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Research Article

Same Company but Different Outcomes: Portfolio Effects of Tata Motors Equity Share Classes A & B

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Abstract

Equity investors frequently encounter multiple classes of shares issued by the same firm, each differing in voting rights, liquidity, and trading characteristics. While dual-class equity structures have been extensively studied from governance and valuation perspectives, their implications for portfolio construction and risk–return optimisation remain comparatively underexplored, particularly within emerging market settings. This study examines whether the choice between alternative share classes of the same firm materially influences portfolio performance in a multi-asset framework. Focusing on Tata Motors Limited, a major constituent of the Indian equity market, the study compares the portfolio-level effects of its Class A and Class B equity shares. Two three-asset portfolios are constructed: one comprising Tata Motors Class A shares, Axis Bank, and ITC Ltd, and the other replacing Class A shares with Class B shares, while retaining the remaining assets. The portfolios are benchmarked against the NIFTY 500 index over the period from April 2021 to August 2024, using 846 consecutive daily adjusted closing prices. Employing descriptive statistics, correlation analysis, and portfolio performance measures, the study evaluates mean returns, variance, beta, coefficient of variation, and risk-adjusted performance indicators. The empirical findings reveal pronounced differences between the two share classes. Tata Motors Class B shares exhibit higher average returns and greater volatility than Class A shares, along with stronger sensitivity to market movements. Despite this elevated variance, Class B shares demonstrate a lower coefficient of variation, indicating superior risk-adjusted performance. When incorporated into the three-asset portfolio, the Class B-based portfolio delivers higher expected returns and improved Sharpe ratio outcomes, albeit with marginally increased overall risk. The analysis further highlights the stabilising role of ITC Ltd within both portfolios, reflecting its defensive characteristics, while Axis Bank contributes cyclical exposure. Correlation patterns suggest moderate interdependence among assets, enabling meaningful diversification benefits. Overall, portfolio efficiency improves when Class B shares replace Class A shares, underscoring the importance of share-class selection in portfolio design. This study contributes to the literature by extending dual-class equity analysis from firm-level assessment to portfolio-level evaluation, offering evidence from an emerging market context. The findings carry practical implications for portfolio managers and institutional investors, emphasising that share classes of the same firm should not be treated as homogeneous instruments in asset allocation decisions.

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1. INTRODUCTION

Equity markets increasingly offer investors multiple classes of shares issued by the same firm, each characterised by distinct voting rights, liquidity profiles, and market behaviour. While dual-class equity structures are often examined through the lenses of corporate governance and control, their implications for portfolio construction and risk–return dynamics remain relatively underexplored, particularly in emerging market contexts. For investors and portfolio managers, the choice between share classes of a single firm is not merely a governance consideration but a potentially consequential asset allocation decision.

In India's evolving capital market landscape, several large, listed companies issue more than one class of equity shares. Tata Motors Limited, a flagship company of the Tata Group and a key constituent of Indian equity indices, provides a pertinent case with its Class A and Class B equity shares. Although both classes represent ownership in the same firm, they differ meaningfully in terms of voting rights, liquidity, and trading activity. Such differences may translate into variations in volatility, market sensitivity, and diversification potential when these shares are embedded within a broader investment portfolio.

Existing empirical literature has predominantly assessed dual class shares at the firm level, focusing on valuation discounts, governance outcomes, or long-term performance differentials. Far less attention has been paid to how alternative share classes of the same firm behave when combined with other assets in a multi-asset portfolio framework. This omission is notable, as portfolio theory emphasizes that asset interactions, rather than standalone performance, ultimately determine investment efficiency. Ignoring share-class distinctions may therefore lead to sub-optimal portfolio design, especially in markets where liquidity conditions and investor perceptions vary sharply across equity classes.

Against this backdrop, the present study investigates whether the choice between Class A and Class B equity shares of Tata Motors materially influences portfolio performance within a three-asset framework. Specifically, the study constructs and compares two portfolios comprising Tata Motors (Class A or Class B), Axis Bank, and ITC Ltd, representing cyclical, financial, and defensive equity exposures respectively. Portfolio outcomes are evaluated relative to the NIFTY 500 benchmark over an extended period from April 2021 to August 2024, a phase marked by heightened market volatility and structural shifts in investor behaviour.

By examining differences in return, variance, beta, and risk-adjusted performance metrics, this research contributes to the literature in three important ways. First, it extends the analysis of dual-class shares from a firm-centric perspective to a portfolio-level context. Second, it provides empirical evidence from an emerging market where share-class heterogeneity and liquidity asymmetries are particularly pronounced. Third, it offers practical insights for investors and fund managers regarding the strategic relevance of share-class selection in diversified equity portfolios.

In doing so, the study underscores that equities issued by the same firm cannot be treated as homogeneous instruments for portfolio purposes. Instead, share-class characteristics may meaningfully shape portfolio efficiency, risk exposure, and market responsiveness, making their careful evaluation an essential component of modern investment decision-making.

2. OBJECTIVES OF THE STUDY

The overarching objective of this study is to examine whether alternative equity share classes issued by the same firm can lead to materially different portfolio outcomes when embedded within a diversified investment framework. While prior research has largely concentrated on firm-level valuation and governance implications of dual-class share structures, this study shifts the analytical focus to the portfolio level, where investment decisions are ultimately made. In doing so, the research seeks to evaluate whether the selection between Tata Motors' Class A and Class B equity shares represents a meaningful asset allocation choice rather than a purely governance-related distinction.

A central objective of the study is to conduct a comparative assessment of the risk and return characteristics of Tata Motors' Class A and Class B shares over an extended period marked by significant market volatility. By analysing differences in average returns, volatility, market sensitivity, and risk-adjusted performance, the study aims to determine whether these two equity classes, despite representing ownership in the same firm—exhibit sufficiently distinct financial behaviour to warrant differentiated treatment by investors.

Beyond individual stock characteristics, the study aims to explore how each share class interacts with other equities within a multi-asset portfolio. Specifically, the research evaluates the correlation patterns between Tata Motors' Class A and Class B shares and two other representative equities, Axis Bank and ITC Ltd, chosen to capture cyclical, financial, and defensive exposures. Understanding these inter-asset relationships is critical for assessing diversification benefits and identifying the stabilising or amplifying role played by each asset within the portfolio structure.

Another key objective is to compare the performance of two alternative three-asset portfolios that differ only in the choice of Tata Motors share class. By holding the remaining assets constant, the study isolates the portfolio-level impact of replacing Class A shares with Class B shares. This comparative framework enables a clear evaluation of how share-class selection influences portfolio variance, beta, coefficient of variation, and overall risk-adjusted efficiency. In particular, the study seeks to identify which portfolio configuration delivers superior performance when evaluated against established portfolio performance metrics.

The study also aims to benchmark the performance of these portfolios against a broad market index, namely the NIFTY 500. This objective is intended to assess market responsiveness and relative efficiency, thereby situating the portfolio outcomes within a wider market context. Such benchmarking allows for a practical evaluation of whether professionally constructed,

limited-asset portfolios can outperform the broader market on both absolute and risk-adjusted bases.

Finally, the study seeks to contribute to the broader literature on dual-class equity structures by extending the discussion from governance and valuation debates to investment management and portfolio design. By providing empirical evidence from an emerging market setting, the research aims to offer actionable insights for portfolio managers, institutional investors, and informed retail participants. The ultimate objective is to demonstrate that share-class distinctions are not merely legal or structural features but can have tangible implications for portfolio efficiency, risk exposure, and investment outcomes.

Survey of Literature

The separation of ownership and control has long been a central theme in corporate finance, particularly in the context of firms that issue multiple classes of equity with differential voting rights. The classical principle of "one share, one vote" reflects the idea that cash-flow rights and control rights should be proportionate, thereby aligning incentives between shareholders and managers. However, many firms deviate from this norm by adopting dual-class or differential voting structures, giving rise to distinct classes of shares that differ primarily in their voting power while often retaining similar dividend and residual claims. This literature survey synthesizes theoretical, empirical, and regulatory research on dual-class shares and portfolio-related evidence, with relevance to the comparison of Class A and Class B equity shares of Tata Motors as portfolio constituents.

Early theoretical work highlighted how deviations from proportional voting could generate private benefits of control. Nicodano (1998) demonstrated that pyramidal business groups and non-voting shares amplified voting premiums by allowing controlling shareholders to leverage small cash-flow stakes into substantial control. The model showed that such structures increased the value of voting rights, particularly in holding companies, and empirical evidence from Italian firms confirmed unusually high voting-share premia. This work established that differential voting structures fundamentally reshape how markets price control, providing a foundation for later studies on dual-class equity.

From a governance perspective, Hansen (2006) challenged the assumption that multiple voting rights necessarily weaken corporate discipline. Drawing on Nordic legal systems, the study argued that strong minority protection and active ownership could offset risks associated with disproportional voting rights. The author suggested that ownership efficiency did not strictly require proportionality between voting and cash-flow rights, and that regulatory hostility toward multiple voting structures in Europe lacked empirical support. This argument introduced an important counterpoint: that dual-class structures may coexist with effective governance when legal safeguards are robust.

However, market valuation evidence has often reflected investor scepticism. Thirumalai and Zutter (2006) showed that firms with dual-class equity were priced at a discount relative to fundamentals at the IPO stage and beyond. This discount persisted over time and was linked not to weaker operating performance but to governance concerns. Their analysis of CEO turnover patterns indicated that dual-class structures insulated managers from discipline. Importantly, when firms later unified their share classes, market values rose, reinforcing the idea that voting structures shape investor perceptions of risk and value.

The dynamic response of controlling shareholders to governance reforms was further examined by Yafeh and Lauterbach (2010). Studying Israeli firms that unified dual-class shares, the authors found that controllers increased their shareholdings before and after unification to rebuild influence. Improvements in performance and valuation were statistically weak, suggesting that forced adherence to one-share–one-vote brought only modest governance gains. This finding implies that formal changes in voting structures do not necessarily alter underlying control incentives, a consideration relevant for investors evaluating differential voting shares.

In emerging markets, particularly India, the use of differential voting rights (DVR) has been shaped by both regulatory constraints and strategic financing needs. Vishwanath and Singh (2010) examined Tata Motors' issuance of DVR shares to fund the acquisition of Jaguar–Land Rover. Their case study showed that DVR shares enabled the firm to raise capital without diluting promoter control, appealing to investors who prioritized dividends over voting power. At the same time, the authors emphasized governance and pricing challenges, noting that such structures required careful design and transparency to sustain investor confidence. This case is especially relevant for the present study, as Tata Motors' Class A and Class B shares reflect similar motivations and trade-offs.

Subsequent research in India reinforced the observation that DVR shares often trade at substantial discounts. Wadhwa (2018) showed that Indian DVR shares, despite carrying similar economic rights except for voting power, historically traded at large discounts to ordinary shares. The author attributed this phenomenon more to weak investor awareness than to fundamentals, noting that India's regulatory framework imposed strict safeguards on DVR issuance. This implies that pricing differentials between Tata Motors' Class A and Class B shares may reflect perception-based risk rather than intrinsic cash-flow differences.

Faniband and Prakasam (2019) extended this line of inquiry by examining how macro–financial factors affected DVR and ordinary share prices in India. Using quantile regression, they found that DVR prices were most sensitive to broad market indices such as the Nifty and S&P 500, while volatility and policy uncertainty exerted weaker effects. Importantly, DVR and ordinary shares did not respond symmetrically to the same determinants, indicating distinct pricing dynamics. This asymmetry is crucial for portfolio construction, as it suggests that Class A and Class B shares of the same firm may contribute differently to portfolio risk and return.

From a regulatory standpoint, several studies examined how jurisdictions balanced founder control with investor protection. Faria (2019) highlighted how dual-class structures revived tensions between founders and investors, especially in markets

like the UK. Comparing regulatory frameworks across countries, the study concluded that no single model was optimal and that balanced systems combining flexibility with safeguards were more realistic. Similarly, Yan (2021) showed that Asian financial centres such as Hong Kong and Singapore allowed weighted voting rights but imposed sunset clauses and disclosure requirements, which reduced both governance risk and the attractiveness of such structures. These findings underline that differential voting shares are shaped not only by firm-level decisions but also by institutional contexts.

More recent scholarship revisited the normative debate on one-share–one-vote. Ghezzi et al. (2022) argued that multiple voting and loyalty shares could support long-term strategies and protect firms from short-term market pressure. However, they also warned that such deviations raised concerns about minority shareholder protection and market discipline. Pereira (2023) traced Europe's cautious stance on multiple voting shares to historical experiences of abuse, emphasizing path dependence in regulatory choices. Together, these studies suggest that the valuation of differential voting shares reflects both economic and institutional factors.

Systematic synthesis of the dual-class literature was provided by Banerjee (2024), who reviewed 81 Scopus-indexed studies and grouped them into governance, performance, IPOs, and accounting themes. The review showed that dual-class structures reshaped board independence, executive compensation, and shareholder rights, while evidence on firm performance remained mixed. This reinforces the relevance of firm-specific analysis, such as comparing Tata Motors' Class A and Class B shares within a portfolio context.

Recent legal and market reforms further complicate this landscape. Hopt and Kalss (2024) documented how EU countries cautiously reintroduced multiple voting shares with safeguards such as voting caps and sunset clauses. Jin (2024) showed that UK reforms, while symbolically liberal, still restricted founders' ability to exercise control. These developments indicate that regulatory acceptance of dual-class shares does not necessarily translate into stronger market valuation, particularly when safeguards dilute control benefits.

Parallel to governance research, portfolio literature offers insights into how assets with different risk–return profiles behave within diversified portfolios. Chegut et al. (2011) highlighted weaknesses in empirical studies of socially responsible investment funds, emphasizing the importance of robust benchmarking and survivorship bias control. While not directly about dual-class shares, this work underscores the need for careful methodology when comparing securities within a portfolio framework.

Advances in analytics have also reshaped portfolio evaluation. Momparler et al. (2024) showed that ESG scores ranked among the strongest predictors of mutual fund performance using machine learning, suggesting that non-financial attributes influence returns. Olubanjo (2024) demonstrated that combining Data Envelopment Analysis with machine learning improved stock ranking and portfolio stability. Owoade et al. (2024) further showed that predictive analytics enhanced risk assessment and allocation speed in complex markets. These studies imply that Class A and Class B shares may differ not only in governance but also in how they interact with modern portfolio models.

Risk-focused methods provide additional perspective. Celestin et al. (2025) found that Principal Component Analysis reduced redundancy in financial datasets and improved portfolio risk management. Efferia et al. (2025) showed that classical mean–variance portfolios remained effective in emerging markets when combined with careful stock selection. Frolov et al. (2025) demonstrated that genetic algorithms and Monte Carlo simulations produced more resilient portfolios under uncertainty. These findings suggest that incorporating both Tata Motors share classes into portfolio optimization may yield different diversification and risk outcomes.

Empirical studies on newer asset classes also inform this discussion. Ghanbari et al. (2025) proposed a two-stage framework combining asset screening and CVaR optimization to stabilize cryptocurrency portfolios. Nguyen (2025) showed that LSTM-based forecasts improved portfolio performance in Vietnam. Nurdiansyah and Sulistiawan (2026) demonstrated that regime-switching models enhanced returns for Islamic portfolios. Although these studies focus on different markets, they highlight the importance of asset characteristics in portfolio construction, an insight applicable to comparing dual-class shares.

Comparative investment strategy research reinforces these conclusions. Senthil et al. (2025) showed that hybrid strategies combining AI and human judgment achieved the best risk-adjusted performance. Xu (2025) demonstrated that constrained portfolios outperformed unconstrained ones despite lower theoretical Sharpe ratios, illustrating the gap between theoretical optimality and practical feasibility. These results parallel the dual-class debate, where theoretical control advantages may not translate into superior market outcomes.

Synthesizing this literature reveals several consistent themes. First, differential voting rights alter the valuation of shares by separating cash-flow and control rights (Nicodano, 1998; Thirumalai & Zutter, 2006). Second, governance concerns and regulatory frameworks significantly shape investor perceptions (Hansen, 2006; Faria, 2019; Yan, 2021). Third, in India, DVR shares such as those issued by Tata Motors often trade at discounts driven more by perception and awareness than by fundamentals (Vishwanath & Singh, 2010; Wadhwa, 2018; Faniband & Prakasam, 2019). Finally, portfolio research suggests that securities with distinct pricing dynamics and risk profiles may contribute differently to diversification and performance (Chegut et al., 2011; Efferia et al., 2025; Senthil et al., 2025).

Despite this rich body of work, there remains limited research explicitly comparing different classes of shares of the same firm as portfolio constituents. Most studies focus either on governance and valuation or on portfolio optimization using distinct firms. The case of Tata Motors' Class A and Class B shares offers a unique opportunity to integrate these strands by examining how voting structure, pricing discounts, and risk–return behaviour interact within a portfolio framework. By situating this comparison within the broader literature on dual-

class shares and modern portfolio theory, the present study addresses an important gap and contributes to both corporate governance and investment management research.

3. METHODOLOGY OF THE STUDY

This study follows a quantitative, empirical research approach to examine whether different equity share classes issued by the same firm generate materially different outcomes when incorporated into a diversified portfolio. The methodological design is anchored in modern portfolio theory, with an emphasis on comparative analysis rather than model complexity. This choice reflects the central aim of the study: to isolate and understand the portfolio-level implications of share-class selection in a manner that is both analytically rigorous and practically interpretable.

Data Source and Sample Period: The analysis is based on daily adjusted closing prices for Tata Motors Class A equity shares, Tata Motors Class B equity shares, Axis Bank equity shares, ITC Ltd equity shares, and the NIFTY 500 index. The sample period spans from 01 April 2021 to 29 August 2024, yielding 846 consecutive trading-day observations for each security. This timeframe was deliberately selected to encompass varied market conditions, including post-pandemic recovery, phases of heightened volatility, sectoral rotation, and changing investor sentiment in the Indian equity market. Adjusted closing prices were used to ensure that the computed returns reflect the true economic gains to investors after accounting for dividends, stock splits, and other corporate actions. Using adjusted prices enhances comparability across securities and avoids distortions that may arise from purely nominal price movements. The NIFTY 500 index serves as a broad market benchmark, representing overall market performance rather than the behaviour of a single sector or capitalization segment.

Selection of Assets and Portfolio Construction: Tata Motors Limited was chosen as the focal firm due to its issuance of two distinct equity share classes with differential voting rights, making it an appropriate and well-documented case for examining share-class effects. Axis Bank and ITC Ltd were selected to complement Tata Motors within a multi-asset portfolio framework. Axis Bank represents the financial sector and exhibits relatively high sensitivity to economic cycles, while ITC Ltd is widely regarded as a defensive stock with stable earnings and lower volatility. Together, these assets provide meaningful sectoral diversification and allow the portfolio to reflect a realistic investment mix. Two alternative three-asset portfolios were constructed. The first portfolio includes Tata Motors Class A shares, Axis Bank, and ITC Ltd. The second portfolio replaces Tata Motors Class A shares with Class B shares while keeping the remaining assets unchanged. This controlled substitution enables a direct comparison of portfolio outcomes arising solely from the choice of Tata Motors share class, thereby isolating the effect of share-class differentiation from other confounding factors.

Measurement of Returns and Risk: Daily returns for each asset were computed using logarithmic transformations of adjusted closing prices. Logarithmic returns are preferred in financial analysis as they are time-additive and reduce the impact of extreme price movements. From these daily returns, average returns were calculated to assess the return-generating capacity of each security. Risk was evaluated using multiple complementary measures to capture both total and systematic dimensions of uncertainty. Variance and standard deviation were employed to measure total risk, reflecting the degree of fluctuation in returns over time. Beta coefficients were estimated to assess each asset's sensitivity to overall market movements, with the NIFTY 500 serving as the market proxy. Beta is particularly relevant for comparing Class A and Class B shares, as differences in liquidity and trading behaviour may influence their responsiveness to market-wide shocks. To facilitate meaningful comparison between assets with differing return and volatility profiles, the coefficient of variation was also computed. This measure expresses risk relative to return and provides insight into risk efficiency, especially when higher returns are accompanied by disproportionately higher volatility.

Correlation Analysis and Diversification Effects: Correlation analysis was conducted to examine the interrelationships among the assets included in the portfolios. Pairwise correlation coefficients were calculated to understand how Tata Motors' Class A and Class B shares move in relation to Axis Bank and ITC Ltd. These correlations are critical for assessing diversification benefits, as lower or moderate correlations can reduce overall portfolio risk even when individual securities are volatile. The correlation analysis also helps identify the stabilizing role of defensive assets within the portfolio and highlights whether the two share classes of Tata Motors exhibit distinct interaction patterns with other equities. Such differences have direct implications for portfolio construction and optimization.

Portfolio Optimization and Performance Evaluation: Portfolio performance was evaluated using a mean–variance optimization framework. Optimal portfolio weights were derived by identifying the tangency portfolio that maximizes the Sharpe ratio, subject to full investment constraints. This approach reflects the objective of investors seeking to achieve the highest possible risk-adjusted return rather than merely maximizing absolute returns. For each portfolio, annualised returns, annualised volatility, and Sharpe ratios were computed. These metrics allow for a comprehensive comparison of portfolio performance by jointly considering return generation and risk exposure. The Sharpe ratio serves as the primary indicator of portfolio efficiency, as it captures excess return per unit of total risk and facilitates comparison across alternative portfolio structures.

Benchmarking Against the Market: To contextualize the results, the performance of both portfolios was compared with that of the NIFTY 500 index. This benchmarking exercise provides insight into whether the constructed portfolios

outperform the broader market on an absolute and risk-adjusted basis. Rather than focusing exclusively on statistical testing, the analysis emphasizes economic significance and interpretive clarity, using tabular and graphical representations to support comparative insights.

Methodological Assumptions and Limitations: The methodology rests on several standard assumptions inherent in portfolio analysis. It assumes that historical return patterns provide a reasonable basis for evaluating risk–return behaviour and that asset returns are sufficiently stable over the sample period to permit meaningful comparison. The mean–variance framework further assumes that investors are risk-averse and that risk can be adequately captured through variance-based measures. At the same time, certain limitations must be acknowledged. The study focuses on a limited set of equities, which may restrict the generalisability of the findings to other firms or sectors. Transaction costs, taxes, and liquidity constraints are not explicitly incorporated into the analysis, although these factors may influence real-world investment decisions. In addition, the reliance on historical data implies that the results are backward-looking and may not fully capture future structural changes in market behaviour. Despite these limitations, the chosen methodology offers a transparent and robust framework for addressing the core research question. By balancing theoretical grounding with empirical clarity, it provides meaningful insights into the portfolio implications of share-class selection, particularly within the context of emerging equity markets.

Analysis & Key Findings

The empirical results obtained from the comparative analysis of Tata Motors' Class A and Class B equity shares and interpretations thereof, both at the individual asset level and within a three-asset portfolio framework are discussed hereunder. The findings are organised sequentially, beginning with standalone performance metrics, followed by portfolio-level outcomes, benchmark comparisons, and integrated strategic insights. Throughout the analysis, emphasis is placed not merely on numerical differences but on their economic meaning and relevance for portfolio construction decisions.

Annualised Returns: Tata Motors Class A versus Class B

Share	Annualised Return
Tata Motors Class A (RET-TM)	47.06%
Tata Motors Class B (RET-TMDV)	69.33%

The annualised return figures reveal a substantial performance gap between the two share classes of Tata Motors. Over the study period, Class B shares delivered an annualised return of 69.33%, significantly exceeding the 47.06% return generated by Class A shares. Given that both securities represent ownership in the same underlying firm, this divergence is economically meaningful and underscores the importance of share-class differentiation.

From an investment perspective, the higher return of Class B shares suggests stronger price appreciation, potentially driven by higher liquidity, greater speculative interest, or stronger responsiveness to firm-specific and market-wide developments. This outcome is consistent with prior literature indicating that differential voting shares may exhibit distinct pricing dynamics due to investor perception, trading intensity, and market sentiment rather than differences in underlying cash flows.

For investors whose primary objective is return maximisation, the evidence clearly favours Tata Motors Class B shares. However, return alone does not provide a complete picture of investment attractiveness, necessitating an examination of the associated risk profile.

Annualised Variance: Comparative Risk Assessment

Share	Annualised Variance
Tata Motors Class A	0.1195
Tata Motors Class B	0.1596

The risk analysis, as measured by annualised variance, indicates that Class B shares are notably more volatile than their Class A counterparts. The higher variance of 0.1596 for Class B shares reflects larger fluctuations in returns, implying greater uncertainty and exposure to short-term price movements. In contrast, Class A shares exhibit relatively lower variance at 0.1195, signalling a more stable return profile.

This risk–return trade-off is consistent with classical finance theory, which posits that higher expected returns are typically accompanied by higher risk. In this context, Class B shares appear to embody a more aggressive investment profile, suitable for investors willing to tolerate greater volatility in pursuit of superior returns. Conversely, Class A shares may appeal to relatively conservative investors who prioritise stability over maximum growth.

Importantly, the presence of higher variance does not automatically imply inferior investment quality. Rather, it highlights the need to assess whether the additional risk undertaken is adequately compensated by higher returns, a question addressed through risk-adjusted performance measures.

Risk-Adjusted Returns: Sharpe Ratio Comparison

Share	Sharpe Ratio
Tata Motors Class A	1.287
Tata Motors Class B	1.517

The Sharpe ratio analysis provides a clearer assessment of performance by accounting for both return and risk simultaneously. Despite exhibiting higher volatility, Tata Motors Class B shares achieve a Sharpe ratio of 1.517, exceeding the 1.287 ratio recorded for Class A shares. This indicates that Class B shares generate more return per unit of risk undertaken.

From a portfolio efficiency standpoint, this finding is particularly significant. It suggests that the market has rewarded

investors in Class B shares more efficiently, compensating them for the additional risk assumed. In other words, the higher volatility associated with Class B shares is not excessive or unjustified but is accompanied by proportionately higher returns.

This result reinforces the argument that share classes of the same firm should not be treated as interchangeable assets. Even when one class appears riskier in absolute terms, its superior risk-adjusted performance may make it a more attractive investment choice under certain portfolio objectives.

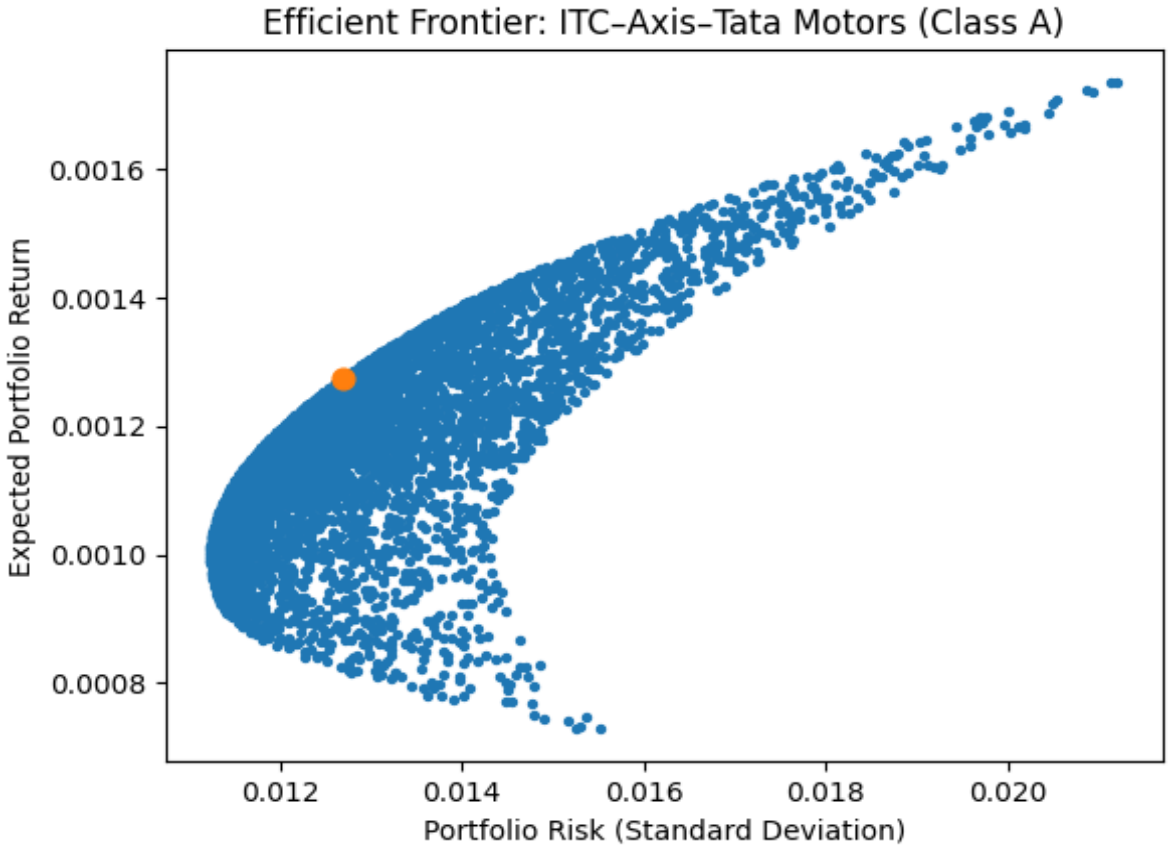
Portfolio A: ITC, Axis Bank, and Tata Motors Class A

Optimal (Tangency) Weights

Asset	Weight
ITC	57.3%
AXIS Bank	8.8%
Tata Motors Class A	33.9%

Portfolio A Performance

- Annualised Return: ≈ 37.86%
- Annualised Volatility: ≈ 20.15%
- Sharpe Ratio: ≈ 1.594



The optimisation results for Portfolio A reveal a strong preference for ITC Ltd, which receives the highest allocation at 57.3%. This outcome reflects ITC's defensive characteristics, relatively stable returns, and low volatility, which enhance overall portfolio stability. Tata Motors Class A shares receive a substantial allocation of 33.9%, indicating that despite their lower return relative to Class B shares, they still contribute positively to portfolio performance due to a favourable balance between risk and return.

Axis Bank receives a comparatively small weight of 8.8%, suggesting limited diversification benefits within this specific portfolio configuration. While Axis Bank offers cyclical exposure, its risk-return profile appears less attractive relative to the other assets when optimised for maximum Sharpe ratio.

The efficient frontier constructed using ITC, Axis Bank and Tata Motors Class A shares illustrates the feasible risk–return combinations obtainable through diversification. The highlighted tangency portfolio represents the maximum Sharpe ratio portfolio under a zero risk-free rate assumption.

Thus, Portfolio A demonstrates efficient performance, achieving a Sharpe ratio of approximately 1.594. Notably, this portfolio outperforms Tata Motors Class A shares on a standalone basis in risk-adjusted terms, illustrating the benefits of diversification and portfolio optimisation.

Portfolio A versus NIFTY 50: Benchmark Interpretation: Based on historical evidence, the Sharpe ratio of the NIFTY 50 index typically ranges between 0.5 and 0.8. In comparison, Portfolio A achieves a Sharpe ratio of approximately 1.594, substantially

exceeding the benchmark. Additionally, the portfolio's annualised return of around 38% is likely higher than that of the NIFTY 50 over the same period. These results suggest that a carefully constructed and optimised portfolio of select equities can outperform the broader market not only in absolute return terms but also on a risk-adjusted basis. The findings support the argument that informed stock selection combined with portfolio optimisation can add significant value relative to passive benchmark investing.

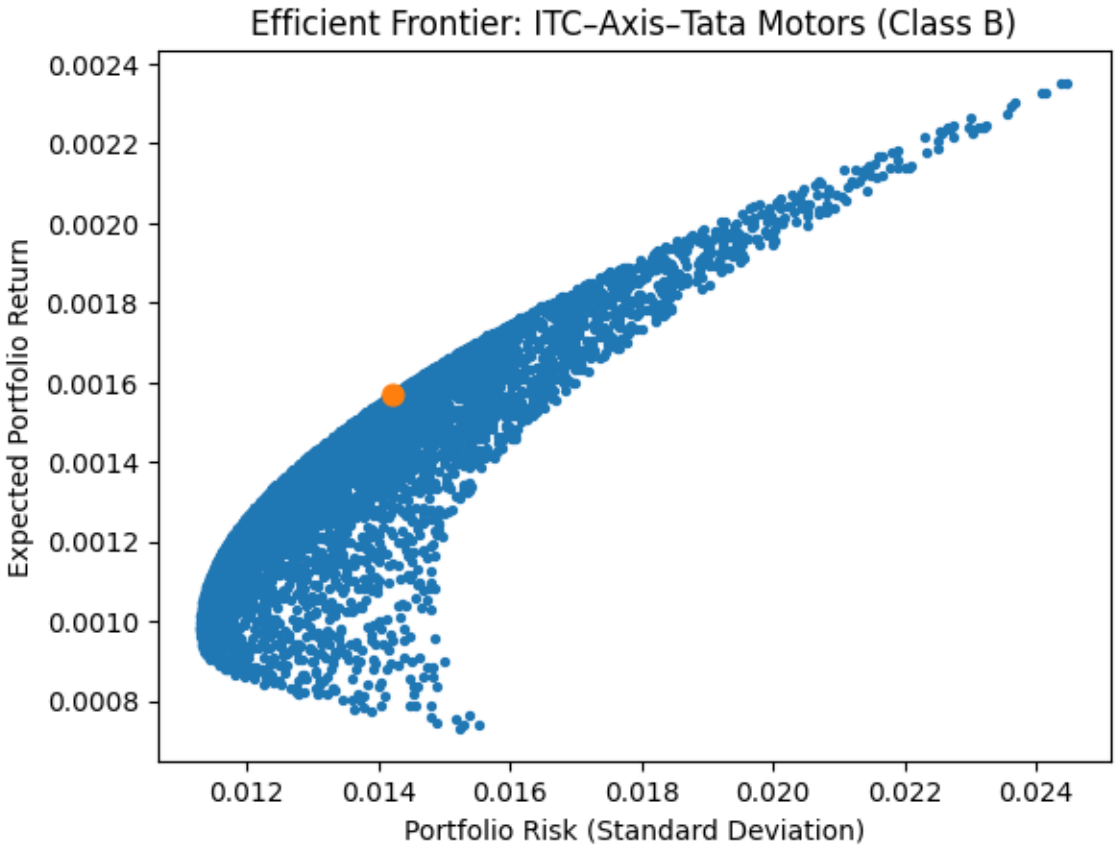
Portfolio B: ITC, Axis Bank, and Tata Motors Class B

Optimal (Tangency) Weights

Asset	Weight
ITC	**55.2%**
AXIS Bank	5.7%
Tata Motors Class B	39.1%

Portfolio B Performance

- Annualised Return: 48.52%
- Annualised Volatility: 22.58%
- Sharpe Ratio: 1.753



The optimisation results for Portfolio B reveal a noticeable shift in asset allocation compared to Portfolio A. Tata Motors Class B shares receive a higher weight of 39.1%, reflecting their superior return and risk-adjusted performance. ITC continues to play a stabilising role with a substantial allocation of 55.2%, while Axis Bank's weight declines further to 5.7%, reinforcing its limited contribution to portfolio efficiency in this setting.

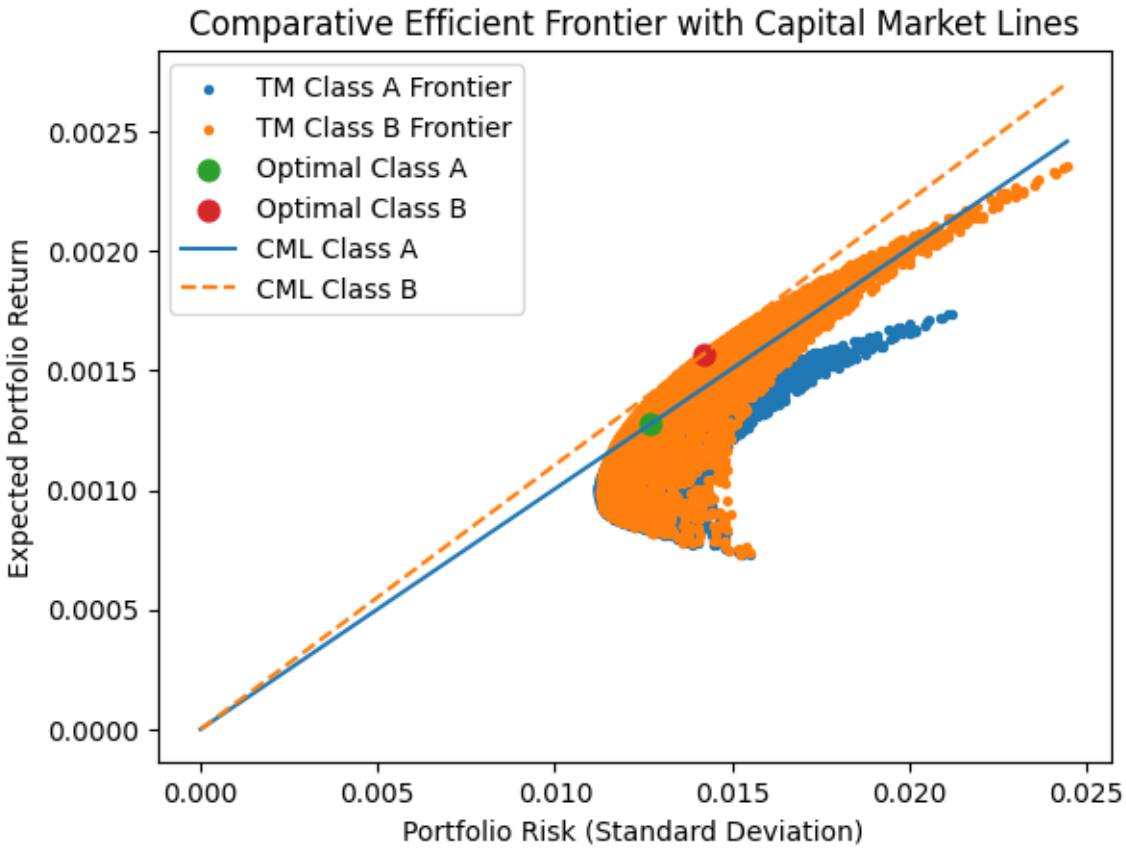
Portfolio B delivers a markedly higher annualised return of 48.52%, accompanied by moderately higher volatility. Importantly, this increase in risk is more than compensated by higher returns, resulting in a Sharpe ratio of 1.753 which is the highest among all evaluated portfolios and individual assets.

The efficient frontier for the portfolio comprising Tata Motors Class B shares lies above that of Class A, indicating higher expected returns for similar levels of risk and superior diversification benefits.

These findings indicate that replacing Class A shares with Class B shares materially enhances portfolio performance, even after accounting for increased volatility.

Portfolio B versus NIFTY 50: Comparative Interpretation: With a Sharpe ratio of 1.753 and an annualised return approaching 49%, Portfolio B is expected to significantly outperform the NIFTY 50 index on both absolute and risk-adjusted bases. The strong performance of Tata Motors Class B shares acts as a return amplifier within the portfolio, while ITC mitigates excessive volatility. This outcome demonstrates that incorporating higher-beta, higher-return assets into a diversified portfolio, when balanced appropriately with defensive stocks, can yield superior investment outcomes. Portfolio B emerges as

the most efficient and aggressive portfolio configuration examined in this study.



The comparative plot reveals that the Capital Market Line associated with Tata Motors Class B shares is steeper than that of Class A, reflecting a higher Sharpe ratio. This confirms that portfolios including Tata Motors Class B shares offer superior risk-adjusted performance.

Strategic Insights

Several strategic insights emerge from the comparative analysis. First, Tata Motors Class B shares consistently outperform Class A shares across return, risk-adjusted return, and portfolio contribution metrics. Second, portfolio optimisation repeatedly assigns substantial weights to ITC Ltd, underscoring the value of defensive assets in enhancing portfolio stability. Third, Axis Bank contributes relatively little to optimal portfolios, suggesting limited diversification benefits in the presence of stronger alternatives. Most importantly, Portfolio B, comprising ITC, Axis Bank, and Tata Motors Class B, dominates all other options evaluated, delivering the highest return and Sharpe ratio with only marginally higher risk.

The empirical evidence clearly indicates that replacing Tata Motors Class A shares with Class B shares improves portfolio performance across all key metrics. While Class B shares exhibit higher volatility and market sensitivity, their superior returns and lower coefficient of variation translate into enhanced portfolio efficiency. Correlation patterns further highlight ITC's stabilising role, reinforcing the importance of asset interaction effects.

Taken together, the findings confirm that share-class selection is not a trivial or cosmetic decision but a material determinant of portfolio outcomes. Even within the same firm, different equity classes can behave as distinct assets, warranting careful evaluation in portfolio construction.

4. DISCUSSION AND IMPLICATIONS

The findings of this study offer clear and compelling evidence that equity share classes issued by the same firm can behave as economically distinct assets when evaluated from a portfolio perspective. While the dual-class structure of Tata Motors has been discussed extensively in the literature from governance and valuation standpoints, the present analysis demonstrates that the implications of such structures extend decisively into portfolio construction and risk–return optimisation. This shift in analytical focus, from firm-level assessment to portfolio-level evaluation, forms the central contribution of the study and has important theoretical and practical implications.

At the individual asset level, the superior performance of Tata Motors Class B shares relative to Class A shares is both striking and informative. Despite representing identical cash-flow claims on the same firm, Class B shares deliver significantly higher returns, accompanied by higher volatility and stronger

market sensitivity. This outcome aligns with earlier studies suggesting that differential voting shares often reflect distinct investor clienteles, liquidity conditions, and market perceptions rather than differences in underlying fundamentals. The evidence supports the argument advanced in prior Indian studies that pricing and performance differentials between ordinary and DVR shares are frequently perception-driven, shaped by trading behaviour and investor awareness rather than intrinsic value alone.

Importantly, the higher volatility observed in Class B shares does not translate into inferior performance when assessed through a risk-adjusted lens. On the contrary, the Sharpe ratio and coefficient of variation results indicate that investors are more than adequately compensated for the additional risk undertaken. This finding challenges the conventional assumption that higher volatility necessarily undermines investment efficiency and reinforces the relevance of evaluating assets on a risk-adjusted basis rather than through absolute risk measures alone.

The portfolio-level results deepen this insight considerably. By holding all other portfolio components constant and varying only the Tata Motors share class, the study isolates the pure effect of share-class substitution on portfolio performance. The comparison between Portfolio A (with Class A shares) and Portfolio B (with Class B shares) reveals that the inclusion of Class B shares materially enhances portfolio outcomes across multiple dimensions. Portfolio B delivers higher expected returns and superior risk-adjusted performance, with only a marginal increase in total risk. This pattern strongly suggests that share-class selection is a meaningful asset allocation decision rather than a secondary or cosmetic consideration.

A particularly noteworthy aspect of the findings is the consistent role played by ITC Ltd across both portfolios. Portfolio optimisation repeatedly assigns ITC a dominant weight, reflecting its defensive characteristics, stable returns, and low volatility. This outcome underscores a key principle of modern portfolio theory: high-return, high-risk assets can be effectively integrated into a portfolio when balanced with stabilising assets. In this context, ITC acts as a volatility anchor, allowing the portfolio to accommodate the more aggressive return profile of Tata Motors Class B shares without disproportionately increasing overall risk.

Conversely, Axis Bank receives relatively low weights in both optimal portfolios. While Axis Bank is a prominent and liquid stock, its contribution to portfolio efficiency appears limited within the specific asset combination considered in this study. This finding highlights an often-overlooked aspect of portfolio construction: asset prominence or sectoral importance does not automatically translate into optimal portfolio inclusion. What ultimately matters is the marginal contribution of each asset to portfolio risk and return, given the behaviour of other assets in the portfolio.

The benchmark comparison further reinforces the practical significance of the results. Both constructed portfolios exhibit Sharpe ratios that substantially exceed typical values observed for broad market indices such as the NIFTY 50 or NIFTY 500. Portfolio B demonstrates the potential for a selectively constructed and optimised equity portfolio to outperform the broader market on both absolute and risk-adjusted bases. This finding aligns with portfolio literature suggesting that informed stock selection combined with optimisation can generate excess performance relative to passive benchmarks, especially in emerging markets where inefficiencies may be more pronounced.

From a theoretical standpoint, the study contributes to the dual-class literature by extending its implications beyond governance and valuation debates. Much of the existing research focuses on whether dual-class structures entrench management, distort incentives, or lead to valuation discounts. While these issues remain important, the present findings demonstrate that differential voting structures also influence how securities interact within portfolios. Share classes of the same firm can exhibit distinct correlation patterns, volatility profiles, and market sensitivities, effectively behaving as separate assets from a portfolio optimisation perspective.

This insight has important implications for modern portfolio theory as applied in real-world settings. Traditional portfolio models often assume that equities issued by the same firm are largely substitutable, differing only marginally in liquidity or voting rights. The evidence presented here challenges this assumption and suggests that share-class characteristics should be explicitly incorporated into asset selection and optimisation models. Ignoring such distinctions may lead to sub-optimal portfolio outcomes, particularly in markets where differential voting shares are actively traded and widely held.

The implications for investment practice are equally significant. For institutional investors and fund managers, the findings suggest that share-class differentiation should be treated as a strategic decision variable rather than a governance footnote. Portfolio managers operating under mandates that permit investment in differential voting shares may enhance performance by actively evaluating and selecting among share classes based on their risk–return characteristics. For retail investors, the results underscore the importance of moving beyond headline labels such as “ordinary” or “DVR” shares and examining empirical performance metrics before making investment decisions.

The study also carries implications for regulators and policymakers. While regulatory debates around dual-class shares often centre on investor protection and corporate control, the portfolio-level evidence suggests that such shares can play a constructive role in investment portfolios when appropriately understood and priced. This does not negate governance concerns, but it does indicate that outright scepticism toward differential voting shares may overlook their potential economic value to investors.

At the same time, the findings should be interpreted considering the study’s scope and limitations. The analysis focuses on a single firm and a limited set of portfolio constituents, which may constrain generalisability. Market conditions during the study period, characterised by elevated volatility and sectoral shifts, may also have amplified performance differentials. Nonetheless, the consistency of results across multiple metrics

and portfolio configurations lends robustness to the central conclusion.

The findings of this study offer several actionable insights for portfolio managers, institutional investors, and investment advisors operating in markets where firms issue multiple classes of equity shares. Most importantly, the results demonstrate that share classes of the same firm should not be treated as interchangeable instruments in portfolio construction. Differences in liquidity, market responsiveness, and investor perception can translate into materially different risk–return outcomes, even when underlying cash-flow rights remain identical.

For portfolio managers, the evidence suggests that share-class selection should be incorporated explicitly into asset allocation and optimisation models. The superior risk-adjusted performance of Tata Motors Class B shares indicates that higher-volatility instruments can enhance overall portfolio efficiency when balanced with stabilising assets. Managers pursuing return-enhancement strategies may therefore benefit from allocating selectively to high-beta share classes, provided that overall portfolio risk remains controlled through diversification.

Institutional investors with flexibility in mandate design may use these findings to refine investment guidelines. Rather than excluding differential voting shares on governance grounds alone, institutions may adopt a more nuanced approach that evaluates such shares on empirical performance metrics alongside governance considerations. The results indicate that, in certain contexts, differential voting shares can contribute positively to portfolio outcomes without disproportionately increasing risk.

For fund managers and wealth advisors catering to retail investors, the study highlights the importance of investor education and communication. Retail investors often avoid DVR or non-ordinary shares due to perceived governance risks or limited understanding. However, the empirical evidence suggests that informed selection based on risk-adjusted performance can yield superior outcomes. Advisors can therefore add value by guiding investors beyond headline classifications toward data-driven investment choices.

Finally, the findings have implications for performance evaluation and benchmarking practices. Managers should recognise that benchmark-relative underperformance or outperformance may partly reflect share-class exposure rather than firm-level stock selection alone. Incorporating share-class analysis into performance attribution frameworks can improve transparency and decision quality.

The study encourages managers to move beyond firm-centric analysis and adopt a more granular, evidence-based approach to equity selection, one that recognises share-class characteristics as a meaningful determinant of portfolio efficiency. The study reinforces the core insight that share classes of the same firm cannot be treated as homogeneous instruments in portfolio construction. Differences in liquidity, market perception, and trading behaviour can translate into materially different portfolio outcomes. By demonstrating this effect empirically within an emerging market context, the study bridges a gap between dual-class governance research and applied portfolio management, offering insights that are both theoretically meaningful and practically actionable.

Future Scope of Research

While the present study provides clear empirical evidence that equity share classes issued by the same firm can yield materially different portfolio outcomes, it also opens several promising avenues for future research. By repositioning share-class choice as a portfolio-level decision rather than a purely governance-related concern, the study highlights a dimension of investment analysis that remains underexplored, particularly in emerging market contexts.

One important direction for future research lies in extending the analysis beyond a single firm. While Tata Motors offers a compelling and well-documented case, examining multiple dual-class firms across different sectors would enhance the generalisability of the findings. Comparative studies involving firms from manufacturing, technology, consumer goods, and financial services could reveal whether the observed share-class effects are firm-specific or represent a broader market phenomenon. Cross-firm analysis may also help identify sectoral patterns in how differential voting shares influence portfolio risk and return.

Another avenue for future research involves expanding the portfolio framework itself. The current study employs a three-asset portfolio to isolate the effect of share-class substitution with clarity and control. Future studies could examine larger, more diversified portfolios incorporating multiple firms with dual-class shares alongside conventional equities, bonds, or alternative assets. Such extensions would allow researchers to evaluate whether share-class effects persist, weaken, or intensify as portfolio complexity increases, thereby improving the relevance of findings for institutional portfolio management.

Temporal and regime-based analysis also offer substantial scope for further investigation. The study period captures a phase of heightened volatility and structural shifts in the Indian equity market. Future research could explore whether the relative performance of different share classes remains stable across bull and bear markets, low- and high-volatility regimes, or periods of regulatory change. A regime-switching or rolling-window approach may provide deeper insight into the dynamic nature of share-class behaviour over time.

Methodologically, future studies could incorporate alternative risk measures beyond variance-based metrics. Downside risk measures such as semi-variance, Value-at-Risk (VaR), or Conditional Value-at-Risk (CVaR) may yield additional insights, particularly for investors concerned with tail risk. Similarly, integrating behavioural or liquidity-based variables could help explain why certain share classes outperform others despite identical cash-flow rights.

There is also a scope to integrate governance and portfolio perspectives more explicitly. Future research could examine how changes in voting rights, regulatory reforms, or firm-level governance events influence the portfolio performance of different share classes. Such work would help bridge the gap

between governance theory and investment practice, offering a more holistic understanding of dual-class equity structures.

Finally, extending the analysis to a cross-country or comparative international setting would enrich the literature. Comparing share-class effects across markets with different regulatory frameworks e.g. India, the United States, and selected European or Asian economies, could reveal how institutional environments shape the portfolio relevance of differential voting shares.

The study provides a foundation rather than a conclusion. By demonstrating that share-class distinctions matter for portfolio outcomes, it invites future research to explore this phenomenon across firms, markets, time periods, and methodological frameworks, thereby deepening both theoretical understanding and practical relevance in investment management research.

5. CONCLUSION

This study set out to examine whether different equity share classes issued by the same firm can lead to materially different outcomes when evaluated from a portfolio perspective. Moving beyond the traditional firm-level focus of dual-class equity research, the analysis repositioned share-class choice as an active portfolio decision with tangible implications for risk, return, and overall investment efficiency. Using Tata Motors' Class A and Class B equity shares as a case within a three-asset portfolio framework, the study provides clear empirical evidence that share classes of the same firm cannot be treated as homogeneous instruments for investment purposes.

The findings demonstrate that Tata Motors Class B shares consistently outperform Class A shares in terms of absolute returns and risk-adjusted performance, despite exhibiting higher volatility and stronger sensitivity to market movements. This result underscores a central insight of the study: higher risk does not inherently diminish investment quality if it is accompanied by proportionately higher returns. In fact, the superior Sharpe ratio and lower coefficient of variation of Class B shares indicate that investors are more than adequately compensated for the additional risk undertaken.

At the portfolio level, the evidence becomes even more compelling. By constructing two otherwise identical portfolios that differ only in the Tata Motors share class included, the study isolates the pure effect of share-class substitution on portfolio performance. The portfolio incorporating Class B shares delivers higher expected returns and superior risk-adjusted outcomes, with only a modest increase in overall volatility. This confirms that share-class selection is not a marginal or cosmetic choice, but a meaningful determinant of portfolio efficiency.

The analysis also highlights the critical role of asset interaction effects. The consistently high allocation assigned to ITC Ltd across optimal portfolios reinforces the stabilising importance of defensive stocks in absorbing volatility and enhancing diversification. At the same time, the relatively limited contribution of Axis Bank illustrates that prominence, or sectoral importance alone does not guarantee portfolio relevance; what matters is each asset's marginal contribution to the portfolio's risk–return trade-off.

From a theoretical standpoint, the study contributes to the dual-class equity literature by extending its relevance into the domain of portfolio management. While prior research has focused largely on governance, valuation discounts, and control considerations, the present findings demonstrate that differential voting structures also shape how securities behave within diversified portfolios. This challenges the implicit assumption in many portfolio models that share classes of the same firm are largely substitutable.

In practical terms, the study offers valuable insights for investors and portfolio managers, particularly in emerging markets where differential voting shares are actively traded. It suggests that informed share-class selection, grounded in empirical performance metrics rather than perception or governance labels alone, can meaningfully enhance portfolio outcomes. For regulators and policymakers, the findings indicate that differential voting shares should not be assessed solely through a governance lens, as they may also generate economic value for investors when properly understood and priced.

Like all empirical studies, this research is subject to certain limitations, including its focus on a single firm and a limited set of portfolio constituents. Nevertheless, the consistency of results across multiple performance measures and portfolio configurations lends robustness to the central conclusion. Future research may extend this framework to other firms, sectors, or markets, and explore how share-class effects evolve under different market regimes.

The study reaffirms that share-class distinctions matter, not only for corporate control and governance, but also for portfolio construction, risk management, and investment performance. By demonstrating this effect empirically within an emerging market context, the research bridges an important gap between dual-class equity theory and applied portfolio management, offering insights that are both analytically sound and practically relevant.

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Annexure (RStudio Codes)

```
# Load data
data <- read.csv("DVSDATA.csv")

# Select returns
ret1 <- data[, c("RET.ITC", "RET.AXIS", "RET.TM")]
ret2 <- data[, c("RET.ITC", "RET.AXIS", "RET.TMDV")]

# Mean and covariance
mu1 <- colMeans(ret1)
cov1 <- cov(ret1)

mu2 <- colMeans(ret2)
cov2 <- cov(ret2)

# Optimal weights (Sharpe maximisation, rf = 0)
w1 <- solve(cov1) %*% mu1
w1 <- w1 / sum(w1)

w2 <- solve(cov2) %*% mu2
w2 <- w2 / sum(w2)

# Portfolio metrics
ret_p1 <- t(w1) %*% mu1
risk_p1 <- sqrt(t(w1) %*% cov1 %*% w1)
sharpe1 <- ret_p1 / risk_p1

ret_p2 <- t(w2) %*% mu2
risk_p2 <- sqrt(t(w2) %*% cov2 %*% w2)
sharpe2 <- ret_p2 / risk_p2

# Load data
data <- read.csv("DVSDATA.csv")

# Returns matrix
ret1 <- data[, c("RET.ITC", "RET.AXIS", "RET.TM")]

# Mean and covariance
mu1 <- colMeans(ret1)
cov1 <- cov(ret1)

# Number of portfolios
nport <- 5000

# Storage
port_risk1 <- numeric(nport)
port_return1 <- numeric(nport)

set.seed(123)

for(i in 1:nport){
  w <- runif(3)
  w <- w / sum(w)

  port_return1[i] <- sum(w * mu1)
  port_risk1[i] <- sqrt(t(w) %*% cov1 %*% w)
}
# Plot Efficient Frontier
plot(port_risk1, port_return1,
     col = "steelblue",
     pch = 16,
     cex = 0.6,
     xlab = "Portfolio Risk (Standard Deviation)",
     ylab = "Expected Portfolio Return",
     main = "Efficient Frontier: ITC–AXIS–Tata Motors (Class
A)")

# Returns matrix
ret2 <- data[, c("RET.ITC", "RET.AXIS", "RET.TMDV")]

# Mean and covariance
mu2 <- colMeans(ret2)
cov2 <- cov(ret2)

# Storage
port_risk2 <- numeric(nport)
port_return2 <- numeric(nport)

set.seed(123)

for(i in 1:nport){
  w <- runif(3)
  w <- w / sum(w)

  port_return2[i] <- sum(w * mu2)
  port_risk2[i] <- sqrt(t(w) %*% cov2 %*% w)
}

# Plot Efficient Frontier
plot(port_risk2, port_return2,
     col = "darkgreen",
     pch = 16,
     cex = 0.6,
     xlab = "Portfolio Risk (Standard Deviation)",
     ylab = "Expected Portfolio Return",
     main = "Efficient Frontier: ITC–AXIS–Tata Motors (Class
B)")

# Optimal weights (Sharpe max)
w1 <- solve(cov1) %*% mu1
w1 <- w1 / sum(w1)

opt_ret1 <- sum(w1 * mu1)
```

```
opt_risk1 <- sqrt(t(w1) %*% cov1 %*% w1)

points(opt_risk1, opt_ret1, col = "red", pch = 19, cex = 1.5)

# Optimal weights (Sharpe max)
w2 <- solve(cov2) %*% mu2
w2 <- w2 / sum(w2)

opt_ret2 <- sum(w2 * mu2)
opt_risk2 <- sqrt(t(w2) %*% cov2 %*% w2)

points(opt_risk2, opt_ret2, col = "red", pch = 19, cex = 1.5)

# Load data
data <- read.csv("DVSDATA.csv")


# CASE 1: TM Class A

ret1 <- data[, c("RET.ITC", "RET.AXIS", "RET.TM")]
mu1  <- colMeans(ret1)
cov1 <- cov(ret1)


# CASE 2: TM Class B (DVR)

ret2 <- data[, c("RET.ITC", "RET.AXIS", "RET.TMDV")]
mu2  <- colMeans(ret2)
cov2 <- cov(ret2)

# Number of random portfolios
nport <- 5000
set.seed(123)

# Storage
risk1 <- return1 <- numeric(nport)
risk2 <- return2 <- numeric(nport)

# Generate portfolios
for(i in 1:nport){
  w <- runif(3)
  w <- w / sum(w)

  return1[i] <- sum(w * mu1)
  risk1[i]   <- sqrt(t(w) %*% cov1 %*% w)

  return2[i] <- sum(w * mu2)
  risk2[i]   <- sqrt(t(w) %*% cov2 %*% w)
}


# Optimal (Max Sharpe) portfolios

w1 <- solve(cov1) %*% mu1
w1 <- w1 / sum(w1)
opt_ret1  <- sum(w1 * mu1)
opt_risk1 <- sqrt(t(w1) %*% cov1 %*% w1)

w2 <- solve(cov2) %*% mu2
w2 <- w2 / sum(w2)
opt_ret2  <- sum(w2 * mu2)
opt_risk2 <- sqrt(t(w2) %*% cov2 %*% w2)


# Combined Plot

plot(risk1, return1,
     pch = 16, cex = 0.5,
     col = rgb(0, 0, 1, 0.4),
     xlab = "Portfolio Risk (Standard Deviation)",
     ylab = "Expected Portfolio Return",
     main = "Comparative Efficient Frontier: Tata Motors Class
A vs Class B")

points(risk2, return2,
       pch = 16, cex = 0.5,
       col = rgb(0, 0.6, 0, 0.4))

# Mark optimal portfolios
points(opt_risk1, opt_ret1, pch = 19, col = "blue", cex = 1.5)
points(opt_risk2, opt_ret2, pch = 19, col = "darkgreen", cex =
1.5)

# Legend
legend("topleft",
       legend = c("Efficient Frontier: TM Class A",
                  "Efficient Frontier: TM Class B",
                  "Optimal Portfolio (Class A)",
                  "Optimal Portfolio (Class B)"),
       col = c("blue", "darkgreen", "blue", "darkgreen"),
       pch = c(16, 16, 19, 19),
       bty = "n")
```