

An Empirical Analysis of Trend Following vs. Buy-and-Hold Strategies: A 20-Year Backtest on 10 Major Equity Indices

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Abstract

This paper provides an empirical comparison of the efficacy of an exponentially moving average (EMA) trend-following strategy and a traditional buy-and-hold strategy across 10 major equity indexes over the past 20 years. By conducting a comprehensive backtest on these globally diverse market benchmarks, the study aims to shed light on the relative benefits and potential drawbacks of these investment approaches.

1. Introduction and Objectives

I wrote this paper to explore my hypothesis that a trend-following strategy can offer greater value than a traditional buy-and-hold strategy. To substantiate this claim, it is necessary to define what “value” means in this context and to articulate the principles behind each of the trading strategies under consideration.

Beginning with the buy-and-hold strategy, it is widely acknowledged that this is a straightforward approach that has generated substantial returns over many years. The primary advantage of this strategy lies in its simplicity: investors purchase securities and hold them for an extended period, capitalizing on both potential future capital gains and ongoing dividend yields. This approach is predicated on the belief that the value of equities will generally increase over time. However, one significant drawback is that the gains are only realized if investors are willing to hold their positions through significant market downturns, a commitment that can be psychologically challenging. Furthermore, these downturns can occur unpredictably.

Conversely, the trend-following strategy aims to forecast future price movements. The central tenet of this approach is that security prices exhibit trends; that is, if a stock price has been rising recently, it is likely to continue doing so until a reversal occurs. This strategy capitalizes on the continuation of such trends. One of its strengths is its resilience in bear markets: when prices are falling, the strategy anticipates a continued decline, prompting investors to hold cash. However, this strategy has its downsides, including higher trading costs due to its more frequent trading activities, as well as the increased effort required to monitor price data and generate trading signals.

This paper will commence with foundational concepts and proceed to a thorough examination of quantitative evidence, supplemented by explanatory analysis.

2. Research Methodology

2.1 Underlying Assumptions

- Assume daily return follows a Gaussian distribution.
- All transaction costs, such as spread, market impact, commission, and taxes, are included as cost per trade. There is no holding cost.

2.2 Analytical Tools and Software

I developed my own backtesting environment in R along with other packages such as *tidyverse*, *quantmod*, and *PerformanceAnalytics*.

I simulated daily portfolio data, such as portfolio value, commissions, etc., and computed the daily return of each strategy given parameters such as universe, cost per trade, and window period.

Language and grammar corrections were performed using ChatGPT, a machine learning model developed by OpenAI, to ensure clarity and coherence in the presentation of the research findings.

2.3 Data Collection

Market Universe

The study incorporates data from a range of 10 major equity indices. These indices include the NASDAQ Composite, S&P 500, Hang Seng Index, Stock Exchange of Thailand Index, Nikkei 225, CAC 40 Index, DAX 30, Financial Times Stock Exchange 100 Index, All Ordinaries, and Dow Jones Industrial Average. The data spans from January 26, 2000, to January 26, 2023.

Data Sources

All historical prices are from stooq.com. I used these 10 main equity indices because equity is a common asset for most general investors. Additionally, I selected equity indices that have historical data for at least 20 years, as this period already covers many bull and bear markets, as well as sideways markets.

2.4 Strategy Formulation

Core Trading Strategy

For the buy-and-hold strategy, the investment is made on the first trading day at the closing price, and the position is held indefinitely. This strategy is implemented with the anticipation that despite market volatility, the investment will grow in value over the long term.

In contrast, the trend-following strategy employs an exponential moving average (EMA) crossover as its buy/sell mechanism. Specifically, a buy signal is generated when the short-term EMA is greater than the long-term EMA. Conversely, a sell signal is triggered when the short-term EMA falls below the long-term EMA. Upon receiving a buy or sell signal, the strategy takes action at the opening price on the following trading day (ATO). If a sell signal is generated, 100% of the holdings are sold at the next ATO.

Position Sizing Techniques

Both the buy-and-hold and trend-following strategies operate under the assumption that 70% of the available cash will be allocated for buying the asset. This approach is practical because brokers typically require a portion of cash to be reserved for 'At The Open' (ATO) orders.

Portfolio Rebalancing Methods

Neither the buy-and-hold strategy nor the trend-following strategy incorporates any form of portfolio rebalancing.

2.5 Key Performance Metrics

I employed four key metrics to assess performance:

- **Annualized Return:** This serves as an indicator of the return on investment over a standardized time period.
- **Annualized Standard Deviation:** This metric quantifies the investment's risk, providing an insight into the volatility of returns.

- **Annualized Sharpe Ratio:** This is used to understand the risk-adjusted returns, essentially quantifying how much excess return is generated for each unit of risk taken.
- **Maximum Drawdown:** This represents the largest single drop from peak to bottom in the value of a portfolio, providing a worst-case scenario for investment loss.

I opted for these four metrics because they are both straightforward and widely accepted in the field of finance. Notably, Maximum Drawdown is an especially important measure as it offers an understanding of the risk an investor is exposed to in pursuit of a given level of return.

3. Empirical Analysis and Findings

3.1 Introductory Overview

Let's start with the Thai equity index (SET index). We can see that over the past 20 years, the index has generally risen but has also experienced several sharp declines. This pattern aligns with other major indices, which, in the long term, tend to rise while also experiencing sharp declines. For now, we will set aside the consideration of costs and will address them in later sections.



Figure 1: Close price of SET Index

Table 1: Buy and Hold Performance metrics

	Value
Annualized Return	0.06
Annualized Std Dev	0.14
Annualized Sharpe (Rf=0%)	0.45
Average Drawdown	0.03
Max drawdown	0.45

According to the table, investing in Thai equity yields an annual return of approximately 6% per year. The table also indicates that the maximum drawdown is 45%. In terms of risk-adjusted return, the Sharpe ratio is 0.45



Figure 2: Close price with EMA crossover

Let's take a look from the perspective of trend-following. After applying an exponential moving average crossover (32,128), we see two additional lines on the chart. The green line represents the fast moving average of the close price, while the blue line represents the slow moving average.

Generally, the principle behind the moving average crossover is that if the fast moving average is higher than the slow moving average, it indicates an uptrend, and vice versa."



Figure 3: Equity Curves for Trend-Following and Buy-and-Hold Strategies

Table 2: Performance metrics

	Buy and Hold	Trend Following
Annualized Return	0.06	0.05
Annualized Std Dev	0.14	0.11
Annualized Sharpe ($R_f=0\%$)	0.45	0.50
Average Drawdown	0.03	0.02
Max drawdown	0.45	0.31

The chart above illustrates the equity curves of two investment strategies. It reveals that the buy-and-hold strategy (represented by the black line) outperforms the trend-following strategy in terms of return. However, a closer look at major drawdowns shows that the absolute drawdown for the trend-following strategy is relatively lower than that for buy-and-hold. The accompanying table indicates that buy-and-hold generates a 1% higher return but also carries a 3% higher risk. The Sharpe ratio for trend-following is 0.5, compared to 0.45 for buy-and-hold. Importantly, the drawdown for trend-following is significantly less than for buy-and-hold. It's worth noting that these performance metrics do not yet include transaction costs. The underlying presumption is that in an index characterized by upward trends interspersed with occasional sharp declines, a trend-following algorithm is likely to capture the majority of the gains while minimizing severe maximum drawdowns.

3.2 Backtesting on Ten Major Equity Indices (Excluding Costs)

The question arises: Is this pattern unique to Thai equity, or is it observed in other major equity indices as well? Let's now explore the performance characteristics of 10 major equity indices.

Table 3: Performance metrics

	Buy and Hold	Trend Following
Annualized Return	0.04	0.03
Annualized Std Dev	0.15	0.10
Annualized Sharpe (Rf=0%)	0.24	0.35
Average Drawdown	0.03	0.02
Max drawdown	0.48	0.26

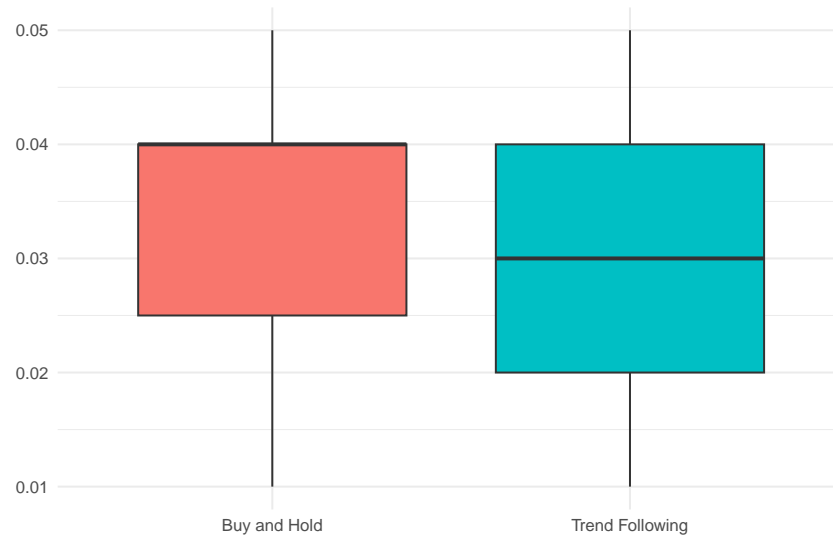


Figure 4: Boxplot of Annualized Return

Let's break down each performance component, starting with return. It is clear that the distribution of annual returns between the two strategies is similar, as evidenced by the overlapping bodies of the two box plots. Even before accounting for costs, trend-following adds no value in terms of return within this particular universe.

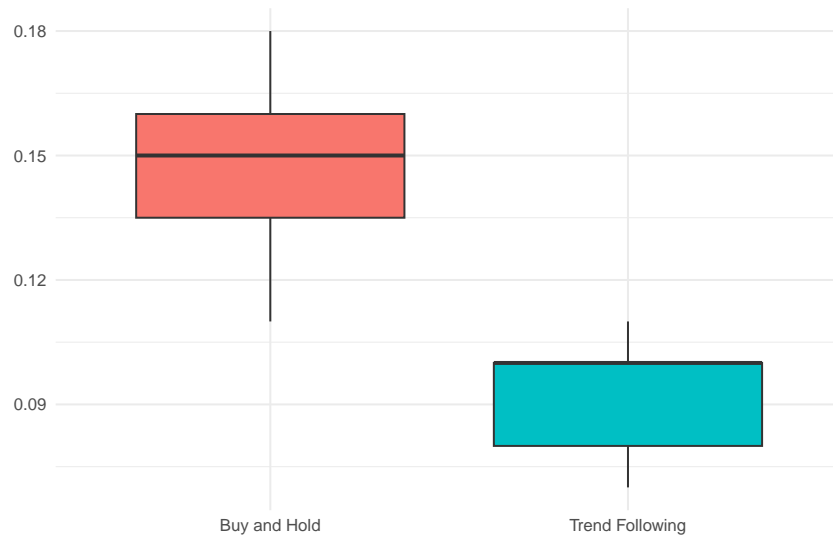


Figure 5: Boxplot of Annualized Standard Deviation

However, upon examining the annualized risk between the two strategies, it becomes clear that their risk profiles differ significantly. This is evident from the box plots, which do not overlap, indicating that the risk distribution for the trend-following strategy is significantly lower than that for the buy-and-hold strategy. At this juncture, we can begin to consider whether trend-following effectively helps to reduce risk.

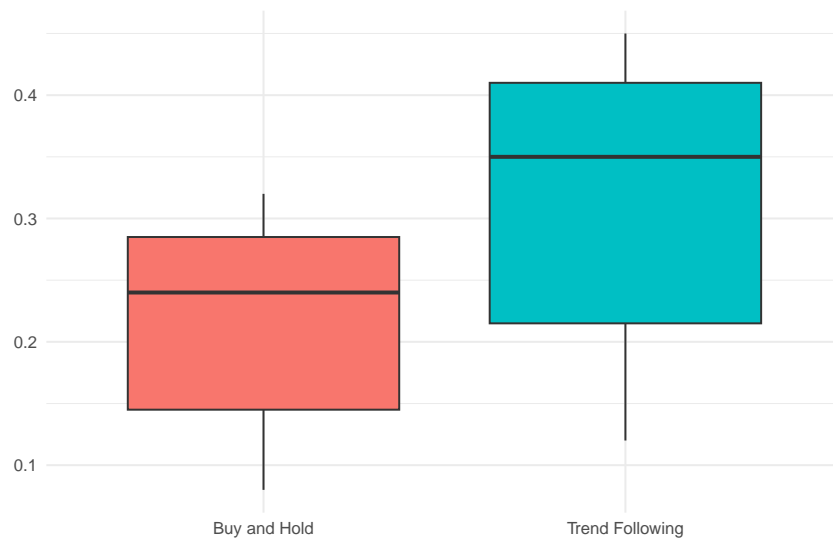


Figure 6: Boxplot of Annualized Sharp

In terms of the Sharpe ratio, the data shows that the trend-following strategy has a higher risk-adjusted return of 0.35, compared to the buy-and-hold strategy, which has a Sharpe ratio of 0.24. First, it is evident that the improvement in the Sharpe ratio for the trend-following strategy arises from risk reduction rather than higher returns. Although the Sharpe ratio for trend-following is higher, it does not conclusively improve

risk-adjusted returns, as the distributions are still overlapping and more dispersed.

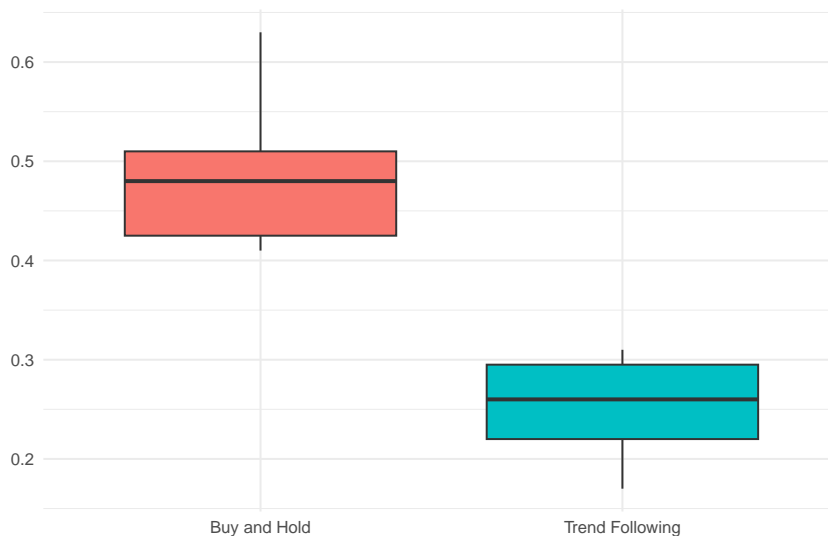


Figure 7: Boxplot of Max Drawdown

In terms of maximum drawdown, it is notable that the trend-following strategy reduced the maximum drawdown from 48% to 26%, representing a reduction of 46%. In brief, it is evident that the trend-following strategy effectively reduces the maximum drawdown of an investment.

To summarize, without considering costs, the trend-following strategy clearly adds value in two specific ways: 1) it reduces annualized risk, and 2) it reduces maximum drawdown. As for returns and risk-adjusted returns, the evidence is not sufficiently clear to draw any conclusions.

Now, let's consider the impact of investment costs. How will these affect the performance of the trend-following strategy?

3.3 Backtesting on Ten Major Equity Indices (Including Transaction Costs)

Table 4: Performance metrics

	Buy and Hold	Trend Following	Trend Following (with Cost)
Annualized Return	0.04	0.03	0.01
Annualized Std Dev	0.15	0.10	0.10
Annualized Sharpe (Rf=0%)	0.24	0.35	0.19
Average Drawdown	0.03	0.02	0.03
Max drawdown	0.48	0.26	0.36

For the sake of simplicity, let's condense the investment cost into a single variable: a 1% risk per trade. After factoring in this cost, the return for the trend-following strategy drops from 3% to 1%, as anticipated. This reduction in return also results in a corresponding decrease in the Sharpe ratio. Under these conditions of a 1% cost per trade, the trend-following strategy lags behind the buy-and-hold strategy in terms of risk-adjusted return.

However, when viewed from a risk standpoint, the trend-following strategy, even after accounting for costs, still exhibits both a lower maximum drawdown and lower annualized risk compared to the buy-and-hold strategy. The metrics for both risk and maximum drawdown support the conclusion that the trend-following strategy adds value in the realm of risk reduction, confirming the earlier evidence.

The critical question now is whether these results are due to luck or overfitted parameter.

To address this, we will delve into the robustness of the trend-following strategy. Specifically, we will examine its sensitivity to parameter changes by arbitrarily halving and doubling the original parameters—from (32, 128) to half (16, 64) and double (64, 256)

3.4 Robustness Assessment Through Parameter Sensitivity

Table 5: Performance metrics

	Buy and Hold	(32,128)	(16,64)	(64,256)
Annualized Return	0.04	0.03	0.00	0.01
Annualized Std Dev	0.15	0.10	0.10	0.11
Annualized Sharpe (Rf=0%)	0.24	0.35	-0.07	0.14
Average Drawdown	0.03	0.02	0.04	0.02
Max drawdown	0.48	0.26	0.46	0.33

According to the table, it is evident that the returns for all three variations of the trend-following strategies are consistently lower than those of the buy-and-hold strategy. However, the annualized risk is also consistently lower.

As for the Sharpe ratio, it becomes clear that the choice of parameters significantly impacts performance. For instance, the moving average pair of (16,64) results in a negative Sharpe ratio. This implies that despite a positive expected return from the index, this specific parameter set can turn it into a loss. The rationale behind this is straightforward: a faster moving average pair tends to generate more trades, thereby increasing costs.

In terms of maximum drawdown, the trend-following strategy consistently reduces the maximum drawdown of the investment.

Further research is needed to understand the nuances of parameter selection and how they influence the characteristics and behavior of the strategy. This is beyond the scope of the current paper, as it is a comprehensive topic that requires separate, detailed analysis.

3.5 Portfolio Simulation Scenarios

Let's consider a hypothetical scenario in which the capital is allocated across ten distinct segments, each invested in one of the major equity indices under study. What would the performance be when incorporating diversification within the asset class?



Figure 8: Equity Curves for Trend-Following and Buy-and-Hold Strategies

Table 6: Performance metrics

	Buy and Hold	Trend Following	Trend Following with cost
Annualized Return	0.05	0.03	0.02
Annualized Std Dev	0.14	0.06	0.06
Annualized Sharpe ($R_f=0\%$)	0.33	0.55	0.29
Average Drawdown	0.02	0.02	0.02
Max drawdown	0.54	0.17	0.21

The figure above reveals that the buy-and-hold strategy outperforms the trend-following strategy in terms of return. However, this superior performance is accompanied by a higher maximum drawdown. Additionally, when examining the Sharpe ratio, the buy-and-hold strategy also outperforms the trend-following strategy. This suggests that trend-following, when applied to 10 equity indices, does not add value in terms of risk-adjusted return. However, it does contribute to the reduction of maximum drawdown. As indicated in the table, the trend-following strategy, even after accounting for costs, reduces the maximum drawdown by approximately half.

4. Conclusions and Implications

The objective of this paper was to furnish a preliminary analysis of the effectiveness of trend-following strategies within the domain of equity indices. Our findings indicate that trend-following strategies add value

primarily in bear markets by sidestepping these unfavorable periods and maintaining cash reserves. This approach effectively mitigates both maximum drawdown and annualized risk. It is imperative to acknowledge that the performance of trend-following strategies is significantly impacted by both transactional costs and the selected look-back period.

For avenues of future research, an in-depth investigation into the behavior and characteristics of trend-following strategies under different parameter settings would be instructive. Moreover, broadening the asset classes examined could provide insights into the added benefits of diversification.