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Backtesting Adaptations of Greenblatt's "Magic Formula" on the Indonesian Stock Exchange

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Abstract

This study focus on applying Greenblatt’s magic formula (2006) and some of its simple adaptations in the Indonesian Stock Exchange over the period of April 2006 to April 2022. Over the full sample period, all tested variations of the magic formula are able to outperform the market with GMF30 portfolio showing 28.05% CAGR as the best performing portfolio whereas the JKSE index return 7.83% CAGR. On a volatility adjusted basis, the GMF30 earns a 0.89 Sharpe ratio and a 1.78 Sortino ratio whereas the JKSE yields a sharpe ratio of 0.17 and a Sortino ratio of 0.26. Though, this study found that the performance of the original magic formula and its adaptations to be far greater in magnitude over the first half of the study period (2006 – 2013) in comparison to the latter half (2014 – 2021).

Keywords: Magic Formula, JKSE, Greenblatt, Value, Indonesia

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1. Introduction

Among various strategies used in the public equity market, value investing is arguably one of the most popular investment philosophies. Value investing was first introduced by Graham and Dodd (1934), where the key premise of the principles was to buy high-quality stocks at a relatively cheap price which many refer to as undervalued stocks[1]. Since then, it has seen extensive research and wide adoption including by figures such as Warren Buffet whom many consider being one of the greatest stock investors of all time.

Greenblatt (2005), in his book "The little book that beats the market", came up with a relatively simple formula that aims to simplify the process of value investing which he refers to as the "magic formula". The main premise of his stock selection criteria was in line with value investing where the investor would look to buy high-quality stocks at a low price. In his formula, return on invested capital (EBIT/Net Working Capital + Net Fixed Assets) is used as proxy for quality and earnings yield (EBIT/EV) as a proxy for value. Then, publicly listed companies will be ranked on these two metrics, and the top company from the overall rank of these two categories are considered as value investments that consists of high-quality companies that can be bought at a bargain price.

In his book, Greenblatt compares the performance of his simple strategy to a drastically more complex strategy created by Professor Haugen (1996), which utilize a 71 factors model that aims to predict best performing stocks through a wide array of

[1] There exists various proxy of what constitutes undervalued stocks, preference of proxy often differ from one investor to another.

measure. In a sampled period between 1994 to 2004, Greenblatt's magic formula earns an annual return of 18.43 percent whereas Haugen's 71 factors model earn 12.55 percent and the market returns 9.38 percent, all of these are applied when holding period of portfolios are one year. Even more remarkably, Greenblatt claimed that in the same period with rolling 36 month return with annual turnover, Haugen's strategy had lost 43.1 percent in its worst performing portfolios which were relatively similar to the overall market's loss in the observed period. Though, the worst performing 36 months period for Greenblatt's magic formula was a positive return of 14.3 percent.

This research aims to tests the performance and validity of Greenblatt's "Magic Formula" in the Indonesian stock exchange to understand the profitability and risk this strategy entails when applied to the Indonesian stock exchange. Testing the magic formula in a specific country (Indonesia in this case) is motivated by past research that found drastically different results of the strategy when applied in different exchanges, suggesting that it may set misleading return expectations based on findings on how it works in different exchanges. given the high degree of result variability on different exchanges which will be shown in the literature review part of this paper (Sareewitwatthana (2011), Hongratanawong (2014), Blackburn & Cakiki (2017), and Jannah (2019), among many others). Several adaptations of the magic formula that is suggested from previous literature are also evaluated as a potential alternative to the original form of the formula.

This study will also serve as further exploration of the magic formula from previous research on the performance of the magic formula in the Indonesian stock exchange[2]. Specifically, this study will introduce other variations of the magic formula suggested by other literature. Then, this study will also examine the performance of the magic formula when different portfolio sizes are used. Lastly, this study expands the studied period of the magic formula to the end of 2021. This new period will be an interesting discovery as not only does it test whether the strategy is still profitable in the latest period, but it also incorporates a bear market scenario caused by the recent Covid-19 pandemic. By studying this specific period, we will be able to get more insights into how the strategy performed in the recent Covid-19, which has not been extensively studied.

2. Literature Review

This Section starts with a review into the efficient market hypothesis (EMH), along with studies that oppose the hypothesis by highlighting some strategies that are empirically shown to be able to outperform the market systematically. Then, literature that particularly display the performance of Greenblatt's magic formula across various exchanges and time period is presented.

2.1 Efficient market hypothesis

The Efficient Market Hypothesis (EMH) was first introduced by Fama (1970), where he defines it as a capital market that consistently incorporates all available information to the price of securities. For EMH to take place, Fama believes that there are three necessary

[2] The magic formula has been previously studied in the Indonesian stock market by Jannah & Imansyah (2019) for the period of 2013 to 2018, and Burhanuddin & Rokhim (2020) for the period of 2007. Both studies apply the magic formula on the Kompas100 index.

conditions: (i) there must be no transaction costs both to execute transaction and to obtain information, (ii) all relevant information must be publicly available, and (iii) economic agents in the market must have the freedom to agree on a price based on available information and trade on them.

He further specifies that theoretically there are three forms of EMF: (a) the weak form, where prices observed in the market take into account all historical price data; (b) the semi-strong form, where prices in the market reflect all historical price data and every publicly available information; and (c) the strong form, where the market priced at historical prices, public information, and also private information. In the weak form of EMH, prices of assets do not follow any patterns, making the use of technical analysis ineffective in the long run. Whereas in the semi-strong form of EMH, fundamental analysis will also become ineffective to generate an excess return in addition to technical analysis. Fama (1970) found some empirical evidence for the first and second form of the EMH, but he was not able to find evidence to prove the existence of a strong form of market.

Jensen (1978) later defines an efficient market in a simpler manner as a marketplace where economic agents are not able to generate abnormal economic profits[3] from up to date information. Accordingly, the expected return of specific assets will only be a function of its fundamental risks (Malkiel, 2003). Nevertheless, there has been an extensive critique of the EMH theory, especially from the perspectives of proponents of the behavioral approach that argue that most individuals have a tendency to make systemic bias in their decisions making which may result in sub-optimal

[3] Here Jensen (1978) was referring to risk-adjusted returns net of all costs.

response to available information (Kahneman & Tversky (1979), and Thaler (2015) among many others).

There have also been numerous critiques of the EMH theory in the form of research that shows the prevalence of various market anomalies such as but not limited to the firm's market value and size effect (Banz, 1981), contrarian and momentum strategies (Lakonishok et. al. (1994), De Bondt & Thaler (1985), and Jegadeesh and Titman (1993), and Moskowitz & Grinblatt (1999) among many others), value stock outperformance to the general market (Basu (1977), Westerfield (1989), and Fama & French (1992) among many others). These literatures suggested that in many markets around the globe, there often persist opportunity to earn abnormal return in financial markets by exploiting certain investment strategy.

2.2 Greenblatt's magic formula tested across various exchanges

Due to its simple appeal, outstanding performance claim, and the popularity of his book, Greenblatt's magic formula triggered further academic research on the strategy in various markets. Hongratanawong (2014), studied the magic formula in US and Thailand Stock Market over the period 1993 to 2012. In the US market, He found that the magic formula generated a 12.7% geometric return when the market generates 6.5%. Whereas in the case of the Thailand Stock Market he found more astonishing results where the magic portfolio generates 24.3% annualized geometric return, the Thailand Stock Market generates 3% over the studied period. This study further confirms Greenblatt's claim with an expanded period, and it also shows promising results for implementation outside the US markets.

Greenblatt's magic formula had also been tested in the Indonesian market by Jannah (2019). In his study that examines the magic formula over the period of 2013 to 2017 using stocks listed in the Kompas100 index, finds that the magic formula generated an average return of 12.67% (Arithmetic mean), whereas the market generates only 5.31%. On the following year, Greenblatt's magic formula is re-examined in the Indonesian stock market over longer period of 2007 to 2019 (Burhanuddin & Rokhim,2020). Over the entire studied period, they found that on average, the magic formula returns 35.11% annual return whereas the market returns 15.11%.

Over the South American continent, Greenblatt's magic formula has been studied in the context of Brazilian Stock Market (Paula, 2016). In a studied period from 2006 to 2015, Paula finds that both magic formula strategy that uses annual and semi-annual rebalancing period can outperform the market in compound annual growth rate terms over the entire period. He also finds that the portfolio beta was lower than 1, suggesting that the outperformance is achieved without taking higher systematic[4] risks. This research also tests portfolio that is formed under the two magic formula factors of ROIC and EY separately and find significant positive performance as a standalone factor.

2.3 Adaptations of Greenblatt's magic formula

Some previous studies had also examined the performance of altered versions of the magic formula (Blackburn & Cakiki (2017), Preet et al. (2021)) studied a slightly altered version of the magic formula, which used P/E (Price to earning) as a substitute for the

[4] Systematic risks here refer to the market risks as described in the capital assets pricing model (Treynor (1962), Sharpe (1964), Lintner (1965), and Mossin (1966)).

original earnings yield and ROIC (Return on Invested Capital) to screen stocks. They argued that the use of P/E instead of the original earnings yield does not change the formula on a fundamental level, though P/E is arguably a more common indicator of valuation. To test the validity of this slight adaptation to the magic formula, they apply the formula to an equally weighted portfolio of 10, 30, and 50 stocks that are ranked under the slightly altered screening method on the Thailand Stock Exchange from 1996 to 2010 on a yearly rebalancing basis benchmarked with BSE SENSEX which were one of the most followed stock index in Thailand Stock Exchange.

On an unadjusted yearly return basis, the thirty stocks magic formula earn on average 17.73 percent whereas the BSE SENSEX portfolio earn yearly return averages to 9.89. It is also found that the magic formula had a more turbulent return distribution where its highest yearly return was 85.17 percent whilst its lowest yearly return was −22.82 percent, on the contrary the BSE SENSEX portfolio highest yearly return was 31.61 percent and its lowest was −8.10 percent. Though, when they adjust the return on risk using Sharpe ratio they concluded that the variability of returns in magic formula is well compensated as its risk adjusted return is still higher than the benchmarked index.

The magic formula has also been studied across North America, Europe, Japan, and Asia altogether by Blackburn and Cakiki (2017) using data from 1991 to 2016. They believe that exposing the strategy to a broad and diverse region will increase the robustness of result, reduces data mining concerns, and will also tests global market integration. They discover that the original magic formula had mixed results across different regions where he found significant risk-adjusted returns in Europe, whereas results are insignificant and even negative in the other region. As a potential solution, they propose adaptations to the strategy which uses Gross profit Instead of EBIT in the profitability measure of the formula which they labeled as the improved magic formula. This adaptation was inspired by Novy-Marx (2013), who argues that profitability measures located farther down the balance sheet are "noisy" due to accounting items subtracted from earnings that may not relate to the "real" expense of generating revenue[5]. After making this modification, they later find a univariate positive abnormal returns across all regions.

3. Hypothesis

Basing off past literature, I made several hypotheses that will be tested against the empirical data. To start, there are numerous evidence against the efficient market hypothesis that points that generating abnormal returns are possible through various strategies. Greenblatt's magic formula falls under the strategy that aims to utilize fundamental data in an attempt to generate alphas which violate the semi-strong form of efficient market. As mentioned within the literature review part of this paper, there has been extensive evidence that shows that the magic formula is able to generate investment payoff superior to the overall market. In this paper, the main research questions this paper tries to uncover is "Can the magic formula or its adaptations beat the market over the long run on a risk-adjusted basis in the Indonesian Stock Market?"

[5] This conclusion is challenged by Ball, Gerakos, Linnainmaa, and Nikoaev (2015) as they argue that the comparison by Marx (2013) are flawed to an extent as he compares "gross profit to assets" and "earnings to book equity". Thus, the suggested superiority might either be due to the profitability measure or choice of deflators.

To help answer the main questions, these hypotheses will be tested:

- *Hypothesis I:* The original magic formula or some of its adaptations shows higher Sortino Ratio compared to the market.
- *Hypothesis II:* The original magic formula or some of its adaptations shows significant and positive three factor alphas.

If the hypothesis *I* holds true while the hypothesis *II* does not, then at least one adaptations of the magic formula is able to beat the market when accounting for return per portfolio downside volatility, but it does not produce abnormal returns above its risk's exposure to portfolio's market premium, small cap stocks permium, and high value stocks premium[6]. If both hypothesis *I* and *II* holds, then at least one adaptations of the magic formula are able to beat the market when accounting for its return per portfolio downside volatility and it creates abnormal return above its risk's exposure to the portfolio's market premium, small cap stocks and high value stocks premium.

4. Data & Research Methodology

This section walks through the data sources used to form this research. Then, goes into detail on the methods and techniques used by the researcher to arrive at the result and conclusion.

[6] The portfolio's market premium refers to the beta coefficient, small cap stocks premium refers to the SMB factor, and the high value stocks premium refer to the HML factor. This factor is depicted by the Fama and French 3 factor model (Fama & French, 1992).

4.1 Data

The data used in this study was historical stock data of the Indonesian Stock Exchange with a sample period of April 2006 to April 2022. Fundamental accounting data are retrieved from the Bloomberg terminal, while monthly returns are obtained from DataStream. The full sample consists of around 300 stock tickers at the beginning of the sample to 840 by the end of the sampled period of publicly listed companies. In his book, Greenblatt suggests that the strategy is ideally implemented on a long-term horizon[7]. Due to data limitations on the Indonesian Stock Exchange before 2006 where significant amount of key data are missing from data source used in this study, the 2006 to 2022 study period was chosen[8].

4.2 Methodology

In this research, three variations of the magic formula are used; the original magic formula (referred to in this study as MF), PE magic formula (referred to in this study as PMF), and gross return magic formula (referred to in this study as GMF). The PE-MF was inspired by Sareewiwatthana (2011), whereas the GMF formula was inspired by Novy-Marx (2013) and Blackburn[9] (2017). Gupta and Khoon (2001), shows in their research that there is no significant benefit of diversifying stocks portfolio above 30 unique stocks. Though, buying equal sums of 30 stocks may not be an option for newer investors with limited funds as buying fractional shares is

[7] Greenblatt (2005) recommends the implementation period to be longer than 5 years due to possibility of short-term market fluctuations.
[8] In addition to missing data, the sample size of companies is also very limited prior to 2006.
[9] Blackburn (2017) main strategy was a long and short magic formula instead of a long only strategy.

currently not an option in the Indonesian Stock Market. Hence, the strategy explored in this paper will also be tested in 10 stocks portfolio which will be more accessible for newer investors.

For this study, the MF portfolio will be constructed with an equally weighted portfolio of the top 30, and 10 companies ranked from these procedures:

1. Screen out the top 40 percentile stocks from the Indonesian Stock Exchange based on their current market cap on the observed date[10].
2. Eliminate company stocks that operate in the financial and banking industry[11].
3. Listed companies are ranked in a descending order based on their Return on Invested Capital (ROIC)[12]. Hence, companies that score highest in ROIC will be given first place.
4. Then, the companies will be ranked based on their Earnings Yield (EY)[13]. Companies with the highest EY will be given first place.
5. Finally, the rank of the companies from the third and fourth steps are summed to get the final rankings. The 1 – 30th ranked portfolio will be used as the top 30 portfolios, the 1 – 10th ranked portfolio will use top 10 portfolio.

[10] Greenblat originally recommends a minimum market cap of US$50 million. Though, this was not feasible for implementation in the Indonesian market as companies are by a significant amount smaller in their nominal market cap value. Hence, the top 40 percentile of market cap is chosen as a proxy for an established company in this study.

[11] these companies are eliminated as they have different debt structure compared to companies operating in other industries which would disrupt the rankings calculation.

[12] In Greenblatt's (2005) books ROIC is calculated as EBIT divided by (Net Working Capital + Net Fixed Assets). This is a less conventional equation for ROIC. Though, this equation is also used in this study to mimic Greenblatt's methodology.

[13] Similarly, to ROIC calculation, earnings yield equation used here is less conventional method of calculating earnings yield. In this formula, earnings yield will be calculated as (EBIT/Enterprise Value).

The construction process of the PMF and GMF is closely identical to the MF portfolio construction steps, with a minor tweak. In the PMF portfolio, p/e (Stock Price / Earnings per share) will be used as a substitute for earnings yield, ranked in ascending manner (lower value will be ranked higher). Whereas in the GMF portfolio, the modification was gross income will be used as a profitability measure in place of EBIT both in the ROIC and earnings yield calculation.

All the variables mentioned above aside from one exception uses variable from the latest yearly financial statements. For calculating the top 40 percentile ranking in the first step, the current market cap is used instead of the market cap in the latest yearly financial statements. In total 6 portfolios will be formed each year, namely: MF30, MF10, GMF30, GMF10, PMF30, and the PMF10.

4.2.1 Addressing potential source of backtesting bias

The first bias that commonly happens in a backtesting study is the look ahead bias, where historical portfolio tests are done by incorporating financial data that are not available in past periods. In this research, each portfolio will be rebalanced on a yearly basis where the portfolio construction process will be done every first calendar day of April[14]. By regulation of the Indonesian Stock Exchange, every listed company is required to release its yearly financial statements prior to the last day of March. Hence, it is reasonable to assume that prices in April will already incorporate data from the latest company yearly financial

[14] This chosen rebalancing is similar to the rebalancing period used in past magic formula study on the Indonesian Stock Exchange (Jannah & Imansyah (2019), and Burhanuddin & Rokhim (2020)).

statements. This chosen rebalancing period eliminates the look ahead bias concerns. For simplicity purposes, all the companies held in the last year's period will be sold on the same day with the yearly portfolio rebalancing.

Another point of concern in a backtest is selection bias where the researchers may re-test many signals and will only report specific results that perform best (Marx, 2016). Though, this is not a concern to this study as the tested strategy was a popular strategy which have been extensively studied by various research. The methodology and selection process used in this research also tries to replicate the original strategy as close as the data permits. Lastly, this paper also tries to address the overfitting bias where the researchers "manipulate" the result by using weighting method that shows best performance which may be subject to replicability and other concerns. In this research, all adaptations of the magic formula only use stocks that is above 40 percentile market cap. Although not a perfect solution, focusing the strategy on a relatively established company reduces liquidity concerns of the strategy.

4.2.2 Portfolio performance measurement

This sub-section will explain how portfolio returns, cumulative returns, risk, and risk-adjusted returns are calculated in this research.

For a given holding period, portfolio returns are calculated from the weighted sum of returns of each individual holding which follows the equation given below:

$$(1) \quad R_{p,t} = \frac{\sum_{i=1}^{n}(\frac{P_{n,t+1}-P_{n,t}}{P_{n,t}})}{n}$$

- $R_{p,t}$ = Return of portfolio p at time t;
- $\sum_{i=1}^{n}(\frac{P_{n,t+1}-P_{n,t}}{P_{n,t}})$ = Sum of all individual holdings returns at end of period return at time t;
- n = number of unique portfolios holdings;

For this research, the original adjusted market price observations used are in a monthly interval. To get the monthly mean (arithmetic mean / simple mean) returns, simply take the average of the portfolio returns over the whole sample period. Then, the standard deviation of the portfolio is also measured over the whole sampled period. To annualize this measurement, the mean monthly return is multiplied by 12 (number of months) to get the annualized monthly return. To get the annualized standard deviation in each period, the monthly mean standard deviation in the given period is multiplied by the square root of 12.

Then, cumulative return in a given period of each portfolio will be derived by compounding the return of each portfolio for the holding period. Then, this equation will be used to calculate each portfolio's geometric return (also known as CAGR) over the holding period:

$$(2) \quad CAGR_{p,t} = (\frac{V_{p,tn}}{V_{p,t0}})^{(\frac{1}{tn-t0})} - 1$$

- $CAGR_{p,t}$ = Compound annual growth rate of portfolio p at t holding period;
- $V_{p,tn}$ = Value of portfolio p at the ending period;

- $V_{p,t0}$ = Value of portfolio p at the beginning period;
- $tn - t0$ = Period difference between the end and first period;

To calculate the risk adjusted returns, this research use two methods namely Sharpe ratio and Sortino ratio. The Sharpe ratio was introduced by Sharpe (1966), and it was widely used as indicator of portfolio performance due to its simplicity. The Sharpe ratio simply indicates unit of market return premium achieved for a unit of risk. Calculation for each portfolio Sharpe ratio will follow the following equation:

$$(3) \quad S_p = \frac{R_p - R_f}{\sigma_p}$$

- S_p = Sharpe ratio of the portfolio p;
- R_p = Arithmetic mean returns of portfolio p;
- R_f = Arithmetic mean returns of the risk-free rate;
- σ_p = Standard deviation of the portfolio p;

Despite its popularity, The Sharpe ratio has received critique as the standard deviation used as the denominator treat both negative and positive deviations similarly (Goetzmann et al., 2007). Hence, the Sharpe ratio penalize a high positive return which is supposedly a desirable feature. On the other hand, the Sortino ratio uses downside deviations as the denominator instead of standard deviation. In this study, the given period risk-free rate is chosen to be the minimum acceptable return. The Sortino Ratio is measured through the following equation:

$$(4) \quad SR_p = \frac{R_p - MAR}{\sqrt{\frac{1}{n}\sum_{R_p < MAR}(R_p - MAR)^2}}$$

- SR_p = Sortino ratio of portfolio p;
- MAR = Minimum acceptable return;

4.2.3 Factor exposure

To check risks exposure of the strategy, regression will be performed on the strategy return with Fama and French three factors model (Fama & French, 1992). The three factors model regression will also show the strategies ability to generate abnormal return of each strategy in excess of the expected return payoff that compensate the three risks factor, the factors used here are $R_{m,t} - R_{f,t}$, SMB_t, HML_t. Due to unavailability of public Fama and French 3 factor portfolio return series for the Indonesian stock market, the Fama and French portfolio monthly return series used in this research was self-constructed by the researcher[15].

The Fama and French 3 factor portfolio used in this research are rebalanced every year on the first calendar day of April which follows the rebalancing procedure of the Magic formula construction in this paper. To start, all the active stocks from the Indonesian stock market are divided into two groups based on its market cap to small and big market cap group using median market cap as breakpoints. Then, three group are formed on each of the two earlier group by dividing them to value, neutral, and growth, portfolio based on its book to market value. Top 30 highest book to market stocks are considered value stocks, the 30th to 70th

[15] This factor constructions follows Professor French construction method found in https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

percentile stocks are considered as neutral stocks, while the 70 percentiles onwards will be considered as growth stocks. Hence, this study will have 6 risk factor portfolios namely: Big Value, Big Neutral, Big Growth, Small value, Small Neutral, and Small Growth.

The market factor returns, denotes the return of the market in excess of the risks free rate. The 10-year Indonesian government bond are used as the risk-free rate in this research[16]. To get the SMB factor return, subtract the average return of all big portfolio from the average return of all the small portfolio. The HML factor returns are obtained by subtracting the average portfolio return of the small growth and big growth portfolio to the average return from the small value and big value portfolio. The regression equation for each of the magic formula variations is written as follows:

$$(5) \quad R_{p,t} - R_{f,t} = \alpha_{p,t} + \beta_p(R_{m,t} - R_{f,t}) + s_p SMB_t + h_p HML_t + \varepsilon_{p,t}$$

- $\alpha_{p,t}$ = Three factor alphas of the portfolio return that is not explained by the independent variables;
- $R_{p,t} - R_{f,t}$ = Portfolio excess return at time t;
- $R_{m,t} - R_{f,t}$ = Excess return of the aggregate stock market index at time t;
- β_p = Correlation coefficient of the dependent variables to the market risk factor ($R_{m,t} - R_{f,t}$);
- s_p = Correlation coefficient of the dependent variables to the small cap premium (SMB_t);

[16] The annual bond yield time series is obtained through Bloomberg. To obtain the discrete monthly yield, the annual yield is simply divided by 12.

- h_p = Correlation coefficient of the dependent variables to the high value premium (HML_t)
- SMB_t = return of the SMB portfolio at time t
- HML_t = return of the HML portfolio at time t

4.2.4 Sub-period analysis

Most past academic explorations of Greenblatt's strategy are interested in comparing the strategy performance pre and post Greenblatt's book "The little book that beats the market" in 2005 (Hoor, 2017 among many others). This is an interesting examination as trading and investment strategy has been pointed out to diminish post publications (McLean & Pontiff, 2016). Though, in the case of the Indonesian Stock Market this was not feasible due to missing key data from data source as previously mentioned in sub-section 3.1.

Hence to test the robustness of the strategy, the study period will be divided into two equal sub-period. The first sub-period will be the first half of the studied period in 2006 to 2013, and the second sub-period will be the latter half of the full study period on 2014 to 2021. At first, this choice could be considered arbitrary to some extent. Though, the strategy performance result in the first two sub section of chapter 4 suggests that a half and half sub-period robustness check may indeed be appropriate given the performance distribution.

5. Results

This section of the study will showcase empirical evidence of the magic formula variations performance tested in the Indonesian stock market. The breakdown of performance will start with examining the gross strategy returns, the risk-adjusted returns, and the three-factor alpha of each strategy over the whole 16 years study period. To test the robustness of the result, similar performance breakdowns will be re-tested over the first half of the study period and compared with the remaining sample period.

5.1 Strategy gross returns

Table 1 shows the gross annualized return of all studied variations of magic formula along with the market, and LQ45 index which are one of the most popular indexes in the Indonesian stock market. The annualized return presented in table was the raw return of portfolio before taking into account trading costs, tax, dividends, and risk-free rate over the whole sampled period. In terms of absolute unadjusted return, the magic formula has shown a remarkable return when applied to the Indonesian stock market over the studied period. It is observed that all variations of the magic formula are able to show higher arithmetic[17] and geometric mean[18] annualized return above the market, while only PMF10 portfolio underperform the market in terms of median annualized return. Though, the return distribution varies from one to another as shown in the strategy skewness and kurtosis.

[17] Arithmetic mean is also often referred to as the simple mean, or just mean.
[18] Geometric means also commonly referred as compound annual growth rate (CAGR)

Among the tested variations of the magic formula, the GMF30 portfolio shown highest compounded annual growth rate of 28.5% far above the market which delivers 10.4% compounded annual growth rate. As shown in (Figure 1) this means that per unit of initial investment of in 2006 will grow to around 52.25 by the end of 2021, whereas per unit invested in the LQ45 index will only grow to 3.34 by the end of investing period. When observing the yearly return of the portfolio (Table 2), I found that many magic formula portfolios show triple digit return within the period of 2009 to 2010 (post 2008 crisis recovery). This abnormally large return may be a concern as it potentially skews the suggested mean of the strategy over the full sample period. Hence, this serves as a confirmation that re-testing the strategy in two equal periods is needed to check the robustness of the return[19].

5.2 Strategy risk adjusted returns

After only reporting the portfolio return premiums of the strategy with respect to the risk-free rate, all variations of the magic formula show far higher return premiums compared to the stock market and the LQ45 index (Table 3). During the entire observed period, the tested magic formula variations had a mean annualized strategy return premium[20] ranging from 12.47% to 18.97% while the market delivered 3.71% excess return, and the LQ45 index only delivered an even lower mean return premia of 1.77%.

Looking at the annualized standard deviation of the portfolio, all the 10 stocks portfolio strategy shows higher annualized standard deviation compared to its 30 stocks counterpart. Though, when only

[19] There exist many valid ways to address this concern. The two equal sub-period are chosen for simplicity purposes.
[20] Return premium here refers to strategy return less risk-free rate.

accounting for annualized downside deviations the GMF strategy shows higher volatility on the smaller size portfolio while the reverse is true where the 30 stocks portfolio shows higher downside volatility compared to its counterpart for the MF and PMF strategy. When accounting for the risk-adjusted return, no clear trends is shown as different magic formula variations had different performance over different portfolio size.

Quite surprisingly, the annualized volatility of all magic formula variations to be lower than the aggregate Indonesian stock market volatility. Adjusting for risks as measured by the portfolio standard deviation, the Sharpe ratio of all magic formula variations to be superior in respect to the market and LQ45 index. When accounting for only downside deviations the risk-adjusted performance as measured by the Sortino ratio to be even more impressive in comparison to the market, suggesting that the risks taken in implementing the magic formula portfolio are well compensated. Similarly to gross portfolio returns, the GMF30 portfolio also shows the most impressive performance in a risk-adjusted basis through both its Sharpe and Sortino ratios over the whole sample period.

5.3 Factor loadings

Based on the observed beta correlation, the tested adaptations of the magic formula portfolio positively correlate with the market all with more than 95% confidence interval. Though, the beta coefficient found in this result are significantly lower compared to most beta coefficient found in other magic formula backtests in various exchanges (Davydov et al. (2016), Hoor (2017), and Paula (2016), among many other). The beta coefficient is also particularly contradictory to findings by past magic formula research on the Indonesian Stock Market which suggests close to one[21] beta coefficient to the market (Jannah & Imansyah (2019), and Burhanuddin & Rokhim (2020)). This difference in coefficient is likely explainable be the difference in return observation where the previously mentioned research uses yearly return observation, whereas this study uses monthly return observation.

Over the whole sampled period, it is found that all the magic formula portfolios loads strongly on the HML factor. The significant and positive factor loadings on the HML factors are expected as the magic formula itself have a step in which the formula aims to select stocks that are relatively cheap. Although the proxy for value is different where the magic formula select value based on earnings yield while the HML portfolio uses book to price as proxy, it is not a surprise to see that their returns are correlated from one another.

It is found that all variations of the MF adaptations shown strong negative correlation to the SMB factor all with t-stat above 4. This is expected with the chosen selection criteria for this study where we only use the top 40th percentile of stocks in the implementation of magic formula, whereas the SMB factor reports the outperformance of stocks below the 50th market cap percentile over the top 50th largest market cap percentile. This means that over the whole sample, the returns achieved from all magic formula adaptations presented in this research do not take advantage of small stocks premium.

[21] Jannah & Imansyah(2019), and Burhanuddin & Rokhim(2020) found the magic formula to often have a beta coefficient slightly higher than 1, while occasionally the beta coefficient is lower than 1.

Over the entire sample period, all six of the magic formula adaptations three factor alphas are all economically strong while also being statistically significant above the 5% level. This indicates that the magic formula are able to earn higher return than the predicted payoff from loading risks factor prescribed by the Fama and French 3 factor model. The highest three factor alpha are achieved by the MF10 portfolio with annualized alpha of 21.91% (t-stat = 3.78), whereas the lowest alpha was captured by PMF10 portfolio with annualized three factor alpha of 14.07% (t-stat = 2.39). Within this period, the LQ45 does not capture any statistically significant correlation with the HML and SMB factor while being very strongly correlated with the market beta which are expected.

5.4 Sub-period analysis

After dividing the sampled period to two equal sub period of 2006 to 2013 and 2014 to 2021, the magnitude of outperformance of the magic formula adaptations greatly differ across the tested sub-period. As shown in Table 5 and Table 6, both the gross annualized mean return and risk-adjusted return of all magic formula variations in the first sub-period (Table 5) greatly outclass all corresponding portfolio in the latter sub-period (Table 6). Similarly, the benchmarked index of JKSE and LQ45 gross annualized mean returns and performance ratios also greatly differ from the two sub-period. Even if the gross return of JKSE and LQ45 over the latter period (Table 6) is still positive, the market return premium of the LQ45 index goes into the negative and the market return premiums of the aggragate stock period is relatively small after substracting the risk-free return.

Overall, the gross return of all magic adaptations outperforms the LQ45 benchmark in both sub-period, while all of magic formula variations aside from the MF30 portfolio were able to outperform both LQ45 and JKSE in terms of Sharpe and Sortino ratio over both sub-periods.

On the regression of the portfolio returns and the factor loadings, it is found that in the 1st sub-period (Table 5) the three factor alphas of the MF30 portfolio were only significant at the 10% level while all the other magic formula adaptations remain statistically significant under either the 5% or 1% level. The highest three factor annualized alphas are observed in the MF10 portfolio with 0.3619 (t-stat = 3.90), closely followed by the GMF30 portfolio with 0.3551 (t-stat = 4.44). Interestingly, the MF10 and GMF30 portfolio on this sub-period shown a beta coefficient that is statistically indifferent to zero which indicates that the strategy may pose a market neutral quality.

Contrary to the full observed period regression, none of the magic formula portfolio across the 2nd sub period (Table 6) shows a statistically significant three factor alphas. It is also found that in all of the magic formula portfolio, the three factor model explains greater variance of returns within the latter periods as shown in the increased r-squared value. Though, the strategy still consistently loads both statistically significant positive correlation with the HML factor and negative correlation with the SMB factor. This findings suggests that the abnormal return produced by the magic formula may not be robust when applied in different time periods.

6. Conclusion and Study Limitations

From this study, it is found that all variations of the magic formula are able to outperform the Indonesian stock market over the whole sample period (2006 – 2021). In terms of compound growth, the best performing magic formula adaptations was the GMF30 which yields a 28.05% compound annual growth rate, and the weakest magic formula adaptations was the PMF10 portfolio which yields a 19.16% compound annual growth rate, whereas the market (JKSE) index returns a 7.83% compound annual growth rate over the entire sample period. Adjusting for volatility, the Sortino and Sharpe ratio of the best peforming magic formula variations (GMF30) was 1.78 and 0.89 consecutively, while the market volatility adjusted returns was 0.26 and 0.17 consecutively.

However, when exposing the returns to Fama and French three factor model I found that all magic formula adaptations loads strongly on value stocks premium. Hence, a significant return variations of tested magic formula adaptations are attributable to its exposure to value stock premium payoff. Though, the all tested magic formula adapatations in this study shows a statistically significant and large negative correlation with the small stocks premium as this study only uses stocks belonging to company in the top 40 percent market cap percentile. In terms of beta coefficient, all magic formula adaptations have a beta coefficient lower than 0.3 when measured on monthly observations. Over the full sample period, all magic formula adaptations are able to show abnormal return in excess to the three factor risks exposure. The portfolio that earns highest abnormal annualized three factor returns is the GMF30 portfolio with 0.2151 (t-stat = 3.79).

Though, after checking the robustness of the return across two sub period (2006 – 2013 and 2014 – 2021). I found an important takeaway that the magnitude of return within the first half of the study period to be far superior compared to the latter half of the study period. Consequently, even if only 1 magic formula adaptations (MF30) are not able to beat the market (JKSE) in gross returns and volatility-adjusted return terms, all magic formula portfolio three factor alphas are insignificant on the latter subperiod.

Hence, Hypothesis *I* is accepted as this study shows that most magic formula adaptations are able to show higher sortino ratio compared to the aggragate stock market across different tested time periods. Though, the hypothesis *II* is only partially accepted as it is true over the full sample period regression and it is rejected after checking its robustness across sub-period.

I also have to point of several key limitations of this study and the research design. First, all reported return presented in this study are gross of transaction costs, tax, and dividends. Factoring in all of those factors into the reported are a complex procedure which nevertheless may suggest different implications. This study also uses an equal weighting method which due to the current lack of fractional shares availability in the Indonesian market may limit replicability aspects of the tested strategy.

I also recognize that the chosen sub-periods are somewhat arbitrary which may bias the takeways from this study where different conculsion might arise from testing the strategy under different sub-period or completely different robustness check design. Though, due to limitations to the researchers ability to implement a more complex sub-period robustness check this bias is unadressed within this study.

Lastly, as the long-only magic formula is a non-market neutral strategy, the suggested performance of the latter sub-period may potentially be largely attributable to the “non-ideal” market environment.

Hence, how the magic formula will perform under fundamentally different market conditions will still be an open question for the future. It will also be interesting to examine a long and short magic formula strategy once short-selling is available to the Indonesian market as previous research has shown the long-short variations of the magic formula to have consistent market neutral qualities (Blackburn & Cakiki (2017), and Hoor (2017)).

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Figures and Tables

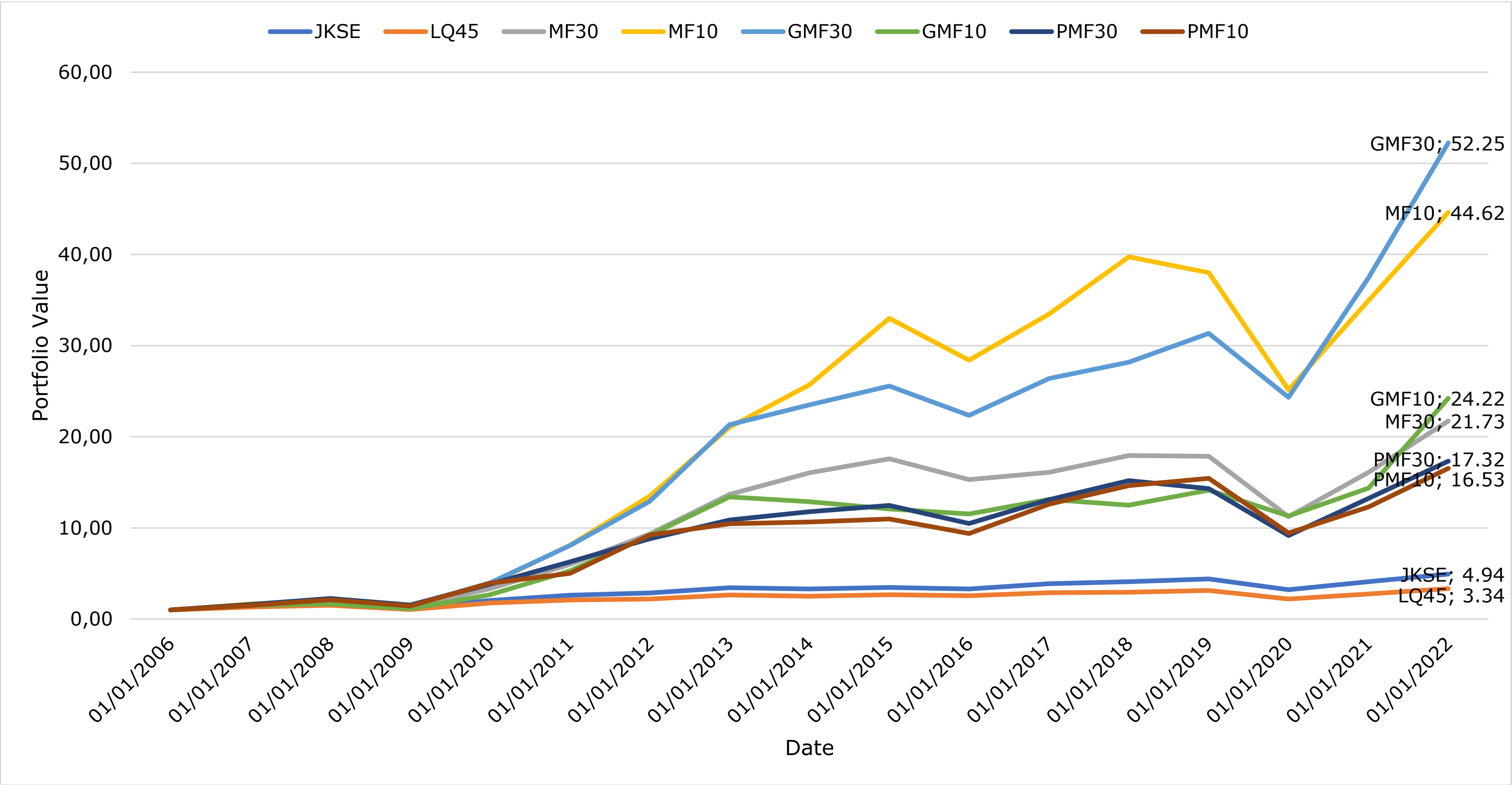

Figure 1 – Portfolio Value of Magic Formula Strategy

The figure above shows how a 1 unit invested at the beginning of the period grows to the end of investing period (2006 – 2021). The portfolio growth above are shown per year (monthly growth are not shown). The x axis depicts the holding period of the portfolio. while the y axis depicts the portfolio value.

	MF30	MF10	GMF30	GMF10	PMF30	PMF10	LQ45	JKSE
Annualized Mean Return	0.2208	0.2712	0.2712	0.2304	0.2064	0.2112	0.1188	0.0998
Annualized Median Return	0.2472	0.2568	0.2964	0.2136	0.2148	0.168	0.1668	0.1854
Annual Cagr	0.2122	0.2679	0.2805	0.2679	0.1951	0.1916	0.1049	0.0783
Skewness	-0.4396	0.5174	-0.0297	0.2714	0.3962	1.1812	-1.0945	-1.1192
Kurtosis	5.6341	5.7972	5.059	4.6495	6.1181	8.0902	9.4232	8.9021

Table 1 - Magic Formula Gross Returns

All results in the table are obtained from monthly return data over the entire sample period (2006 - 2021). obtained annualized variables are esplained in section 4.2.2. Figures shown above are all in decimals. rounded to the nearest fourth decimal points. JKSE and LQ45 index serves as portfolio benchmark.

Year	MF30	MF10	GMF30	GMF10	PMF30	PMF10	LQ45	JKSE
2006	53.85%	**65.99%**	56.03%	47.02%	58.48%	49.40%	30.60%	36.52%
2007	32.06%	25.36%	28.42%	14.45%	**42.27%**	41.37%	16.23%	15.27%
2008	-30.94%	-30.51%	**-25.69%**	-33.30%	-32.01%	-32.24%	-30.75%	-25.24%
2009	137.90%	167.70%	165.53%	137.77%	148.64%	**175.28%**	67.78%	72.47%
2010	79.67%	**108.65%**	103.94%	98.17%	64.91%	26.86%	18.71%	28.55%
2011	55.69%	66.80%	60.13%	73.87%	40.21%	**84.33%**	4.52%	9.45%
2012	46.33%	56.24%	**65.28%**	45.69%	23.20%	13.40%	20.49%	20.41%
2013	17.38%	**22.14%**	10.11%	-3.85%	8.47%	2.04%	-4.92%	-3.85%
2014	9.67%	**28.31%**	8.86%	-6.23%	5.72%	2.96%	6.68%	5.09%
2015	-13.01%	-13.95%	-12.68%	-4.60%	-15.71%	-14.50%	**-4.25%**	-4.87%
2016	5.17%	17.90%	18.18%	13.86%	24.74%	**34.24%**	13.00%	17.50%
2017	11.53%	**18.74%**	6.76%	-4.83%	16.05%	16.10%	1.88%	5.44%
2018	-0.44%	-4.37%	11.25%	**13.37%**	-5.75%	5.54%	6.36%	7.69%
2019	-37.17%	-33.84%	-22.40%	**-20.15%**	-36.10%	-38.81%	-29.99%	-26.94%
2020	43.40%	38.96%	**53.91%**	26.98%	44.54%	30.28%	25.24%	27.12%
2021	34.93%	27.70%	39.55%	**68.73%**	30.99%	34.36%	21.45%	20.55%

Table 2 - Magic Formula Yearly Return

This table presents the yearly return of each portfolio over the full sampled period (2006 - 2021). Figures above all are shown in total percentage gain at the end of the yearly period. Due to the chosen study rebalancing period. the return represented in each year reflects the return from the 4th month of given year to the 3rd month of the next year. As an example. the 2006 period in the table represent an investment period starting in April 2006 to March 2007. The yearly return is obtained by compounding the monthly return of the first month until the twelve month. Figure in bold represents the top performing portfolio within subsequent year.

	MF30	MF10	GMF30	GMF10	PMF30	PMF10	LQ45	JKSE
Mean annualized excess return (Ri - Rf)	0.1389	0.1894	0.1897	0.1479	0.1247	0.1292	0.0177	0.0371
Annualized standard deviation	0.2325	0.2579	0.2126	0.2459	0.2371	0.2726	0.1912	0.2146
Annualized Downside Deviation	0.1483	0.1391	0.1066	0.1261	0.1244	0.1158	0.1167	0.1409
Sharpe Ratio	0.5973	0.7345	0.8921	0.6016	0.5257	0.4738	0.0926	0.1729
Sortino Ratio	0.9365	1.3613	1.7792	1.1731	1.0020	1.1151	0.1518	0.2633

Table 3 - Magic Formula Volatility and Performance Ratios

All results in the table are obtained from monthly return data over the entire sample period (2006 - 2021). obtained annualized variables are esplained in section 4.2.2. Figures shown above are all in decimals. rounded to the nearest fourth decimal points. JKSE and LQ45 index serves as portfolio benchmark.

	MF30	MF10	GMF30	GMF10	PMF30	PMF10	LQ45
Annualized 3-factor alpha	0.1786***	0.2191***	0.2151***	0.1789**	0.1479***	0.1407**	-0.0272**
	(3.79)	(3.78)	(4.63)	(3.10)	(2.96)	(2.39)	(-2.27)
Beta	0.1929***	0.1830**	0.1464**	0.1907**	0.2329***	0.2743***	1.1044***
	(2.49)	(1.99)	(2.12)	(2.14)	(3.08)	(3.19)	(67.22)
HML	0.5428***	0.5983***	0.4956***	0.4392***	0.5931***	0.6828***	-0.0187
	(6.48)	(5.34)	(6.49)	(4.94)	(5.99)	(4.81)	(-1.02)
SMB	-0.7809***	-0.7642***	-0.6369***	-0.6327***	-0.7307***	-0.7461***	0.0414
	(-4.99)	(-4.79)	(-4.66)	(-4.14)	(-4.73)	(-4.00)	(1.50)
N	192	192	192	192	192	192	192
Adj.R-Squared	0.3416	0.2966	0.2991	0.2095	0.3938	0.3286	0.9626

Table 4 - Magic Formula Factor Loadings. 2006 – 2021 (Full sample)

All results in the table are obtained from monthly return data over the entire sample period (2006 - 2021). Figures shown above are all in decimals. rounded to the nearest fourth decimal points. The dependant variables are the monthly return of each strategy. N denotes the number of observations used in the calculation. and adj.r-sqared represent the adjusted R2 measure for the 3 factor model regression. In parentheses are white (1980) robust t-statistics. *p<0.1. **p<0.05. ***p<0.01

	2006 - 2013							
PANEL A: GROSS RETURNS	MF30	MF10	GMF30	GMF10	PMF30	PMF10	LQ45	JKSE
Annualized Mean return	0.3848	0.4489	0.4302	0.358	0.3468	0.3422	0.1498	0.1736
Annualized Median return	0.5391	0.5175	0.561	0.3865	0.3852	0.3036	0.3023	0.3309
Annualized cagr	0.4146	0.5006	0.4838	0.3764	0.3611	0.3442	0.1217	0.1612
Skewness	-0.6630	0.6372	-0.3882	0.0781	0.0497	1.0343	-1.1201	-1.1221
Kurtosis	5.3868	5.8537	4.9247	4.4517	5.1911	7.6516	7.9917	7.8577
PANEL B: VOLATILITY AND PERFORMANCE RATIOS	MF30	MF10	GMF30	GMF10	PMF30	PMF10	LQ45	JKSE
Mean annualized excess return (Ri - Rf)	0.2941	0.3576	0.3393	0.2672	0.2559	0.2514	0.0588	0.0590
Annualized standard deviation	0.2584	0.2795	0.2452	0.2681	0.2680	0.3050	0.2553	0.2357
Annualized Downside Deviation	0.1962	0.1604	0.1654	0.1756	0.1815	0.1787	0.2128	0.1990
Sharpe Ratio	1.1382	1.2794	1.3838	0.9966	0.9549	0.8243	0.2303	0.2505
Sortino Ratio	1.4989	2.2297	2.0512	1.5215	1.4096	1.4065	0.2955	0.2955
PANEL C: FACTOR LOADINGS	MF30	MF10	GMF30	GMF10	PMF30	PMF10	LQ45	
Annualized 3 factor alpha	0.3075*	0.3619***	0.3551***	0.2762***	0.2535***	0.2346**	-0.0434***	
	(1.81)	(3.90)	(4.44)	(3.00)	(2.99)	(2.58)	(-3.42)	
Beta	0.1858*	0.1973	0.1333	0.2149*	0.2251**	0.2997***	1.0789***	
	(1.81)	(1.65)	(1.42)	(1.87)	(2.25)	(2.88)	(75.25)	
HML	0.4331***	0.4824***	0.3920***	0.3444**	0.4893***	0.6462***	-0.0205	
	(3.54)	(2.76)	(3.25)	(2.57)	(3.18)	(2.99)	(-0.95)	
SMB	-0.6963***	-0.6963***	-0.6330***	-0.5819***	-0.6794***	-0.8090***	0.0692**	
	(-3.83)	(5.81)	(-3.31)	(-2.97)	(-3.13)	(-3.10)	(2.1)	
N	96	96	96	96	96	96	96	
Adj.R-Squared	0.2426	0.2309	0.1925	0.1774	0.2602	0.3238	0.9810	

Table 5 - Magic Formula Sub-Period Analysis. 2006 - 2013

All results in the table are obtained from monthly return data from 2006 to 2013. Figures shown above are all in decimals. rounded to the nearest fourth decimal points. Panel A reports annualized return distribution of each strategy. Panel B reports the annualized volatility and peromance ratios of each strategy. Panel C reports the factor loadings of each portfolio with the Fama and French 3 factor model. The dependant variables are the monthly return of each strategy. N denotes the number of observations used in the calculation. and adj.r-sqared represent the adjusted R2 measure for the 3 factor model regression. In parentheses are white (1980) robust t-statistics. *p<0.1. **p<0.05. ***p<0.01

				2014 - 2021				
PANEL A: GROSS RETURNS	MF30	MF10	GMF30	GMF10	PMF30	PMF10	LQ45	JKSE
Annualized Mean return	0.0570	0.0941	0.1134	0.1021	0.0667	0.0803	0.0498	0.0591
Annualized Median return	0.0843	0.0984	0.1082	-0.0008	0.0775	-0.0168	0.1132	0.1124
Annualized cagr	0.0387	0.0713	0.1051	0.0821	0.0494	0.0564	0.0365	0.0514
Skewness	-0.5291	-0.0036	0.1255	0.3843	0.7535	1.1692	-1.2002	-1.1971
Kurtosis	6.7004	4.5182	4.6848	4.9186	8.3619	7.2386	6.7167	6.5025
PANEL B: VOLATILITY AND PERFORMANCE RATIOS	MF30	MF10	GMF30	GMF10	PMF30	PMF10	LQ45	JKSE
Mean annualized excess return (Ri - Rf)	-0.0164	0.0206	0.0399	0.0286	-0.0067	0.0068	-0.0236	-0.0138
`	0.1944	0.2252	0.1642	0.2175	0.1956	0.2317	0.1646	0.1322
Annualized Downside Deviation	0.1483	0.1391	0.1066	0.1261	0.1244	0.1158	0.1167	0.1409
Sharpe Ratio	-0.0844	0.0915	0.2430	0.1315	-0.0343	0.0293	-0.1434	-0.1042
Sortino Ratio	-0.1106	0.1481	0.3742	0.2268	-0.0539	0.0587	-0.2023	-0.0977
PANEL C: FACTOR LOADINGS	MF30	MF10	GMF30	GMF10	PMF30	PMF10	LQ45	
3 factor alpha	0.0575	0.0752	0.0567	0.0776	0.0392	0.0164	0.0001	
	(1.1)	(1.08)	(1.30)	(1.08)	(0.78)	(0.22)	(0.01)	
Beta	0.1936	0.1109	0.1656*	0.1019	0.2485**	0.1655	1.1941***	
	(1.66)	(0.83)	(1.84)	(0.90)	(2.10)	(1.06)	(33.48)	
HML	0.6531***	0.7183***	0.6422***	0.5412***	0.7196***	0.7512***	-0.0188	
	(6.98)	(6.22)	(7.93)	(4.85)	(6.12)	(4.59)	(-0.61)	
SMB	-0.8566***	-0.7882***	-0.5030***	-0.6398**	-0.7238***	-0.5293**	-0.0283	
	(-3.73)	(-3.28)	(-3.12)	(-2.49)	(-4.07)	(-2.22)	(-0.60)	
N	96	96	96	96	96	96	96	
Adj.R-Squared	0.5290	0.4107	0.5263	0.2638	0.5380	0.3432	0.9272	

Table 6 - Magic Formula Sub-Period Analysis. 2014 – 2021

All results in the table are obtained from monthly return data from 2014 to 2021. Figures shown above are all in decimals. rounded to the nearest fourth decimal points. Panel A reports annualized return distribution of each strategy. Panel B reports the annualized volatility and peromance ratios of each strategy. Panel C reports the factor loadings of each portfolio with the Fama and French 3 factor model. The dependant variables are the monthly return of each strategy. N denotes the number of observations used in the calculation. and adj.r-sqared represent the adjusted R2 measure for the 3 factor model regression. In parentheses are white (1980) robust t-statistics. *p<0.1. **p<0.05. ***p<0.01