# Stock Market Statistical Analysis: Investing Versus Trading Strategies

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***Abstract* — In 2008, Warren Buffett issued a 10-years challenge against a hedge fund, Protégé Partners LLC, stating that the hedge fund industry's returns are not able to beat that of the S&P 500 Index in the long term, and he won. Surprisingly, the hedge fund comprehensively analyzed and traded stocks, whereas Warren Buffett simply invested in an S&P 500 Index Fund. Being very fascinated with the results, we want to compare investing with different trading strategies' returns ourselves to determine which would be more profitable in the long term. Based on Warren Buffet's results, our initial hypothesis is that investing is more profitable than trading in the long term. To prove this, we created a backtesting simulation (Paper Trading) Python program; comparing multiple trading strategies to a simple buy-and-hold investing strategy, using multiple Indonesian Blue-Chip stocks' data, which is gathered using Yahoo Finance's API. Then, we added Linear Regression on each strategies' cumulative returns to determine their long-term sustainability. Next, we compare the results for each strategy by plotting all of their returns together into a single chart. Finally, we determine which strategy generates the highest annual return, through visual and statistical approaches, and thereby prove our initial hypothesis. Through our analysis, it is concluded that the Investing strategy generates the highest Average Annual Return compared to the other strategies used in this research. This proves our hypothesis to be correct. Additionally, we also determined causes for the prior outcomes through general and mathematical reasonings.**

***Keywords — Investor, Hedge Fund, S&P 500 Index, Index Fund, Blue-Chip Stocks, Paper Trading, Linear Regression***

## I. Introduction

The stock market is a place where people are able to buy and sell shares of publicly traded equities through an intermediary stock exchange and broker. In general, there are two main ways of generating profit in the Stock Market, and that is through Trading & Investing strategies. Although there are countless of methodological differences between the two, the main distinction are actually the time frames between their buy and sell trades; traders often try to profit in the short term (intraday, days, weeks, up to months), whereas investors tend to pursue returns in the long term, usually holding their positions in their portfolio for years.

In 2008, a very famous & successful investor, Warren Buffett issued a challenge against a hedge fund, Protégé Partners LLC, stating that the hedge fund industry's returns are not able to beat that of the S&P 500 Index in the long term. The challenge was accepted, both parties placed a 1 Million USD bet, and the one who made the most returns within the next 10 years wins it. The hedge fund comprehensively analyzed and traded stocks, whereas Warren Buffett simply passively invested in an S&P 500 Index Fund. One decade later, Warren Buffett's investments gained him an average annual return of 7.1%, whereas the hedge fund only acquired about 2.2% [1].

Based on the fascinating results of the Case Study above, we figured out that it would be interesting to statistically compare passive investing with multiple different trading strategies' profitability ourselves, and determine which is more profitable in the long term. Based on Warren Buffett's results, our initial hypothesis is that investing is more profitable than a compilation of short term trades in the long term. Our research tries to prove if this hypothesis is true or false.

## II. Related Work

There are a few works that are related to what we are trying to prove in our study. One such paper is titled 'Are Random Strategies More Successful Than Technical Ones?' [2], where they compare trading strategies with each other in comparison to a random one to see which would yield the most profit. Another study that delves into similar topics to our own is 'Stock market and investment: Is the market a sideshow?' [3]. This study talks about investing and how it affects economic activity. We have also found one where they try to predict the stock market instead of backtesting it in the study called 'Predicting stock market movements using network science: an information theoretic approach' [4]. However, at the time of writing this paper, there were limited works that properly tried to backtest these investing and trading strategies and compare them to each other as a scientific study to find which of them is more profitable.

## III. Methodology

### A. Gathering Data

For our research, we collected 10 years of historical market data for the top 45 Indonesian Blue-Chip Stocks in the present Indonesian Stock Exchange [5], using Yahoo Finance's database API in Python.

In finance, long-term refers to a period of time that is beyond 3 years. Therefore, we figured out that 10 years of backtesting or simulation will be enough to convey long-term results. Also, there are a few reasons as to why we are only using Blue-Chip stocks for this study:

1. These are well-established companies; more reputable, fundamentally and financially stable.
2. Their price movements are more consistent over the years.
3. They have a huge market capital:
    a. Less prone to impacts of market movers (pumps & dumps).
    b. Price movements are more impactful to changes in the overall Indonesian stock exchange index (IHSG).
4. Some non Blue-Chip stocks are listed after 2011, which is less than our 10 year paper trading period.
5. There are hundreds of non Blue-Chip stocks circulating in the market, computing for all of their returns will be time consuming & inefficient for this research.

Table I: Example Market Data (Stock: TLKM)

| Date | Close |
|---|---|
| 2010-12-28 | 1600 |
| 2010-12-29 | 1600 |
| ... | ... |
| 2021-12-24 | 4110 |
| 2021-12-27 | 4080 |

The above table depicts an example market data for TLKM stock. 'Close' refers to the stock's closing market price for each of its trading dates.

*B. Investing & Trading Strategies Used*

For this study, we have chosen 7 different indicator trading strategies to be compared to a single buy-and-hold investing strategy. These strategies are: Price to Moving Average Crossover (PMAC), Price to 2 Moving Average Crossover (P2MAC), Double Moving Average Crossover (DMAC), Bollinger Bands (BB), RSI (RSI), Stochastic (S), MACD Crossover (MACD).

The reason why there are multiple trading strategies, but only one single investing strategy used, are because:

1. Traders use countless different trading strategies to trade over the years. Therefore, to be as fair as possible, we need to compare the most commonly used trading strategies.
2. There are multiple investing strategies too, but most importantly, investors do not actually worry about the time fluctuations of their stock prices as they invest in the company for years. Thus, it is fair for us to implement a universal buy-and-hold strategy to represent the investing strategy.

Below are the specifications for each strategy's buy & sell trade signals that are implemented to our datasets:

Table II: Each Strategy's Buy and Sell signal

| Strategy | Buy Signal | Sell Signal |
|---|---|---|
| Investing | Dataset's beginning date's Close price | Last dataset's last date's Close price |
| PMAC | Crosses above 10-period SMA line | Crosses below 10-period SMA line |
| P2MAC | Crosses above 10-period and & 100-period SMA line | Crosses below 10-period and & 100-period SMA line |
| DMAC | 20-period SMA line crosses above 50-period SMA line | 20-period SMA line crosses below 50-period SMA line |
| BB | Crosses below lower band of 20-period BB indicator | Crosses above upper band of 20-period BB indicator |
| RSI | 14-period RSI indicator is crosses above 30 | 14-period RSI indicator is crosses below 70 |
| S | 14-period Stochastic's fast line crosses above the slow line, but still below 20 | 14-period Stochastic's fast line crosses above the slow line, but still above 80 |
| MACD | MACD Histogram value is negative | MACD Histogram value is positive |

*C. Backtesting Strategies (Paper Trading)*

As mentioned before, we will implement Paper Trading to backtest each of these strategies.

Table III: Example Trade Data using MACD Strategy

| | Entry Date | Exit Date | Entry Price | Exit Price | Profit | Profit (%) |
|---|---|---|---|---|---|---|
| 1 | 2019-02-20 | 2019-03-06 | 3940 | 3860 | -80 | -2.03 |
| 2 | 2019-03-25 | 2019-04-15 | 3730 | 3860 | 130 | 3.49 |
| ... | ... | ... | ... | ... | ... | ... |
| 31 | 2021-10-25 | 2021-10-26 | 3800 | 3800 | 0 | 0 |
| 32 | 2021-11-22 | 2021-12-15 | 3920 | 4060 | 140 | 3.57 |

Table III conveys an example dataframe of all trades made using the MACD strategy on TLKM stock for the past 36 months of data. Using MACD trading strategy's signals listed on Table II, we computed both entry (buy) & exit (sell) dates as well as their corresponding prices. Thereby, we can now determine their profit amount and percentages relative to their entry and exit prices.

To get the strategy's profit (in percentage) for the whole period (3 years), we add all of the percentages in the 'Profit (%)' column. In this case, we've got -26.9%. We also want to get the total number of trades found by our program; the number of rows multiplied by 2, as every row includes a Buy & Sell trade. In this case, it should be $32 \times 2 = 64$.

The investing strategy, however, is a little different. Since it is a Buy & Hold strategy, we simply need to find the percentage change between the beginning date's Close price and the end date's Close price (Table I). For example, if the beginning date's Close price is 100, and the ending date's close price is 150, this means that the total returns within this interval is 50%. Also, as it is a Buy & Hold strategy, this means that we will only include 1 buy and sell trade within the whole interval; 1 buy trade to enter the market, and 1 sell trade to exit it. Likewise, the program will save the percentage returns, as well as the number of trades executed within the time period/interval.

However, the above is an example for only one ticker (TLKM), on a single strategy (MACD), and within a single time frame period (36 months). In order to backtest all 45 tickers for each strategy, we need to iterate every single ticker, strategy, and every single month of historical data from the present date up to 10 years back (120 months). For example, let's assume that the present date of this research is 14/12/2021. The 1st month iteration would mean we should backtest each strategy, for each ticker, with data from intervals 14/11/2021 (1 month prior) up to 14/12/2021. Similarly, 5

months iteration would mean to backtest data from intervals 14/17/2021 (5 months prior) up to 14/12/2021. The algorithm will iteratively compute returns up until 120 months prior, for which the date will be 14/12/2011.

Additionally, since we are getting the number of month/s historical data backwards from the present date, therefore, the data computed by our backtesting program are cumulative results for each time interval.

Table IV: Trade Returns (%) for each Strategy & Ticker, within the 1st Month's Interval

| Ticker | Investing | Price-MA Cross | ... | MACD Cross |
|---|---|---|---|---|
| ACES.JK | -5.86 | -1.17 | ... | 0 |
| ADRO.JK | 28.99 | 0 | ... | 0 |
| ... | ... | ... | ... | ... |
| UNVR.JK | -9.07 | -2.5 | ... | 0 |
| WIKA.JK | -8.54 | -5.71 | ... | 0 |

Table V: Number of Trades for each Strategy & Ticker, within the 1st Month's Interval

| Ticker | Investing | Price-MA Cross | ... | MACD Cross |
|---|---|---|---|---|
| ACES.JK | 2 | 4 | ... | 0 |
| ADRO.JK | 2 | 0 | ... | 0 |
| ... | ... | ... | ... | ... |
| UNVR.JK | 2 | 4 | ... | 0 |
| WIKA.JK | 2 | 2 | ... | 0 |

Tables IV & V show an example output on the first month's iteration. As seen in both of these tables, we end up with 45 different tickers' results for each trading strategy. We will now compile all the rows into one by finding the average results for each strategy column, as shown on Tables VI & VII below:

Table VI: Average Trade Returns (%) of each Strategy, within the 1st Month's Interval

| Months | Start Dates | End Dates | Investing | Price-MA Cross | ... | MACD Cross |
|---|---|---|---|---|---|---|
| 1 | 14/11/2021 | 14/12/2021 | -1.13 | -2.36 | ... | -1.5 |

Table VII: Average Number of Trades of each Strategy, within the 1st Month's Interval

| Months | Start Dates | End Dates | Investing | Price-MA Cross | ... | MACD Cross |
|---|---|---|---|---|---|---|
| 1 | 14/11/2021 | 14/12/2021 | 2 | 2.93 | ... | 0.76 |

Next, we will repeat the iteration for each month, up until 120 months. Once completed, we will get 2 resulting dataframes (Tables VII & IX) as shown below:

Table VIII: Average Trade Returns (%) for each Strategy & Time Interval

| Months | Start Dates | End Dates | Investing | Price-MA Cross | ... | MACD Cross |
|---|---|---|---|---|---|---|
| 1 | 14/11/2021 | 14/12/2021 | -1.13 | -2.36 | ... | -1.5 |
| 2 | 14/10/2021 | 14/12/2021 | -4.57 | -4.39 | ... | -1.86 |
| ... | ... | ... | ... | ... | ... | ... |
| 119 | 14/01/2012 | 14/12/2021 | 150.24 | 18.74 | ... | 41.67 |
| 120 | 14/12/2011 | 14/12/2021 | 160.58 | 23.3 | ... | 44.83 |

Table IX: Average Number of Trades for each Strategy & Time Interval

| Months | Start Dates | End Dates | Investing | Price-MA Cross | ... | MACD Cross |
|---|---|---|---|---|---|---|
| 1 | 14/11/2021 | 14/12/2021 | 2 | 2.93 | ... | 0.76 |
| 2 | 14/10/2021 | 14/12/2021 | 2 | 6.44 | ... | 1.51 |
| ... | ... | ... | ... | ... | ... | ... |
| 119 | 14/01/2012 | 14/12/2021 | 2 | 433.56 | ... | 194.62 |
| 120 | 14/12/2011 | 14/12/2021 | 2 | 437.2 | ... | 196.53 |

Table VIII represents the percentage returns, whereas Table IX conveys the number of trades, for each strategy within each time frame/intervals. Therefore, this concludes the *Backtesting Strategies (Paper Trading)* section of the research.

### *D. Preprocessing Data*

Upon completing backtesting, it's time to combine both Table VIII and Table IX, into a single data frame. We do this by labeling each 'Months', 'Trades', and 'Returns' data with their respective 'Strategy', as shown on Table X below:

Table X: Number of Trades & Trade Returns, for each Strategy within each Time Interval

| | Months | Trades | Returns | Strategy |
|---|---|---|---|---|
| 0 | 1 | 0.04 | -0.06 | 2MA Cross |
| 1 | 2 | 0.27 | -0.88 | 2MA Cross |
| ... | ... | ... | ... | ... |
| 958 | 119 | 25.74 | 73.29 | Stochastic |
| 959 | 120 | 26.71 | 73.91 | Stochastic |

Next, to get more realistic and accurate results, we also want to take away the total brokerage & transaction fees off the total returns. This is because most brokers in Indonesia charge fees for every single transaction. The top brokerage firms in Indonesia charge an average of 0.16% and 0.26% for buy and sell fees respectively [6]. As seen in Table III, the total number of buy trades are equal to sell trades, as each row includes a buy and sell trade. Therefore, we can simply divide the total number of Trades by 2 to get these numbers of buy and sell trades. We then follow the equation below:

Total Buy Brokerage Fees = Number of Buy Trades × 0.16%

Total Sell Brokerage Fees = Number of Sell Trades × 0.26%

Returns Including Fees = Returns - (Total Buy Brokerage Fee + Total Buy Brokerage Fees)

Where:

- Number of Trades refer to the 'Trades' column in Table XI
- Trade Returns refer to the 'Returns' column in Table XI

Following the above steps, we will get the resulting Table XI as shown below:

Table XI: Number of Trades, Trade Returns, & Trade Returns Including Fees, for each Strategy within each Time Interval

| | Months | Trades | Returns | Returns Including Fees | Strategy |
|---|---|---|---|---|---|
| 0 | 1 | 0.04 | -0.06 | -0.0684 | 2MA Cross |
| 1 | 2 | 0.27 | -0.88 | -0.9367 | 2MA Cross |
| ... | ... | ... | ... | ... | ... |
| 958 | 119 | 73.29 | 25.74 | 10.3491 | Stochastic |
| 959 | 120 | 73.91 | 26.71 | 11.1889 | Stochastic |

## IV. Results

### A. Data Visualization & Observation

As shown in Table XI, all the data have been separated with respect to each strategy's labels on the 'Strategy' column.

Next, we can plot the 'Trades', 'Returns', and 'Returns Including Fees' columns' data all on the y-axis, with the 'Months' column as the x-axis, for each strategy on their own respective charts.

To extract more information and study deeper on the results, we will have to add more features for each chart, such as the best-fit line. This can be used as an indication to whether the strategy is sustainable in the long term or not, determined by looking at the value of the slope/gradient of the line; if it is positive, this means that it is sustainable as it is profitable within our given time ranges. If it is negative, the strategy is not sustainable in the long term, and thus resulting in financial losses.

Likewise, we will be using Linear Regression to generate the best-fit line for each of the figures above. Linear Regression itself is a Machine Learning model which is commonly used to determine a relationship between 2 variables [7]. Likewise, the Linear Regression formula is:

$$Yi = \beta 0 + \beta 1\ xi + \varepsilon i$$

Now, we can simply apply the Linear Regression to each of our strategies' charts, specifically on the 'Returns Including Fees' data, as this is the most realistic set of data that we have computed so far, as described in the *Preprocessing Data* section above. Since there are 8 different strategies, this will give us 8 different figures, as shown in Figures 1-8 below:

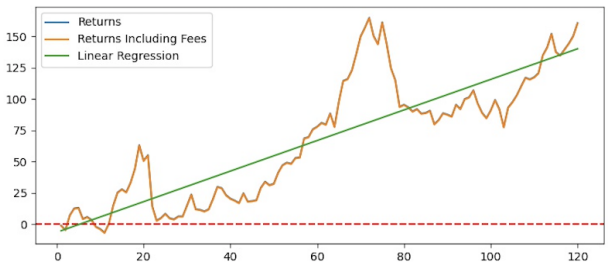


Figure 1: Investing Strategy Results

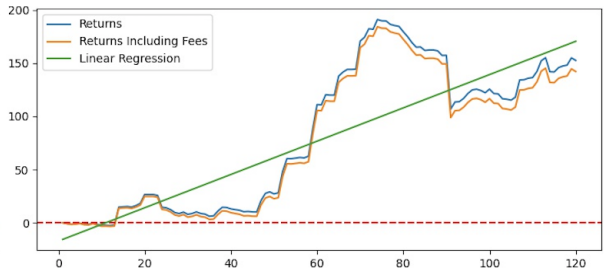


Figure 2: 2MA Crossover Strategy Results

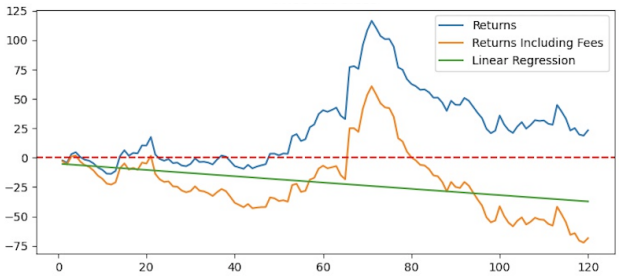


Figure 3: Price-MA Crossover Strategy Results

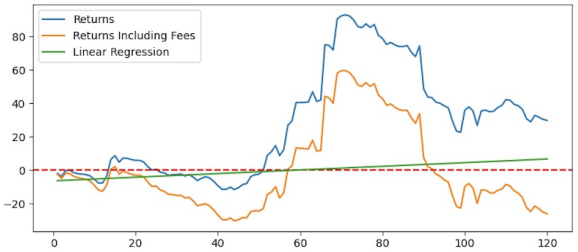


Figure 4: Price-2MA Crossover Strategy Results

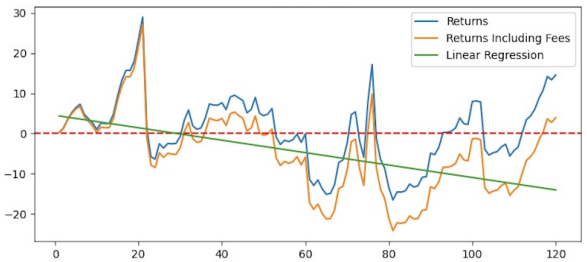


Figure 5: Bollinger Bands Strategy Results

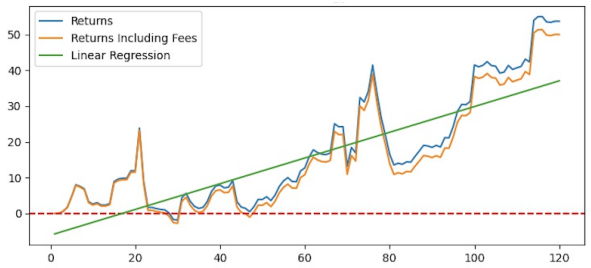


Figure 6: RSI Strategy Results

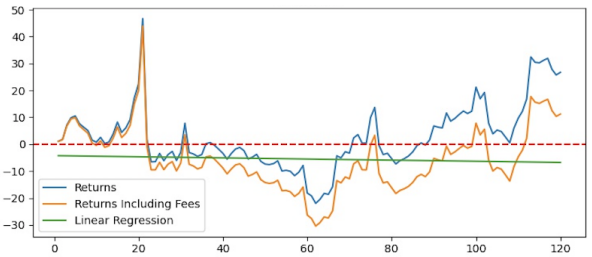


Figure 7: Stochastic Strategy Results

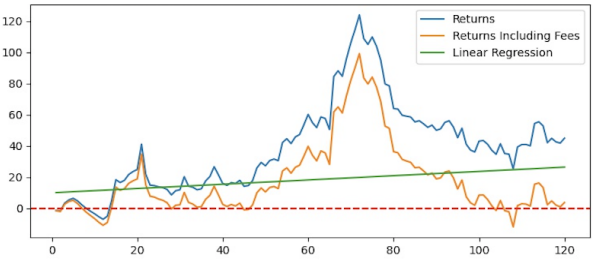


Figure 8: MACD Crossover Strategy Results

Note: The red dotted lines represent the zero intercept on the y-axis for each figure. This is added to determine if the strategy's returns are either positive or negative, depending if they are above or below the dotted lines respectively.

Neglecting the Linear Regression on Figures 1-8, we can conclude a few facts, as well as provide possible causes for it:

1. There is a major difference in Returns between different investing & trading strategies, indicating that different strategies do yield different results.
2. There is a clear difference between the Returns and Returns Including Fees plots in most of the charts. Indicating that it is able to cause a major drawback to our long term profitability.

3. On Figure 1, the Investing strategy seems to have a clear difference between Returns and Returns Including Fees. This is due to the fact that it does not place any trades in between, making the transaction fee constant at 0.42% for each data point.

Visually, we can already see the profitability 'trend' of each strategy. However, to be more accurate, we can compute the gradients and put them into the following table:

Table XII: Gradients of Best-Fit Line for each Strategy

| Strategies | Gradients |
|---|---|
| Investing | 1.22078 |
| Price-MA Crossover | -0.268099 |
| Price-2MA Crossover | 0.10876 |
| Bollinger Bands | -0.15464 |
| 2MA Crossover | 1.56689 |
| RSI Strategy | 0.359465 |
| Stochastic | -0.020901 |
| MACD Crossover | 0.137059 |

With Linear Regression on Figures 1-8, as well as Table XII, we can now conclude the following additional fact:

1. 5 of our strategies have a positive slope, and 3 of them have a negative slope meaning that not all of our strategies are profitable in the long term.
    a. Profitable Strategies are Investing, Price-2MA Cross, 2MA Cross, RSI Strategy, MACD Cross.
    b. Not-Profitable Strategies are Price-MA Cross, Bollinger Bands, Stochastic.
2. For strategies with positive slopes, the Investing and 2MA Crossover strategy stands out the most compared to the others, with gradients larger than 1.2, where other gradients are on average 0.23.
3. For strategies with negative slopes, we can see that Price-MA Crossover has the lowest overall gradient, followed by Bollinger Bands as the second least, and finally Stochastic strategy with a really close to zero negative gradient.
4. 2MA Crossover is the only trading strategy with a larger gradient than that of Investing strategy. Therefore, it is deemed to be more profitable than that of the Investing strategy.

## B. *Strategies' Returns Comparison Through Visualization*

We can now plot all of the Returns Including Fees data for each strategy to determine which of them is the most profitable in the long-term.

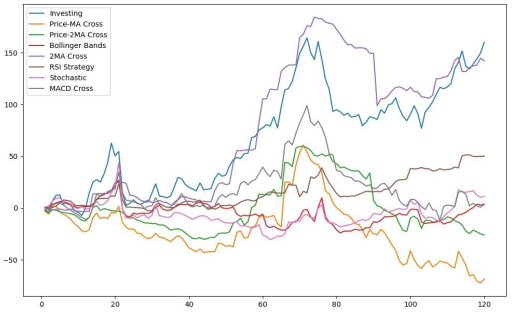


Figure 9: Comparison of All Strategies' Returns (Including Fees)

Based on this, we can conclude the following:

1. The differences between cumulative returns for each strategy is moving apart further away from one another the larger the time frame/interval.
2. Overall, 2MA Crossover and Investing strategies are the most profitable strategies.
3. The Investing strategy is able to beat nearly all of our trading strategies.
4. The Investing strategy generates similar results like the 2MA Crossover strategy. This is because:
    a. The 2MA Crossover's returns outperform that of the Investing strategy in about 50% of the time, specifically between around 55-115 months.
    b. Investing's returns outperforms the 2MA Crossover's returns in about 50% of the time, specifically between around 0-55 and around 115-120 months.

## C. *The Most Profitable Long-Term Strategy*

As shown in Figure 9, there are a lot of 'tangles' between strategies' results in the chart, and thereby making it difficult for us to determine which is the best and most profitable long-term strategy visually.

To address this issue, we should try to evaluate results using Average Annual Returns instead, just like in the Case Study above. To do this, we filter the data from Table XIII into each respective strategy. Then, we filter the 'Months' column to only values divisible by 12, so that each row represents annual results. Next, as mentioned in the *Backtesting Strategies (Paper Trading)* section of this paper, this column's data is cumulative, therefore, we now need to get its value changes for each row. This will now be the annual percentage changes for the column, we now name this new column 'Returns Including Fees Changes (%)'. An example of the above statement for the Investing strategy data is shown in Table XIII below:

Table XIII: Annual Returns (%) & Returns' Changes (%) for Investing strategy (Including Fees)

| Months | Returns Including Fees (%) | Returns Including Fees Changes (%) | Strategy |
|---|---|---|---|
| 12 | 0.05 | 0.05 | Investing |
| 24 | 4.52 | 4.47 | Investing |
| … | … | … | … |
| 108 | 116.63 | 10.08 | Investing |
| 120 | 160.16 | 43.53 | Investing |

Moving on, we calculate the average of the 'Returns Including Fees Changes (%)' column to get the Average Annual Return (Including Fees) for each of the 8 strategies, and thereby we get the following results:

Table XIV: Average Annual Returns for each Strategy

| Strategies | Average Annual Returns (Including Fees) |
|---|---|
| Investing | 16.02 |
| 2MA Cross | 14.22 |
| RSI Strategy | 5.00 |
| Stochastic | 1.12 |
| Bollinger Bands | 0.39 |
| MACD Cross | 0.36 |
| Price-2MA Cross | -2.61 |
| Price-MA Cross | -6.85 |

As shown in Table XIV, Investing strategy generates the highest Average Annual Return compared to the other trading strategies. Hence, this proves our hypothesis to be true; that passive investing is more profitable than any forms of active trading strategies in the long term.

## V. Discussion

Upon doing some statistical and general lookups for the possible causes upon the matter, we have found following reasons:

1. Investing ensures you don't lose out on the market's greatest days. Alternatively, it is also incredibly difficult for a trader to predict the stock market. [8]
2. Trading frequently can rack up brokerage fees over time without much realization. This is also proven in the *Data Visualization & Observation* section of this research. [9]
3. Long-term Investing adapts a concept of compounding interest. It is when the interest one earns on a principal balance is reinvested and generates additional interest. This concept helps accelerate the growth of money exponentially over long periods of time. [10] Alternatively, all the trading strategies miss this concept, as they require the trader to repetitively enter and exit the market.

### *A. Final Thoughts on the Most Profitable Strategy*

If the Investing strategy is more profitable than the trading strategies, why are there still traders in the present day? Some logical explanation to the question are:

1. Some people are still unaware of some/all of the points listed in *Possible Causes for the Results*
2. Most people want to get rich fast, especially the youth. Therefore, they attempt to beat the market. According to Warren Buffett, beating the market is possible but difficult with any consistency. In his view, most investors lack the time, commitment, knowledge, and discipline to succeed at active investing. [11]
3. Trading can be exhilarating which can induce reward pathways in the brain. When a day trader makes or even gets excited about a potential profit, the brain releases “feel good” neurochemicals such as dopamine and serotonin. Thus, you can become addicted, just like with casino gambling. [12]

### *B. Limitations of this Research*

Although we have come a long way in analyzing the different types of trading and investing strategies, there are still limitations to our study.

1. Even though we implemented the most commonly used trading strategies, there are still countless other different technical analysis strategies used by people for trading, and it is not possible to simulate every single one of them in this study.
2. All of the trading strategies we used fell in the same category of only indicator trading, whereas in general, there are many other categories of short-to-medium trading strategies too; Price Action, Insider Trading, and many more.

## VI. Conclusion and Future Work

As proven before, Investing is able to beat all the trading strategies, with the highest Average Annual return of over 16%. Surprisingly, it is also the strategy that requires the least amount of effort, as the ‘investor’ simply needs to buy-and-hold their positions, whereas the other strategies require the trader to buy and sell repetitively depending on their respective signals. Perhaps in the future, we may broaden our list of tickers or number of strategies to test to further prove our hypothesis.

## VII. Supplementary Files

GitHub Link to our program’s codes:
https://github.com/mariofrans/PROJECT__Stock-Market-Statistical-Analysis-Investing-Versus-Trading-Strategies

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