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**POSTAL SAVINGS IN INDIA – A COMPARATIVE ANALYSIS USING REGRESSION AND ARIMA MODELS**

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**ABSTRACT**

*This paper analyses the receipts and outstandings of postal savings in India during the period 1970-71 to 2008-09 and forecast the receipts and out standings for the succeeding years. This analysis is made with reference to seven types of regression models and the Autoregressive Integrated Moving Average (ARIMA) model. In regression analysis, the choice of the best model will be on the basis of maximum  $R^2$  and the principal of minimum mean square error used for best time series models. In ARIMA, the model which has minimum value of AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) is selected.*

**KEYWORDS**

Regression model,  $R^2$  value, Principal of minimum mean square error, ACF, PACF, ARIMA, Receipts, Outstanding, AIC and BIC.

**INTRODUCTION**

aving is the difference between income and expenditure. Savings help the economy to grow significantly through proper investment. Developing countries could encourage domestic savings through postal departments. Before the advent of private financial services, postal savings had played crucial role in both developing and developed countries by providing financial assistance to all segments of the people. Postal departments involved the public in the savings with the development objectives towards meeting the national infrastructure requirements such as electric power, railroads, highways and the like. When the nation was reeling under acute financial crisis, such savings were timely and they boosted the morale of a nation.

During the early stages, postal banking and other state owned banks had been complementary to each other rather than competing. The distinct features of postal savings which have their sway both in rural and urban areas have been caught by the adverse political influence.

The financial liberalization initiated in the 80's gathered momentum only after 1991. Presently, all interest rates, except on all small savings schemes of post office, provident fund, Government bonds and schemes for senior citizens are market determined. Yet, the overall household savings increased from 17 % of GDP in 1980's to 25.5 % of GDP in 2003-04. The paradigm shift from an inefficient and sheltered economy to an efficient and a market determined economy made the public feel insecure and prompted them to accumulate savings unmindful of less interest to face any eventuality like loss of job. Pensioners also started increasing their savings to the optimum level.

Several countries face major challenges of regulating and managing the government backed financial institutions competently keeping in pace with the changing business scenario. Such regulatory treatment helps the depositors to repose their confidence in the savings in the context of market volatility elsewhere in the financial sector. If a strong private financial sector develops the need for Government backed savings and banking institutions shall decline. However, the process of privatizing such institutions is fraught with political conflict. Under the guises of financial crisis, the financial sector of any country poses a threat of uncertainty in the minds of people. In this juncture the postal savings method shall be a morale booster and will create confidence among the investing public. Hence a strong political consensus must be evolved to give more support to postal savings which is a protectionist form of banking institution in India.

**THE STUDY**

India possesses the largest postal network in the world with 155000 post offices spread all over the country as on March 31, 2001, of which 89 per cent in the rural sector. Post offices in India play a vital role in the rural areas. They connect these rural areas with the rest of the country and also provide banking facilities in the absence of banks in the rural areas. Post office saving is the best form of savings schemes which provide substantially higher rates of interest and pose relatively lesser risks of suffering losses.

Post offices offer various types of accounts. They are:

- Savings Account
- Recurring Deposit Account
- Monthly Income account
- Time Deposit Account

Post offices also offer various saving and tax saving instruments such as:

- National Savings Certificates
- Public Provident Fund
- Kisan Vikas Patra

The post office savings are easily accessible and people friendly. Therefore, the post office savings has been widely accepted by different sections of Indian society and the people of different age groups. Estimation of postal receipts and outstanding shall help government to plan the development of infrastructure and to implement different welfare schemes in India. However, postal saving systems have received little attention in the academic literature and are even excluded from the research studies. Hence an attempt is being made to forecast the values of postal receipts and postal outstanding which has a bearing on the exchequer of the Central Government. An attempt is also proposed to check the adaptability of the statistical models of regression and ARIMA in forecasting the values of postal receipts and outstanding.

**METHODOLOGY AND TOOLS**

Forecasting can be done in many ways. There are many models available for forecasting a time series data. Exponential smoothing method and Regression methods are some of the methods used for forecasting. Auto Regressive Integrated Moving Average (ARIMA) model is also another popular method and is widely used to forecast the time series data in the recent days.

This paper is dealt with the analysis of two aspects of postal savings namely receipts and outstanding, using Regression and ARIMA methods. For the study, the total postal receipts and outstanding during the period 1970-71 to 2008-09 has been taken.

**MODEL DESCRIPTION**

The following tentative regression models have been set out to forecast the postal receipts and outstanding.

- |    |                          |                              |
|----|--------------------------|------------------------------|
| 1. | Linear (LIN)             | $y_t = a + bt$               |
| 2. | Quadratic (QUA)          | $y_t = a + bt + ct^2$        |
| 3. | Power (POW)              | $y_t = at^b$                 |
| 4. | Exponential Growth (EPG) | $y_t = ae^{bt}$              |
| 5. | Logarithm (LOG)          | $y_t = a + b \log t$         |
| 6. | Cubic (CUB)              | $y_t = a + bt + ct^2 + dt^3$ |
| 7. | Inverse (INV)            | $y_t = a + \frac{b}{t}$      |

where a,b,c,d are the constants and t the time.

A time series is said to be stationary if its underlying generating process is based on constant mean and constant variance with its Autocorrelation Function (ACF). The Autocorrelation function refers the simple correlation between the current observation ( $Y_t$ ) and the previous observation ( $Y_{t-p}$ ). The ACF is defined by,

$$r_p = \frac{\sum_{t=p+1}^n (Y_t - \bar{Y})(Y_{t-p} - \bar{Y})}{\sum_{t=1}^n (Y_t - \bar{Y})^2}$$

It ranges from  $-1 < r_p < 1$ . Box-Jenkins [1] has suggested that the maximum of useful  $r_p$  are roughly  $N/4$ , where N is the number of periods upon which information on  $Y_t$  is available. The Partial Autocorrelation Function (PACF) is used to measure the degree of association between  $Y_t$  and  $Y_{t-p}$ , when the Y effects at other time lags  $1 \dots p-1$  are removed.

The general model is ARIMA(p,d,q) :

AR: p = order of the Regression part

I : d = degree of difference

MA: q = order of the moving average part

ARIMA (p,d,q) is defined by  $\phi_p(B) \Delta^d Y_t = \theta_q(B) \epsilon_t$  where  $\phi_p(B) = 1 - \phi_1 B - \dots - \phi_p B^p$ ,  $\theta_q(B) = 1 - \theta_1 B - \dots - \theta_q B^q$ , B is the backshift operator,  $\Delta$  is the difference operator,  $\epsilon_t$  is residual follows normal distribution with mean 0 and variance  $\sigma^2$ .  $\phi_p$ , p and  $\theta_q$ , q are respectively autoregressive and moving average parameters. d denotes differences.

The different models can be obtained for various combinations of autoregressive and moving average individually and collectively. The best model is obtained with the following diagnostics Law.

Akaike's Information Criteria (AIC) is defined by

$$AIC = -2 \log L + 2m,$$

where  $m = p + q$  and L is the likelihood function.

However, a useful approximation to the AIC is obtained via the approximation  $-2 \log L \approx n [1 + \log(2\pi)] + n \log \sigma^2$ , where  $\sigma^2$  is the variance of the residuals and n is the number of observations in the series. Also AIC can be written as,  $AIC \approx n[1 + \log(2\pi)] + n \log \sigma^2 + 2m$ .

Schwartz Bayesian Criteria (SBC or BIC) is defined by,

$$SBC = \log \sigma^2 + (m \log n)/n.$$

Forecasting the future periods using the parameters of the tentative model has been selected. We entertain six tentative ARIMA models and choose the model which has minimum AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion).

**MODEL IDENTIFICATION FOR RECEIPTS**

The values of the tentative regression and ARIMA models have been calculated for postal receipts [see Table 3] by using the SPSS package are given in Table1. Since  $R^2$  value of EPG is maximum, it is the best regression model to forecast the receipts and since the ARIMA (2,1,1) has the smallest AIC and SBC vales this model has been selected.

**ACTUAL AND ESTIMATED VALUES FOR RECEIPTS**

The actual receipts of postal savings and the values of forecast through regression and ARIMA models are given in Table 3. It is inferred from Table 3 that the actual receipts of postal savings which stood at Rs.785 crore in the year 1970-71 has increased to Rs.1,54,836 crore in the year 2006-07, bearing a marginal decrease during the years 1986-87, 1991-92, 1992-93, 1995-96 and 1996-97. But it could be observed that there was a decrease of considerable amount of Rs.31,184 crore during the year 2007-08. The reduction in interest rates by banking sector to face the financial crisis had some positive impact on postal savings and has been witnessed by the increase in receipts by Rs.20,004 crore during the year 2008-09. The amount of decrease during the years 2006-07 and 2007-08 had its influence on estimated values of receipts of postal savings for the future periods. The forecast values under regression model seem to be continuously increasing from Rs.785 crore to Rs.5,65,888 crore during the period 1970-71 to 2014-15. Whereas the values of forecast under ARIMA model fluctuated according to the trends in actual receipts of postal savings during the period 1970-71 to 2014-15. The increase in estimated values under ARIMA model did not correlate with the forecast values of regression. The value of Rs.5,65,888 crore estimated under regression for the year 2014-15 seems to be abnormal and which cannot be realised in the present financial situation. The forecast value of Rs.98,368 crore for the year 2014-15 under ARIMA model could be reasonable and justified. The graphical presentation given below also proves the results.

**MODEL IDENTIFICATION (FOR OUTSTANDING)**

The values of the tentative regression and ARIMA models have been calculated for postal outstanding by using the package is given Table 2: Since  $R^2$  value of EPG is maximum, it is the best regression model to forecast the postal outstanding and since ARIMA (1,1,1) has the smallest AIC and SBC values, ARIMA (1,1,1) is the most suitable model to forecast.

**ACTUAL AND ESTIMATED VALUES FOR OUTSTANDING:**

The actual postal outstanding and the values of forecast through regression and ARIMA models have been given in Table 3. It could be observed from table 2 that the actual postal outstanding has increased from Rs.1,281 crore in the year 1970-71 to Rs.56,4372 crore in the year 2006-07. But the actual outstanding was Rs.5,09,411 crore in the year 2007-08 resulting to a decrease by Rs.54,961 crore. Whereas the year 2008-09 marked with an increase in outstanding and it amounts to Rs.5,44,340 crore with an increase of Rs.34929 crore. The fluctuating trend in postal receipts from the year 1970-71 to 2007-08 was the reason for decrease in postal outstanding in the year 2007-08.



The estimated value of postal outstanding under regression was steadily increasing from Rs.1,591 crore in the year 1970-71 to Rs.21,52,656 crore in the year 2014-15. It is evident from the table that the postal outstanding estimated under ARIMA is Rs.5,94,816 crore in the year 2014-15. The forecast value worked out under ARIMA model is quite reasonable because it nearer to actual postal outstanding. But the amount worked out under regression is assumed to be over estimation.

**MODEL ESTIMATION AND TESTING**

The parameters of the receipts model ARIMA (2,1,1) are estimated using SPSS package. They are reported as AR<sub>1</sub> = 0.24476; AR<sub>2</sub> = - 0.50115 and MA<sub>1</sub> = - 0.99006. Although our selected model may appear to be the best among those models considered, it is also necessary to do diagnostic checking to verify the model is adequate. After finding out the ACF and PACF for residuals, it is checked whether there is any significant autocorrelation and significant partial autocorrelation. Since there is no significant autocorrelations and partial autocorrelations (Fig 3 and Fig 4) the selected ARIMA model is an appropriate one.

The fitted model for the postal receipt is

$$(1 - \Phi_1 B - \Phi_2 B^2)(1 - B)Y_t = (1 - \Theta_1 B)e_t$$

i.e  $Y_t - 1.24476 Y_{t-1} + 0.74591 Y_{t-2} - 0.50115 Y_{t-3}$   
 $= e_t + 0.99006 e_{t-1}$

The parameters of the outstanding model ARIMA (1,1,1) are estimated using SPSS package. They are reported as AR<sub>1</sub> = 0.72386; and MA<sub>1</sub> = - 0.26141. As above we have the selected ARIMA model is an appropriate one.

The fitted model for the postal outstanding is

$$(1 - \Phi_1 B)(1 - B)Y_t = (1 - \Theta_1 B)e_t$$

i.e  $Y_t - 1.72386 Y_{t-1} + 0.72386 Y_{t-2} = 0.26141 e_{t-1} + e_t$

It is proved with the help of the graph (Fig 1 & Fig 2) that the regression curve shows a steep increase in postal receipts as well as outstanding whereas the curve of ARIMA is normal and represents the real increase in postal receipts and outstanding.

**TABLE 1**

Model	Estimated Model Equation	R <sup>2</sup>
LIN	$y_t = -38981.71 + 4004.76t$	0.73576
QUA	$y_t = 17178.61 - 4213.82t + 205.46t^2$	0.93162
POW	$y_t = 98.54 + t^{1.798}$	0.83772
EPG	$y_t = 6.515886e^{0.149561t}$	<b>0.99187</b>
LOG	$y_t = -67326.45 + 39661.37 \log t$	0.42160
CUB	$y_t = 5508.34 - 919.44t + 2.149t^2 + 3.388t^3$	0.93680
INV	$y_t = 52482.07 - \frac{104235.63}{t}$	0.11661

ARIMA (p,d,q)	AIC	SBC
111	797.41086	802.32362
<b>211</b>	<b>792.5842</b>	<b>799.13454</b>
212	801.10628	809.29421
213	796.46595	806.29147
312	796.9906	806.81612
313	800.86801	812.32111

**TABLE 2**

Model	Estimated Model Equation	R <sup>2</sup>
LIN	$y_t = -133716.39 + 13132.757t$	0.71218
QUA	$y_t = 73928.55 - 17254.32t + 759.68t^2$	0.95058
POW	$y_t = 156.31 + t^{1.99}$	0.86415
EPG	$y_t = 7.23e^{0.16t}$	<b>0.99554</b>
LOG	$y_t = -221286.76 + 128093.05 \log t$	0.39583
CUB	$y_t = -11475.30 + 6854.17t - 728.20t^2 + 24.80t^3$	0.97815
INV	$y_t = 165173.57 - \frac{332232.51}{t}$	0.10663

ARIMA(p,d,q)	AIC	SBC
111	865.44	868.71
112	866.95	871.86
113	868.63	875.18
211	867.13	872.05
212	869.29	875.84
213	869.04	877.23

ERROR ANALYSIS

$$\sum_{i=1}^n [\text{Forecasted value of year } i - \text{Actual value of year } i]^2$$

Mean square error (M.S.E) =  $\frac{\sum_{i=1}^n [\text{Forecasted value of year } i - \text{Actual value of year } i]^2}{n}$   
 where n is the number of years.

$$\frac{|\text{forecasted value} - \text{actual value}|}{\text{actual value}} \times 100$$

Forecasting error =  $\frac{\text{sum of forecasting error}}{\text{number of errors}}$

Average forecasting error (A.F.E) =

TABLE 3: VALUES OF M.S.E AND A.F.E

	Receipts		Outstanding	
	Regression	ARIMA	Regression	ARIMA
M.S.E	106405044.2	41783102.82	2673381523	402545307.8
A.F.E	13.35 %	11.29%	8.75%	7.32%

TABLE 4: SHOWS THAT THE VALUES OF M.S.E AND A.F.E ARE LESS IN ARIMA FOR BOTH RECEIPTS AND OUTSTANDING

Year	Actual Receipt Values	Forecast Through Regress.	Forecast Through ARIMA	Actual Outstanding	Forecast Through Regress.	Forecast Through ARIMA
1970-1971	785	785	--	1281	1624	--
1971-1972	914	911	785	1604	1913	1281
1972-1973	1047	1058	1006	2035	2252	1811
1973-1974	1290	1229	1127	2608	2652	2322
1974-1975	1325	1428	1486	2969	3122	2989
1975-1976	1553	1658	1253	3664	3677	3284
1976-1977	1716	1925	1800	4190	4330	4112
1977-1978	2033	2236	1734	4824	5098	4609
1978-1979	2563	2597	2428	5764	6003	5282
1979-1980	2918	3015	2867	6978	7068	6382
1980-1981	3119	3502	3161	8244	8323	7786
1981-1982	4006	4067	3098	9774	9800	9149
1982-1983	4362	4723	5002	11507	11540	10840
1983-1984	5558	5485	4283	14321	13588	12730
1984-1985	7123	6370	6904	17953	16000	16114
1985-1986	8594	7397	7877	22365	18840	20348
1986-1987	8302	8591	10198	25820	22184	25358
1987-1988	9591	9977	6452	29613	26122	28589
1988-1989	12619	11586	11870	34954	30758	32456
1989-1990	16875	13455	15157	44329	36218	38555
1990-1991	18016	15626	21360	52874	42647	50121
1991-1992	17238	18147	14948	58595	50217	59109
1992-1993	17735	21074	17249	60948	59130	63667
1993-1994	24077	24474	18557	67696	69626	63989
1994-1995	34667	28422	33158	83337	81985	72036
1995-1996	32748	33077	40967	93728	96537	92365
1996-1997	33612	38332	25543	106111	113673	102066
1997-1998	46935	44516	35603	126755	133850	115125
1998-1999	55820	51698	63249	155296	157609	139922
1999-2000	69965	60038	32697	187510	185586	173768
2000-2001	79311	69723	75379	225087	218527	209735
2001-2002	81753	80971	81473	262856	257317	251270
2002-2003	105602	94034	90313	313793	302991	290637
2003-2004	135970	109204	126571	375737	356773	348391
2004-2005	158519	126822	157813	457732	420101	418122
2005-2006	173283	147281	173686	527629	494671	512537
2006-2007	154836	171041	173569	564372	582476	581460
2007-2008	123652	198634	127254	509411	685865	602199
2008-2009	143668	230679	103193	544340	807611	497905
2009-2010	--	267893	93189	--	950965	556427
2010-2011	--	311111	97389	--	1119764	566729
2011-2012	--	361301	100063	--	1318525	575511
2012-2013	--	419588	98446	--	1552568	582996
2013-2014	--	487278	97787	--	1828153	589377
2014-2015	--	565888	98368	--	2152656	594816

FIG. 1: COMPARISON OF ACTUAL, REGRESSION AND ARIMA VALUES (FOR RECEIPTS)

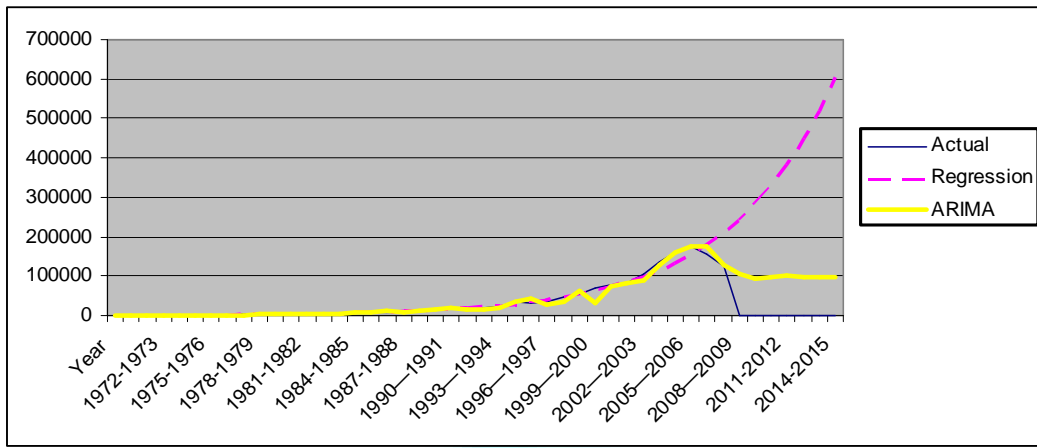


FIG. 2: COMPARISON OF ACTUAL, REGRESSION AND ARIMA VALUES (FOR OUTSTANDING)

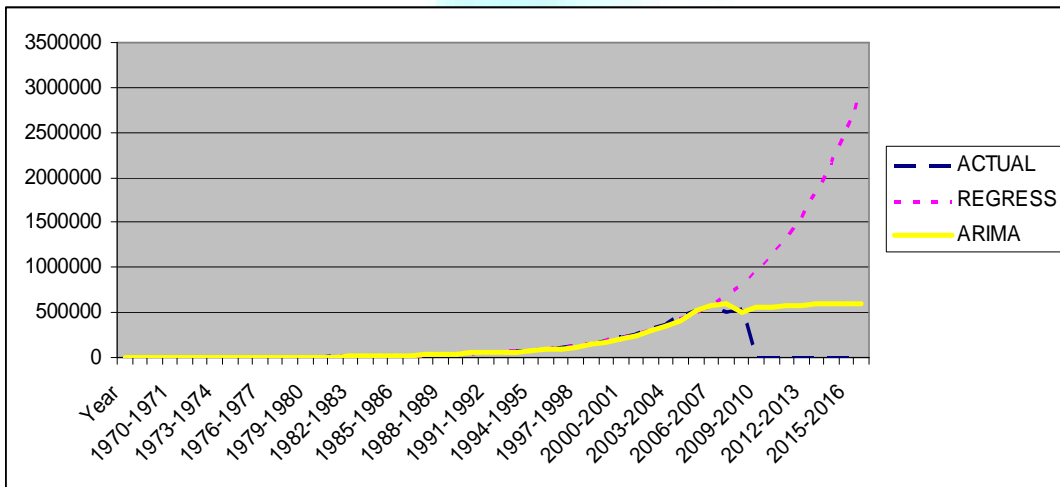


FIGURE 3: ACF OF RESIDUALS (RECEIPTS) OF FITTED ARIMA MODEL

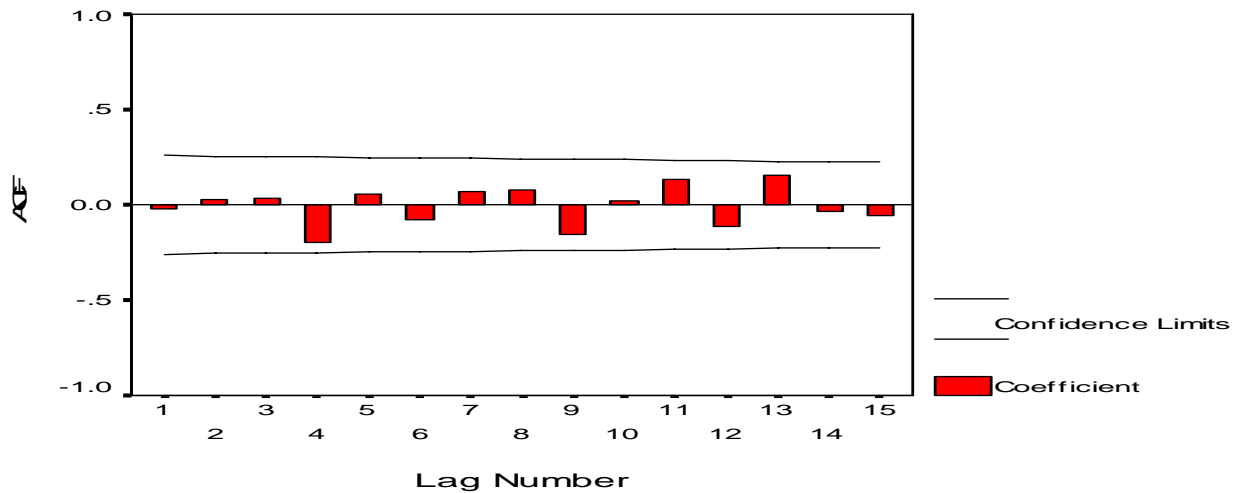
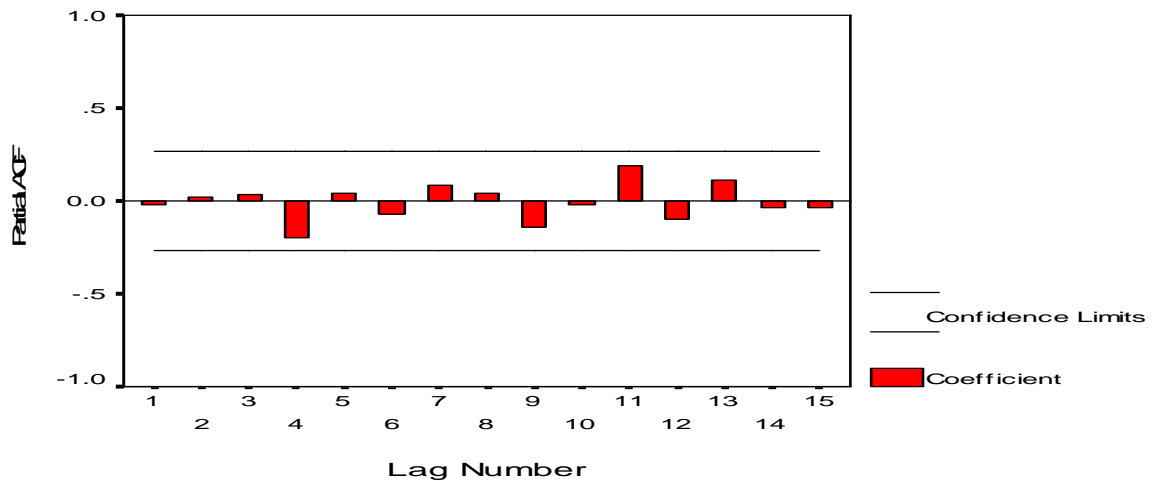


FIGURE 4: PACF OF RESIDUALS (RECEIPTS) OF FITTED ARIMA MODEL



## CONCLUSION

ARIMA model offers a good technique for predicting the magnitude of any variable. Its strength lies in the fact that the method is suitable for any time series with any pattern of change and it does not require the forecaster to choose a priori, the value of any parameter. It can be successfully used for forecasting long time series data. Predicted values of postal receipts and out standings for the years 1970-1971 to 2014-2015 are shown in table 3. The inflow of postal savings is not encouraging in the study period. But the outstanding seems to be a over burden on the part of the government. The study acknowledges that the values of forecast under ARIMA model are realistic and accurate.

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