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FORECASTING IMPORTS OF INDIA USING AUTOREGRESSIVE INTEGRATED MOVING AVERAGE

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Abstract
This study attempts to forecast imports of India using Auto Regressive Moving Average (ARMA) and Auto Regressive Integrated Moving Average (ARIMA) models of forecasting. Using data for 1971-72 to 2014-15, imports of India are forecasted for imminent 5 years starting from 2015-16 to 2019-2020. ARMA (2,1,2)are found appropriate for imports of India. Some diagnostic tests are also performed on fitted models and are found well fitted.

INTRODUCTION
Various models have been used in the literature to forecast time series data; however, Auto Regressive Integrated Moving Average (ARIMA) technique is used by this study to forecast imports of India. It is the most general form of stochastic models for analysing time series data. The ARIMA models include Auto Regressive (AR) terms, Moving Average (MA) terms and differencing (or integrated) operations. The model is called AR model if it contains only the Auto Regressive terms. Model is known as MA model if it involves only the moving average terms. It is known as ARMA models when both Auto Regressive and Moving Average are involved. Finally when non-stationary series is made stationary by differencing method, it is known as ARIMA model. The general form of ARIMA is denoted by ARIMA (p,d,q), where 'p' represents the order of auto regressive , 'q' represents the order of moving average process, while 'd' shows the order of differencing the series to make it stationary.

In this study Box-Jenkins (1976) procedure of ARIMA modelling i,e. Identification, estimation, diagnostic checking and forecasting time series data of Indian imports is used. The ARIMA modelling procedure starts with identification of the model; however stationarity of the variables of interest is also required. The stationarity can be tested both through graphical method viz. Correlogram (i,e. Partial Autocorrelation Function (PACF) and Autocorrelation Function (ACF)) and other through formal technique namely Augmented Dickey-Fuller Test (ADF) of Unit Root. If the variables of interest are found non-stationary at level, the data need information such way to make them stationary. The model can be identified through correlogram (PACF and ACF) and Augmented Dickey-Fuller Test (ADF) of Unit Root. After the identification of the model, the next step is the estimation of model parameters which is done through Ordinary Least Square (OLS) method. Moving further various diagnostic tests are used on residual of the model like correlogram of residuals (Q statistic probabilities adjusted for 1 ARMA terms, correlogram of squared residuals, histogram of normality test and serial correlation LM test. If the model passes successfully through these diagnostic tests, then the estimated coefficients of forecasting can be used for the future values.

OBJECTIVE: The objective of the study is to forecast of imports of India for the impending 2015-2020.

DATA AND METHODOLOGY
The study is based on secondary data for forecasting of Indian imports. The data has been collected from rbi.org and other sources. The study covers data from 1970-71 to 2014-15. This data has been converted into log imports to maintain time consistency.

RESULTS AND DISCUSSIONS
The results of correlogram of 1 difference level of log of Indian imports and the unit root test for it are given in Table-1 and 2 respectively. The results depict that ACFs were suffered from linear decline and hence, series of Indian imports are non-stationary at level. It was made stationary by taking first order differencing of log of Indian imports. It was evident from the results of ADF statics that null hypothesis of unit root test has been denied since ADF t static prob. is less than 0.05. Therefore, ARMA model has been used for forecasting Indian imports whereas; ARIMA model was employed to forecast Indian imports.

Table-1,Correlogram of 1 difference level of log of Imports of India

Date: 10/14/15 Time: 06:46						
Sample: 1 50						
Included observations: 42						
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.*| . |	.*| . |	1	-0.194	-0.194	1.6886	0.194

**| . |	***| . |	2	-0.295	-0.345	5.7039	0.058
. | . |	**| . |	3	-0.044	-0.222	5.7971	0.122
. | . |	.*| . |	4	0.017	-0.198	5.8116	0.214
. | . |	**| . |	5	-0.025	-0.211	5.8433	0.322
. |*. |	. | . |	6	0.166	0.034	7.2632	0.297
. | . |	. | . |	7	0.036	0.048	7.3323	0.395
.*| . |	.*| . |	8	-0.189	-0.100	9.2646	0.320
. | . |	. | . |	9	0.029	0.017	9.3105	0.409
. | . |	. | . |	10	0.059	0.003	9.5140	0.484
.*| . |	.*| . |	11	-0.080	-0.093	9.8960	0.540
. | . |	. | . |	12	0.038	-0.029	9.9850	0.617
. | . |	.*| . |	13	-0.057	-0.178	10.194	0.678
.*| . |	**| . |	14	-0.086	-0.208	10.677	0.711
. |*. |	. | . |	15	0.167	0.004	12.586	0.634
. |*. |	. |*. |	16	0.135	0.089	13.879	0.608
.*| . |	. | . |	17	-0.166	-0.014	15.913	0.530
. | . |	. |*. |	18	-0.004	0.104	15.915	0.598
. |*. |	. |*. |	19	0.092	0.161	16.594	0.617
.*| . |	. | . |	20	-0.094	0.049	17.340	0.631

Table -2 Unit Root Test

Null Hypothesis: D(LNIM) has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.21213	**0.0001**
Test critical values:	1% level		-3.59662	
	5% level		-2.93316	
	10% level		-2.60487	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNIM,2)				
Method: Least Squares				
Date: 10/12/15 Time: 22:29				
Sample (adjusted): 3 44				
Included observations: 42 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNIM(-1))	-0.81374	0.156124	-5.21213	0
C	0.141149	0.0324	4.356463	0.0001
R-squared	**0.404463**	Mean dependent var		-0.00039
Adjusted R-squared	**0.389575**	S.D. dependent var		0.14659
S.E. of regression	**0.114531**	Akaike info criterion		**-1.4495**
Sum squared resid	0.524691	Schwarz criterion		**-1.36675**
Log likelihood	32.4395	Hannan-Quinn criter.		**-1.41917**
F-statistic	27.1663	Durbin-Watson stat		**1.496328**
Prob(F-statistic)	0.000006			

Using diverse values of p and q, a range of ARIMA model has been fitted in order to choose appropriate model. Appropriate model was selected based on certain selection criterion namely R^2, adjusted R^2 Standard Error Regression (SEE), Akaike Information criterion (AIC) Schwarz-Bayesian Information (SBIC). Consequently, ARMA was found appropriate for imports of India. The parameters estimate for imports of India are given in table-3A,3B 3C &3D.

Table 3A- Selection of model based on Estimates of imports of India parameters

ARIMA odel(p,d,q,)	R^2	Adjusted R^2	SEE	AIC	SIC
(1’1’0)	0.162695	0.119756	0.108008	-1.54448	-1.42036
(2’1’0)	0.181829	0.138767	0.099502	-1.70691	-1.58153
(0’1’1)	0.079784	0.05734	0.112653	-1.48362	-1.4017
(1’1’1)	0.162695	0.119756	0.108008	-1.54448	-1.42036
(2’1’1)	0.216555	0.153033	0.098675	-1.7015	-1.53433
(2’1’2)	**0.323566**	**0.248407**	**0.092953**	**-1.79959**	**-1.59062**
(1’1’2)	0.163419	0.097373	0.109372	-1.49773	-1.33224
(3’1’2)	0.167595	0.045182	0.097915	-1.67196	-1.41863
(2’1’3)	0.29563	0.195006	0.096199	-1.71034	-1.45957
(3’1’3)	0.471845	0.375817	0.079167	-2.07689	-1.78134

Table 3B -Graphical ARMA structure

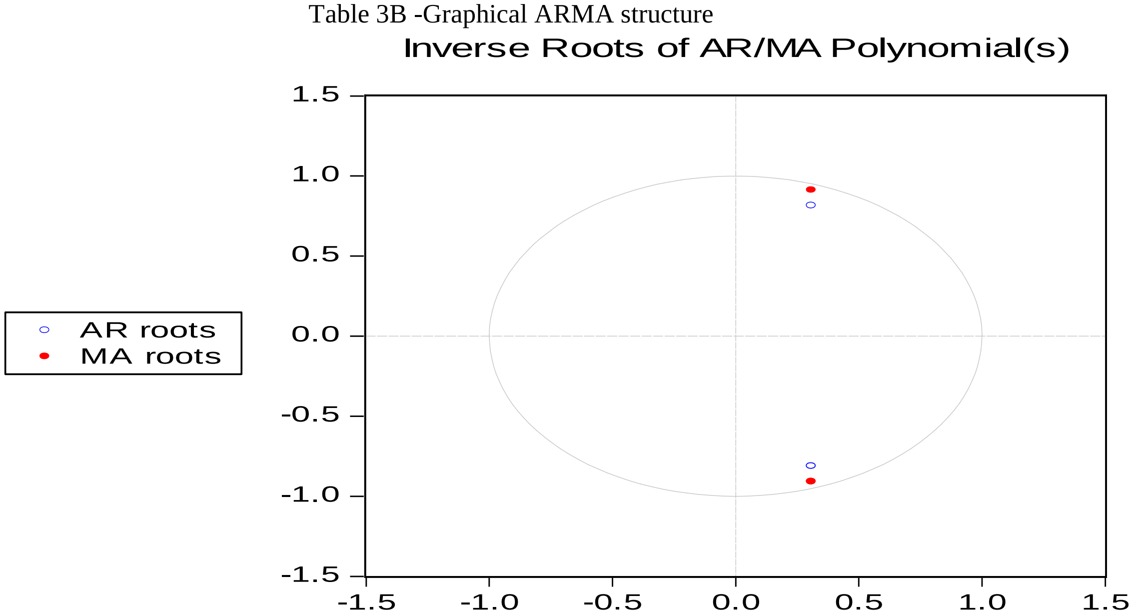

Table 3C - ARMA structure

Inverse Roots of AR/MA Polynomial(s)		
Specification: NLNIM C AR(1) AR(2) MA(1) MA(2)		
Date: 10/14/15 Time: 07:23		
Sample: 1 50		
Included observations: 41		
AR Root(s)	Modulus	Cycle
0.310780 ± 0.814036i	0.871343	5.209516
No root lies outside the unit circle.		
ARMA model is stationary.		
MA Root(s)	Modulus	Cycle
0.309948 ± 0.910400i	0.961715	5.056268
No root lies outside the unit circle.		
ARMA model is invertible.		

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Table 3D –parameters of selected model estimate for imports of India

Dependent Variable: NLNIM				
Method: Least Squares				
Date: 10/14/15 Time: 07:29				
Sample (adjusted): 4 44				
Included observations: 41 after adjustments				
Convergence achieved after 18 iterations				
MA Backcast: 2 3				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.162051	0.016693	9.707951	0
AR(1)	0.62156	0.074822	8.307182	0
AR(2)	-0.75924	0.070772	-10.72795	0
MA(1)	-0.6199	0.058979	-10.51049	0
MA(2)	0.924896	0.037103	24.92812	0
R-squared	0.323566	Mean dependent var		0.166583
Adjusted R-squared	0.248407	S.D. dependent var		0.107219
S.E. of regression	0.092953	Akaike info criterion		-1.79959
Sum squared resid	0.311052	Schwarz criterion		-1.59062
Log likelihood	41.89157	Hannan-Quinn criter.		-1.72349
F-statistic	4.305066	Durbin-Watson stat		1.696275
Prob(F-statistic)	0.005999			
Inverted AR Roots	.31-.81i	.31+.81i		
Inverted MA Roots	.31+.91i	.31-.91i		

The ARIMA model (2’1’2) was fitted and estimated, the next step in Box-Jenkins (1976) procedure was diagnostic checking of the fitted models. For this purpose, residual diagnostic checking was done through correlogram of residuals (Q statistic probabilities adjusted for 4 ARMA terms), histogram of normality test and serial correlation LM test. The results of diagnostic checking are shown in Table-4A, 4B & 4C. The results of imports of India from those tables were found within the limits which indicated that model was well fitted.

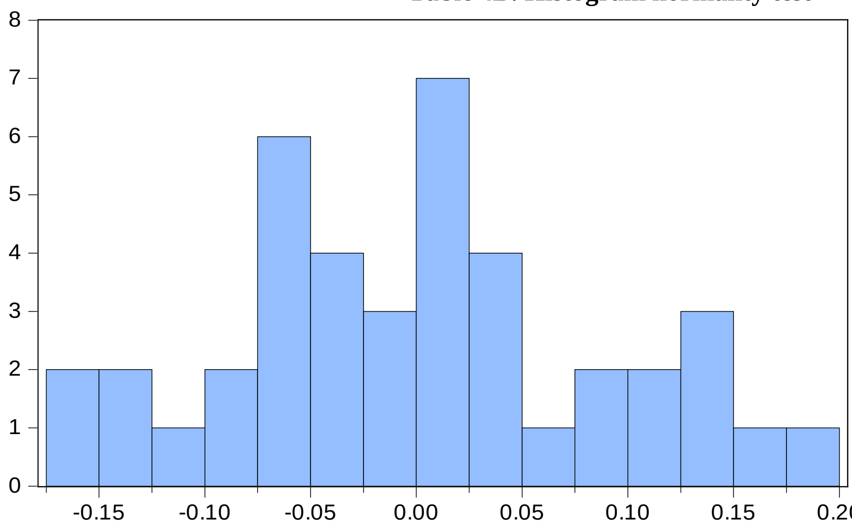
Table-4 Residual Diagnostic Checking

Table-4A **Q-statistic probabilities adjusted for 4 ARMA term(s)**

Date: 10/13/15 Time: 21:01						
Sample: 4 44						
Included observations: 41						
Q-statistic probabilities adjusted for 4 ARMA term(s)						
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*. |	. |*. |	1	0.111	0.111	0.5452	
.*| . |	.*| . |	2	-0.13	-0.145	1.3136	
. |*. |	. |*. |	3	0.082	0.118	1.6244	
. | . |	. | . |	4	-0.016	-0.065	1.6371	
.*| . |	.*| . |	5	-0.122	-0.086	2.3673	0.124

.*| . |	.*| . |	6	-0.135	-0.134	3.2843	0.194
. | . |	. | . |	7	-0.039	-0.029	3.3629	0.339
.*| . |	.*| . |	8	-0.127	-0.149	4.2187	0.377
.*| . |	.*| . |	9	-0.125	-0.092	5.0842	0.406
.*| . |	**| . |	10	-0.169	-0.224	6.7078	0.349
.*| . |	.*| . |	11	-0.094	-0.114	7.224	0.406
. |*. |	. | . |	12	0.135	0.07	8.3379	0.401
. |*. |	. |*. |	13	0.16	0.1	9.9513	0.354
. | . |	.*| . |	14	-0.028	-0.093	10.002	0.44
. |*. |	. |*. |	15	0.145	0.114	11.421	0.409
. |** |	. |*. |	16	0.216	0.088	14.703	0.258
. | . |	. | . |	17	-0.051	-0.06	14.894	0.314
. | . |	. |*. |	18	0.045	0.09	15.05	0.375
. | . |	.*| . |	19	-0.061	-0.165	15.345	0.427
.*| . |	.*| . |	20	-0.193	-0.179	18.486	0.296

Table 4B. Histogram normality test



Series: Residuals	
Sample 4 44	
Observations 41	
Mean	0.000791
Median	4.19e-05
Maximum	0.187287
Minimum	-0.153300
Std. Dev.	0.088180
Skewness	0.240063
Kurtosis	2.399258
Jarque-Bera	1.010329
Probability	0.603406

Table 4C. Serial correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	0.681467	Prob. F(2,34)		0.5126
Obs*R-squared	1.576943	Prob. Chi-Square(2)		0.4545
Test Equation:				
Dependent Variable: RESID				
Method: Least Squares				
Date: 10/13/15 Time: 21:02				
Sample: 4 44				
Included observations: 41				
Presample missing value lagged residuals set to zero.				
Variable	Coefficient	Std. Error	t-Statistic	Prob.

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C	0.000295	0.017064	0.017272	0.9863
AR(1)	-0.01049	0.087409	-0.120007	0.9052
AR(2)	0.022689	0.074045	0.306417	0.7612
MA(1)	0.000419	0.060593	0.006918	0.9945
MA(2)	0.004118	0.037802	0.108948	0.9139
RESID(-1)	0.142183	0.199744	0.711827	0.4814
RESID(-2)	-0.17509	0.202683	-0.86388	0.3937
R-squared	0.038462	Mean dependent var		0.000791
Adjusted R-squared	-0.13122	S.D. dependent var		0.08818
S.E. of regression	0.093787	Akaike info criterion		-1.74133
Sum squared resid	0.299063	Schwarz criterion		-1.44877
Log likelihood	42.69729	Hannan-Quinn criter.		-1.6348
F-statistic	0.22667	Durbin-Watson stat		1.904905
Prob(F-statistic)	0.965232			

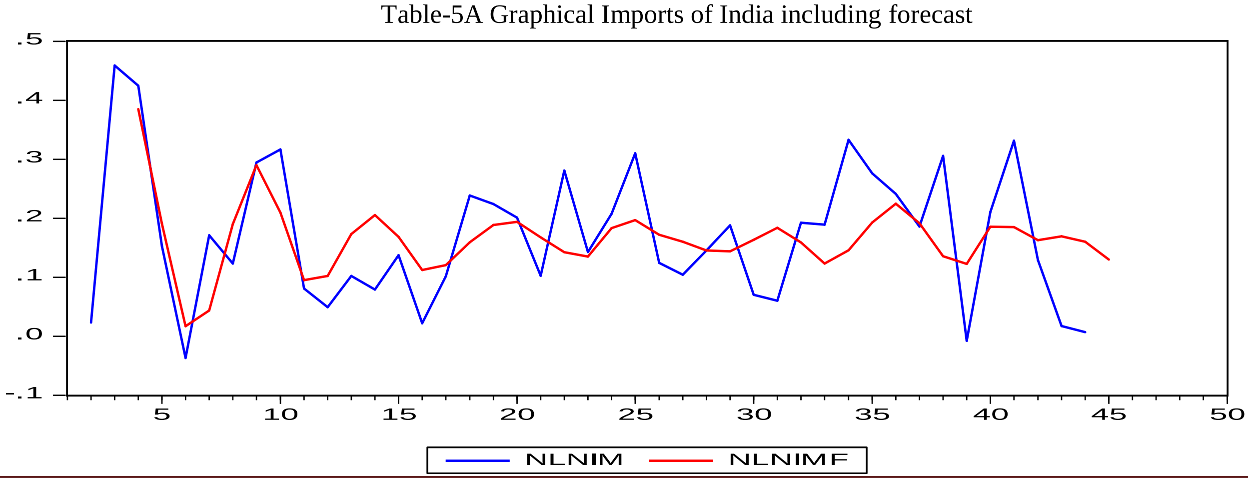
Using parameter estimate of the fitted model, forecast of imports of India for the years 2015-16 to 2019-20 was estimated and presented in Table 5.

Table-5 Forecast of Imports of India

Table-5A Imports of India including forecast during 1972-2021

Year	Imports	Year	Imports	Year	Imports	Year	Imports	Year	Imports
1971-72	18.245	1981-82	136.076	1991-92	478.508	2001-02	2451.997	2011-12	23454.63
1972-73	18.674	1982-83	142.927	1992-93	633.745	2002-03	2972.059	2012-13	26691.62
1973-74	29.554	1983-84	158.315	1993-94	731.01	2003-04	3591.077	2013-14	27154.34
1974-75	45.188	1984-85	171.342	1994-95	899.707	2004-05	5010.645	2014-15	27340.49
1975-76	52.648	1985-86	196.577	1995-96	1226.781	2005-06	6604.089	**2015-16**	**27341.67**
1976-77	50.738	1986-87	200.958	1996-97	1389.197	2006-07	8405.063	**2016-17**	**27342.84**
1977-78	60.202	1987-88	222.437	1997-98	1541.763	2007-08	10123.12	**2017-18**	**27344.02**
1978-79	68.106	1988-89	282.352	1998-99	1783.319	2008-09	13744.36	**2018-19**	**27345.19**
1979-80	91.426	1989-90	353.284	1999-00	2152.365	2009-10	13637.36	**2019-2020**	**27346.37**
1980-81	125.492	1990-91	431.929	2000-01	2308.728	2010-11	16834.67	**2020-2021**	**27346.37**

Table-5A Graphical Imports of India including forecast



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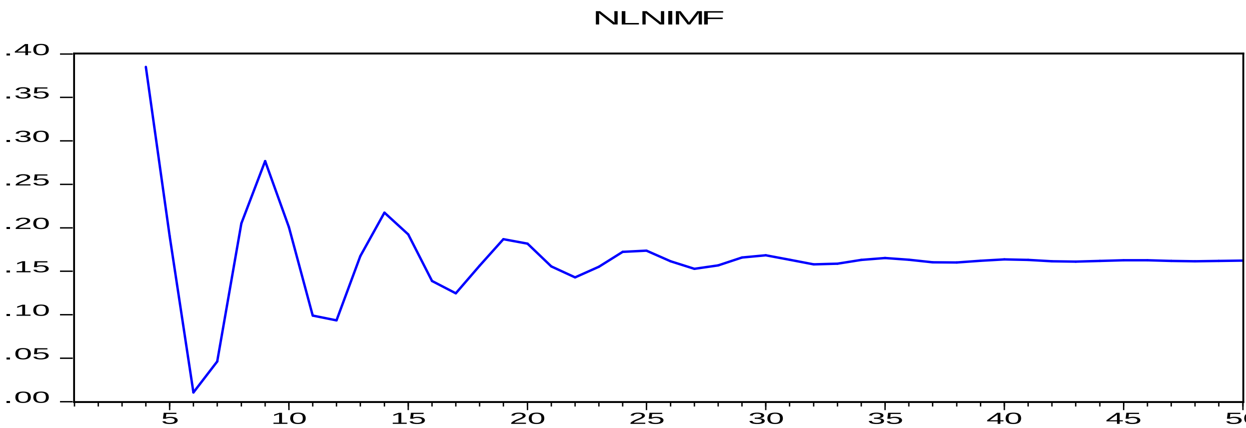

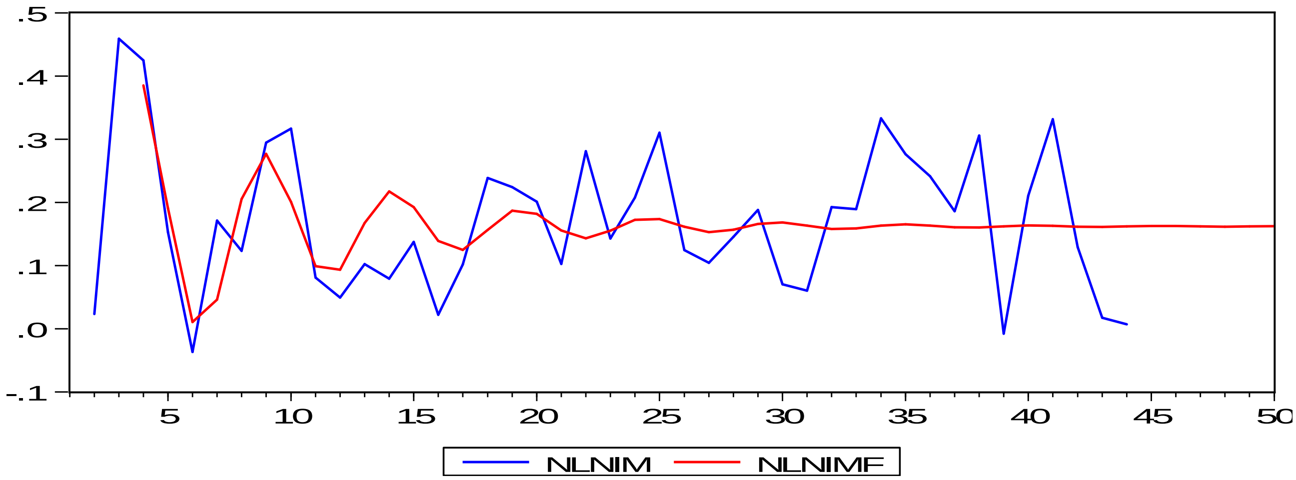

CONCLUSION

One of the main objectives of the study is to forecast the imports of India. ARIMA model is used for this purpose. Time series data of 43 years (1971-2015) is used in this study. All essential steps of ARIMA modelling is systematically followed to forecast Indian imports from 2015-2020. These forecast values could be used for formulating EXIM policy especially at national level. . These models use the historical time series data for forecasting. However, there could be other factors affecting imports viz. Economic condition, monsoon, technological innovation, foreign policy etc. Consequently, future thrust of this study is to apply other available models of forecasting which have features of incorporating more information to forecast imports of India.

The study is used univariate analysis of forecasting; however this does not mean that the technique supersedes multivariate techniques. ARIMA does not perform well in case of volatile series. Moreover, ARIMA models of forecasting are backward looking and do not perform better during forecasting at turning points.

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