FRE 7831 Course Project: Analysis of Nike Inc. (NKE) Trading Strategies

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1 Introduction

This report details the analysis of Nike Inc. (ticker: NKE) stock performance over the period March 1, 2005, to February 27, 2025, following the requirements outlined in the FRE 7831 Course Project description. Daily adjusted closing prices were obtained from Yahoo Finance. The analysis includes descriptive statistics of the NKE log return series, estimation of an ARMA model, implementation and comparison of three trading strategies (Buy-and-Hold (B&H), Time Series Momentum (TSM), and Simple Moving Average (SMA)), and a performance comparison over rolling 10-year windows. Statistical significance of performance differences is also assessed.

2 Data Description and Statistics (Step 2)

The analysis utilizes daily adjusted closing prices for NKE spanning 5032 trading days from 2005-03-01 to 2025-02-27. Daily log returns were calculated for the statistical analysis and modeling steps.

Table 1 presents the key descriptive statistics for the daily log returns, annualized where appropriate.

Table 1: Descriptive Statistics of NKE Daily Log Returns (2005-2025)

Annualized Mean	Annualized Sigma	Skewness	Excess Kurtosis
0.1118	0.2889	-0.2120	12.7213

Source: R console output 'output.txt'.

The annualized mean log return is approximately 11.2%, with an annualized volatility (sigma) of 28.9%. The distribution exhibits negative skewness (-0.21) and significant excess kurtosis (12.72), indicating fatter tails than a normal distribution.

The sample Autocorrelation Function (ACF) plot for the daily log returns is shown in Figure 1.

The ACF plot shows no significant autocorrelation for lags greater than zero, as most spikes fall within the 95% confidence bounds (dashed blue lines). This suggests that the daily log returns are close to being serially uncorrelated, consistent with findings for many financial return series.

3 Time Series Modeling (Step 3)

An ARMA model was estimated for the daily log returns using the 'auto.arima()' function from the 'forecast' package in R.

The best model identified was an ARIMA(1,0,1) with a non-zero mean:

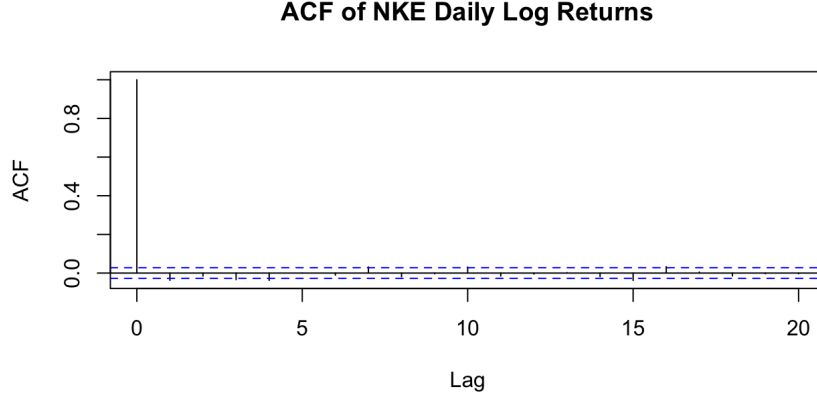$$(1 - \phi_1 B)(X_t - \mu) = (1 + \theta_1 B)\epsilon_t$$

ACF of NKE Daily Log Returns

Figure 1: ACF Plot of NKE Daily Log Returns

Source: R graphic output.

where X_t is the log return at time t, B is the backshift operator, μ is the mean, ϕ_1 is the AR(1) coefficient, θ_1 is the MA(1) coefficient, and ϵ_t is white noise.

The estimated coefficients are presented in Table 2.

Table 2: Estimated ARIMA(1,0,1) Model Coefficients for NKE Log Returns

Coefficient	Estimate	Std. Error	Approx. p-value
AR(1) (ϕ_1)	0.7150	0.1041	< 0.001
MA(1) (θ_1)	-0.7563	0.0974	< 0.001
Mean (μ)	0.0004	0.0002	≈ 0.046

Source: R console output 'output.txt'. p-values estimated assuming normality.

Both the AR(1) and MA(1) coefficients are statistically significant. The mean term is also statistically significant at the 5% level, suggesting the presence of a slight drift in the log returns.

An Augmented Dickey-Fuller (ADF) test was performed to check for a unit root. The test statistic was -17.5 with a p-value of 0.01. Since the p-value is less than the conventional significance level of 0.05, we reject the null hypothesis of a unit root, concluding that the daily log return series is stationary.

4 Strategy Implementation and Selection (Step 4)

Three trading strategies were implemented: Buy-and-Hold (B&H), Time Series Momentum (TSM), and Simple Moving Average (SMA) crossover. For the SMA strategy, three combinations of short/long moving average periods (63/15, 126/30, 252/63 days) were initially evaluated over the entire sample period (2005-2025) based on their Sharpe Ratios. The risk-free rate was assumed to be 0%.

Table 3 shows the Sharpe Ratios for the SMA strategies over the full sample.

Based on the highest Sharpe Ratio over the entire sample, the SMA 126/30 combination was selected as the "most profitable" for subsequent rolling window analysis, as required by the project description and clarified by the professor's email.

Table 3: Full-Sample Sharpe Ratios for SMA Strategy Combinations

SMA Combination (Short/Long Days)	Full Sample Sharpe Ratio
SMA 63 / 15	0.348
SMA 126 / 30	**0.357**
SMA 252 / 63	0.193

Source: R console output 'output.txt'.

5 Rolling Window Performance Comparison (Step 5)

The performance of the selected SMA (126/30) strategy, the TSM (252/21) strategy, and the B&H strategy was compared over all 10-year rolling windows within the sample period. The windows slide forward by one trading day for each calculation. Performance metrics include Annualized Return, Annualized Sharpe Ratio, and Maximum Drawdown (MDD). For strategy return calculations, periods where the strategy indicated being out of the market (signal = 0) were assigned a return of zero for that day.

5.1 Distribution of Performance Metrics

Summary statistics for the distributions of the key performance metrics across all 10-year windows are presented in Table 4.

On average over the 10-year rolling windows, the B&H strategy yielded the highest mean annualized return (18.0%) and the highest mean Sharpe ratio (0.747). The TSM strategy was second in both mean return (13.2%) and mean Sharpe ratio (0.665). The SMA strategy had the lowest mean return (7.3%) and mean Sharpe ratio (0.499). However, the TSM and SMA strategies exhibited lower average Maximum Drawdowns (33.8% and 34.6%, respectively) compared to B&H (43.0%).

The distributions of annualized returns and Sharpe ratios are visualized in Figures 2 and 3.
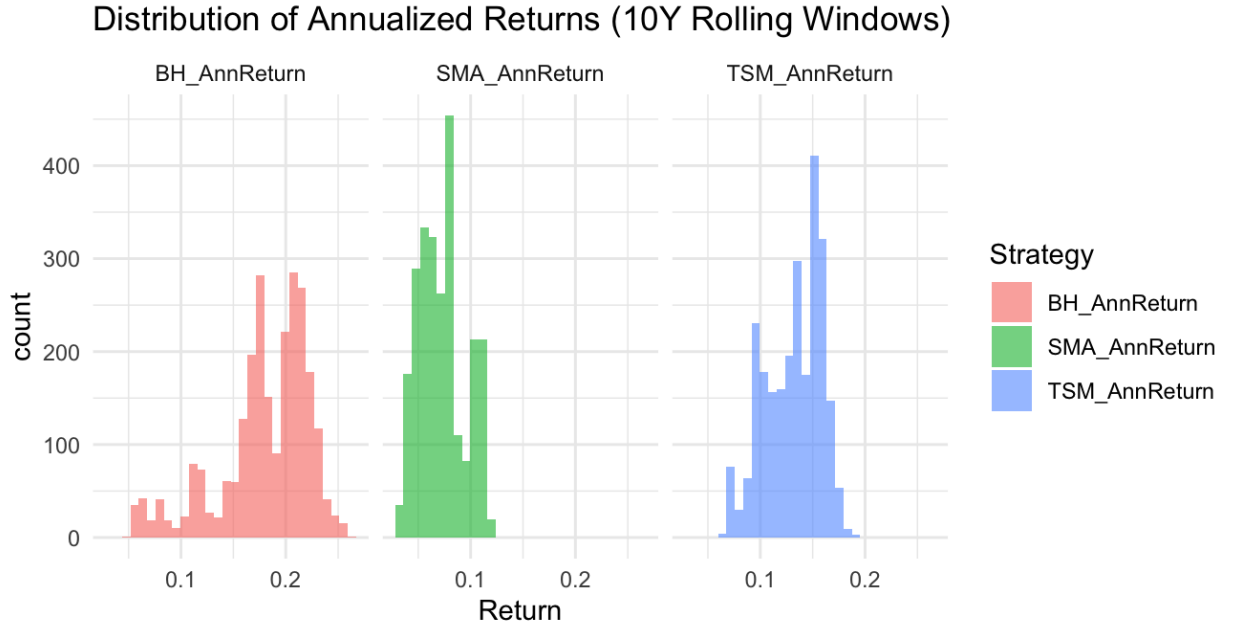

Figure 2: Distribution of Annualized Returns (10-Year Rolling Windows)

Source: R graphic output.

Table 4: Summary Statistics of Performance Metrics (10-Year Rolling Windows)

Metric	Strategy	Min	1st Qu.	Median	Mean	3rd Qu.	Max
Ann. Return	B&H	0.051	0.163	0.187	0.180	0.212	0.261
	TSM	0.067	0.110	0.136	0.132	0.153	0.189
	SMA	0.030	0.054	0.070	0.073	0.084	0.120
Sharpe Ratio	B&H	0.316	0.677	0.767	0.747	0.876	1.062
	TSM	0.408	0.585	0.686	0.665	0.749	0.862
	SMA	0.244	0.370	0.464	0.499	0.669	0.803
Max Drawdown	B&H	0.253	0.398	0.441	0.430	0.441	0.596
	TSM	0.261	0.309	0.346	0.338	0.346	0.427
	SMA	0.198	0.198	0.425	0.346	0.425	0.468

Source: R console output 'output.txt'. Returns and Sharpe Ratios are annualized.

Figure 2 visually confirms the ranking of average returns, with B&H centered highest, followed by TSM, then SMA. The B&H distribution is the widest, indicating greater variability in 10-year outcomes compared to TSM and especially SMA. Figure 3 shows a similar ranking for risk-adjusted returns (Sharpe Ratio), with B&H generally superior, although there appears to be overlap, particularly between B&H and TSM.

5.2 Statistical Significance of Performance Differences

Paired t-tests were conducted to assess the statistical significance of the differences in mean Annualized Returns and mean Sharpe Ratios between the strategies across the rolling windows. The results are summarized in Table 5.

All pairwise comparisons yielded highly significant p-values ($< 2.2e\text{-}16$). This indicates that the observed differences in average 10-year annualized returns and average 10-year Sharpe ratios between B&H, TSM, and SMA (126/30) strategies for NKE during this period are statistically significant. Specifically, B&H significantly outperformed both TSM and SMA, and TSM significantly outperformed SMA, on average, in terms of both raw and risk-adjusted returns over the rolling 10-year periods analyzed.

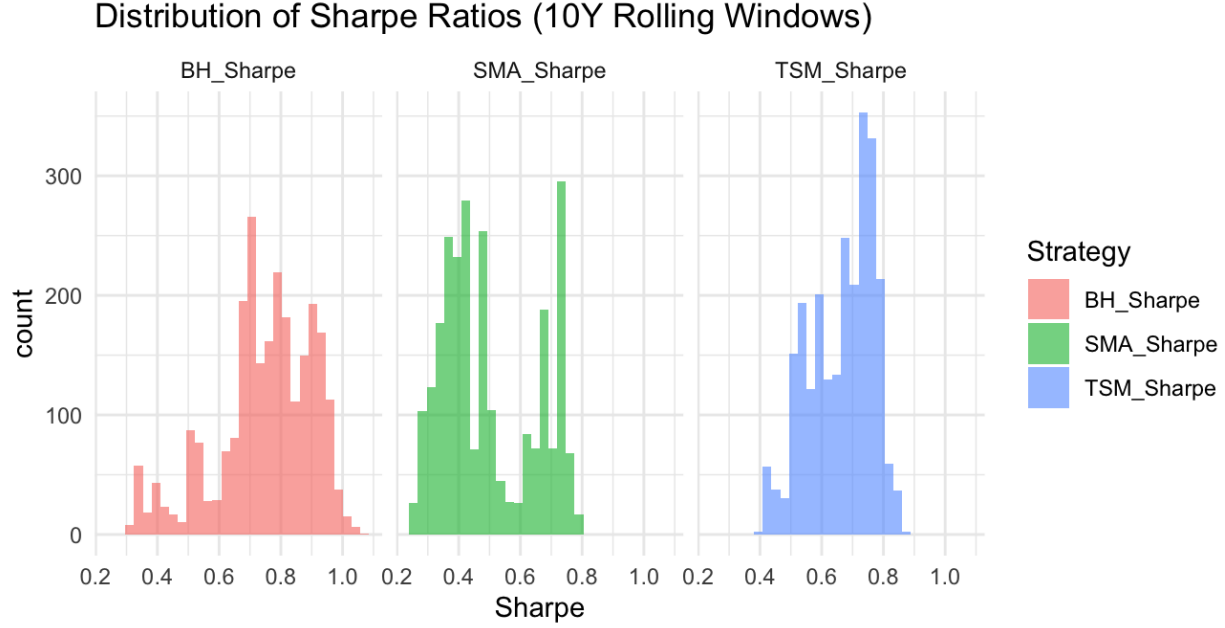## Distribution of Sharpe Ratios (10Y Rolling Windows)

Figure 3: Distribution of Sharpe Ratios (10-Year Rolling Windows)

Source: R graphic output (Assumed filename).

Table 5: Paired t-test Results for Performance Differences

Comparison	Metric	Mean Difference	p-value
TSM vs B&H	Ann. Return	-0.0481	< 2.2e-16
SMA vs B&H	Ann. Return	-0.1070	< 2.2e-16
TSM vs SMA	Ann. Return	0.0589	< 2.2e-16
TSM vs B&H	Sharpe Ratio	-0.0824	< 2.2e-16
SMA vs B&H	Sharpe Ratio	-0.2480	< 2.2e-16
TSM vs SMA	Sharpe Ratio	0.1657	< 2.2e-16

Source: R console output 'output.txt'.

6 Conclusion

This analysis examined Nike Inc. (NKE) stock returns from 2005 to 2025. The daily log returns were found to be stationary with negative skewness and high excess kurtosis. An ARIMA(1,0,1) model with drift provided the best fit according to 'auto.arima'.

Three trading strategies were compared: B&H, TSM (252/21), and the best-performing SMA crossover (126/30 based on full-sample Sharpe ratio). A rolling 10-year window analysis revealed that, on average, the B&H strategy delivered significantly higher annualized returns and Sharpe ratios than both TSM and SMA strategies for NKE during the period studied. The TSM strategy, in turn, significantly outperformed the SMA strategy on both metrics. While B&H showed superior returns, it also exhibited the highest average maximum drawdown over the 10-year periods, whereas TSM and SMA offered slightly better downside protection on average. All observed performance differences were statistically significant.