



Analysis and Forecasting of India's Defense Expenditure

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Abstract. The analysis and forecasting of defense expenditure plays an instrumental role in the rational allocation of resources, ensuring the security and advancement of the nation. Furthermore, it has significant implications for the economic and social development of the country. This paper presents a comprehensive examination of the size of India's defense expenditure, spanning from FY 2013-2014 to FY 2022-2023. It encompasses an in-depth analysis of the absolute size, share of GDP, share of government fiscal expenditure, per capita defense expenditure of citizens and per capita defense expenditure of military personnel. Subsequently, the structure of India's defense expenditure is analyzed from FY 2017-2018 to FY 2022-2023, including the resource cost structure and the force group structure. Ultimately, in order to forecast India's defense expenditure for the subsequent three fiscal years, ARIMA, the grey-system forecasting method GM(1, 1) and exponential smoothing are employed when considering defense expenditure as time series data.

Keywords: Defense Expenditure, ARIMA, GM(1, 1), Exponential Smoothing

1 Introduction

As a critical component of national fiscal expenditure, defense expenditure serves as a fundamental material basis for national security and military development, providing robust financial support for the objectives of strengthening both the nation and its armed forces. The issues surrounding the moderate growth and determination of the size of defense expenditure are important areas of research in the field of defense economics. Moreover, defense expenditure reflects India's strategic military policy and is an essential tool for regulating military capabilities, optimising force structure and driving national defense reforms. This paper aims to provide a comprehensive analysis of the size and structure of India's defense expenditure, using three time-series forecasting methods to project future expenditure.

2 Analysis of the Size of India's Defense Expenditure

2.1 Analysis of the Absolute Size of India's Defense Expenditure

As indicated in the Union Budget [1] of the Indian Ministry of Finance, India's actual defense expenditure from FY 2013-2014 to FY 2022-2023 has increased from Rs.

254,133.3 crores to Rs. 573,098.1 crores. This represents a steady growth trend with an average growth rate of 9.64% and a compound annual growth rate of 9.53%. Nevertheless, an analysis of the size of defense expenditure in national currency is not without its limitations and does not fully reflect the actual pattern of growth. It is standard practice to convert the total amount of defense expenditure in national currency into constant base year dollars using the exchange rate [2] and the US Consumer Price Index [3] in order to eliminate the influence of factors such as inflation on the results of the analysis. Table 1 indicates that India's defense expenditure for FY 2022-2023 is \$68,054 million in constant 2021 dollars, representing an increase of \$321 million over the previous fiscal year. The data set reveals two principal phases: the first spanning FY 2013-2014 to FY 2018-2019 and the second extending from FY 2019-2020 to FY 2022-2023. The initial phase evinces an overall upward trajectory, with a cumulative increase from \$50,444 million to \$68,154 million. This encompasses an average growth rate of 4.39% and an average annual growth rate of 2.95%. In contrast, the latter phase demonstrates a relatively stable trajectory, exhibiting only minor fluctuations.

Table 1. Relevant data about India.

	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
USD/Rupee ER	58.60	61.03	64.15	67.19	65.12
US CPI	232.95	236.72	237.00	242.64	245.12
India's DE	25413.33	28500.48	29391.98	35154.98	37970.40
India's GDP	1123352.16	1246795.93	1377187.39	1539166.90	1709004.24
India's FE	155944.70	166367.30	179078.30	197519.40	214197.30
India's Population	12.52	12.67	13.11	13.27	13.39
India's Active	1325000	1325000	1346000	1346000	1395100
India's Army	1129900	1129900	1150900	1150900	1200000
	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
USD/Rupee ER	68.39	70.42	74.10	73.92	78.60
US CPI	251.10	255.65	258.85	270.97	292.62
India's DE	40345.73	45299.64	48568.05	50068.09	57309.81
India's GDP	1889966.84	2010359.29	1982992.71	2347101.17	2724071.22
India's FE	231511.30	268633.00	350983.60	379380.10	419315.70
India's Population	13.54	13.69	13.80	13.93	14.07
India's Active	1395100	1444500	1455550	1458500	1460350
India's Army	1200000	1237000	1237000	1237000	1237000
Note	ER: Exchange Rate; DE: Defense Expenditure; FE: Fiscal Expenditure; India's DE/GDP/FE are all measured in 100 million rupees.				

2.2 Analysis of the Relative Size of India's Defense Expenditure

The Proportion of GDP Allocated to Defense Expenditure in India. The India's economy continues to demonstrate robust growth, driven by a demographic dividend, accelerated manufacturing and infrastructure development, and economic policy reforms. India's GDP from FY 2013-2014 to FY 2022-2023 exhibited a notable growth trajectory, increasing from \$2,229,789 million to \$3,234,779 million in constant 2021 dollars. This represented an average growth rate of 4.08% and an average annual growth

rate of 3.95%. However, it is important to consider the impact of external factors, such as the global pandemic of 2020, which led to a deviation from this trend in the FY 2020-2021 period. It is noteworthy that India's GDP has achieved a period of sustained high growth from FY 2014-2015 to FY 2017-2018. Furthermore, India's GDP demonstrated a robust recovery in FY 2021-2022 relative to FY 2020-2021, with an increase of 12.78%. India's defense expenditure as a percentage of GDP has remained relatively stable, oscillating between 2 and 3% with minor fluctuations, with an average of 2.23%.

The Proportion of Government Fiscal Expenditure Allocated to Defense Expenditure in India. In consequence of the rapid growth of India's GDP, the fiscal expenditure of the Indian government has increased in accordance with the natural progression of events. In constant 2021 dollars, the actual fiscal expenditure of the Indian government from FY 2013-2014 to FY 2022-2023 has demonstrated a generalized pattern of steady growth, with an average growth rate of 5.04% and an average annual growth rate of 4.80%. This growth can be observed in the figures for the period under review, which show a rise from \$309,541 million to \$497,929 million. In the fiscal year with the highest growth rate of expenditure in rupee terms, namely FY 2020-2021, the rate of growth in expenditure was 23.30%. Furthermore, India's fiscal expenditure as a proportion of GDP has remained above 12% in all fiscal years. India's defense expenditure as a proportion of fiscal expenditure broadly exhibits two distinct phases: from FY 2013-2014 to FY 2019-2020 and from FY 2020-2021 to FY 2022-2023. During the former period, the proportion was above 16% in all fiscal years, with an average of 17.09%. Conversely, during the latter period, the proportion was below 14% in all fiscal years, with an average of 13.57%.

Per Capita Defense Expenditure of India's Nationals. India has a large population base, with its total population growing from 1.252 billion to 1.407 billion [4], with an average growth rate of 1.12% and an average annual growth rate of 1.13%. India has a young and growing workforce, with a population structure that is pyramidal in nature and offers a significant demographic dividend advantage, providing a substantial reservoir of human resources for its economic development. The national defense expenditure per capita of India from FY 2013-2014 to FY 2022-2023 evinces an overall growth trend, with minor fluctuations in certain fiscal years. The average growth rate is 1.93%.

Per Capita Defense Expenditure of India's Military Personnel. The armed forces of India are constituted by the India's Army, Navy, Air Force and Coast Guard. As indicated in The Military Balance [5], published by the IISS, the number of active military personnel in India is increasing. This figure has risen from 1,325,000 to 1,460,350, representing an average growth rate of 0.99% and an average annual growth rate of 0.98%. India's service structure evinces a pronounced tendency towards continental militarism, with the total number of army personnel increasing, but the army's share of active personnel undergoing a discernible shift. This shift can be observed in two distinct phases: an upward phase from FY 2013-2014 to FY 2018-2019 and a downward phase from FY 2019-2020 to FY 2022-2023. In the former phase, the army's share of

active personnel increased from 85.28% to 86.02%, while in the latter, it decreased from 86.02% to 84.71%. With the exception of the aforementioned service, all other military services demonstrate an increase in their share of the active military following FY 2019-2020. The per capita defense expenditure of the India’s military demonstrates an overall upward trajectory, with minor fluctuations observed in certain fiscal years. The average growth rate is 2.05%, while the average annual growth rate is 1.94%.

3 Analysis of the Structure of the India’s Defense Expenditure

3.1 Analysis of the Resource Cost Structure of India’s Defense Expenditure

As the UN military expenditure database did not provide data on the structure of India’s military expenditure from FY 2013-2014 to FY 2016-2017, this section will analyze only the structure from FY 2017-2018 to FY 2022-2023, as illustrated in Table 2 [6]. It should be noted that there is a discrepancy between the size of India’s defense expenditure calculated by the database and that indicated in the Union Budget. However, this does not affect the structural analysis.

Personnel. In terms of Personnel cost, there has been a substantial year-on-year decline of 9.5% in constant 2021 dollars from FY 2017-2018 to FY 2022-2023, with the exception of FY 2020-2021. Furthermore, the proportion of Personnel cost in India’s defense expenditure has exhibited a similar pattern, with a minimum of 36% and an average of 38.67%. While there has been a general decline in both the size and proportion of Personnel cost, it has consistently constituted a minimum of one-third of India’s defense expenditure and represents a fundamental component of India’s defense expenditure.

Table 2. Resource cost and force group structure (unit: 100 million rupees).

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Personnel	11298.77	11904.09	12455.21	12325.28	13645.63	14626.78
Operations & Maintenance	2853.41	3098.89	3724.80	3314.95	3732.36	4532.15
Procurement & construction	11582.66	12067.18	13948.31	16793.81	17448.98	18666.90
Research & development	1520.30	1705.96	1737.56	1580.70	1829.10	2057.48
Land forces	15556.30	16262.47	17254.19	16716.17	18317.47	20744.72
Naval forces	3880.07	4242.52	4983.41	6483.29	6887.46	7610.96
Air forces	6231.07	6474.38	7522.85	9096.28	8759.64	9053.72
Other forces	1587.70	1796.75	2105.43	1719.00	2691.50	2473.91

Operations & Maintenance. A comparison of the constant 2021 dollars value of Operations & Maintenance cost and its share of defense expenditure reveals two distinct upward phases: from FY 2017-2018 to FY 2019-2020 and from FY 2020-2021 to FY 2022-2023. The former increased by 15.62%, representing a 1.22% increase as a share

of total defense expenditure, while the latter increased by 14.34%, representing a 1.59% increase as a share of total defense expenditure. The cost of Operations & Maintenance for the 2020-2021 fiscal year is estimated at \$4,707 million, representing a 16.01% decline from the preceding fiscal year.

Equipment. The financial outlay required for the Procurement & Construction and Research & Development can be considered to constitute the total cost of Equipment. In constant 2021 dollars, India's total Equipment cost and its share of defense expenditure from FY 2017-2018 to FY 2022-2023 demonstrate an essentially increasing and then decreasing trend. The total increases from \$22,256 million to \$26,088 million and then decreases to \$24,610 million, with an average of \$24,053 million. Additionally, its share of defense expenditure increases from 48.08% to 54.02% and then decreases to 51.96%, with an average of 50.62%. Notwithstanding considerable fluctuations in Equipment cost, they have constituted approximately half of the total defense expenditure in each fiscal year.

3.2 Analysis of the Force Group Structure of India's Defense Expenditure

In constant 2021 dollars, India's military expenditure on the army from FY 2017-2018 to FY 2022-2023 is not less than \$23 billion. This figure represents an overall declining trend, with an average decline rate of 1.29%. However, it should be noted that the share of total defense expenditure is not less than 49%. This figure also demonstrates a trend of first decreasing and then increasing, with an average of 53.14%. The military expenditure of the air force and its share of total defense expenditure were the second highest in each year, exhibiting a general trend of initial increase and subsequent decrease, with a general stability. The military expenditure of the navy and its share of total defense expenditure were the third highest in each year, with an overall upward trend and an average growth rate of 6.92%. Additionally, there was an increase in its share of total defense expenditure, from 14.24% in FY 2017-2018 to 19.08% in FY 2022-2023. In general, there is a discernible trend of shifting defense expenditure from the army to the navy. The fluctuations in military expenditure of other armed forces are more pronounced from year to year; however, as a percentage of total defense expenditure, they remain relatively low.

4 Forecast of India's Defense Expenditure

The primary factors that shape the size of defense expenditure include the expansion of national interests, the nature of security threats, changes in military technology, rising military costs and the state of the national economy. As it is challenging to accurately quantify these influencing factors, it is not straightforward to make an accurate forecast of the size of a country's defense expenditure. In considering defense expenditure as time series data, the most commonly employed methods are the Autoregressive Integrated Moving Average (ARIMA) model, the grey-system forecasting method GM(1, 1), and exponential smoothing. All forecasting methods and analytical processes are

based on the SPSSAU data science online analysis platform, as referenced in reference [7].

4.1 Forecasting Process

ARIMA. The ARIMA model is a well-established and frequently utilized time series forecasting method. It is capable of effectively processing and forecasting time series data with trends and seasonal variations by combining autoregressive, differential and moving average components. In light of the India’s defense expenditure in rupees position, combined with the AIC information criterion, SPSSAU automatically models and compares several potential candidate models, and finally identifies the optimal model as ARMA(0, 1, 0), with AIC = 183.14, regression coefficients = 3424.56, standard error = 725.89, p-value = 0.00, 95% CI = 2001.83 ~ 4847.29, BIC = 183.74. The ARIMA model requires that the residuals are white noise, that is to say, that there is no autocorrelation in the residuals. The white noise test can be performed using the Q statistic test. The Q_6 test is employed to ascertain whether the autocorrelation coefficient of the first six orders of the residuals satisfies the criteria for white noise. In the majority of cases, a p-value exceeding 0.1 signifies that the white noise test is satisfied. The Q-statistic yields a p-value of 0.17 for Q_6 , indicating that the null hypothesis cannot be rejected at the 0.1 significance level. This implies that the model residuals are white noise, thereby satisfying the requisite conditions.

GM(1, 1).

Table 3. GM(1, 1) model parameters.

Original Value	λ	DE+Shift	λ Shifted	Forecast Value	Residual	MAPE	Level Deviation
23064.21	-	80374.21	-	23064.21	0.00	0.00%	-
25413.33	0.91	82723.33	0.97	25030.69	382.64	1.51%	0.06
28500.48	0.89	85810.48	0.96	28004.85	495.63	1.74%	0.08
29391.98	0.97	86701.98	0.99	31086.44	-1694.46	5.77%	-0.00
35154.98	0.84	92464.98	0.94	34279.34	875.64	2.49%	0.13
37970.40	0.93	95280.40	0.97	37587.56	382.84	1.01%	0.04
40345.73	0.94	97655.73	0.98	41015.28	-669.55	1.66%	0.02
45299.64	0.89	102609.64	0.95	44566.81	732.83	1.62%	0.08
48568.05	0.93	105878.05	0.97	48246.62	321.43	0.66%	0.03
50068.09	0.97	107378.09	0.99	52059.34	-1991.25	3.98%	-0.01
57309.81	0.87	114619.81	0.94	56009.79	1300.02	2.27%	0.09

The grey forecasting model is a forecasting method based on grey system theory. It employs a scientific and quantitative approach to forecasting the future development trend of a system, generating data and building a differential equation model. This method has the advantages of low data requirement, full information utilization, simple calculation and high accuracy. As illustrated in Table 3, the initial step in the construction of the GM(1, 1) model for India’s defense expenditure is the performance of a

lambda value test, which determines the applicability of the data series for model construction. The lambda value is defined as the ratio of the data from the previous period to the data from the current period. The results demonstrate that the original data did not meet the criteria for the lambda value test. Consequently, a shift transformation was conducted, whereby the shift transformation value of 57310 was added to the original value, resulting in the lambda values of the final shifted data falling within the standard range [0.846, 1.181], indicating that the data were suitable for GM(1, 1) model construction. Once the model has been constructed, the following values are obtained: evolution parameter $a = -0.04$, grey action quantity $b = 78036.54$, C-value = 0.01. The C value of $0.01 \leq 0.35$ indicates that the model exhibits a high degree of accuracy.

As illustrated in Table 3, the mean absolute percentage error (MAPE) and level deviation values can be analyzed subsequent to the construction of the model to ascertain its efficacy. The maximum value of MAPE for the model is 0.058, which is less than 0.1, indicating that the model exhibits an excellent fitting effect. With regard to the level deviation value, a value of less than 0.2 indicates that the requisite criteria have been met. A value of less than 0.1 indicates that the more exacting criteria have been satisfied. The maximum value of the level deviation of the model is $0.134 \leq 0.2$, which indicates that the fitting effect of the model meets the requisite criteria.

Exponential Smoothing. This method is frequently employed in instances where the data series is limited in number and is typically applicable only to short to medium term forecasting. This can be further categorized into three sub-categories: single exponential smoothing, double exponential smoothing and triple exponential smoothing. The SPSSAU online platform is programmed to identify the optimal alpha value and smoothing type based on the RMSE value, thereby achieving the most effective forecasting outcome. With regard to the initial value S_0 , the SPSSAU is programmed so that the average of the first two original values is set as the initial value. Following the automatic identification of the optimal model parameters by the SPSSAU, the identified values were found to be $S_0 = 24238.77$, $\alpha = 0.40$, and the smoothing type was triple exponential smoothing, with an RMSE value of 2266.35. The model is constructed with these parameters in order to obtain the predicted value of the data.

4.2 Forecasting Result Analysis

The aforementioned three methods have been employed in order to forecast India's defense expenditure for the subsequent three fiscal years, with the resulting forecasts presented in Table 4. The root mean square error (RMSE), mean absolute error (MAE) and mean absolute percentage error (MAPE) values for the GM(1,1) method are the lowest. In the Union budget, there are three types of defense expenditure: Estimates for the current fiscal year, Revised Estimates for the previous fiscal year and Actuals for the fiscal year before last. India's defense expenditure Estimates for FY 2023-2024 is Rs. 593537.6 crores, while the Revised Estimates is Rs. 623888.9 crores. The Estimates for FY 2024-2025 is Rs. 621540.9 crore. In terms of the relationship between Actuals, Estimates and Revised Estimates, it can be observed that the Actuals and Revised

Estimates are generally more closely related. Therefore, it would be reasonable to compare the forecast result for FY 2023-2024 with the Revised Estimates. As illustrated in Table 4, the exponential smoothing forecast is 61512.93, which is more accurate than the other two methods.

Table 4. Forecasting result comparison.

Method	FY 2023	FY 2024	FY 2025	RMSE	MAE	MAPE
ARIMA	60734.37	64158.93	67583.49	1877.39	1536.99	0.04
GM(1, 1)	60102.92	64343.90	68738.06	1045.01	884.63	0.02
Exponential Smoothing	61512.93	66702.73	72213.32	2266.35	1916.23	0.05

5 Conclusion

This paper presents a more comprehensive analysis of India's actual expenditure on defense from FY 2013-2014 to FY 2022-2023. It employs a range of analytical techniques, including absolute size analysis, relative size analysis, resource cost structure analysis and force group structure analysis. Furthermore, it applies three time-series forecasting methods through the SPSSAU platform to make a forecast. As the three time-series forecasting methods employed in this paper do not take into account the factors that directly influence a country's defense expenditure, the subsequent work will construct a dataset comprising GDP, Global Peace Index (GPI) [8] and other indicators. This will then be used with regression and machine learning methods to more accurately forecast a country's defense expenditure.

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