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Time series ARIMA forecasting of FDI inflow in India

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Abstract
India is a rapidly developing country which is often seen as an investment ground by the industry giants of foreign countries. The recent trends show an exponential increase in the net foreign direct investment in India from the year 2010-2020. Thus, it becomes crucial for the policy makers and the economist to forecast the future inflows of investment in order to produce effective policies and take better decisions. The result of the better policies would help in overcoming the unbalanced market viability. ARIMA modelling is a technique used in statistics and econometrics which harness the advantages of both Auto Regression (AR) and Moving Average (MA) models by integrating them together to form auto regression integrated moving average model. The present study based on data regarding FDI inflow from 2001-2020 which aims to generate a customised box-Jenkins ARIMA model for forecasting and analysing the trend of FDI in India. It proposes ARIMA (0,1,0) model for optimal forecasting of net FDI inflow in India.

Keywords: Indian mustard, path coefficient analysis

Introduction
One of the most striking developments during the last two decades is in the spectacular growth of FDI (Foreign Direct Investment) in the global economic landscape. Foreign direct investment (FDI) is an integral part of an open and effective international economic system and a major catalyst to development. Yet, the benefits of FDI do not accrue automatically and evenly across countries, sectors and local communities. National policies and the international investment architecture matter for attracting FDI to a larger number of developing countries and for reaping the full benefits of FDI for development.

In India role of FDI was first introduced by then finance minister Dr. Manmohan Singh in 1991 in the form of Foreign Exchange Management Act which led to increase in the domestic capital cash inflows in the country and this will help in economic growth of the country. The importance of FDI has grown considerably in Indian economy day by day. After liberalization its role has changed significantly. Earlier the amount of FDI was low conforming to some selected sectors but now the inflow of FDI has grown tremendously and almost in all the sectors of the economy. The result of the better policies would help in overcoming the unbalanced market viability. ARIMA modelling is a technique used in statistics and econometrics which harness the advantages of both Auto Regression (AR) and Moving Average (MA) models by integrating them together to form auto regression integrated moving average model. Researchers like Perera and Prasanna utilized this model and customized it to forecast the FDI inflow in SAARC countries. Nyoni *et al*. used Box-Jenkins ARIMA for forecasting the FDI in Zimbabwe. This study aims at generating a customised box-Jenkins ARIMA model for forecasting and analysing the trend of FDI in India. It also aims at evaluating the minimum AIC value for determining the fitness of the model and highlights the 95% confidence interval for the predictions made for year 2020-2025.

Methodology
The study is performed on the dataset of net FDI in India from 1950-2020(expressed as US dollars in millions). A customized box-Jenkins ARIMA model was generated in order to forecast the FDI and analyzing the trend. Initially, the trend of the investment from 1950-2020 was visualized and it was found to be overall exponential in nature. While forecasting using ARIMA model, Stationarity and differencing has to be taken into consideration. Once the conditions are satisfied and validated using Augmented Dicker Fuller test, the ARIMA model was generated using the 3 parameters: p, q and d. The major steps followed are:

Step 1: Model Identification – Augmented Dickey Fuller test used.

Step 2: Parameter Estimation – Auto correlation Function (ACF) and Partial Auto Correlation Function (PACF) for identification of the order of ARIMA model (parameters p and q).

Step 3: Training and Testing the model- Dividing the dataset into 7:3, the model is fitted using ARIMA (p,d,q). These model parameters were acquired using the minimum AIC score for best accuracy.

Step 4: Diagnostic Check: Determining the Residuals of the ACF and PACF graphs for identical and independent distribution.

Step 5: Forecasting the data: The future FDI expenditure was forecasted for forthcoming years along with its lower bound and upper bound values with 95% confidence.

Results and Discussion

This section summarizes the findings of the research. The first and foremost outcomes depicts the trend of the time series data. Fig. 1. illustrates an exponential increasing trend of FDI in India. The data was observed and transformed into its stationary form for modelling. For this, ADF test accepted the null hypothesis, approximately less than 0.05. Using the differencing value (d=1) where the data is validated to be stationary, the other parameters: p and q, are estimated using the ACF and PACF graphs. The graphs are depicted in the fig. 2. The dataset was then used for training and testing purposes, divided into the ratio of 7:3 for generated the ARIMA model. A range of p and q values were used for modelling to achieve the stability of the generated model. For the range of p and q values, a respective AIC score is computed. The minimum AIC score was considered to select the optimal p and q values for further evaluations. Parameters obtained for optimal modelling of the time series data using ARIMA method are as follows: p: 0; d: 1 q: 0; The AIC value is minimum among the others. It is worth mentioning that the actual and predicted values of testing data comes out to be approximately close to each other the plot is described in fig. 1. After the model generation for ARIMA (0,1,0), the forecasted values for the forthcoming years (2020-2030) are illustrated in the Table 1.

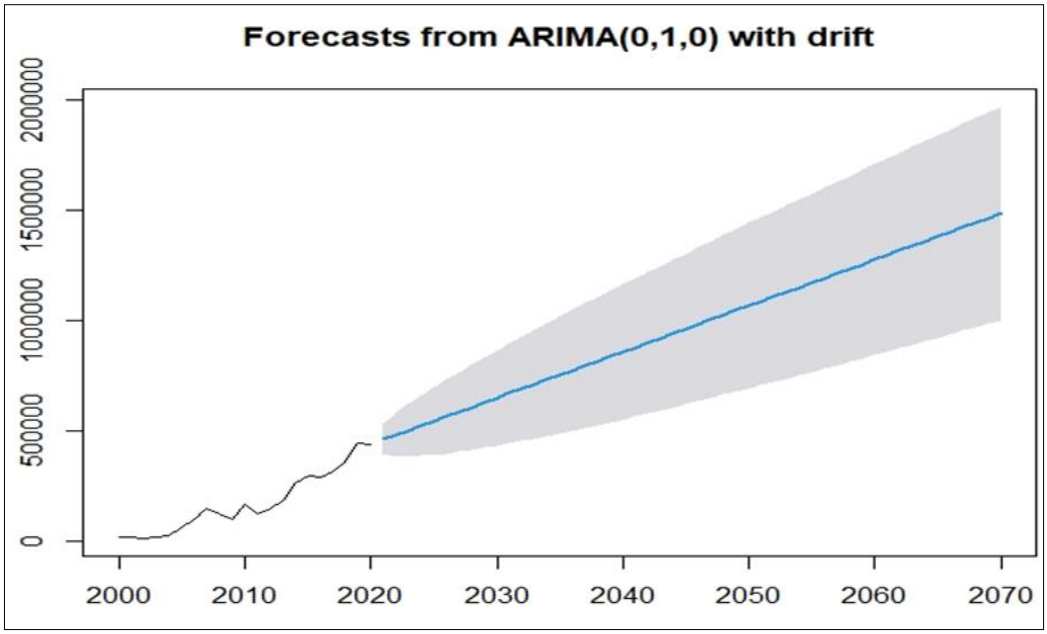

Fig 1: Forecasts of FDI

Table 1: Projected FDI inflow in India for period 2021-203 (₹ in crores)

Year	Lower limit	point Forecast	Upper limit
2021	389665	458114	526563
2022	382240	479041	575842
2023	381411	499968	618525
2024	383997	520894	657792
2025	388765	541821	694877
2026	395083	562748	730412
2027	402576	583674	764773
2028	410999	604601	798204
2029	420181	625528	830874
2030	430000	646455	862909

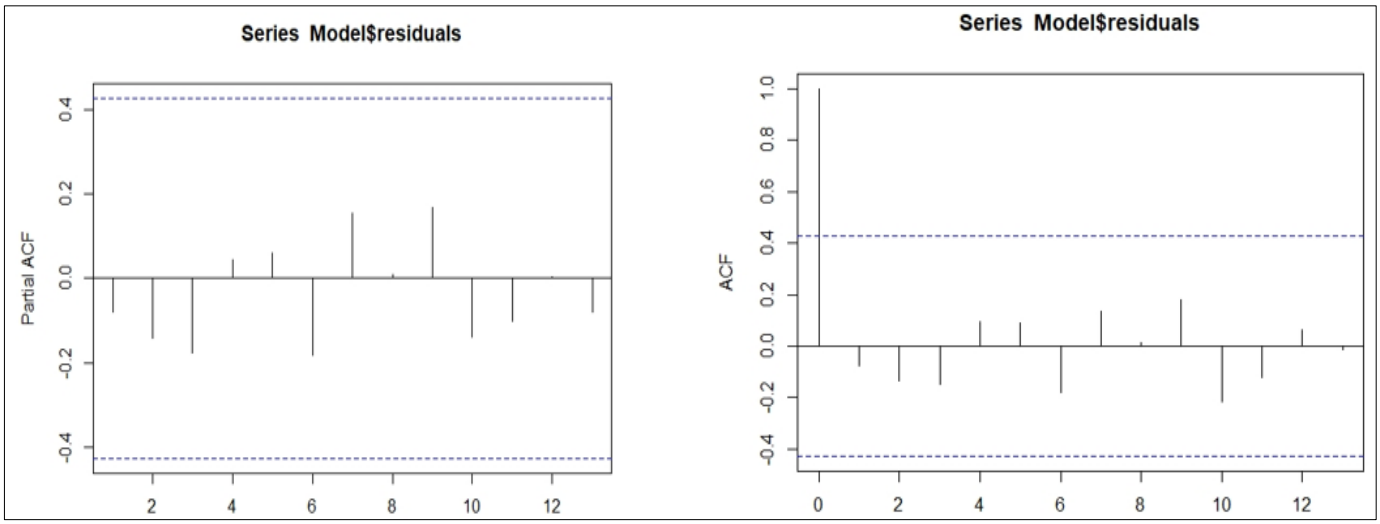

Fig 2: Autocorrelation function (ACF) and Partial autocorrelation function (PACF) of residuals of fitted ARIMA

Conclusion

The rapid development of India is often observed as an investment opportunity by the huge industries of foreign countries. It has become necessary for the economist of India to forecast the future inflows of investments to structure the policies for better decision making. The proposed ARIMA model shows an increasing trend and a differencing value of 1. The estimated parameters for auto regressive (AR) and moving average (MA) are p=0 and q=0 respectively using the PACF and ACF plotted graphs. The AIC score acquired accounts to minimum with the above formulated parameters, describing a better fitted ARIMA model when compared to other values of the parameters. This proposed model not only helps to forecast the Foreign Direct Investment for the forthcoming years but would also help in allocation of the designing the policies which in turn helps in overcoming the unbalanced market viability.

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