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Mohammad Ibrahim
Ph.D. Candidate, Department of Statistic, Yildiz Technical University, İstanbul, Turkey

Ahmed Alturfi
Ph.D. Candidate, Department of Statistic, Yildiz Technical University, İstanbul, Turkey

Corresponding Author:
Mohammad Ibrahim
Ph.D. Candidate, Department of Statistic, Yildiz Technical University, İstanbul, Turkey

Impact of exogenous and endogenous variables in time series analysis, exchange rate in turkey as case study

Mohammad Ibrahim and Ahmed Alturfi

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Abstract
This study aimed to investigate the impact of exogenous and endogenous variables in time series Analysis, the study sample consisted of data from 2014 to 2018. The analysis ARIMA, ARIMAX was carried out on exchange rate and interest rate in Turkey during 2014 to 2018 (Monthly data), the results indicated that arimx model explains better the change in dependent variable more than arima model,Also the results are statistically more significant.

Keywords: Exogenous variables, endogenous variables, time series, exchange rate

1. Introduction
Over the years throughout history, statistics and analysis have had played a major role in economy and politicise in developed countries in order to find out the reasons, to make informed decisions or to clarify the causal relationship between the different variables. Hence, the simple and complex regression analysis tries to identify the relationship between two or more variables and how they affect each other.
Among the most important statistical analysis that were used in the past, are time series analysis, which analyses the time-related variables that modifies with the change of time, either daily, monthly or annually. The exchange rate can be termed as an example for such variable.
This is a well-known fact that most of the fields that use time series and their analysis are academic and social domains of Economy or Social Sciences. The best practice includes the formation of a model that includes several types of variables, Such as exogenous and endogenous variables.

1.2 Importance and Objectives of study
This study aims to investigate the impact of exogenous and endogenous variables in time series analysis, proposing as (the model will change if it include exogenous or endogenous variables i mean the result will be different about the result if the variables excluded
So this paper will describe the impact of exogenous variable, one of the factors which effect on exchange rate in turkey such as interest rate, inflation, exports, imports and political issues. While the hypothesis of the study will be described as the exogenous and endogenous will not effect on time series model.

1.3 Operational Definitions
1.3.1 Exogenous
A factor in a causal show or causal framework whose esteem is free of the states of other factors within the framework, a figure whose esteem is decided by variables or factors exterior the causal system. For example, the unemployment rate in any country is one of the external factors that affect the economy in general and the exchange rate in particular. There are some causal factors that determine the exchange rate, so the unemployment rate is the internal factor

to the exchange rate model but these factors are not in themselves part of the causal model we use to explain the exchange rate level.

An exogenous variable is defined as a variable whose value is completely causally independent of other variables in the system. In the analysis of time series, one of the proposed goal of this research, a lot of models are used that can be obtained through statistical programs, the most famous is ARIMA model.

The ARIMA model with exogenous variables can be written in the following equation

$$y_t = \mu + \sum_{i=1}^{p} \emptyset_i y_{t-i} + \varepsilon_t - \sum_{i=1}^{q} \theta_q \varepsilon_{t-1} + \beta x_t$$

Then we label that Autoregressive Moving Average with Exogenous Variables (ARMAX)

Where; x: Exogenous variable.

1.3.2 Endogenous

The internal variable is the variable whose value is determined by the economic model, describing that the internal variable is the dependent variable and its value depends on other variables within the model. Since the endogenous variable is located within the economic model, the model can predict the value of the endogenous variable. The endogenous variable is the opposite of the exogenous variable, as the later one is independent variables that cannot be predicted by the economic model.

Through the example, used in the statistical analysis in this research about the exchange rate as an example of a time series, which depends on many variables such as interest rate, exports, imports and other variables, so the internal variable in this case study is the exchange rate.

So in this part the equation will be same arima model, and we can be written as following

$$y_t = \mu + \sum_{i=1}^{p} \emptyset_i y_{t-i} + \varepsilon_t - \sum_{i=1}^{q} \theta_q \varepsilon_{t-1}$$

2.1 Literature review

The difference between exogenous and endogenous variables and impact of these variables on analysis has been investigated in-detail, also the relationship between exchange rate and other factor was studied too. Almost all the outcomes indicated a significant result, as described below.

2.1.1 Exogenous and endogenous variables

G.Zaman, Z.Goschin (2010) illustrated the technical change as exogenous or endogenous factor in the production of function models as empirical evidence from Romania. This study endeavored to incorporate it unequivocally within the financial development models, either as an exogenous or endogenous figure of impact utilizing the system of the total Cobb-Douglas generation work in its classical shape as well as in a few refined variations. We evaluated the flexibilities of generation components for Romania over the 1990-2007 period, finding that specialized advance has had a little commitment to the financial development. Moreover, Themba G. Chirwa, Nicholas M. Odhiambo (2018) [9] investigated "Exogenous and Endogenous Growth Models: as a Critical Review". In this article, the author examines internal growth patterns and external growth patterns through certain concepts. The results indicated that within the internal model, there are two types of assumptions. The first of which is the capital that considers the difference in production, and the second assumes that technological progress is the main determinant of economic growth & externally. Also, C. Bennett, Rodney A. Stewart examined in the paper, the variables affecting the demand of the low-voltage network were identified and the development of the total energy use on the next day and models to forecast the peak demand on the next day for each stage .The models were created utilizing both Autoregressive Coordinates Moving Normal with Exogenous Factors (ARIMAX) and Neural Arrange (NN) strategies. The information utilized in this inquire about were collected from a moo voltage transformer serving 128 private clients.

2.1.2 Exchange rate modeling

Jackie D. Urrutia, Jaya D. De Guzman, Joseph Mercado, Lincoln Bautista, EdconBaccay (2015) [5] outlined the trade rate within the Philippines as regression model. This think about defined a condition which clarified the connection between trade rate and intrigued rate (x1), swelling rate (x2), Labor Drive Interest Rate (x3) and Add up to Exchange (x4) as the free variable. The comes about appeared Trade rate and add up to exchange appears an expanding drift whereas swelling rate and intrigued rate and labor constrain cooperation rate appears a few variances inside the period of time. Moreover, Mori K, Rozilee A, Jaratin L, Dullah Mand Nanthakumar L (2012) [4] looked into the impacts of the exchange rates on financial development in Malaysia utilizing time arrangement information traversing from 1971 to 2009. The comes about of the ARDL bounds test proposed that long-run cointegration exists between both ostensible and genuine exchange rates and financial development with a noteworthy positive coefficient recorded for genuine trade rate. Also, M. Kandil *et al*. (2007) [3] explored the impacts of exchange rate variances on genuine yield, the cost level, and the genuine esteem of components of total request in Turkey. The comes about appeared that unexpected exchange rate variances have topsy-turvy impacts that highlight the significance of unexpected devaluation in contracting yield development and the development of private utilization and venture, in spite of an increment in exchange development. Furthermore, Sanam M, Fetullah A (2017) [2] examined "The Relationship between Exchange Rates and Inflation: The Case of Iran". The point of this study was to analyze the relationship between Trade rate and swelling based on time arrangement information, utilizing Hendry Common to Particular Modeling strategy and Vector Autoregression (VAR) demonstrate. It utilized quarterly information between 1997/3 to 2011/4 to assess the VAR demonstrate. The result appeared that an increment in remote trade rates makes the expansion goes up, and there's a coordinate relationship between Trade rate and expansion.

3.1 Research Methodology

3.1.1 Data and Methodology

Within the third segment of the paper, the analyst needs to analyze the trade rate in Turkey by utilizing time arrangement, the information utilized for the ponder is the month to month information that was collected between 2014-2018. Whereas conducting this consider, R-studio is utilized to analyze the dataset, estimation and analysis are appeared within the comes about segment.

a. Exchange rate is the value of one nation's currency versus the currency of another nation or economic zone, The

study adopted exchange rate data from the Turkish Central Bank during the period 2014-2018

b. It Include exogenous variable in the second sector (exogenous variable was interest rate).

3.1.2. Analysis and Result

The ARIMA model is used to find out the impact of included exogenous and endogenous variables, also data is divided into sections as described following

3.1.2.1 Time series without exogenous variable

1) plot the series to visualize if stationary or not;

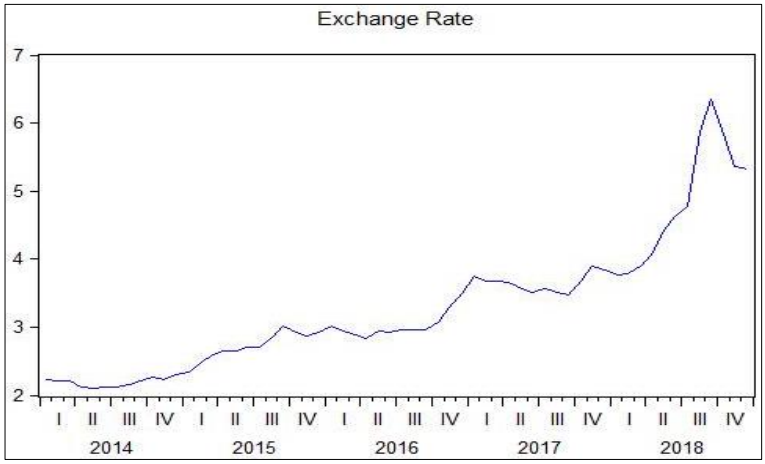
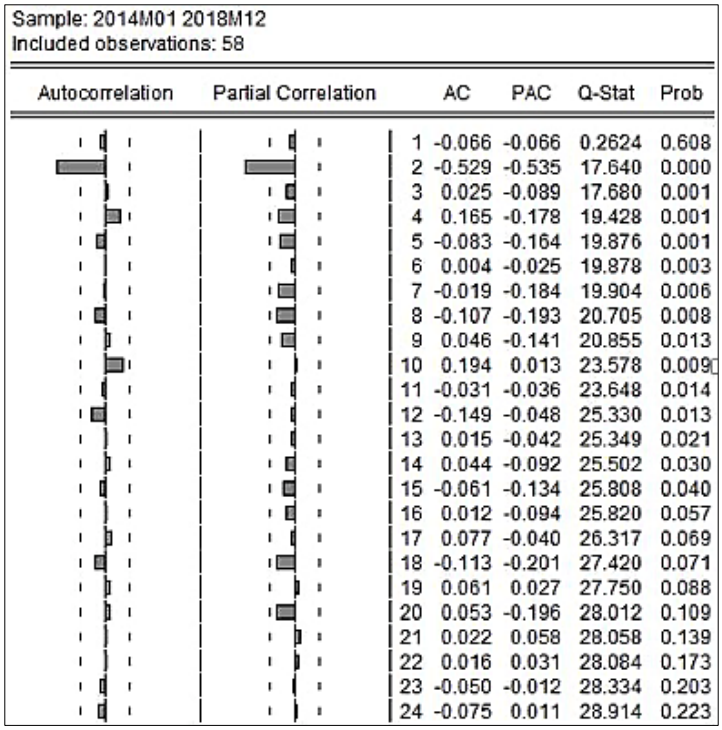


Fig 1: From the figure above we can see clearly that the time series **is** not stationary in some periods

1) From the correlogram, calculate the ACF and PACF of the crude information. Check whether the arrangement is stationary or not. On the off chance that the arrangement is stationary go to step 4, in case not go to step 3We took the first differences.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.066	-0.066	0.2624	0.608
		2	-0.529	-0.535	17.640	0.000
		3	0.025	-0.089	17.680	0.001
		4	0.165	-0.178	19.428	0.001
		5	-0.083	-0.164	19.876	0.001
		6	0.004	-0.025	19.878	0.003
		7	-0.019	-0.184	19.904	0.006
		8	-0.107	-0.193	20.705	0.008
		9	0.046	-0.141	20.855	0.013
		10	0.194	0.013	23.578	0.009
		11	-0.031	-0.036	23.648	0.014
		12	-0.149	-0.048	25.330	0.013
		13	0.015	-0.042	25.349	0.021
		14	0.044	-0.092	25.502	0.030
		15	-0.061	-0.134	25.808	0.040
		16	0.012	-0.094	25.820	0.057
		17	0.077	-0.040	26.317	0.069
		18	-0.113	-0.201	27.420	0.071
		19	0.061	0.027	27.750	0.088
		20	0.053	-0.196	28.012	0.109
		21	0.022	0.058	28.058	0.139
		22	0.016	0.031	28.084	0.173
		23	-0.050	-0.012	28.334	0.203
		24	-0.075	0.011	28.914	0.223

Fig 2: AC (Autocorrelation), PAC (Partial Autocorrelation)

From figure above we see the series or observe the similarities of both AC and PAC, both show rapid decline, so this model is not apparently AR or MA but an ARIMA model. The AC shows good exponential decay and adapted sinewave pattern. lag 2 was statistically significant, for PAC same pattern.

The instruments required for distinguishing proof are: Correlogram, autocorrelation work and halfway autocorrelation work. The fractional autocorrelation (PAC) measures the relationship between (time arrangement) perceptions that are k-time periods separated after controlling for relationships at middle slacks (i.e., lags less than k). In other words, partial autocorrelation is the correlation between Y_t and Y_{t-k} after removing the effect of the intermediate Y's (measures the marginal impact). To identify the appropriate ARMA/ARIMA model, I have outlines 5 procedures:

3.1.2.2 Time series with exogenous variable

In this part we use R studio to make analysis

Firstly plot the two variables exchange rate and interest rate by date.

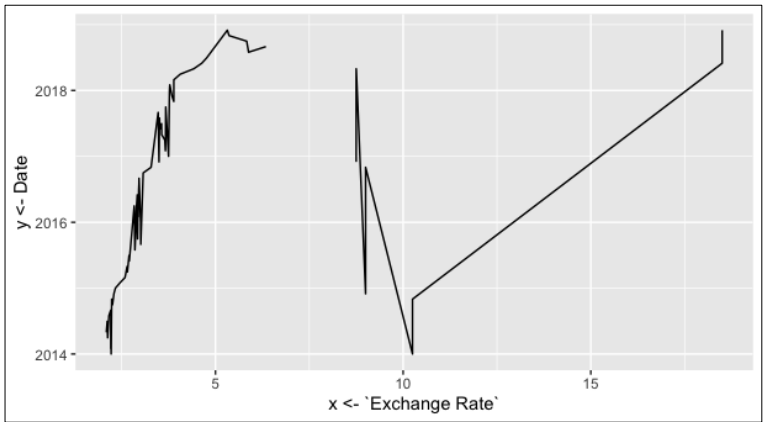


Fig 3: Time series included exogenous variable

From the figure above, we conclude that the series is not stationary, so with exogenous variable Arima model will be such as following

3.1.2.3 Compare between results in previous two section

Table 1: In this table we can summarize the results

Differenced Model	Arima (2, 2, 1)	Arimax (1, 1, 1)	Arimax (2, 1, 1)	Arimax (3, 1, 1)	Arimax (1, 8, 1)
Significant coefficients	1	3	1	3	1
Sigma^2 (volatility)	0.035057	0.029	0.042	0.068	0.043
Adj. R^2	0.108951	0.96	0.95	0.92	0.95
AIC	-0.315026	-0.45	-0.082	0.434	-0.082
SBIC	-0.260044	-0.28	0.092	0.61	0.0927

The table above we can summarize the result such that the appropriate model should have most significant coefficients, lowest volatility, highest adjusted R^2 and lowest AIC and SBIC.

In Arimax model with exogenous variable, we have 4 models so we have to examine on that by the rules which we mentioned above, so the ARIMAX (1, 1, 1) is proved as the best model for our research. While, when the compare was made between arima model and arimax model, we find the ariamx model better than arima due to inclusion of other variables which may explain the variability of dependent variable. It also brings the change in dependent variable by time.

4. Conclusions

According to the results that have been reached through the investigation carried out in this research, we can say that adding a variable (exogenous variable) has a greater effect and have more parameters so that the change can be explained by the time series more efficiently without an additional external variable. This was approved by a study Themba G. Chirwa, Nicholas M. Odhiambo, 2018 [9] that's the results confirmed the exogenous variables more effective in growth model than endogenous variable in same model. So, in our case study exchange rate can be explained by many models one of that is time series model, but the researchers want to include more than one variables to investigate that which one more effect on exchange rate. It means as used model with exogenous variables which gave us more explanation on change by time in exchange rate and for casting well as possible

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