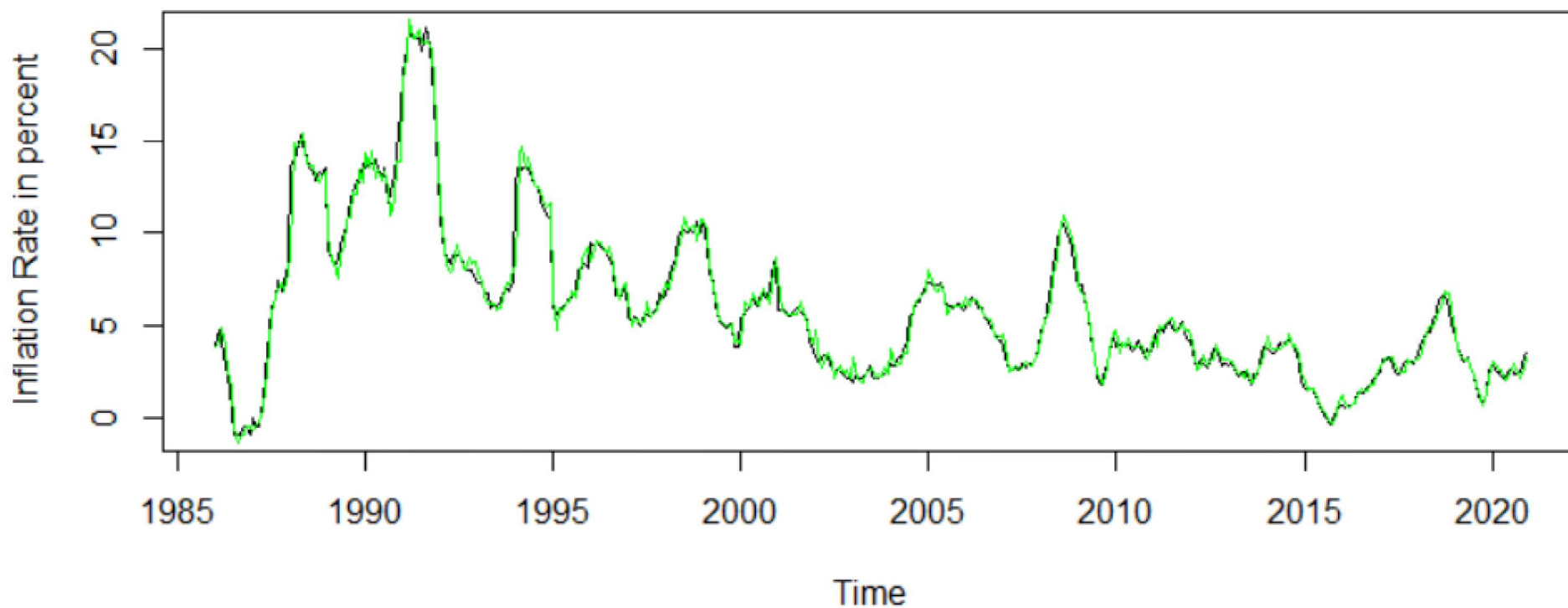
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Predicted vs. Actual Inflation Rate in the Philippines





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Month	Actual	Forecast	Forecast Error
January 2020	2.9	3.07	-0.17
February 2020	2.6	3.07	-0.47
March 2020	2.5	2.59	-0.09
April 2020	2.2	2.46	-0.26
May 2020	2.1	2.05	0.05
June 2020	2.5	2.27	0.23
July 2020	2.7	2.54	0.16
August 2020	2.4	2.76	-0.36
September 2020	2.3	2.49	-0.19
October 2020	2.5	2.26	0.24
November 2020	3.3	2.50	0.80
December 2020	3.5	3.14	0.36

January 2021	4.2	3.81	0.39
February 2021	4.7	4.91	-0.21
March 2021	4.5	5.05	-0.55
April 2021	4.5	4.78	-0.28
May 2021	4.5	4.49	0.01
June 2021	4.1	4.32	-0.22
July 2021	4.0	3.82	0.18
August 2021	4.9	4.22	0.68
September 2021	4.8	5.24	-0.44
October 2021	4.6	4.69	0.09



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Month	Point Forecast	Lower 90% Confidence Bound	Upper 90% Confidence Bound
November 2021	5.2	4.19	6.13
December 2021	4.6	3.04	6.15
January 2022	3.9	1.84	6.06
February 2022	3.9	1.21	6.52
March 2022	4.2	1.07	7.40
April 2022	4.5	0.84	8.12
May 2022	4.5	0.42	8.58
June 2022	4.8	0.24	9.28
July 2022	4.8	-0.18	9.68
August 2022	4.2	-1.11	9.51
September 2022	4.4	-1.27	10.06
October 2022	4.4	-1.58	10.47

FINDINGS

- The trend of the Philippine Inflation Rate showed irregular fluctuations and a downward trend. Moreover, there was existence of seasonality based on the ACF and PACF plots.
- Like in the Philippine Inflation Rate, the trends of both Forex and Crude Oil Prices in the world market were both fluctuating.

FINDINGS

The final and appropriate model for the Philippine Inflation Rate is $ARIMA(3, 1, 3) \times (0, 0, 1)_{12}$ with the regressor US Dollar Foreign Exchange Rate against Philippine Peso and all model terms are significant different from zero. Moreover, the residuals of the final model were appeared to be white noise and uncorrelated.

FINDINGS

Hence, the final model is adequate. Finally, the estimated Dynamic Regression Model in the fitted regression form is

$$\hat{y} = -0.0374x + \eta_t$$

where x is US Dollar Foreign Exchange Rate against the Philippine Peso, with the backshift notation in the ARIMA error structure,

$$\begin{aligned} & (1 - 0.8304B + 1.0386B^2 - 0.7379B^3)(1 - B)\eta_t \\ & = (1 - 0.8570B^{12})(1 - 0.5784B + 1.0521B^2 - 0.4667B^2)\epsilon_t \end{aligned}$$

FINDINGS

The forecasted values of the final model from January 2020 to October 2021 are ranges from 2.05% to 5.24%. Based on the observations, the trend of both actual and forecasted values for the Philippine Inflation Rate were fluctuating due to the external factors.

RECOMMENDATIONS

- Based on the findings of the study, the researcher offers the following recommendations:
 1. The Philippine Statistics Authority (PSA) and Bangko Sentral ng Pilipinas (BSP) may make the results of this study a supplement to its technique for calculating the updated Inflation Rate, such as updating the base year.
 2. Interested researchers with similar problems to the ones mentioned in this paper may make use of the methods executed in this study.



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Thank you!



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