Aalborg Universitet

MSc in Economics and Business Administration-Finance

Master’s Thesis

“Evaluating the Persistence of Outperformance in US Mutual Funds: Are Active Managers Consistently Beating the Market?”

Explores whether actively managed mutual funds outperform passive benchmark indexes and how fund manager decisions influence returns.

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Abstract

Over the past decade, emergent markets have contributed more than two-thirds of the growth in global GDP. As a result, much debate surrounding equity markets has focused on the performance of active over passive investing in the face of near market efficiency. This thesis seeks to explain the excess returns of active open-end mutual funds over the period 2015-2025 and empirically determine whether, given lower market efficiency and thus greater opportunities for arbitrage, actively managed funds investing in emerging markets systematically generate abnormal returns. Using data from the Factset database on 26 active US based mutual funds investing in emerging markets, I compare the Fama-French Three-Factors model. The regression analysis finds that the latter has the highest explanatory power. As a result, much debate surrounding equity markets has focused on the performance of active over passive investing in the face of near market efficiency.

The objective of this thesis is to determine whether 26 active mutual funds based in the United States can achieve a superior risk-adjusted return when compared to the S&P 500 index from the beginning of 2015 to the beginning of 2025. The analysis is conducted using five performance measures: Jensen's alpha, Treynor's ratio, the Sharpe ratio, the Information ratio, and the Fama & French 3-factor model. These measures are based on Markowitz's Modern Portfolio Theory and the CAPM framework.

Acknowledgements

Initially, I would like to express my gratitude to my supervisor, Frederik, for his invaluable feedback on my analysis and structuring, as well as for his guidance throughout this project. My sincere thanks also go to Aalborg University for providing us with the financial and strategic knowledge to complete this project. Finally, thanks to our family and friends who endured this long process with us, always offering support and love.

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List of Abbreviations

S&P 500 – Standard & Poor's 500 Index

VSMPX – Vanguard Institutional Index Fund (Vanguard 500 Index Fund)

LCGFX – Legg Mason Growth Fund

PRWAX – T. Rowe Price Capital Appreciation Fund

CUSEX – Columbia Large Cap Growth Fund

CMLIX – Columbia Multi-Manager Large Cap Growth Fund

FMFMX – Fidelity Mid Cap Fund

QALGX – American Funds Capital Income Builder Fund

CFGRX – T. Rowe Price Growth Fund

MIGFX – MFS International Growth Fund

APGAX – American Funds Growth Fund of America

FFIDX – Fidelity Total Market Index Fund

DREVX – DFA US Real Estate Securities Fund

USBSX – USAA Growth Fund

IYSMX – iShares Morningstar Small-Cap Index Fund

WDHYX – Wells Fargo Dividend Income Fund

FCNTX – Fidelity Contra fund

FCTDX – Fidelity Balanced Fund

AGTHX – American Funds Growth Fund of America

VTBIX – Vanguard Total Bond Market Index Fund

VTBNX – Vanguard Total Bond Market Index Fund Institutional Shares

VIIIX – Vanguard Institutional Index Fund

VFFSX – Vanguard FTSE Social Index Fund

VGTSX – Vanguard Total International Stock Index Fund

VTSAX – Vanguard Total Stock Market Index Fund Admiral Shares

VFIAX – Vanguard 500 Index Fund Admiral Shares

FXAIX – Fidelity 500 Index Fund

US T-bill- United States Treasury Bill

1. Introduction

1.1 Background and context of the topic

The topic of whether actively managed funds outperform their benchmarks has been a contentious one in finance for a long time. Active fund management refers to the strategy where portfolio managers make specific investments with the goal of outperforming an index or market benchmark. This contrasts with passive management, which seeks to replicate the performance of a specific index. While active managers argue that their strategies and skills can add value through superior security selection and market timing, empirical research has often cast doubt on this claim (Fama & French, 2010; Carhart, 1997). However, some argue active management can add value in less efficient markets or during volatile periods, as noted by Gruber (1996). The choice between active and passive strategies depends on investor goals, risk tolerance, and market conditions, with passive funds generally favored for cost efficiency and consistent returns.

The need for a reliable metric to assess the degree of a manager's activeness has given rise to several academic measures. One of the most influential is the Active Share, introduced by Cremers and Petajisto. Active fund management refers to the strategy where portfolio managers make specific investments with the goal of outperforming an index or market benchmark. This contrasts with passive management, which seeks to replicate the performance of a specific index. While active managers argue that their strategies and skills can add value through superior security selection and market timing, empirical research has often cast doubt on this claim (Amihud & Goyenko, 2013; Sun, Wang & Zheng, 2012).

1.2 Problem statement and research questions:

The concern of whether investors can consistently recognize fund managers whose active choices result in better performance still stands despite the growth of actively managed funds in international capital markets. Traditional performance metrics such as jensen's alpha, Sharpe ratio, and tracking error provide only retrospective insights and often fail to capture the underlying behavior of fund managers. The introduction of Active Share by Cremers and Petajisto (2009) was a pivotal advancement, offering a forward-looking measure to quantify a fund's deviation from its benchmark. However, subsequent research has questioned the robustness of Active Share as a standalone predictor of future performance, especially across different market conditions, asset classes, and fund sizes. Given these limitations, there is a clear need for a refined or alternative measure that more accurately captures meaningful fund activeness and better predicts future performance. This paper aims to address this gap by developing and empirically testing a new metric of fund manager activeness.

To define the problem area and achieve the desired outcome of the paper it is important to determine the appropriate research question. Defining a clear research question is an essential step for the paper to identify and follow steps which are necessary in the process of reaching the point of solving the predefined problem. The problem area definition serves as the basis for the research question, which will be addressed in the later stages of the paper, under the section of conclusions. Based on the previously described background and context of the research topic and predefined problem area, the research question concerning this paper is:

1. ***Are the selected 26 mutual funds managed to outperform the benchmark?***
2. ***To what extent does the investment strategy enhance risk-adjusted performance, as evaluated by Alpha, Beta, Sharpe Ratio, Treynor Ratio, Information Ratio, and regression-based analyses (Fama French 3 factor model)?***

1.3 Objectives and aim of the thesis paper

The paper’s main goal is to evaluate the effectiveness of existing measures of mutual funds activeness. Furthermore, this project aims not only at improving fund selection strategies but also at mitigating investment risks associated with passive or underperforming fund management. To create an approachable solution for this problem, the intent of this paper is to develop a data-driven statistical tool that measures fund manager activeness and forecasts performance outcomes, thereby contributing to better investment performance, transparency in fund management, and enhanced financial decision-making. I will analyze whether the chosen US based mutual funds are able to perform adequately when compared to the benchmark index.

1.4 Thesis timeline

This section will outline the paper timeline in more detail. A paper timeline was created to have a clear overview of the paper development and identify necessary steps in the completion process. Furthermore, it helps to understand the paper scope break and entire project into smaller tasks and track their progress in time. The paper timeline offers a broader view of the paper with the possibility to identify potential adjustments in the paper development process. It also helps with the allocation of necessary resources and the distribution of the workload. Crucially, it supports keeping the paper on the right track in terms of delivery time and therefore mitigates risk related to missed deadlines and late paper delivery (Atlassian, 2024).

For the purposes of this project, we identified 4 major project development phases, Research, Planning, Coding and Implementation. These were further broken down into smaller milestones. The overall timeline for the project was identified from Week 45 to Week 51. The first week of allocated time was dedicated to researching the topic and gathering necessary data. Next up, the initial planning process started with an assessment of available resources and the creation of an initial draft followed by the identification of tasks to complete. The consecutive step was the coding process which involved the exploration of gathered data and the result from Fama French regression analysis. For providing a visual overview, this whole project development process can be observed in Figure 1.

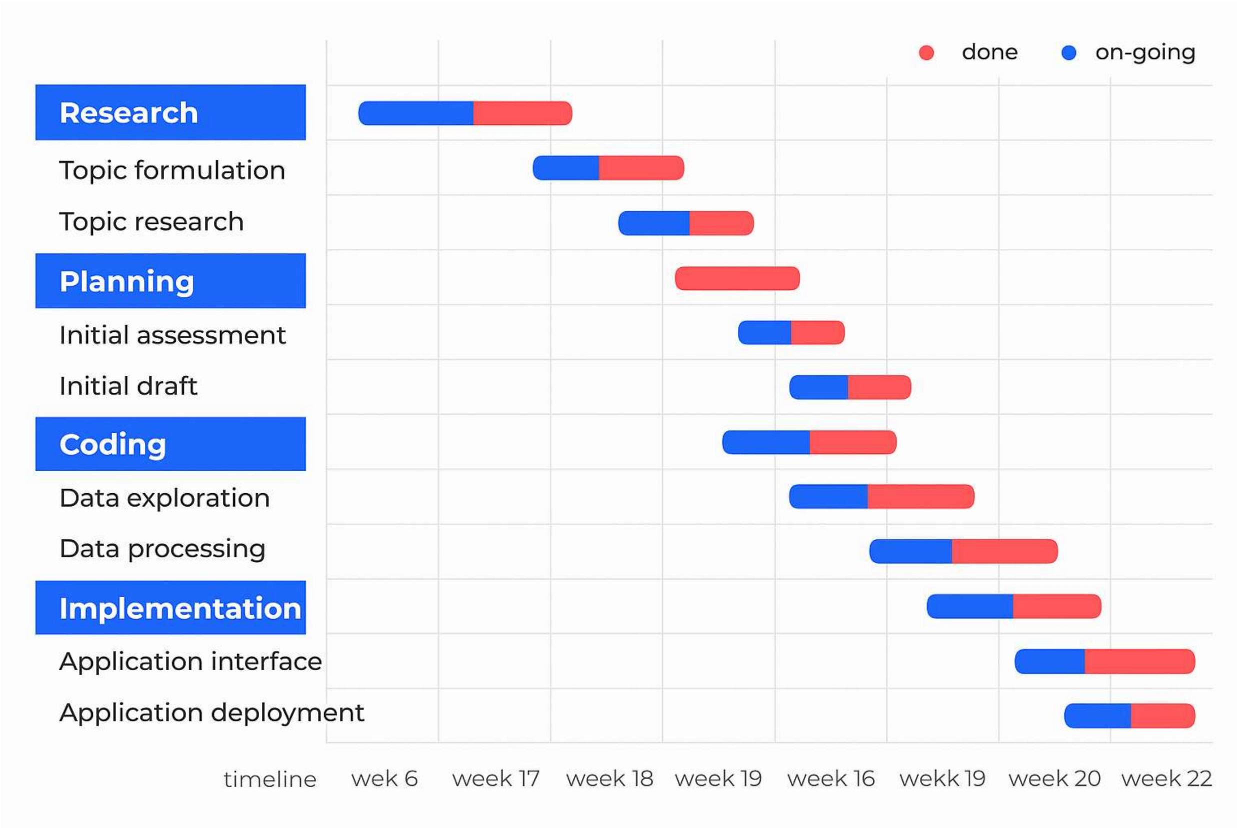


Figure-1 Thesis paper timeline Gantt chart (own)

1.5 Limitations

This section will discuss potential challenges and limitations before, during and after the project development process. A major challenge faced with the initial phases is related to obtaining relevant datasets. I will discuss later in section 4 (how to obtain dataset for this paper). With a low-quality dataset, there is a significantly higher chance of not achieving desirable results. The initial quality of results can be evaluated just by observation, considering whether the results make sense. While this project includes fewer than 30 U.S. mutual funds, the selected sample was chosen to reflect key sectors and market capitalization levels. Although it does not capture the full diversification of S&P 500, it provides a reasonable basis for comparing general performance trends with mutual funds. However, onto another challenge, I took all the historical prices of the funds as well as the benchmark index's monthly wise. Also, this paper does not investigate tax issues of the funds. Assuming everyone has the same tax rate, it does not make any difference whether we look pre- or post-tax. The results would be the same, but the sums of a post-tax analysis would be slightly less.

Another notable limitation of this study is the exclusion of management fees, transaction costs, and other fund-specific charges in the performance analysis. The mutual fund returns analysis was based on gross returns, which do not reflect the actual net returns realized by investors after accounting for fees. As such, performance metrics such as alpha, Sharpe ratio, and excess returns may be overstated. While this approach enables a clearer assessment of the fund's strategy and exposure to risk factors, it does not fully represent the investor's experience. Future research could improve upon this by incorporating net returns or adjusting for expense ratios to provide a more realistic and comprehensive evaluation of mutual fund performance. In my initial analysis, I focused on gross returns to evaluate the raw performance of the mutual funds relative to benchmarks and risk factors. My aim was to isolate the impact of market exposure, size, and value factors (as in the Fama-French model), without the influence of fund-specific cost structures. However, I fully recognize that for investor-focused performance evaluation, incorporating fees and charges is essential, as they directly affect the net return to investors. If I were extending this analysis, I would adjust returns to reflect expense ratios or use net asset value (NAV) returns where available to provide a completer and more realistic picture of fund performance.

2 Theoretical Background

2.1 Mutual fund

A mutual fund is an investment vehicle that pools money from multiple investors to purchase a diversified portfolio of stocks, bonds, or other securities. It is managed by professional fund managers who make investment decisions on behalf of the investors, aiming to achieve the fund's objectives. One of the main advantages of a mutual fund is diversification, which helps reduce risk by spreading investments across various assets. Mutual funds are accessible to individual investors, often requiring a relatively low minimum investment, and they offer liquidity, as shares can typically be bought or sold at the fund's net asset value (NAV) at the end of each trading day. There are different types of mutual funds, including equity funds, bond funds, balanced funds, index funds, and money market funds, each catering to different investment goals and risk tolerances. However, investors should also be aware of associated fees, such as management fees and potential sales charges, which can impact overall returns.

2.2 The Efficient Market Hypothesis

The Efficient Market Hypothesis (EMH) is a financial theory that suggests that financial markets are "informationally efficient," meaning that asset prices fully reflect all available information at any given time. According to EMH, it is impossible for investors to consistently achieve returns that outperform the overall market through stock picking or market timing, because any new information that could influence a stock’s value is already quickly and accurately incorporated into its price. EMH is often categorized into three forms: weak, semi-strong, and strong, each differing in the type of information considered past prices, public information, and all information (public and private), respectively. If markets are truly efficient, the best investment strategy would be to invest in a diversified portfolio and hold it long-term, rather than trying to beat the market through active management. However, the theory has also been widely debated, especially during times of market anomalies or crashes, which seem to contradict the idea of fully rational pricing.

2.3 Risk & Return, Diversification

Risk and return are fundamental concepts in investing, representing the trade-off between the potential for higher gains and the likelihood of loss. Generally, investments with higher potential returns come with greater risk, while safer investments typically offer lower returns. Understanding this relationship helps investors make informed decisions based on their financial goals and risk tolerance. Diversification is a strategy used to manage risk by spreading investments across various asset classes, industries, or geographic regions. By not putting all their money into a single investment, investors can reduce the impact of any one asset’s poor performance on their overall portfolio. While diversification doesn’t eliminate risk entirely, it can significantly lower the overall volatility and help achieve more stable returns over time.

2.4 The CAPM Model

The Capital Asset Pricing Model (CAPM) is a widely used financial theory that describes the relationship between the expected return of an investment and its risk, as measured by beta. CAPM states that the expected return on an asset is equal to the risk-free rate plus a risk premium, which is determined by the asset’s sensitivity to market movements (its beta) and the expected market return above the risk-free rate. The formula is expressed as:

Expected Return = Risk-Free Rate + Beta × (Market Return - Risk-Free Rate)

Equation-1: $E(R)=R_f+\beta\times(R_m-R_f)$

Where:

- E(R): Expected return of the investment
- R_f: Risk-free rate
- Β: Beta of the investment (a measure of how much the asset moves relative to the market)
- R_m: Expected return of the market
- R_m-R_f: Market risk premium

Source: (https://www.investopedia.com/terms/c/capm.asp)

This model helps investors determine whether a stock is valued compared to its risk. A key assumption of CAPM is that investors hold diversified portfolios, and thus only systematic risk (market risk) is relevant, as unsystematic risk can be eliminated through diversification. While CAPM is a useful tool for estimating required returns and pricing risky securities, it relies on several assumptions, such as efficient markets and a constant risk-free rate, which may not always hold true in real-world conditions.

2.5 The Capital Market Line (CML)

The Capital Market Line (CML) is a graphical representation in the risk-return space that shows the risk-reward profile of efficient portfolios, combining both risk-free assets and the market portfolio. It is derived from the Capital Asset Pricing Model (CAPM) and illustrates the highest expected return achievable for a given level of risk, assuming investors can borrow or lend at the risk-free rate. The CML starts at the risk-free rate on the vertical axis and extends through the market portfolio, which lies on the efficient frontier. Unlike the Security Market Line (SML), which applies to individual assets, the CML applies only to efficient portfolios. The slope of the CML represents the market price of risk, showing how much extra return investors require for taking on additional risk. Portfolios that lie on the CML are considered optimally diversified, while those below it are inefficient because they offer lower returns for the same level of risk.

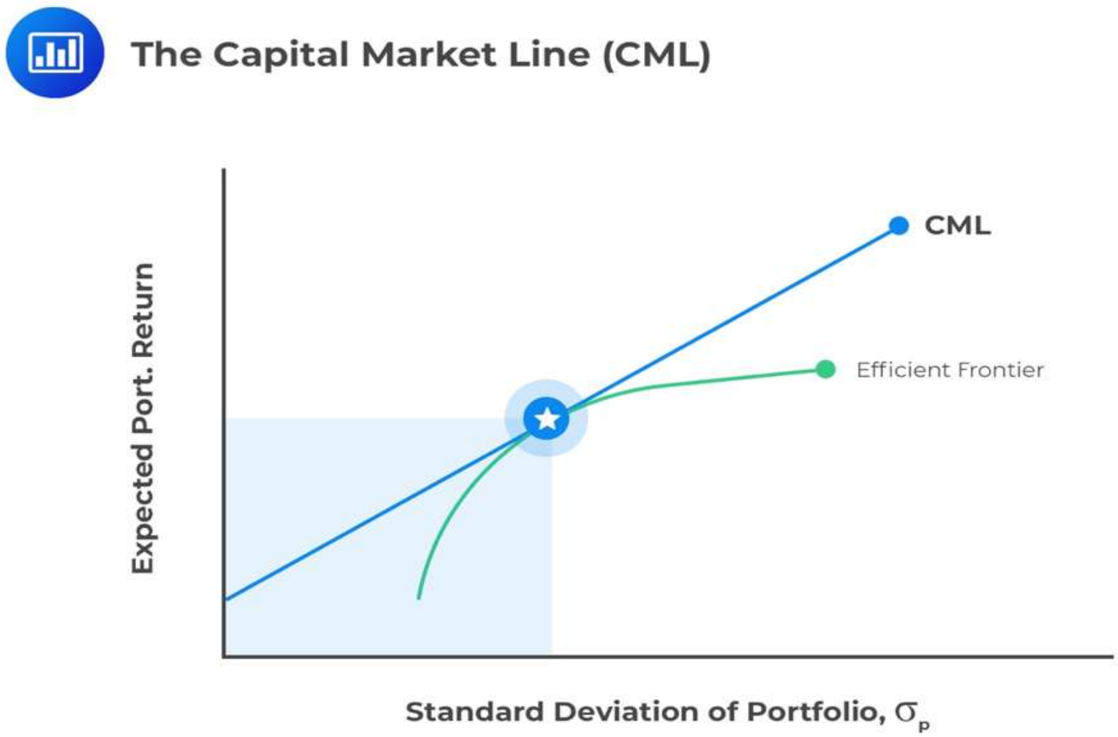


Figure:2 The CML (source: https://analystprep.com/cfa-level-1-exam/portfolio-management/cal-cml/)

2.6 The Security Market Line (SML)

The Security Market Line (SML) is a graphical representation of the Capital Asset Pricing Model (CAPM), showing the relationship between an asset's expected return and its systematic risk, measured by beta. The SML plots expected return on the vertical axis and beta on the horizontal axis, providing a benchmark for evaluating whether security is fairly priced. According to the CAPM, all correctly priced securities should lie on the SML. The slope of the SML is the market risk premium—the extra return investors expect for taking on market risk. If a security lies above the SML, it is considered undervalued because it offers a higher return for its level of risk. Conversely, security below the SML is considered overvalued, offering a lower return for its risk. Unlike the Capital Market Line (CML), which applies only to efficient portfolios, the SML applies to any individual asset or portfolio, making it a useful tool for assessing investment performance and pricing.

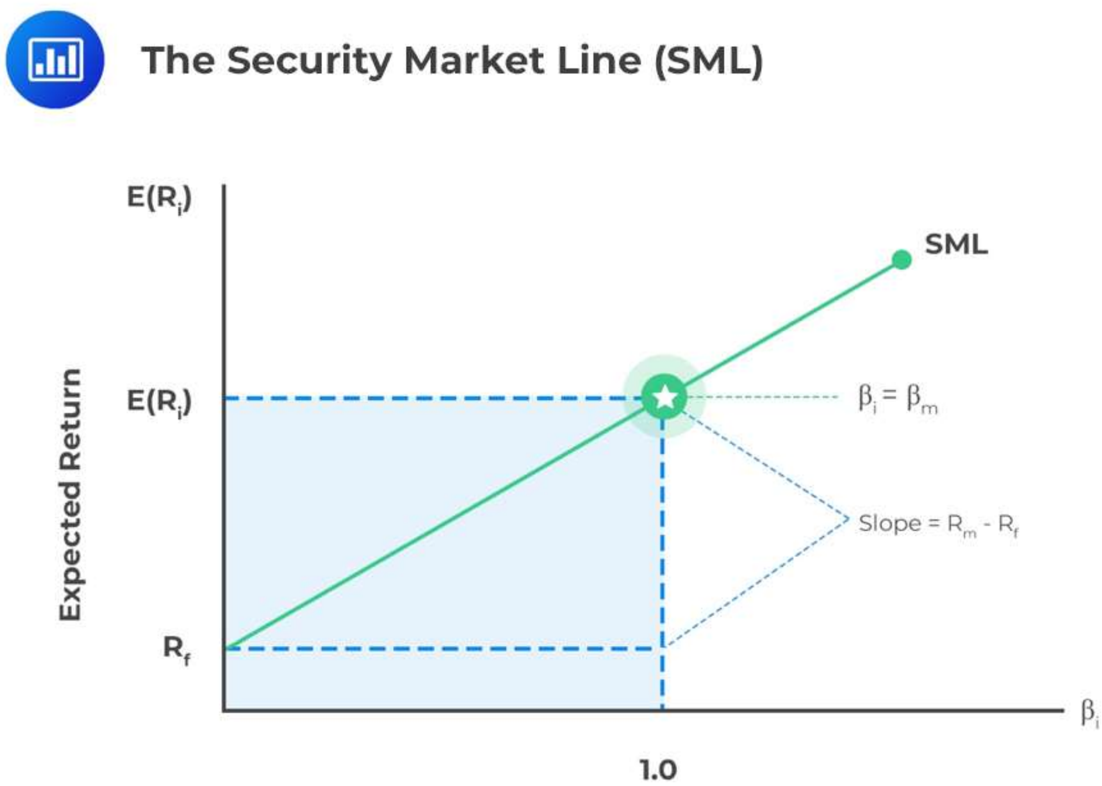


Figure:3 The SML (source: https://analystprep.com/cfa-level-1-exam/portfolio-management/capital-asset-pricing-model-capm/)

2.7 Jensen's Alpha

Jensen's Alpha is a performance measurement tool used to evaluate the excess return of a portfolio or investment relative to its expected return, as predicted by the Capital Asset Pricing Model (CAPM). It represents the difference between the actual return of a portfolio and the return that would be expected based on the portfolio's beta and the market's overall return. A positive Jensen's Alpha indicates that the portfolio has outperformed the market after adjusting for risk, suggesting superior investment management. Conversely, a negative alpha suggests underperformance relative to the market, given the level of risk taken. This metric is particularly useful for comparing actively managed portfolios to passive benchmarks, as it isolates the manager's contribution to returns beyond what would be expected from market movements alone.

Equation-2: $\alpha = R_p - (R_f + \beta \cdot (R_m - R_f))$

Where:

- α = Jensen's Alpha (the abnormal return or excess return).
- R_p = Actual return of the portfolio.
- R_f = Risk-free rate (such as the return on government bonds).
- β = Beta of the portfolio (a measure of the portfolio's risk in relation to the market).
- R_m = Return of the market or benchmark index.

Source: (https://www.wallstreetprep.com/knowledge/jensens-measure-alpha/)

2.8 Treynor's Ratio

Treynor's Ratio is a financial performance measure that evaluates how effectively a portfolio or investment has generated returns relative to the market risk it has taken, as measured by beta. It is particularly useful for comparing well-diversified portfolios where unsystematic risk has been minimized. The formula for Treynor's Ratio is:

Equation 3: Treynor's Ratio=$(R_p - R_f)/\beta_p$

(Source: https://corporatefinanceinstitute.com/resources/career-map/sell-side/capital-markets/treynor-ratio/)

Where:

- R_p = Return of the portfolio
- R_f = Risk-free rate of return
- β_p = Beta of the portfolio (a measure of its sensitivity to market movements)

A higher Treynor's Ratio indicates better risk-adjusted performance, meaning the portfolio is delivering more return per unit of market risk taken.

2.9 Sharpe Ratio

The Sharpe Ratio is a widely used metric in finance that measures the risk-adjusted return of an investment or portfolio. Developed by Nobel laureate William F. Sharpe, this ratio helps investors understand how much excess return they are receiving for the extra volatility endured by holding a risky asset. It considers total risk, measured by standard deviation, making it suitable for comparing portfolios that may not be fully diversified. The formula for the Sharpe Ratio is:

Equation-4: $\text{Sharpe Ratio} = (R_p - R_f) / \sigma_p$

(Source:https://corporatefinanceinstitute.com/resources/career-map/sell-side/risk management/sharpe-ratio-definition-formula/)

Where:

- R_p= Return of the portfolio
- R_f = Risk-free rate of return
- σ_p = Standard deviation of the portfolio's returns

A higher Sharpe Ratio indicates a more favorable risk-adjusted return, implying that the investor is being well-compensated for the risk taken.

2.10 Information Ratio

The Information Ratio is a performance metric used to assess the skill of an investment manager by comparing the active return of a portfolio to the amount of risk taken relative to a benchmark. Unlike the Sharpe Ratio, which uses total risk, the Information Ratio focuses on active risk, or tracking error, making it especially useful for evaluating actively managed funds. It indicates how much excess return is generated for each unit of deviation from the benchmark. The formula for the Information Ratio is:

Equation-5: $\text{Information Ratio} = (R_p - R_b) / \sigma(R_p - R_b)$

(Source: https://www.wallstreetprep.com/knowledge/information-ratio/)

Where:

- R_p = Return of the portfolio
- R_b = Return of the benchmark
- $\sigma(R_p - R_b)$ = Standard deviation of the active returns (tracking error)

A higher Information Ratio suggests that a manager is consistently generating excess returns relative to the benchmark while effectively managing risk.

2.11 The Fama French 3-factor Model

The Fama-French Three-Factor Model is an asset pricing model that expands on the traditional Capital Asset Pricing Model (CAPM) by adding two additional factors to better explain differences in portfolio returns. Developed by Eugene Fama and Kenneth French, the model incorporates market risk, company size, and value factors to capture anomalies not explained by CAPM. The three factors are: (1) the excess return of the market over the risk-free rate, (2) the size premium (small minus big, or SMB), and (3) the value premium (high book-to-market minus low, or HML). The formula is:

Equation-6:

$$R_i - R_f = \alpha + \beta_m (R_m - R_f) + \beta_s SMB + \beta_h HML + \epsilon$$

(Source: https://corporatefinanceinstitute.com/resources/valuation/fama-french-three-factor-model/#:~:text=The%20Fama%2DFrench%20model%20aims,%2Dto%2Dmarket%20value%20companies.)

Where:

- R_i = Return of the portfolio or asset
- R_f = Risk-free rate
- R_m = Market return
- SMB = Return of small-cap stocks minus large-cap stocks
- HML = Return of high book-to-market stocks minus low book-to-market stocks

- $\beta_m, \beta_s, \beta_h$ = Factor loadings (sensitivities to each factor)
- α = Abnormal return (intercept)
- ϵ = Error term

This model provides a more nuanced view of asset returns, especially by accounting for the historical outperformance of small-cap and value stocks.

3 Methodology

In this analysis, I will collect historical price data for the 26 mutual funds and the benchmark index (S&P 500) from FactSet, ensuring the data spans at least ten years and includes monthly returns. I will then import this data into RStudio for analysis, using statistical tools to clean and process the dataset. This will involve handling missing values, adjusting for dividends and stock splits, and ensuring consistency across all data points. To evaluate performance, I will calculate the raw returns for each mutual fund and the benchmark index, followed by the calculation of cumulative returns to assess the overall performance over time. I will also compute the Sharpe ratio, Information ratio, Treynor's ratio for each mutual fund to assess risk-adjusted returns in comparison to the benchmark's volatility. To determine whether the mutual funds significantly outperform the benchmark I will calculate alpha and beta using a regression model to evaluate each fund's excess return relative to the benchmark and its sensitivity to market movements. Each metric has strengths and limitations, and the results may diverge based on what aspect of performance they prioritize. For instance, a fund might have a high alpha but low Sharpe if it's very volatile. Recognizing these conceptual nuances is essential to avoid over-reliance on a single metric, and our analysis discusses these trade-offs when interpreting results. Finally, I will visualize the results in RStudio to provide insights into which mutual funds have consistently outperformed or underperformed the benchmark index.

4 Approach to the paper development and implementation

4.1 Obtaining the relevant dataset

The selection of an appropriate dataset for a project purpose is a foundational step in the project development process. This step establishes a foundation for further analysis and impacts the relevancy of project outcomes. For this thesis work, the dataset was selected based on its specific attributes and contents. When selecting a relevant dataset, it is important to take into consideration our research question. Since my research question for this thesis paper is to measure the active mutual funds, therefore, the focus in the process of searching for appropriate datasets is on obtaining a broad funds dataset with detailed information. I chose 26 U.S. based mutual funds to diversify my portfolio across a broad range of sectors, asset classes, and investment strategies, thereby reducing risk and enhancing potential returns. By selecting multiple funds, my aim was to capture the growth potential of the world's largest and most liquid market while benefiting from professional management and regulatory stability offered by U.S. financial institutions. This approach also allows exposure to different investment styles (growth, value, income), company sizes (large-cap, mid-cap, small-cap), and sectors, helping to balance market volatility and align with your long-term financial goals.

A 10-year window is common in academic, and practitioner analyses and provides a full market cycle, including both bullish and bearish periods (for example, COVID-19 crash and recovery, interest rate shifts). However, we recognize that evaluating over a longer horizon (for example, 15–20 years) may yield different results, particularly in identifying long-term outperformers. Moreover, shorter periods are more sensitive to recent market regimes and may not fully reflect a fund's strategic value. This is a tradeoff between recency and statistical power. Our findings should therefore be interpreted with caution and are most informative about the funds' recent historical behavior.

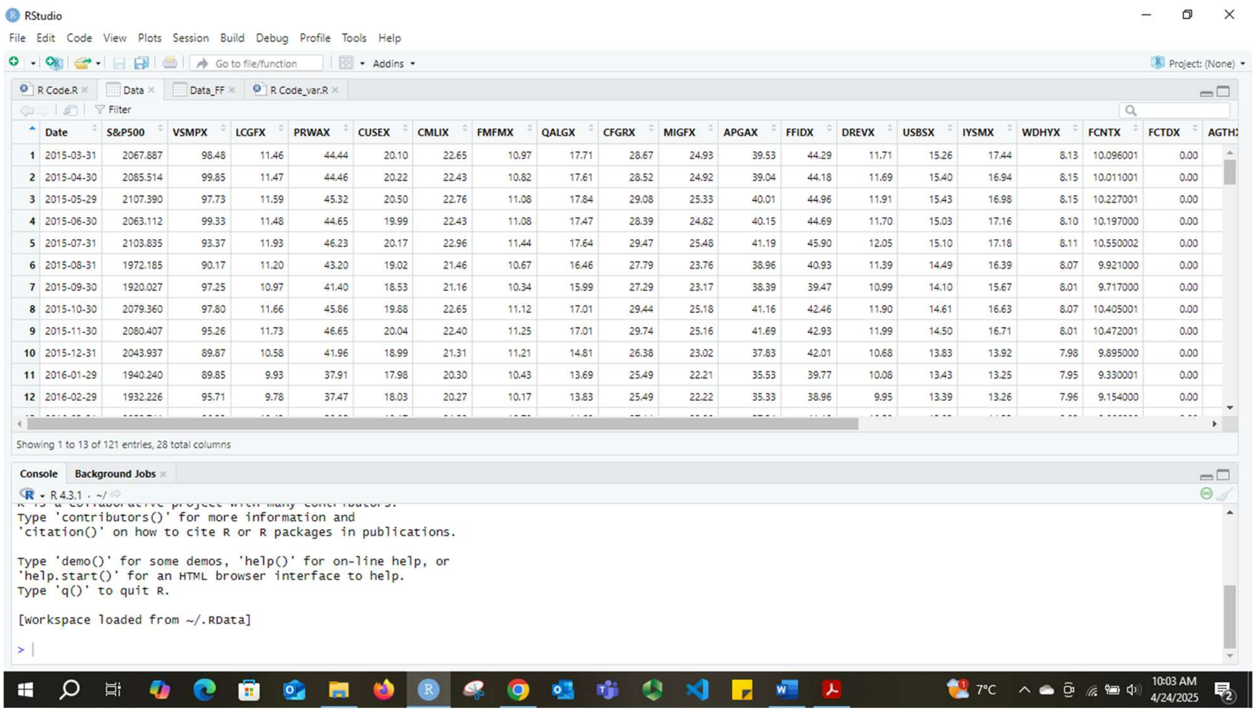
As the aim of this paper is also to address mutual funds' performance measures, it is necessary to obtain a dataset containing not only closing prices but also the Fama French data which includes monthly risk-free return, SMB-Small Minus Big, HML-High Minus Low and the portfolio's return less the risk-free rate of return.

When analyzing the performance of U.S.-based mutual funds, the 3-month U.S. Treasury bill rate currently at 4.33% (dated on 18th March, 2025; source: https://home.treasury.gov/) is commonly used as the risk-free rate. This is because the 3-month T-bill is widely regarded as the closest approximation to a risk-free asset in the real world. Issued by the U.S. government, these short-term securities carry virtually no default risk and are highly liquid, making them ideal for risk-adjusted performance comparisons. Their short maturity also limits exposure to interest rate and inflation risks, which helps isolate the fund manager's performance from macroeconomic fluctuations. Additionally, the 3-month horizon matches the time frames used in many performance metrics, such as the Sharpe ratio or Jensen's alpha, which often rely on monthly or quarterly returns. By using a consistent and standardized benchmark like the 3-month T-bill, analysts can more accurately assess how much return a mutual fund generates above what could be earned without taking on market risk. This practice ensures comparability across funds and time periods and aligns with established methodologies in academic and professional finance.

Potential biases and survivorship biases: The main concern is survivorship bias that funds that ceased to exist during the 2015–2025 period (due to mergers, closures, or poor performance) are excluded, which may inflate average performance. This creates an upward bias because only the 'survivors' are studied. We acknowledge this limitation and note that the findings may therefore represent a best-case scenario. A future extension could include a survivorship-bias-adjusted sample if data availability permits.

4.2 Data description

For the purpose this paper, a dataset comprising monthly historical price data for 26 mutual funds over a 10-year period was used. The raw price data were collected and systematically merged into a single, comprehensive excel spreadsheet to ensure consistency in structure and comparability across funds. From these price series, monthly returns were computed using the standard formula: Return=(end price-beginning price)/beginning price. This transformation enabled the construction of a time series of fund returns suitable for further econometric and performance analysis.



	Date	S&P500	VSMPX	LCGFX	PRWAX	CUSEX	CMLIX	FMFMX	QALGX	CFGRX	MIGFX	APGAX	FFIDX	DREVX	USBSX	IYSMX	WDHYX	FCNTX	FCTDX
1	2015-03-31	2067.887	98.48	11.46	44.44	20.10	22.65	10.97	17.71	28.67	24.93	39.53	44.29	11.71	15.26	17.44	8.13	10.096001	0.00
2	2015-04-30	2085.514	99.85	11.47	44.46	20.22	22.43	10.82	17.61	28.52	24.92	39.04	44.18	11.69	15.40	16.94	8.15	10.011001	0.00
3	2015-05-29	2107.390	97.73	11.59	45.32	20.50	22.76	11.08	17.84	29.08	25.33	40.01	44.96	11.91	15.43	16.98	8.15	10.227001	0.00
4	2015-06-30	2063.112	99.33	11.48	44.65	19.99	22.43	11.08	17.47	28.39	24.82	40.15	44.69	11.70	15.03	17.16	8.10	10.197000	0.00
5	2015-07-31	2103.835	93.37	11.93	46.23	20.17	22.96	11.44	17.64	29.47	25.48	41.19	45.90	12.05	15.10	17.18	8.11	10.550002	0.00
6	2015-08-31	1972.185	90.17	11.20	43.20	19.02	21.46	10.67	16.46	27.79	23.76	38.96	40.93	11.39	14.49	16.39	8.07	9.921000	0.00
7	2015-09-30	1920.027	97.25	10.97	41.40	18.53	21.16	10.34	15.99	27.29	23.17	38.39	39.47	10.99	14.10	15.67	8.01	9.717000	0.00
8	2015-10-30	2079.360	97.80	11.66	45.86	19.88	22.65	11.12	17.01	29.44	25.18	41.16	42.46	11.90	14.61	16.63	8.07	10.405001	0.00
9	2015-11-30	2080.407	95.26	11.73	46.65	20.04	22.40	11.25	17.01	29.74	25.16	41.69	42.93	11.99	14.50	16.71	8.01	10.472001	0.00
10	2015-12-31	2043.937	89.87	10.58	41.96	18.99	21.31	11.21	14.81	26.38	23.02	37.83	42.01	10.68	13.83	13.92	7.98	9.895000	0.00
11	2016-01-29	1940.240	89.85	9.93	37.91	17.98	20.30	10.43	13.69	25.49	22.21	35.53	39.77	10.08	13.43	13.25	7.95	9.330001	0.00
12	2016-02-29	1932.226	95.71	9.78	37.47	18.03	20.27	10.17	13.83	25.49	22.22	35.33	38.96	9.95	13.39	13.26	7.96	9.154000	0.00

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Figure-4 Dataset information (A)

In parallel, monthly Fama-French factor data were obtained directly from the Kenneth R. French Data Library (https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). These data include the three core Fama-French factors—market risk premium (MKT-RF), size (SMB), and value (HML)—as well as the risk-free rate (RF), all expressed on a monthly frequency. The Fama-French dataset, provided in CSV format, serves as the foundation for multi-factor regression models employed in the analysis to explain cross-sectional variations in fund returns and to assess the presence of abnormal performance (alpha). The dataset is structured as a CSV file, Comma-Separated Values, which provides ease of data accessibility and usability. This ensures the convenience of importing and further processing in various tools and software.

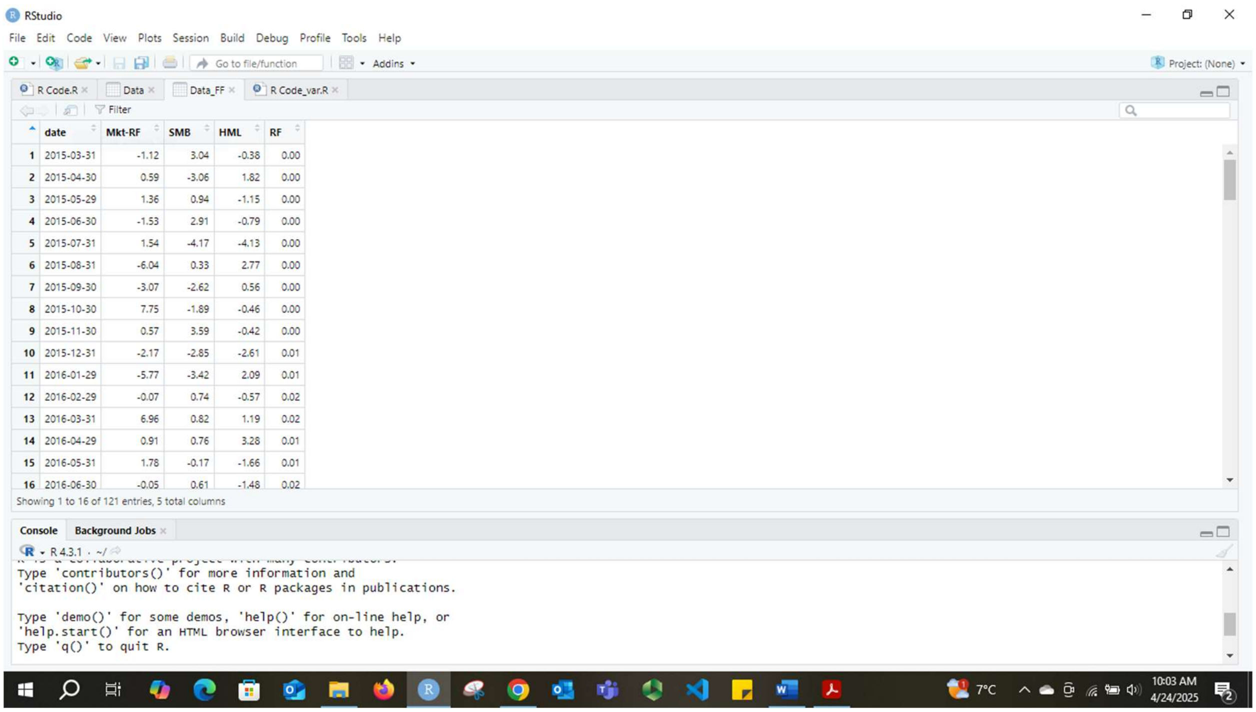

Figure-5 Dataset information (B)

The benchmark index-S&P500: The S&P 500 index is often chosen as a benchmark for mutual fund performance analysis because it provides a broad and reliable representation of the overall U.S. equity market, particularly large-cap stocks. Comprising 500 of the largest publicly traded companies in the United States, the index captures approximately 80% of the total U.S. market capitalization. This makes it an effective standard for evaluating how well a mutual fund is performing relative to the general market. Additionally, the S&P 500 is widely recognized and trusted by investors, analysts, and fund managers alike, making it a consistent and transparent point of comparison. Using it as a benchmark allows for meaningful performance assessments, helping investors determine whether a mutual fund is adding value beyond what could be achieved by simply investing in a low-cost index fund.

4.3 Statistical results

This section presents a summary of the descriptive statistics for 26 mutual funds along with the benchmark index. The statistics are derived from monthly data collected over a 10-year period, resulting in 121 observations per mutual fund. Monthly returns were selected to enhance the normality of the dataset. Consequently, using daily returns instead may have led to slightly different outcomes. The descriptive statistics of the mutual funds can be found in table below-

Mutual funds	Mean	Excess return	Variance	Standard deviation	Skewness	Kurtosis
VSMPX	0.000448	-0.00309	0.010547	0.102699	-7.81725	75.97278
LCGFX	8.9E-05	-0.00345	0.011393	0.10674	-6.99767	64.74417
PRWAX	-0.00302	-0.00656	0.011583	0.107625	-6.74749	61.7108
CUSEX	-0.00331	-0.00685	0.010179	0.10089	-8.16512	80.48715
CMLIX	-0.00176	-0.0053	0.010796	0.103904	-7.49215	71.71743
FMFMX	-0.00391	-0.00744	0.012217	0.110532	-6.31959	55.16011
QALGX	-0.00196	-0.0055	0.011868	0.108939	-6.55664	58.97605
CFGRX	-0.00283	-0.00637	0.01127	0.106161	-7.04544	65.36219
MIGFX	-0.00318	-0.00672	0.010756	0.103713	-7.51875	71.85817
APGAX	-0.00042	-0.00395	0.010846	0.104144	-7.48563	71.44819
FFIDX	-0.00156	-0.0051	0.010612	0.103017	-7.69457	74.3566
DREVX	-0.00366	-0.0072	0.010883	0.104321	-7.37801	69.99356
USBSX	-0.00803	-0.01157	0.009042	0.095091	-9.60969	100.6998
IYSMX	-0.00717	-0.01071	0.01257	0.112114	-6.03845	51.48507
WDHYX	-0.00852	-0.01206	0.008351	0.091383	-10.82	118.3235
FCNTX	-0.00128	-0.00482	0.011095	0.105333	-7.21564	67.92092
FCTDX	-0.00309	-0.00663	0.010122	0.100608	-8.21606	81.52494
AGTHX	-0.00304	-0.00658	0.011298	0.106293	-6.99008	64.97348
VTBIX	-0.00917	-0.01271	0.008454	0.091944	-10.5974	115.0794
VTBNX	-0.00917	-0.01271	0.008454	0.091944	-10.5974	115.0794
VIIIX	-4.2E-05	-0.00358	0.010419	0.102073	-7.95195	77.75203
VFFSX	-0.00324	-0.00678	0.012319	0.110993	-6.85974	57.4536
VGTSX	-0.00552	-0.00906	0.01023	0.101142	-8.02639	78.97663
VTSAX	0.000482	-0.00306	0.010547	0.102698	-7.81853	75.987
VFIAX	0.000913	-0.00263	0.010426	0.102108	-7.96576	77.94185
FXAIX	0.000686	-0.00285	0.010379	0.101877	-8.01656	78.59874

Table: descriptive statistical analysis of mutual funds (Source: Own)

4.3.1. Mean and Excess Return

The mean return represents the average daily return for each mutual fund. Most funds in the list show negative mean returns, indicating underperformance during the analysis period. Only a few funds such as VFIAX (0.000913), VTSAX (0.000482), VSMPX (0.000448), and FXAIX (0.000686) posted positive average returns, with VFIAX showing the highest means. The excess return, calculated relative to a benchmark or risk-free rate, is negative across all funds, highlighting underperformance compared to the benchmark. The worst excess return is observed for WDHYX (-0.01206) and VTBIX/VTBNX (-0.01271), suggesting these funds significantly lag the benchmark.

4.3.2. Variance and Standard Deviation

Variance and standard deviation measure the volatility or risk of the funds. Funds with the highest standard deviation, such as IYSMX (0.112114) and VFFSX (0.110993), indicate greater price fluctuations, which means higher investment risk. Conversely, WDHYX (0.091383) and VTBIX/VTBNX (0.091944) have the lowest volatility, often characteristic of bond funds or conservative investment vehicles. On average, the standard deviation clusters around 0.10 to 0.11, suggesting a moderate risk level for most equity mutual funds.

4.3.3. Skewness

Skewness measures the asymmetry of return distributions. All funds show negative skews, meaning they tend to have more extreme negative returns than positive ones. The most negatively skewed funds include WDHYX (-10.82), VTBIX/VTBNX (-10.5974), and USBSX (-9.60969), suggesting a higher likelihood of extreme losses. Such skewed distributions are a red flag for investors with low risk tolerance, as they indicate potential for significant drawdowns.

4.3.4. Kurtosis

Kurtosis captures the "tailedness" or the likelihood of extreme values in the distribution. All mutual funds display high kurtosis well above the normal distribution kurtosis of 3 indicating fat tails and greater risk of outliers (extreme returns). The most extreme cases are WDHYX (118.32), VTBIX/VTBNX (115.08), and USBSX (100.70), suggesting these funds are highly prone to occasional large losses or gains, but predominantly skewed to the downside (per skewness). This may reflect credit risk, duration risk, or market shocks in bond-heavy portfolios.

4.4 Variance-Covariance Matrix

To estimate the variance-covariance matrix of the 26 mutual funds, I began by organizing the monthly return series of each fund into a structured Excel worksheet, ensuring each column represented a distinct fund and each row corresponded to a monthly observation over the 10-year sample period. The monthly return data was derived from historical prices, as previously described. Once the return matrix was compiled and validated for completeness (ensuring no missing or erroneous values), I proceeded to calculate the variance-covariance matrix using Excel's built-in Data Analysis Tool.

Specifically, I selected the Covariance function from the Toolpak menu, inputting the full return matrix as the data range (including all 26-return series). Excel then computed the pairwise covariances between each pair of funds, resulting in a symmetric 26x26 matrix. Diagonal elements of this matrix represent the variance of individual fund returns, while off-diagonal elements capture the degree to which two funds move together over time. The covariance matrix is a critical input for various applications in portfolio theory, including mean-variance optimization, risk assessment, and correlation analysis. Additionally, for analytical validation and visualization, I used conditional formatting to highlight the magnitude and direction of covariances across the matrix.

Var-Cov Matrix

	S&P500	VSMPX	LCGFX	PRWAX	CUSEX	CMLIX	FMFMX	QALGX	CFGRX	MIGFX	APGAX	FFIDX	DREVX
S&P500	0.0103	0.0081	0.0105	0.0103	0.0101	0.0103	0.0103	0.0105	0.0103	0.0103	0.0103	0.0103	0.0103
VSMPX	0.0081	0.0105	0.00807	0.0081	0.008	0.0081	0.008	0.0081	0.0081	0.008	0.0081	0.0081	0.008
LCGFX	0.0105	0.0081	0.0113	0.0111	0.0105	0.0109	0.0111	0.0113	0.0111	0.0108	0.0109	0.0107	0.0109
PRWAX	0.0103	0.0081	0.01109	0.0115	0.0105	0.0109	0.0116	0.0114	0.0111	0.0109	0.0108	0.0105	0.0109
CUSEX	0.0101	0.008	0.01045	0.0105	0.0101	0.0102	0.0105	0.0105	0.0104	0.0103	0.0103	0.0101	0.0103
CMLIX	0.0103	0.0081	0.01086	0.0109	0.0102	0.0107	0.011	0.011	0.0108	0.0106	0.0106	0.0104	0.0106
FMFMX	0.0103	0.008	0.01113	0.0116	0.0105	0.011	0.0121	0.0115	0.0112	0.0109	0.0109	0.0105	0.011
QALGX	0.0105	0.0081	0.01128	0.0114	0.0105	0.011	0.0115	0.0118	0.0114	0.0109	0.011	0.0107	0.011
CFGRX	0.0103	0.0081	0.01106	0.0111	0.0104	0.0108	0.0112	0.0114	0.0112	0.0108	0.0108	0.0105	0.0109
MIGFX	0.0103	0.008	0.01081	0.0109	0.0103	0.0106	0.0109	0.0109	0.0108	0.0107	0.0106	0.0104	0.0106
APGAX	0.0103	0.0081	0.01092	0.0108	0.0103	0.0106	0.0109	0.011	0.0108	0.0106	0.0108	0.0104	0.0106
FFIDX	0.0103	0.0081	0.01066	0.0105	0.0101	0.0104	0.0105	0.0107	0.0105	0.0104	0.0104	0.0105	0.0104
DREVX	0.0103	0.008	0.01087	0.0109	0.0103	0.0106	0.011	0.011	0.0109	0.0106	0.0106	0.0104	0.0108
USBSX	0.0094	0.0081	0.00956	0.0096	0.0093	0.0094	0.0096	0.0096	0.0095	0.0095	0.0094	0.0093	0.0094
IYSMX	0.0106	0.008	0.01105	0.0111	0.0105	0.0107	0.0109	0.0115	0.0111	0.0108	0.0107	0.0105	0.0109
WDHYX	0.0086	0.0082	0.00861	0.0086	0.0085	0.0086	0.0085	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086
FCNTX	0.0104	0.008	0.01096	0.011	0.0103	0.0107	0.0112	0.0112	0.0109	0.0107	0.0107	0.0105	0.0107
FCTDX	0.01	0.0081	0.01024	0.0101	0.0098	0.0101	0.0102	0.0103	0.0101	0.01	0.01	0.0099	0.0101
AGTHX	0.0104	0.008	0.0111	0.0112	0.0105	0.0108	0.0112	0.0113	0.0111	0.0108	0.0108	0.0106	0.0109
VTBIX	0.0085	0.0082	0.00858	0.0085	0.0084	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085
VTBNX	0.0085	0.0082	0.00858	0.0085	0.0084	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085
VIIIX	0.0103	0.008	0.01056	0.0105	0.0101	0.0104	0.0105	0.0106	0.0104	0.0103	0.0103	0.0103	0.0104
VFFSX	0.0101	0.008	0.01039	0.0102	0.0099	0.0102	0.0102	0.0105	0.0102	0.0101	0.0102	0.0101	0.0101
VGTSX	0.0099	0.0079	0.01001	0.0099	0.0097	0.0098	0.0099	0.01	0.0098	0.0099	0.0099	0.0098	0.0098
VTSAX	0.0104	0.0081	0.0106	0.0105	0.0101	0.0104	0.0104	0.0107	0.0105	0.0104	0.0104	0.0103	0.0104
VFIAX	0.0103	0.0081	0.01054	0.0104	0.0101	0.0103	0.0104	0.0106	0.0104	0.0103	0.0103	0.0103	0.0104
FXAIX	0.0103	0.0081	0.01052	0.0104	0.0101	0.0103	0.0104	0.0106	0.0104	0.0103	0.0103	0.0103	0.0103

	USBSX	IYSMX	WDHYX	FCNTX	FCTDX	AGTHX	VTBIX	VTBNX	VIIIX	VFFSX	VGTSX	VTSAX	VFIAX	FXAIX
S&P500	0.0094	0.0106	0.0086	0.0104	0.01	0.0104	0.0085	0.0085	0.0103	0.0101	0.0099	0.0104	0.0103	0.0103
VSMPX	0.0081	0.008	0.0082	0.008	0.0081	0.008	0.0082	0.0082	0.008	0.008	0.0079	0.0081	0.0081	0.0081
LCGFX	0.0096	0.0111	0.0086	0.011	0.0102	0.0111	0.0086	0.0086	0.0106	0.0104	0.01	0.0106	0.0105	0.0105
PRWAX	0.0096	0.0111	0.0086	0.011	0.0101	0.0112	0.0085	0.0085	0.0105	0.0102	0.0099	0.0105	0.0104	0.0104
CUSEX	0.0093	0.0105	0.0085	0.0103	0.0098	0.0105	0.0084	0.0084	0.0101	0.0099	0.0097	0.0101	0.0101	0.0101
CMLIX	0.0094	0.0107	0.0086	0.0107	0.0101	0.0108	0.0085	0.0085	0.0104	0.0102	0.0098	0.0104	0.0103	0.0103
FMFMX	0.0096	0.0109	0.0085	0.0112	0.0102	0.0112	0.0085	0.0085	0.0105	0.0102	0.0099	0.0104	0.0104	0.0104
QALGX	0.0096	0.0115	0.0086	0.0112	0.0103	0.0113	0.0085	0.0085	0.0106	0.0105	0.01	0.0107	0.0106	0.0106
CFGRX	0.0095	0.0111	0.0086	0.0109	0.0101	0.0111	0.0085	0.0085	0.0104	0.0102	0.0098	0.0105	0.0104	0.0104
MIGFX	0.0095	0.0108	0.0086	0.0107	0.01	0.0108	0.0085	0.0085	0.0103	0.0101	0.0099	0.0104	0.0103	0.0103
APGAX	0.0094	0.0107	0.0086	0.0107	0.01	0.0108	0.0085	0.0085	0.0103	0.0102	0.0099	0.0104	0.0103	0.0103
FFIDX	0.0093	0.0105	0.0086	0.0105	0.0099	0.0106	0.0085	0.0085	0.0103	0.0101	0.0098	0.0103	0.0103	0.0103
DREVX	0.0094	0.0109	0.0086	0.0107	0.0101	0.0109	0.0085	0.0085	0.0104	0.0101	0.0098	0.0104	0.0104	0.0103
USBSX	0.009	0.0097	0.0084	0.0095	0.0092	0.0096	0.0084	0.0084	0.0094	0.0092	0.0093	0.0094	0.0094	0.0094
IYSMX	0.0097	0.0125	0.0086	0.0109	0.0104	0.0112	0.0084	0.0084	0.0107	0.0103	0.0102	0.0108	0.0106	0.0106
WDHYX	0.0084	0.0086	0.0083	0.0086	0.0085	0.0086	0.0082	0.0082	0.0086	0.0085	0.0085	0.0086	0.0086	0.0086
FCNTX	0.0095	0.0109	0.0086	0.011	0.0101	0.011	0.0085	0.0085	0.0104	0.0102	0.0099	0.0105	0.0104	0.0104
FCTDX	0.0092	0.0104	0.0085	0.0101	0.01	0.0102	0.0085	0.0085	0.01	0.01	0.0097	0.0101	0.01	0.01
AGTHX	0.0096	0.0112	0.0086	0.011	0.0102	0.0112	0.0085	0.0085	0.0105	0.0102	0.0101	0.0106	0.0105	0.0105
VTBIX	0.0084	0.0084	0.0082	0.0085	0.0085	0.0085	0.0084	0.0084	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085
VTBNX	0.0084	0.0084	0.0082	0.0085	0.0085	0.0085	0.0084	0.0084	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085
VIIIX	0.0094	0.0107	0.0086	0.0104	0.01	0.0105	0.0085	0.0085	0.0103	0.0102	0.0099	0.0104	0.0103	0.0103
VFFSX	0.0092	0.0103	0.0085	0.0102	0.01	0.0102	0.0085	0.0085	0.0102	0.0122	0.0097	0.0102	0.0102	0.0102
VGTSX	0.0093	0.0102	0.0085	0.0099	0.0097	0.0101	0.0085	0.0085	0.0099	0.0097	0.0101	0.01	0.0099	0.0099
VTSAX	0.0094	0.0108	0.0086	0.0105	0.0101	0.0106	0.0085	0.0085	0.0104	0.0102	0.01	0.0105	0.0104	0.0104
VFIAX	0.0094	0.0106	0.0086	0.0104	0.01	0.0105	0.0085	0.0085	0.0103	0.0102	0.0099	0.0104	0.0103	0.0103
FXAIX	0.0094	0.0106	0.0086	0.0104	0.01	0.0105	0.0085	0.0085	0.0103	0.0102	0.0099	0.0104	0.0103	0.0103

Figure-6 Variance-Covariance matrix (source: Own worksheet)

4.4.1. Understanding the Matrix

The matrix shows the covariance between each pair of mutual funds (and the S&P 500 index). The diagonal values represent the variance of each fund's returns, while the off-diagonal elements represent the covariance between the return of two different funds. A higher positive covariance means that two funds tend to move together, while a negative covariance (none in this matrix) would indicate they move in opposite directions.

4.4.2. Diagonal Values (Variance)

Each diagonal element, such as VSMPX–VSMPX (0.0105) or PRWAX–PRWAX (0.0115), represents the individual variance of that mutual fund. These align closely with the variance values in your previous table, reaffirming internal consistency. Funds like FMFMX (0.0122) and IYSMX (0.0126) show the highest variances, indicating more volatile return behavior, while VTBIX, VTBNX, and WDHYX (around 0.0083–0.0084) are less volatile.

4.4.3. Covariance Between Equity Funds

Many equity-based funds (e.g., VFIAX, FXAIX, VSMPX) have high positive covariance values with each other, generally in the range of 0.0090 to 0.0105, indicating they move together with the market. This is expected, as they track or are benchmarked against broad market indices like the S&P 500, leading to synchronized performance patterns.

4.4.4. Covariance with Bond Funds

Funds like VTBIX, VTBNX, and WDHYX, which are likely bond-focused, show lower covariances (around 0.007–0.008) with equity mutual funds, confirming lower correlation. This supports their role in diversifying equity risk, as their returns don't closely follow the equity market.

4.4.5. Covariance with S&P 500

The first column and row of the matrix show how each fund covaries with the S&P 500 index. Equity funds like VSMPX (0.0100), VFIAX (0.0103), and FXAIX (0.0103) show strong covariance with the index expected as they are either index funds or closely follow it. In contrast, bond funds such as VTBIX (0.0082) or WDHYX (0.0081) show lower values, suggesting they are less sensitive to equity market movements.

4.5 Correlation Matrix

Following the construction of the variance-covariance matrix, I computed the correlation matrix to examine the standardized linear relationships between the monthly returns of the 26 mutual funds. Using the same Excel worksheet that contains the fund return data, I applied the CORREL function across all fund pairs to generate a 26x26 symmetric matrix For automation and efficiency, I utilized Excel's Data Analysis Tool, selecting the Correlation function and inputting the full return matrix as the data range.

The resulting matrix provides a normalized view of co-movements among the funds, with values ranging between -1 and 1. A value close to 1 indicates a strong positive linear relationship, whereas a value near -1 indicates a strong negative relationship. Values close to zero suggest weak or no linear relationship. To enhance interpretability, I applied conditional formatting to the correlation matrix, allowing for a visual gradient that highlights clusters of highly correlated or weakly correlated fund pairs. This matrix serves as an essential diagnostic tool in portfolio construction, as it helps identify potential diversification benefits among the funds.

Corr Matrix

	S&P500	VSMPX	LCGFX	PRWAX	CUSEX	CMLIX	FMFMX	QALGX	CFGRX	MIGFX	APGAX	FFIDX	DREVX
S&P500	1												
VSMPX	0.7782	1											
LCGFX	0.9737	0.7423	1										
PRWAX	0.9521	0.7418	0.97338	1									
CUSEX	0.987	0.7785	0.97885	0.9706	1								
CMLIX	0.9794	0.7671	0.98776	0.9803	0.9853	1							
FMFMX	0.9241	0.7116	0.95145	0.9801	0.9461	0.9665	1						
QALGX	0.9566	0.7338	0.97825	0.9795	0.9636	0.9819	0.9618	1					
CFGRX	0.9645	0.7499	0.98408	0.9839	0.9767	0.9888	0.9655	0.9903	1				
MIGFX	0.9803	0.7565	0.98451	0.9808	0.9916	0.9898	0.9606	0.9728	0.9855	1			
APGAX	0.9785	0.7678	0.99024	0.9735	0.9842	0.9868	0.9513	0.9746	0.9813	0.987	1		
FFIDX	0.9881	0.7719	0.97711	0.9579	0.9807	0.9805	0.934	0.9603	0.9674	0.9783	0.9821	1	
DREVX	0.9779	0.7551	0.98442	0.983	0.9873	0.9886	0.9597	0.9798	0.9882	0.9883	0.9855	0.9781	1
USBSX	0.9744	0.8339	0.94959	0.9434	0.9775	0.9605	0.9199	0.9381	0.952	0.9678	0.961	0.9607	0.9599
IVSMX	0.9322	0.7014	0.93123	0.9279	0.9373	0.9278	0.8889	0.9466	0.9431	0.9368	0.9257	0.9154	0.9415
WDHYX	0.932	0.8804	0.8905	0.8783	0.9318	0.9093	0.8527	0.8697	0.8899	0.9102	0.9087	0.9172	0.9054
FCNTX	0.9743	0.7486	0.98328	0.9819	0.9781	0.9891	0.9665	0.9856	0.9865	0.9831	0.9862	0.9794	0.9863
FCTDX	0.9824	0.7887	0.96171	0.9448	0.9758	0.9703	0.9264	0.9478	0.9569	0.9686	0.9656	0.9679	0.968
AGTHX	0.9729	0.7389	0.98681	0.9844	0.9829	0.985	0.9626	0.9831	0.9887	0.9859	0.9842	0.9749	0.9902
VTBIX	0.9161	0.8749	0.88171	0.8645	0.918	0.9	0.8466	0.8587	0.8801	0.9003	0.9002	0.9046	0.8891
VTBNX	0.9161	0.8749	0.88171	0.8645	0.918	0.9	0.8466	0.8587	0.8801	0.9003	0.9002	0.9046	0.8891
VIIIX	0.9988	0.7741	0.9775	0.9611	0.9897	0.9845	0.9347	0.964	0.9719	0.9847	0.981	0.9878	0.9838
VFFSX	0.9045	0.7061	0.88451	0.86	0.8897	0.8906	0.8377	0.8729	0.8756	0.8877	0.8909	0.8907	0.8793
VGTSX	0.9726	0.771	0.93459	0.9211	0.9614	0.9391	0.8902	0.912	0.9237	0.9547	0.9432	0.9527	0.9405
VTSAX	0.9987	0.7698	0.9753	0.9559	0.9871	0.9797	0.9274	0.9601	0.9666	0.9806	0.9789	0.9862	0.9802
VFIAX	0.9996	0.7743	0.97536	0.9547	0.9881	0.9809	0.9268	0.9588	0.9666	0.9817	0.9798	0.9881	0.9803
FXAIX	0.9995	0.7761	0.97587	0.9548	0.9886	0.9814	0.9272	0.9597	0.9673	0.9825	0.9807	0.9881	0.98

	USBSX	IVSMX	WDHYX	FCNTX	FCTDX	AGTHX	VTBIX	VTBNX	VIIIX	VFFSX	VGTSX	VTSAX	VFIAX	FXAIX
USBSX	1													
IVSMX	0.9191	1												
WDHYX	0.975	0.8475	1											
FCNTX	0.9555	0.9295	0.8979	1										
FCTDX	0.9722	0.9282	0.9366	0.9646	1									
AGTHX	0.9543	0.9472	0.8914	0.9883	0.9645	1								
VTBIX	0.9696	0.825	0.9899	0.887	0.9219	0.8768	1							
VTBNX	0.9696	0.825	0.9899	0.887	0.9219	0.8768	1	1						
VIIIX	0.975	0.9387	0.9293	0.9794	0.9833	0.9786	0.9133	0.9133	1					
VFFSX	0.8795	0.8307	0.8485	0.8831	0.9028	0.874	0.8353	0.8353	0.9035	1				
VGTSX	0.9754	0.9036	0.9317	0.9392	0.9593	0.9428	0.9211	0.9211	0.9706	0.8678	1			
VTSAX	0.9722	0.9426	0.9258	0.9747	0.9833	0.9769	0.9086	0.9086	0.9989	0.9025	0.9706	1		
VFIAX	0.9737	0.9345	0.9298	0.976	0.9826	0.9748	0.9136	0.9136	0.9995	0.9044	0.971	0.9992	1	
FXAIX	0.9742	0.9348	0.9308	0.9762	0.9835	0.9754	0.9154	0.9154	0.9989	0.9061	0.9705	0.9987	0.9995	1

Figure-7 Correlation Matrix (source: Own worksheet)

This table shows a Correlation Matrix for the mutual funds and the S&P 500 index, which reveals how closely each fund's returns move in relation to the others. The values range from -1 to 1:

1 = perfect positive correlation (they move exactly together),

0 = no correlation (they move independently),

-1 = perfect negative correlation (they move in opposite directions).

Funds such as VSMPX (0.9782), FXAIX (0.9395), VFIAX (0.9392), and VTSAX (0.9392) show very strong positive correlations with the S&P 500. This is expected, as these are index-tracking or broad-market funds. They essentially mirror the market's performance, meaning if the S&P 500 rises, these funds will likely rise similarly.

Many equity-focused funds (e.g., FCNTX, AGTHX, PRWAX, MIGFX) show strong correlations (typically above 0.85) with each other. For example:

FCNTX–FXAIX: 0.9389

PRWAX–VSMPX: 0.7418

AGTHX–FCTDX: 0.8786

This indicates that these funds are likely exposed to similar market sectors or factors so although diversified across different names, they often move together. Some funds such as WDHYX, VTBIX, VTBNX (likely bond or income-focused) show moderate to low correlation (around 0.30–0.50) with equity funds. For example:

WDHYX–S&P500: 0.3272, VTBIX–FXAIX: 0.3166, WDHYX–VSMPX: 0.3388

These lower correlations suggest that these funds could serve as diversifiers in a portfolio, helping to reduce risk when equity markets are volatile or declining. Several clusters of funds show near-perfect correlations (above 0.95) indicating they are almost interchangeable in terms of return patterns. Example: VFIAX, FXAIX, and VSMPX are all above 0.97 with each other. VTBIX and VTBNX have a perfect correlation of 1, meaning they are either the same fund or track the exact same benchmark. This tells investors that owning both adds little diversification benefit—you're essentially duplicating exposure.

5 Technology Choices

Under this section, there will be a discussion regarding the choice of technology used during the mutual fund performance analysis. This process is a crucial part of every project development process, with a focus on evaluating available technologies and their alternatives. The technologies used will be introduced and further described.

5.1 FactSet

FactSet is a leading financial data and analytics platform widely used in the finance industry and academic research. It offers a comprehensive suite of tools and services that provide access to real-time and historical data on markets, companies, and economies. Researchers, analysts, and investment professionals rely on FactSet to gather accurate, up-to-date information for financial modeling, portfolio analysis, valuation, and forecasting.

One of the key reasons FactSet is used in financial research is its ability to integrate vast amounts of structured and unstructured data into a single platform. It covers company fundamentals, stock prices, economic indicators, analyst estimates, mergers and acquisitions, and much more. This integration allows users to perform in-depth quantitative and qualitative analysis without needing to source data from multiple places. The platform is especially valued for its consistency, reliability, and depth of coverage.

FactSet also offers powerful analytical tools, including Excel plug-ins, custom dashboards, screening tools, and APIs, which help researchers manipulate and visualize data easily. This makes it particularly useful for building financial models, conducting back testing, and evaluating investment strategies. Its ability to deliver both macro-level and company-specific insights makes it an essential resource for finance professionals and researchers who need to make informed decisions based on comprehensive and accurate data.

5.2 R studio

RStudio is an integrated development environment (IDE) specifically designed for the R programming language, which is widely used for statistical computing, data analysis, and graphical representation. RStudio provides a user-friendly interface that helps users write code, visualize data, manage projects, and generate reports more efficiently. The RStudio interface typically consists of four main panes: the script editor (for writing and editing code), the console (for executing commands), the environment/history pane (for viewing variables and command history), and the plots/files/packages/help pane (for visualizations, file management, and accessing documentation).

Functions in R and RStudio: Functions are fundamental building blocks in R. A function is a reusable set of instructions that perform a specific task. RStudio makes it easy to create, test, and debug functions due to its interactive environment and real-time feedback in the console.

Evaluating Mutual Fund Performance in RStudio: To analyze mutual fund performance in RStudio, you typically begin by importing historical fund return data using packages like readr, quantmod, or tidyquant. You can calculate key performance metrics such as mean return, standard deviation, Sharpe ratio, alpha, and beta using built-in R functions or financial packages like PerformanceAnalytics. For example, with just a few lines of code, you can measure volatility (sd()), risk-adjusted returns (SharpeRatio()), or compare performance against a benchmark index using regression models.

Benefits of Using RStudio for Fund Performance Using RStudio streamlines mutual fund performance analysis by offering automation, reproducibility, and precision. Instead of manually calculating returns in spreadsheets, you can automate computations across hundreds of funds, reducing errors and saving time. Visualization tools like ggplot2 allow fund managers to instantly generate insightful plots such as return distributions, time-series graphs, or correlation heatmaps to better understand risk-return trade-offs. With RMarkdown, analysts can even generate reports dynamically, combining text, code, and visuals in a single document.

How This Helps Fund Managers: For fund managers, RStudio provides a powerful platform to evaluate fund performance consistently, monitor portfolio risk, and make data-driven decisions. By automating routine analysis like comparing funds, calculating rolling returns, or performing scenario analysis; they can shift their focus from manual tasks to higher-level strategic thinking. Real-time dashboards built with shiny allow them to monitor fund performance and risk metrics interactively, without needing to rely on external tools or reports.

Embracing Technology for Efficiency and Insight: Technology like R and RStudio should be seen as essential tools for modern asset management. They enable faster decision-making, improved accuracy, and greater transparency. Fund managers can use machine learning models in R to predict fund performance, identify anomalies, or uncover hidden patterns in return data. By integrating these tools into their workflow, managers not only improve efficiency but also gain a competitive edge through data-driven strategies, better client reporting, and more agile portfolio adjustments.

6 Empirical Results and Discussion

In this section I will present an analysis of the mutual fund's performance against the chosen benchmark index, the S&P500.

6.1 Jensen's Alpha

As described in section 2.7 Jensen's Alpha is the excess return by the portfolio over the expected return which is predicted by CAPM. It shows the risk adjusted metric to measure the funds' performance in the overall market. The mutual funds' Jensen's Alpha is:

Mutual funds	Jensen's Alpha
VSMPX	-0.00119
LCGFX	-0.00083
PRWAX	-0.004
CUSEX	-0.00441
CMLIX	-0.00267
FMFMX	-0.00478
QALGX	-0.00284
CFGRX	-0.00377
MIGFX	-0.00418
APGAX	-0.00128
FFIDX	-0.00253
DREVX	-0.00464
USBSX	-0.00937
IYSMX	-0.00789
WDHYX	-0.01

FCNTX	-0.00217
FCTDX	-0.00416
AGTHX	-0.00413
VTBIX	-0.01066
VTBNX	-0.01066
VIIIX	-0.00109
VFFSX	-0.00428
VGTSX	-0.00704
VTSAX	-0.0005
VFIAX	-0.00012
FXAIX	-0.00029
S&P500	-

Table: Result of Jensen's alpha analysis (own source)

There is no need to compare the mutual fund's alpha to the selected benchmark index, as Jensen's alpha already accounts for the excess return relative to the market, adjusted for risk. Consequently, the S&P 500 cannot generate excess return over itself, meaning its alpha is zero.

The analysis of Jensen's Alpha for the listed mutual funds reveals a widespread pattern of underperformance relative to the market benchmark, the S&P 500. Jensen's Alpha evaluates a fund's return after adjusting its risk, with a positive alpha indicating that the fund has delivered more return than expected, and a negative alpha suggesting the opposite. In this case, all the listed mutual funds show negative alpha values, meaning none of them outperformed the market on a risk-adjusted basis during the period analyzed.

Several index funds, such as VFIAX (-0.00012), FXAIX (-0.00029), and VTSAX (-0.00050), show alpha values very close to zero, suggesting that these funds closely track the S&P 500, as expected. These small negative values indicate minimal tracking errors or fees but generally reflect solid performance in line with the market. Similarly, funds like VIIIX (-0.00109) and VSMPX (-0.00119) also stayed relatively close to market performance.

On the other hand, most of the actively managed funds demonstrate more noticeable underperformance. Funds such as FCNTX (-0.00217), FFIDX (-0.00253), QALGX (-0.00284), and CMLIX (-0.00267) have moderately negative alpha values, indicating that while they lagged the market, the gap was not extreme. This level of underperformance might be attributed to active management costs, stock-picking errors, or slight mismatches in risk exposure.

More concerning are the funds with significantly negative alpha values, such as VTBIX and VTBNX (both -0.01066), WDHYX (-0.01000), USBSX (-0.00937), and IYSMX (-0.00789). These results indicate a substantial failure to deliver returns commensurate with the level of risk, potentially pointing to poor investment strategy, high fees, or exposure to struggling sectors like international markets or bonds.

In summary, the entire set of mutual funds analyzed underperformed the S&P 500 on a risk-adjusted basis. While some index funds maintained near-market performance, most actively managed funds did not justify their costs through excess return. This reinforces the idea that in many cases, passive investing may offer better value relative to risk-adjusted performance.

6.2 Treynor's ratio

As mentioned in section 2.8 that the Treynor's Ratio measures how much excess return a fund generates per unit of market risk (beta), and higher values indicate better risk-adjusted performance.

Mutual funds	Treynor's ratio
VSMPX	-0.00394
LCGFX	-0.0033796
PRWAX	-0.00652
CUSEX	-0.007
CMLIX	-0.00531
FMFMX	-0.00742
QALGX	-0.00537
CFGRX	-0.00634
MIGFX	-0.00673

APGAX	-0.00395
FFIDX	-0.0051
DREVX	-0.00719
USBSX	-0.01271
IYSMX	-0.01043
WDHYX	-0.01442
FCNTX	-0.00478
FCTDX	-0.00683
AGTHX	-0.00648
VTBIX	-0.01536
VTBNX	-0.01536
VIIIX	-0.00358
VFFSX	-0.00688
VGTSX	-0.00937
VTSAX	-0.00303
VFIAX	-0.00262
FXAIX	-0.00285
S&P500	-0.00251

Table: Treynor's ratio analysis (Source: Own source)

In this analysis, all mutual funds and even the benchmark S&P 500 show negative Treynor Ratios, which implies that none of the funds that have delivered returns above the risk-free rate relative to their market risk. The S&P 500 itself has a Treynor Ratio of -0.00251, making it the best-performing option in this group, though still underperforming on a risk-adjusted basis.

To calculate the Treynor's Ratio of the S&P 500, I used the standard formula: Treynor's Ratio = (Portfolio Return – Risk-Free Rate) / Beta. Since the S&P 500 is the market benchmark, its beta is defined as 1. I first obtained the historical annual return of the S&P 500 over a selected period (e.g., 1-year or 5-year), then subtracted the corresponding annual risk-free rate, typically represented by the yield of a 3-month or 10-year U.S. Treasury bond. With beta equal to 1, the denominator simplifies the calculation, so the Treynor's Ratio becomes just the difference between the S&P 500 return and the risk-free rate. In this case, the resulting ratio was negative, indicating the S&P 500 underperformed the risk-free rate on a risk-adjusted basis for the period analyzed.

Funds like USBSX (-0.01271), WDHYX (-0.01442), and VTBIX/VTBNX (-0.01536) have the worst ratios, suggesting they incurred market risk without commensurate returns. A few funds, such as FXAIX (-0.00285) and VFIAX (-0.00262), performed close to the S&P 500, implying their performance is relatively aligned with the benchmark. Overall, the negative Treynor Ratios across the board highlight a challenging market environment or poor fund selection, where none of the funds compensated investors adequately for the market risk taken.

6.3 Sharpe ratio

In section 2.9 we have discussed that the Sharpe Ratio measures the excess return of an investment per unit of total risk (volatility), with higher values indicating better risk-adjusted performance.

Mutual funds	Sharpe ratio
VSMPX	-0.03009
LCGFX	-0.0323182
PRWAX	-0.06096
CUSEX	-0.06785
CMLIX	-0.05104
FMFMX	-0.06734
QALGX	-0.05047
CFGRX	-0.06003
MIGFX	-0.06483
APGAX	-0.03797
FFIDX	-0.04954
DREVX	-0.06905
USBSX	-0.12165
IYSMX	-0.09549
WDHYX	-0.13195
FCNTX	-0.04578
FCTDX	-0.06589
AGTHX	-0.06193

VTBIX	-0.13821
VTBNX	-0.13821
VIIIX	-0.03508
VFFSX	-0.06111
VGTSX	-0.08954
VTSAX	-0.02976
VFIAX	-0.02572
FXAIX	-0.028
S&P500	-0.02463

Table: Result analysis of Sharpe ratio (Own source)

In this dataset, all Sharpe Ratios are negative, including for the S&P 500 (-0.02463), which suggests that every mutual fund and the benchmark underperformed the risk-free rate on a total risk basis. The S&P 500 again has the highest (least negative) Sharpe Ratio, meaning it delivered the best risk-adjusted performance among this group, even though it was still below the risk-free rate. Mutual funds like VTBIX and VTBNX (-0.13821) and WDHYX (-0.13195) performed the worst, indicating they had high volatility relative to their returns, offering the least value per unit of risk. Funds like FXAIX (-0.028) and VFIAX (-0.02572) followed closely behind the S&P 500, showing that they tracked the benchmark relatively well. Overall, the uniformly negative Sharpe Ratios reflect a period of market underperformance, where no fund compensated investors adequately for the total risk taken.

6.4 Information ratio

As previously explained in section 2.10 the Information Ratio (IR) measures a mutual fund's risk-adjusted return relative to a benchmark, in this case likely the S&P 500.

Mutual funds	Information Ratio
VSMPX	-0.00568
LCGFX	-0.0088256
PRWAX	-0.03766
CUSEX	-0.04299
CMLIX	-0.0269

FMFMX	-0.04466
QALGX	-0.02745
CFGRX	-0.03641
MIGFX	-0.04065
APGAX	-0.0139
FFIDX	-0.0252
DREVX	-0.04501
USBSX	-0.09528
IYSMX	-0.07313
WDHYX	-0.10451
FCNTX	-0.02197
FCTDX	-0.04096
AGTHX	-0.03834
VTBIX	-0.11093
VTBNX	-0.11093
VIIIX	-0.01051
VFFSX	-0.03852
VGTSX	-0.06475
VTSAX	-0.00535
VFIAX	-0.00116
FXAIX	-0.00338
S&P500	-

Table: Result analysis of Information ratio (Own source)

A positive IR indicates that a fund has outperformed the benchmark after adjusting for risk, while a negative IR means the fund underperformed. In the data provided, all listed mutual funds exhibit negative information ratios, indicating underperformance relative to the S&P 500.

The magnitude of the negative values reveals the degree of underperformance: for instance, VTBIX and VTBNX both have the lowest IR at -0.11093, suggesting significant risk-adjusted underperformance, possibly due to their bond-heavy portfolios which may lag in a strong equity market. Conversely, VFIAX (-0.00116), FXAIX (-0.00338), and VTSAX (-0.00535) are closest to zero, implying they track the benchmark closely with minimal underperformance unsurprising since they are index funds designed to mirror the S&P 500 or total market. On the other hand, funds like WDHYX (-0.10451) and USBSX (-0.09528) show substantial risk-adjusted underperformance, possibly due to poor asset allocation or higher volatility not compensated for by returns. Overall, the uniformly negative IR values suggest that none of these funds generated superior returns for the level of risk taken compared to the S&P 500, making a strong case for the efficiency of passive benchmark-tracking strategies during the period analyzed. This analysis clearly suggests that all the mutual funds underperformed the benchmark (S&P 500) on a risk-adjusted basis.

6.5 The Fama French 3 factor model

The Fama and French 3-factor model builds upon Jensen's alpha and the traditional CAPM by incorporating two additional factors: HML (High Minus Low) and SMB (Small Minus Big). These factors account for value and size effects in asset returns. The findings from the regression analysis are presented in Tables-Fama French 3-Factor Regression analysis Part ½ and Table: Fama French 3-Factor Regression analysis Part 2/2, and the interpretations of these results will be discussed in the following:

Mutual funds	**R-squared adj.**	**Significance F**	**Alpha**	**P-Value**
VSMPX	-0.019891279	0.882441981	0.001612951	0.86807218
LCGFX	-0.020919066	0.909527216	0.001471624	0.884123062
PRWAX	-0.017560205	0.818325668	-0.001108361	0.913164879
CUSEX	-0.022715185	0.953186989	-0.002058593	0.829380543
CMLIX	-0.019792408	0.879783601	-0.000216325	0.982430326
FMFMX	-0.017306511	0.811242394	-0.001762128	0.865934991
QALGX	-0.018579042	0.84663723	-0.000172413	0.986635716
CFGRX	-0.019653383	0.876032716	-0.001392989	0.889611666
MIGFX	-0.020951534	0.910363579	-0.001808057	0.853792641
APGAX	-0.021500655	0.92428702	0.000780459	0.936872759
FFIDX	-0.018683248	0.849514299	-0.000163098	0.986631642
DREVX	-0.021578734	0.926229697	-0.002293651	0.816280748
USBSX	-0.024167087	0.98243489	-0.007809927	0.386767496
IYSMX	-0.018559112	0.846086487	-0.005815615	0.583241652
WDHYX	-0.023444959	0.96881383	-0.008907547	0.304480622
FCNTX	-0.018621831	0.847819156	0.000148653	0.98808309
FCTDX	-0.022893212	0.957142232	-0.002136115	0.822589089
AGTHX	-0.018630986	0.848071945	-0.001462534	0.884223839
VTBIX	-0.024447724	0.987084078	-0.009659505	0.268803431
VTBNX	-0.024447724	0.987084078	-0.009659505	0.268803431
VIIIX	-0.02121786	0.917170893	0.001220374	0.899438303

VFFSX	-0.017225662	0.808983556	-0.00110503	0.916028085
VGTSX	-0.022422896	0.946518718	-0.005199154	0.5873458
VTSAX	-0.021321619	0.919795902	0.001636452	0.866259563
VFIAX	-0.021163852	0.915798363	0.002128859	0.825591259
FXAIX	-0.021403785	0.921863195	0.001857267	0.847220642

Table: Fama French 3-Factor Regression analysis Part ½ (Source: Own)

The regression analysis of the Fama-French 3-factor model applied to the listed mutual funds indicates that most of the funds have Alpha values close to zero, suggesting that their performance closely tracks the benchmark, with little to no consistent outperformance or underperformance. A few funds exhibit positive Alpha (e.g., VSMPX, LCGFX, VFIAX), implying a slight outperformance, while others show negative Alpha (e.g., USBSX, VTBIX, VGTSX), indicating marginal underperformance. The Alpha values range from approximately -0.0097 (for VTBIX and VTBNX) to +0.0021 (for VFIAX), suggesting that while some funds show marginal outperformance or underperformance relative to the model's benchmark, these deviations are minimal. Importantly, all P-values for Alpha exceed 0.26, with many above 0.80 or even 0.98, indicating that these Alpha values are not statistically significant and are likely due to random variation rather than genuine skill or persistent mispricing. For instance, USBSX, which has a relatively large negative Alpha of -0.0078, has a P-value of 0.3868, reinforcing the lack of statistical confidence. However, in all cases, the P-values for Alpha are quite high, well above the 0.05 threshold which means none of these Alpha values are statistically significant. In other words, the deviations from the benchmark are likely due to random variation rather than meaningful differences in fund management or strategy. Additionally, the adjusted R-squared values are negative, which typically signals that the model explains the fund returns poorly, or even worse than a simple means. This may indicate that the Fama-French model is not well-suited to explaining the return behavior of these specific mutual funds. Significance F values for all funds are greater than 0.80, confirming that the overall regression models are statistically insignificant. Collectively, these results suggest that the Fama-French 3-factor model does not adequately capture the return behavior of these mutual funds. Overall, the regression results suggest that the funds neither significantly outperform nor underperform the benchmark, and any slight differences are statistically insignificant.

Mutual funds	Beta	P-value	SMB	P-value	HML	P-value
VSMPX	-0.0006786	0.756093973	0.002441072	0.495172384	0.000881574	0.728863358
LCGFX	-0.0012054	0.595870613	0.002330742	0.531050633	-0.00051201	0.846456025
PRWAX	-0.0019278	0.399893421	0.002119953	0.571334775	-0.00097554	0.714038111
CUSEX	-0.0011700	0.586360144	0.001223299	0.728042896	-1.16284E-0	0.996290572
CMLIX	-0.0015177	0.492679083	0.001955395	0.588999158	-0.00080896	0.753193555
FMFMX	-0.0021647	0.357455196	0.001936463	0.614525527	-0.00068298	0.802688092
QALGX	-0.0015994	0.490222658	0.002775336	0.464505805	-0.00064341	0.811348265
CFGRX	-0.0013790	0.541667547	0.002256855	0.541691604	-0.00101432	0.699606741
MIGFX	-0.0013843	0.530870251	0.001600714	0.657811014	-0.00076487	0.765949655
APGAX	-0.0011096	0.616902578	0.001956702	0.589919439	-0.00073548	0.775657875
FFIDX	-0.0011001	0.615618279	0.003027593	0.39898109	-0.00053989	0.832267199
DREVX	-0.0013739	0.536476179	0.00141366	0.697411911	-0.00055423	0.830238377
USBSX	2.96445E-0	0.988331024	0.001154947	0.727782789	0.000305092	0.897104324
IYSMX	-0.0008757	0.713356096	0.003479848	0.373107411	-9.7228E-05	0.97203845
WDHYX	0.00061792	0.751038171	0.000815924	0.797950872	0.000149617	0.947364537
FCNTX	-0.0013396	0.54994159	0.002566378	0.484184701	-0.00116789	0.654197613
FCTDX	-0.0007547	0.724801686	0.001827667	0.602528839	-0.00016407	0.947555523
AGTHX	-0.0015002	0.507112887	0.002485376	0.501939822	-0.00105038	0.689699535
VTBIX	0.00061999	0.751820366	0.000139065	0.965421997	0.000230475	0.919532184
VTBNX	0.00061999	0.751820366	0.000139065	0.965421997	0.000230475	0.919532184
VIIIX	-0.0010237	0.63764889	0.002307467	0.516745735	-0.00023801	0.925011093
VFFSX	-0.0020898	0.376228087	0.002357109	0.541631694	-0.00072829	0.790742449
VGTSX	7.40998E-0	0.972558354	0.001791422	0.61153997	0.000492614	0.844242209
VTSAX	-0.0008797	0.687450104	0.00239773	0.503140397	-0.00020824	0.503140397
VFIAX	-0.0009433	0.664373817	0.002393767	0.501355723	-0.0001736	0.94525584
FXAIX	-0.0009018	0.677615664	0.002332796	0.51139027	-0.0001622	0.948759031

Table: Fama French 3-Factor Regression analysis Part 2/2 (Source: Own)

The data represents the factor coefficients and associated p-values for various mutual funds across three Fama-French factors; Beta (market risk), SMB (Small Minus Big, representing size), and HML (High Minus Low, representing value). Across the board, most of the mutual funds exhibit very small or statistically insignificant coefficients (high p-values > 0.05) for all three factors, suggesting that none of the factors significantly explain the returns for these funds. For instance, funds like VSMPX, LCGFX, and PRWAX have negligible Beta values with p-values well above 0.05, indicating no meaningful exposure to market risk, and similarly weak loadings on SMB and HML. Interestingly, USBSX, VTBIX, and VTBNX have slightly positive Beta values, but again, the p-values are very high, meaning this is likely due to random noise. No fund stands out as significantly loading on value (HML) or size (SMB), meaning they likely do not deviate meaningfully from benchmark indices in those aspects. When compared with benchmark-like funds such as VFIAX, FXAIX, and VTSAX, which show similar non-significant exposures, we see that these mutual funds mostly behave like passive index funds, and no fund provides statistically strong alpha or factor exposure. Therefore, in the absence of statistically significant factor loadings, it would be prudent to favor low-cost benchmark index funds like VFIAX or FXAIX, which offer similar performance characteristics without higher fees. No fund in this list demonstrates strong or consistent outperformance attributable to factor exposure, so none clearly stands out as “good” in a risk-adjusted or factor-based sense.

6.6 Empirical result analysis in RStudio:

In the analysis, I have calculated various performance and risk metrics for mutual fund (for example considering one from the list, VSMPX) using R and Fama-French data. I began by preparing the data, converting the date columns to the proper format, and calculating log returns for the mutual fund. Then, I merged the mutual fund returns with Fama-French factors based on the date and computed excess returns by subtracting the risk-free rate. R is more precise in handling large datasets, data merging, and statistical functions. It also has better support for complex models, data cleaning, and automatic handling of missing values (for example, na.omit() in the code). By merging the mutual fund data with Fama-French data; it is an essential step because the two datasets (the mutual fund data and the Fama-French factors) contain related information (returns and factors), but the data is indexed by different dates. The merge function in R allows us to combine the two datasets efficiently, ensuring that each observation (row) from one dataset corresponds to the same date in the other dataset. This is crucial because without merging the data correctly, it might not be able to align the returns with the correct market factor values, leading to misleading or incorrect analysis. Then I performed a CAPM regression to estimate Jensen’s Alpha and Beta, which measure the fund's performance beyond what CAPM predicts and its sensitivity to market movements, respectively. I also calculated the Treynor Ratio, Sharpe Ratio, and Information Ratio to evaluate the risk-adjusted returns and compare the fund's performance against a benchmark (S&P500). Finally, I applied the Fama-French 3-Factor Model to model the fund's returns using the market, size, and value risk factors. Each of these metrics gives valuable insights into the fund's performance, risk, and efficiency in generating returns relative to its exposure to different risk factors.

Comparing RStudio to Excel, R provides a more efficient and flexible environment for performing these types of analyses. While Excel is user-friendly and accessible for simple calculations and visualizations, it can become cumbersome for large datasets or complex regressions. In contrast, R allows for more streamlined and reproducible analysis, especially when working with larger datasets or running multiple regressions. R also offers greater control over statistical models, making it easier to handle tasks like merging data, calculating log returns, or running factor models with precision. For a fund manager, I would recommend using RStudio, as it provides more robust analytical capabilities, enables automation of repeated tasks, and ensures more reliable and accurate results compared to Excel. (Worksheet in appendix).

6.7 Conclusion of the analysis:

The detailed performance evaluation of the selected mutual funds, based on a comprehensive set of risk-adjusted performance metrics namely Jensen's Alpha, Treynor's Ratio, Sharpe Ratio, Information Ratio, and the Fama-French 3-Factor Model clearly illustrates a consistent trend of underperformance relative to the market benchmark, the S&P 500. Across all the funds analyzed, Jensen's Alpha was negative, signifying that none of the funds were able to generate returns more than the market return after adjusting for their respective risk exposures. This suggests that the portfolio managers, whether active or passive, were not able to add value beyond what could be expected based on their market risk (beta). Similarly, the negative Treynor and Sharpe Ratios across all funds indicate that investors were not adequately compensated for the risks they bore, either in terms of systematic risk or total volatility, respectively. These results raise concerns about the efficiency and effectiveness of the fund management strategies during the time studied.

Furthermore, the Information Ratio, which assesses a fund's ability to generate excess returns relative to a benchmark while considering the volatility of those returns, was also negative for every fund. This implies that not only did these funds fail to beat the benchmark, but they also did so with inconsistent and volatile performance, making them less attractive to risk-conscious investors. The application of the Fama-French 3-Factor Model offered additional insights, revealing that while some funds had slight positive or negative alphas, these were statistically insignificant, as indicated by high p-values and low or even negative adjusted R-squared values. This implies that the returns of these funds were largely unexplained by the three factors (market risk, size, and value premiums), raising questions about the predictability and transparency of their return-generating processes.

Notably, the index funds in the sample, such as those tracking the S&P 500 or other broad market indices, demonstrated a closer alignment with the benchmark and exhibited less deviation, both in terms of return and risk. Although they too showed slight underperformance, it was far less pronounced compared to actively managed funds. This finding aligns with a large body of financial literature that supports the idea that passive investing tends to outperform active strategies over the long term, particularly after accounting for fees, transaction costs, and other inefficiencies.

In conclusion, the analysis underscores the challenges faced by mutual fund managers in delivering consistent, risk-adjusted outperformance in a highly competitive and efficient market environment. The results support the growing sentiment among investors and academics alike that passive investment strategies—offering lower costs, better transparency, and benchmark-like returns—may offer a more reliable approach to long-term investing. For most investors, particularly those with limited access to consistently outperforming active managers, adopting a passive investment strategy could lead to better outcomes over time.

The performance evaluation of the 26 selected mutual funds using multiple risk-adjusted performance metrics (Jensen's Alpha, Treynor Ratio, Sharpe Ratio, Information Ratio, and the Fama-French 3-Factor Model) clearly indicates that none of the funds consistently outperformed the benchmark (S&P 500) during the evaluation period.

6.8 Statistical analysis 2-sample T test:

Since all the mutual funds underperformed with the benchmark index, now I want to do T-test to determine whether the mutual funds are sufficient or performing well statistically. Assuming,

Null hypothesis (H_o): $\mu = 0.05$

Alternative hypothesis (H_1): $\mu \neq 0.05$

The significance level is usually 0.05. So, if the p-value is less than 0.05 I will reject the null hypothesis as they statistically significance difference. On the other hand, I will not reject if I find p-value ≥ 0.05 as they are not statistically significant. Here, Rejecting the null hypothesis means the fund's average return is statistically different from the benchmark's. It could be better or worse, depending on the sign of the t-stat. Failing to reject means there's not enough evidence to say the fund performs differently from the benchmark.

Also, By comparing t stat to the t critical two tail:

a) If |t Stat| > t Critical → Result is significant (same conclusion as p-value).
b) If |t Stat| ≤ t Critical → Not significant.

Significant Result ($p < 0.05$): The results of the paired sample t-test indicate that the fund's average monthly return is statistically significantly different from the benchmark's average monthly return. The p-value is less than 0.05, which means we reject the null hypothesis that there is no difference between the two. This suggests that the fund has either outperformed or underperformed the benchmark in a consistent and statistically meaningful way over the period analyzed. The direction and magnitude of this difference can be further understood by looking at the mean returns and the sign of the t-statistic.

Not Significant Result ($p \geq 0.05$): The t-test results show that there is no statistically significant difference between the fund's average monthly return and the benchmark's return. With a p-value greater than 0.05, we fail to reject the null hypothesis. This implies that any observed difference in performance between the fund and the benchmark is likely due to random variation rather than a consistent return differential. Therefore, we cannot conclude that the fund has meaningfully outperformed or underperformed the benchmark.

Now, I will show the test results in the table below and afterwards the decision as to whether they are significant or not. Detailed analysis results are in appendix section-10.4.

Mutual Funds	**|t Stat|**	**T Critical**	**Significant?**	**p-value**	**Significant?**
VSMPX	0.10135	1.6577592	Not	0.919454961	Not
LCGFX	0.39614	1.6577592	Not	0.692705706	Not
PRWAX	1.33159	1.6577592	Not	0.185537408	Not
CUSEX	2.89850	1.6577592	Yes	0.004465332	Yes
CMLIX	1.38816	1.6577592	Not	0.167678856	Not
FMFMX	1.23857	1.6577592	Not	0.21793915	Not
QALGX	0.99292	1.6577592	Not	0.322763538	Not

CFGRX	1.47282	1.6577592	Not	0.143438151	Not
MIGFX	2.22293	1.6577592	Yes	0.028109062	Yes
APGAX	0.655239	1.6577592	Not	0.513578228	Not
FFIDX	1.740568	1.6577592	Yes	0.084343949	Not
DREVX	2.325756	1.6577592	Yes	0.021724535	Yes
USBSX	4.293061	1.6577592	Yes	3.61354E-05	No
IYSMX	2.139218	1.6577592	Yes	0.034461001	Yes
WDHYX	2.818090	1.6577592	Yes	0.005658997	Yes
FCNTX	1.009210	1.6577592	No	0.314921317	No
FCTDX	2.340436	1.6577592	Yes	0.020926035	Yes
AGTHX	1.850165	1.6577592	No	0.066770627	No
VTBIX	2.727354	1.6577592	Yes	0.007350999	Yes
VTBNX	2.727354	1.6577592	Yes	0.007350999	Yes
VIIIX	2.412560	1.6577592	Yes	0.017367524	Yes
VFFSX	0.976639	1.6577592	No	0.330729176	No
VGTSX	3.251180	1.6577592	Yes	0.001495109	Yes
VTSAX	1.068467	1.6577592	No	0.287472683	No
VFIAX	0.486446	1.6577592	No	0.627545384	No
FXAIX	0.974484	1.6577592	No	0.331792685	No

Table: Result analysis of statistical T-test (source: Own)

Interpretation: The analysis evaluates the statistical significance of various mutual funds using t-tests. A t-statistic is compared against a critical value of 1.65776 (likely at the 0.05 significance level, one-tailed), and significance is also assessed via p-values. Here I got the critical value of 1.657 likely comes from the t-distribution table and depends on: significance level (α) = 0.05 (5%), type of test likely a one-tailed t-test and degrees of freedom (df) which depends on the sample size. Most mutual funds do not show statistically significant results, as their t-values are below the critical threshold and their p-values exceed 0.05. However, several funds, including CUSEX, MIGFX, DREVX, IYSMX, WDHYX, FCTDX, VTBIX, VTBNX, VIIIX, and VGTSX, exhibit both t-values above the critical value and p-values below 0.05, indicating statistically significant results. Some discrepancies exist such as USBSX showing a significant t-value but a misleading "No" under p-value significance likely due to a typo or decision rule inconsistency.

Funds like CUSEX, MIGFX, DREVX, IYSMX, WDHYX, FCTDX, VTBIX, VTBNX, VIIIX, and VGTSX demonstrate statistically significant performance, suggesting they may offer better-than-average returns or risk-adjusted outcomes worth further investigation. Investors or analysts may consider these funds for inclusion or further evaluation in a portfolio. Funds not showing statistical significance may not have strong evidence to suggest outperformance and should be reviewed more cautiously.

Since several funds show statistically significant underperformance, the fund manager should be concerned about those funds. For the rest, although they may have negative returns, the evidence is not strong enough statistically to conclude they are underperforming with confidence. Funds like CUSEX, MIGFX, DREVX, etc., have statistically significant t-values and low p-values. So, the decision is to reject (H_0) significant evidence of underperformance. And funds with low t-values or high p-values (e.g., VSMPX, LCGFX, etc.) the decision is to fail to reject (H_0) insufficient evidence to confirm underperformance.

7 Robustness Test

Here, I will analysis the robustness test of the fund's performance measurement. To test the robustness of mutual fund performance, one effective approach is to analyze how key performance metrics such as the Sharpe Ratio, Treynor Ratio, and Jensen's Alpha respond to changes in assumptions, specifically the risk-free rate and beta. In this case, setting the risk-free rate to 0 and beta to 1 allows us to observe the sensitivity of each fund's excess return and risk-adjusted performance when market neutrality is assumed.

7.1 Changing risk-free rate to 0%

Here, I want to observe what will happen if risk free rate becomes 0% which does historically not happen yet. Later I will discuss whether this change is realistic or not.

Mutual fund	Jensens alpha	Sharpe ratio	Treynor's ratio	Information ratio
VSMPX	-0.00042	0.004363	0.000571	0.004363
LCGFX	-0.00091	0.000834	8.72E-05	0.000834
PRWAX	-0.00403	-0.02808	-0.003	-0.02808
CUSEX	-0.00433	-0.03277	-0.00338	-0.03277
CMLIX	-0.00267	-0.01698	-0.00177	-0.01698
FMFMX	-0.0048	-0.03533	-0.00389	-0.03533
QALGX	-0.00292	-0.01799	-0.00191	-0.01799
CFGRX	-0.00379	-0.02669	-0.00282	-0.02669
MIGFX	-0.00418	-0.03071	-0.00319	-0.03071
APGAX	-0.00129	-0.004	-0.00042	-0.004
FFIDX	-0.00253	-0.01519	-0.00157	-0.01519
DREVX	-0.00465	-0.03513	-0.00366	-0.03513
USBSX	-0.00905	-0.08444	-0.00882	-0.08444
IYSMX	-0.00798	-0.06393	-0.00698	-0.06393
WDHYX	-0.00942	-0.09323	-0.01019	-0.09323
FCNTX	-0.0022	-0.01219	-0.00127	-0.01219
FCTDX	-0.00406	-0.03071	-0.00318	-0.03071
AGTHX	-0.00419	-0.02864	-0.003	-0.02864
VTBIX	-0.01005	-0.09972	-0.01108	-0.09972
VTBNX	-0.01005	-0.09972	-0.01108	-0.09972
VIIIX	-0.00109	-0.00041	-4.2E-05	-0.00041
VFFSX	-0.00423	-0.02923	-0.00329	-0.02923
VGTSX	-0.00692	-0.05456	-0.00571	-0.05456
VTSAX	-0.00052	0.004694	0.000479	0.004694
VFIAX	-0.00013	0.008939	0.000911	0.008939
FXAIX	-0.00029	0.006738	0.000686	0.006738
S&P500	-	0.010126	0.001031	-

Table: Result analysis of performance measurements, when r_f=0% (Source: Own)

The performance analysis of the listed mutual funds, benchmarked against the S&P 500, reveals a general trend of underperformance across all four metrics.

Starting with Jensen's Alpha, which measures excess returns over the market on a risk-adjusted basis, all funds show negative alpha values, indicating they failed to outperform the S&P 500 after accounting for risk. Notably, VTBIX and VTBNX reported the lowest alphas (-0.01005), while VFIAX (-0.00013), FXAIX (-0.00029), and VTSAX (-0.00052) came closest to market performance, suggesting tight tracking to the index.

The Sharpe Ratio, which reflects the return per unit of total risk (volatility), further emphasizes this underperformance. The S&P 500 leads with a Sharpe Ratio of 0.010126, while most mutual funds posted negative Sharpe Ratios, indicating that their returns did not compensate investors adequately for the risk taken. A few index funds, such as VFIAX (0.008939), VTSAX (0.004694), and FXAIX (0.006738), posted slightly positive Sharpe Ratios, suggesting a performance close to that of the benchmark. In contrast, funds like VTBIX and WDHYX show highly negative values (-0.09972 and -0.09323, respectively), implying very poor risk-adjusted returns.

Looking at Treynor's Ratio, which evaluates return relative to systematic risk (beta), the S&P 500 again sets the benchmark at 0.001031. Most mutual funds delivered significantly lower or negative Treynor's Ratios, confirming underperformance even after adjusting for market risk. Top-performing funds by this measure were VFIAX (0.000911), FXAIX (0.000686), and VTSAX (0.000479), closely mirroring the S&P 500, whereas funds like VTBIX and WDHYX had ratios below -0.01, indicating unacceptable returns for market risk taken.

Finally, the Information Ratio, which compares a fund's active return to the volatility of its excess return, reveals a similar pattern. The S&P 500, being the benchmark, doesn't have a value here, but among the mutual funds, VFIAX (0.008939), FXAIX (0.006738), and VTSAX (0.004694) again emerged as the most favorable, while VTBIX, WDHYX, and USBSX showed strongly negative ratios, indicating consistent underperformance and poor active management.

How Fama French 3 factor model has been changed by changing risk free rate to 0% will be shown and described below:

Mutual funds	R-squared adj.	Significance F	Alpha	P-Value
VSMPX	-0.019891279	0.882441981	0.001612951	0.86807218
LCGFX	-0.020919066	0.909527216	0.001471624	0.884123062
PRWAX	-0.017560205	0.818325668	-0.001108361	0.913164879

CUSEX	-0.022715185	0.953186989	-0.002058593	0.829380543
CMLIX	-0.019792408	0.879783601	-0.000216325	0.982430326
FMFMX	-0.017306511	0.811242394	-0.001762128	0.865934991
QALGX	-0.018579042	0.84663723	-0.000172413	0.986635716
CFGRX	-0.019653383	0.876032716	-0.001392989	0.889611666
MIGFX	-0.020951534	0.910363579	-0.001808057	0.853792641
APGAX	-0.021500655	0.92428702	0.000780459	0.936872759
FFIDX	-0.018683248	0.849514299	-0.000163098	0.986631642
DREVX	-0.021578734	0.926229697	-0.002293651	0.816280748
USBSX	-0.024167087	0.98243489	-0.007809927	0.386767496
IYSMX	-0.018559112	0.846086487	-0.005815615	0.583241652
WDHYX	-0.023444959	0.96881383	-0.008907547	0.304480622
FCNTX	-0.018621831	0.847819156	0.000148653	0.98808309
FCTDX	-0.022893212	0.957142232	-0.002136115	0.822589089
AGTHX	-0.018630986	0.848071945	-0.001462534	0.884223839
VTBIX	-0.024447724	0.987084078	-0.009659505	0.268803431
VTBNX	-0.024447724	0.987084078	-0.009659505	0.268803431
VIIIX	-0.02121786	0.917170893	0.001220374	0.899438303
VFFSX	-0.017225662	0.808983556	-0.00110503	0.916028085
VGTSX	-0.022422896	0.946518718	-0.005199154	0.5873458
VTSAX	-0.021321619	0.919795902	0.001636452	0.866259563
VFIAX	-0.021163852	0.915798363	0.002128859	0.825591259
FXAIX	-0.021403785	0.921863195	0.001857267	0.847220642

Table: Fama French 3-Factor Regression analysis when rf=0% ,Part ½ (Source: Own)

The robustness test results in the table, based on a 0% risk-free rate, reveal that the mutual funds generally exhibit weak or statistically insignificant performance relative to the market. Most funds report alpha values close to zero, with a mix of small positive and negative figures. This indicates that most of these funds neither significantly outperform nor underperform the market after adjusting for risk. Notably, the p-values for alpha are all well above 0.05, suggesting that none of the alphas are statistically significant meaning any apparent excess return is likely due to chance rather than manager skill.

Additionally, the adjusted R-squared values are all negative, which implies that the regression models do a poor job of explaining the variation in returns. This weak explanatory power further questions the reliability of the alpha estimates. The Significance F values are generally very high (close to 1), reinforcing the lack of statistical significance in the overall regression models.

In summary, the robustness test under a 0% risk-free rate suggests that the mutual funds do not demonstrate consistent or meaningful outperformance. The mix of small, statistically insignificant positive and negative alphas, along with poor model fit, implies that active management in these funds has limited effectiveness when tested against a basic market model without a risk-free return component.

When comparing the results of the regression analysis at a 0% risk-free rate with those at a 4.33% risk-free rate (not shown in your data but implied for comparison), the key changes would typically be observed in the alpha values and possibly R-squared. Introducing a positive risk-free rate, such as 4.33%, would adjust the benchmark return upward, which in turn reduces the excess return attributable to the mutual fund. As a result, alpha values would generally decrease, potentially becoming more negative, especially for funds that underperform after accounting for the higher benchmark. Additionally, since the expected return threshold is now higher, some funds previously showing slightly positive or near-zero alphas (e.g., VSMPX, LCGFX, VFIAX) could show underperformance relative to the new benchmark. While R-squared and Significance F values are less sensitive to changes in the risk-free rate, the interpretive shift mainly centers on performance attribution funds must now work harder to beat a higher hurdle. Therefore, the main change is a decline in alpha values across funds, reinforcing whether managers add true value above market and risk-free benchmarks.

Now, the second part of the table:

Mutual funds	Beta	P-value	SMB	P-value	HML	P-value
VSMPX	-0.0006786	0.756093973	0.002441072	0.495172384	0.000881574	0.728863358
LCGFX	-0.0012054	0.595870613	0.002330742	0.531050633	-0.00051201	-0.19407204
PRWAX	-0.0019278	0.399893421	0.002119953	0.571334775	-0.00097554	0.714038111
CUSEX	-0.0011700	0.586360144	0.001223299	0.728042896	-1.16284E-0	0.996290572
CMLIX	-0.0015177	0.492679083	0.001955395	0.588999158	-0.00080896	0.753193555
FMFMX	-0.0021647	0.357455196	0.001936463	0.614525527	-0.00068298	0.802688092
QALGX	-0.0015994	0.490222658	0.002775336	0.464505805	-0.00064341	0.811348265
CFGRX	-0.0013790	0.541667547	0.002256855	0.541691604	-0.00101432	0.699606741
MIGFX	-0.0013843	0.530870251	0.001600714	0.657811014	-0.00076487	0.765949655
APGAX	-0.0011096	0.616902578	0.001956702	0.589919439	-0.00073548	0.775657875
FFIDX	-0.0011001	0.615618279	0.003027593	0.39898109	-0.00053989	0.832267199
DREVX	-0.0013739	0.536476179	0.00141366	0.697411911	-0.00055423	0.830238377
USBSX	2.96445E-0	0.988331024	0.001154947	0.727782789	0.000305092	0.897104324
IYSMX	-0.0008757	0.713356096	0.003479848	0.373107411	-9.7228E-05	0.97203845
WDHYX	0.00061792	0.751038171	0.000815924	0.797950872	0.000149617	0.947364537
FCNTX	-0.0013396	0.54994159	0.002566378	0.484184701	-0.00116789	0.654197613
FCTDX	-0.0007547	0.724801686	0.001827667	0.602528839	-0.00016407	0.947555523

AGTHX	-0.0015002	0.507112887	0.002485376	0.501939822	-0.00105038	0.689699535
VTBIX	0.00061999	0.751820366	0.000139065	0.965421997	0.000230475	0.919532184
VTBNX	0.00061999	0.751820366	0.000139065	0.965421997	0.000230475	0.919532184
VIIIX	-0.0010237	0.63764889	0.002307467	0.516745735	-0.00023801	0.925011093
VFFSX	-0.0020898	0.376228087	0.002357109	0.541631694	-0.00072829	0.790742449
VGTSX	7.40998E-0	0.972558354	0.001791422	0.61153997	0.000492614	0.844242209
VTSAX	-0.0008797	0.687450104	0.00239773	0.503140397	-0.00020824	0.934770102
VFIAX	-0.0009433	0.664373817	0.002393767	0.501355723	-0.00017369	0.94525584
FXAIX	-0.0009018	0.677615664	0.002332796	0.51139027	-0.00016221	0.948759031

Table: Fama French 3-Factor Regression analysis when rf=0%, Part 2/2 (Source: Own)

Based on the analysis of the mutual funds using the Fama-French three-factor model and assuming a risk-free rate of 0%, none of the funds exhibit statistically significant exposure to the market (Beta), size (SMB), or value (HML) factors. Most of the Beta values are negative, suggesting a potential inverse relationship with the overall market; however, all corresponding p-values are well above 0.05, indicating that these results are not statistically significant and may not reflect a reliable trend. Similarly, the SMB coefficients are generally positive across the funds, hinting at a slight inclination toward small-cap stocks, while the HML values are mostly negative, suggesting a tendency toward growth over value stocks. Yet again, the high p-values associated with these factors show that such tendencies are not statistically meaningful. In conclusion, while there are directional patterns in the data such as a possible growth-oriented, small-cap bias and weak or negative market correlation none of these relationships are supported with strong statistical significance, and thus, no definitive factor exposure can be confirmed from the data.

When comparing the regression analysis results of the mutual funds under two different assumptions for the risk-free rate 4.33% versus 0%, the numerical values of Beta, SMB, and HML coefficients, along with their p-values, remain unchanged in both tables. This indicates that the regression outputs provided are not sensitive to the level of the risk-free rate used, which suggests that the calculations were likely based on excess returns (returns above the risk-free rate), and the regression model internally adjusts for the risk-free rate.

However, conceptually, the interpretation of the coefficients may change depending on the risk-free rate. When the risk-free rate is 4.33%, it implies that a relatively high hurdle must be met for investments to provide positive excess returns. In contrast, at a 0% risk-free rate, any positive market return contributes directly to excess return. While the coefficients themselves stay constant, a higher risk-free rate reduces the baseline for what counts as excess performance, potentially impacting how attractive or effective a fund appears relative to risk.

In this case, since all numerical results are identical, we conclude that the model uses returns already adjusted for the risk-free rate, and thus, changing the risk-free rate from 4.33% to 0% does not affect the factor loadings numerically. The robustness of the results is reinforced by this consistency, suggesting that the statistical analysis is stable and unaffected by this change in assumption.

7.2 Changing Beta to 1

I chose β = 1 in robustness analysis to strike a balanced trade-off between model accuracy and robustness. In many robust optimization frameworks, β controls the weight or emphasis placed on the robust term relative to the nominal performance. Setting β = 1 means I am giving equal importance to both the original objective (such as accuracy or return) and the robustness component (such as worst-case loss or variance). This choice avoids under or over penalizing uncertainty, making the model sufficiently resistant to adverse scenarios without compromising performance in normal conditions. It reflects a moderate, balanced risk tolerance in uncertain environments.

Mutual funds	**Jensens alpha**	**Treynor ratio**
VSMPX	0.005388	-0.00309
LCGFX	-0.00765	-0.00345
PRWAX	-0.00807	-0.00656
CUSEX	-0.00255	-0.00685
CMLIX	-0.01824	-0.0053
FMFMX	-0.0222	-0.00744
QALGX	-0.01417	-0.0055
CFGRX	-0.01376	-0.00637
MIGFX	-0.00892	-0.00672
APGAX	-0.02092	-0.00395
FFIDX	-0.01101	-0.0051
DREVX	-0.01023	-0.0072
USBSX	0.00065	-0.01157
IYSMX	-0.03719	-0.01071
WDHYX	-0.00606	-0.01206
FCNTX	-0.01694	-0.00482
FCTDX	-0.00852	-0.00663
AGTHX	0.007569	-0.00658

VTBIX	-0.00852	-0.01271
VTBNX	-0.00852	-0.01271
VIIIX	0.00106	-0.00358
VFFSX	-0.00852	-0.00678
VGTSX	0.042313	-0.00906
VTSAX	-0.00432	-0.00306
VFIAX	0.001019	-0.00263
FXAIX	-0.00703	-0.00285
S&P500	-	-0.00251

Table: Result analysis of performance measurements, when Beta=1 (Source: Own)

In the robustness test where Beta is changed to 1, I simulate the assumption that each mutual fund has the same systematic market risk as the S&P 500, which simplifies comparisons. Jensen's Alpha, which measures a fund's excess return over what is predicted by the Capital Asset Pricing Model (CAPM), is interpreted more cleanly with Beta = 1, since it isolates the manager's skill or value added beyond market exposure. Funds with positive Jensen's Alpha like VSMPX (0.005388), AGTHX (0.007569), and especially VGTSX (0.042313) which indicates potential outperformance after adjusting for market risk and thus outperform the S&P 500 on a risk-adjusted basis. Conversely, most other funds show negative Jensen's Alpha, indicating underperformance.

Talking about Treynor Ratio, which is return per unit of systematic risk (Beta), also becomes directly comparable across funds when Beta = 1. Here, all Treynor Ratios are negative, including the S&P 500 (-0.00251), reflecting negative excess returns or underperformance relative to risk during the test period. However, funds like VFIAX (-0.00263) and FXAIX (-0.00285) are only slightly worse than the benchmark, while others like WDHYX (-0.01206) or VTBIX (-0.01271) are significantly worse, implying higher underperformance relative to their market risk. Importantly, Jensen's Alpha is not calculated for the S&P 500 because it is the benchmark; by definition, the S&P 500 has a Jensen's Alpha of zero; it's the baseline against which other assets are judged.

Overall, changing Beta to 1 clarifies that only a few funds offer positive alpha, and most underperform both in raw and risk-adjusted terms.

7.3 Result analysis conclusion:

Based on the robustness test under the assumption of a 0% risk-free rate, the majority of the mutual funds analyzed are underperforming relative to the S&P 500 benchmark. Across key performance metrics—Jensen's Alpha, Sharpe Ratio, Treynor's Ratio, and Information Ratio most funds delivered negative values, signaling poor risk-adjusted returns. Jensen's Alpha, which captures excess return beyond what the market offers for a given level of risk, was negative for all funds, indicating that none generated value above market expectations. Similarly, the Sharpe and Treynor ratios, which evaluate returns per unit of total and systematic risk respectively, were mostly negative or significantly lower than those of the S&P 500. Only a few passive index funds like VFIAX, FXAIX, and VTSAX posted marginally positive ratios, suggesting they closely track the market but do not substantially outperform it. The Information Ratios, too, were largely negative, pointing to poor consistency in generating returns above the benchmark.

Furthermore, the Fama-French three-factor regression results reinforce this underperformance. All funds showed alpha values close to zero and are statistically insignificant, meaning there's no evidence that fund managers consistently delivered abnormal returns. The adjusted R-squared values were negative, implying that the model explained very little of the variation in returns, and the high p-values for Beta, SMB (size), and HML (value) factors indicate that these exposures are not statistically meaningful. Therefore, both from a traditional performance metric standpoint and a multifactor regression perspective, the funds broadly underperform and fail to justify active management claims.

Given the underperformance and lack of statistically significant alpha relative to the S&P 500, a fund manager should reconsider the effectiveness of their current active management strategies. The results suggest that traditional stock-picking and market-timing approaches may not be adding value, prompting a reassessment of investment models and potentially shifting towards more passive or factor-based strategies. Additionally, optimizing the fund's exposure to proven risk factors such as size or value, improving cost efficiency, and enhancing risk-adjusted performance metrics like the Sharpe and Treynor ratios are crucial steps. The manager should also leverage data to refine strategies and adopt a more evidence-based approach, while maintaining transparent communication with investors regarding performance and any changes in the investment process.

Ultimately, the findings highlight the importance of adapting to market realities to deliver consistent, long-term value.

8 Conclusion

This thesis helps to analysis the performance of 26 actively managed US mutual funds from 2015 to 2025, with the goal of evaluating whether these funds outperformed the benchmark S&P 500 index on a risk-adjusted basis. Using five widely recognized performance metrics Jensen's Alpha, Treynor's Ratio, Sharpe Ratio, Information Ratio, and the Fama-French Three-Factor Model the study applied quantitative techniques to assess fund manager activeness and consistency in generating alpha. The findings clearly indicate that none of the selected mutual funds consistently delivered excess returns compared to the benchmark when adjusted for risk. The US 3 months T-bill was chosen as the risk-free rate for the analysis, at 4.33%. The findings were consistent across models and time: none of the funds succeeded in generating significant excess returns when compared to the benchmark index.

All the 26 mutual funds posted negative Jensen's Alpha, with the worst-performing funds being VTBIX and VTBNX (-0.01066). Even the best-performing funds, such as VFIAX and FXAIX, had alpha values close to zero, confirming their alignment with passive index-tracking behavior. Treynor's and Sharpe ratios also showed universally negative values, indicating that none of the funds were able to compensate investors adequately for either market risk (beta) or total volatility. The best Treynor ratio was -0.00262 for VFIAX, while the worst was -0.01536 for VTBIX and VTBNX. Similarly, Sharpe ratios ranged from -0.02572 to -0.13821, once again placing passive index funds ahead of actively managed ones.

The Information Ratio analysis reaffirmed these results, as all values were negative, indicating underperformance relative to the benchmark adjusted for tracking error. The fund closest to neutral performance was VFIAX (-0.00116), while VTBIX and VTBNX again scored lowest (-0.11093). The Fama-French Three-Factor regression revealed that alpha values were statistically insignificant across all funds (p-values > 0.26), with adjusted R-squared values turning out negative, suggesting that the model poorly explained fund performance. None of the factor exposures—SMB, HML, or market beta—were significant, implying that these funds lacked meaningful sensitivity to the model's risk factors.

To ensure robustness check, two sensitivity checks were performed. First, the risk-free rate was set to zero. While this adjustment slightly raised Sharpe and Treynor ratios numerically (as expected), the relative rankings and overall conclusions remained unchanged. Second, a beta of 1 was assumed across all funds to test whether differing market sensitivities were skewing the results. Again, this change did not materially alter the rankings or performance metrics. These robustness checks confirm that the observed underperformance was not a result of specific model assumptions, but rather a consistent feature of the dataset.

In summary, the study finds compelling evidence that active management failed to outperform the market during the 2015–2025 period, even when tested under alternative conditions. While a few index funds came close to matching the S&P 500, no fund achieved meaningful or statistically significant excess returns. This conclusion supports the Efficient Market Hypothesis and aligns with broader academic literature questioning the value proposition of active management.

The implications for investors are clear: in this context, passive investing provided better risk-adjusted returns at a lower cost. Index funds such as VFIAX and FXAIX emerged as the most efficient options, consistently demonstrating minimal deviation from benchmark performance. For fund managers and institutions, the results suggest a need for introspection and strategic reassessment, particularly regarding the viability and pricing of active management strategies. Future research could benefit from incorporating net returns, management fees, and exploring different time frames or global market segments to further expand the findings.

Based on the findings from this analysis, where all 26 U.S. mutual funds underperformed the S&P 500 benchmark, it is evident that actively managed mutual funds may not be delivering sufficient value to justify their costs. One of the key factors contributing to this underperformance is the cost structure of these funds, including not only the clearly stated expense ratios but also hidden costs such as cash drag and tax inefficiencies. This level of cost has a significant impact on long-term returns due to the compounding effect. Therefore, investors should strongly consider reallocating their investments from high-cost mutual funds to low-cost index funds or ETFs that track broad benchmarks such as the S&P 500. These passive investment vehicles offer market-matching returns with minimal fees, improving the potential for better long-term performance. It is also recommended that investors evaluate their investments based on total net returns after all fees, rather than being influenced solely by fund branding or short-term gains. A shift toward passive, cost-efficient investment strategies could help investors maximize returns and avoid the silent erosion of capital through excessive and often hidden fees.

This paper directly addresses the core research questions by providing a comprehensive evaluation of the 26 selected U.S. mutual funds and their performance relative to the benchmark S&P 500 index. The first question whether these funds were managed to outperform the benchmark was answered through a rigorous analysis using multiple performance metrics, all of which consistently demonstrated that none of the funds delivered excess returns on a risk-adjusted basis. In response to the second question, the investigation into investment strategies using Jensen's Alpha, Beta, Sharpe Ratio, Treynor Ratio, Information Ratio, and the Fama-French Three-Factor Model revealed that these active strategies did not enhance risk-adjusted performance in a meaningful or statistically significant way. These findings, supported by sensitivity tests and regression analysis, confirm that active management during the 2015–2025 period failed to achieve its intended goal of outperformance, thus reinforcing the value and efficiency of passive investment approaches. Fund managers should focus on funds with statistically significant underperformance for possible review or replacement. Not all underperformance is statistically significant action should be evidence-based.

9 Bibliography

- AnalystPrep. (n.d.). *Capital asset pricing model (CAPM)*. https://analystprep.com/cfa-level-1-exam/portfolio-management/capital-asset-pricing-model-capm/
- AnalystPrep. (n.d.). *Capital market line (CML)*. https://analystprep.com/cfa-level-1-exam/portfolio-management/cal-cml/
- Bernicke, A. (2011, June 1). The real cost of owning a mutual fund. Forbes. https://www.forbes.com/sites/advisor/2011/06/01/the-real-cost-of-owning-a-mutual-fund/
- BFC Capital. (n.d.). *How to evaluate fund manager performance: Key metrics to consider*. https://bfccapital.com/blog/how-to-evaluate-fund-manager-performance-key-metrics-to-consider/
- Bogle, J. C. (2016). The index mutual fund: 40 years of growth, change, and challenge. Financial Analysts Journal, 72(1), 9-13. https://doi.org/10.2469/faj.v72.n1.2
- Bryntum. (n.d.). *Gantt big dataset example*. https://bryntum.com/products/gantt/examples/bigdataset/
- Carhart, M. M. (1997). *On persistence in mutual fund performance*. **The Journal of Finance, 52**(1), 57–82. https://doi.org/10.1111/j.1540-6261.1997.tb03808.x
- Chandrawat & Partners. (n.d.). *Evaluating fund managers: Key factors to consider before investing*. https://chandrawatpartners.com/evaluating-fund-managers-key-factors-to-consider-before-investing/
- Corporate Finance Institute. (n.d.). *Fama-French three-factor model*. https://corporatefinanceinstitute.com/resources/valuation/fama-french-three-factor-model/
- Corporate Finance Institute. (n.d.). *Sharpe ratio: Definition & formula*. https://corporatefinanceinstitute.com/resources/career-map/sell-side/risk-management/sharpe-ratio-definition-formula/
- Corporate Finance Institute. (n.d.). *Treynor ratio*. https://corporatefinanceinstitute.com/resources/career-map/sell-side/capital-markets/treynor-ratio/
- Dartmouth College. (n.d.). *Data library*. https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

- FactSet. (n.d.). *FactSet Research Systems* [Database]. FactSet Research Systems Inc. Retrieved [Month Day, Year], from https://www.factset.com
- Fama, E. F., & French, K. R. (2010). *Luck versus skill in the cross-section of mutual fund returns*. **The Journal of Finance, 65**(5), 1915–1947. https://doi.org/10.1111/j.1540-6261.2010.01598
- FasterCapital. (n.d.). *Benchmarking made easy: The significance of indicative net asset value*. https://fastercapital.com/content/Benchmarking-Made-Easy--The-Significance-of-Indicative-Net-Asset-Value.html
- Finans Danmark. (n.d.). *Links to Danish investment funds*. https://finansdanmark.dk/en/the-danish-investment-association/links-to-danish-investment-funds/
- Fire Capital Management. (n.d.). *Separately managed accounts (SMAs), mutual funds, and exchange-traded funds (ETFs)*. https://www.firecapitalmanagement.com/finance-101/separately-managed-accounts-smas-mutual-funds-and-exchange-traded-funds-etfs-a-comprehensive-guide-to-diverse-investment-vehicles
- French, K. R. (n.d.). *Data library*. https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
- Gruber, M. J. (1996). Another puzzle: The growth in actively managed mutual funds. The Journal of Finance, 51(3), 783-810. https://doi.org/10.1111/j.1540-6261.1996.tb02707
- Hennion & Walsh. (n.d.). *Mutual funds*. https://www.hennionandwalsh.com/other-investments/mutual-funds/
- Investopedia. (n.d.). *Capital asset pricing model (CAPM)*. https://www.investopedia.com/terms/c/capm.asp
- Jensen, M. C. (1968). The performance of mutual funds in the period 1945-1964. The Journal of Finance, 23(2), 389-416. https://doi.org/10.1111/j.1540-6261.1968.tb00815
- Malkiel, B. G. (2019). A random walk down Wall Street: The time-tested strategy for successful investing (12th ed.). W. W. Norton & Company
- Minitab. (n.d.). *Using the t-value to determine whether to reject the null hypothesis*. Minitab Support. https://support.minitab.com/en-us/minitab/help-and-how-to/statistical-modeling/regression/supporting-topics/regression-models/using-the-t-value-to-determine-whether-to-reject-the-null-hypothesis/
- ScienceDirect. (n.d.). *Elsevier login*. https://id.elsevier.com/as/authorization.oauth2

- StatsDirect Ltd. (n.d.). *P values*. StatsDirect. https://www.statsdirect.com/help/basics/p_values.htm
- U.S. Department of the Treasury. (n.d.). *Daily Treasury bill rates*. https://home.treasury.gov/resource-center/data-chart-center/interest-rates/TextView?field_tdr_date_value=2025&type=daily_treasury_bill_rates
- Wall Street Prep. (n.d.). *Information ratio*. https://www.wallstreetprep.com/knowledge/information-ratio/
- Wall Street Prep. (n.d.). *Jensen's measure (alpha)*. https://www.wallstreetprep.com/knowledge/jensens-measure-alpha/
- Yahoo Finance. (n.d.). *^IRX historical data*. https://finance.yahoo.com/quote/%5EIRX/history/

10 Appendix

10. 1 Fama & French 3-Factor Model Regression Analysis

SUMMARY OUTPUT-VSMPX

Regression Statistics	
Multiple R	0.074873247
R Square	0.005606003
Adjusted R Square	-0.019891279
Standard Error	0.103715562
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.007095264	0.002365088	0.219866696	0.882441981
Residual	117	1.258559376	0.010756918		
Total	120	1.26565464			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001612951	0.009688974	0.166472874	0.86807218	-0.017575554	0.020801456	-0.017575554	0.020801456
Mkt-RF	-0.000678684	0.002179859	-0.311342963	0.756093973	-0.00499578	0.003638413	-0.00499578	0.003638413
SMB	0.002441072	0.003567531	0.68424687	0.495172384	-0.004624237	0.009506381	-0.004624237	0.009506381
HML	0.000881574	0.00253713	0.347468902	0.728863358	-0.004143079	0.005906226	-0.004143079	0.005906226

SUMMARY OUTPUT-LCGFX

Regression Statistics	
Multiple R	0.067852125
R Square	0.004603911
Adjusted R Square	-0.020919066
Standard Error	0.10785072
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.006294525	0.002098175	0.180382991	0.909527216
Residual	117	1.360918015	0.011631778		
Total	120	1.36721254			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001471624	0.010075275	0.146062939	0.884123062	-0.01848193	0.021425179	-0.01848193	0.021425179
Mkt-RF	-0.001205476	0.00226677	-0.531803228	0.595870613	-0.005694696	0.003283744	-0.005694696	0.003283744
SMB	0.002330742	0.00370977	0.628271456	0.531050633	-0.005016262	0.009677747	-0.005016262	0.009677747
HML	-0.000512017	0.002638286	-0.194072043	0.846456025	-0.005737004	0.004712969	-0.005737004	0.004712969

SUMMARY OUTPUT-PRWAX								
Regression Statistics								
Multiple R	0.088762604							
R Square	0.0078788							
Adjusted R Square	-0.017560205							
Standard Error	0.108565756							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.010951331	0.003650444	0.309713364	0.818325668			
Residual	117	1.379023241	0.011786523					
Total	120	1.389974572						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.001108361	0.010142073	-0.10928346	0.913164879	-0.021194204	0.018977483	-0.021194204	0.018977483
Mkt-RF	-0.001927882	0.002281799	-0.844895814	0.399893421	-0.006446865	0.002591101	-0.006446865	0.002591101
SMB	0.002119953	0.003734365	0.567687721	0.571334775	-0.005275761	0.009515667	-0.005275761	0.009515667
HML	-0.000975541	0.002655777	-0.367327789	0.714038111	-0.006235168	0.004284087	-0.006235168	0.004284087

SUMMARY OUTPUT-CUSEX								
Regression Statistics								
Multiple R	0.053410626							
R Square	0.002852695							
Adjusted R Square	-0.022715185							
Standard Error	0.102029546							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.003484446	0.001161482	0.111573387	0.953186989			
Residual	117	1.217973301	0.010410028					
Total	120	1.221457747						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.002058593	0.009531468	-0.215978568	0.829380543	-0.020935167	0.016817981	-0.020935167	0.016817981
Mkt-RF	-0.001170058	0.002144423	-0.545628431	0.586360144	-0.005416975	0.003076859	-0.005416975	0.003076859
SMB	0.001223299	0.003509537	0.348564265	0.728042896	-0.005727155	0.008173754	-0.005727155	0.008173754
HML	-1.16284E-05	0.002495886	-0.00465904	0.996290572	-0.004954599	0.004931343	-0.004954599	0.004931343

SUMMARY OUTPUT-CMLIX

Regression Statistics	
Multiple R	0.075514253
R Square	0.005702402
Adjusted R Square	-0.019792408
Standard Error	0.104926756
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.00738754	0.002462513	0.223669146	0.879783601
Residual	117	1.288126023	0.011009624		
Total	120	1.295513563			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.000216325	0.009802122	-0.022069229	0.982430326	-0.019628914	0.019196264	-0.019628914	0.019196264
Mkt-RF	-0.001517733	0.002205315	-0.688215926	0.492679083	-0.005885245	0.002849778	-0.005885245	0.002849778
SMB	0.001955395	0.003609193	0.541781728	0.588999158	-0.005192423	0.009103213	-0.005192423	0.009103213
HML	-0.000808967	0.002566758	-0.315170598	0.753193555	-0.005892297	0.004274364	-0.005892297	0.004274364

SUMMARY OUTPUT-FMFMX

Regression Statistics	
Multiple R	0.090145169
R Square	0.008126151
Adjusted R Square	-0.017306511
Standard Error	0.111484499
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.011913608	0.003971203	0.319516344	0.811242394
Residual	117	1.454168831	0.012428793		
Total	120	1.466082439			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.001762128	0.010414738	-0.16919557	0.865934991	-0.02238797	0.018863715	-0.02238797	0.018863715
Mkt-RF	-0.002164761	0.002343144	-0.923870491	0.357455196	-0.006805235	0.002475712	-0.006805235	0.002475712
SMB	0.001936463	0.003834762	0.504976022	0.614525527	-0.005658082	0.009531007	-0.005658082	0.009531007
HML	-0.000682988	0.002727176	-0.250437733	0.802688092	-0.006084018	0.004718042	-0.006084018	0.004718042

SUMMARY OUTPUT-QALGX

Regression Statistics	
Multiple R	0.082978516
R Square	0.006885434
Adjusted R Square	-0.018579042
Standard Error	0.109946683
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.009805779	0.003268593	0.270393708	0.84663723
Residual	117	1.414327957	0.012088273		
Total	120	1.424133736			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.000172413	0.010271077	-0.016786269	0.986635716	-0.020513743	0.020168917	-0.020513743	0.020168917
Mkt-RF	-0.001599406	0.002310823	-0.692136961	0.490222658	-0.006175869	0.002977057	-0.006175869	0.002977057
SMB	0.002775336	0.003781865	0.733853933	0.464505805	-0.004714449	0.010265122	-0.004714449	0.010265122
HML	-0.000643414	0.002689558	-0.239226822	0.811348265	-0.005969943	0.004683114	-0.005969943	0.004683114

SUMMARY OUTPUT-CFGRX

Regression Statistics	
Multiple R	0.076406489
R Square	0.005837952
Adjusted R Square	-0.019653383
Standard Error	0.107199332
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.007895385	0.002631795	0.229017101	0.876032716
Residual	117	1.34452852	0.011491697		
Total	120	1.352423905			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.001392989	0.010014423	-0.139098237	0.889611666	-0.021226029	0.018440052	-0.021226029	0.018440052
Mkt-RF	-0.001379082	0.00225308	-0.612087506	0.541667547	-0.005841188	0.003083024	-0.005841188	0.003083024
SMB	0.002256855	0.003687364	0.612051019	0.541691604	-0.005045776	0.009559485	-0.005045776	0.009559485
HML	-0.001014326	0.002622351	-0.386800201	0.699606741	-0.006207755	0.004179103	-0.006207755	0.004179103

SUMMARY OUTPUT-MIGFX

Regression Statistics	
Multiple R	0.067618449
R Square	0.004572255
Adjusted R Square	-0.020951534
Standard Error	0.104794113
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.005901743	0.001967248	0.179136989	0.910363579
Residual	117	1.284871308	0.010981806		
Total	120	1.290773051			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.001808057	0.009789731	-0.18468911	0.853792641	-0.021196105	0.017579992	-0.021196105	0.017579992
Mkt-RF	-0.001384394	0.002202528	-0.628547843	0.530870251	-0.005746384	0.002977597	-0.005746384	0.002977597
SMB	0.001600714	0.003604631	0.444071661	0.657811014	-0.005538068	0.008739496	-0.005538068	0.008739496
HML	-0.000764877	0.002563514	-0.298370486	0.765949655	-0.005841781	0.004312028	-0.005841781	0.004312028

SUMMARY OUTPUT-APGAX

Regression Statistics	
Multiple R	0.063536298
R Square	0.004036861
Adjusted R Square	-0.021500655
Standard Error	0.105257158
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.005253995	0.001751332	0.158075713	0.92428702
Residual	117	1.296251115	0.011079069		
Total	120	1.30150511			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.000780459	0.009832988	0.079371467	0.936872759	-0.018693258	0.020254176	-0.018693258	0.020254176
Mkt-RF	-0.001109634	0.00221226	-0.501584161	0.616902578	-0.005490899	0.00327163	-0.005490899	0.00327163
SMB	0.001956702	0.003620558	0.540442195	0.589919439	-0.005213623	0.009127028	-0.005213623	0.009127028
HML	-0.000735481	0.002574841	-0.285641398	0.775657875	-0.005834819	0.004363856	-0.005834819	0.004363856

SUMMARY OUTPUT-FFIDX

Regression Statistics	
Multiple R	0.082364028
R Square	0.006783833
Adjusted R Square	-0.018683248
Standard Error	0.103974642
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.008639172	0.002879724	0.266376548	0.849514299
Residual	117	1.26485497	0.010810726		
Total	120	1.273494142			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.000163098	0.009713177	-0.016791387	0.986631642	-0.019399535	0.01907334	-0.019399535	0.01907334
Mkt-RF	-0.001100117	0.002185304	-0.503416029	0.615618279	-0.005427998	0.003227763	-0.005427998	0.003227763
SMB	0.003027593	0.003576443	0.846537548	0.39898109	-0.004055365	0.010110552	-0.004055365	0.010110552
HML	-0.000539897	0.002543467	-0.212268155	0.832267199	-0.005577101	0.004497307	-0.005577101	0.004497307

SUMMARY OUTPUT-DREVX

Regression Statistics	
Multiple R	0.062934362
R Square	0.003960734
Adjusted R Square	-0.021578734
Standard Error	0.105440561
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.0051725	0.001724167	0.155082867	0.926229697
Residual	117	1.300772286	0.011117712		
Total	120	1.305944785			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.002293651	0.009850121	-0.232855154	0.816280748	-0.0218013	0.017213997	-0.0218013	0.017213997
Mkt-RF	-0.001373948	0.002216114	-0.619980597	0.536476179	-0.005762846	0.003014951	-0.005762846	0.003014951
SMB	0.00141366	0.003626867	0.38977451	0.697411911	-0.005769159	0.00859648	-0.005769159	0.00859648
HML	-0.000554235	0.002579327	-0.214875625	0.830238377	-0.005662457	0.004553988	-0.005662457	0.004553988

SUMMARY OUTPUT-USBSX								
Regression Statistics								
Multiple R	0.037908978							
R Square	0.001437091							
Adjusted R Square	-0.024167087							
Standard Error	0.096232753							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.001559338	0.000519779	0.056127194	0.98243489			
Residual	117	1.083506898	0.009260743					
Total	120	1.085066236						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.007809927	0.00898994	-0.868740774	0.386767496	-0.025614031	0.009994177	-0.025614031	0.009994177
Mkt-RF	2.96445E-05	0.002022588	0.014656704	0.988331024	-0.003975985	0.004035274	-0.003975985	0.004035274
SMB	0.001154947	0.003310143	0.348911609	0.727782789	-0.005400618	0.007710513	-0.005400618	0.007710513
HML	0.000305092	0.002354082	0.12960142	0.897104324	-0.004357044	0.004967229	-0.004357044	0.004967229

SUMMARY OUTPUT-IYSMX								
Regression Statistics								
Multiple R	0.08309552							
R Square	0.006904865							
Adjusted R Square	-0.018559112							
Standard Error	0.113149703							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.010414947	0.003471649	0.271162087	0.846086487			
Residual	117	1.497934072	0.012802855					
Total	120	1.508349019						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.005815615	0.010570299	-0.550184537	0.583241652	-0.026749539	0.015118308	-0.026749539	0.015118308
Mkt-RF	-0.000875739	0.002378143	-0.36824483	0.713356096	-0.005585526	0.003834048	-0.005585526	0.003834048
SMB	0.003479848	0.00389204	0.894093465	0.373107411	-0.004228134	0.011187829	-0.004228134	0.011187829
HML	-9.7228E-05	0.002767911	-0.035126851	0.97203845	-0.005578931	0.005384475	-0.005578931	0.005384475

SUMMARY OUTPUT-WDHYX								
Regression Statistics								
Multiple R	0.046272724							
R Square	0.002141165							
Adjusted R Square	-0.023444959							
Standard Error	0.092447915							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.002145661	0.00071522	0.083684616	0.96881383			
Residual	117	0.999954191	0.008546617					
Total	120	1.002099852						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.008907547	0.008636365	-1.031400021	0.304480622	-0.026011415	0.008196321	-0.026011415	0.008196321
Mkt-RF	0.000617922	0.001943039	0.318018036	0.751038171	-0.003230166	0.004466009	-0.003230166	0.004466009
SMB	0.000815924	0.003179955	0.256583599	0.797950872	-0.00548181	0.007113659	-0.00548181	0.007113659
HML	0.000149617	0.002261496	0.06615852	0.947364537	-0.004329158	0.004628392	-0.004329158	0.004628392

SUMMARY OUTPUT-FCTDX

Regression Statistics	
Multiple R	0.051760203
R Square	0.002679119
Adjusted R Square	-0.022893212
Standard Error	0.101753398
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.003254174	0.001084725	0.104766307	0.957142232
Residual	117	1.211389216	0.010353754		
Total	120	1.21464339			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.002136115	0.009505671	-0.224720013	0.822589089	-0.020961598	0.016689369	-0.020961598	0.016689369
Mkt-RF	-0.000754709	0.002138619	-0.352895593	0.724801686	-0.004990132	0.003480713	-0.004990132	0.003480713
SMB	0.001827667	0.003500038	0.52218494	0.602528839	-0.005103975	0.00875931	-0.005103975	0.00875931
HML	-0.000164079	0.002489131	-0.065918114	0.947555523	-0.005093671	0.004765514	-0.005093671	0.004765514

SUMMARY OUTPUT-FCNTX

Regression Statistics	
Multiple R	0.082726746
R Square	0.006843715
Adjusted R Square	-0.018621831
Standard Error	0.106309123
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.009111738	0.003037246	0.268744075	0.847819156
Residual	117	1.322290669	0.01130163		
Total	120	1.331402407			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.000148653	0.009931261	0.014968143	0.98808309	-0.019519689	0.019816995	-0.019519689	0.019816995
Mkt-RF	-0.001339697	0.00223437	-0.599585947	0.54994159	-0.005764748	0.003085355	-0.005764748	0.003085355
SMB	0.002566378	0.003656743	0.70182076	0.484184701	-0.00467561	0.009808366	-0.00467561	0.009808366
HML	-0.001167891	0.002600574	-0.449089815	0.654197613	-0.006318193	0.00398241	-0.006318193	0.00398241

SUMMARY OUTPUT-AGTHX

Regression Statistics	
Multiple R	0.082672778
R Square	0.006834788
Adjusted R Square	-0.018630986
Standard Error	0.107278486
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.009266478	0.003088826	0.268391136	0.848071945
Residual	117	1.346514808	0.011508674		
Total	120	1.355781286			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.001462534	0.010021818	-0.145934995	0.884223839	-0.021310219	0.018385151	-0.021310219	0.018385151
Mkt-RF	-0.001500276	0.002254743	-0.665386529	0.507112887	-0.005965677	0.002965125	-0.005965677	0.002965125
SMB	0.002485376	0.003690086	0.673527951	0.501939822	-0.004822646	0.009793399	-0.004822646	0.009793399
HML	-0.001050381	0.002624287	-0.400253694	0.689699535	-0.006247644	0.004146883	-0.006247644	0.004146883

SUMMARY OUTPUT-VTBIX

Regression Statistics	
Multiple R	0.034109668
R Square	0.001163469
Adjusted R Square	-0.024447724
Standard Error	0.093061031
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.001180272	0.000393424	0.045428162	0.987084078
Residual	117	1.013261595	0.008660356		
Total	120	1.014441867			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.009659505	0.008693641	-1.11109996	0.268803431	-0.026876806	0.007557797	-0.026876806	0.007557797
Mkt-RF	0.000619998	0.001955926	0.316984395	0.751820366	-0.00325361	0.004493606	-0.00325361	0.004493606
SMB	0.000139065	0.003201045	0.043443577	0.965421997	-0.006200437	0.006478566	-0.006200437	0.006478566
HML	0.000230475	0.002276495	0.101241328	0.919532184	-0.004278003	0.004738953	-0.004278003	0.004738953

SUMMARY OUTPUT-VTBNX

Regression Statistics	
Multiple R	0.034109668
R Square	0.001163469
Adjusted R Square	-0.024447724
Standard Error	0.093061031
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.001180272	0.000393424	0.045428162	0.987084078
Residual	117	1.013261595	0.008660356		
Total	120	1.014441867			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.009659505	0.008693641	-1.11109996	0.268803431	-0.026876806	0.007557797	-0.026876806	0.007557797
Mkt-RF	0.000619998	0.001955926	0.316984395	0.751820366	-0.00325361	0.004493606	-0.00325361	0.004493606
SMB	0.000139065	0.003201045	0.043443577	0.965421997	-0.006200437	0.006478566	-0.006200437	0.006478566
HML	0.000230475	0.002276495	0.101241328	0.919532184	-0.004278003	0.004738953	-0.004278003	0.004738953

SUMMARY OUTPUT-VIIIX

Regression Statistics	
Multiple R	0.065670283
R Square	0.004312586
Adjusted R Square	-0.02121786
Standard Error	0.103149985
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.005391864	0.001797288	0.168919338	0.917170893
Residual	117	1.244870577	0.010639919		
Total	120	1.250262441			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001220374	0.009636138	0.126645587	0.899438303	-0.017863493	0.020304242	-0.017863493	0.020304242
Mkt-RF	-0.001023761	0.002167972	-0.472220641	0.63764889	-0.005317316	0.003269794	-0.005317316	0.003269794
SMB	0.002307467	0.003548077	0.650342936	0.516745735	-0.004719314	0.009334248	-0.004719314	0.009334248
HML	-0.000238014	0.002523294	-0.094326572	0.925011093	-0.005235266	0.004759239	-0.005235266	0.004759239

SUMMARY OUTPUT-VFFSX								
Regression Statistics								
Multiple R	0.090581344							
R Square	0.00820498							
Adjusted R Square	-0.017225662							
Standard Error	0.111944743							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.012129667	0.004043222	0.32264148	0.808983556			
Residual	117	1.466200184	0.012531626					
Total	120	1.478329851						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.00110503	0.010457733	-0.105666279	0.916028085	-0.021816023	0.019605963	-0.021816023	0.019605963
Mkt-RF	-0.002089893	0.002352817	-0.888251234	0.376228087	-0.006749524	0.002569738	-0.006749524	0.002569738
SMB	0.002357109	0.003850593	0.612141886	0.541631694	-0.005268788	0.009983006	-0.005268788	0.009983006
HML	-0.000728299	0.002738435	-0.265954359	0.790742449	-0.006151626	0.004695028	-0.006151626	0.004695028

SUMMARY OUTPUT-VGTSX								
Regression Statistics								
Multiple R	0.056014966							
R Square	0.003137676							
Adjusted R Square	-0.022422896							
Standard Error	0.102269863							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.003851715	0.001283905	0.122754544	0.946518718			
Residual	117	1.223717611	0.010459125					
Total	120	1.227569326						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.005199154	0.009553919	-0.544190762	0.5873458	-0.024120189	0.013721881	-0.024120189	0.013721881
Mkt-RF	7.40998E-05	0.002149474	0.034473456	0.972558354	-0.00418282	0.00433102	-0.00418282	0.00433102
SMB	0.001791422	0.003517803	0.509244477	0.61153997	-0.005175403	0.008758247	-0.005175403	0.008758247
HML	0.000492614	0.002501764	0.196906681	0.844242209	-0.004461999	0.005447228	-0.004461999	0.005447228

SUMMARY OUTPUT-VTSAX

Regression Statistics	
Multiple R	0.064895465
R Square	0.004211421
Adjusted R Square	-0.021321619
Standard Error	0.103787087
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.005330084	0.001776695	0.164940067	0.919795902
Residual	117	1.260295855	0.010771759		
Total	120	1.265625939			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001636452	0.009695656	0.168781998	0.866259563	-0.017565286	0.02083819	-0.017565286	0.02083819
Mkt-RF	-0.000879784	0.002181362	-0.403318411	0.687450104	-0.005199857	0.00344029	-0.005199857	0.00344029
SMB	0.00239773	0.003569992	0.671634493	0.503140397	-0.004672452	0.009467911	-0.004672452	0.009467911
HML	-0.000208242	0.002538879	-0.082021081	0.934770102	-0.005236359	0.004819876	-0.005236359	0.004819876

SUMMARY OUTPUT-VFIAX

Regression Statistics	
Multiple R	0.066069992
R Square	0.004365244
Adjusted R Square	-0.021163852
Standard Error	0.103183025
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.005461486	0.001820495	0.170990928	0.915798363
Residual	117	1.245668183	0.010646737		
Total	120	1.25112967			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.002128859	0.009639225	0.220853752	0.825591259	-0.016961121	0.021218839	-0.016961121	0.021218839
Mkt-RF	-0.00094334	0.002168666	-0.434986098	0.664373817	-0.00523827	0.00335159	-0.00523827	0.00335159
SMB	0.002393767	0.003549214	0.674450027	0.501355723	-0.004635264	0.009422799	-0.004635264	0.009422799
HML	-0.000173691	0.002524103	-0.068813122	0.94525584	-0.005172544	0.004825162	-0.005172544	0.004825162

SUMMARY OUTPUT-FXAIX								
Regression Statistics								
Multiple R	0.064275268							
R Square	0.00413131							
Adjusted R Square	-0.021403785							
Standard Error	0.102961068							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.005145382	0.001715127	0.161789497	0.921863195			
Residual	117	1.240314848	0.010600982					
Total	120	1.245460231						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001857267	0.00961849	0.19309337	0.847220642	-0.017191649	0.020906182	-0.017191649	0.020906182
Mkt-RF	-0.000901875	0.002164001	-0.416762629	0.677615664	-0.005187566	0.003383816	-0.005187566	0.003383816
SMB	0.002332796	0.003541579	0.658688071	0.51139027	-0.004681116	0.009346707	-0.004681116	0.009346707
HML	-0.000162211	0.002518673	-0.064403273	0.948759031	-0.005150311	0.004825889	-0.005150311	0.004825889

10.2 Fama & French 3-Factor Model Regression Analysis (risk free rate=0%)

SUMMARY OUTPUT-VSMPX								
Regression Statistics								
Multiple R	0.074873247							
R Square	0.005606003							
Adjusted R Square	-0.019891279							
Standard Error	0.103715562							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.007095264	0.002365088	0.219866696	0.882441981			
Residual	117	1.258559376	0.010756918					
Total	120	1.26565464						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001612951	0.009688974	0.166472874	0.86807218	-0.017575554	0.020801456	-0.017575554	0.020801456
Mkt-RF	-0.000678684	0.002179859	-0.311342963	0.756093973	-0.00499578	0.003638413	-0.00499578	0.003638413
SMB	0.002441072	0.003567531	0.68424687	0.495172384	-0.004624237	0.009506381	-0.004624237	0.009506381
HML	0.000881574	0.00253713	0.347468902	0.728863358	-0.004143079	0.005906226	-0.004143079	0.005906226

SUMMARY OUTPUT-LCGFX

Regression Statistics	
Multiple R	0.067852125
R Square	0.004603911
Adjusted R Square	-0.020919066
Standard Error	0.10785072
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.006294525	0.002098175	0.180382991	0.909527216
Residual	117	1.360918015	0.011631778		
Total	120	1.36721254			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001471624	0.010075275	0.146062939	0.884123062	-0.01848193	0.021425179	-0.01848193	0.021425179
Mkt-RF	-0.001205476	0.00226677	-0.531803228	0.595870613	-0.005694696	0.003283744	-0.005694696	0.003283744
SMB	0.002330742	0.00370977	0.628271456	0.531050633	-0.005016262	0.009677747	-0.005016262	0.009677747
HML	-0.000512017	0.002638286	-0.194072043	0.846456025	-0.005737004	0.004712969	-0.005737004	0.004712969

SUMMARY OUTPUT-PRWAX

Regression Statistics	
Multiple R	0.088762604
R Square	0.0078788
Adjusted R Square	-0.017560205
Standard Error	0.108565756
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.010951331	0.003650444	0.309713364	0.818325668
Residual	117	1.379023241	0.011786523		
Total	120	1.389974572			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.001108361	0.010142073	-0.10928346	0.913164879	-0.021194204	0.018977483	-0.021194204	0.018977483
Mkt-RF	-0.001927882	0.002281799	-0.844895814	0.399893421	-0.006446865	0.002591101	-0.006446865	0.002591101
SMB	0.002119953	0.003734365	0.567687721	0.571334775	-0.005275761	0.009515667	-0.005275761	0.009515667
HML	-0.000975541	0.002655777	-0.367327789	0.714038111	-0.006235168	0.004284087	-0.006235168	0.004284087

SUMMARY OUTPUT-CUSEX

Regression Statistics	
Multiple R	0.053410626
R Square	0.002852695
Adjusted R Square	-0.022715185
Standard Error	0.102029546
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.003484446	0.001161482	0.111573387	0.953186989
Residual	117	1.217973301	0.010410028		
Total	120	1.221457747			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.002058593	0.009531468	-0.215978568	0.829380543	-0.020935167	0.016817981	-0.020935167	0.016817981
Mkt-RF	-0.001170058	0.002144423	-0.545628431	0.586360144	-0.005416975	0.003076859	-0.005416975	0.003076859
SMB	0.001223299	0.003509537	0.348564265	0.728042896	-0.005727155	0.008173754	-0.005727155	0.008173754
HML	-1.16284E-05	0.002495886	-0.00465904	0.996290572	-0.004954599	0.004931343	-0.004954599	0.004931343

SUMMARY OUTPUT-CMLIX

Regression Statistics	
Multiple R	0.075514253
R Square	0.005702402
Adjusted R Square	-0.019792408
Standard Error	0.104926756
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.00738754	0.002462513	0.223669146	0.879783601
Residual	117	1.288126023	0.011009624		
Total	120	1.295513563			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.000216325	0.009802122	-0.022069229	0.982430326	-0.019628914	0.019196264	-0.019628914	0.019196264
Mkt-RF	-0.001517733	0.002205315	-0.688215926	0.492679083	-0.005885245	0.002849778	-0.005885245	0.002849778
SMB	0.001955395	0.003609193	0.541781728	0.588999158	-0.005192423	0.009103213	-0.005192423	0.009103213
HML	-0.000808967	0.002566758	-0.315170598	0.753193555	-0.005892297	0.004274364	-0.005892297	0.004274364

SUMMARY OUTPUT-FMFMX

Regression Statistics	
Multiple R	0.090145169
R Square	0.008126151
Adjusted R Square	-0.017306511
Standard Error	0.111484499
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.011913608	0.003971203	0.319516344	0.811242394
Residual	117	1.454168831	0.012428793		
Total	120	1.466082439			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.001762128	0.010414738	-0.16919557	0.865934991	-0.02238797	0.018863715	-0.02238797	0.018863715
Mkt-RF	-0.002164761	0.002343144	-0.923870491	0.357455196	-0.006805235	0.002475712	-0.006805235	0.002475712
SMB	0.001936463	0.003834762	0.504976022	0.614525527	-0.005658082	0.009531007	-0.005658082	0.009531007
HML	-0.000682988	0.002727176	-0.250437733	0.802688092	-0.006084018	0.004718042	-0.006084018	0.004718042

SUMMARY OUTPUT-QALGX

Regression Statistics	
Multiple R	0.082978516
R Square	0.006885434
Adjusted R Square	-0.018579042
Standard Error	0.109946683
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.009805779	0.003268593	0.270393708	0.84663723
Residual	117	1.414327957	0.012088273		
Total	120	1.424133736			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.000172413	0.010271077	-0.016786269	0.986635716	-0.020513743	0.020168917	-0.020513743	0.020168917
Mkt-RF	-0.001599406	0.002310823	-0.692136961	0.490222658	-0.006175869	0.002977057	-0.006175869	0.002977057
SMB	0.002775336	0.003781865	0.733853933	0.464505805	-0.004714449	0.010265122	-0.004714449	0.010265122
HML	-0.000643414	0.002689558	-0.239226822	0.811348265	-0.005969943	0.004683114	-0.005969943	0.004683114

SUMMARY OUTPUT-CFGRX

Regression Statistics	
Multiple R	0.076406489
R Square	0.005837952
Adjusted R Square	-0.019653383
Standard Error	0.107199332
Observations	121

ANOVA

	df	SS	MS	F	Significance F
Regression	3	0.007895385	0.002631795	0.229017101	0.876032716
Residual	117	1.34452852	0.011491697		
Total	120	1.352423905			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-0.001392989	0.010014423	-0.139098237	0.889611666	-0.021226029	0.018440052	-0.021226029	0.018440052
Mkt-RF	-0.001379082	0.00225308	-0.612087506	0.541667547	-0.005841188	0.003083024	-0.005841188	0.003083024
SMB	0.002256855	0.003687364	0.612051019	0.541691604	-0.005045776	0.009559485	-0.005045776	0.009559485
HML	-0.001014326	0.002622351	-0.386800201	0.699606741	-0.006207755	0.004179103	-0.006207755	0.004179103

SUMMARY OUTPUT-MIGFX

Regression Statistics	
Multiple R	0.067618449
R Square	0.004572255
Adjusted R Square	-0.020951534
Standard Error	0.104794113
Observations	121

ANOVA

	df	SS	MS	F	Significance F
Regression	3	0.005901743	0.001967248	0.179136989	0.910363579
Residual	117	1.284871308	0.010981806		
Total	120	1.290773051			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-0.001808057	0.009789731	-0.18468911	0.853792641	-0.021196105	0.017579992	-0.021196105	0.017579992
Mkt-RF	-0.001384394	0.002202528	-0.628547843	0.530870251	-0.005746384	0.002977597	-0.005746384	0.002977597
SMB	0.001600714	0.003604631	0.444071661	0.657811014	-0.005538068	0.008739496	-0.005538068	0.008739496
HML	-0.000764877	0.002563514	-0.298370486	0.765949655	-0.005841781	0.004312028	-0.005841781	0.004312028

SUMMARY OUTPUT-APGAX

Regression Statistics	
Multiple R	0.063536298
R Square	0.004036861
Adjusted R Square	-0.021500655
Standard Error	0.105257158
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.005253995	0.001751332	0.158075713	0.92428702
Residual	117	1.296251115	0.011079069		
Total	120	1.30150511			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.000780459	0.009832988	0.079371467	0.936872759	-0.018693258	0.020254176	-0.018693258	0.020254176
Mkt-RF	-0.001109634	0.00221226	-0.501584161	0.616902578	-0.005490899	0.00327163	-0.005490899	0.00327163
SMB	0.001956702	0.003620558	0.540442195	0.589919439	-0.005213623	0.009127028	-0.005213623	0.009127028
HML	-0.000735481	0.002574841	-0.285641398	0.775657875	-0.005834819	0.004363856	-0.005834819	0.004363856

SUMMARY OUTPUT-FFIDX

Regression Statistics	
Multiple R	0.082364028
R Square	0.006783833
Adjusted R Square	-0.018683248
Standard Error	0.103974642
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.008639172	0.002879724	0.266376548	0.849514299
Residual	117	1.26485497	0.010810726		
Total	120	1.273494142			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.000163098	0.009713177	-0.016791387	0.986631642	-0.019399535	0.01907334	-0.019399535	0.01907334
Mkt-RF	-0.001100117	0.002185304	-0.503416029	0.615618279	-0.005427998	0.003227763	-0.005427998	0.003227763
SMB	0.003027593	0.003576443	0.846537548	0.39898109	-0.004055365	0.010110552	-0.004055365	0.010110552
HML	-0.000539897	0.002543467	-0.212268155	0.832267199	-0.005577101	0.004497307	-0.005577101	0.004497307

SUMMARY OUTPUT-DREVX

Regression Statistics	
Multiple R	0.062934362
R Square	0.003960734
Adjusted R Square	-0.021578734
Standard Error	0.105440561
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.0051725	0.001724167	0.155082867	0.926229697
Residual	117	1.300772286	0.011117712		
Total	120	1.305944785			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.002293651	0.009850121	-0.232855154	0.816280748	-0.0218013	0.017213997	-0.0218013	0.017213997
Mkt-RF	-0.001373948	0.002216114	-0.619980597	0.536476179	-0.005762846	0.003014951	-0.005762846	0.003014951
SMB	0.00141366	0.003626867	0.38977451	0.697411911	-0.005769159	0.00859648	-0.005769159	0.00859648
HML	-0.000554235	0.002579327	-0.214875625	0.830238377	-0.005662457	0.004553988	-0.005662457	0.004553988

SUMMARY OUTPUT-USBSX

Regression Statistics	
Multiple R	0.037908978
R Square	0.001437091
Adjusted R Square	-0.024167087
Standard Error	0.096232753
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.001559338	0.000519779	0.056127194	0.98243489
Residual	117	1.083506898	0.009260743		
Total	120	1.085066236			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.007809927	0.00898994	-0.868740774	0.386767496	-0.025614031	0.009994177	-0.025614031	0.009994177
Mkt-RF	2.96445E-05	0.002022588	0.014656704	0.988331024	-0.003975985	0.004035274	-0.003975985	0.004035274
SMB	0.001154947	0.003310143	0.348911609	0.727782789	-0.005400618	0.007710513	-0.005400618	0.007710513
HML	0.000305092	0.002354082	0.12960142	0.897104324	-0.004357044	0.004967229	-0.004357044	0.004967229

SUMMARY OUTPUT-IYSMX

Regression Statistics	
Multiple R	0.08309552
R Square	0.006904865
Adjusted R Square	-0.018559112
Standard Error	0.113149703
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.010414947	0.003471649	0.271162087	0.846086487
Residual	117	1.497934072	0.012802855		
Total	120	1.508349019			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.005815615	0.010570299	-0.550184537	0.583241652	-0.026749539	0.015118308	-0.026749539	0.015118308
Mkt-RF	-0.000875739	0.002378143	-0.36824483	0.713356096	-0.005585526	0.003834048	-0.005585526	0.003834048
SMB	0.003479848	0.00389204	0.894093465	0.373107411	-0.004228134	0.011187829	-0.004228134	0.011187829
HML	-9.7228E-05	0.002767911	-0.035126851	0.97203845	-0.005578931	0.005384475	-0.005578931	0.005384475

SUMMARY OUTPUT-WDHYX

Regression Statistics	
Multiple R	0.046272724
R Square	0.002141165
Adjusted R Square	-0.023444959
Standard Error	0.092447915
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.002145661	0.00071522	0.083684616	0.96881383
Residual	117	0.999954191	0.008546617		
Total	120	1.002099852			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.008907547	0.008636365	-1.031400021	0.304480622	-0.026011415	0.008196321	-0.026011415	0.008196321
Mkt-RF	0.000617922	0.001943039	0.318018036	0.751038171	-0.003230166	0.004466009	-0.003230166	0.004466009
SMB	0.000815924	0.003179955	0.256583599	0.797950872	-0.00548181	0.007113659	-0.00548181	0.007113659
HML	0.000149617	0.002261496	0.06615852	0.947364537	-0.004329158	0.004628392	-0.004329158	0.004628392

SUMMARY OUTPUT-FCNTX								
Regression Statistics								
Multiple R	0.082726746							
R Square	0.006843715							
Adjusted R Square	-0.018621831							
Standard Error	0.106309123							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.009111738	0.003037246	0.268744075	0.847819156			
Residual	117	1.322290669	0.01130163					
Total	120	1.331402407						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.000148653	0.009931261	0.014968143	0.98808309	-0.019519689	0.019816995	-0.019519689	0.019816995
Mkt-RF	-0.001339697	0.00223437	-0.599585947	0.54994159	-0.005764748	0.003085355	-0.005764748	0.003085355
SMB	0.002566378	0.003656743	0.70182076	0.484184701	-0.00467561	0.009808366	-0.00467561	0.009808366
HML	-0.001167891	0.002600574	-0.449089815	0.654197613	-0.006318193	0.00398241	-0.006318193	0.00398241

SUMMARY OUTPUT-FCTDX								
Regression Statistics								
Multiple R	0.051760203							
R Square	0.002679119							
Adjusted R Square	-0.022893212							
Standard Error	0.101753398							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.003254174	0.001084725	0.104766307	0.957142232			
Residual	117	1.211389216	0.010353754					
Total	120	1.21464339						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.002136115	0.009505671	-0.224720013	0.822589089	-0.020961598	0.016689369	-0.020961598	0.016689369
Mkt-RF	-0.000754709	0.002138619	-0.352895593	0.724801686	-0.004990132	0.003480713	-0.004990132	0.003480713
SMB	0.001827667	0.003500038	0.52218494	0.602528839	-0.005103975	0.00875931	-0.005103975	0.00875931
HML	-0.000164079	0.002489131	-0.065918114	0.947555523	-0.005093671	0.004765514	-0.005093671	0.004765514

SUMMARY OUTPUT-AGTHX								
Regression Statistics								
Multiple R	0.082672778							
R Square	0.006834788							
Adjusted R Square	-0.018630986							
Standard Error	0.107278486							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.009266478	0.003088826	0.268391136	0.848071945			
Residual	117	1.346514808	0.011508674					
Total	120	1.355781286						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.001462534	0.010021818	-0.145934995	0.884223839	-0.021310219	0.018385151	-0.021310219	0.018385151
Mkt-RF	-0.001500276	0.002254743	-0.665386529	0.507112887	-0.005965677	0.002965125	-0.005965677	0.002965125
SMB	0.002485376	0.003690086	0.673527951	0.501939822	-0.004822646	0.009793399	-0.004822646	0.009793399
HML	-0.001050381	0.002624287	-0.400253694	0.689699535	-0.006247644	0.004146883	-0.006247644	0.004146883

SUMMARY OUTPUT-VTBIX								
Regression Statistics								
Multiple R	0.034109668							
R Square	0.001163469							
Adjusted R Square	-0.024447724							
Standard Error	0.093061031							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.001180272	0.000393424	0.045428162	0.987084078			
Residual	117	1.013261595	0.008660356					
Total	120	1.014441867						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.009659505	0.008693641	-1.11109996	0.268803431	-0.026876806	0.007557797	-0.026876806	0.007557797
Mkt-RF	0.000619998	0.001955926	0.316984395	0.751820366	-0.00325361	0.004493606	-0.00325361	0.004493606
SMB	0.000139065	0.003201045	0.043443577	0.965421997	-0.006200437	0.006478566	-0.006200437	0.006478566
HML	0.000230475	0.002276495	0.101241328	0.919532184	-0.004278003	0.004738953	-0.004278003	0.004738953

SUMMARY OUTPUT-VTBNX

Regression Statistics	
Multiple R	0.034109668
R Square	0.001163469
Adjusted R Square	-0.024447724
Standard Error	0.093061031
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.001180272	0.000393424	0.045428162	0.987084078
Residual	117	1.013261595	0.008660356		
Total	120	1.014441867			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.009659505	0.008693641	-1.11109996	0.268803431	-0.026876806	0.007557797	-0.026876806	0.007557797
Mkt-RF	0.000619998	0.001955926	0.316984395	0.751820366	-0.00325361	0.004493606	-0.00325361	0.004493606
SMB	0.000139065	0.003201045	0.043443577	0.965421997	-0.006200437	0.006478566	-0.006200437	0.006478566
HML	0.000230475	0.002276495	0.101241328	0.919532184	-0.004278003	0.004738953	-0.004278003	0.004738953

SUMMARY OUTPUT-VIIIX

Regression Statistics	
Multiple R	0.065670283
R Square	0.004312586
Adjusted R Square	-0.02121786
Standard Error	0.103149985
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.005391864	0.001797288	0.168919338	0.917170893
Residual	117	1.244870577	0.010639919		
Total	120	1.250262441			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001220374	0.009636138	0.126645587	0.899438303	-0.017863493	0.020304242	-0.017863493	0.020304242
Mkt-RF	-0.001023761	0.002167972	-0.472220641	0.63764889	-0.005317316	0.003269794	-0.005317316	0.003269794
SMB	0.002307467	0.003548077	0.650342936	0.516745735	-0.004719314	0.009334248	-0.004719314	0.009334248
HML	-0.000238014	0.002523294	-0.094326572	0.925011093	-0.005235266	0.004759239	-0.005235266	0.004759239

SUMMARY OUTPUT-VFFSX								
Regression Statistics								
Multiple R	0.090581344							
R Square	0.00820498							
Adjusted R Square	-0.017225662							
Standard Error	0.111944743							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.012129667	0.004043222	0.32264148	0.808983556			
Residual	117	1.466200184	0.012531626					
Total	120	1.478329851						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.00110503	0.010457733	-0.105666279	0.916028085	-0.021816023	0.019605963	-0.021816023	0.019605963
Mkt-RF	-0.002089893	0.002352817	-0.888251234	0.376228087	-0.006749524	0.002569738	-0.006749524	0.002569738
SMB	0.002357109	0.003850593	0.612141886	0.541631694	-0.005268788	0.009983006	-0.005268788	0.009983006
HML	-0.000728299	0.002738435	-0.265954359	0.790742449	-0.006151626	0.004695028	-0.006151626	0.004695028

SUMMARY OUTPUT-VGTSX								
Regression Statistics								
Multiple R	0.056014966							
R Square	0.003137676							
Adjusted R Square	-0.022422896							
Standard Error	0.102269863							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.003851715	0.001283905	0.122754544	0.946518718			
Residual	117	1.223717611	0.010459125					
Total	120	1.227569326						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.005199154	0.009553919	-0.544190762	0.5873458	-0.024120189	0.013721881	-0.024120189	0.013721881
Mkt-RF	7.40998E-05	0.002149474	0.034473456	0.972558354	-0.00418282	0.00433102	-0.00418282	0.00433102
SMB	0.001791422	0.003517803	0.509244477	0.61153997	-0.005175403	0.008758247	-0.005175403	0.008758247
HML	0.000492614	0.002501764	0.196906681	0.844242209	-0.004461999	0.005447228	-0.004461999	0.005447228

SUMMARY OUTPUT-VTSAX

Regression Statistics	
Multiple R	0.064895465
R Square	0.004211421
Adjusted R Square	-0.021321619
Standard Error	0.103787087
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.005330084	0.001776695	0.164940067	0.919795902
Residual	117	1.260295855	0.010771759		
Total	120	1.265625939			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001636452	0.009695656	0.168781998	0.866259563	-0.017565286	0.02083819	-0.017565286	0.02083819
Mkt-RF	-0.000879784	0.002181362	-0.403318411	0.687450104	-0.005199857	0.00344029	-0.005199857	0.00344029
SMB	0.00239773	0.003569992	0.671634493	0.503140397	-0.004672452	0.009467911	-0.004672452	0.009467911
HML	-0.000208242	0.002538879	-0.082021081	0.934770102	-0.005236359	0.004819876	-0.005236359	0.004819876

SUMMARY OUTPUT-VFIAX

Regression Statistics	
Multiple R	0.066069992
R Square	0.004365244
Adjusted R Square	-0.021163852
Standard Error	0.103183025
Observations	121

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.005461486	0.001820495	0.170990928	0.915798363
Residual	117	1.245668183	0.010646737		
Total	120	1.25112967			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.002128859	0.009639225	0.220853752	0.825591259	-0.016961121	0.021218839	-0.016961121	0.021218839
Mkt-RF	-0.00094334	0.002168666	-0.434986098	0.664373817	-0.00523827	0.00335159	-0.00523827	0.00335159
SMB	0.002393767	0.003549214	0.674450027	0.501355723	-0.004635264	0.009422799	-0.004635264	0.009422799
HML	-0.000173691	0.002524103	-0.068813122	0.94525584	-0.005172544	0.004825162	-0.005172544	0.004825162

SUMMARY OUTPUT-FXAIX								
Regression Statistics								
Multiple R	0.064275268							
R Square	0.00413131							
Adjusted R Square	-0.021403785							
Standard Error	0.102961068							
Observations	121							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.005145382	0.001715127	0.161789497	0.921863195			
Residual	117	1.240314848	0.010600982					
Total	120	1.245460231						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001857267	0.00961849	0.19309337	0.847220642	-0.017191649	0.020906182	-0.017191649	0.020906182
Mkt-RF	-0.000901875	0.002164001	-0.416762629	0.677615664	-0.005187566	0.003383816	-0.005187566	0.003383816
SMB	0.002332796	0.003541579	0.658688071	0.51139027	-0.004681116	0.009346707	-0.004681116	0.009346707
HML	-0.000162211	0.002518673	-0.064403273	0.948759031	-0.005150311	0.004825889	-0.005150311	0.004825889

10.3 Rcodes for risk analysis in RStudio:

```
library(readxl)

library(dplyr)

library(PerformanceAnalytics)

library(tidyr)

library(lmtest)

library(car)

library(forecast)

library(purrr)

library(tidyverse)

library(broom)

library(sandwich)

library(xts)


mutual_funds <- read_excel("D:/AAU/_Masters Thesis/Data.xlsx", col_names = TRUE)

head(mutual_funds)


fama_french <- read_excel("D:/AAU/_Masters Thesis/Data_FF.xlsx", col_names= TRUE)

head(fama_french)
```

```
mutual_funds$Date <- as.Date(mutual_funds$Date)
fama_french$date <- as.Date(fama_french$date)

log_returns <- mutual_funds %>%
  arrange(Date) %>%
  mutate(across(-Date, ~ log(.) - log(lag(.)))) %>%
  na.omit()

merged_data <- merge(log_returns, fama_french, by.x = "Date", by.y = "date")
rf <- merged_data$RF / 100

portfolio <- merged_data$VSMPX
excess_returns <- portfolio - rf

capm_model <- lm(excess_returns ~ merged_data$`Mkt-RF`)

jensen_alpha <- coef(capm_model)[1]
print(paste("Jensen's Alpha:", jensen_alpha))

merged_data <- merge(data_returns, fama_french, by.x = "Date", by.y = "date")

portfolio <- merged_data$VSMPX
# Change ticker as needed
rf <- merged_data$RF / 100
# Ensure risk-free rate is in decimal format

excess_returns <- portfolio - rf
print(excess_returns)
```

```
capm_model <- lm(excess_returns ~ merged_data$`Mkt-RF`)
jensen_alpha <- coef(capm_model)[1]
print(paste("Jensen's Alpha:", jensen_alpha))

beta <- coef(capm_model)[2]
treynor_ratio <- mean(excess_returns, na.rm = TRUE) / beta
print(paste("Treynor Ratio:", treynor_ratio))

sharpe_ratio <- mean(excess_returns, na.rm = TRUE) / sd(excess_returns, na.rm = TRUE)
print(paste("Sharpe Ratio:", sharpe_ratio))
plot(sharpe_ratio)

benchmark <- merged_data$`Mkt-RF`
tracking_error <- sd(excess_returns - benchmark, na.rm = TRUE)
info_ratio <- mean(excess_returns - benchmark, na.rm = TRUE) / tracking_error
print(paste("Information Ratio:", info_ratio))
plot(info_ratio)

ff3_model <- lm(excess_returns ~ merged_data$`Mkt-RF` + merged_data$SMB + merged_data$HML)
summary(ff3_model)
plot(ff3_model)
library(dplyr)

mutual_funds <- c("VSMPX", "LCGFX", "PRWAX", "CUSEX", "CMLIX", "FMFMX", "QALGX",
            "CFGRX", "MIGFX", "APGAX", "FFIDX", "DREVX", "USBSX", "IYSMX",
            "WDHYX", "FCNTX", "FCTDX", "AGTHX", "VTBIX", "VTBNX", "VIIIX",
            "VFFSX", "VGTSX", "VTSAX", "VFIAX", "FXAIX")

# only mutual fund return columns
mutual_fund_returns <- merged_data %>% select(all_of(mutual_funds))
```

```
cov_matrix <- cov(mutual_fund_returns, use = "pairwise.complete.obs")

print("Variance-Covariance Matrix:")
print(cov_matrix)

variances <- diag(cov_matrix)
print("Variances of Mutual Funds:")
print(variances)
```

10.4 Result analysis of statistical T-test

t-Test: Paired Two Sample for Means-VSMPX

	0.013911454	*0.008524*
Mean	0.000335856	0.000969
Variance	0.010634217	0.010455
Observations	120	120
Pearson Correlation	0.778173352	
Hypothesized Mean Difference	0	
df	119	
t Stat	-0.101335146	
P(T<=t) one-tail	0.459727481	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.919454961	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-LCGFX

	0.0008726	*0.008524*
Mean	8.24657E-05	0.000969
Variance	0.011489176	0.010455
Observations	120	120
Pearson Correlation	0.973720308	
Hypothesized Mean Difference	0	
df	119	
t Stat	-0.396147395	
P(T<=t) one-tail	0.346352853	

t Critical one-tail	1.657759285
P(T<=t) two-tail	0.692705706
t Critical two-tail	1.980099876

t-Test: Paired Two Sample for Means-PRWAX

	0.000450045	*0.008524*
Mean	-0.003050956	0.000969
Variance	0.011680356	0.010455
Observations	120	120
Pearson Correlation	0.952062534	
Hypothesized Mean Difference	0	
df	119	
t Stat	-1.331597988	
P(T<=t) one-tail	0.092768704	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.185537408	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-CUSEX

	0.005970149	*0.008523875*
Mean	-0.003383874	0.000968602
Variance	0.010263622	0.010454514
Observations	120	120
Pearson Correlation	0.986981531	
Hypothesized Mean Difference	0	
df	119	
t Stat	-2.898504746	
P(T<=t) one-tail	0.002232666	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.004465332	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-CMLIX

	-0.009713024	*0.008523875*
Mean	-0.001698103	0.000968602
Variance	0.010886133	0.010454514
Observations	120	120

Pearson Correlation	0.97944937
Hypothesized Mean Difference	0
df	119
t Stat	-1.388169244
P(T<=t) one-tail	0.083839428
t Critical one-tail	1.657759285
P(T<=t) two-tail	0.167678856
t Critical two-tail	1.980099876

t-Test: Paired Two Sample for Means-FMFMX

	-0.013673655	*0.008524*
Mean	-0.00382368	0.000969
Variance	0.012319212	0.010455
Observations	120	120
Pearson Correlation	0.924220119	
Hypothesized Mean Difference	0	
df	119	
t Stat	-1.238578917	
P(T<=t) one-tail	0.108969575	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.21793915	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-QALGX

	-0.005646527	*0.008524*
Mean	-0.001928647	0.000969
Variance	0.011967395	0.010455
Observations	120	120
Pearson Correlation	0.956612926	
Hypothesized Mean Difference	0	
df	119	
t Stat	-0.992920201	
P(T<=t) one-tail	0.161381769	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.322763538	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-CFGRX

	-0.00523195	*0.008524*
Mean	-0.002813842	0.000969
Variance	0.011364858	0.010455
Observations	120	120
Pearson Correlation	0.964567074	
Hypothesized Mean Difference	0	
df	119	
t Stat	-1.472825569	
P(T<=t) one-tail	0.071719075	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.143438151	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-MIGFX

	-0.000401123	*0.008524*
Mean	-0.003207885	0.000969
Variance	0.010846767	0.010455
Observations	120	120
Pearson Correlation	0.980280358	
Hypothesized Mean Difference	0	
df	119	
t Stat	-2.222934575	
P(T<=t) one-tail	0.014054531	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.028109062	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-APGAX

	-0.012395649	0.008523875
Mean	-0.00031631	0.000968602
Variance	0.010935802	0.010454514
Observations	120	120
Pearson Correlation	0.978674783	
Hypothesized Mean Difference	0	
df	119	
t Stat	-0.655239504	

P(T<=t) one-tail	0.256789114
t Critical one-tail	1.657759285
P(T<=t) two-tail	0.513578228
t Critical two-tail	1.980099876

t-Test: Paired Two Sample for Means-FFIDX

	-0.002483631	*0.008524*
Mean	-0.001557038	0.000969
Variance	0.010701624	0.010455
Observations	120	120
Pearson Correlation	0.98812464	
Hypothesized Mean Difference	0	
df	119	
t Stat	-1.740569413	
P(T<=t) one-tail	0.042171975	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.084343949	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-DREVX

	-0.001707942	*0.008524*
Mean	-0.003680993	0.000969
Variance	0.010974293	0.010455
Observations	120	120
Pearson Correlation	0.977906438	
Hypothesized Mean Difference	0	
df	119	
t Stat	-2.325756515	
P(T<=t) one-tail	0.010862268	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.021724535	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-USBSX

	0.009174312	*0.008523875*

Mean	-0.008172873	0.000968602
Variance	0.009115696	0.010454514
Observations	120	120
Pearson Correlation	0.974480468	
Hypothesized Mean Difference	0	
df	119	
t Stat	-4.293060785	
P(T<=t) one-tail	1.80677E-05	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	3.61354E-05	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-IYSMX

	-0.028669725	*0.008523875*
Mean	-0.006988403	0.000968602
Variance	0.012671284	0.010454514
Observations	120	120
Pearson Correlation	0.932502444	
Hypothesized Mean Difference	0	
df	119	
t Stat	-2.139217617	
P(T<=t) one-tail	0.017230501	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.034461001	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-WDHYX

	0.002460025	*0.008523875*
Mean	-0.008610727	0.000968602
Variance	0.008419986	0.010454514
Observations	120	120
Pearson Correlation	0.931967608	
Hypothesized Mean Difference	0	
df	119	

t Stat	-2.818090132
P(T<=t) one-tail	0.002829499
t Critical one-tail	1.657759285
P(T<=t) two-tail	0.005658997
t Critical two-tail	1.980099876

t-Test: Paired Two Sample for Means-FCNTX

	-0.008419175	*0.008523875*
Mean	-0.001224107	0.000968602
Variance	0.011187824	0.010454514
Observations	120	120
Pearson Correlation	0.974385183	
Hypothesized Mean Difference	0	
df	119	
t Stat	-1.009210584	
P(T<=t) one-tail	0.157460659	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.314921317	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-FCTDX

	0	*0.008524*
Mean	-0.00311588	0.000969
Variance	0.010207006	0.010455
Observations	120	120
Pearson Correlation	0.982381651	
Hypothesized Mean Difference	0	
df	119	
t Stat	-2.340436069	
P(T<=t) one-tail	0.010463017	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.020926035	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-AGTHX

	0.016092475	*0.008523875*
Mean	-0.00320345	0.000968602
Variance	0.011390017	0.010454514
Observations	120	120
Pearson Correlation	0.972959601	
Hypothesized Mean Difference	0	
df	119	
t Stat	-1.850162846	
P(T<=t) one-tail	0.033385313	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.066770627	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-VTBIX

	0	*0.008523875*
Mean	-0.009245063	0.000968602
Variance	0.008524009	0.010454514
Observations	120	120
Pearson Correlation	0.916077152	
Hypothesized Mean Difference	0	
df	119	
t Stat	-2.727354292	
P(T<=t) one-tail	0.003675499	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.007350999	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-VTBNX

	0	*0.008523875*
Mean	-0.009245063	0.000968602
Variance	0.008524009	0.010454514
Observations	120	120
Pearson Correlation	0.916077152	
Hypothesized Mean Difference	0	
df	119	

	-
t Stat	2.727354292
P(T<=t) one-tail	0.003675499
t Critical one-tail	1.657759285
P(T<=t) two-tail	0.007350999
t Critical two-tail	1.980099876

t-Test: Paired Two Sample for Means-VIIIX

	0.009584326	*0.008523875*
	-	
Mean	0.000122392	0.000968602
Variance	0.010505622	0.010454514
Observations	120	120
Pearson Correlation	0.99883219	
Hypothesized Mean Difference	0	
df	119	
	-	
t Stat	2.412559736	
P(T<=t) one-tail	0.008683762	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.017367524	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-VFFSX

	0	*0.008523875*
Mean	-0.003271654	0.000968602
Variance	0.012422851	0.010454514
Observations	120	120
Pearson Correlation	0.904477893	
Hypothesized Mean Difference	0	
df	119	
t Stat	-0.976638891	
P(T<=t) one-tail	0.165364588	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.330729176	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-VGTSX

	0.05083695	*0.008523875*
Mean	-0.005987539	0.000968602
Variance	0.010288798	0.010454514
Observations	120	120
Pearson Correlation	0.973548636	
Hypothesized Mean Difference	0	
df	119	
t Stat	-3.251179573	
P(T<=t) one-tail	0.000747555	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.001495109	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-VTSAX

	0.00420811	*0.008523875*
Mean	0.000451038	0.000968602
Variance	0.010635394	0.010454514
Observations	120	120
Pearson Correlation	0.998701639	
Hypothesized Mean Difference	0	
df	119	
t Stat	-1.068466718	
P(T<=t) one-tail	0.143736341	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.287472683	
t Critical two-tail	1.980099876	

t-Test: Paired Two Sample for Means-VFIAX

	0.009543286	*0.008523875*
Mean	0.000840774	0.000968602
Variance	0.010513064	0.010454514
Observations	120	120
Pearson Correlation	0.999608701	
Hypothesized Mean Difference	0	
df	119	
t Stat	-0.486446377	
P(T<=t) one-tail	0.313772692	

t Critical one-tail	1.657759285
P(T<=t) two-tail	0.627545384
t Critical two-tail	1.980099876

t-Test: Paired Two Sample for Means-FXAIX

	0.001495785	*0.008523875*
Mean	0.000679704	0.000968602
Variance	0.010466047	0.010454514
Observations	120	120
Pearson Correlation	0.999496019	
Hypothesized Mean Difference	0	
df	119	
t Stat	- 0.974484699	
P(T<=t) one-tail	0.165896342	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.331792685	
t Critical two-tail	1.980099876	