



# Modern Portfolio Theory in Practice: Optimizing Risk-Return Trade-offs through a Case Study of Tesla and Procter & Gamble

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**Abstract.** This study investigates the practical application of Modern Portfolio Theory (MPT) by examining two stocks with markedly different risk-return profiles: Tesla (TSLA) and Procter & Gamble (PG). Based on historical data from 2018 to 2024, Tesla—a high-volatility growth stock—shows an annualised return of 47.96% alongside a volatility of 74.13%, while PG, a low-volatility defensive stock, delivers a 16.71% return with a volatility of 42.91%. Using Excel Solver to optimise the Sharpe ratio, the research identifies the best-performing portfolio as 88% Tesla and 12% PG, achieving an annualised return of 44.26% and reducing volatility to 68.02%—6.11% lower than holding Tesla alone—while boosting the Sharpe ratio to 0.621. These findings validate MPT’s core principle that combining low-correlation assets (covariance 0.158) can effectively manage unsystematic risk while maintaining a high risk-adjusted return. They also underscore the value of quantitative tools for small and medium-sized investors, who can dynamically rebalance their portfolios in response to changing market conditions and personal risk preferences. However, the study acknowledges limitations, including a reliance on historical data, potential discrepancies between theoretical optima and real-world implementation, and an exclusive focus on just two U.S. large-cap stocks. Future research could broaden the scope of asset classes, incorporate ESG factors, and examine different market scenarios. Overall, this study highlights MPT’s utility as both a theoretical framework and a practical guide, illustrating how disciplined diversification—combined with fundamental analysis—can balance growth and stability under constrained investment choices.

**Keywords:** Modern Portfolio Theory; Risk-Return; Diversification

## 1 Introduction

In the financial market, the balance between risk and return has always been the core proposition of investment strategy. Since Harry Markowitz proposed the Modern Portfolio Theory in 1952, the theory has proved through mathematical methods that investors can maximise their returns under a given risk level by diversifying their investments [1]. Although the theoretical framework of MPT is highly respected, its practical application in the limited asset portfolio of individual investors is still lacking in-depth

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research. This study takes two listed companies with very different risk-return characteristics, Tesla, a high-volatility innovator in the electric vehicle field, and Procter & Gamble, a low-volatility leader in the consumer goods industry, as cases to explore how to use MPT to guide actual investment decisions and bridge the gap between theory and practice.

The symbiotic relationship between risk and return is particularly evident in the two types of assets: Tesla, driven by technological innovation and market expectations, has high return potential but is accompanied by violent fluctuations, while Procter & Gamble, relying on stable consumer demand and mature supply chains, has slow growth but has shown significant risk resistance. The core of MPT is to build a portfolio to optimise allocation by quantifying risk and return. However, individual investors often find it difficult to apply this theory due to cognitive thresholds or resource limitations. Instead, they rely on subjective judgment or concentrated investment in a single asset. This study will verify the feasibility of MPT in small-scale portfolios through empirical analysis.

The research objectives focus on three core issues: First, how are the risk-return characteristics of Tesla and P&G differentiated? Second, what is the optimal asset allocation ratio based on MPT indicators such as the Sharpe ratio [2]? Third, can such a portfolio provide benefits for individual investors? To this end, this paper adopts a mixed research method: quantitatively, based on historical data from 2018 to 2024 [3], daily returns, volatility, covariance and correlation coefficients are calculated, and Excel-solver is used to maximise the Sharpe ratio or minimise the risk under a specific return target; qualitatively, the data results are analysed in combination with the business model of the enterprise to ensure that the conclusions fit the real market logic.

## 2 Portfolio Theory

### 2.1 Risk and Return

The relationship between risk and return forms the cornerstone of Modern Portfolio Theory. In his seminal 1952 paper, *Portfolio Selection*, Harry Markowitz redefined risk as the statistical volatility of an asset's returns [1]. It demonstrated that portfolios, rather than individual assets, should be the focus of investment analysis. For instance, Tesla, a high-volatility growth stock, and Procter & Gamble, a low-volatility defensive stock, exhibit starkly different risk-return profiles. Tesla's returns are driven by technological innovation and market speculation, while Procter & Gamble's stability stems from consistent consumer demand. Markowitz's key insight—combining such assets reduces overall portfolio risk without proportionally sacrificing returns—laid the foundation for diversification as a risk management tool.

William Sharpe expanded this framework in 1964 by distinguishing between systematic risk, which affects all assets through market-wide factors like economic cycles, and unsystematic risk, which is specific to individual companies [4]. Systematic risk, measured by beta—a metric reflecting an asset's sensitivity to market movements—cannot be eliminated through diversification. Tesla amplifies market swings with its high beta, whereas Procter & Gamble's low beta insulates it from broader volatility.

This duality underscores Modern Portfolio Theory's core principle: portfolios blending high-beta and low-beta assets achieve superior risk-adjusted outcomes compared to standalone investments.

## 2.2 Sharpe Ratio

To objectively evaluate investment efficiency, William Sharpe introduced the Sharpe Ratio in 1966 [2], later refining it in 1994 as a universal metric for risk-adjusted returns [5]. The ratio quantifies how much excess return an investor earns per unit of risk taken, calculated by dividing the portfolio's excess return over the risk-free rate by its volatility. A higher Sharpe Ratio signals more efficient compensation for risk. (Equation (1))

$$\text{Sharpe Ratio} = \frac{R_p - R_f}{\sigma_p} \quad (1)$$

where  $R_p$  is the portfolio return,  $R_f$  the risk-free rate and  $\sigma_p$  the portfolio's volatility. The Sharpe Ratio quantifies how much excess return an investor earns per unit of risk taken. A higher ratio indicates more efficient compensation for risk. For example, consider Tesla's hypothetical annual return of 20% with 40% volatility and Procter & Gamble's 8% return with 15% volatility. Assuming a 2% risk-free rate, Tesla's Sharpe Ratio of 0.45 slightly edges out Procter & Gamble's 0.40. However, as Sharpe emphasised in his 1994 work [5], standalone metrics can mislead. When combined in a portfolio—say, 60% Tesla and 40% Procter & Gamble—the blended volatility might drop to 28% while maintaining a 15% return, lifting the Sharpe Ratio to 0.50. This optimisation illustrates Modern Portfolio Theory's power: diversification mitigates risk and enhances the quality of returns.

## 2.3 Portfolio Theory

Markowitz's 1952 framework introduced two critical concepts: covariance and the efficient frontier [1]. Covariance measures how asset returns move relative to one another. When assets like Tesla and Procter & Gamble exhibit low or negative covariance—Tesla's growth surges offset by Procter & Gamble's stability during downturns—their combined portfolio volatility declines disproportionately. The efficient frontier, a curve mapping all optimal portfolios that maximise returns for a given risk level, visually encapsulates this principle. For instance, a 70% Tesla and 30% Procter & Gamble allocation might achieve a 17% return with 30% volatility, while a 50-50 split could reduce volatility to 22% with only marginal return loss.

James Tobin's 1958 separation theorem further advanced portfolio theory by dividing investment decisions into two steps: selecting an optimal mix of risky assets and allocating between this mix and risk-free investments like Treasury bonds [6]. While this study focuses on a two-asset portfolio, Tobin's framework underscores Modern Portfolio Theory's scalability. Tools such as Excel Solver enable investors to identify weightings that align portfolios with the efficient frontier, even with limited assets. For example, if Tesla and Procter & Gamble historically correlate at  $-0.2$ —a hypothetical but plausible value—their combined portfolio could achieve 25% lower volatility than

Tesla alone. This aligns with Markowitz's famed assertion that diversification is "the only free lunch in finance," [1] a principle validated by theory and practice.

Modern Portfolio Theory transforms abstract financial concepts into actionable strategies by integrating Markowitz's diversification, Sharpe's risk-adjusted metrics, and Tobin's allocation principles. Even simplified portfolios, when grounded in empirical data and optimisation tools, can reconcile growth and stability, proving that disciplined diversification is mathematically rigorous and practically attainable.

### 3 Analysis and Discussion

#### 3.1 Stock and Company Introduction

**Tesla (TSLA).** Tesla is a leading global enterprise in the electric vehicle (EV) and clean energy fields. Founded in 2003, its core business covers designing and manufacturing electric cars, energy storage systems, and solar products. By continuously innovating its technology, Tesla has driven major shifts in the industry, with key markets in North America, Europe, and Asia. The company's valuation logic heavily depends on future growth expectations, making it a classic example of a high-growth stock.

**Procter & Gamble (PG).** Procter & Gamble is a multinational consumer goods giant with more than 185 years of history. Its main product categories include personal care essentials (e.g., Gillette, Pantene) and household cleaning essentials (e.g., Tide, Pampers). Thanks to a diversified brand lineup and stable consumer demand, P&G holds a strong position in the defensive sector. Operating in over 180 countries, it is known for low volatility and consistent dividend payments.

#### 3.2 Stock Performance (Risk and Return)

According to the historical stock prices of Yahoo Finance from 2018 to 2024 [3], Tesla and P&G's stock price movements showed clear differences in risk and returns. This section analyses their characteristics—using annualised returns, volatility, and covariance—along with sector and company fundamentals and then explores how their combination might be optimised.

**Tesla (TSLA): A Prime Example of High Growth and Volatility.** Tesla has an annualised return of 47.96%, well above the market average. This performance is tightly linked to its disruptive position in the EV industry. Tesla also benefits from global carbon-neutral policies by continuously enhancing product competitiveness through technological innovations. However, its annualised volatility reaches 74.13%, highlighting how varied the market's views are on its future development. Investor sentiment, supply chain changes, and policy adjustments can all trigger significant stock price swings. Moreover, as a quintessential growth-oriented company, Tesla's valuation logic relies heavily on projected future cash flows, making its stock price especially sensitive to macroeconomic conditions.

**Procter & Gamble (PG): A Stable Pick in the Defensive Sector.** In comparison, P&G shows an annualised return of 16.71%. Although it lacks the explosive growth of Tesla, it nonetheless delivers strong results for a consumer staples leader. With a diversified brand mix (featuring well-known names like Gillette, Tide, and Pampers) and steady consumer demand, P&G weathers economic cycles effectively. Its annualised volatility is just 42.91%, significantly lower than Tesla's, reflecting investors' confidence in P&G's earnings stability. The inelastic demand for essential consumer goods, robust branding, and ongoing cost-optimisation initiatives collectively help stabilise P&G's share price.

**Portfolio Performance: Practical Evidence of Risk Diversification.** To balance risk and return, this study constructs a portfolio of 88% Tesla and 12% P&G. The results show an annualised return of 44.26%, nearly matching Tesla's standalone level and confirming that a high-growth stock still drives most of the portfolio's gains. At the same time, annualised volatility is 68.02%, 6.11 percentage points lower than holding Tesla alone—evidence that diversification works. The Sharpe ratio (0.621) further indicates that this portfolio earns higher excess returns per unit of risk than any single asset. Notably, the covariance between Tesla and P&G is 0.158, so they are not perfectly positively correlated, although the scope for diversification is somewhat limited. This outcome stems from their differing industry drivers: Tesla is influenced by technological innovations and policy changes, while P&G relies on stable consumer demand, with each stock's price fluctuations governed by distinct factors.

### 3.3 Optimal Allocation Based on Modern Portfolio Theory

The core of Modern Portfolio Theory (MPT) lies in achieving an optimal risk-return balance through asset allocation [1]. This study aims to achieve the highest possible Sharpe ratio and applies Excel Solver to determine the optimal weighting of Tesla and P&G. The process is as follows.

**Theoretical Framework and Model Setup.** The objective function is set to maximise the Sharpe ratio in Equation (2).

$$\text{Max Sharpe ratio} = \frac{E(R_p) - R_f}{\sigma_p} \quad (2)$$

Here, cap E open paren cap R sub p, close paren is the portfolio's expected return, and  $\sigma_p$  is the portfolio's volatility. Refer to the 10-year US Treasury bond rate, assuming the risk-free rate is 2%,  $R_f = 2\%$ . Portfolio returns and volatility are calculated by weighting the individual stocks' returns, variances, and covariance. Constraints include full investment (weights summing to 1) and a ban on short selling (nonnegative weights).

**Data Input and Solver Process.** Tesla's and P&G's annualised returns (47.96% and 16.71%), volatilities (74.13% and 42.91%), and covariance (0.158) are input into the Excel model. Then, the Solver tool is used to compute the optimal weighting iteratively. The results show that an 88% Tesla and 12% P&G allocation yields a Sharpe ratio of 0.621, representing the best risk-adjusted outcome in the sample.

**Interpretation and Practical Implications.** This allocation confirms MPT's central principle: combining assets with lower correlation reduces unsystematic risk [1]. For more risk-tolerant investors, keeping a high proportion in Tesla maximises potential returns; for conservative investors, modestly increasing P&G's weighting (for instance, to 20–30%) can reduce overall volatility to around 50–55%, trading off some gains for greater stability. Additionally, dynamic rebalancing is vital: macroeconomic changes (e.g., interest-rate policy shifts) or major corporate events (like Tesla opening a new factory) could significantly impact the covariance matrix, requiring periodic re-optimisation to maintain portfolio efficiency.

### 3.4 Discussion: Theoretical Depth and Practical Insights

#### Theoretical Contributions and Limitations.

*Market Efficiency and Rationality Assumptions.* MPT assumes fully rational market participants and symmetric information [1]. In reality, Tesla's stock price often reacts to market sentiment, while P&G may face irrational sell-offs if a quarterly report disappoints. The model does not capture such behavioural finance phenomena, which could lead to inflated Sharpe ratio estimates [7].

*Fragility of Static Covariance.* The covariance matrix (0.158) derives from historical data, implying that future volatility patterns will mirror the past. However, during the Federal Reserve's aggressive rate hikes in 2022, growth and defensive stocks exhibited a noticeably higher correlation, weakening diversification benefits [8].

*Simplified Risk-Free Rate.* The assumption of a 2% risk-free rate ignores rate-cycle effects. For example, when the Fed maintained the federal funds rate in the 4.75% to 5% range as of September 2024—following four years without any rate cuts—risk assets became less attractive [9]. This divergence between policy and model assumptions may have led the theoretically optimal portfolio allocations to deviate from actual investor behavior.

#### Practical Challenges and Strategy Optimisation.

*Liquidity Constraints and Transaction Costs.* The theoretical model excludes trading expenses (e.g., brokerage fees, bid-ask spreads). If weights are adjusted too often (for example, quarterly), costs might erode portfolio returns. More conservative investors

can adopt threshold-based rebalancing (only rebalance if weights deviate by  $\pm 5\%$ ) to limit frictional losses [10].

*Industry Concentration Risk.* Although Tesla and P&G come from different industries, both are US large-cap stocks and remain subject to systemic risks (like dollar exchange rate fluctuations and geopolitical tensions). Including international assets (such as emerging-market ETFs) or alternative assets (like commodities) could improve a portfolio's resilience [11].

*Lack of ESG Factors.* Environmental, Social, and Governance (ESG) metrics increasingly shape capital flows. Tesla attracts surplus capital for its carbon-reduction technologies [12], whereas P&G has been criticised for plastic pollution [13]. Future research could incorporate ESG scores to adjust expected returns, creating portfolios aligned with socially responsible investing [14][15].

## 4 Conclusion

This study uses Tesla (TSLA) and Procter & Gamble (PG) as case examples to empirically demonstrate the practical value of Modern Portfolio Theory (MPT) in a limited-asset allocation context. Drawing on historical data from 2018 to 2024, the research quantifies both companies' risk-return profiles: Tesla, as a high-volatility growth stock, delivers an annualised return of 47.96% but carries a volatility of 74.13%, whereas Procter & Gamble, classified as a low-volatility defensive stock, shows an annualised return of 16.71% with a volatility of only 42.91%. Through optimising the Sharpe ratio using Excel Solver, the study finds that a portfolio consisting of 88% Tesla and 12% P&G achieves a 44.26% annualised return and reduces volatility to 68.02%—6.11% lower than holding Tesla alone—while raising the Sharpe ratio to 0.621. This result confirms the core tenet of MPT: by diversifying with low-correlation assets (covariance of 0.158), investors can manage unsystematic risk while maintaining high risk-adjusted returns.

Theoretically, the findings validate Markowitz's concept of diversification: combining assets with low correlation or covariance effectively reduces unsystematic risk. Tesla and P&G exhibit sectoral heterogeneity (technology-driven innovation versus consumer defensive), causing their price fluctuations to be influenced by different factors—Tesla relies on technological breakthroughs and policy incentives. At the same time, P&G benefits from stable demand for everyday goods. Their low covariance diminishes simultaneous price swings, significantly lowering the portfolio risk. Furthermore, optimising the Sharpe ratio highlights the importance of risk-adjusted returns rather than focusing on the absolute returns of a single asset. This discovery provides direct evidence of MPT's relevance for individual investors, addressing a gap in research on small-scale portfolio applications.

From a practical standpoint, the study provides several strategic insights for small and medium-sized investors. First, appropriately using Excel Solver or similar optimisation tools enables a quantitative comparison of historical returns and volatility across

different assets, allowing investors to make flexible decisions aligned with specific risk or return targets. Second, investors may adjust portfolio weights according to risk preferences and market conditions rather than maintaining rigid positions. For instance, those with high-risk tolerance can increase Tesla's share to pursue higher potential returns. At the same time, conservative investors can raise their allocation to defensive assets like P&G to control overall volatility.

Nevertheless, this study has certain limitations. For one, historical volatility and covariance assume stable market structures, which may become invalid in the face of drastic macroeconomic fluctuations or significant negative events at the company level. Additionally, transaction costs, liquidity constraints, and psychological factors can hinder the precise execution of theoretically optimal allocations. Moreover, as this study only examines two U.S. large-cap stocks, future research might include international assets, sector-specific ETFs, or alternative assets to enhance diversification further and reinforce external validity.

In conclusion, Modern Portfolio Theory is not solely a theoretical framework but also a practical investment tool with genuine guiding significance. Through empirical analysis, this research shows that even when assets are limited, combining quantitative methods with fundamental insights enables investors to construct portfolios balancing growth and defence. This conclusion offers methodological support for individual investors and lays a practical foundation for further expanding MPT in diverse market settings. As financial technology becomes more widespread and data grows increasingly accessible, MPT's scope can be expected to broaden, helping more investors achieve long-term value by dynamically balancing risk and return.

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