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Forecast Foreign Exchange Rate: The Case Study of PKR/USD

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Abstract

The main aim of this paper is to forecast the future values of the exchange rate of the USD. Dollar (USD) and Pakistani Rupee (PR). For this purpose was used the ARIMA model to forecast the future exchange rates, because the time series was stationary at first difference. Data reported to five years ranging from the first day of April 2014 to 31st March 2019. The results proved that ARIMA (1,1,9) is the most suitable model to forecast the exchange rate. The difference between the forecasted values and actual values are less than 1%; therefore, it was found that the ARIMA is robust and this model will be helpful for the government functionaries, monetary policymakers, economists and other stakeholders to identify and forecast the future trend of the exchange rate and make their policies accordingly.

Keywords: *Autoregressive, forecasting, exchange rate, ARIMA*

1. Introduction

Forecasting is now one of the essential tools in the secondary research; therefore, the development under this area is exceptional. The exchange rate is one of the crucial macroeconomic indicators for any economy; therefore, investors, lenders, borrowers, people in business etc., are always keen to know about the trend of exchange rate near future because their investments and transactions are significantly affected by the fluctuation in exchange rates. It also affects the profit forecasting, capital budgeting plans and the foreign investment worth. Exchange rates are derived via market forces, i.e. supply and demand elements of the market forces, which are purchasers and sellers; therefore, the uncertainty always exists. Forecasting helps to reduce uncertainty and unwanted fluctuation. Forecasting is vital for the managerial and financial decision process. The fluctuation in exchange rates takes place rapidly due to deviation of behaviour in market forces. Therefore the risk becomes

more tangible for international transactions. The exchange rate also counts as one of the essential macro-economic variables. Therefore an accurate forecasting model is required to decrease the risk of uncertainty among businessman, investors, importers, exporters etc. Increase in Exchange Rate affects the balance of payments and many areas of International Finance as well. In the case of Pakistan, if exchange rate increase then the value of debt payable also increases. In result, the balance of payment will be disturbed and maybe government increase money supply which increases inflation. The policy makers must keep an eye on the exchange rate; otherwise, the unwanted deviation may affect the other macroeconomic variables. (Pandaa et al., 2007).

Box et al. (1994) there is not any proper substantial methodology which predicts the upcoming trend of the exchange rate. However, on the other hand, historical data can be used to speculate the variation in exchange rate according to the past trend. It is an assumption that the past fluctuation in data has digested the behaviours of any variable; therefore, the researchers incorporate the historical secondary data to find out the expected outcomes of such variable.

Pakistan has been facing several socio-economic problems; therefore, the monetary policymakers need to keep looking for the forecasting tool, which will enable them to forecast the critical macro, micro-economic and financial indicators. The accurate forecasting will be helpful for the policymakers to adjust their plans and policies accordingly. The forecasting will also be helpful in decision making because it will be helpful for the policymakers to take effective decisions. (Georgoff & Murdick, 1986). In Pakistan, the exchange rate of USD. dollar into PR mostly observed an upward trend. Before the dictatorship rule of General Pervez Musharraf, the dollar was trading at Rs 45 in interbank. However, during the tenure of eight years of dictatorship, the exchange rate increased by more than 30%. There was a rapid increase in the exchange rate during the period of the P.P.P. government when the dollar exchange rate was climbing up to Rs. 95. Furthermore, the same trend was followed under Nawaz Sharif's tenure, where the maximum exchange rate was over Rs. 120. In just eight months of Imran Khan's government, it was traded at the price of Rs. 143. Currently, the exchange rate of PR against the US Dollar is Rs. 160, which is expected to be increased further in the near future. It is also found that in some period, but insignificant, there was a downward trend in the exchange rate. Therefore, it is a significant issue which the researcher is going to address in this paper by finding out the suitable forecasting model in order to take timely decisions regarding monetary and financial investments.

The researcher has taken the exchange rate as a variable for the forecasting purpose. The five years daily data of the exchange rate of USD/PKR has taken as a sample, and ARMA/ARIMA tool will be used as a statistical instrument. The reason of employing USD exchange rate with PR is that most of the traders, importers, exporters, remittances, foreign currency deposits, reserves etc. are using USD. dollar as the transacting exchange currency.

The main goal of this paper is to find out an effective forecasted model for the analysis of PR Exchange Rate versus United State Dollars which will provide the best output of forecasting by which policymakers will be benefited.

2. Literature Review

There are an extensive literature regarding the forecasting of exchange rates of different currencies from different regions. It is also known that the time series is dynamic. Therefore, the forecasting models may be changed according to the behaviour or trends, or main goals (Dos Santos, 2018Dos-Santos and Diz, 2019). Some determinants of exchange rates are uncontrollable, i.e. government interference, surplus or deficit in the balance of payment or trades, therefore, the analysis of forecasting exchange rate and other time series is always gaining the attention of researchers. Numerous authors have employed different methodologies in order to forecast the exchange rate. Ishfaq (2018) using that methodology concluded that the VIX index could provide a fear prediction of the direction of the CNY exchange rate movement. Also, Prado et al., (2020) proposed a new model which includes several individual models, for example, autoregressive integrated moving average,

genetic algorithm, extreme machine learning, ANN models, SVR techniques, adaptive neuro-fuzzy inference system and fuzzy inference system models. The author concluded that the assembling of these models enhances the predicting ability. Mance et al. (2015) applied the causality test to find out the link between exchange rate movement and Inflation and other macro-economic variables. However, there are several types of research where the methodology of ARMA/ARIMA has been utilized to predict the exchange rate, and they get a more accurate response, i.e. close to actual.

3. Research Methods

The ARIMA methods was be used by Joshi et al. (2020) who forecasted the exchange rate time series of Indian Rupee against the US Dollar by using Box-Jerkins approach. The authors concluded that ARIMA (1,1,5) had provided more effective results, i.e. close to actual observations. Al-Gounmein et al. (2020) forecasted the exchange rate of the Jordanian Dinar against the US Dollar by employing ARIMA models. The results concluded that ARIMA (1,0,1) and SARIMA(1,0,1) provided better forecasting. Deka et al. (2019) applied ARIMA methodology to forecast the consumer price index and an exchange rate of Turkish Lira and Turkish Inflation rate. The results revealed that ARIMA (3,1,3) and ARIMA (1,1,4) are providing the most effective forecasting in terms of the exchange rate and inflation rate, respectively. Abreu et al. (2019) tested the forecast accuracy of EUO/US Dollar between two models, i.e. ARIMA and Singular Spectrum Analysis (SSA) model. It was concluded by the authors that ARIMA is highly effective for the forecasting exchange rate of EURO/US Dollar if compared to the SSA model. Umar et al. (2019) also proved the importance of ARIMA approach in their study. They concluded that ARIMA (2, 1, 1) is the highly efficient model in case of the forecasting exchange rate of Naira against UK pound.

Farhan et al. (2019) forecasted the exchange rate of Iraqi Dinar versus the US Dollar by employing ARIMA approach. The author concluded that ARIMA (1,1,1) provides the most reliable forecast compared with other models. Dhankar (2019) forecasted the four exchange rate time series, i.e. US Dollar, Sterling Pound, EURO and Yen against Indian Rupee by using ARIMA approach. The out of sample forecasting results predicted that in future, the exchange rate of Pound, Dollar and EURO would increase slightly. However, there will be a constant behaviour in case of Japanese Yen. Nwankwo Steve (2014) studies the forecasting of the exchange rate of Nigerian Naira to Dollar. For this purpose, the researcher has taken the data from 1982-2011 and used ARIMA model for the analysis. Based upon results, the author found that an AR(1): order one provide robust forecasting. Tran (2016) tested the forecasting of the exchange rate of Vietnam Dong and USD. Dollar. The author has taken the data of three years to forecast the exchange rate for next year. The researcher used ARIMA model for the analysis. It was concluded that after the comparison of real data and forecasted values, the ARIMA model is appropriate for the short term predicting rather than long term forecasting. Humphrey et al. (2015) forecasted the exchange rate of Zambian Kwacha to Us Dollars by using Autoregressive integrated model. For forecasting, the authors have taken the data from 1964 to 2014. The researchers stated that the ARIMA model is more suitable for short term forecasting rather than long period speculation.

Kadilar et al. (2009) find ARIMA as the suitable model, for forecasting, by using weekly rates of USDTRY for the sample ranging from the dates of the third day of January 2005 and 28th day of January 2008 with 160 observations. Cenk et al. (2017) have taken a total of 3069 observations of USDTRY over the period from the third day of January 2005 to 8th March 2017. The researchers generated both short and long term models for the forecasting. For short- term forecasting, the appropriate specification was ARIMA (2,1,0) and ARIMA (0,1,1) for the long run. They concluded that the forecasting of short term is more appropriate than the long-term forecasting values.

Babu et al. (2015) compare the different methods of forecasting. The researchers have taken 1,284 daily observations of USDINR, GBPINR, EURINR, JPYINR over the period from January 2010 to April 2015. These researchers concluded that ARIMA gives more significant results than other systems (Babu et al., 2015). Newaz (2008) compared different forecasting models of the exchange rate of

Indian rupee into Us Dollar. The researcher had taken the monthly data from September 1985 to June 2002. The researcher forecasts the exchange rate until 2006 to find out the suitable model. The author concluded that the ARIMA model is more robust than M.A.E., MEAE, MAPE, M.S.E. and RMSE models in forecasting short term or long term exchange rates.

Vergil et al. (2007) compare the effectiveness of the ARIMA model against the monetary model, i.e. MM Model. For this purpose, the researchers have taken the data over the period from January 1980 to July 2001 of the exchange rate of USDTRY. By estimation ARIMA (3,12) as a suitable specification, the authors concluded that the ARIMA model is much better than other models.

Bircan et al. (2003) tested the monthly mean exchange rate of USDTRY by employing 132 observations. The observations were from the period of the 1991 1st day to the last day of 2002. The researchers estimate the ARIMA model and find the suitable specification, i.e. ARIMA (2,1,1). It was finally concluded that the ARIMA method is appropriate for the forecasting of USDTRY exchange rate.

Several researchers have used ARIMA model to forecast some other variables. For example, Ahmed et al. (2017) forecasted the KIBOR rate and found it robust. Massarrat (2013) forecast the gold price.

Through ARIMA we can also forecast the macroeconomic variable trends, for example, Meyler (1998) forecast Ireland's inflation rate, whereas Jarrett (2011), Ariyo (2014), Isenah (2014), Mondal (2014) employed ARIMA model for forecasting the future trend in stock price. Dua et al. (2004) forecasted the rates of Treasury bill by using the ARIMA model for different periods.

3.1 Data and Variable

Daily data of variable, i.e. exchange rate of USD. Dollar into PR was used. The data has taken from the 1st day of April 2014 to 31st day of March 2019. We will forecast the short term exchange rate from the first day of April 2019 to the fifth day of April 2019. The data of daily exchange rate are easily available in different websites and published surveys; however, has taken the publish data from the Bloomberg website. The daily data of univariate time series is beneficial under the analysis of forecasting models. More the data, efficient the results in this case. Efficient results can be explained as close to the actual value of the forecasting time series.

3.2 Empirical Framework

For the forecasting purpose, has incorporated the ARMA, ARIMA models as we know that previous authors have also integrated such useful tools for the forecasting of their variables**.** If time series found stationary at level, then ARMA approach will be utilized; however, in case of integrated time series at 1st difference or 2nd, the ARIMA model will be applied.

3.3 ARIMA Model

Box and Jerkins (1976) are one of the most frequently used models for the forecasting of future values. The ARIMA model used the past and current values to predict the future values of time series. ARIMA model is the integrated model when the time series become stationary after taking the first or second Difference. It takes the historical data and decomposes into Autoregressive process. The ARIMA models are written as ARIMA (a,*b,c*) where *a* defines the order of the autoregressive model, *b* defines the order of the moving average and *c* indicate the order of the stationary according to the Bo-Jenkins methodology. If the time series is stationary at level, then it will be referred to as the ARMA model, (*a,b*). Where:

$$\emptyset_P \ (B)(1-B)^d \mathrm{y} = \vartheta + \theta_q(\mathrm{B})\alpha_t$$

4. Analysis Result

The initial step in time series analysis is to draw the graph and find out the pattern of the given time series. The pattern should not have any certain upward or downward trend, and there will be no constant or seasonality trend as well because such trends lead to the non-stationary issues, and the results will be spurious.Was found that there is an upward trend in the exchange rate of USD into P.K.R. Although during some period, it was stable. From 2017 to 2019, it is observed that there is an upward trend, whereas the deviation from 2014 to 2017 is significantly less. Such trend induced that there is an issue of non-stationary. The author has adjusted all the upward and downward trends by integrating the 1st Difference, and the graph revealed that most of the trends had been adjusted except a few of the spreads.

The mean and standard deviation of the given data are 0.025342 and 0.450698, respectively. The mean and standard deviation are 0.025 and 0.000 separately. The resulted values of Skewness and Kurtosis are 6.718 and 204.1191. Jarque-Bera resulted in value was 284572 with significant p-value, i.e. 0.00000.

4.1 Unit Root

Table # 1: Unit Root Test

	Level	**1st Difference**
Exchange Rate	1.596037	23.67911***

****Significant at 1%*

It is important to find out the stationary of time series before forecasting. Therefore, the researcher has conducted the Augmented Dickey-Fuller Test. The results stated that in level, it was found that data was not stationary with the p-value of 0.995 and t-value of 1.596037. Afterwards, the author has taken the 1st Difference of the time series data and run the test again, which indicates that data is now stationary at 1% significant with the t-value of 23.6791.

	A.C.	P.A.C.	Q-Stat	Prob
1	0.997	0.997	1673.8	0.000
2	0.994	0.029	3338.2	0.000
3	0.991	0.014	4993.5	0.000
4	0.987	-0.023	6639.2	0.000
5	0.984	0.002	8275.4	0.000
6	0.981	-0.014	9901.8	0.000
7	0.978	0.009	11519.	0.000
8	0.975	0.027	13127.	0.000
9	0.972	-0.025	14726.	0.000
10	0.969	-0.023	16315.	0.000
11	0.965	0.003	17894.	0.000
12	0.962	0.005	19464.	0.000
13	0.959	0.002	21025.	0.000
14	0.956	0.005	22576.	0.000
15	0.953	0.010	24119.	0.000
16	0.950	0.021	25653.	0.000
17	0.947	-0.017	27178.	0.000
18	0.944	-0.003	28694.	0.000
19	0.941	0.004	30202.	0.000
20	0.938	-0.001	31701.	0.000
21	0.935	-0.001	33191.	0.000
22	0.932	-0.002	34673.	0.000

23	0.929	-0.007	36146.	0.000
24	0.926	-0.007	37611.	0.000
25	0.923	0.007	39067.	0.000
26	0.920	-0.008	40514.	0.000
27	0.917	0.003	41952.	0.000
28	0.914	-0.011	43382.	0.000
29	0.911	0.023	44804.	0.000
30	0.908	0.001	46218.	0.000
31	0.905	-0.002	47623.	0.000
32	0.902	-0.035	49020.	0.000
33	0.899	-0.006	50407.	0.000
34	0.896	0.021	51787.	0.000
35	0.893	-0.017	53158.	0.000
36	0.890	-0.011	54519.	0.000

In the Correlogram, it is found that the author has to take 36 M.A. lags and 1 A.R. lags. Furthermore, it was earlier tested that the given time series data was stationary at 1st Difference; therefore, the researcher has to employed the ARIMA model for forecasting. All p-values show significant results.

4.2 ARIMA Model

Table # 2: ARIMA Model Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.776824	0.149444	5.198100	0.0000
MA(1)	-0.911002	0.150741	-6.043484	0.0000
MA(2)	0.050259	0.026873	1.870202	0.0616
MA(3)	0.170587	0.028387	6.009440	0.0000
MA(4)	-0.117652	0.042979	-2.737426	0.0063
MA(5)	0.053902	0.039320	1.370851	0.1706
MA(6)	-0.073366	0.040329	-1.819186	0.0691
MA(7)	0.041630	0.035446	1.174468	0.2404
MA(8)	0.054512	0.018427	2.958348	0.0031
MA(9)	-0.070207	0.016740	-4.194084	0.0000
SIGMASQ	0.194826	0.000729	267.4251	0.0000
R-squared	0.040305	Mean dependent var		0.025342
Adjusted R-squared	0.034559	S.D. dependent var		0.450698
S.E. of regression	0.442842	Akaike info criterion		1.215392
Sum squared residual	327.5021	Schwarz criterion		1.250906
Log likelihood	-1010.537	Hannan-Quinn criter.		1.228547
F-statistic	5.124770	Durbin-Watson stat		1.997704
Prob(F-statistic)	0.000000			
Inverted AR Roots	.78			
Inverted MA Roots	.85	.67-.36i	.67+.36i	.31+.69i
	.31-.69i	-.28-.66i	-.28+.66i	-.67+.19i
	-.67-.19i			

In ARIMA Model, it is found that the AR(1) and MA(9) are significant at less than 1% level of significance. The DW value lies closer to 2, which reveals that there is not an issue of serial correlation. The F-statistic and p-value of (F-Statistics) are 5.124770 and 0.0000, which indicate that the model is fit. The R-squared and adjusted R-square are 0.040.05 and 0.034559, respectively.

4.3 Forecast

After finding significant A.R. and M.A. lags, an essential step is to forecast the time series. The author has extended the time series by integrating five days in the prescribed range of data from 1st April 2019 to 5th April 2019, respectively. The first step toward forecasting to draw the graph to find out the forecasted value range.

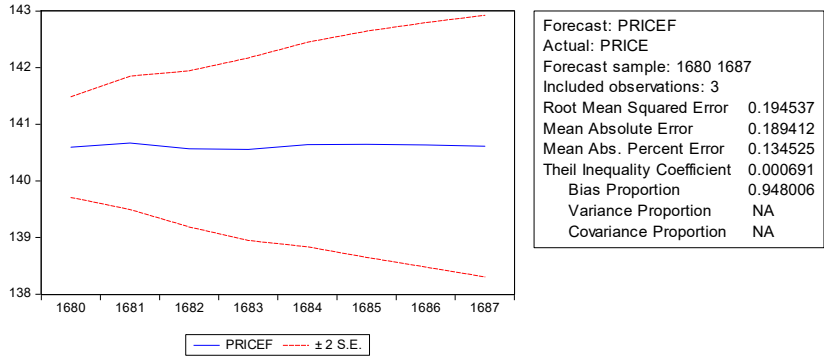

Fig 4.

In figure 4 of the forecasting graph, it is found that the forecasting value will have a slightly stable trend, and they are between the bandwidth, which shows the robustness of the test. The values of RMSE, MAE and MAPE are 0.194537, p.189412 and 0.134525, respectively.
For the forecasting of the next five days, the researcher has included five more days in the range of the sample. In options, the dynamic forecasting was selected as we know that the time series is dynamic rather than static. The forecasted values, actual values and the differences between the forecasted and actual values of exchange rates for the next five days are as below:

Table # 3: Table of Forecasted and Actual Values

Date	Forecasted Values	Actual Values	Difference
1st April 2019	140.558	140.850	0.207%
2nd April 2019	140.642	140.300	0.244%
3rd April 2019	140.645	141.650	0.71%
4th April 2019	140.635	141.575	0.665%
5th April 2019	140.614	141.450	0.59%

In Table 3, it is found that there are minor differences between the actual and estimated rates, which is not more than 0.7% in any case. The forecasted rate is nearly equivalent to actual rates, which represent the accuracy in the excellence of the applied model. The least difference between the actual and forecasted values was 0.207% when the actual value of the exchange rate was 140.85, and the forecasted value was 140.558 on 1st April 2019. However, the most differential forecasted value was 140.650 when the actual exchange rate was 141.65 on 3rd April 2019. The difference was estimated at 0.71%. The deviation between the exchange rates of the five days is significantly less, which indicates the stability of the exchange rate in the short run, therefore, can say that the forecasted model is robust.

5. Conclusion

The key objective was to forecast the future values of the exchange rate of USDPKR. The researcher has taken the four years daily data of USDPKR from the first day of April 2015 to 31st day of March 2019. The

data was not stationary at level; therefore, the first Difference was taken in order to transform the series stationary. The stationary is one of the vital assumptions; therefore, it is compulsory to develop stationary series. As we know that, when the series is stationary at first Difference then the integrated model, which will be used for forecasting refer as ARIMA model. The stationary was checked by employing the Augmented Dickey-Fuller Test. The results concluded that ARIMA (1,1,9) is suitable for the forecasting, and simultaneously after increasing the range, the forecasted were very close to actual values. Therefore, it was concluded by the author that the ARIMA model is robust, and its forecasting values are nearer to the actual values which reject the null hypothesis. It is found that the exchange rate has shown minimal deviation in the forecasted dates and found to be stable.

The results are consistent with the findings of Babu et al. (2015), Vergil et al. (2007), Cenk et al. (2015), Humprhey et al. (2015). The extracted results from the model will be helpful for the policymakers, government functionaries, financial experts and economists of the government to design their policies accordingly. The motivation of this study is the requirement of forecasting tool because almost all international transactions in Pakistan economy utilize USD. Dollar as currency. The deviation in exchange rate sometimes affects the importers, exporters and other parties. Therefore, it is an effort by the researcher to develop an effective model which will be helpful for them in order to forecast the upcoming regular or irregular trend in the exchange rate. The effective forecasted models enable to take timely decisions regarding investments, savings, reserves and businesses, which will lessen the chances of loss due to fluctuation in the exchange rate. These findings are also helpful in other areas of finance, like asset pricing models, because the exchange rate affects the returns significantly. Therefore, investors are keen to minimize the risk of exchange rate fluctuation, which eventually affect the returns. For example; Phiri. A (2020) studied the structural changes in stock return-exchange return dynamics in South Africa. The author concluded that prior crises the appreciation in exchange return increase the stock return. Nordin (2020) revealed that exchange rate showed a significant impact on stock market performance and return in the case of Malaysia.

6. Limitation

In this study, the researcher has taken the exchange rate of USD into PKR only and the daily data of last five years. The forecasted model may be effectively applied for the exchange rate of USDPKR. Furthermore, only the short term forecasted values were checked in this study.

7. Recommendations for Future Researchers

It is recommended for the future researchers to forecast the USDPKR in the short and long run both. Moreover, other exchange rates forecasted with different data sets are suggested. The researcher may combine different techniques and compare their forecasting abilities.

References

Abreu, R. J., Souza, R. M., & Oliveira, J. G. (2019). Applying singular spectrum analysis and ARIMA-GARCH for forecasting EUR/USD exchange rate. Revista de Administração Mackenzie, 20(4), 34-52.

Ariyo, A. A, Adewumi, A. O and Ayo. C .K (2014). Stock Price Prediction Using the ARIMA Model. UKSim-AMSS 16th International Conference on Computer Modelling and Simulation, Cambridge, 106-112.

Ahmed, R. R., Vveinhardt, J., Ahmad, N. & Štreimikienė, D. (2017). Karachi Inter-Bank Offered Rate (KIBOR) Forecasting: Box-Jenkins (ARIMA) Testing Approach. Economics and Management Research, 20(2), 188–198.

Al-Gounmeein, R. S. & Ismail, M. T. (2020). Forecasting the Exchange Rate of the Jordanian Dinar versus the US Dollar Using a Box-Jenkins Seasonal ARIMA Model, International Journal of Mathematics and Computer Science, 15(1), 27–40.

Babu, A. S., & Reddy, S. K. (2015). Exchange rate forecasting using ARIMA, neural network and fuzzy neuron. Journal of Stock & Forex Trading, 3(4), 1–5.

Bircan, H., &Karagoz, Y. (2003). Box Jenkins Modelleri İle Aylık Döviz Kuru Tahmini Üzerine Bir Uygulama. Kocaeli Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 6(2), 49–62.

Box, G.E.P., Jenkins, G.M. (1976). Time Series Analysis: Forecasting and Control. San Francisco: Holden-Day.
Box, G.E.P, and Jenkins, G.M. (1994). Time Series Analysis: Forecasting and Control. 3rd Edition Prentice Hal.
Cenk, U. Y., & Abdurrahman, F. (2017), Forecasting USDTRY rate by ARIMA method, Yıldıran & Fettahoğlu, Cogent Economics & Finance, 5:1335968, 1-11.
Deka, A., & Resatoglu, N. G. (2019). Forecasting Foreign Exchange Rate and Consumer Price Index with ARIMA Model: The Case of Turkey. International Journal of Scientific Research and Management, 7(8), 1254-1275.
Dos Santos, M. J. P. L. (2018). Nowcasting and forecasting aquaponics by Google Trends in European countries. Technological Forecasting and Social Change, 134, 178-185.
Dos-Santos, M. J. P. L., & Diz, H. (2019). Impact of corporate R&D on efficiency in OECD industries. In The Cross-Disciplinary Perspectives of Management: Challenges and Opportunities. Emerald Publishing Limited.
Dhankar R.S. (2019) Forecasting Exchange Rate. Capital Markets and Investment Decision Making, Springer, New Delhi.
Dua, P., Raje, N., & Sahoo, S. (2008). Forecasting Interest Rate in India. The Journal of Applied Economic Research, 2(1), 1–41.
Farhan, A. K. & Fakhir, M. R (2019). Forecasting the Exchange Rates of the Iraqi Dinar against the US Dollar using the Time Series model (ARIMA). International Journal of Engineering and Management Research, 9(6), 51-55.
Georgoff, D., & Murdick, R. (1986). Manager's Guide to Forecasting. Harvard Business Review, 64(3), 110-120.
Humphrey, F., Mercy, F. M., & Wilson, F. (2015), Forecasting ZMK/USD Exchange Rate with ARIMA Model, American International Journal of Research in Humanities, Arts and Social Sciences, 5(15), 5-10.
Kadilar, C., Simsek, M., Aladag, C.H. (2009). Forecasting the exchange rate series with ANN: the case of Turkey, Istanbul University Journal of Econometrics and Statistics, 9(1), 17-29.
Isenah, G. M. O., Olusanya E. (2014). Forecasting Nigerian Stock Market Returns Using ARIMA and Artificial Neural Network Models. CBN Journal of Applied Statistics, 5(2), 25-48.
Ishfaq, M., Qiong, Z., & Abbas, G. (2018). Global Volatility Spillover, Transaction Cost and CNY Exchange Rate Parities. Mediterranean Journal of Social Sciences, 9(2), 161-168.
Jarrett, J. E., & Kyper, E. (2011). ARIMA modelling with intervention to forecast and analyze Chinese stock prices. International Journal of Engineering Business Management. 3(3), 53-58.
Joshi, V. K., Band, G., Naidu, K., & Ghangare (2020), A. Modeling Exchange Rate in India–Empirical Analysis using ARIMA Model. Studia Rosenthaliana (Journal for the Study of Research), 12(3), 13-26.
Mance. D., Žiković, S., & Mance D., (2015), Econometric Analysis of Croatia's Proclaimed Foreign Exchange Rate. South East European Journal of Economics and Business, 10(1), 7-17.
Massarrat, A.K. (2013), Forecasting of gold prices (box Jenkins approach). International Journal of Emerging Technology and Advanced Engineering, 3(3), 662-670.
Meyler, A., Kenny, G., & Quinn, T. (1998). Forecasting Irish Inflation Using ARIMA Model. Technical Paper Series 3/RT/98. Dublin, Ireland: Central Bank and Financial Services Authority of Ireland.
Mondal, P. S., Labani & Goswami, S. (2014). Study on Effectiveness of Time Series Modelling (Arima) in Forecasting Stock Prices. International Journal of Computer Science, 4(2), 13-29.
Newaz, M. K. (2005). Comparing The Performance Of Time Series Models For Forecasting Exchange Rate, BRAC University Journal, 5(2), 55-65.
Nordin. N (2020), The Impact of Commodity Prices, Interest Rate and Exchange Rate on Stock Market Performance: An Empirical Analysis From Malaysia, Malaysian Management Journal, 18(1), 39-52.
Nwanko, S. C. (2014). Autoregressive Integrated Moving Average (ARIMA) Model for Exchange Rate (Naira to Dollar); Academic Journal of Interdisciplinary Studies, 3(4), 429-433.
Pandaa, C. and Narasimhanb, V. (2007). Forecasting exchange rate better with artificial neural network, Journal of Policy Modelling, 29(1), 227-236.
Phiri, A. (2020), Structural changes in exchange rate-stock returns dynamics in South Africa: Examining the role of crisis and new trading platform. Economic Changes & Restructuring 1(1), 171–193.
Prado. F., Minutolo, M. C., & Kristjanpoller, W. (2018). Forecasting Based on an Ensemble Autoregressive Moving Average - Adaptive Neuro-Fuzzy Inference System – Neural Network - Genetic Algorithm Framework. Energy, 197, (117159). doi.org/10.1016/j.energy.2020.117159
Tran. M. U .N, (2016). Forecasting Foreign Exchange Rate by using ARIMA Model: A Case of VND/USD Exchange Rate. Research Journal of Finance and Accounting, 7(12), 38-44.
Umar, S., Abubakar, S. S., Salihu, A. M., & Umar, Z (2019). Modelling Naira/Pounds Exchange Rate Volatility: Application of Arima And Garch Models. International Journal of Engineering Applied Sciences and Technology, 4(8), 238-242.
Vergil, H., & Özkan, F. (2007). Döviz Kurları Öngörüsünde Parasal Model ve Arima Modelleri: Türkiye Örneği. Kocaeli Üniversitesi Sosyal Bilimler Dergisi, 13(1), 211-231.