

MATHEMATICAL ANALYSIS OF GOLD AND SHARE INVESTMENTS IN INDIA USING STATISTICS, PROBABILITY AND LINEAR PROGRAMMING

Rhythm Gupta and Aryaman Talwar

Class XII Students

Birla Vidya Niketan, New Delhi, India

(Under the guidance of Ms. Meenakshi Kushwaha, Principal, and Mr. Neeraj Choudhary, PGT Mathematics, Birla Vidya Niketan, New Delhi, India)

Abstract : Investment decisions involve choosing between financial alternatives that differ in their potential returns and associated levels of risk. In India, gold and shares are two significant investment avenues. Gold is traditionally associated with preservation of value and comparatively lower fluctuations, whereas shares can offer greater possibilities for growth along with greater exposure to market movements. This research compares these two investment categories using three mathematical concepts from the Class XII curriculum: Statistics, Probability, and Linear Programming. Historical price data for selected shares and gold during May 2026 is examined using statistical measures including mean, percentage return, median, standard deviation and Risk–Return Ratio. Probability is used to study the frequency of positive and negative daily returns and to compare the performance of the selected shares with Gold. Linear Programming is subsequently used to formulate an investment allocation problem subject to specified financial restrictions. The study examines whether combining Gold and shares can provide an appropriate balance between return and risk. The analysis also illustrates the practical use of mathematical techniques in evaluating financial information and developing an investment strategy.

Keywords : Gold Investment, Share Market, Statistics, Probability, Linear Programming, Risk Analysis, Portfolio Optimization, Investment Decision-Making, India.

I. INTRODUCTION

Investment is an important part of financial planning and can contribute towards wealth creation over time. In India, gold has traditionally held significance as an investment because of its cultural importance, perceived stability and ability to retain value during uncertain economic conditions. Shares, in comparison, represent ownership in companies and can provide returns through capital appreciation as well as dividend income.

An investor therefore has to evaluate more than just the possible return from an investment. Shares may provide comparatively greater growth opportunities, but their prices can fluctuate considerably with changes in market conditions. Gold generally experiences lower fluctuations, although its return may also be lower over particular periods. Recent changes in gold prices have consequently made it useful to compare its performance with that of shares rather than assuming that it will always be the safer alternative.

Mathematical methods provide a systematic way to carry out this comparison. Statistics can be used to study average prices, returns and variability. Probability can be applied to measure the likelihood of different daily outcomes. Linear Programming can then be used to determine an allocation of limited funds while taking specified restrictions into account.

This research therefore studies gold and selected shares from a mathematical perspective and examines how these concepts can assist in analysing investment choices.

II. CASE STUDY

Comparative Analysis of Shares and Gold Using Statistics and Probability

Background

An investor may wish to compare shares and gold in terms of both their returns and the stability of their performance. For this purpose, historical price data of three shares belonging to different sectors and one gold-based investment was collected for May 2026.

The selected investments were:

- Banking Sector – HDBK
- Information Technology Sector – INFY
- Automobile Sector – TAMO
- Gold Investment – GBES

The objective was to compare their performance using statistical measures and probability analysis.

III. STATISTICAL ANALYSIS

A. Mean Price

The mean gives the arithmetic average of the prices observed during the selected period.

Table 1: Mean price of selected investments

Investment	Mean Price
HDBK	769.02
INFY	1160.83
TAMO	359.21
GBES	127.77

The calculated mean provides an indication of the typical trading value of each investment over the study period.

B. Standard Deviation

Standard deviation indicates how widely the observed prices vary around their mean. It is therefore useful for comparing the degree of volatility associated with the selected investments.

Table 2: Standard deviation of selected investments

Investment	Standard Deviation
HDBK	14.64
INFY	26.20
TAMO	18.48
GBES	3.41

Interpretation

- GBES had the lowest standard deviation.
- INFY had the highest standard deviation.

The results indicate that Gold experienced the smallest variation in its observed prices, while INFY showed the greatest degree of fluctuation among the four investments.

C. Median Price

The median is the central value obtained after arranging the observed price data in ascending order.

Table 3: Median price of selected investments

Investment	Median Price
HDBK	767.50
INFY	1167.70
TAMO	358.15
GBES	129.41

Interpretation

The median values are relatively close to their corresponding mean values for all four investments. This suggests that the price observations were not strongly influenced by extreme values. Consequently, the mean values provide a reasonable indication of the typical prices during the period examined.

D. Percentage Return

Percentage return indicates the overall change in the value of an investment during the study period.

Table 4: Percentage return of selected investments

Investment	Percentage Return (%)
HDBK	-4.47
INFY	-0.64
TAMO	14.82
GBES	5.12

Interpretation

- TAMO recorded the highest return of **14.82%**, making it the best-performing investment during the study period.
- GBES generated a positive return of **5.12%**, indicating moderate growth with lower volatility.
- HDBK and INFY experienced negative returns of **4.47%** and **0.64%** respectively.
- Based solely on returns, TAMO outperformed both gold and the other selected shares.

E. Risk–Return Ratio

The Risk–Return Ratio indicates the amount of return generated in relation to the risk undertaken. In this analysis, standard deviation is considered as the measure of risk.

Table 5: Risk–return ratio of selected investments

Investment	Risk–Return Ratio
HDBK	-0.31
INFY	-0.02
TAMO	0.80
GBES	1.50

Interpretation

- GBES achieved the highest Risk–Return Ratio (**1.50**), indicating the most efficient return relative to risk.
- TAMO ranked second with a ratio of 0.80, providing strong returns but with higher volatility than GBES.
- HDBK and INFY produced negative ratios because they generated negative returns during the study period.
- Although TAMO delivered the highest overall return, GBES provided the best risk-adjusted performance, demonstrating that gold offered a more favorable balance between risk and return during May 2026.

F. Conclusion from Statistical Analysis

The statistical results show that TAMO achieved the highest percentage return of 14.82%, making it the strongest investment when performance is considered in terms of overall return. In contrast, GBES recorded the lowest standard deviation of 3.41 and the highest Risk–Return Ratio of 1.50, indicating comparatively greater stability and efficiency.

The close relationship between the mean and median values also indicates that the data was not substantially affected by extreme observations. Overall, the results show that shares offered greater potential for growth in the selected period, whereas Gold displayed lower volatility and comparatively more consistent performance.

IV. PROBABILITY ANALYSIS

A. Probability of Positive and Negative Returns

The daily returns of each investment are considered in order to determine how frequently positive and negative movements occurred.

- Number of days with a positive return
- Number of days with a negative return

P(Positive Return) = Number of Positive Days / Total Number of Days

P(Negative Return) = Number of Negative Days / Total Number of Days

Table 6: Probability of positive and negative returns

Investment	Positive Days	Negative Days	Total Days	P(Positive)	P(Negative)
HDBK	8	11	19	8/19 = 0.42	11/19 = 0.58
INFY	8	11	19	8/19 = 0.42	11/19 = 0.58
TAMO	12	6	19*	12/19 = 0.63	6/19 = 0.31
GBES	9	10	19	9/19 = 0.47	10/19 = 0.53

*TAMO had one day where the price remained constant.

Interpretation

TAMO recorded the highest probability of a positive daily return. Since 12 out of 19 observed days had positive returns:

P(Positive Return) = 12/19 = 0.6316 = 63.16%

- GBES produced positive returns on 47.37% of the trading days. Although this was lower than TAMO's probability, its daily price movements were considerably smaller.
- HDBK and INFY each recorded positive returns on 42.11% of the trading days. Therefore, negative-return days occurred more frequently than positive-return days for both investments.
- From the probability perspective, TAMO showed the greatest likelihood of a positive daily return, while GBES remained comparatively more stable despite its lower probability of gains.

B. Probability of Outperforming Gold

The daily percentage return of each selected share was compared with the return of GBES for the corresponding trading day.

Table 7: Probability of outperforming gold

Investment	Days Better than GBES	Total Days	Probability
HDBK	7	19	7/19 = 0.37
INFY	8	19	8/19 = 0.42

Investment	Days Better than GBES	Total Days	Probability
TAMO	12	19	$12/19 = 0.63$

Interpretation

- TAMO generated a return higher than Gold on 12 out of 19 trading days, giving a probability of $12/19 = 0.63$, or 63.16%.
- INFY performed better than Gold on 8 out of 19 days, corresponding to $8/19 = 0.42$, or 42.11%.
- HDBK exceeded the return of Gold on 7 out of 19 days, giving a probability of $7/19 = 0.37$, or 36.84%.
- The comparison indicates that Gold displayed greater consistency, whereas TAMO had the greatest frequency of daily returns above those of Gold.

C. Conclusion from Probability Analysis

The probability results support the main observations obtained from the statistical analysis. TAMO had the greatest probability of recording positive daily returns and also exceeded Gold on the largest proportion of the observed trading days. This is consistent with its highest overall percentage return.

GBES, despite having fewer positive-return days, showed comparatively stable daily movements because of its lower volatility. Therefore, the probability analysis highlights the difference between the frequency of favourable returns and the stability of those returns.

V. LINEAR PROGRAMMING

A. Introduction

Linear Programming (LPP) is a mathematical method used to obtain the most suitable value of an objective while satisfying a defined set of restrictions. It is useful in situations where limited resources have to be distributed efficiently.

In this study, the results obtained from the statistical analysis are used to formulate an investment allocation problem involving Gold (GBES) and Tata Motors (TAMO).

B. Problem Statement

The statistical analysis showed that Tata Motors (TAMO) achieved the highest percentage return, whereas Gold (GBES) recorded the lowest volatility and the highest risk-adjusted return.

Suppose an investor has ₹1,00,000 available for investment. The problem is to determine the allocation of this amount between Gold and Tata Motors so that the expected return is maximised while all the specified restrictions are satisfied.

C. Mathematical Formulation

Let:

- x = Amount invested in Gold (GBES)
- y = Amount invested in Tata Motors (TAMO)

Objective Function

The percentage return observed during the study period for Gold (GBES) was 5.12%, while Tata Motors recorded a return of 14.82%. These values are used as the coefficients in the objective function. Therefore, the objective function is

$$\text{Maximise } Z = 0.0512x + 0.1482y$$

where Z represents the total expected return.

Constraints

The following constraints are considered:

- Total investment should not exceed ₹1,00,000.

$$x + y \leq 100000$$

- At least ₹30,000 should be invested in Gold to ensure stability.

$$x \geq 30000$$

- Investment in Tata Motors should not exceed ₹70,000 to reduce risk.

$$y \leq 70000$$

- The investment amounts cannot be negative.

$$x \geq 0, y \geq 0$$

D. Feasible Region

The above constraints form the feasible region. The corner points of the feasible region are:

Table 8: Corner points of the feasible region

Corner Point	x	y
A	30000	0
B	30000	70000
C	100000	0

E. Evaluation of the Objective Function

Table 9: Evaluation of the objective function at corner points

Corner Point	Value of Z (₹)
A (30000, 0)	1536
B (30000, 70000)	11910
C (100000, 0)	5120

F. Graphical Representation

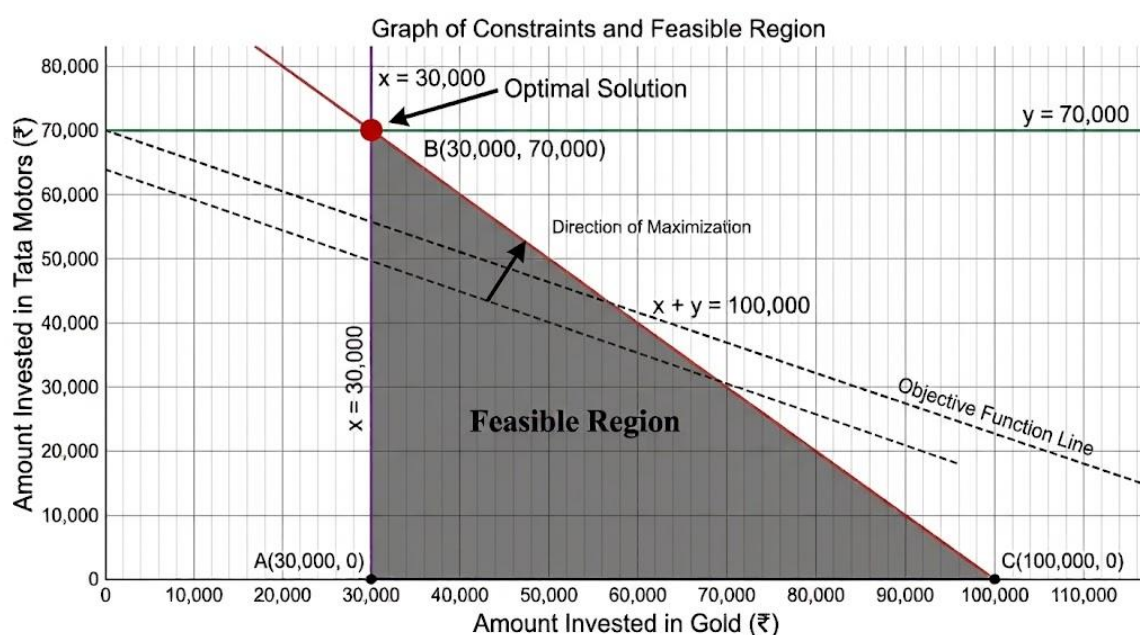


figure 1. graph of constraints and feasible region

The graph represents the feasible region obtained from the given constraints. The objective-function line is moved parallel to itself in the direction in which the value of Z increases. The maximum value is reached when the objective-function line touches the feasible region at point B (₹30,000, ₹70,000).

Hence, the optimal allocation is ₹30,000 in Gold (GBES) and ₹70,000 in Tata Motors (TAMO). This combination gives the maximum expected return while continuing to satisfy all the constraints.

G. Optimal Solution

The maximum value of the objective function is obtained at Point B (30000, 70000).

Therefore, the optimum investment strategy is to invest ₹30,000 in Gold (GBES) and ₹70,000 in Tata Motors (TAMO). This allocation gives the highest expected return among the feasible solutions while satisfying the specified restrictions.

H. Interpretation

The Linear Programming model identifies ₹30,000 in Gold and ₹70,000 in Tata Motors as the optimum allocation. This combination gives the maximum estimated return among the permissible investment combinations. The model demonstrates how an investment decision can be represented mathematically by combining the expected returns of different assets with restrictions on the amount that can be invested in each.

VI. APPLICATION OF THE LINEAR PROGRAMMING MODEL

A. Introduction

The Linear Programming model can be extended to investors having different amounts of available capital. Although the original model was developed for an investment of ₹1,00,000, the same mathematical allocation can be applied proportionally to other investment amounts.

Three hypothetical investors with different budgets are considered below to demonstrate the application of the model.

B. Case 1: Student Investor

Profile

A college student has savings of ₹20,000 and wishes to earn higher returns while also retaining a portion of the investment in a relatively stable asset.

Investment Strategy

Using the optimal allocation obtained from the Linear Programming model:

- Gold (30%) = ₹6,000
- Tata Motors (70%) = ₹14,000

Expected Return

$$Z = 0.0512(6000) + 0.1482(14000) = 307.20 + 2074.80 = ₹2,382$$

Interpretation

Even though the amount available to the student is smaller, the same investment proportion can be maintained. A larger share is allocated to Tata Motors because of its higher observed return, while the remaining portion is invested in Gold.

C. Case 2: Salaried Professional

Profile

A working professional has ₹1,00,000 available for investment and wishes to seek higher returns while keeping the portfolio within the specified risk conditions.

Investment Strategy

According to the Linear Programming solution:

- Gold (30%) = ₹30,000
- Tata Motors (70%) = ₹70,000

Expected Return

$$Z = 0.0512(30000) + 0.1482(70000) = 1536 + 10374 = ₹11,910$$

Interpretation

The larger portion of the capital is directed towards Tata Motors because it recorded the higher historical return. At the same time, ₹30,000 is retained in Gold in accordance with the investment constraint and its comparatively lower volatility.

D. Case 3: High-Net-Worth Investor

Profile

An experienced investor has ₹5,00,000 available for investment and wishes to apply the same allocation strategy.

Investment Strategy

Applying the same optimal allocation:

- Gold (30%) = ₹1,50,000
- Tata Motors (70%) = ₹3,50,000

Expected Return

$$Z = 0.0512(150000) + 0.1482(350000) = 7680 + 51870 = ₹59,550$$

Interpretation

When the total amount invested increases, the expected return also increases proportionally because the investment proportions remain unchanged. This illustrates that the Linear Programming approach can be applied to different scales of investment.

E. Comparative Analysis

Table 10: Comparative analysis across investor profiles

Investor	Investment Budget (₹)	Gold Investment (₹)	Tata Motors Investment (₹)	Expected Return (₹)
Student Investor	20,000	6,000	14,000	2,382
Salaried Professional	1,00,000	30,000	70,000	11,910
High Net-Worth Investor	5,00,000	1,50,000	3,50,000	59,550

F. Findings

The case studies demonstrate that the Linear Programming model can be used for investors with different amounts of available capital. Irrespective of the size of the investment, the model maintains the same allocation of 30% to Gold (GBES) and 70% to Tata Motors (TAMO), based on the historical data used in the research.

Gold contributes to the stability of the allocation because of its relatively lower volatility, while Tata Motors contributes a larger expected return because of its stronger historical performance. Thus, the model provides a mathematical framework that can be applied to different financial situations.

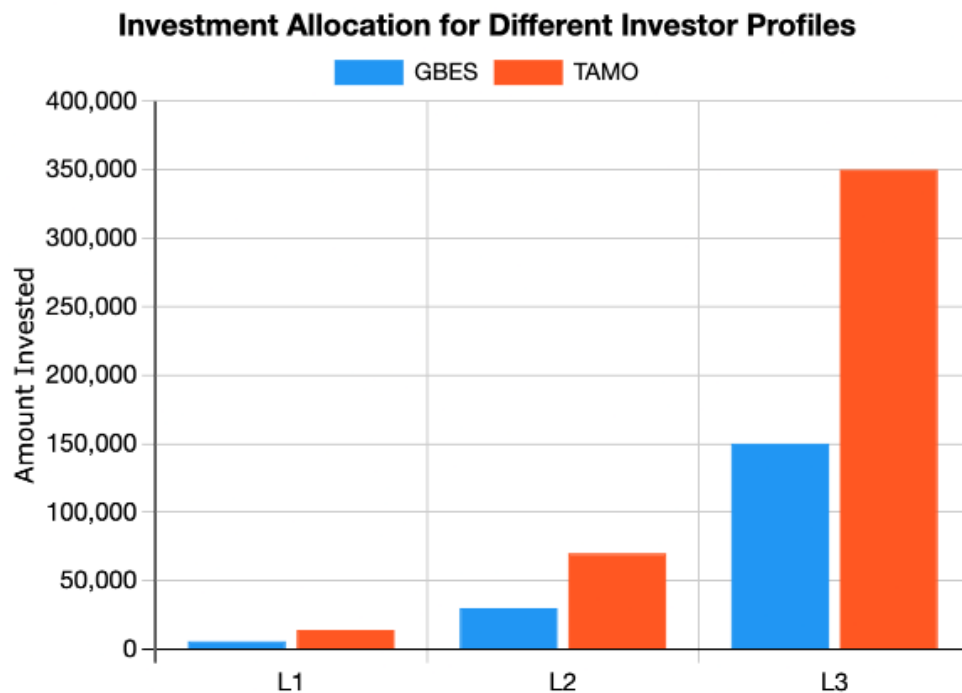


figure 2. investment allocation for different investor profiles (student, salaried professional, and high-net-worth investor)

VII. CONCLUSION

This study examined the performance and investment potential of selected Indian financial assets through the mathematical tools of Statistics, Probability and Linear Programming. Historical market data collected for May 2026 was used to analyse the behaviour of the selected investments and to construct an investment allocation model.

The statistical analysis showed differences in both returns and levels of risk among the four investments. Tata Motors (TAMO) recorded the highest percentage return during the period under consideration, while Gold ETFs (GBES) displayed the lowest volatility and the highest Risk–Return Ratio. HDBK and INFY recorded negative returns during the selected period, while their levels of variation were greater than those observed for Gold. These results demonstrate why both return and risk need to be considered when comparing investment alternatives.

The probability analysis provided further support for these observations. TAMO showed the highest probability of positive daily returns, while Gold continued to display comparatively stable movements and lower volatility. TAMO recorded positive returns on 12 out of 19 observed days:

$$P(\text{Positive Return}) = 12/19 = 0.6316 = 63.16\%$$

The comparison with Gold also showed that TAMO exceeded Gold's daily return on 12 out of 19 days. This indicates that TAMO had a greater frequency of superior daily performance during the selected period, although Gold remained the more stable investment.

The results were then incorporated into a Linear Programming model to determine an appropriate allocation of ₹1,00,000. Under the constraints specified in the model, the optimum allocation was identified as 30% of the capital in Gold and 70% in Tata Motors. The corresponding investment amounts are ₹30,000 in Gold and ₹70,000 in Tata Motors.

The application of the same allocation to different hypothetical investors demonstrated that the model can be scaled according to the amount of available capital. The expected return increases as the investment amount increases while the 30:70 proportion remains constant.

Overall, the study demonstrates the practical application of mathematical concepts to a financial problem. Statistical analysis helps describe investment performance and risk, Probability measures the likelihood of particular outcomes, and Linear Programming assists in determining an allocation of limited resources. Although the study is based on a relatively small set of historical observations, the same approach could be extended in future research by considering larger datasets, additional investments and longer periods of market activity.

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