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Unravelling the magic of Magic Formula investing

Master Thesis Financial Economics

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Contents

This Master Thesis investigates whether a investing strategy called the Magic Formula, introduced by Greenblatt (2010), is effective at generating abnormal returns by identifying undervalued stocks. The Magic Formula creates a ranking based on price (P/E ratio) and quality (Return On Capital). Previous literature did not reach consensus on this topic and the more recent sample of this thesis (1987-2021) gives insight in the effectiveness of the formula in recent years. By back testing the Magic Formula and dissecting its returns with the Carhart (1997) four factor and the Fama & French (2015) five factor models, this thesis shows that the Magic Formula was able to generate alpha until 2010, but not after. Analysis of earnings surprises as well as cumulative abnormal returns around earnings announcement does not provide convincing evidence that the Magic Formula identified undervalued stocks during the whole sample period. Adding momentum as an extra ranking does not change the generated alpha with statistical significance. Neither does adjusting the quality ranking by replacing EBIT with Gross Profit. Overall, the Magic Formula was very effective at generating alpha (with and without adjustments) until 2009, but not between 2010 and 2021.

Keywords: Magic Formula; value investing; formula investing; stock ranking; investment strategy.

Introduction

In 2010, value investor Joel Greenblatt published ‘The Little Book That Still Beats The Market’. This book, a revision of a previous edition, presents a simple ranking strategy called the ‘Magic Formula’. Formula investing is not a new phenomenon. Value investing founder Benjamin Graham used a formula long before Greenblatt did, for example. Alternatively, he came up with a list of seven criteria which identified a stock as a ‘value stock’ (Graham, 2003). It resulted in an investment method requiring individual stocks to satisfy certain conditions in order to capture a ‘margin of safety’. Examples of these requirements are a Current Ratio of over 1.50, price-to-book values of below 1.20 and the company should pay dividends while also being cheap from a price-to-earnings standpoint. However, Graham’s requirements are hardly ever met in modern day stock markets anymore as stocks tend to have higher prices nowadays. This calls for an alternative method or formula that can stand the test of time, which Joel Greenblatt claims to have found (Greenblatt, 2010). Greenblatt’s use of a ranking method is robust to changing market conditions while also simplifying the process greatly, because investors need to check less financial fundamentals. On top of that Greenblatt claims above-market returns. This might seem too good to be true and the aim of this thesis is to validate Greenblatt’s Magic Formula. Greenblatt provides results of back tests in his book, but does not clearly describe the methods used for this back test, nor does he evaluate how these results compare with existing factor models. The analysis in this thesis verifies the results presented by Greenblatt and increases our understanding of the origin of the returns achieved by the Magic Formula.

Literature review

In 2005, Joel Greenblatt first published his Magic Formula. In an easily comprehensible book he claimed to have a value investing strategy that would beat the market in the long run while being easy to implement for every investor (Greenblatt, 2010). The strategy consists of a ranking method which aims to find the best combination of price and quality.

Price ranking

The first of the two metrics used in the Magic Formula ranking method is the Earnings Yield (earnings per share divided by stock price). Earnings yield contains the same information but is the inverse of the P/E ratio, which is one of the most widely used tools for investors. It measures the price of a stock compared to its earnings per share. In Greenblatt's view, this is the price metric. Previous literature investigated the effect of a low P/E ratio on stock returns. According to the Efficient Market Hypothesis (EMH), P/E ratio should not cause excess returns, because the stock price should on average accurately be the discounted value of all future cash flows. This means the Magic Formula should not be able to provide alpha consistently. According to the EMH, stock prices reflect all available information and all returns should be the result of the time value of money and a reward for the exposure to risk. If the Magic Formula succeeds in achieving higher returns than what can be explained by risk factors and the time value of money, market efficiency does not hold.

Consequently, the EMH would leave no room for systemic predictable misvaluation. However, Basu (1977) shows that low P/E stocks earned higher absolute and risk-adjusted returns compared to high P/E stocks between 1957 and 1971, which indicates market inefficiency. This effect persists after controlling for the size factor. Goodman & Peavy (1983) find similar results when controlling for size and industry. Conversely, Reinganum (1981) finds that the P/E effect disappears after controlling for size. In an attempt to give more conclusive evidence on whether the effect exists, Jaffe et al. (1989) and Keim (1990) use a longer period and find significant effects for both size and P/E ratio. According to these authors, a possible explanation can be found in exaggerated investor expectations, whether positive or negative. Benjamin Graham (2003), who is often regarded as the founder of value investing, claims that markets often overreact to news. This leads stock prices to decrease (increase) too much after bad (good) news, causing a gap between price and value which could be profitable for investors and evidence of the efficient market hypothesis being incorrect.

Quality ranking

But on top of price through the P/E ratio, the Magic Formula also takes into account the quality of the company behind the stock. According to Greenblatt, Return On Capital (ROC) captures company quality and therefore serves as the quality metric of the Magic Formula. A high ROC means that the company is able to reinvest earnings in a profitable way, thus creating value. Compared to the P/E ratio, only little research has been done into the effect of ROC. Novy-Marx (2013) investigates multiple quality metrics, including ROC and gross profitability. He finds that quality at least marginally improves stock performance. Especially the gross profit ratio has a strong positive effect. However, the author emphasizes that looking only at quality metrics is suboptimal. Novy-Marx advocates the implementation of the quality strategy into existing value strategies. This is also what the Magic Formula aims to do by ranking on both price and quality. Bouchaud et al. (2016) investigate Return On Assets (EBIT/Total Assets), Return On Equity (Net Income/Common equity) and cash-flows (Net Operating Cash-flows/Total Assets) as quality metrics and claim that analysts underestimate the value of profitability indicators which results in relatively high risk-adjusted returns for high quality stocks. Asness et al. (2019) define quality in a different way. In this paper, the authors compute three composite quality measures: profitability, growth, and safety. The average of these scores is taken and represents the overall quality score. Asness et al. find that investors pay more for high quality stocks, but not enough relative to low quality stocks. This is results in an alpha for a long-short portfolio going long in high quality stocks and short in low quality stocks. In general, literature shows that high quality stocks earn higher risk-adjusted returns than low quality stocks.

Magic Formula method

However this research proposal does not consider the price or quality factor separately, but the combination of the two. Greenblatt (2010) tries to capture both factors by ‘buying good businesses at bargain prices’ with a method he calls the ‘Magic Formula’. The method works by first ranking companies on Return On Capital and then on Earnings Yield (both from high to low). These two rankings are then combined by adding up the ranks per stock. The resulting value is used to make the final ranking. According to Greenblatt, this way investors can look for the companies with the best combination of both the price and quality factor. Greenblatt believes equity markets are inefficient in the short term, which causes a gap between price and value. According to Greenblatt, his ranking method or Magic Formula will enable investors to create portfolios with stocks which, on average, have such a large gap. In the long run, price and value will converge which increases returns. However, whether this method actually delivers on its promises is not clear. Greenblatt claims the formula would have achieved an average yearly return of 23.8% between 1988 and 2009 compared to 9.5% of the Standard & Poor's 500, using a monthly rolling window with a window size of one year. Apart from the returns, Greenblatt does not provide Sharpe ratios, t-values or other statistical metrics nor does he use control variables to check whether the Magic Formula is just another manifestation of risk factors already mentioned in finance literature. Greenblatt mentions the risk of the strategy is low, because the strategy never lost money in a three year period in the researched period and did better than the market in most three year periods. Volatility as a risk measure is not discussed at all.

The Magic Formula in finance literature

The remarkable returns of the Magic Formula claimed by Greenblatt resulted in several research papers investigating the strategy. Davydov et al. (2016) find that the Magic Formula beats the market in Finland and the abnormal returns are not caused by a higher level of risk as captured by the Carhart four factor model (Carhart, 1997). Blackburn & Cakici (2017) report that the Magic Formula does not yield above market returns from 1991 until 2016 in North America and Asia, but it does in Europe. For the Thai stock market, the Magic Formula earns higher risk-adjusted returns relative to the market between 1993 and 2012 (Hongratanawong, 2014). The paper reporting this result also does not find significant differences in risk-adjusted returns between the Magic Formula and market returns for the U.S. stock market. Remarkably, the discussed literature does not examine whether the Magic Formula is effective additional to the Fama-French five factor model, which includes a quality factor (Fama & French, 2015). Following this literature, there is no consensus whether the Magic Formula is effective in identifying undervaluation of stocks. This is the main research question of my thesis, which can be split up further into two parts: the first part examines the effectiveness of the Magic Formula and the second looks at possible adjustments to the Magic Formula that might improve its performance.

Hypothesis 1

The first null hypothesis which will be discussed in this thesis is that the Magic Formula does not yield abnormal excess returns. Put differently:

$H1_0$: the Magic Formula does not generate abnormal returns;

$H1_\alpha$: the Magic Formula is able to generate abnormal returns.

To check this hypothesis, the returns of the Magic Formula will be decomposed by examining what known risk factors cause the returns. As described above, both the price and quality factors have been documented in finance literature before. Does ranking stocks by these factors actually result in higher returns compared to when these factors are used separately? Additionally to the Carhart four factor model, the Fama & French five factor model will be used to control for the profitability or quality factor. If the null hypothesis holds, the returns are just manifestations of existing risk factors. However, the alternative hypothesis that the Magic Formula succeeds in capturing alpha holds when the factor models are not successful in explaining the returns and leaves alpha to be explained.

Hypothesis 2

Secondly, if the returns of the Magic Formula are actually caused by underestimation of the quality of the underlying business, then this underestimation will be corrected later on when earnings turn out higher than anticipated. This results in the following hypotheses:

$H2_0$: the Magic Formula ranking has no predictive power for future earnings beyond analysts' estimates and investors' expectations;

$H2_\alpha$: the Magic Formula ranking does have predictive power for future earnings beyond analysts' estimates and investors' expectations.

Whether the null hypothesis holds will be examined in two ways. The first investigates whether there is a relationship between earnings surprises and the Magic Formula ranking. The null hypothesis holds when there is no correlation. Secondly, undervaluation by investors should be corrected when a company turns out to be in better shape than expected. As earnings announcements contain information about the company, returns around earnings announcements are expected to be higher for firms that are ranked higher by the Magic Formula if this investment strategy actually captures undervaluation. This would also lead to a rejection of the null hypothesis.

Momentum and value strategies

A factor not incorporated by the Magic Formula, but found in multiple research papers is the momentum factor. Jegadeesh & Titman (1993) show that, on average, stocks that performed well in the past year, will continue to do so in the next three to twelve months. This holds not only for individual stocks, but also for size and value portfolios (Lewellen, 2002). More recent evidence suggests that return momentum is still present in North America, Europe, Japan and Asia Pacific (Fama & French, 2012). Asness et al. (2013) find strong correlation between the returns of value and momentum strategies in portfolios diversified across multiple markets and asset classes. Combining the two strategies results in lucrative strategies with relatively high Sharpe Ratios. They suggest liquidity funding risk as a partial explanation, which could prevent this phenomenon from being traded away.

Hypothesis 3

The second objective of this thesis is to explore additional factors which might improve the Magic Formula. This means examining whether Greenblatt's strategy can be improved by adding momentum to the rankings, resulting in a combined ranking of price, quality and momentum. Similar to Jegadeesh & Titman (1993), the momentum ranking will be based on the preceding twelve month periods. The hypotheses are as follows:

$H3_0$: adding momentum as an extra ranking to the Magic Formula does not improve its performance;

$H3_\alpha$: adding momentum as an extra ranking to the Magic Formula enhances its performance.

Hypothesis 4

Further alterations can be made by modifying the price and quality ranking method. As mentioned, Greenblatt's Magic Formula uses ROC. However, according to Novy-Marx (2013) and Blackburn & Cakici (2017), Gross Profit is a better indicator. They conclude that Gross Profit captures the quality anomaly more effectively compared to other profitability metrics. Novy-Marx argues that this is caused by accounting firms treating economic investments as expenses, which causes noise in the profitability measures further down the income statement. This would cause the ratio of Gross Profitability divided by Invested Capital to be more effective at capturing economic profitability compared to Return On Capital. If the quality factor is important for the performance of the Magic Formula, then a more accurate metric should lead to a more accurate return prediction and higher performance. This leads to the following hypotheses:

$H4_0$: replacing EBIT with Gross Profitability in the quality factor does not improve performance;

$H4_\alpha$: replacing EBIT with Gross Profitability in the quality factor improves performance.

Transaction costs

A valid concern regarding trading strategies is the magnitude of transaction costs incurred with the strategy. The existence of alpha may persist, because transaction costs prevent investors from actually benefitting from the anomaly. Berkowitz et al. (1988) find average one-way transaction costs of 23 basis points of the principal. Selling seems to be more expensive than buying in their sample, but the evidence is minimal. Jegadeesh & Titman (1993) use more conservative one-way transaction costs of 50 basis points for their relative strength strategies. In the final part of the results section, turnover and transaction costs are considered to check whether the Magic Formula is profitable after transaction costs or only viable in theory.

Methods

Hypothesis 1

For the first hypothesis concerning the abnormal returns of the Magic Formula portfolios are formed by ranking the stocks from high to low on Earnings Yield and Return On Capital, adding the ranks and splitting up these combined ranks into deciles. In contrast to Greenblatt, all stocks are divided into deciles instead of only picking the top 20 or 30 stocks. This way, more comprehensive and convincing evidence is gathered to test the hypotheses, because the influence of individual outlier stocks is reduced. In order to be able to compare the results of this paper with Greenblatt's and avoid data mining, Greenblatt's method is followed as closely as possible as far as metrics and other known characteristics of the Magic Formula are concerned. All tests are done on both equal-weighted as well as value-weighted portfolios. Greenblatt used equal-weighted portfolios in his book, but value-weighted portfolios are considered to be more realistic as it mitigates practical and costly problems with low liquidity in small cap stocks. For all the returns data, a one month rolling window with a window length of one month will be used, which is different from Greenblatt who suggests a one year holding period. This decision is based on limitations in the analysis, as a rolling window length of one year with a one month frequency would artificially increase persistence as individual months are examined multiple times in the tests.

To check for abnormal returns, Ordinary Least Squares (OLS) regressions are run on the returns of the long-short portfolios, which are formed by going long in the decile with the best ranked stocks and short in the worst decile. First, the Carhart (1997) four factor model is used of the form

$$r_{it} = \alpha_i + b_i RMRF_t + s_i SMB_t + h_i HML_t + p_i PR1YR_t + e_{it} \qquad (1)$$

where r_{it} is the return on a portfolio in excess of the one-month T-bill return, $RMRF$ is the excess return on the market return and SMB, HML and $PR1YR$ represent the size, value and momentum factors respectively.

Secondly, the Fama & French (2015) five factor model is used with the form

$$r_{it} = \alpha_i + b_i RMRF_t + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it} \qquad (2)$$

which drops the momentum factor compared to the four factor model, but distinguishes between firms with robust and weak profitability (RMW) and low and high investment (CMA). For both models, if the factors capture all variation in expected returns, then the intercept or alpha will be zero. Conversely, a statistically significant alpha means that these models do not fully explain the returns of the portfolios. Statistically significant alphas would cause the first null hypothesis to be rejected.

Additionally, a graphical analysis of cumulative returns is done to determine at which point returns are achieved, by calculating the cumulative returns achieved with different investment horizons and plotting these against time.

Hypothesis 2

The second hypothesis tests whether investors and analysts underestimate companies ranked better by the Magic Formula ranking, compared to the worse ranked stocks. To answer this, it is tested if earnings surprises differ between the deciles of the magic formula ranking with the model

$$ES_{it} = \alpha + \beta_1 d2_{i,t-1} + \beta_2 d3_{i,t-1} \dots + \beta_9 d10_{i,t-1} + \gamma'_{i,t-1} b + \eta_m + e_{it} \qquad (3)$$

where ES_{it} stands for earnings surprise measured as the difference between the average of analysts' earnings estimates and actual earnings scaled by the standard deviation of the estimates in the spirit of Smajlbegovic (2019). Furthermore, this model consists of nine dummy variables and one constant representing all Magic Formula ranking deciles. The first portfolio, with the best ranked stocks and long portfolio, is represented by the constant. β is the coefficient of the deciles denoted by dq, with q identifying the decile. The coefficient stands for the deviation of the earnings surprises within decile q from decile one. If the earnings surprises differ between the deciles, then this would suggest that analysts over- or underestimate companies in certain deciles compared to other deciles. γ'_i is a vector denoting the control variables of size measured as market capitalization, book-to-market ratio and the number of analysts covering the specific earnings event of firm i. Apart from this month fixed effects are implemented to control for all time-unit specific effects, which is denoted by η_m. Due to extreme outliers in the Earnings Surprise data, 99% winsorization is used.

A similar model is estimated to check whether investors are surprised by earnings announcements, which would indicate misvaluation. If this is the case abnormal returns should be visible after these announcements which is checked with the model

$$CAR_{it} = \alpha + \beta_1 d2_{i,t-1} + \beta_2 d3_{i,t-1} \ldots + \beta_9 d10_{i,t-1} + \gamma'_{i,t-1}\, b + \eta_m + e_{it} \quad (4)$$

where CAR_{it} represents the cumulative abnormal returns of the day before until the day after the earnings announcement, as Ball & Kothari (1991) show that these days show the most significant differences. Abnormal returns are measured relative to the Fama & French (2015) five factor model and the estimation window ranges from 120 days before until 10 days before the earnings announcement. This is an adjustment to the method proposed by MacKinlay (1997), who suggested an estimation window starting 120 days before continuing until the event window. Excluding the 10 trading days before the earnings announcement is to ensure that possible effects of the event window are not captured in the estimation window. If β_1 until β_9 are significantly different, then misvaluation differs between these deciles and decile 1, containing the highest ranked stocks. Control variables, represented by the vector γ'_i, are size (market capitalization) and book-to-market ratio. η_m again denotes month fixed effects. An important advantage of model (4) over model (3) is that model (4) also includes the earnings events with one analyst or less. Another advantage is that it incorporates the view of the market as a whole, which ultimately determines prices and returns, as opposed to only analysts' view.

For both models testing hypothesis two, deciles are lagged one month to make sure the deciles are not formed after or too close to the earnings announcement. The same holds for the control variables.

Hypothesis 3 & 4

The second part of this thesis examines two different alterations to Greenblatt's (2010) method. In the first change momentum is added as an extra ranking. The ranks of the price, quality and momentum factors are added together and result in the adjusted Magic Formula ranking. For the other alteration EBIT is replaced by Gross Profit. After both alterations are made, the same ranking method is used as mentioned for the first hypothesis, after which the statistical significance of the difference in returns is computed and checked against known risk factors of the Carhart and Fama & French models. The method to calculate the alpha is identical to model (1) and model (2). If one of the alterations or the combination leads to a higher alpha in the long-short portfolios, then this adjusted Magic Formula is better able to capture misvaluation compared to the original.

To test whether the spread between alphas of different models is statistically significant, the following test is used:

$$t = \frac{\alpha_i - \alpha_j}{\sqrt{SE_{\alpha i}^2 + SE_{\alpha j}^2}}. \quad (5)$$

Where α_i and α_j represent the alpha of portfolio *i* and *j*, respectively. $SE_{\alpha i}$ and $SE_{\alpha j}$ stand for the standard errors of the alpha of portfolio *i* and *j*, respectively. This test is used to determine whether the adjustments mentioned in hypotheses H3 and H4 cause a statistically significant difference in returns compared to the original Magic Formula.

For all of the hypotheses, the data will be split into two subsamples; one from 1987 until 2009 and the other from 2010 until 2021. The first subsample is covered by Greenblatt in his book and this paper will analyse the results in this period to enable comparisons with Greenblatt's claims. The second subsample is more recent and useful to check whether the Magic Formula strategy has been effective in the 12 years following the moment the book was published.

Data

This sample period of this thesis lasts from 1987, which is one year before Greenblatts tests enable calculations of ratios necessary for the back tests one year later, until 2021, which is the most recent available data. For the whole sample, financial and utility companies are excluded, because the business model of these companies is very different from other companies in the sample. The cause can be found in high leverage for financial firms and strict regulation for utility companies.

Monthly stock returns on company level are retrieved from CRSP. The quality factor or Return On Capital of the Magic Formula is calculated as EBIT divided by the sum of Net Working Capital and Net Fixed Assets. The price factor or Earnings Yield is EBIT divided by the Enterprise Value, which is calculated as the Market Value of Equity added to Net Interest-bearing Debt. The accounting metrics for both factors are obtained from Compustat. The Fama & French five factor model and Carhart model data are provided by the Kenneth R. French Data Library. The momentum factor is calculated by use of the monthly stock returns of the last twelve month except the most recent month and used as a ranking metric. Leaving out the most recent month is useful to avoid the one-month return reversal as mentioned by Jegadeesh (1990). Analyst's estimates for earnings are retrieved from the IBES database. Gross Profit is used instead of EBIT for the quality factor in the second part of this paper and is obtained from Compustat. All metrics provided by companies in their earnings reports are assumed to be available four months after their realization. This means that metrics such as EBIT and Gross Profit which are realized in the first quarter, are assumed to be publicly available in the first month of the third quarter. Observations in which the announcement date was before the end of the concerning quarter were dropped, as well as observations for which the announcement was more than four months after the concerning quarter. One-month Treasury bill yields, which are used as a proxy for the risk free rate and (excess) market returns, are retrieved from the Kenneth R. French Data Library.

Results

Hypothesis 1

Table 1.1 shows the average monthly returns of the deciles formed by the Magic Formula ranking method for the full sample, as well as for both the subsamples. The full sample is consistent with the results mentioned by Greenblatt (2010): the deciles with the best ranking perform better than the deciles with lower ranks. However, the results are not quite the same as the returns claimed by Greenblatt. In his book Greenblatt claims that the Magic Formula would have yielded an average yearly return of 23.8% through 2009 when considering the largest 3,500 stocks on the US market and 19.7% considering the 1,000 largest stocks. This translates to a monthly return of 1.8% and 1.5%, respectively. However, these returns are achieved by investing only in the 30 stocks ranked best by the Magic Formula. Greenblatt also provides results of back tests based on deciles. The top decile in Greenblatt's back test returns 1.2% and the bottom 0.0% monthly leaving a difference of 1.2%. This is very similar to the returns in the first sample, which generates 1.3% monthly. However, the full sample and the last subsample cannot keep up with this return, with only 0.9% and 0.0% respectively.

The last subsample, which shows the returns of the Magic Formula after the publication of the book does not provide evidence for the effectiveness of the strategy. There does not seem to be a pattern in the returns per decile, nor does decile 1 outperform decile 10. Sharpe ratios are considerably higher for the deciles with the higher ranked stocks compared to the ones with lower rankings for the full sample and first sub-sample. The pattern of the Sharpe Ratio is fairly linear as well, giving evidence for the effect of Magic Formula ranking on portfolio performance. This is not the case for the second sub-sample, which is in line with the lack of evidence for a relationship between return and Magic Formula ranking in this period.

Table 1.1 Monthly raw stock returns and Sharpe Ratios by decile with stocks ranked according to the Magic Formula from 1987 until 2021 (value-weighted).

	1987-2021			1987-2009			2010-2021			Back test Greenblatt
VARIABLES	mean	sd	ann. SR	mean	sd	ann. SR	mean	sd	ann. SR	mean
Return decile 1	0.011	0.051	0.59	0.011	0.051	0.51	0.009	0.049	0.61	0.012
Return decile 2	0.010	0.044	0.60	0.009	0.045	0.43	0.013	0.043	1.02	0.010
Return decile 3	0.008	0.042	0.46	0.006	0.043	0.21	0.011	0.039	0.94	0.010
Return decile 4	0.008	0.045	0.43	0.006	0.047	0.19	0.012	0.043	0.94	0.090
Return decile 5	0.008	0.048	0.41	0.006	0.051	0.17	0.011	0.042	0.88	0.090
Return decile 6	0.008	0.053	0.37	0.004	0.056	0.04	0.014	0.046	1.03	0.080
Return decile 7	0.004	0.056	0.10	0.001	0.060	-0.14	0.009	0.049	0.61	0.070
Return decile 8	0.005	0.072	0.13	0.000	0.079	-0.15	0.015	0.058	0.87	0.060
Return decile 9	0.002	0.083	-0.02	-0.002	0.089	-0.21	0.009	0.071	0.42	0.030
Return decile 10	0.002	0.083	-0.02	-0.002	0.082	-0.23	0.009	0.085	0.35	0.000
dec1 - dec10	0.009	0.068	0.34	0.013	0.068	0.49	0.000	0.066	-0.02	0.012

Adapted source: Greenblatt(2010)
Note decile 1 contains the stocks with the highest ranks. Ann. SR stands for annualized Sharpe Ratio. Greenblatt's back test runs from 1988 until 2009 and the returns are changed from yearly to monthly.

Table 6 in the appendix shows the returns by decile with equal-weighted portfolios. Overall the results are similar to the value-weighted deciles in Table 1.1, but more extreme. There is more disparity within the deciles, which could be caused by the higher risk of smaller stocks. These have more weight in the equal-weighted portfolio and their higher risk might be rewarded higher portfolio returns. The long-short portfolios achieve higher returns in Table 6 compared to Table 1.1, which suggests that deciles with worse ranked stocks, contain companies with relatively low market capitalizations compared to the deciles with the better ranks. With equal-weights, the second subsample also has a positive return on the long-short portfolio albeit considerably smaller than in the first sample. This could again be caused by equal-weighted portfolios containing relatively more smaller companies.

Table 1.2 examines how the returns of the Magic Formula hold up against the Carhart four factor and Fama & French five factor models. In the full sample, the difference between the first and tenth decile is not fully explained by the factors of these models. The long-short portfolio still provides positive abnormal returns at a five percent confidence level. The statistically significant values at the ten percent level of the high-minus-low factor suggest that some of the excess returns are caused by the value factor. In the Carhart model none of the factors are significant. In conclusion about the full sample, some of the abnormal return of the

Magic Formula is explained by previously known risk factors. However, after controlling for these factors the abnormal returns persist for the long-short portfolio and amounts to around 0.9% monthly in the full sample.

The subsamples suggest that the strategy was effective before the Magic Formula was published, but not after. From 1987 until 2009 the abnormal returns are positive and significant after controlling for the Carhart and Fama & French factors. In the second subsample the returns are still positive, but these results are not statistically significant. This indicates that the Magic Formula was not effective in the recent past. For both subsamples, the Carhart and Fama & French factors are not significant, which means they do not explain the long-short portfolio returns of the Magic Formula.

Table 1.2 Linear regression results for the relationship between Magic Formula long-short portfolio (long decile 1, short decile 10) returns and Carhart (1997) and Fama & French (2015) factors from 1987 until 2021 (value-weighted).

	1987-2021		1987-2009		2010-2021	
VARIABLES	Carhart dec-1-dec10	F&F5 dec-1-dec10	Carhart dec-1-dec10	F&F5 dec-1-dec10	Carhart dec-1-dec10	F&F5 dec-1-dec10
β_{RMRF}	-0.0013	-0.0012	-0.0012	-0.0011	-0.0010	-0.0015
	(0.0010)	(0.0010)	(0.0012)	(0.0013)	(0.0017)	(0.0017)
β_{SMB}	0.0013	0.0017	0.0013	0.0016	0.0014	0.0025
	(0.0021)	(0.0018)	(0.0025)	(0.0021)	(0.0024)	(0.0026)
β_{HML}	0.0032*	0.0028	0.0031	0.0033	0.0037	0.0020
	(0.0017)	(0.0021)	(0.0020)	(0.0023)	(0.0029)	(0.0036)
β_{RMW}		0.0017		0.0011		0.0038
		(0.0024)		(0.0029)		(0.0035)
β_{CMA}		-0.0008		-0.0014		0.0002
		(0.0034)		(0.0041)		(0.0052)
β_{MOM}	-0.0000		-0.0005		0.0022	
	(0.0014)		(0.0016)		(0.0016)	
α (constant)	0.0093**	0.0088**	0.0132***	0.0126***	0.0018	0.0016
	(0.0036)	(0.0037)	(0.0044)	(0.0047)	(0.0063)	(0.0062)
R^2	0.0286	0.0313	0.0304	0.0310	0.0289	0.0276
Adj. R^2	0.0191	0.0195	0.0159	0.0129	0.000779	-0.00785
Observations	416	416	273	273	143	143

Note robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The first possible explanation for the failure of the Magic Formula from 2010 onwards is that investors started using the Magic Formula. However, it is unlikely that the extend of this effect would completely eradicate the abnormal returns of the strategy. Much more likely is that the problem with the strategy might be caused by data mining bias: the strategy does not actually perform, but it did in the data that was used to design the strategy itself. The period from 2010 onwards reveals that the previously perceived anomaly does not persist out of sample. It is important to note however, that the first sample uses more than twice as many observations and the second sample only covers eleven years. A larger sample could give more confidence regarding these conclusions. Overall, the Magic Formula did seem to generate abnormal returns in the past, but evidence on the persistence of these results is weak.

Table 6 and 7 in the appendix shows the linear regression results for the alphas from the equal-weighted long-short portfolio. For the full sample the alphas remain strongly significant at the one percent level. The subsample shows that these abnormal returns mostly originate from the first subsample, where the alpha is strongly significant. In the second subsample, the alpha is positive but not statistically significant. For the full sample and both sub-samples, the value factor (high-minus-low) partially explains the difference in return between the top and bottom decile. It is statistically significant with all regressions at the ten percent level at least, except for the F&F5 model in the second subsample. This could be caused by earnings yield, used in the Magic Formula ranking, being a useful tool in distinguishing between value and growth stocks. This results in the quality factor in the Magic Formula ranking and the high-minus-low factor measuring similar aspects of companies.

Figure 1 gives a graphical overview of the cumulative returns of the long-short portfolio by investment horizon. The equal-weighted portfolio performs best in the first six months of investing, where the line is the steepest. After these six months, the Magic Formula achieves a return of 4.7%, which only increases with 2.3 percentage points after that until 24 months. The value-weighted portfolio is more stable. After four months, the long-short portfolio achieves a 2.9% return, after which it steadily increases to 7.4% in 24 months. For both methods, value- and equal-weighted, the first half year performs better than the period after this.

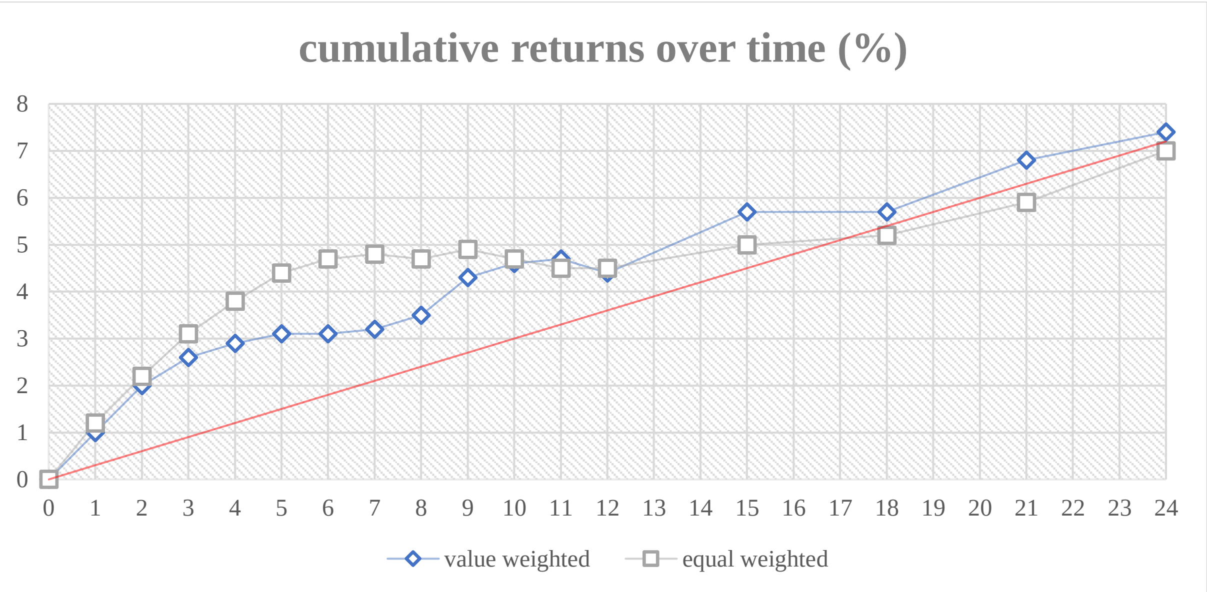

Figure 1 Cumulative return of value- and equal-weighted long-short portfolios formed by the Magic Formula from 1987 until 2021.

Overall, the ranking strategy was able to achieve abnormal returns in the first subsample, ranging from 1987 until 2009. This was also the period that Greenblatt (2010) studied, but after this the Magic Formula did not generate alpha. Over the whole sample, the Magic Formula seemed to be most effective with an investment horizon of under 6 months.

Hypothesis 2

The second hypothesis proposes that abnormal returns of the Magic Formula are caused by misvaluation by investors and analysts. This would result in surprises when companies publish their quarterly earnings. Table 2.1, which reports decile 1 as the constant, shows no convincing evidence that this is the case. In the full sample, the earnings surprises of companies in decile 10 are significantly lower than those of decile 1 at a one percent significance level. Companies with the lowest rank, in decile 10, have on average 0.764 lower earnings surprises. Except for deciles 5 until 7 which do not differ significantly from decile 1, all deciles in the full sample have lower earnings surprises than decile one at a one percent confidence level. However, there is no clear linear relationship between ranking deciles and earnings surprises. Deciles 2 until 3 show a much stronger effect than deciles 5 until 7 and a weaker effect than deciles 9 and 10. This means that the relationship between deciles and earnings surprises is inconsistent and evidence for the relationship is weak, even though there is a difference in earnings surprises between deciles.

In the two sub-samples, companies in decile 10 have 0.747 and 0.750 lower earnings surprises than decile 1, on average and respectively. This is almost identical to the coefficient for this decile in the full sample. For the period between 1987 and 2009, all deciles perform significantly worse than deciles with weak evidence for decile 5, with a confidence level of only ten percent. In the second subsample, the effect is similar for deciles 9 and 10. However, for the other deciles only decile 3 and 4 have significantly lower surprises than decile 1. Deciles 2 and 5 until 8 do not show significantly lower earnings surprises. What holds for the full sample also holds for the two subsamples: even though there is some difference in earnings surprises between deciles, there is no consistent linear relationship, which causes evidence for the effect between Magic Formula ranking and earnings surprises to be weak.

The worst ranking stocks, in decile 9 and 10 perform considerably worse compared to the other deciles when regarding the coefficients of the deciles in all samples. The other deciles, across all samples, do not lower the earnings surprises by more than 0.203, whereas the surprises of decile 9 and 10 are around 0.5 and 0.75 lower across all samples, respectively. This means that the lowest ranking stocks do surprise more negatively than the stocks in decile 1, which could indicate undervaluation of the highest ranked stocks compared to the lowest ranked ones. However, in general the evidence for the effect of Magic Formula ranking on earnings surprises is not clear given the lack of a linear relationship.

Table 2.1 Linear regression results for the relationship between earnings surprises and Magic Formula deciles from 1987 until 2021.

	1987-2021	1987-2009	2010-2021
VARIABLES	ES	ES	ES
Decile 2	-0.125***	-0.196***	-0.035
	(0.035)	(0.044)	(0.058)
Decile 3	-0.178***	-0.131***	-0.250***
	(0.035)	(0.044)	(0.056)
Decile 4	-0.169***	-0.178***	-0.169***
	(0.035)	(0.044)	(0.057)
Decile 5	-0.043	-0.077*	-0.019
	(0.035)	(0.045)	(0.057)
Decile 6	-0.049	-0.130***	0.043
	(0.035)	(0.045)	(0.058)
Decile 7	-0.046	-0.148***	0.074
	(0.036)	(0.045)	(0.059)
Decile 8	-0.123***	-0.203***	-0.016
	(0.038)	(0.047)	(0.062)
Decile 9	-0.515***	-0.504***	-0.508***
	(0.040)	(0.052)	(0.064)
Decile 10	-0.764***	-0.747***	-0.750***
	(0.043)	(0.059)	(0.065)
Ln(size)	0.245***	0.190***	0.309***
	(0.007)	(0.009)	(0.012)
Ln(BM)	-0.434***	-0.546***	-0.334***
	(0.012)	(0.016)	(0.016)
Ln(#analysts)	-0.459***	-0.439***	-0.489***
	(0.014)	(0.017)	(0.023)
α (constant)	-0.316	-0.075	0.019
	(0.667)	(0.662)	(0.121)
R^2	0.059	0.059	0.048
Adj. R^2	0.057	0.057	0.046
Observations	179,859	102,082	77,777

Note robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Even though Table 2.1 finds a strong difference in earnings surprises between the first decile and the ninth and tenth, investors are not necessarily rewarded with higher returns around these earnings surprises. Unlike analysts, the market might take this phenomenon into account, which could mean that this is already priced in. Another flaw of the model above is that it does not analyse the earnings surprises of companies that are covered by one analyst or no analyst at all. This is the result of the fact that standard deviation cannot be calculated when there are less than two analysts and consequently the dependent variable cannot be computed. To mitigate these flaws, we look at the cumulative abnormal returns in the days around the earnings announcements.

Table 2.2 shows the results of the analysis based on Cumulative Abnormal Return (CAR) relative to the Fama & French (2015) five factor model. Decile 1 is again represented by the constant of the model and the other deciles are dummy variables relative to this constant. The numbers are in line with what is to be expected following the analysis of Table 2.1. In the full sample, companies in decile 1 have a positive average CAR in the day before until the day after the earnings announcement, but this is not statistically significant. The numbers do not provide very convincing evidence for a difference in CAR between the first decile and the second until seventh decile, as only the 4th and 6th decile show a lower CAR, significant at the 10% level only. However, the bottom three deciles clearly perform worse compared to the top decile in the full sample at a 5 percent (decile 8) and 1 percent (decile 9 and 10) confidence level and have a lower CAR. The companies in decile 10 have a CAR which is on average 0.60 percentage points lower than the companies in decile 1. This means that the bottom deciles surprise negatively relative to the top decile. Overall, these results are similar to the previous test in which the relationship between earnings surprises and Magic Formula ranking was examined. The best ranked stocks in decile one perform better in terms of CAR than the worst ranked stocks in decile 10, but there is no linear relationship. The evidence for the effect of Magic Formula ranking on CAR is therefore limited.

The first subsample corresponds with the full sample, except the gap in CAR between the top decile and the bottom deciles is bigger. Again the bottom three deciles perform worse compared to the top decile at a 1 percent confidence level. The CAR of decile 10 is 0.75 percentage points lower than the CAR of decile 1. The second subsample suggests the Magic Formula was less able to predict which stocks were undervalued between 2010 and 2021. Decile 9 and 10 still perform worse than decile 1, but the coefficients of these worst two deciles are less negative than in the full sample and first subsample. Stocks in decile 10 have 0.41 percentage points lower cumulative abnormal returns than those in decile 1. These results suggest that investors are more positively surprised by the earnings of decile 1 companies than decile 10 companies across all samples. However, just as in the previous test there is no linear relationship which makes the evidence unconvincing.

Table 2.2 Linear regression results for the relationship between Cumulative Abnormal returns on t_{-1}, t_0 and t_{+1} and Magic Formula deciles around earnings announcements from 1987 until 2021.

	1987-2021	1987-2009	2010-2021
VARIABLES	CAR	CAR	CAR
Decile 2	-0.0011	-0.0009	-0.0015
	(0.0008)	(0.0009)	(0.0014)
Decile 3	-0.0013	-0.0002	-0.0028**
	(0.0008)	(0.0010)	(0.0014)
Decile 4	-0.0015*	-0.0010	-0.0023*
	(0.0008)	(0.0010)	(0.0014)
Decile 5	-0.0010	-0.0019*	0.0003
	(0.0008)	(0.0010)	(0.0014)
Decile 6	-0.0014*	-0.0020**	-0.0003
	(0.0008)	(0.0010)	(0.0014)
Decile 7	-0.0009	-0.0011	-0.0006
	(0.0008)	(0.0010)	(0.0015)
Decile 8	-0.0022**	-0.0028***	-0.0012
	(0.0009)	(0.0011)	(0.0016)
Decile 9	-0.0046***	-0.0053***	-0.0034**
	(0.0010)	(0.0012)	(0.0017)
Decile 10	-0.0060***	-0.0075***	-0.0041**
	(0.0011)	(0.0014)	(0.0020)
Ln(size)	0.0005***	0.0010***	-0.0002
	(0.0001)	(0.0002)	(0.0002)
Ln(BM)	-0.0090***	-0.0095***	-0.0084***
	(0.0003)	(0.0004)	(0.0004)
α (constant)	0.0125	0.0092	0.0009
	(0.0121)	(0.0121)	(0.0026)
R^2	0.0119	0.0139	0.0103
Adj. R^2	0.0102	0.0120	0.00871
Observations	208,021	124,465	83,556

Note robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

To conclude, these results do not explain the results of Tables 1.1 and 1.2. The Magic Formula generated abnormal returns before 2010, but Tables 2.1 and 2.2 do not provide convincing evidence on whether this was caused by market mispricing. Stocks in decile 10 did have worse earnings surprises, but it is not clear whether this is attributable to Magic Formula ranking as there is no linear relationship between the two. The same holds for the relationship between CAR and Magic Formula ranking. The ambiguity on whether Magic Formula ranking is an indicator of under- or overvaluation is increased by the fact that the strategy does not create alpha in de period from 2010 onward, even though earnings surprises and CAR are better in decile 1 compared to decile 10 in this time period. This suggests that the relationship between Magic Formula ranking and misvaluation is weak, if it even exists.

Hypothesis 3

Table 3.1 shows the average monthly return of the ten ranked portfolios when momentum is added as an additional ranking factor. When looking at raw returns over the whole sample, this method does not seem to work as well as the original Magic Formula ranking: the difference between the top and bottom decile is considerably lower than in Table 1.1. However, just as with the original Magic Formula, the full sample and the first subsample show that a higher ranking leads to higher returns, but this does not continue in the last subsample. The last subsample actually shows a reverse effect: the lower ranked stocks perform better than the higher ranked ones.

In the full sample and first subsample, Sharpe Ratios are generally higher for higher ranked stocks. In the second subsample, there does not seem to be a relationship between the deciles and Sharpe Ratio. As a matter of fact, decile 1 has a lower Sharpe Ratio than decile 10.

Table 3.1 Monthly raw stock returns and Sharpe Ratios by decile with stocks ranked according to the Magic Formula adjusted with momentum from 1987 until 2021 (value-weighted).

	1987-2021			1987-2009			2010-2021		
VARIABLES	mean	sd	ann. SR	mean	sd	ann. SR	mean	sd	ann. SR
Return decile 1	0.011	0.065	0.46	0.012	0.064	0.46	0.010	0.066	0.50
Return decile 2	0.009	0.049	0.47	0.008	0.050	0.32	0.010	0.049	0.68
Return decile 3	0.009	0.044	0.52	0.007	0.045	0.27	0.012	0.042	0.96
Return decile 4	0.008	0.044	0.44	0.007	0.045	0.27	0.011	0.042	0.88
Return decile 5	0.007	0.043	0.37	0.004	0.044	0.04	0.013	0.040	1.09
Return decile 6	0.006	0.048	0.26	0.003	0.050	-0.03	0.012	0.043	0.94
Return decile 7	0.009	0.054	0.42	0.006	0.057	0.16	0.013	0.047	0.93
Return decile 8	0.007	0.059	0.27	0.004	0.062	0.03	0.012	0.054	0.74
Return decile 9	0.007	0.065	0.25	0.002	0.069	-0.07	0.014	0.057	0.83
Return decile 10	0.006	0.072	0.17	0.001	0.075	-0.11	0.015	0.066	0.77
dec1 - dec10	0.005	0.07	0.13	0.01	0.075	0.30	-0.006	0.061	-0.36

Note decile 1 contains the stocks with the highest ranks. Ann. SR stands for annualized Sharpe Ratio.

Table 3.2 analyses the difference in return between the top and bottom decile for the full sample and subsamples. After controlling for the Carhart and F&F5 model, the full sample does not provide evidence for abnormal returns caused by the adjusted Magic Formula. In the Carhart model, the high-minus-low or value factor is able to partially explain the positive return of the long-short portfolio, at the five percent confidence level. This suggest that this adjusted Magic Formula is indeed a value strategy, but does not bring anything new to the table. In the F&F5 model, the size and profitability factor are significant and leave no alpha to explain. Quite possibly, the top deciles contain on average smaller companies, which explains the difference in returns. Furthermore, it is likely that the profitability factor is statistical significant, because it provides similar information to the quality ranking of the Magic Formula. Both are based on similar profitability factors, albeit the F&F5 factor uses gross profit and the Magic Formula Factor uses EBIT. The first subsample gives weak evidence for alpha with the Carhart model at a ten percent confidence level, but this is not visible with the F&F5 model. Both models show that the high-minus-low factor explains the returns of the long-short portfolio. This is in line with the Magic Formula being a value strategy, but also means that it does not provide returns unexplained by the value factor of both models. The second subsample even has a negative alpha, but this is not significant. The known risk factors of the two models do not explain the returns of the long-short portfolio, except the momentum factor.

Overall, adding the momentum factor does not provide alpha and where the original Magic Formula still has statistically significant alphas in the full sample and first subsample, the adjusted Magic Formula does not. This could mean that ranking stocks while taking momentum into account does not enhance performance. This is also confirmed by the alpha spread test of which the results can be found in Table 12 in the appendix. None of the models leaves alpha that is significantly different from the alphas of the original Magic Formula. Another explanation could be that adding momentum distorts the ranking and in this way reduces the beneficial influence of the value and quality factors which results in a performance loss which is of similar size to the performance gain of adding the momentum ranking. This then does not result in a net improvement of returns or, in other words, a higher alpha.

Table 3.2 Linear regression results for the relationship between Magic Formula (adjusted by adding momentum ranking) long-short portfolio (long decile 1, short decile 10) returns and Carhart (1997) and Fama & French (2015) factors from 1987 until 2021 (value-weighted).

	1987-2021		1987-2009		2010-2021	
VARIABLES	Carhart dec-1-dec10	F&F5 dec-1-dec10	Carhart dec-1-dec10	F&F5 dec-1-dec10	Carhart dec-1-dec10	F&F5 dec-1-dec10
β_{RMRF}	-0.0006	-0.0003	0.0008	0.0012	-0.0018	-0.0021
	(0.0011)	(0.0009)	(0.0014)	(0.0013)	(0.0016)	(0.0013)
β_{SMB}	0.0010	0.0022*	0.0022	0.0034**	0.0002	0.0016
	(0.0026)	(0.0013)	(0.0031)	(0.0016)	(0.0021)	(0.0025)
β_{HML}	0.0038**	0.0020	0.0063***	0.0054**	0.0014	-0.0027
	(0.0016)	(0.0016)	(0.0019)	(0.0021)	(0.0021)	(0.0022)
β_{RMW}		0.0033**		0.0029		0.0050
		(0.0017)		(0.0021)		(0.0031)
β_{CMA}		0.0013		-0.0008		0.0064
		(0.0024)		(0.0031)		(0.0039)
β_{MOM}	0.0007		0.0001		0.0036**	
	(0.0013)		(0.0014)		(0.0016)	
α (constant)	0.0044	0.0031	0.0078*	0.0067	-0.0039	-0.0048
	(0.0037)	(0.0037)	(0.0046)	(0.0048)	(0.0059)	(0.0054)
R^2	0.0282	0.0366	0.0606	0.0702	0.0584	0.0650
Adj. R^2	0.0184	0.0245	0.0459	0.0520	0.0311	0.0309
Observations	404	404	261	261	143	143

Note robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8 and 9 in the appendix provide results of the tests above for equal-weighted portfolios, which are very similar to Table 3.1 and Table 3.2: none of the models leave statistically significant alpha for the Magic Formula adjusted by adding the momentum ranking. Again, the value factor is very well able to explain the returns of the long-short portfolio, especially in the period between 1987 and 2009.

In conclusion, adding the momentum factor to the Magic Formula in the form of an added ranking is not beneficial for the strategy. The spread between the highest and lowest ranking stocks decreases with this adjustment and even turns negative in the second subsample, but this difference is not statistically significant.

Hypothesis 4

Table 4.1 shows the per decile returns of another adjustment to the Magic Formula, using Gross Profitability in the price factor ranking instead of Earnings Before Interest and Taxes. According to Novy-Marx (2013) Gross Profit serves as a better proxy for quality compared to EBIT and other measures. This should result in more convincing returns for the adjusted Magic Formula, compared to the original. Table 4.1 gives an overview of the mean returns per decile.

Over the full sample and the first subsample, the return of the long-short portfolio is slightly higher than for the original Magic Formula. The second subsample performs the same as the original Magic Formula. Just as in Table 1.1 and Table 3.1, Sharpe Ratios decrease with a better ranking of stocks in the full sample and first subsample, but this effect disappears in the second subsample.

Table 4.1 Monthly raw stock returns and Sharpe Ratios by decile with stocks ranked according to the Magic Formula adjusted with Gross Profit from 1987 until 2021 (value-weighted).

	1987-2021			1987-2009			2010-2021		
VARIABLES	mean	sd	ann. SR	mean	sd	ann. SR	mean	sd	ann. SR
Return decile 1	0.012	0.052	0.64	0.013	0.055	0.60	0.011	0.047	0.78
Return decile 2	0.011	0.046	0.65	0.010	0.048	0.47	0.012	0.042	0.96
Return decile 3	0.011	0.045	0.66	0.009	0.046	0.42	0.014	0.041	1.15
Return decile 4	0.009	0.046	0.50	0.008	0.047	0.34	0.012	0.045	0.89
Return decile 5	0.009	0.045	0.51	0.008	0.046	0.34	0.011	0.042	0.88
Return decile 6	0.008	0.049	0.40	0.005	0.051	0.11	0.013	0.044	0.99
Return decile 7	0.006	0.050	0.25	0.002	0.053	-0.09	0.012	0.046	0.87
Return decile 8	0.004	0.053	0.11	0.001	0.054	-0.16	0.009	0.050	0.60
Return decile 9	0.001	0.069	-0.07	-0.003	0.074	-0.30	0.008	0.058	0.45
Return decile 10	0.002	0.084	-0.02	-0.003	0.085	-0.26	0.011	0.081	0.45
dec1 - dec10	0.010	0.066	0.40	0.016	0.068	0.64	0.000	0.063	-0.02

Note decile 1 contains the stocks with the highest ranks. Ann. SR stands for annualized Sharpe Ratio.

Table 4.2 decomposes the returns of the long-short portfolio of the Magic Formula adjusted by using Gross Profit. The same pattern as seen with the original Magic Formula ranking method is visible in this table: the Magic Formula adjusted with Gross Profit does provide alpha in the full sample and first subsample, but not in the period from 2010 onwards. Using Gross Profit causes an increase of alpha compared to the original strategy after controlling for the Carhart factors, but an decrease of similar magnitude occurs after controlling for the F&F5 factors for the full sample and first subsample. The second subsample does not show any positive or negative alpha which was also the case with testing the previous hypotheses. Overall, the difference in alpha caused by using Gross Profit in the ranking is not statistically significant for any of the models, which is shown by the t-values of Table 12 in the appendix. None of the alphas are significantly different from the original Magic Formula. In the full sample and the first subsample, the return of the long-short portfolio is partially explained by the high-minus-low factor in the Carhart model. This means that value factor is more present in the top decile, which is plausible given that Greenblatt presents the Magic Formula as a value strategy. However, the F&F5 model points to the size and profitability factor as explanations for the long-short portfolio returns. Controlling for the F&F5 factors leaves an alpha that is 0.2 percentage points lower than the alpha of the Carhart model in these two samples. For the period ranging from 2010 until 2021, the alpha is insignificant just as the Carhart and F&F5 factors.

Table 4.2 Linear regression results for the relationship between Magic Formula (adjusted with Gross Profit instead of EBIT) long-short portfolio (long decile 1, short decile 10) returns and Carhart (1997) and Fama & French (2015) factors from 1987 until 2021 (value-weighted).

	1987-2021		1987-2009		2010-2021	
	Carhart	F&F5	Carhart	F&F5	Carhart	F&F5
VARIABLES	dec-1-dec10	dec-1-dec10	dec-1-dec10	dec-1-dec10	dec-1-dec10	dec-1-dec10
β_{RMRF}	-0.0008	-0.0003	-0.0006	0.0002	0.0005	0.0001
	(0.0009)	(0.0008)	(0.0011)	(0.0010)	(0.0015)	(0.0014)
β_{SMB}	0.0011	0.0027**	0.0021	0.0036***	-0.0005	0.0008
	(0.0022)	(0.0012)	(0.0026)	(0.0014)	(0.0030)	(0.0026)
β_{HML}	0.0035**	0.0017	0.0054***	0.0035*	0.0002	-0.0008
	(0.0014)	(0.0014)	(0.0017)	(0.0019)	(0.0023)	(0.0024)
β_{RMW}		0.0046***		0.0044**		0.0037
		(0.0015)		(0.0018)		(0.0033)
β_{CMA}		0.0010		0.0008		-0.0004
		(0.0022)		(0.0027)		(0.0041)
β_{MOM}	0.0002		-0.0002		0.0017	
	(0.0013)		(0.0016)		(0.0016)	
α (constant)	0.0102***	0.0081**	0.0142***	0.0118***	-0.0012	-0.0013
	(0.0035)	(0.0034)	(0.0044)	(0.0042)	(0.0061)	(0.0057)
R^2	0.0287	0.0495	0.0618	0.0829	0.0078	0.0103
Adj. R^2	0.0193	0.0379	0.0478	0.0657	-0.0209	-0.0258
Observations	416	416	273	273	143	143

Note robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The results of the regressions using equal-weighted portfolios are in line with those of the results of this section, as can be seen in Table 10 and Table 11 of the appendix. The same model factors are significant for the equal-weighted portfolios with as addition the value factor in the F&F5 model, at a ten percent level for the full sample and first subsample. The value factor is also significant for the Carhart model in the last subsample, which emphasizes the importance of the value factor for the returns of the long-short portfolio.

This adjusted Magic Formula performed well in the period investigated by Greenblatt (2010), albeit not (significantly) better. Especially the size, value and profitability factors are effective at explaining the returns of the long-short portfolio, without eradicating all the abnormal returns. However, just like the original Magic Formula, this strategy does not yield alpha in the recent past which casts doubt on the effectiveness of the (adjusted) Magic Formula in the present.

Transaction costs

Table 5 shows decile turnover based on the original Magic Formula ranking method, with a monthly investment horizon. Especially for higher and lower ranked stocks, the majority stays in the same decile in a one month period. In decile 1 and decile 10, 78.78% and 89.70% stay in the same decile respectively. This results in an monthly turnover of 21.22% for decile 1 and 10.30% for decile 10 or an average long-short portfolio turnover of 15.76%. According to the method used by Jegadeesh & Titman (1993) one-way transaction costs are 0.5%. Considering that for every stock sold (or bought on the short side) after rebalancing the long-short portfolio another stock has to be bought (sold) the round trip transaction costs are 1%. This results in annual transaction costs of 0.16% for the long-short portfolio using the original Magic Formula. These costs are relatively small compared to the difference in return of the long-short portfolio, which is 0.9% for the whole sample and 1.3% for the first subsample (Table 1.2). The return difference in the second subsample is already 0.0% before transaction costs, so the return in this period is negative after adding transaction costs. In conclusion, transaction costs do not impose a big burden upon the strategy of the Magic Formula and its (lack of) effectiveness should be sought in the ability to select undervalued stocks itself. In the first subsample, the transaction costs do not impose a large enough burden to mitigate the returns difference. In the second subsample, the Magic Formula is ineffective regardless of transaction costs.

Table 5 Monthly stock turnover between deciles formed with the original Magic Formula by Greenblatt (2010) in percentages from 1987 until 2021.

	Deciles at t										
Deciles at t+1	1	2	3	4	5	6	7	8	9	10	Total
1	78.78	10.92	2.80	1.63	1.19	0.99	1.00	0.97	1.00	0.72	100.00
2	10.82	65.91	13.61	3.74	2.13	1.38	0.98	0.66	0.44	0.32	100.00
3	2.52	13.79	60.70	14.45	3.85	2.13	1.18	0.67	0.39	0.31	100.00
4	1.64	3.38	14.74	58.77	14.53	3.64	1.68	0.82	0.43	0.37	100.00
5	1.22	2.03	3.37	14.62	59.56	13.91	3.03	1.24	0.56	0.46	100.00
6	1.08	1.39	2.00	3.23	13.48	62.85	12.37	2.21	0.79	0.61	100.00
7	1.13	0.99	1.25	1.65	2.76	11.24	68.68	10.22	1.56	0.51	100.00
8	1.05	0.71	0.75	0.93	1.30	2.25	8.96	75.20	7.90	0.94	100.00
9	0.92	0.49	0.46	0.51	0.68	0.90	1.51	7.01	80.59	6.93	100.00
10	0.74	0.24	0.22	0.25	0.32	0.48	0.44	0.83	6.77	89.70	100.00

Table 13 in the Appendix shows the decile turnover for the year-long investment horizon, as proposed by Greenblatt (2010). By using this investment horizon, transaction costs for the long-short portfolio amount to 0.4% based on an average turnover of 41.13% for the long-short portfolio. Figure 1 shows raw returns for the long-short portfolio of 4.5% over the full sample for both the equal- as well as the value-weighted portfolio, which is more than enough to compensate for the transaction costs.

Conclusion

Greenblatt (2010) claims that individual investors have a great tool with the Magic Formula, which should yield returns higher than market averages. The Magic Formula ranks stocks on price and quality and combines these rankings in order to identify undervalued stocks. In this thesis, this strategy is examined and results show that the Magic Formula used to be very effective at generating alpha between 1987 and 2009. The long-short portfolio going long in the decile with the best stocks and short in the decile with the worst stocks indeed produced abnormal returns that could not be fully explained by known risk factors of the Carhart (1997) four factor and the Fama & French (2015) five factor model. However, this effect disappeared after 2009, the year Greenblatt published 'The Little Book That Still Beats The Market'. The graphical analysis shows that, over the full sample, the long-short portfolio performs best in the first six months of investing. The results of this thesis show no clear evidence that returns achieved by the Magic Formula between 1987 and 2009 were caused by undervaluation by analysts and investors. The 'worst' stocks according to the strategy perform worse than the 'best' stocks in terms of cumulative abnormal returns around earnings announcements and had lower earnings surprises. However, across all deciles, this relationship was not linear and evidence is thus limited and unconvincing.

Additionally, the results regarding earnings surprises and cumulative abnormal returns are similar across both subsamples, whereas abnormal returns disappear in the second subsample. This casts even more doubt on the undervaluation theory, which suggests that the Magic Formula generates abnormal returns through finding undervalued stocks. This casts more doubt on the ability of the Magic Formula to identify over- and undervalued stocks.

The second part of this thesis shows tests of two adjustments to the original Magic Formula. The first adjustment consists of adding momentum as an extra ranking factor next to the price and quality rankings. This adjusted strategy performed worse than the original, albeit not significantly worse. Returns were slightly lower in the full sample as well as the first subsample, compared to the original Magic Formula. The second adjustment, consists of replacing EBIT by Gross Profit in the Quality Ranking. Performance of this strategy was very similar to the original Magic Formula after controlling for the four and five factor models and the differences between the alphas is statistically insignificant.

This thesis adds to existing literature by examining whether the Magic Formula actually identifies undervaluation instead of only looking at whether it provides excess returns. The graphical analysis of Hypothesis 1 adds to finance literature by examining at what point in time the Magic Formula realizes its returns. Using more recent data than previous research papers, this sample casts light on whether the Magic Formula (still) beats the market and what drives the returns of the Magic Formula. This information gives investors the opportunity to be better informed when choosing an investment strategy.

Further research could shed light upon whether the Magic Formula performs better in bull or bear markets. Depending on the results, the Magic Formula could be employed as an aggressive or defensive strategy. Further adjustments could also be done to the Magic Formula to investigate whether the strategy regains its magic with different metrics and rankings. A possibly interesting alteration is to use (some of) Graham's (2003) criteria and use these in the rankings, giving a more comprehensive image of individual stocks. Cyclicality of company earnings might also throw spanners in the works of the Magic Formula. For example, oil companies' earnings rely heavily on global oil prices. When oil prices reach extremes, stock prices might lag behind because investors anticipate the oil price not to stay on the extreme, which causes the company to rank highly (lowly) in the rankings without seeing abnormal long term stock (under)performance. Using longer term financials instead of only last quarter financials, which were used in this paper, might benefit the reliability of the rankings as an indicator of undervaluation. A possible drawback of this approach might be that it takes more time for the Magic Formula to identify companies as undervalued.

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Appendix

Table 6 Raw stock returns and Sharpe Ratios by decile with stocks ranked according to the Magic Formula from 1987 until 2021 (equal-weighted).

	1987-2021			1987-2009			2010-2021			Back test Greenblatt
VARIABLES	mean	sd	ann. SR	mean	sd	ann. SR	mean	sd	ann. SR	mean
Return decile 1	0.017	0.065	0.78	0.018	0.062	0.81	0.014	0.069	0.68	0.012
Return decile 2	0.015	0.058	0.75	0.015	0.058	0.69	0.015	0.059	0.86	0.010
Return decile 3	0.013	0.056	0.66	0.013	0.056	0.59	0.014	0.055	0.86	0.010
Return decile 4	0.013	0.056	0.66	0.012	0.057	0.52	0.014	0.055	0.86	0.090
Return decile 5	0.012	0.056	0.60	0.011	0.058	0.45	0.014	0.054	0.87	0.090
Return decile 6	0.010	0.058	0.46	0.008	0.060	0.26	0.013	0.055	0.79	0.080
Return decile 7	0.009	0.064	0.36	0.007	0.067	0.18	0.012	0.056	0.72	0.070
Return decile 8	0.008	0.074	0.26	0.006	0.080	0.11	0.013	0.062	0.70	0.060
Return decile 9	0.006	0.083	0.15	0.004	0.089	0.02	0.010	0.071	0.47	0.030
Return decile 10	0.005	0.097	0.09	0.002	0.102	-0.05	0.010	0.089	0.37	0.000
dec1 - dec10	0.012	0.067	0.50	0.016	0.071	0.61	0.003	0.058	0.16	0.012

Adapted source: Greenblatt(2010)
Note decile 1 contains the stocks with the highest ranks. Ann. SR stands for annualized Sharpe Ratio. Greenblatt's back test runs from 1988 until 2009 and the returns are changed from yearly to monthly.

Table 7 Linear regression results for the relationship between Magic Formula long-short portfolio (long decile 1, short decile 10) returns and Carhart (1997) and Fama & French (2015) factors from 1987 until 2021 (value-weighted).

	1987-2021		1987-2009		2010-2021	
VARIABLES	Carhart dec-1-dec10	F&F5 dec-1-dec10	Carhart dec-1-dec10	F&F5 dec-1-dec10	Carhart dec-1-dec10	F&F5 dec-1-dec10
β_{RMRF}	-0.0017*	-0.0013	-0.0012	-0.0007	-0.0016	-0.0019
	(0.0010)	(0.0010)	(0.0013)	(0.0013)	(0.0012)	(0.0014)
β_{SMB}	-0.0001	0.0013	0.0007	0.0024	-0.0014	-0.0010
	(0.0022)	(0.0018)	(0.0026)	(0.0022)	(0.0022)	(0.0024)
β_{HML}	0.0043***	0.0031*	0.0054**	0.0047**	0.0036*	0.0011
	(0.0016)	(0.0018)	(0.0022)	(0.0023)	(0.0022)	(0.0026)
β_{RMW}		0.0045*		0.0050		0.0024
		(0.0026)		(0.0032)		(0.0031)
β_{CMA}		-0.0002		-0.0017		0.0035
		(0.0034)		(0.0044)		(0.0039)
β_{MOM}	0.0004		-0.0003		0.0033**	
	(0.0014)		(0.0017)		(0.0013)	
α (constant)	0.0118***	0.0102***	0.0149***	0.0128***	0.0046	0.0045
	(0.0035)	(0.0035)	(0.0045)	(0.0046)	(0.0051)	(0.0052)
R^2	0.0560	0.0752	0.0681	0.0959	0.0656	0.0492
Adj. R^2	0.0468	0.0640	0.0542	0.0790	0.0386	0.0145
Observations	416	416	273	273	143	143

Note robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8 Raw stock returns and Sharpe Ratios by decile with stocks ranked according to the Magic Formula adjusted by adding momentum from 1987 until 2021 (equal-weighted).

	1987-2021			1987-2009			2010-2021		
VARIABLES	mean	sd	ann. SR	mean	sd	ann. SR	mean	sd	ann. SR
Return decile 1	0.015	0.076	0.58	0.016	0.072	0.60	0.012	0.082	0.49
Return decile 2	0.013	0.062	0.59	0.012	0.060	0.49	0.014	0.064	0.74
Return decile 3	0.013	0.056	0.66	0.011	0.055	0.48	0.016	0.058	0.93
Return decile 4	0.013	0.052	0.71	0.012	0.052	0.57	0.016	0.053	1.02
Return decile 5	0.012	0.051	0.65	0.010	0.051	0.45	0.014	0.052	0.91
Return decile 6	0.011	0.052	0.57	0.009	0.054	0.36	0.014	0.050	0.94
Return decile 7	0.011	0.059	0.51	0.010	0.061	0.37	0.014	0.055	0.86
Return decile 8	0.009	0.070	0.33	0.008	0.073	0.22	0.012	0.065	0.62
Return decile 9	0.008	0.078	0.25	0.005	0.083	0.07	0.013	0.067	0.65
Return decile 10	0.010	0.082	0.32	0.007	0.087	0.14	0.015	0.072	0.70
dec1 - dec10	0.005	0.066	0.14	0.009	0.071	0.27	-0.003	0.057	-0.21

Note decile 1 contains the stocks with the highest ranks. Ann. SR stands for annualized Sharpe Ratio.

Table 9 Linear regression results for the relationship between Magic Formula (adjusted by adding momentum ranking) long-short portfolio (long decile 1, short decile 10) returns and Carhart (1997) and Fama & French (2015) factors from 1987 until 2021 (equal-weighted).

	1987-2021		1987-2009		2010-2021	
	Carhart	F&F5	Carhart	F&F5	Carhart	F&F5
VARIABLES	dec-1-dec10	dec-1-dec10	dec-1-dec10	dec-1-dec10	dec-1-dec10	dec-1-dec10
β_{RMRF}	-0.0001	0.0001	0.0019	0.0020	-0.0024	-0.0026**
	(0.0011)	(0.0009)	(0.0014)	(0.0012)	(0.0015)	(0.0012)
β_{SMB}	0.0002	0.0013	0.0012	0.0026*	0.0008	0.0013
	(0.0024)	(0.0012)	(0.0028)	(0.0015)	(0.0023)	(0.0023)
β_{HML}	0.0027*	0.0020	0.0055***	0.0057***	0.0006	-0.0038*
	(0.0015)	(0.0015)	(0.0015)	(0.0020)	(0.0023)	(0.0020)
β_{RMW}		0.0032**		0.0035*		0.0032
		(0.0016)		(0.0020)		(0.0028)
β_{CMA}		-0.0008		-0.0036		0.0072**
		(0.0023)		(0.0029)		(0.0035)
β_{MOM}	0.0004		-0.0002		0.0038**	
	(0.0012)		(0.0013)		(0.0016)	
α (constant)	0.0044	0.0035	0.0065	0.0056	-0.0008	-0.0014
	(0.0037)	(0.0035)	(0.0047)	(0.0045)	(0.0054)	(0.0049)
R^2	0.0148	0.0249	0.0569	0.0786	0.0971	0.0926
Adj. R^2	0.0049	0.0127	0.0422	0.0606	0.0710	0.0595
Observations	404	404	261	261	143	143

Note robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 10 Raw stock returns and Sharpe Ratios by decile with stocks ranked according to the Magic Formula adjusted with Gross Profit from 1987 until 2021 (equal-weighted).

	1987-2021			1987-2009			2010-2021		
VARIABLES	mean	sd	ann. SR	mean	sd	ann. SR	mean	sd	ann. SR
Return decile 1	0.017	0.064	0.79	0.018	0.064	0.79	0.015	0.065	0.78
Return decile 2	0.015	0.059	0.74	0.015	0.059	0.68	0.015	0.059	0.86
Return decile 3	0.014	0.058	0.69	0.013	0.058	0.57	0.015	0.057	0.89
Return decile 4	0.013	0.060	0.61	0.012	0.061	0.49	0.015	0.057	0.89
Return decile 5	0.012	0.060	0.56	0.011	0.061	0.43	0.014	0.057	0.83
Return decile 6	0.012	0.060	0.56	0.010	0.062	0.37	0.014	0.055	0.86
Return decile 7	0.009	0.062	0.37	0.007	0.064	0.19	0.014	0.057	0.83
Return decile 8	0.007	0.067	0.24	0.005	0.070	0.08	0.011	0.061	0.60
Return decile 9	0.003	0.076	0.03	0.002	0.082	-0.06	0.005	0.065	0.25
Return decile 10	0.005	0.095	0.10	0.001	0.098	-0.09	0.013	0.089	0.49
dec1 - dec10	0.012	0.065	0.51	0.017	0.068	0.69	0.003	0.058	0.16

Note decile 1 contains the stocks with the highest ranks. Ann. SR stands for annualized Sharpe Ratio

Table 11 Linear regression results for the relationship between Magic Formula (adjusted with Gross Profit instead of EBIT) long-short portfolio returns (long decile 1, short decile 10) and Carhart (1997) and Fama & French (2015) factors from 1987 until 2021 (equal-weighted).

	1987-2021		1987-2009		2010-2021	
VARIABLES	Carhart dec-1-dec10	F&F5 dec-1-dec10	Carhart dec-1-dec10	F&F5 dec-1-dec10	Carhart dec-1-dec10	F&F5 dec-1-dec10
β_{RMRF}	-0.0009	-0.0007	-0.0003	0.0003	-0.0011	-0.0016
	(0.0009)	(0.0008)	(0.0012)	(0.0011)	(0.0011)	(0.0013)
β_{SMB}	0.0004	0.0021*	0.0012	0.0032**	-0.0005	0.0000
	(0.0021)	(0.0012)	(0.0025)	(0.0014)	(0.0021)	(0.0023)
β_{HML}	0.0037***	0.0023*	0.0050***	0.0037*	0.0027	0.0004
	(0.0014)	(0.0014)	(0.0018)	(0.0019)	(0.0019)	(0.0021)
β_{RMW}		0.0050***		0.0058***		0.0024
		(0.0015)		(0.0018)		(0.0029)
β_{CMA}		-0.0006		-0.0014		0.0018
		(0.0022)		(0.0027)		(0.0037)
β_{MOM}	0.0007		0.0001		0.0034***	
	(0.0014)		(0.0016)		(0.0013)	
α (constant)	0.0118***	0.0103***	0.0152***	0.0131***	0.0038	0.0041
	(0.0035)	(0.0033)	(0.0045)	(0.0042)	(0.0050)	(0.0051)
R^2	0.0353	0.0599	0.0481	0.0877	0.0515	0.0259
Adj. R^2	0.0260	0.0484	0.0339	0.0706	0.0240	-0.00964
Observations	416	416	273	273	143	143

Note robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 12 Significance tests results testing the difference in alpha between the original Magic Formula and the adjusted versions from 1987 until 2021 (value-weighted).

		1986-2021		1986-2009		2010-2021	
		Carhart	F&F5	Carhart	F&F5	Carhart	F&F5
Original MF	alpha (α)	0.0093	0.0088	0.0132	0.0126	0.0018	0.0016
	robust std. err.	0.0036	0.0037	0.0044	0.0047	0.0063	0.0062
MF with Momentum	alpha (α)	0.0044	0.0031	0.0078	0.0067	-0.0039	-0.0048
	robust std. err.	0.0037	0.0037	0.0046	0.0048	0.0059	0.0054
	t value	-0.95	-1.09	-0.85	-0.88	-0.66	-0.78
MF with Gross Profit	alpha (α)	0.0102	0.0081	0.0142	0.0118	-0.0012	-0.0013
	robust std. err.	0.0035	0.0034	0.0044	0.0042	0.0061	0.0057
	t-value	0.18	-0.14	0.16	-0.13	-0.34	-0.34

Note t-values depend on the difference between the tested Magic Formula adjustment and the original Magic Formula.

Table 13 Annual stock turnover between deciles formed with the original Magic Formula by Greenblatt (2010) in percentages from 1987 until 2021.

	Deciles at t										
Deciles at t+12	1	2	3	4	5	6	7	8	9	10	Total
1	55.96	19.92	7.92	4.38	2.93	2.27	1.94	1.50	1.39	1.79	100.00
2	18.98	34.22	20.82	10.17	5.84	3.66	2.49	1.55	1.20	1.09	100.00
3	7.17	19.08	28.81	20.38	10.65	6.09	3.69	2.06	1.10	0.98	100.00
4	4.02	9.60	18.37	26.29	19.90	10.61	5.60	2.86	1.53	1.20	100.00
5	3.05	5.57	9.48	17.48	25.45	19.61	10.77	4.85	2.15	1.58	100.00
6	2.50	3.85	5.69	9.14	16.88	26.44	20.71	9.12	3.24	2.43	100.00
7	2.16	2.83	3.71	5.43	8.88	16.79	29.33	22.00	6.63	2.24	100.00
8	1.97	2.15	2.46	3.37	4.86	7.86	16.81	34.81	21.13	4.58	100.00
9	1.87	1.43	1.71	1.94	2.83	3.80	6.41	16.81	43.89	19.31	100.00
10	2.28	1.56	1.46	1.48	1.93	2.80	2.62	4.99	19.09	61.78	100.00