https://doi.org/10.58419/gbs.v9i2.922303

FORECASTING INVESTMENTS BY LIC OF INDIA BY ARIMA MODEL

ARCHITA NAYAK
Professor, Department of Commerce, Kalipada Ghosh Tarai Mahavidyalaya, Siliguri
archita.nayak@gmail.com

KANTI PAUL
Professor, Department of Commerce, Kalipada Ghosh Tarai Mahavidyalaya, Siliguri
kantipaul@gmail.com

ABSTRACT

In order to preserve the value of the premiums received, continue to pay for claims when required and offset inflation, insurers invest premiums in the economy and seek investment returns which constitutes a major component on insurance products. For certain insurance products, the time elapsed between an insurer receiving premiums and paying claims can range over many years. Depending on the duration and predictability of their liabilities, insurers adopt different investment strategies. Investors utilize forecasting to determine if events affecting a company will increase or decrease the price of shares in that company. Forecasting also provides an important benchmark for firms, which need a long-term perspective of operations. Time series analysis, forecasting and controlling have become increasingly important. Forecasting of different types of investments by LIC have been made utilizing ARIMA model. ARIMA model has been found to best suited for forecasting investments in most cases.

Keywords: *Premium, Reinsurance, Stock Exchange Security, Pension, Reserve Bank of India*

JEL Codes: B23, C02, C22, C53, E27

1. INTRODUCTION

Policyholders pay premiums to insurers in exchange of protecting from a wide range of risks. In order to preserve the value of the premiums received, continue to pay for claims when required and offset inflation, insurers invest premiums in the economy and seek investment returns which constitutes a major component on insurance products. For certain insurance products, such as life insurance and pension products, the time elapsed between an insurer receiving premiums and paying claims can range over many years. Depending on the duration and predictability of their liabilities, insurers adopt different investment strategies (ABI, n.d.).

Effective management of an insurance company's investment function is a key component of its operations and a key determinant of its profitability. Insurance companies develop investment

strategies whose complexity depend on the nature of the business underwritten, with the economic, financial and geopolitical environment standing as a defining element in this strategy.

Investors utilize forecasting to determine whether the business data fluctuating in a company, such as sales expectations, will increase or decrease the price of shares in that company. Forecasting also provides an important benchmark for firms, which need a long-term perspective of operations. Time series analysis, forecasting and controlling have become increasingly important due to the massive production of time series data like production, consumption, money supply, stock prices etc. and as continuous monitoring and collection of such data becomes more common, the need for more efficient analysis and forecasting will only increase.

1. 1. Objectives, Data and Methodology of the Study

The present study is based on the investments (Rs Crores) (A. sector-wise: public, private, joint and co-operative and B. instrument-wise: stock exchange securities and loans) by Life Insurance Corporation (LIC) in India based on the secondary data for the period 1991–2022 obtained from Handbook of Statistics on the Indian Economy, Reserve Bank of India, 2021-22 (Page No. 129, Table No. 74).

The autocorrelation function (ACF) assesses the correlation between observations in a time series for a set of lags. The ACF for time series y is given by: Correlation coefficient between y_t and y_{t-k} at time t and lags k=1,2,….

The partial autocorrelation function (PACF) is similar to the ACF except that it displays only the correlation between two observations that the shorter lags between those observations do not explain (Gujarati et al., 2011).

The data are non-stationary time series in nature. The estimates of parameters of parameters based on non-stationary time series are unreliable. A series is considered as stationary if its mean, variance and the autocorrelation structures do not change over time. If a series is found to be non-stationary based on tests, it can be made stationary either by differencing or by transformations. The stationarity of a time series can be confirmed either by a time plot or by using unit root tests like Augmented Dickey Fuller (ADF) test, Phillips Peron (PP) test and Kwiatkowski -Phillips-Scmidt-Shin (KPSS) test etc. For ADF and PP tests, null hypothesis: H_0: variable has unit root, that is variable is non stationary; whereas for KPSS test, null hypothesis: H_0: variable is stationary.

In case of both ADF test and PP test, the time series may be considered as stationary, if P-value < level of significance (α). But in case of KPSS test, the time series may be considered as stationary, if Lagrange Multiplier (LM) statistics less than all asymptotic critical values of LM-Stat at 1%, 5% and 10% levels of significance. Asymptotic critical values of LM-Stat at 1%, 5% and 10% levels of significance are 0.739, 0.463 and 0.347 respectively. Sometimes ADF, PP and KPSS tests provide contradictory results in selecting order of differencing. It is advisable to perform several unit root tests. If the time series be non-stationary, it is to be converted to stationary by appropriate order of differencing.

The Box-Jenkins methodology is a five-step process for identifying, selecting, and assessing conditional mean models for discrete, univariate time series data.

1. Determine whether the time series is stationarity. If the series is not stationary, successively difference it to attain stationary. The sample autocorrelation function (ACF) and partial autocorrelation function (PACF) of a stationary series decay exponentially (or cut off completely after a few lags).
2. Identify a stationary conditional mean model for the series. The sample ACF and PACF functions can help with this selection. For an autoregressive (AR) process, the sample ACF decays gradually, but the sample PACF cuts off after a few lags. Conversely, for a moving average (MA) process, the sample ACF cuts off after a few lags, but the sample PACF decays gradually. If both the ACF and PACF decay gradually, consider an ARMA model.
3. Create a model template for estimation, and then fit the model to the series.
4. Conduct goodness-of-fit checks to ensure the model describes the series adequately.
5. After choosing a model—and checking its fit and forecasting ability— one can use the model to forecast or generate Monte Carlo simulations over a future time horizon. (Box et al., 1994)

Differencing can help stabilize the mean of a time series by removing changes in the level of a time series, and therefore eliminating (or reducing) trend and seasonality. If the time series data is stationary, that is, it does not require any differencing, then it is denoted by I(0). A time series is I(d), if successive d times differencing converts the non stationary time series into stationary time series, that is, I(0). Again, differencing may be over differencing and under differencing. Choosing the right order of differencing is important, because too much or too little differencing can affect the accuracy and validity of the forecasts. Differencing has some disadvantages for time series

analysis. First, it can introduce noise and randomness into the time series, which can obscure the signal and reduce the information content. Second, it can affect the interpretation and meaning of the time series, as the differenced values may not have a clear or intuitive explanation. Third, it can cause problems with inference and hypothesis testing, as the differenced values may not follow a normal distribution, have constant variance, or be independent.

The Difference symbol is Δ (capital delta). Then r^{th} order difference symbol is Δ^r. Let y_t denotes the value of the time series variable at time t.

Then $\Delta y_t = y_t - y_{t-1}$ or $y_t = y_{t-1} + \Delta y_t$

$\Delta^2 y_t = \Delta y_t - \Delta y_{t-1}$

In general, $\Delta^r y_t = \Delta^{r-1} y_t - \Delta^{r-1} y_{t-1}$

Autoregressive moving average (ARMA) method: ARMA (p, q) is applied on the converted stationary time series. p and q are lags of autoregressive (AR) and moving average (MA) methods respectively. In AR (p) method, time series variable (y) at a time is the function of values of variable (y) at p previous time periods. In MA (q) method, time series variable (y) at a time is the function of error (residual) values related to variable (y) at q previous time periods. The lags p and q of ARMA (p, q) are determined from ACF and PACF.

If the values of both the ACF and PACF functions for all lags lie between -0.5 to +0.5, the time series may be considered as free from non stationarity; that the time series is stationary.

A time series is an ARIMA (p, d, q), where p denotes the number of autoregressive terms, d denotes the number of times the series has to be differenced before it becomes stationary and q denotes of moving average terms. ARIMA (p, 0, q) is ARMA (p, q). ARIMA(p, 0, 0) is AR(p). ARIMA(0,0,q) is MA(q).

The expressions for AR, MA, ARMA and ARIMA are given below:

AR(p): $y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \alpha_3 y_{t-3} + \ldots\ldots + \alpha_p y_{t-p}$ where $\alpha_1, \alpha_2, \alpha_3, \ldots. \alpha_p$ are the constants and u_t is the error (residual) corresponding to y_t.

MA(q): $y_t = \mu + \beta_0 u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \beta_3 u_{t-3} + \ldots\ldots + \beta_q u_{t-q}$ *where* μ *is the* intercept, and $\beta_0, \beta_1, \beta_2, \beta_3, \ldots. \beta_q$ are the constants and u_t is the error (residual) corresponding to y_t.

ARMA(p,q): $y_t = \theta + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \alpha_3 y_{t-3} + \ldots\ldots + \alpha_p y_{t-p} + \beta_0 u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \beta_3 u_{t-3} + \ldots\ldots + \beta_q u_{t-q}$ where θ is the intercept, α_1, α_2, α_3, …. α_p, β_0, β_1, β_2, β_3, …. β_q are the constants and u_t is the error (residual) corresponding to y_t.

Let $Y_t = \Delta^d y_t$ be the d^{th} order differenced value of y_t. Then

ARIMA(p,d,q): $Y_t = \theta + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \alpha_3 Y_{t-3} + \ldots\ldots + \alpha_p Y_{t-p} + \beta_0 u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \beta_3 u_{t-3} + \ldots\ldots + \beta_q u_{t-q}$ where θ is the intercept, $\alpha_1, \alpha_2, \alpha_3, \ldots \alpha_p$, $\beta_0, \beta_1, \beta_2, \beta_3, \ldots \beta_q$ are the constants and u_t is the error (residual) corresponding to Y_t.

Some of the statistics for testing of goodness of fit the model are (1) stationary R-square, (2) R-square, (3) normalized Bayesian Information Criterion (BIC) and (4) Ljung-Box Q.

Stationary R-squared is a measure that compares the stationary part of the model to a simple mean model. Stationary R-squared can be between -∞ to 1.

Normalized Bayesian Information Criterion can measure the efficiency of the parameterized model in terms of predicting the data (model with the lower value of BIC is the one to be preferred).

The null hypothesis of the Ljung-Box Test, H_0, is that the model does not show lack of fit (or in simple terms—the model is just fine). The alternate hypothesis, Ha, is just that the model does show a lack of fit.

IBM SPSS ver 21 and Eviews 11 software have been utilized for the data analyses. Unit root tests are done using Eviews 11 and rest are done using IBM SPSS ver 21. Ten years forecasted values of all concerned variables have been provided.

Compound annual growth rates (CAGR) of each variable have been presented. The formula for CAGR is

$$\mathbf{CAGR = 100 * [(V_n/V_0)^{1/n} - 1]}$$

where V_n = Value at n^{th} year, V_0 = Value at beginning year and n = Number of years.

The paper is organized in sections as follows: 1. Introduction, 2. Review of Literature, 3. Forecasting of Investments by LIC in India, 4. Conclusions and Policy Recommendations and 5. Limitations and Future Research Directions.

2. REVIEW OF LITERATURE

Lavanya (2013) made a growth and trend analysis on premium collection, total investment and investment portfolio of LICI with some parameters like the growth and trend of total premium, total investment, and ready to fund-wise investment portfolio and sector-wise investment portfolio of LICI in India for the period of 2000-01 to 2012-13 based on secondary data obtained from Insurance Regulatory and Development Authority of India.

Gründl et al. (2016) provided an overview of the evolving investment strategies of insurers and identified the opportunities and constraints they might face with respect to long-term investment activity. The study examined the extent to which changes in macroeconomic conditions, market developments and insurance regulation might affect the role of insurers in long-term investment financing. Reinsurers insure the risk of primary insurers. There are several reasons for primary insurance companies to purchase reinsurance. Based on Organization for Economic Cooperation and Development Large Insurer Survey for 2012–14 data, the study revealed that insurance regulation should continue to place priority on incentivizing prudent asset and liability management. Investing in long-term projects can substantially contribute to a better matching of life insurers' assets and long-term liabilities, if they entail well predictable returns.

Dash (2018) based on secondary data for the period 2001-02 to 2015-16 from RBI Handbook of statistics on the Indian economy for the year 2015-16 and Annual Reports of LIC BBSR Division 2009-10 to 2015-16 provided the growth rates for different sectors using compound annual growth rates.

Vanitha et al. (2018) endeavored to link insurance investment decisions with underwriting activities of insurance companies. Using a sample of public life insurer, the study conducted an empirical investigation of how underwriting impact investment in the period of 2004–17. The result of study suggested that premium and claim is significantly influenced the investment of insurance sector. The study used linear regression of investment on premium and claims.

Vijayalakshmi et al. (2018) based on secondary data for the period 1990-91 to 2016-17 from RBI Handbook of statistics on the Indian economy analyzed the data through linear trends and provided compound annual growth rates for different sectors.

Amrutrao (2019) mentioned that funds collected from market (policy owner) are invested by the LIC again in various investment options to get return from it. The study was based on secondary data for the period 2010-19 from RBI Handbook of statistics on the Indian economy, presented data on tabular and graphical forms to analyze the data. The study revealed that the trends of loans and investments on joint sector were in decreasing.

Parikh (2019) studied the norms and amount of investments made by LIC of India from the year 2003-04 to 2013-14 obtained from secondary sources (LIC annual reports) through descriptive statistics like average, minimum and maximum trend lines.

Reddy et al. (2019) studied the financial performance and investment performance of LIC during the period 2001-02 to 2015-16 based on secondary data obtained from database and Central Statistical Organization. Exponential growth rates were calculated to observe which variables are having high growth during the study period. Regression technique was employed to assess the impact of investment on total income of LIC during the study period.

Singh et al. (2020) attempted to analyze the growth of life insurance industry in India in terms of some important components. Comprehensive data available through annual reports of Insurance *Regulatory and Development Authority* for the period 2001-18 were used for that purpose. The estimated values of first year premium and total premium of public and private companies for the year 2020 have been obtained by linear trend analysis.

2.1. Identification of Research Gap

After extensive review of literature, it is understood that there has not been substantial study on investments by insurance companies particularly LIC. Presently available studies were merely based on linear trends, linear regression and presenting data on tabular and graphical forms. No studies were based on rigorous statistical and econometric analyses. In that sense, the present study is brand new endeavor in this area of study.

2.2. Forecasting of Investments by LIC in India

Different investments (Rs Crores) by LIC (a) sector-wise: public, private, joint co-operative and (b) instrument-wise: stock exchange securities and loans have been presented in Table 1 and analyzed in the following sub-sections.

Table 1. Different investments (Rs Crores) by LIC (a) sector-wise: public, private, joint co-operative and (b) instrument-wise: stock exchange securities and loans during the period 1991-2022

Year	Sector-wise					Instrument-wise	
	Public	Private	Joint	Co-operative	Total	Stock Exchange Securities	Loans
1991	19980	3310	165	1444	24900	15871	7417
1992	24425	4240	175	1563	30402	19057	10942
1993	28983	5397	284	1658	36322	23083	11585
1994	36247	5894	305	1716	44162	29536	12876
1995	44319	7017	350	1793	53480	37420	14169
1996	54003	8814	380	1859	65057	47086	18086
1997	65917	9589	490	1942	77938	58851	16751
1998	79236	11834	500	2030	93600	72537	18490
1999	96411	15048	549	2095	114103	90824	26110
2000	117059	19268	576	2129	139032	114032	28926
2001	141256	22780	800	2168	167004	140106	32155
2002	180574	23708	793	2129	207203	178943	34913
2003	219597	29407	685	2082	251770	222449	27540
2004	271779	51924	960	2080	326741	297566	31800
2005	322022	68485	1270	1408	393185	355635	37530
2006	378807	105148	1915	1356	487227	450557	37135
2007	433810	84294	75	3555	521735	480427	41308
2008	503388	128468	74	3818	635748	590467	45281
2009	572050	187141	72	3629	762892	715710	47181
2010	678374	236135	71	3667	918247	872062	45855
2011	799009	267518	82	3667	1070276	1026492	43784
2012	899655	300510	85	3567	1203818	1162388	41430
2013	1018781	329308	86	822	1348996	1307333	41664
2014	1194261	316024	94	754	1511133	1468886	42247
2015	1369713	337997	94	685	1708489	1668047	40442
2016	1578842	345852	96	1159	1925949	1891161	34788
2017	1797369	385729	94	986	2184178	2152592	31586
2018	2046432	395296	108	838	2442674	2415496	27178
2019	2264149	396317	102	996	2661564	2636655	24909
2020	2504578	451787	97	701	2957163	2936030	21134
2021	2769876	507332	105	682	3277696	3258952	19043
2022	2932198	622689	83	566	3555536	3539141	16395

Source: Handbook of Statistics on the Indian Economy, Reserve Bank of India

2.3. Sector-wise Investments: Public, Private, Joint and Co-operative by LIC (Rs. Crores)

Correlation coefficient matrix of sector-wise investments by LIC is provided in Table 2.

Table 2. Correlation Coefficient Matrix of Sector-wise Investments by LIC (Figures in brackets indicate P-values)

	Public	Private	Joint	Co-operative
Public	1	0.966* (<0.001)	-0.429* (0.014)	-0.494* (0.004)
Private		1	-0.479* (0.006)	-0.391* (0.027)
Joint			1	-0.056 (0.761)
Co-operative				1

**indicates significant*

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Investments in public and private sectors are highly positively significantly correlated. The coefficient of correlation between the investments in joint and co-operative sectors is insignificant. Others are negatively significantly correlated.

Investments in public sector (Rs Crores) by LIC have been presented in the following Figure 1. There is an upward trend of investments in public sector with CAGR 17.46 (Rs Crores).

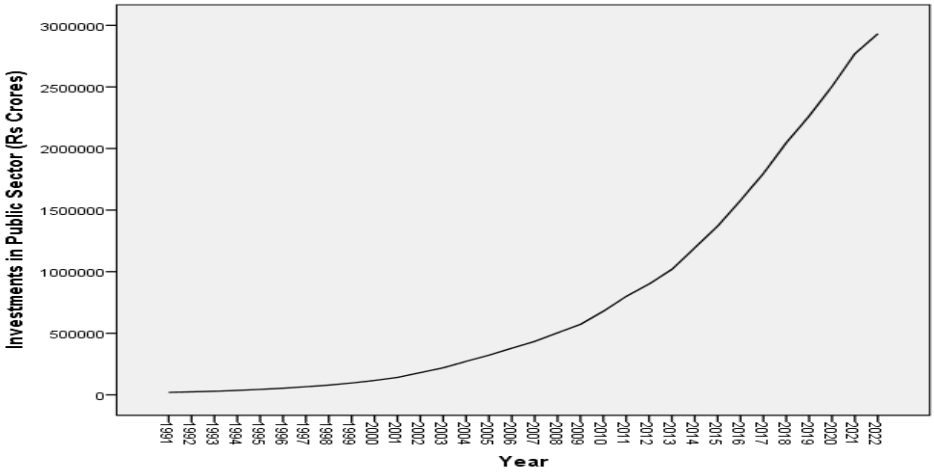


Figure 1. Investments in Public Sector (Rs Crores) by LIC

Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Results of (a) unit root tests, (b) ACF and PACF and (c) best suited ARIMA model for the investments in public sector (Rs Crores) by LIC have been presented in Table 3.

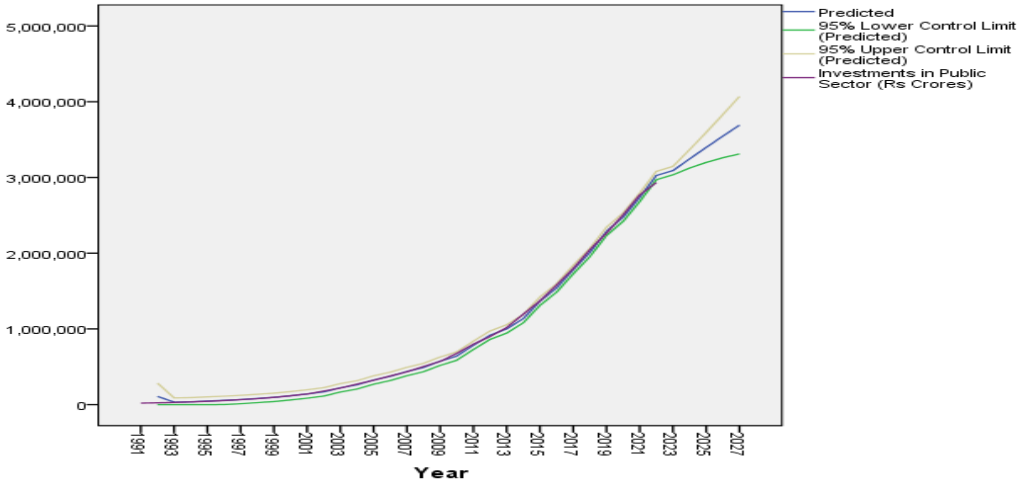
Table 3. Results of Unit Root Tests, ACF and PACF and Best Suited ARIMA Model for Investments in Public Sector (Rs Crores) by LIC (Figure in Bracket Indicates P-Value)

Order of Differencing							Best Suited Model : ARIMA (1,1,0) with Parameters and Fit Statistics
	Zero		1st		2nd		
Lag	ACF	PACF	ACF	PACF	ACF	PACF	
1	0.886	0.886	0.923	0.923	-0.176	-0.176	**Parameters**
2	0.767	-0.083	0.824	-0.183	-0.083	-0.117	Constant : 88724.671 (0.203)
3	0.654	-0.041	0.735	0.040	0.237	0.209	AR (1) : 0.949* (<0.001)
4	0.546	-0.046	0.627	-0.215	0.006	0.084	
Unit Root Test							Fit Statistics
ADF : P-Value	0.0068*		0.7518		0.0004*		Stationary R^2 : 0.874
PP : P-Value	1.0000		0.7655		0.0004*		R^2 : 0.999
KPSS : LM Stat	0.667765		0.658295		0.144292*		Normalized BIC :20.897
Inference on Order of Differencing, AR and MA	Contradictory on Order of Differencing, Better to Consider as 1 Lags of AR and MA may be 1 and 0 respectively						Ljung-Box Q : 7.425 (0.977)

**indicates significant*

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Actual, predicted, 95% LCL predicted, 95% UCL predicted investments in public sector by LIC (Rs Crores) have been presented in Figure 2. Model for investments in public sector by LIC is very good as actual and predicted values for all years coincide.



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 2. Actual, Predicted, 95% LCL Predicted, 95% UCL Predicted Investments in Public Sector by LIC (Rs Crores)

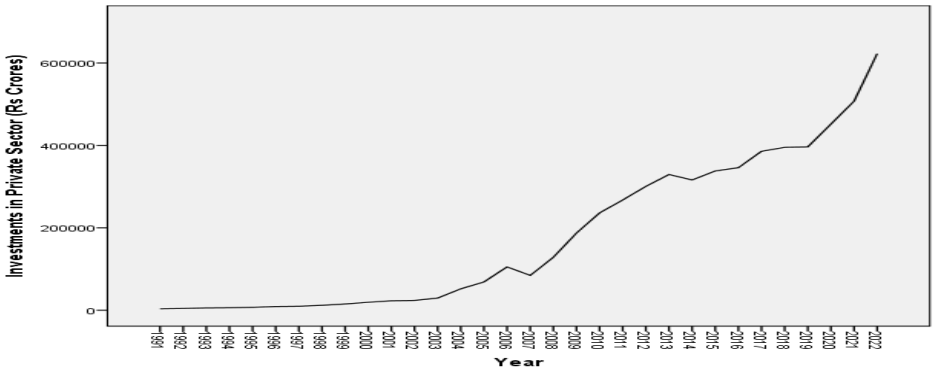
Predicted, 95% LCL predicted, 95% UCL predicted investments in public sector by LIC (Rs Crores) for the years 2023-27 have been presented in Table 4.

Table 4. Predicted, 95% LCL Predicted, 95% UCL Predicted Investments in Public Sector by LIC (Rs Crores) for Years 2023-27

Year	Predicted	95% LCL Predicted	95% UCL Predicted
2023	3090752	3035399	3146105
2024	3245731	3124487	3366975
2025	3397318	3198396	3596239
2026	3545686	3260053	3831319
2027	3691001	3311520	4070481

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Investments in private sector (Rs Crores) by LIC have been presented in Figure 3. There is an upward trend of investments in private sector with CAGR 18.40 (Rs Crores).



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 3. Investments in Private Sector (Rs Crores) by LIC

Results of (a) unit root tests, (b) ACF and PACF and (c) best suited ARIMA model for the investment in private sector (Rs Crores) by LIC have been presented in Table 5.

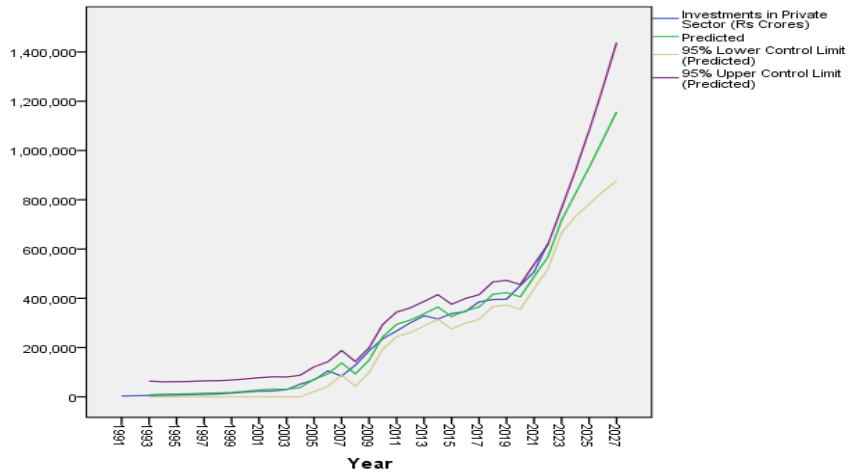
Table 5. Results of Unit Root Tests, ACF and PACF and Best Suited ARIMA Model for Investments in Private Sector (Rs Crores) by LIC (Figure in Bracket Indicates P-Value)

Order of Differencing							**Best Suited Model : ARIMA (1,2,0) with Parameters and Fit Statistics**
	Zero		**1st**		**2nd**		
Lag	**ACF**	**PACF**	**ACF**	**PACF**	**ACF**	**PACF**	
1	0.873	0.873	0.340	0.340	-0.383	-0.383	**Parameters**
2	0.779	0.067	0.259	0.163	0.162	0.182	Constant : 3271.150 (0.307)
3	0.693	0.000	0.025	-0.121	-0.086	-0.021	AR (1) : -0.438* (0.027)
4	0.622	0.021	0.092	0.088	-0.025	-0.078	
Unit Root Test							Fit Statistics
ADF : P-Value	1.0000		0.3206		<0.0001*		Stationary R^2 : 0.174 R^2 : 0.983 Normalized BIC :20.436 Ljung-Box Q : 15.847 (0.535)
PP : P-Value	1.0000		0.3206		<0.0001*		
KPSS : LM Stat	0.712957		0.562680		0.232110*		
Inference on Order of Differencing, AR and MA	Order of Differencing : 2 Lags of AR and MA may be 1 and 0 respectively						

**indicates significant*

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Actual, predicted, 95% LCL predicted, 95% UCL predicted investments in private sector by LIC (Rs Crores) have been presented in Figure 4. Model for investments in private sector by LIC is good as actual and predicted values for all years somehow closer.



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 4. Actual, Predicted, 95% LCL Predicted, 95% UCL Predicted Investments in Private Sector by LIC (Rs Crores)

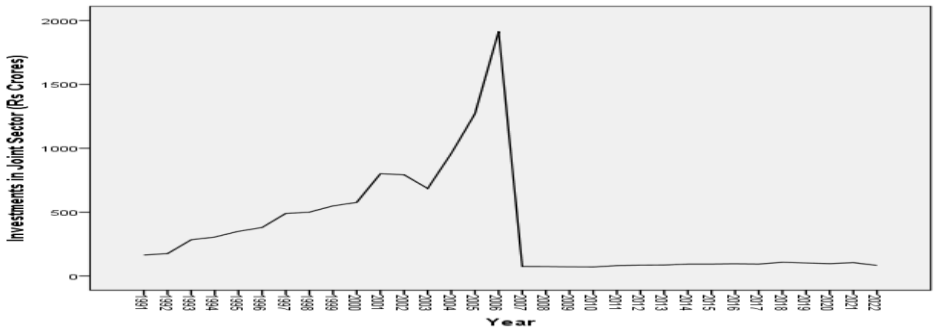
Predicted, 95% LCL predicted, 95% UCL predicted investments in private sector by LIC (Rs Crores) for the years 2023-27 have been presented in Table 6.

Table 6. Predicted, 95% LCL Predicted, 95% UCL Predicted Investments in Private Sector by LIC (Rs Crores) for Years 2023-27

Year	Predicted	95% LCL Predicted	95% UCL Predicted
2023	716557	666476	766639
2024	824539	731650	917429
2025	931045	782447	1079642
2026	1042900	832087	1253713
2027	1157116	876689	1437543

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Investments in joint sector (Rs Crores) by LIC have been presented in Figure 5. There is an upward trend of investment in joint sector up to year 2007, after that there is a sudden abrupt downward trend.



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 5. Investments in Joint Sector (Rs Crores) by LIC

Results of (a) unit root tests, (b) ACF and PACF and (c) best suited ARIMA model for the investments in public sector (Rs Crores) by LIC have been presented in Table 7.

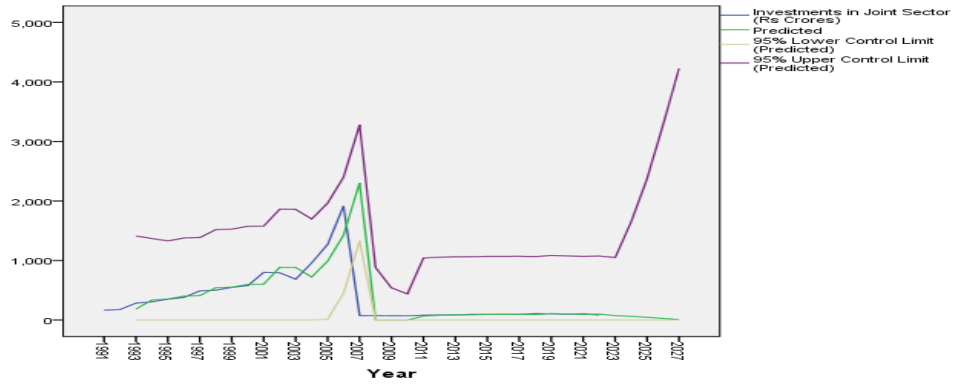
Table 7. Results of Unit Root Tests, ACF and PACF and Best Suited ARIMA Model for Investments in Joint Sector (Rs Crores) by LIC (Figure in Bracket Indicates P-Value)

Order of Differencing							Best Suited Model : ARIMA (2,2,0) with Parameters and Fit Statistics
	Zero		1st		2nd		
Lag	ACF	PACF	ACF	PACF	ACF	PACF	
1	0.618	0.618	-0.224	-0.224	-0.549	-0.549	**Parameters**
2	0.404	0.038	-0.104	-0.162	0.058	-0.350	Constant : -1.928 (0.965)
3	0.270	0.013	-0.125	-0.203	-0.088	-0.387	AR (1) : -0.718* (<0.001)
4	0.230	0.081	0.070	-0.040	0.089	-0.314	AR (2) : -0.328 (0.080)
Unit Root Test							Fit Statistics
ADF : P-Value	0.1111		<0.0001*		0.0001*		Stationary R^2 : 0.387
PP : P-Value	0.1168		<0.0001*		0.0001*		R^2 : -0.133
KPSS : LM Stat	0.258211*		0.387783		0.267955*		Normalized BIC :12.670
Inference on Order of Differencing, AR and MA	Contradictory on Order of Differencing, Better to Consider as 2 Lags of AR and MA may be 2 and 0 respectively						Ljung-Box Q : 7.336 (0.966)

*indicates significant

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Actual and predicted investments in joint sector by LIC (Rs Crores) have been presented in Figure 6. Model for investments in joint sector by LIC is not good as there is a sudden abrupt downward trend.



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 6. Actual and Predicted Investments in Joint Sector by LIC (Rs Crores)

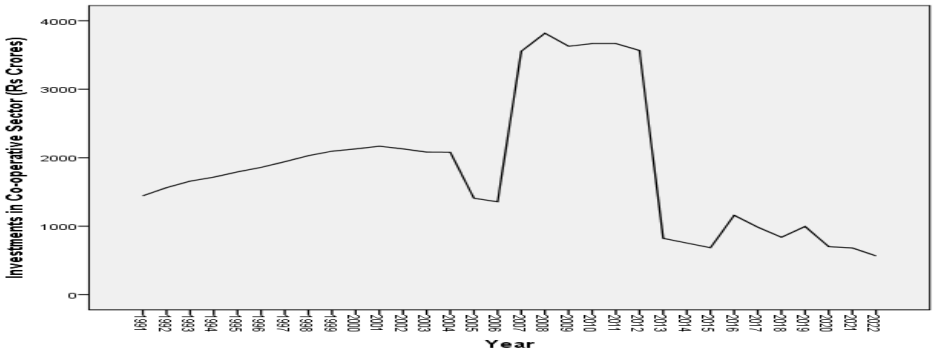
Predicted investments in joint sector by LIC (Rs Crores) for the years 2023-27 have been presented in Table 8.

Table 8. Predicted, 95% LCL Predicted, 95% UCL Predicted Investments in Joint Sector by LIC (Rs Crores) for Years 2023-27

Year	Predicted	95% LCL Predicted	95% UCL Predicted
2023	74	0	1050
2024	62	0	1648
2025	44	0	2375
2026	27	0	3277
2027	8	0	4227

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Investments in co-operative sector (Rs Crores) by LIC have been presented in Figure 7.



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 7. Investments in Co-operative Sector (Rs Crores) by LIC

Results of (a) unit root tests, (b) ACF and PACF and (c) best suited ARIMA model for the investments in co-operative sector (Rs Crores) by LIC have been presented in Table 9.

Table 9. Results of Unit Root Tests, ACF and PACF and Best Suited ARIMA Model for Investments in Co-operative Sector (Rs Crores) by LIC (Figure in Bracket Indicates P-Value)

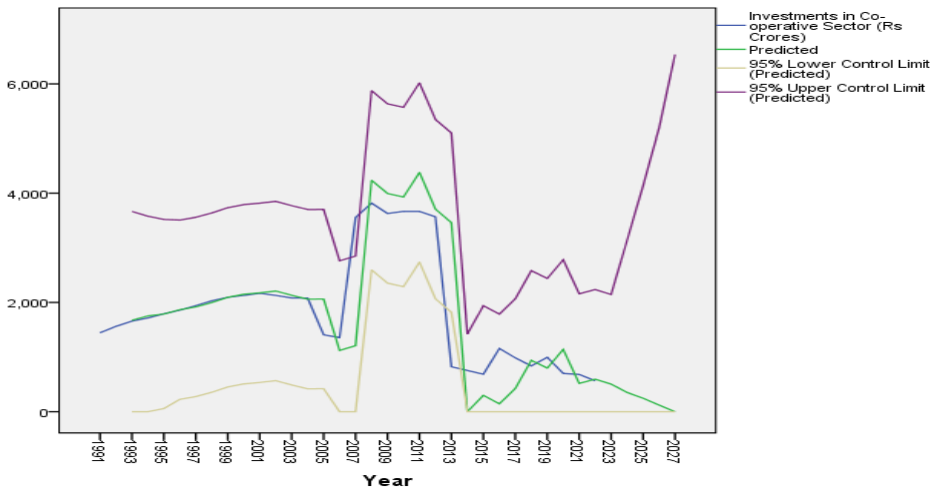
Order of Differencing							Best Suited Model : ARIMA (3,2,0) with Parameters and Fit Statistics
	Zero		1st		2nd		
Lag	ACF	PACF	ACF	PACF	ACF	PACF	

1	0.759	0.759	0.058	0.058	-0.401	-0.401	**Parameters**
2	0.498	-0.182	-0.127	-0.131	-0.116	-0.330	Constant : -6.663 (0.916) AR (1) : -0.628* (0.002) AR (2) : -0.482* (0.023) AR (3) : -0.318* (0.098)
3	0.293	-0.038	-0.097	-0.082	-0.065	-0.347	
4	0.140	-0.042	0.059	0.054	0.139	-0.156	
Unit Root Test							Fit Statistics
ADF : P-Value	0.4371		0.0003*		<0.0001*		Stationary R^2 : 0.342 R^2 : 0.471 Normalized BIC :13.819 Ljung-Box Q : 13.913 (0.532)
PP : P-Value	0.4371		0.0004*		0.0001*		
KPSS : LM Stat	0.190785*		0.143698*		0.284492*		
Inference on Order of Differencing, AR and MA	Contradictory on Order of Differencing, Better to Consider as 2 Lags of AR and MA may be 3 and 0 respectively						

**indicates significant*

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Actual and predicted investments in co-operative sector by LIC (Rs Crores) have been presented in Figure 8. Model for investments in co-operative sector by LIC is not good as there are very steep ups and down trends.



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 8. Actual and Predicted Investments in Co-operative Sector by LIC (Rs Crores)

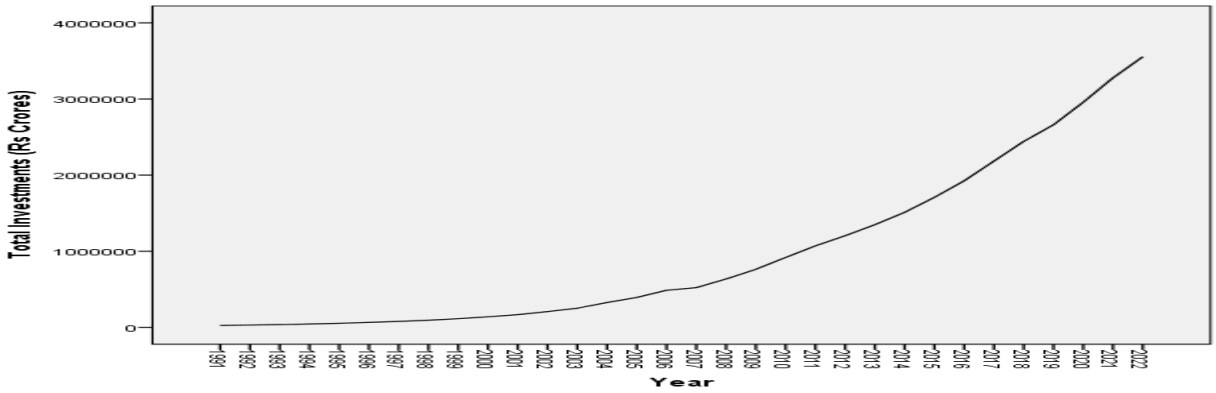
Predicted investments in co-operative sector by LIC (Rs Crores) for the years 2023-27 have been presented in Table 10.

Table 10. Predicted, 95% LCL Predicted, 95% UCL Predicted Investments in Co-operative Sector by LIC (Rs Crores) for Years 2023-27

Year	Predicted	95% LCL Predicted	95% UCL Predicted
2023	505	0	2146
2024	353	0	3138
2025	246	0	4135
2026	121	0	5188
2027	0	0	6538

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Total investments (Rs Crores) by LIC have been presented in Figure 9. There is an upward trend of total investments with CAGR 17.36 (Rs Crores).



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 9. Total Investments (Rs Crores) by LIC

Results of (a) unit root tests, (b) ACF and PACF and (c) best suited ARIMA model for the total investments in public sector (Rs Crores) by LIC have been presented in Table 11.

Table 11. Results of Unit Root Tests, ACF and PACF and Best Suited ARIMA Model for Total Investments (Rs Crores) by LIC (Figure in Bracket Indicates P-Value)

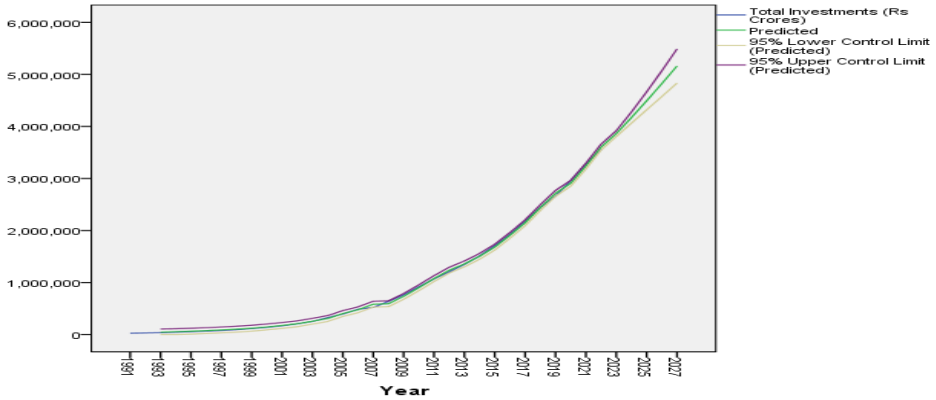
Order of Differencing							Best Suited Model : ARIMA (1,2,0) with Parameters and Fit Statistics
	Zero		1st		2nd		
Lag	ACF	PACF	ACF	PACF	ACF	PACF	
1	0.884	0.884	0.891	0.891	-0.337	-0.337	**Parameters**
2	0.770	-0.052	0.777	-0.086	-0.080	-0.219	Constant : 9626.451
3	0.663	-0.033	0.674	-0.006	-0.067	-0.206	(0.015)

4	0.562	-0.034	0.612	0.134	0.053	-0.088	AR (1) :-0.369* (0.059)
Unit Root Test							Fit Statistics
ADF : P-Value	1.0000		0.9801		<0.0001*		Stationary R^2 : 0.124 R^2 : 0.999 Normalized BIC :20.675 Ljung-Box Q : 12.587 (0.763)
PP : P-Value	1.0000		0.9763		<0.0001*		
KPSS : LM Stat	0.680282		0.699304		0.500000		
Inference on Order of Differencing, AR and MA	Order of Differencing: 2 Lags of AR and MA may be 1 and 0 respectively						

**indicates significant*

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Actual, predicted, 95% LCL predicted, 95% UCL predicted total investments by LIC (Rs Crores) have been presented in Figure 10. Model for total investments by LIC is very good as all actual and predicted values for all years coincide.



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 10. Actual, Predicted, 95% LCL Predicted, 95% UCL Predicted Total Investments by LIC (Rs Crores)

Predicted, 95% LCL predicted, 95% UCL predicted total investments by LIC (Rs Crores) for the years 2023-27 have been presented in Table 12.

Table 12. Predicted, 95% LCL Predicted, 95% UCL Predicted Total Investments by LIC (Rs Crores) for Years 2023-27

Year	Predicted	95% LCL Predicted	95% UCL Predicted
2023	3862237	3805788	3918686
2024	4171354	4063364	4279344
2025	4492759	4319595	4665922
2026	4822808	4576025	5069591
2027	5162846	4834000	5491692

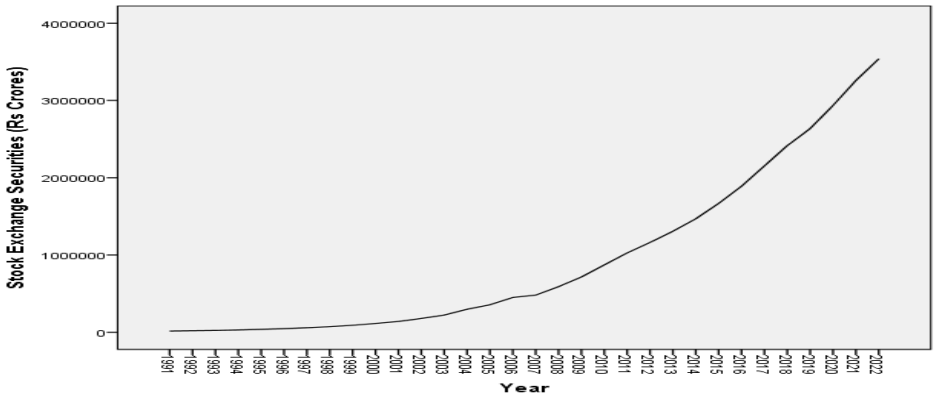
Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

In cases of sector wise investments by LIC, ARIMA model has been found to be best suited forecasting model in cases of public and private investments.

3.2 Instrument-wise Investments: Stock Exchange Securities and Loans by LIC (Rs Crores)

Stock exchange securities and loans are very insignificantly correlated. Coefficient of correlation between them is 0.078.

Stock exchange securities (Rs Crores) by LIC have been presented in Figure 11. There is an upward trend of Stock exchange securities with CAGR 19.06 (Rs Crores).



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 11. Stock Exchange Securities (Rs Crores) by LIC

Results of (a) unit root tests, (b) ACF and PACF and (c) best suited ARIMA model for stock exchange securities (Rs Crores) by LIC have been presented in Table 13.

Table 13. Results of Unit Root Tests, ACF and PACF and Best Suited ARIMA Model for Stock Exchange Securities (Rs Crores) by LIC (Figure in Bracket Indicates P-Value)

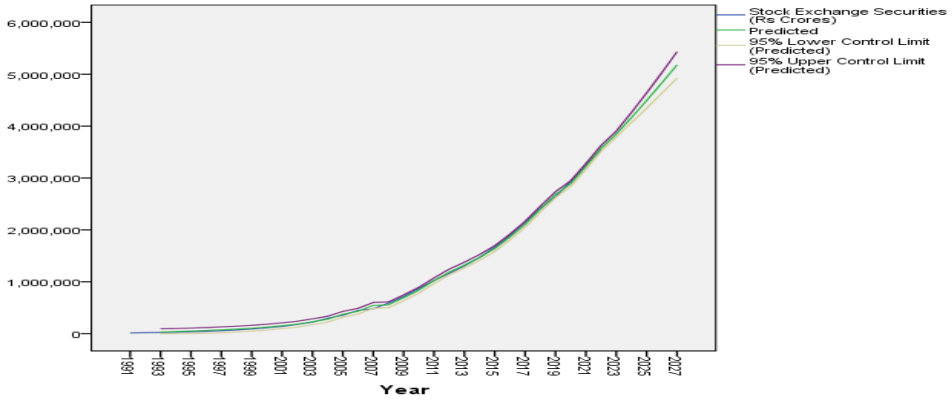
Order of Differencing							Best Suited Model : ARIMA (0,2,1) with Parameters and Fit Statistics
	Zero		1st		2nd		
Lag	ACF	PACF	ACF	PACF	ACF	PACF	
1	0.883	0.883	0.890	0.890	-0.370	-0.370	**Parameters**
2	0.769	-0.053	0.779	-0.061	-0.008	-0.168	Constant : 10153.092* (<0.001)
3	0.661	-0.034	0.673	-0.039	-0.117	-0.218	
4	0.559	-0.034	0.612	0.153	0.052	-0.107	MA (1) : 0.536* (0.003)
Unit Root Test							Fit Statistics
ADF : P-Value	1.0000		0.9813		<0.0001*		Stationary R^2 : 0.212
PP : P-Value	1.0000		0.9738		<0.0001*		

KPSS : LM Stat	0.676394	0.697703	0.500000	R^2 : 0.999 Normalized BIC :20.661 Ljung-Box Q : 9.238 (0.933)
Inference on Order of Differencing, AR and MA	Order of Differencing: 2 Lags of AR and MA may be 0 and 1 respectively			

*indicates significant

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Actual, predicted, 95% LCL predicted, 95% UCL predicted stock exchange securities by LIC (Rs Crores) have been presented in Figure 12. Model for stock exchange securities by LIC is very good as all actual and predicted values for all years coincide.



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 12. Actual, Predicted, 95% LCL Predicted, 95% UCL Predicted Stock Exchange Securities by LIC (Rs Crores)

Predicted, 95% LCL predicted, 95% UCL predicted stock exchange securities by LIC (Rs Crores) for the years 2023-27 have been presented in Table 14.

Table 14. Predicted, 95% LCL Predicted, 95% UCL Predicted Stock Exchange Securities by LIC (Rs Crores) for Years 2023-27

Year	Predicted	95% LCL Predicted	95% UCL Predicted
2023	3847144	3791119	3903168
2024	4165299	4065971	4264628
2025	4493608	4346864	4640352
2026	4832070	4633340	5030800
2027	5180685	4925544	5435826

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Loans (Rs Crores) by LIC have been presented in Figure 13. The overall CAGR of loans is 17.36 (Rs Crores).

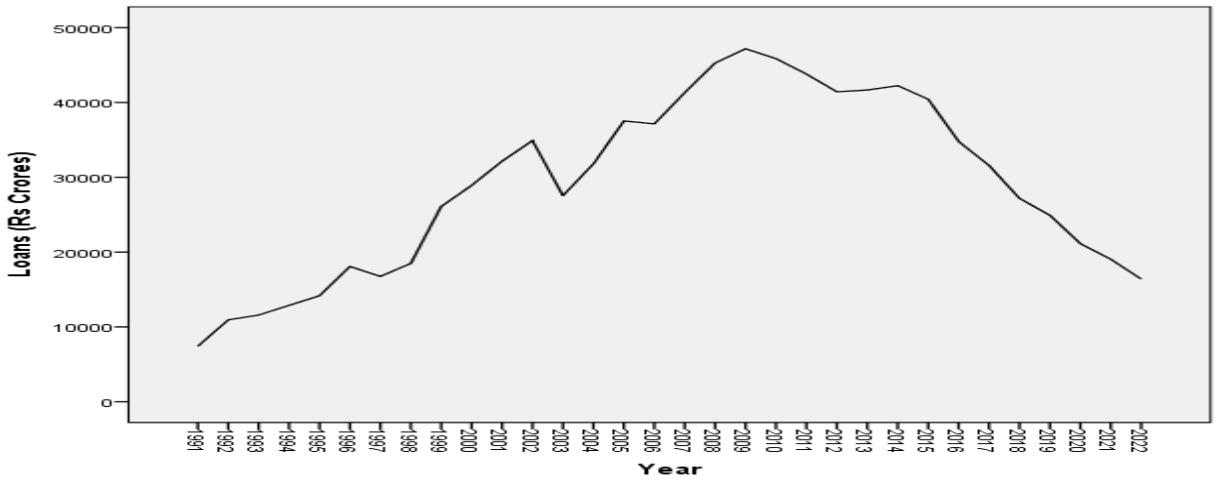


Figure 13. Loans (Rs Crores) by LIC
Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

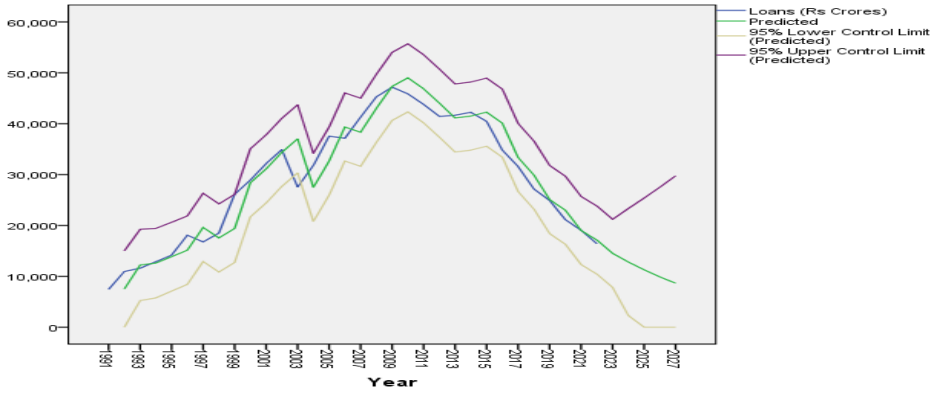
Results of (a) unit root tests, (b) ACF and PACF and (c) best suited ARIMA model for the loans (Rs Crores) by LIC have been presented in Table 15.

Table 15. Results of Unit Root Tests, ACF and PACF and Best Suited ARIMA Model for Loans (Rs Crores) by LIC (Figure in Bracket Indicates P-Value)

Order of Differencing							Best Suited Model : ARIMA (1,1,1) with Parameters and Fit Statistics
	Zero		1st		2nd		
Lag	**ACF**	**PACF**	**ACF**	**PACF**	**ACF**	**PACF**	
1	0.886	0.886	0.336	0.336	-0.389	-0.389	**Parameters**
2	0.769	-0.077	0.195	0.092	-0.269	-0.495	Constant : 79.019 (0.971)
3	0.644	-0.102	0.374	0.322	0.351	0.004	AR(1) : 0.907* (<0.001)
4	0.505	-0.146	0.115	-0.120	-0.300	-0.350	MA (1) : 0.694* (0.049)
Unit Root Test							Fit Statistics
ADF : P-Value	0.6146		0.0092*		<0.0001*		Stationary R^2 : 0.180
PP : P-Value	0.4433		0.0070*		<0.0001*		R^2 : 0.923
KPSS : LM Stat	0.328177*		0.545168		0.058241*		Normalized BIC :16.525
Inference on Order of Differencing, AR and MA	Contradictory on Order of Differencing, Better to Consider as 1 Lags of AR and MA may be 1 and 1 respectively						Ljung-Box Q : 17.059 (0.382)

**indicates significant*
Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Actual, predicted, 95% LCL predicted, 95% UCL predicted loans by LIC (Rs Crores) have been presented in Figure 14. Model for the loans by LIC is somehow good as actual and predicted values for all years are nearby.



Source: Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

Figure 14. Actual, Predicted, 95% LCL Predicted, 95% UCL Predicted Loans by LIC (Rs Crores)

Predicted, 95% LCL predicted, 95% UCL predicted loans by LIC (Rs Crores) for the years 2023-27 have been presented in Table 16.

Table 16. Predicted, 95% LCL Predicted, 95% UCL Predicted Loans by LIC (Rs Crores) for Years 2023-27

Year	Predicted	95% LCL Predicted	95% UCL Predicted
2023	14509	7815	21203
2024	12807	2287	23326
2025	11270	0	25381
2026	9885	0	27517
2027	8636	0	29759

Source: Calculated by Authors Based on Handbook of Statistics on the Indian Economy, Reserve Bank of India

In cases of instrument wise investments by LIC, ARIMA model has been found to be best suited forecasting model in cases of both stock exchange securities and loans.

3. CONCLUSIONS AND POLICY RECOMMENDATIONS

In order to preserve the value of the premiums received, continue to pay for claims when required and offset inflation, insurers invest premiums in the economy and seek investment returns which constitutes a major component on insurance products. For certain insurance products, such as life insurance and pension products, the time elapsed between an insurer receiving premiums and paying claims can range over many years. Depending on the duration and predictability of their liabilities, insurers adopt different investment strategies.

Investors utilize forecasting to determine whether the business data fluctuating in a company, such as sales expectations, will increase or decrease the price of shares in that company. Forecasting also provides an important benchmark for firms, which need a long-term perspective of operations. Time series analysis, forecasting and controlling have become increasingly important.
Forecasting of different types of investments by LIC have been made utilizing ARIMA model. ARIMA model has been found to best suited for forecasting investments in most of the cases.

4. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

We have to explore different models for forecasting and find out best suited one for different cases. Although ARIMA model is a unique time series model for forecasting and control and has capabilities in dealing with linear and nonlinear time series, there are various models for the same. ARIMA with Explanatory Variable (ARIMAX) model can be viewed as a multiple regression model with one or more autoregressive terms and/or one or more moving average terms. ARIMAX model where number of policyholders, gross domestic product per capita etc as explanatory variable may be used for forecasting milk production. Other forecasting models like ARIMA-ANN, exponential smoothing etc may be utilized. Forecasting of number of policyholders of LIC may be done. Data scientists utilize statistical and computational methods to extract insights from data, build predictive models, and develop new algorithms. Data analytics involves analyzing data to gain insights and inform business decisions. Data analytics may develop new forecasting models.

REFERENCES

ABI (n.d.). Insurers as investors. *https://www.abi.org.uk/data-and-resources/tools-and-resources/regulation/insurers-as-investors/*

Amrutrao, S. A. (2019). An analysis of Sector wise Investment Management of Life Insurance Corporation of India, International Journal of Research and Analytical Reviews (IJRAR), Vol. 6, Issue 4, 897-904.

Box, G. E. P.; Jenkins, G. M. & Reinsel, G. C. (1994). Time Series Analysis Forecasting & Control, Pearson Education.

Dash, M. C. (2018). Investment Pattern of LIC: An Emperical Study of Bhubaneswar Division, International Journal of Creative Research Thoughts (IJCRT), Vol. 6, Issue 1, 188-198.

Gründl, H.; Dong, M. & Gal, J. (2016). The evolution of insurer portfolio investment strategies for long-term investing, OECD Journal: Financial Market Trends, Vol. 2016, Issue 1, 55 pages.

Gujarati, D. N. & Sangeetha (2011). Basic Econometrics, Tata McGraw Hill Education Private Limited, New Delhi.

Lavanya (2013). Investment Portfolio of LIC: A Trend Analysis, Financial Markets and Services Emerging Trends 2013, 32-47.

Parikh, H. (2019). An Analysis of Investments Made by LIC of India as per IRDA Norms, Zenith International Journal of Multidisciplinary Research, Vol. 9, Issue 3, 199-216.

Reddy, V. V. N. & Reddy, S. M. (2019). Performance of Life Insurance Corporation of India: A Post-deregulation Experience, International Journal of Management, Technology and Engineering, Vol. IX, Issue II, 1782-1791.

Reserve Bank of India (2021-22). Handbook of Statistics on the Indian Economy, 407 page https://dbie.rbi.org.in

Singh, P. and Ali, S. (2020). Analysis of Growth of Life Insurance Industry in India – A Comparative Study of Public and Private Sector, International Journal of Advanced Research in Engineering and Technology (IJARET), Vol. 11, Issue 7, 808-823.

Vanitha, D. & Rajakrishna, V.S. (2018). Determinants of Insurance Investment: A Case Study of Life Insurance Corporation of India, International Journal of Science and Research (IJSR), Vol. 7, Issue 7, 81-85.

Vijayalakshmi, P. & Satishkumar, R. (2018). Investment Pattern of Life Insurance Corporation of India, International Journal for Science and Advance Research in Technology (IJSART), Vol. 4, Issue 8, 451-457.