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Forecasting of Foreign Direct Investment of BRICS Countries: A Model Based Study

Abstract

This study is an effort to construct a mathematical model to forecast Foreign Direct Investment (FDI) in BRICS countries for period (2017 -2026). BRICS FDI data have been collected from ACTAUD website for the period (1970- 2016). Nature of data is stationary as tested by Augmented Dickey Fuller Test. ARIMA (0,1,1) model has been used for forecasting of FDI in BRICS countries as AIC value was found minimum for it. Different kinds of diagnostic have been used for the accuracy of the results obtained. Projected value of FDI inflows in BRICS countries will be 334.7417 Billion US $ by the year 2026. Open source software R GUI has been used for data analysis and forecasting.

Keywords: FDI, Augmented Dickey Fuller Test, Forecasting, Box-Jenkins Methodology, ARIMA

Introduction

The acronym "BRICS" was proposed by Jim O"Neill(2001) as a association of fastest growing economies Brazil, Russia, India, China in the year 2001 to compete with the G7 in future. In the year 2009 the first submit of the association was held with objectives to bridging the gap between developed and developing countries and to promote technological information exchange among member country. Population of BRICS countries shares 41.1% of the world population with India and China consists of 17.1% and 18.5%   world population. Whereas share of BRICS economy to the world economy is only 29.6% with 2.1% of India and 7.1% of China. With the Share of 41.1% of the world population, on one hand BRICS economies are homes of population deprived of basic needs and on the other hand, have the fastest growing middle class. BRICS is a club of economies with common and significant similarities in terms of geographic size, market size and huge population.

As FDI plays major role in the development of a nation and BRIC countries have growth potential so it is clear that BRICS nations are suitable place for attracting FDI in large scale in future. Low cost labor, growing economy and diversified social-economic position are the key factors for attracting FDI inflows in BRICS nations.

Forecasting of FDI is essential for making decision about future planning by investors. A lot of models and methods have been used for analysis and forecasting time series data. Among these Auto Regressive Integrated Moving Average is most common. This method analyzes historical univariate data to obtain its own trend and to forecast future values.

Review of Literature

Researcher's contribution is very significant to use ARIMA models for forecasting FDI inflows. AI-Abdulrazag and Bataineh (2007) used BoxJenkins ARIMA model to forecast FDI inflows of Jordan and found ARIMA (0, 1, 1) was optimal model for forecasting FDI inflows in Jordan. Box (1994) explained the basic concept of mathematic used to develop model for forecasting. Batcelor, R.,(2000) studied suitable and efficient ARIMA models for macroeconomic forecasts of G7 countries. Kala & Remesh (2018) forecasted FDI inflow in India for the period (July2017-July2018) and output shows that the total FDI inflow into India from July 2017 to July 2018 is 163899.64 million US dollars. Kumar and Dhingra (2012) used SPSS (7.5) to forecast FDI inflows of Sri Lanka and obtained short term projection of FDI inflows to Sri Lanka for the period (2011-2020). Darussalam. Tsitsika et al. (2007) forecast fish production with the help of ARIMA model. ARIMA (1,0,1) and ARIMA(0,1,1) were found suitable

Rahul
Assistant Professor,
Deptt.of Commerce,
DAV PG College,
BHU Varanasi

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models for projection. Kumar et al.(2004) found ARIMA (1,0,1) was suitable model to forecast daily ozone concentrations in Brunei airport. Judi (2007) forecast the non-oil Gross Domestic Product (GDP) in the United Arab Emirates (UAE) with ARIMA mode. The analysis was based on the GDP cost prices data for the period (1970-2006) and projection was obtained for the period (2006-2020)

Now it is clear that we can use Auto Regressive Integrated Moving Average model to forecast FDI inflows in BRICS countries. Very few studies have been done to model the past behavior of time series data and to find out best ARIMA model with the help of AIC and BIC. The present study is designed to select best Auto Regressive Integrated Moving Average to forecast FDI in BRICS countries.

Objectives of the Study

Main objective of time series data analysis is to study the behavior of past data available and to forecast future data with help of suitable model and methods. This study has following specific sub-objectives to achieve the main objective:

1. To test stationary of time series data
2. To select suitable ARIMA model based on some diagnostics.
3. To make projection of Foreign Direct Investment

Nature and Source of Data

In this study secondary sources of data have been used for analysis. The secondary data has been collected from reports of UNCTAD on FDI inflow, BRICS Joint statistical publication, and reports from central banks of Member countries of BRICS Economies.

Total of FDI inflow in Brazil, Rusia, India, China and South Africa before the formation of BRICS.
FDI inflow in BRICS after formation of BRICS

Year	FDI Inflows in US Billion $	Year	FDI Inflows in US Billion $	Year	FDI Inflows in US Billion $
1970	0.77	1990	4.63	2009	191.84
1971	0.77	1991	5.79	2010	261.20
1972	0.59	1992	14.49	2011	297.43
1973	1.25	1993	30.55	2012	256.12
1974	1.96	1994	37.96	2013	266.86
1975	1.48	1995	47.38	2014	271.08
1976	1.46	1996	58.44	2015	257.52
1977	1.67	1997	76.55	2016	276.80
1978	2.09	1998	80.27		
1979	1.97	1999	75.85		
1980	2.036	2000	80.62		
1981	2.94	2001	84.40		
1982	3.95	2002	79.96		
1983	2.32	2003	76.46		
1984	3.36	2004	100.64		
1985	3.03	2005	116.12		
1986	2.63	2006	149.62		
1987	3.50	2007	204.92		
1988	6.25	2008	285.54		
1989	4.57				

Source:UNCTAD.
(http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=96740)

Methodology

The paper considered different models for forecasting BRICS FDI inflows with the help of BoX,Jenkins and Reinsel (1994) Auto Regressive Integrated Moving Average (ARIMA). In this model nature of the data is explained by its own past value i.e. auto-regressive(AR term) and by is its own past and present error term (MA terms). A lots of model are available for forecasting but we have preferred BoX, Jenkins (ARIMA) due to its simplicity and appropriateness in context of data. R software has been used for analysis of data.

The stepwise methodology is used in this study and it is outlined below:

Firstly, we have presented the data graphically to check whether the series of data is stationary or not.

Augmented Dickey-Fuller (ADF) test based on unit root process has been used to test the stationary of data. ADF test confirmed that our data series is non stationary so we used first order difference to get stationary time series data.

$Ydt=Yt-Yt-1$ (first order difference);
$Yd2t=Ydt-Ydt-1=(Yt-Yt-1)-(Yt-1-Yt-2)$ (second order difference)

We have chosen appropriate value of p and q in ARIMA (p, d, q) to get a suitable model. To do so "Correlogram" and "Partial Auto Correlogram" have been used with the help of "acf()" and "pact()" function in R software. We have also used "Auto-ARIMA" and "Forecast" function of R software to estimate the parameters and forecast time series data in future. Diagnostics Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) have been used to select best model for fitting and projection of time series data.

Analysis and Discussion

The plot of FDI inflows in figure 1 shows that there is upward trend in time series. Here FDI inflow data is not stationary.

FIGURE 1   BRICS COUNTRIES FDI INFLOWS IN DOLLAR
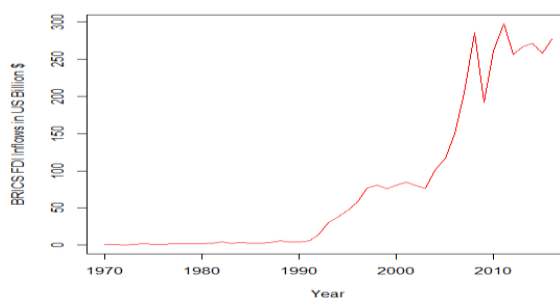
Augmented Dicky Fuller Test: Test to check stationarity of data

Dickey-Fuller = -1.7024, Lag order = 3,
p-value = 0.6926   Alternative hypothesis: stationary

Since the p-value is above .05 so our data is non-stationary time series. We used first order difference to make it stationary.

First Order Difference

First Order Differnce has been used to get stationary time series data of BRICS countries.

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FIGURE 2   FIRST ORDER DIFFERENCE
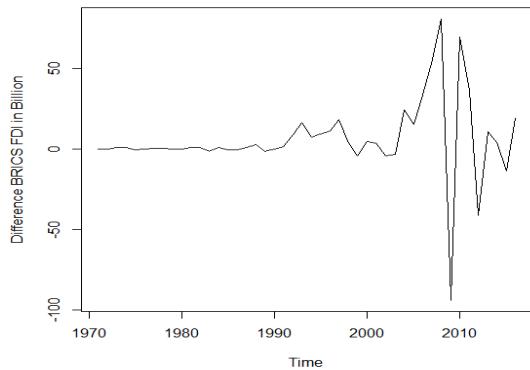
Partial Auto Correlogram and Correlogram in figure 3 and 4 suggest the value of p and q in ARIMA
Figure 2 shows that series obtain by First order difference of FDI inflow is stationary time series data. So the value of d in ARIMA (p,d,q) is 1.

Partial Auto Correlogram and Correlogrma

Partial Auto Correlogram and Correlogrma have been used to get appropriate p and q in ARIMA (p,d,q).
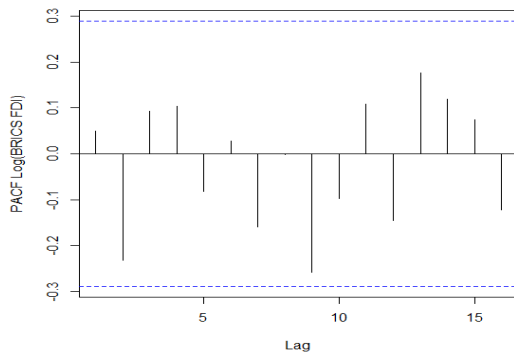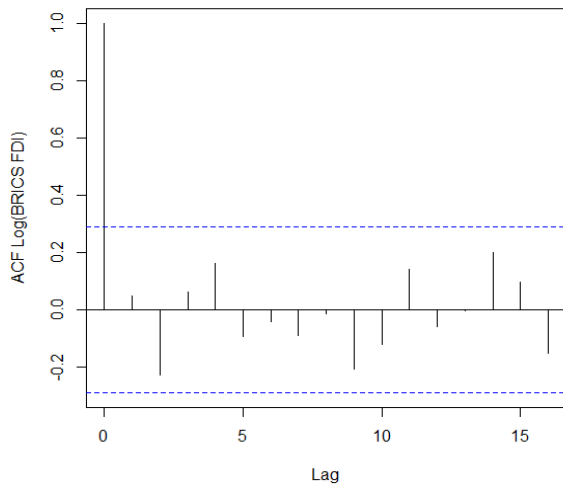
FIGURE 3

FIGURE 4

(p,d,q) should be 0 and 1 respectively. So our estimated value of p,d,q is 0,1,1 respectively. Hence ARIMA (0,1,1) is our best model to predict future value of BRICS inflows.

Auto.ARIMA Function

R software provides "auto.arima ()" function to find appropriate ARIMA model in a moment. Outputs of "auto.arima ()" function for given below:

| ARIMA(0,1,1) with drift Coefficients:		
ma1	drift	
-0.2655	6.0026	
s.e. 0.1232	2.5948	
sigma ^2 estimated as 590.8: likelihood=-211.06		
AIC=428.12	AICc=428.69	BIC=433.6

Here we get ARIMA (0, 1, 1) a suitable model which is same as we found it earlier with help of Correlaogram, Partial Auto Correlogram and Differencing. This model satisfies all diagnostic checking. Since all diagnostic checking are satisfied by ARIMA (0, 1, 1) hence we used it for forecasting the FDI inflows in BRICS countries.

Table 2 Forecast of FDI Inflow with Confidence Interval

Year	Forecast	95% Confidence Interval	
		Lo 95	Hi 95
2017	280.7186	233.0794	328.3578
2018	286.7212	227.6135	345.8288
2019	292.7237	224.0365	361.411
2020	298.7263	221.6409	375.8117
2021	304.7289	220.0744	389.3833
2022	310.7314	219.1312	402.3316
2023	316.734	218.6788	414.7892
2024	322.7366	218.6259	426.8473
2025	328.7391	218.9063	438.572
2026	334.7417	219.4704	450.013

Table 2 and Figure5 show the forecast value of FDI inflows in BRICS countries with their confidence interval. The red line in the graph shows fitted value of data with ARIMA (0, 1,1) ,black line shows the real data and blue line shows the projected value with confidence interval.

Figure 5 Forecast of FDI Inflows in BRICS Countries

Forecasts from ARIMA(0,1,1) with drift
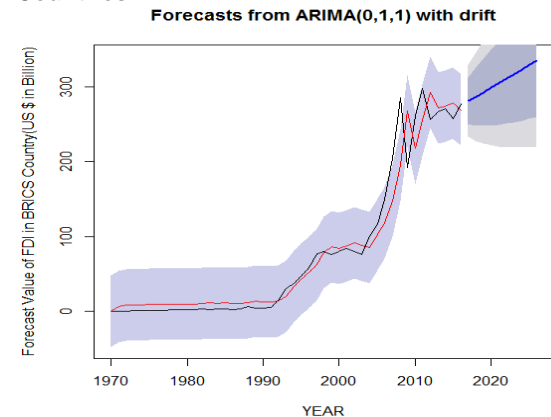
Conclusion

The study made the best endeavor to develop the best ARIMA model, to estimate the parameters of model and to forecast the BRICS FDI inflows. The empirical analysis confirms that ARIMA (0, 1, 1) model is best model for prediction of FDI inflows in BRICS countries. The forecasted value of BRICS FDI inflows is 334.74 Billion US Dollar for the year 2026. Finally there is an expected smooth increase of FDI inflows in BRICS countries over the period (2017-2026).

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