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FUNDAMENTAL TRADING SYSTEMS

Master Thesis

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Annotation

The goal of the submitted thesis named "Fundamental Trading Systems" is a research of fundamental factors and development of fundamental trading strategies. The first part deals with defining parts of the fundamental trading systems and methodology. The second part describes research of several fundamental criteria and their behavior in time. The third part focuses on the development of fundamental trading systems and their optimization. The fourth part is dedicated to the combination of advanced ranking and screening and its impact on the systems' performance. The final part concludes.

Keywords

fundamental analysis, investment, performance, strategy, factor, screening, ranking

JEL Classification

G17 – Financial Forecasting and Simulation

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Declaration

I hereby declare that this master thesis named "Fundamental Trading Systems" is my original authorial work which I have written on my own under the supervision of Ing. Dagmar Linnertová. All sources, reference and literature used during the elaboration of this thesis are properly cited and listed in complete reference to the due source.

In Brno on January 6, 2014

Signature of the Author

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Contents

Introduction

Fundamental trading systems represent a field that is both over-researched and under-researched. The over-research refers to a wide body of literature that was published in the past several decades which focuses on the behavior of stocks of companies with different values of certain fundamental criteria. The works quoted in this thesis represent only a negligible fraction of the research already dedicated to the study of the performance of fundamental factors.

Yet, not many researchers put together different pieces of knowledge stemming from the findings to create a complete system. The lack or a mere nonexistence of complete fundamental systems is the aforementioned under-research. Why if certain anomalies have been discovered, they are not exploited to create money-making strategies?

The other side of the problem is that the research is actually conducted but not published. It is widely known what high-frequency trading does and how it works, but no HFT systems are publicly available because of the amount of research that went into it and their ability to make money. The same applies to FTS. These systems, as will be shown, are executable and do not require powerful supercomputers in order to run. But not many people have access to quality fundamental data and long enough data series to conduct thorough research on their own. Institutions researching FTS will rather use the strategies to trade them since after publishing, many of such strategies stop working because too many market participants trying to exploit one strategy will cause it to stop working.

This thesis aims to shed light into the under-researched area of fundamental trading systems and offer a peak into the performance of these strategies and each specific factor they are composed of.

The primary goal of this thesis is to develop and backtest FTS. Furthermore, there are three sub-goals leading to the fulfillment of the overall goal: backtesting of one-factor and two-factor screens, backtesting of screening and certain factors to increase alpha, and backtesting of ranking on the performance of strategies.

The first part of the thesis will define necessary parts of the FTS, provide discussion of advantages and disadvantages of FTS, and most importantly, explain methodology used to develop these FTS. The second part will provide the most important input for the FTS. One-factor and-two factor strategies (screens) will be tested in order to discover the best ones based on their performance and other metrics. The third part will be the most crucial one. Backtests of several strategies

will be described together with their complete characteristics. One dividend, three value, and four own strategies, respectively, will be presented.

In the fourth part, all strategies presented in the third part will be combined with advanced ranking to find the influence of ranking on the return of strategies using only screening. The final part will conclude.

Previous academic research has discovered factors that worked well and those that did not. It is expected that the tests in this thesis will confirm the previous findings. Building on such findings, strategies built on these well-performing factors are expected to exhibit market-beating results. In order to de-randomize the outcomes and stocks selection process, simple and advanced rankings will be used. It is expected that simple ranking will improve the returns to strategies that do not use ranking and that advanced ranking will help push the boundaries of performance of these strategies further.

Part I – Defining Parts of FTS

Fundamental trading systems (further referred to as FTS) are sets of rules used in the management of portfolio. These systems use fundamental criteria from income statement, balance sheet, statement of cash flows and other criteria mostly related to quantifiable characteristics of stocks. Such systems with predefined and properly backtested inputs then shortlist stocks that an investor can invest into.

These systems differ from other types of trading systems called ATS (Automatic Trading Systems) that use mostly price-related inputs. FTS are mostly applicable to instruments that are analyzable, which is the case of equities and exchange-traded funds. Instruments ATS tend to work with are predominantly currency or other futures. These instruments are traded only on signals derived from technical analysis that relates only to price. On the other hand, FTS use not only price (without the use of technical analysis) in relation to an accounting metric such as earnings per share, book value per share, but also factors like current ratio, debt to equity and other balance sheet, income statement and cash flow statement ratios.

The most defining feature of FTS is that they are purely mechanical. Once a system has been developed and properly backtested, it should be used and followed in order to generate required, and from historical performance expected, returns. Although „past returns are not indicative of future returns" applies in this case as well, not deviating from the model should enable the investor to achieve long-term returns at least similar to those that would be achieved in the backtest.

Being mechanical, FTS are advantageous in the way that they prevent investors from making behavioral mistakes. It means that if investor knows that a certain systems earned required and satisfactory return in the long term, he should not deviate from it if the state of the market and the ongoing developments seem to be playing against him.[1]

[1] Many great investors with outstanding investment records always repeat that investor's largest enemy is himself (Benjamin Graham) and that a successful investor is one that has the right temperament and the right psychology (Warren Buffett).

1. Discussion of Positives and Negatives of Quantitative Systems

1.1. Omission of Investor's Own Judgment

Since FTS are mechanical and quantitative, they are missing perhaps the most important part in the investment process – a human judgment. A preset group of rules can never appropriately chose which stocks to invest into since these rules are ipso facto limited. When a human factor is omitted from the investment process, many mistakes can be made. Thus a stock that passes through all criteria of the system is selected to be invested into. But with investor's own judgment, the same stock could be left out since after a deeper analysis the investor might find that the particular stock is accounting fraud. It is not impossible that at a certain time a system with preset rules might have selected into portfolio stocks of companies such as Enron, WorldCom or banks that went bankrupt at the outbreak of the 2008 financial crisis.

On the other hand, FTS are mostly short-term oriented (a short holding period), which limits serious losses that might have been incurred in the "buy-and-hold" approach. Furthermore, limiting investor's judgment may improve investment results for less skilled investors that need strict rules to adhere to, while at the same time limit results of skilled investors who might leverage the use of deep business analysis instead of a mere quantitative analysis.

1.2. Advantages of Diversification

FTS quite often select multiple securities that pass the criteria. This helps spread the idiosyncratic risk that each stock carries with itself. It should be noted though that diversification should be kept between the borders since too much diversification could limit the system's performance because of fees and slippage.

1.3. Too Strict and Too Loose Criteria

From the point above stems another limitation. If an investor uses too strict criteria in the creation of the system, he might, at times, find the system not invested at all. This was the case of Benjamin Graham's Net Current Asset Value approach (Gray and Carlisle (2012)). In certain periods, especially at market tops in 2000, 2007, and in today's (autumn 2013) market, there would not be a reasonable amount of stocks that would pass the criteria.

If too loose criteria are used, the system operates with too many stocks. Each new position that an investor has to open increases the space for mistake and each trade subtracts from performance since the investor has to pay commissions to the broker. Therefore, a maximum number of stocks that a system can contain will be set (see paragraph "Portfolio Size").

1.4. Elimination of Behavioral Biases

As stated above, the strict following of the system should eliminate investor's behavioral biases. If a system shortlists a stock that recorded several weeks of declining price, an investor might not be interested in such a stock if he did the research himself. On the other hand, this stock might be one of those inefficiently priced stocks whose price could soon return to what is a more reasonable valuation, thus rewarding the investor with handsome profit. The absence of human factor in a systematical approach to portfolio management could lead to the inclusion of the stock into portfolio.

1.5. Reasonable Objections

Many investors have proven[2] that success can be achieved without complicated computerized models and quantitative approaches. This fact stands out more these days as the highly quantitative models failed to protect investors from huge losses in the market downturn in 2008. Furthermore, high frequency trading that uses far more elaborate and complex models than those that are going to be presented in this thesis has also its dark side. A mistake in a computer code might cause stocks to move excessively back and forth without changes in fundamentals or even cause a market collapse as has happen in a famous May 6, 2010 flash crash.[3]

This thesis will try to provide support to the proponents of "non-computerized" investing showing that even computerized and quantitative approach to portfolio management might by of sound quality and of help to investors' portfolios.

[2] Buffett, W. The Superinvestors from Graham-and-Doddsville [online]. c1984 [quoted September 9, 2013]. Available on:
<http://www4.gsb.columbia.edu/null?&exclusive=filemgr.download&file_id=522>
[3] Flash Crash – A sudden and sharp drop in the value of an index

2. Methodology

2.1. Backtesting Software

Backtests in this thesis will be performed on Portfolio123[4] backtester and on Bloomberg. Portfolio123 is a web-based platform and features all necessary criteria that may be used in the construction of FTS. Bloomberg will be used in order to fully comply with academic standards regarding common approach to factor testing. Portfolio123 enables users to optimize the performance. The outputs of Bloomberg backtests are equity curves similar to Portfolio123 but also break down of returns into quintiles (deciles, etc.). This functionality therefore enables comparison of the results of this thesis with other publications. Bloomberg backtests will be used predominantly in Part II. From Part III on, the backtests will be conducted with Portfolio123.

2.2. Benchmark

Returns from one- and two-factor strategies as well as composite strategies will be measured against Standard & Poor's 500 Index. The index returned 6.22% per annum from March 1995 to September 2013 (used for comparison in Bloomberg backtests) and 2.16% per annum from January 1999 to September 2013 (used for comparison in Portfolio123 backtests).[5]

2.3. Data Source

Portfolio123 uses a quality fundamental data from Capital IQ Compustat database. Price data are obtained from the same source. The database contains non-restated, point-in-time data. At any given point in time, the database contains values that would be accessible to then-living investor. Non-restated data are used to secure the most realistic results. If a company reported earnings of $2 per share in May 2003 and then corrected the number to $2.1 in August 2003, the database would contain a reading of $2 per share for that company for the three months before the correction was made. This is because investors would have to calculate with EPS of $2 for the time when the information was first published until it was corrected. Bloomberg uses its own fundamental and price data.

[4] Available on www.portfolio123.com (www.stockscreen123.com was transformed to www.portfolio123.com with the functionalities remaining unchanged).
[5] Returns do not include dividends and are not adjusted for inflation.

2.4. Time Period

The Portfolio123 platform uses fundamental and price data beginning on January 2, 1999 and ending on the previous day to the day when the backtest is done, meaning that it is getting larger with coming days. The time period used in this thesis will end on September 30, 2013, thus making 14.75-year long backtesting period.

Bloomberg database contains data from 1995 until the previous day to the day when the backtest is done, similar to Portfolio123. Using Bloomberg will add value thanks to additional years. The period covered by Bloomberg is 19.5 years from March 31, 1995 to September 30, 2012.[6]

With the time period is connected a significant problem, which is its length. Fourteen and a quarter and nineteen and a half years are unfortunately not enough to prove that a fundamental system is robust enough. A period of 50 or more years would be more appropriate.

In order to prove the system to be really working, a longer time period would be also needed to perform out of sample tests. When a system is developed in a period of certain interest rates, market and political conditions etc., it might fail to work nearly as well in other time periods when conditions change. A study from the early 1970s to the early 1980s will find strong results for value investing. And any study from the 1960s and 1990s (the two longest bull markets in history) will favor growth strategies (O'Shaughnessy, 2012, p. 49). In a bull market, basically every simple system would work nicely. But when the markets fall, the system does not protect the investor from losses. It will be shown in some of the following tests that many systems suffer from similar (and often worse) drawdowns than the general market.

An out of sample test of the system would be able to prove whether the system works with the data that might have a different character than those on which the FTS was tested in the first place.

2.5. Rebalancing

Rebalancing period will be chosen appropriately (quarterly, annually, or different). It should correspond to the character of the backtested system. A system built only on criteria from financial statements would require 3- or 12-month rebalancing period, meaning that stocks are sold from and bought into portfolio each quarter

[6] This period was chosen because data from the last quarter of 2012 to the first quarter of 2013 showed extreme sharp increase that enormously skewed the results upwards. The backtests showed results of several hundred percent in one quarter.

or each year. On the other hand, systems built on criteria containing price information (P/E, P/B, Enterprise Value multiples etc.) might use shorter rebalancing periods. This is because sometimes the market might be very quick in re-pricing mispriced stocks. A shorter holding period also diminishes correlation of the system with the overall market as will be shown in some of the backtests.

2.6. Market Capitalization

O'Shaughnessy's (2011) backtests work with stocks of companies with market capitalization greater than $200 million and for inflation adjusted values for prior years. For December 2008 the minimum market capitalization is set to $200 million, for December 1993 $138.7 million etc. $138.7 million in 1993 corresponds to $200 million in 2008 because of adjustment for inflation.

Neither Bloomberg, nor Portfolio123 enable adjusting changes in market capitalization. Once a limit is set, it cannot be changed from year to year. Tests performed with Bloomberg will not limit[7] stocks with market capitalization lower than $100 million. This criterion eliminates very small stocks (not only OTC as in the case of Portfolio123) that distort returns. Portfolio123 backtests will use a different approach to size limitation.

This approach uses price multiplied by the average trading volume over the past 10 days[8]. The price-volume condition must be larger than 100 000.[9] Small and especially micro capitalization stocks tend to trade at very low prices. On the other hand, some stocks do not trade much and are illiquid. The price times volume condition solves both problems. If an illiquid stock (1000 shares traded daily) trades at a high price, the bid/asked spread is low and therefore the performance is not weakened. If a "penny" stock trades at very high volumes (hundreds of thousands of shares), again, the bid/asked spread is low and therefore not skewing the results.

2.7. Stock Selection Criteria

Stocks will be selected based on performed backtest. Bloomberg does not enable eliminations of different stocks or groups of stocks. Its database will be used to test criteria in general to give a perspective into the workings of different ratios. In order to more accurately test different systems, Portfolio123 will need to be used.

[7] This feature is unavailable on Bloomberg.
[8] The exact formula is: Price*Vol10DAvg>0.1
[9] For example: the stock trades at $112 per share and has an average daily volume in the past 10 days of 1 000. The price-volume is 112 000. Thus the stock passes. Another stock trades at $0.9 per share and has an average daily volume in the past 10 days of 200 000. The price-volume is 180 000. Thus the stock passes through the screen.

Compustat database used by Portfolio123 features all fundamental data of companies traded on American stock exchanges. Systems backtested with this platform will not include:

1) OTC stocks
2) Chinese companies listed on American exchanges
3) ADRs

Most importantly, companies traded on OTC markets will be excluded. Their prices are often very low, which makes trading them impossible due to large bid/asked spreads. Although academic research normally does not exclude such stocks, the aim of this thesis is to develop tradable systems. Stock quoted at prices as low as 10 US cents with sometimes 100% bid/asked spreads would significantly distort systems' performance.

Such distortion would cause systems' performance to look better because the Compustat database contains only close (bid) prices on each stock. Therefore, the bid/asked spread investors need to calculate with is not included in the performance. If taken into account, the systems would perform worse than in the backtest.[10]

Chinese companies will be omitted due to high risk connected with them because of their often fraudulent accounting practices. American Depository Receipts will not be included because of insufficient data on those companies in the Compustat database and their different performances on their "home" markets and American market.

2.8. Portfolio Size

In order to create tradable systems, portfolio size will be limited to a maximum of 10 shares (30 in the case of Dividend & Buyback strategy).[11] This number is also suitable for very short-term FTS that are rebalanced in monthly or shorter periods. At times, many stocks pass the screen. Buying tens or hundreds of stocks that fulfill a set of criteria works well in backtest but is difficult, if not impossible to implement in reality. Furthermore, diversification has diminishing marginal utility, meaning that the largest benefits of diversification are achieved with portfolios of

[10] An illustration to clarify. If the price of the stock is quoted as \$0.10/\$0.20 it means that an investor buys the stock for \$0.20 and is immediately able to sell it for \$0.10. Assuming that the spread will remain \$0.10 and the stock price grows to \$0.30, then the new quotation is \$0.20/\$0.30. At this point the investor is at his break-even price. If he decides to sell the stock, his return is 0%. The backtest would calculate the trade as 50% gain. Stock was bought at \$0.20 and sold at \$0.30.

[11] It will be shown in Part III that portfolios with 10 stocks achieved better risk-adjusted returns than portfolios of 30 or more stocks.

around 30 stocks, and that sufficiently diversified portfolio should contain approximately 30 stocks (Statman (1987)).

2.9. Trading Costs

Portfolio123 features the option to set trading costs in the size of a slippage and carry costs. Setting slippage allows the system to count with prices the investor would pay that differ from those used by a system. The system uses the prices from the database and uses exact prices. If the system is told to buy stocks at closing prices, the system will calculate performance based on the exact price. But an investor trying to buy a stock at $10 might not obtain this price, but, say, will have to pay $10.1. This 1% difference in price is called slippage. Counting with slippage brings system's performance more in line with reality.

Many academic studies do not include slippage or fees investors have to pay to brokers, thus overstating achievable returns. Slippage of 1% and carry cost of 2% were chosen to represent costs that every investor incurs and fees he pays to the broker. It may happen that an investor willing to buy a stock for $10 might get a price $9.99 but it is not supposed that positive slippage (in paying a lower than planned price) and negative slippage (in paying a higher than planned price) balance to bring total costs to zero. The addition of costs therefore leads to results that are achievable in reality.

Bloomberg does not enable to control for trading costs or slippages. Its outcome will mostly serve to make the results comparable with those of some previous studies than to develop a fully tradable system.

2.10. Scalability

Investors willing to trade FTS need to be wary of their scalability. The reasonable minimum amount of money to be traded with these strategies is $10,000. Investing $1,000 into each stock (in strategies with a maximum of 10 stocks) is adequate regarding the fees an investor pays. A fee of $1 diminishes the return by 0.1% (1/1,000 = 0.001 = 0.1%). If larger sums are invested, the impact of fees diminishes.

The maximum amount is virtually unlimited, but investing several billions into simple strategies is not intelligent and more profound approach is recommended. Furthermore, should $5 billion be invested this way, it would dedicate $500 million to each single stock. If a certain company could be bought for $200 million, then investing such a large amount of money would effectively take the company private.

2.11. Data Mining

Strategies and backtests presented in this thesis were created to be data mining-free. Each strategy is assumed to be capable of performing well in different periods of time. Some of very simple strategies such as buying low P/E stocks or buying companies with high ROIC (presented either in Tortoriello (2009) or O'Shaughnessy (2011)) should perform well over long stretches of time.

The strategies cover 14.75 years (Portfolio123) and 19.5 years (Bloomberg), respectively, due to the availability of data in the backtesting database. This time period was not chosen to fit the data perfectly. The 14.75-year and 19.5-year periods are the best that could be achieved.

2.12. Survivorship Bias

Many strategies do not include stocks of companies that fail or are taken over by another company, thus producing an upward bias to their results. The Compustat database includes all stocks that could be bought or sold on every single day that the database covers.

As of September 2013 the database does not include stock of banks that went bankrupt in 2008. But for years prior to the bankruptcy of these banks, their stocks are included in the database. If the database included only stocks that "survived" until these days, it would upwardly bias the results of studies since they would not include stocks with negative returns.

The same applies for stock of companies that were taken over. Since usually companies are acquired for prices surpassing their market capitalization, returns to their stocks are positively affected. If the database didn't contain stocks that were bought, it would eliminate many stocks with large positive returns, which would negatively impact investors' portfolios.

2.13. Look-ahead Bias

Some studies might assume that fundamental data were available to investors when they were not. Annual reports containing crucial fundamental data about the business of each company in a given year are not available on the first trading day in January of the following year, but later on. Therefore, calculating P/E ratio in January 2009 with an EPS of the whole year 2008 is misleading, since this information becomes known to investors when the company reports the results of operations for 2008 in February or March of 2009.

To avoid a look-ahead bias, it would be appropriate to lag data. On the one hand, this makes the data a little stale, but on the other hand, it prevents the system to count with unknown data. Unfortunately, this option is not available in Portfolio123 and Bloomberg.

3. Identification of Strong Quantitative Strategies

A quantitative strategy that works and that is applicable in practice should have following characteristics (Tortoriello, 2009, pp. 2 – 28):

1) *Significant outperformance for the top quintile*

The larger the outperformance, the better, but in general, an outperformance of more than 2% for one-factor and more than 4% for two-factor strategies is adequate.

2) *Significant underperformance for the bottom quintile*

The bottom quintile should underperform as much as possible. For one-factor strategy, the bottom quintile should underperform by at least 2%. For two-factor strategy, the bottom quintile should underperform by 4% or more. If the strategy is meant to be used for short sales (not tested in this thesis), underperformance of 10% or more is preferable.

3) *Good linearity of excess returns among the quintiles*

In general, the most preferable situation is to have the top quintile outperform the second quintile, which should outperform the third quintile, and so on. The bottom quintile should have the lowest return. The smoother, or more linear, the trend of excess returns, the higher is the possibility that the strategy really works.

4) *Strong consistency of returns over time*

The top quintile should outperform the universe for 60% or more of the annual periods tested. The bottom quintile should underperform the universe by 60% or more. The information of under or outperformance is not available in Bloomberg and in Portfolio123.

5) *Low volatility and low maximum loss for the top quintile. High volatility and high maximum loss for the bottom quintile*

Low volatility is always preferable as well as low maximum loss. The aim of this thesis is to develop quantitative systems that lead to possibly the lowest attainable losses given the used criteria.

4. Literature Discussion

The research in academia concerning returns to fundamental analysis ratios is divided into two parts. The first part researches and describes return to stocks based on valuation criteria (price to book, price to earnings etc.) while the second leverages the information contained in financial statements (of which a subsection focuses on accruals) to discriminate stocks of companies that are capable of outperforming the market.

Fama and French (1992) and Lakonishok, Vishny, and Shleifer (1994) show that portfolios of low price to book shares outperform portfolios of high price to book shares and the market as a whole. These findings are corroborated by the research conducted by Ibbotson (1986).

Similarly, an outperformance was discovered with the strategy of buying low price to earnings stocks. Basu (1977) found that low price to earnings stocks had outperformed high price to earnings stocks (in a period from April 1957 to March 1971) by 7 percentage points per annum. Furthermore, Ibbotson (1986) offers supporting evidence to the outperformance of buying low P/E stocks in contrast to high P/E stocks (in a period from 1966 to 1984). Portfolios of low price to earning stocks have a lower beta than portfolios of high price to earnings stocks. Lakonishok, Vishny, and Shleifer (1994) confirm these findings. A decile of the lowest price to earnings stocks earned on average higher returns (19% p.a.) than a decile of high price to earnings stocks (11.4% p.a.). Buying low priced stocks yielded higher returns because the strategies exploited the suboptimal behavior of investors and not because they were fundamentally riskier (which confirms Ibbotson's findings). Similarly, Malkiel (2003) shows that low P/E stocks (specifically stocks with P/E lower than 9.9) earn higher returns than high P/E stocks (P/E higher than 20.9).

Gray and Carlisle (2012) performed similar tests of value and other criteria to find supporting evidence to the performance of valuation factors. They focused on enterprise value metrics instead of just a simple P/E and find that low EV/EBITDA and low EV/EBIT portfolios earn superior returns to high EV multiples portfolios and to the overall market as well.

Another large body of research centers around information contained in the financial statements. Lev and Thiagarajan (1993) identified a set of fundamental variables and examined their relevance over earnings. They found that the factors (change in inventories, change in accounts receivable, effective tax rate, gross margin, order backlog, capital expenditures etc.) are capable of predicting changes in future earnings. Abarbanell and Bushee (1997) tested Lev and Thiagarajan's findings and found evidence that the factors can explain future earnings changes

and analyst revisions. Furthermore, Abarbanell and Bushee (1998), continuing the work by Lev and Thiagarajan, discovered that accounting-based signals such as relative changes in inventory, capital expenditures and effective tax rate appear to be strong indicators of one-year-ahead earnings information to which the market underreacts. Their findings are consistent with the work by Ou and Penman (1989), notwithstanding the fact that Ou and Pennman use more mathematical approach. Ou (1990) uses non-earnings accounting numbers (growth in net sales to total assets, growth in depreciation expense, growth in the capital expenditures to total assets etc.) to show that these information can predict future earnings changes. Further, Cooper, Gulen, and Schill (2006) elaborate more on asset growth to find that companies with the lowest asset growth earn an annualized return of 9.1% on average while companies with the highest asset growth rates earn a negative 10.4% annualized return.

A subsection of the research on accounting measures focuses on the quality of earnings and accruals. It should be noted, however, that many topics in the research papers concerning earnings quality overlap with a more general approach to earnings measurement. Much of Lev and Thiagarajan's and others' work relates to creative accounting and accounting fraud detection (del Vecchio and Jacobs (2012), Schilit (2010)).

Accruals were first studied by Sloan (1996). His research led to a conclusion that high levels of current accruals are a leading indicator of deterioration in earnings and stock returns. Richardson, Sloan, Soliman, and Tuna (2001) show that non-current accruals provide more information about future stock returns than current accruals.

There has not been paid much attention to the fundamental trading systems from academia. Although numerous studies have identified persistent market anomalies, criteria that performed well in the past and criteria that still work even after they have been found and described, these have not been put together to create tradable investment strategies. One such exception is a quantitative model built on the aforementioned research created by Piotroski (2002). He devised a 9-criteria screening process to identify potential winners and losers. Piotroski's study will not be backtested in this thesis.

The most significant contribution to the field of quantitative trading systems is a work by Tortoriello (2009) who identified many valuable criteria that performed well during the period from 1987 to 2006. O'Shaughnessy (2011) used data as far back as 1926 to show the most profitable factors over a period of approximately 70 years. A study published by Tweedy, Browne (2009) condensed academic research and tested mostly value criteria to show which of them performed best in the several past decades. All three works will provide background for this thesis.

Part II – One-factor and Two-factor Screens

This part will focus on strategies composed of both one and two factors. Although named differently, one-factor screen tests are ordinarily performed by many academic researchers. Mostly every significant research conducted in the prior years tested the performance of a single factor and its performance in the stock market. The following parts will discuss major findings regarding price to book anomaly and market size.

1. Price to Book Anomaly

Lakonishok, Vishny, and Shleifer in their paper Contrarian Investment, Extrapolation and Risk (1994) performed tests of price to book, price to earnings and price to cash flow ratios. Value strategies (low price to book, low price to earnings and low price to cash flow) outperformed glamour strategies (high price to book etc.). Using a 1-year horizon, value outperformed glamour in 17 out of 22 years using price to cash flow, and in 17 out of 22 years using price to book ratio. The consistency of outperformance of the value strategy relative to the glamour strategy increased in longer horizons.

Roger Ibbotson in "Decile Portfolios of the New York Exchange, 1967 – 1984" (in Tweedy, Browne, 2009, p. 3) studied the relationship between the price to book ratio and investment returns. The study ranked all stocks traded on NYSE on December 31 of each year according to stock price in relation to book value per share and sorted the stocks into deciles. Stocks with a low price to book ratio had significantly better investment returns over the 18-year period than stocks with a high price in relation to book value.

Table 1 Ibbotson Research

Decile	**Compound Annual Return**
1 (Lowest price to book values)	14.36%
2	14.40%
3	14.39%
4	12.43%
5	8.82%
NYSE	*8.60%*
6	8.36%
7	7.69%
8	5.63%
9	5.26%
10 (Highest price to book values)	6.06%

Source: Ibbotson, R. 1986, in Tweedy, Browne (2009)

These findings are supported by the research conducted by Tweedy, Browne (2009). In the research period from April 1970 to April 1981 stocks priced cheaply in relation to book value largely outperformed expensive stocks as measured by the price to book multiple.

Tweedy, Browne (2009) in examined historical returns from stocks trading at less than book value as well as from stocks trading at less than 66% of net current asset value. Similarly, Tortoriello (2009) and O'Shaughnessy (2011) tested one-factor screens in their works, many of which will be backtested in this thesis.

2. Market Size Effect

Fama and French (1993) found that small market capitalization stocks earned higher returns than large market capitalization stocks in the period from 1941 to 1990. The average monthly return fell from 1.96% for the smallest market capitalization stocks to 0.93% for the largest market capitalization stocks.

This effect does not prevail in all markets. There are periods when large capitalization stocks outperform small capitalization stocks. As notes Malkiel (2003), from the mid-1980 through the decade of the 1990s, there has been no gain from holding smaller stocks. This finding is corroborated by BMO Private Bank researchers that found large capitalization stocks outperforming from 1982 to 1991 and then from 1994 to 1999.[12]

Table 2 Market Size Effect

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	12.01	6.37	3.75	3.01	2.32	6.22
Active CAGR (%)	10.00	5.14	2.94	2.59	2.13	6.22
Average Turnover (%)	19.88	26.45	24.71	19.32	10.44	N.A.
Information Ratio	0.39	0.29	0.17	0.17	0.14	N.A.
Volatility	35.88	16.05	18.22	16.94	16.89	12.54
Tracking Error (%)	41.64	13.34	11.51	10.17	9.14	N.A
Hit Ratio (%)	44.04	47.22	48.27	49.40	50.09	N.A
Quantile Hit Ratio (%)	55.41	52.70	55.41	59.46	60.81	N.A
Number of Securities	773	773	773	773	772	500
Maximum Drawdown (%)	-79.17	-63.34	-63.63	-58.31	-58.74	-56.78

Source: Own simulations (Bloomberg)

[12] WisdomTree. U.S. Equities: Historical Trends of Large Caps vs. Small Caps [online]. c2013 [quoted on November 1, 2013]. Available on: <http://www.wisdomtree.com/blog/index.php/u-s-equities-historical-trends-of-large-caps-vs-small-caps/>

Tests of market capitalization have one serious drawback. Although not mentioned in the research, low market capitalization quintiles (or deciles) contain non-tradable stocks. The results of the first quintile presented hereby are probably not achievable in reality. As of the end of September 2012, the first quintile contained stocks with market capitalization ranging from $1.5 thousand to $20.4 million (median market capitalization was $6.15 million). Such stocks are mostly illiquid and may be subject to special commissions.[13]

The rest of this thesis will aim to research other factors than those mentioned above. Some of the factors have been extensively researched; other factors are not tested in a way presented research in this thesis. The added value of Part II of this thesis to the vast amount of already published research will the time period of the backtests which will be conducted up until September 2012 and 2013, and which will cover the largest market fall since the Great Depression.

Tortoriello (2009) has identified several factors that led to consistent outperformance of the market. He broke down the criteria into 7 groups: Profitability, Valuation, Cash Flow, Growth, Capital Allocation, Price Momentum and Red Flags. Growth and Price Momentum strategies will not be tested in this thesis, only with an exception of free cash flow per share growth which is included in Cash Flow section.

3. Profitability

Profitability ratios tested in this section include: gross margin, operating margin, net margin and return on invested capital (ROIC).

Although the best results from Tortoriello's backtests in this category were achieved by economic profits measure (Tortoriello, 2009, p. 87), backtest of this measure is not going to be reproduced here since Bloomberg does not enable the inclusion of WACC among backtestable criteria. The best returns in this category were achieved by economic profits measure that was based on cash ROIC and that used price to sales ratio in the calculation of WACC (normally, WACC uses beta instead).

[13] Some brokers charge a special fee for investing in stocks that trade at less than $2 per share or that are traded on OTC market, which may be the case of stocks included in the first quintile.

3.1. Gross Margin

Gross margin (or gross profit margin) is the broadest margin since it considers only revenues and costs of goods sold incurred by every company. It does not take into account capital intensity of the company nor its research and development costs.

Gross margin backtest did not produce linear results[14]. The best performing quintile was the second quintile. The top and the bottom quintile had similar volatility, but the maximum drawdown for the top quintile was the lowest. Furthermore, the top and the bottom quintiles had the lowest average turnover, signaling low variability in gross margin for companies with high and low gross margins. It means that companies with high gross margins are capable of sustaining their competitive advantage and that companies with low gross margins do not have much chances to improve their profitability. This applies in general. In some quarters a low margin company can be ranked in a higher quintile and a high margin company be ranked in a lower quintile. But on average, the low turnover means that fewer companies change places between quintiles in the top and the bottom quintile.[15]

3.2. EBITDA and OIBDA Margin

EBITDA is often used as a proxy for the cash generating strength of the company and is compared to operating cash flow. Compared to gross margin, EBITDA margin does not take into account the capital intensity since it excludes amortization.
OIBDA has been growing in popularity recently because it conveys a more realistic picture of the company's profitability. The difference between EBITDA and OIBDA is:

a) EBITDA = net income + interest paid + taxes paid + depreciation and amortization
b) OIBDA = operating income + depreciation and amortization

The difference between EBITDA and OIBDA lies in the items that are included in net income. Mostly these are: interest earned and non-operating gains and losses. From a quantitative point of view, there were insignificant differences in backtests of EBITDA and OIBDA.

[14] See Appendix.
[15] This phenomenon might be a good foundation for a future research. It will not be developed in this thesis because it would significantly reach beyond its scope.

Table 3 EBITDA Margin

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	11.05	8.21	6.45	6.01	3.86	6.22
Active CAGR (%)	9.71	7.74	5.80	4.96	-0.18	6.22
Average Turnover (%)	12.92	20.78	25.31	25.00	18.26	N.A.
Information Ratio	0.36	0.61	0.45	0.29	0.10	N.A.
Volatility	34.32	18.33	17.26	17.06	40.22	12.54
Tracking Error (%)	41.57	11.67	10.42	11.94	43.53	N.A
Hit Ratio (%)	50.58	49.94	49.05	46.91	41.62	N.A
Quantile Hit Ratio (%)	63.77	62.32	57.97	57.97	46.38	N.A
Number of Securities	549	549	549	549	548	500
Maximum Drawdown (%)	-59.96	-58.04	-60.24	-65.41	-83.63	-56.78

Source: Own simulations (Bloomberg)

EBITDA margin backtest showed strong outperformance for the top quintile, an underperformance for the bottom quintile and linear returns. Again, turnover in the top quintile is low. The same applies to EBITDA margins as to gross margins. High margin companies with great businesses can sustain their competitive advantage and secure their high margins for longer periods of time than companies with lower (and variable) margins. 63.77% of companies ranked in the first quintile outperformed the benchmarks, which is favorable.

On the risk adjusted basis, the first quintile loses its favorability since the information ratio is the third highest due to the high volatility of returns. The best IR was achieved by the second quintile – a combination of not a low active return and one of the lowest volatilities. Maximum drawdown is almost linear and increasing through the quintiles. The bottom quintile recorded the third largest maximum drawdown of all backtest.

3.3. Operating Margin

Operating margin (sometimes called EBIT margin) is a measure of operating profitability of the company. It is not as broad as gross margin, but is more suitable for company-to-company comparisons between industries since is takes capital intensity into account through inclusion of amortization. Unfortunately, operating profits, since they are mostly watched and used in other metrics such as ROIC, are very prone to manipulation. Many companies "cook the books" to look better in the eyes of Wall Street and therefore include non-operating profits and exclude some costs that relate to the operations of the company. Non-operating items oftentimes calculated into operating profit might include gains from sale of parts of the business, foreign exchange gains etc. Costs relating to the operations that were not properly recorded include capitalization of marketing expenses and other accounting manipulative practices (del Vecchio and Jacobs (2012), Schilit (2010)).

In the case of quantitative systems, the aforementioned should not pose a serious problem. Quantitative backtests using one or two criteria end up investing into tens of stocks. Thus, a manipulation of operating income in one or two companies should not blow a hole into investor's portfolio should he find the system selected a stock of a company that misstated operating income.

Because strategies developed in Part III will mostly work with 10 stocks, investors might "manually" check the selected companies for the possible accounting manipulation. If convinced that the stocks shortlisted by the strategy are low quality ones, they might either exclude such stocks and buy less stocks into the portfolio, or look for additional stocks if they wish to be fully invested.

Returns to operating margin factor did not show linear and strong results[16] as did EBITDA test. The third and fourth quintiles outperformed the second quintile which did not outperform the benchmark. Other measures showed mixed results as well. The average turnover was the lowest for the top quintile, while volatility was the second largest (after the bottom quintile that had the largest volatility). Maximum drawdown was more linear, increasing from the top to the bottom quintile. The bottom quintile recorded the largest drawdown of all one-factor tests.

Information ratio was the highest for the third quintile which performed second best and had one of the lowest volatilities. The first quintile's IR was decreased by a high volatility. Also, more companies in quintiles 2 and 3 outperformed the market than in quintile 1. The highest operating margin therefore does not ensure the best returns. This result might have to be somehow connected with the aforementioned manipulation with operating income. Analysis of this phenomenon would reach beyond the scope of this thesis and will not be presented.

3.4. Net Margin

Net margin (or net income margin) measures how many dollars a company made from each dollar of sales. This measure carries with itself similar problems as operating margin. Net income is often a subject of manipulation. Depicting this problem goes far beyond the reach of this thesis. The same that was said for operating margin applies for net margin. As one and two-factor systems tend to select tens of stocks into the portfolio, a handful of stocks of companies that creatively manage earnings should not cause serious problems in investor's portfolio. Again, strategies in Part III enable investors to check manually if the earnings were not manipulated.

[16] See Appendix.

Table 4 Net Margin

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	9.70	7.01	6.64	5.57	0.82	6.22
Active CAGR (%)	8.96	6.64	6.09	4.68	-2.77	6.22
Average Turnover (%)	27.25	41.83	46.14	44.12	35.22	N.A.
Information Ratio	0.38	0.52	0.46	0.26	-0.02	N.A.
Volatility	26.54	15.62	15.26	15.77	34.24	12.54
Tracking Error (%)	29.57	10.62	11.07	11.94	33.94	N.A
Hit Ratio (%)	50.28	50.17	49.51	47.09	41.20	N.A
Quantile Hit Ratio (%)	60.87	62.32	57.97	56.52	47.83	N.A
Number of Securities	805	805	805	805	804	500
Maximum Drawdown (%)	-58.26	-56.51	-57.09	-62.01	-83.47	-56.78

Source: Own simulations (Bloomberg)

Net margin showed fairly satisfactory results. Returns were linear, the top quintile outperformed other quintiles and the market as well. It had the lowest turnover and not very high volatility (compared to other more volatile strategies). The maximum drawdown was the third lowest, but drawdowns for the adjacent quintiles were not much lower.

The top quintile does not have a satisfactory IR due to a high volatility of returns. More stocks from quintile 2 outperformed the market than from quintile 1, which should not happen with a great strategy.

3.5. Return on Invested Capital

Return on invested capital (ROIC) measures the profitability of the operations of the company in relation to the total capital that is used by the business. ROIC divides net operating profit after taxes (NOPAT = EBIT*(1 – tax rate)) by total invested capital. Total invested capital includes long-term debt, short-term debt, current portion of long-term debt, shareholder's equity and preferred shared.

The strength of this measure is in the use of only operating results of the company. It does not include other gain or losses and financial income and expense (interest earned and paid). However, as mentioned above, operating income which is used to derive NOPAT is prone to manipulation.

Table 5 Return on Invested Capital

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	12.21	7.46	5.77	4.09	5.20	6.22
Active CAGR (%)	11.15	7.05	5.26	3.51	4.55	6.22
Average Turnover (%)	21.81	32.04	36.01	34.77	28.03	N.A.
Information Ratio	0.40	0.59	0.40	0.26	0.31	N.A.
Volatility	33.41	16.08	15.10	13.77	13.74	12.54
Tracking Error (%)	39.91	10.45	10.90	11.42	12.05	N.A
Hit Ratio (%)	51.69	51.13	49.79	49.00	49.19	N.A
Quantile Hit Ratio (%)	69.57	66.67	57.97	53.62	62.32	N.A
Number of Securities	423	423	423	423	422	500
Maximum Drawdown (%)	-55.66	-56.03	-57.29	-58.43	-61.58	-56.78

Source: Own simulations (Bloomberg)

The ROIC factor is one of the best performing factors backtested in this thesis. Returns are linear, the top quintile strongly outperforms the bottom quintile underperforms (although it does not have the lowest return). One of the striking results is the volatility. The top quintile suffers from the highest volatility of all quintiles. Not considering the risk free rate, the top quintile has the second lowest Sharpe ratio (0.36), while the second quintile has the highest Sharpe ratio of 0.46. On the other hand, the maximum drawdown increases from the highest to the lowest ROIC quintiles.

Risk adjusted returns for this strategy suffer from the same problem as previous strategies – an information ratio lower in the second quintile. On the other hand, more stocks outperform the market in the top quintile and the top quintile also has the lowest maximum drawdown. The top quintile in this factor ranks second of all factors in the percentage of stocks that outperform the market.

3.6. Summary Statistics

Table 6 Profitability - Summary Statistics

Factor	Gross Margin	EBITDA Margin	Operating Margin	Net Margin	ROIC
QSpread Ann Active Return (%)	-2.54	-1.29	-1.02	0.39	-1.48
Cumulative QSpread Return (%)	146.02	39.91	26.97	107.01	171.58
Security Count	2599	2744	3404	4024	2113
Average Turnover (%)	25.98	19.29	23.01	36.37	28.14
Average IC	0.0223	0.0731	0.0769	0.0797	0.0204
QSpread IR	-0.12	-0.03	-0.02	0.01	-0.06
QSpread Sharpe	0.45	0.22	0.21	0.29	0.36
QSpread Volatility	6.59	16.38	16.60	14.57	9.82
Q1 Hit Ratio (%)	47.81	50.58	50.32	50.28	51.69
Q5 Hit Ratio (%)	45.37	41.62	41.46	41.20	49.19
QSpread Max Drawdown (%)	20.73	65.83	67.39	57.50	24.03

Source: Own simulations (Bloomberg)

The best profitability strategies were ROIC, EBITDA margin and net margin. Although ROIC strategy achieved the largest return in the top quintile, the QSpread return was not high enough. The largest difference in active returns was achieved by the net margin strategy (9.70% – 0.82%). This strategy also had a high information coefficient, a desirable trait. From a risk point of view, the QSpread Sharpe is the highest for gross margin strategy due to the low QSpread volatility.

ROIC strategy recorded a high cumulative QSpread return, however, the higher volatility lowers the Sharpe ratio under the one achieved by gross margin strategy. This strategy also had the largest quintile 1 hit ratio – 51.69%

In summary, profitability strategies showed better IR for the second quintile. High volatility in the top quintile should be a warning sign for investors. Despite the fact that it is better to choose profitable companies, returns of the basket of such companies vary to a great degree. Although the average and median profitability in each quintile during the backtested period was not researched, the problem with high volatility might come from a sustainability of the margins. As was pointed out in the market capitalization strategy and as is mentioned in the dividend yield strategy in Part III, the top quintile often contains stocks with extreme values. Investors therefore might be aware of such values and their behavior and uncertainty about the sustainability of such values leads to volatile prices.

4. Valuation

Valuation is the single most useful and the strongest factor in any portfolio. Since investing results are related to the prices paid, not overpaying for a stock of a company (in relation to earnings or cash flow) is the crucial element of every investment endeavor. Thus, paying a reasonable price in relation to other criteria is necessary to protect the portfolio from losses. Furthermore, the combination of valuation and another factors such as cash flow, profitability, and growth, results in the strongest two-factor tests (Tortoriello, 2009, p. 104).

The tests in this section include: free cash flow to price, enterprise value to EBITDA, price to earnings and price to book ratio.

4.1. Free Cash Flow to Price

Free cash flow to price (FCF/P, or free cash flow yield) divides free cash flow per share by the price of the share. Free cash flow is arrived at by subtracting capital expenditures (CAPEX) from operating cash flow. In general, the larger the free cash

flow, the better for the company and its shareholders. The more free cash the company has, the more it can pay in dividends, the more it can repurchase its outstanding shares or it can repay the debt.

Although the return of each factor for different industry groups will not be described in this thesis, it is necessary to make an exception in the case of free cash flow. The table below lists performance for each industry group.

Table 7 Performance of Industry Groups

Industry Sector	**Compound Annual Return**
Utilities	21.50%
Health Care	21.30%
Information Technology	19.50%
Financials	18.10%
Energy	18.00%
Consumer Staples	17.40%
Industry	14.50%
Materials	14.40%
Consumer Discretionary	13.30%
S&P 500	12.00%
Telecom Services	10.70%

Source: Tortoriello (2009, p. 108)

Although the performance of each group does not relate exactly to the "CAPEX-heaviness" of each industry, some pattern is observable. According to Global Corporate Capital Expenditure Survey[17] conducted by Standard & Poor's, energy and materials sectors were the largest CAPEX spenders in the sample universe in 2012, accounting for 42% of total CAPEX. The largest CAPEX spenders were energy (PetroChina, Petrobras, Exxon Mobil, Royal Dutch Shell), utilities (EdF, GDF Suez), materials (BHP Billiton, Rio Tinto, Vale), and telecom (China Mobile, AT&T) companies. This explains why they are closer to the top of the table.

On the other side of the spectrum stand IT, consumer discretionary, and services companies. Aswath Damodaran's database[18] drawn from Valueline show that among the least CAPEX-heavy companies are newspaper, e-commerce, entertainment technology, healthcare information, human resources, reinsurance, and investment companies.

[17] Standard & Poor's Rating Services. Global Corporate Capital Expenditure Survey 2013 [online]. c2013 [quoted on October 21, 2013]. Available on: <http://www.ft.com/intl/cms/a71a3892-f5cb-11e2-a55d-00144feabdc0.pdf>

[18] Damodaran, A. Capital Expenditures by Sector [online]. c2013 [quoted on October 21, 2013]. Available on: <http://pages.stern.nyu.edu/~%20adamodar/New_Home_Page/datafile/capex.html>

Table 8 Free Cash Flow to Price

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	13.06	9.91	6.60	5.63	3.19	6.22
Active CAGR (%)	12.17	9.53	6.25	5.37	2.58	6.22
Average Turnover (%)	35.84	53.15	56.86	56.41	51.54	N.A.
Information Ratio	0.87	0.81	0.56	0.49	0.16	N.A.
Volatility	16.79	15.02	15.22	16.37	18.60	12.54
Tracking Error (%)	13.73	10.85	9.91	9.46	11.17	N.A
Hit Ratio (%)	50.46	51.41	50.75	49.58	47.54	N.A
Quantile Hit Ratio (%)	63.77	66.67	62.32	63.77	49.28	N.A
Number of Securities	385	384	384	384	384	500
Maximum Drawdown (%)	-69.43	-56.96	-54.51	-53.02	-57.89	-56.78

Source: Own simulations (Bloomberg)

Free cash flow to price factor as well as other valuation strategies worked well. Results are strong and linear. The top quintile has the lowest average turnover which is, on the other hand, much larger than turnovers for profitability strategies: 27.25 for net margin strategy, 21.81 for ROIC strategy, and 12.92 for EBITDA margin strategy. Volatility is quite stable across quintiles and the highest for the bottom quintile.

This factor also has very few securities in each quintile. This may be the reason of incomplete data on Bloomberg or exclusion of stocks with negative free cash flow yield (stocks with negative free cash flow).

The price to free cash flow factor showed the second highest information ratio for the top quintile – a combination of a high return and low volatility. Although the quantile hit ratio is not the highest, the outperforming stocks achieve high returns.

4.2. Enterprise Value to EBITDA

Enterprise value to EBITDA (EV/EBITDA) has become very popular in the investment world. The ratio divides total enterprise value by earnings before interest, taxes, depreciation and amortization. Enterprise value represents the theoretical price that an acquirer would have to pay to buy the whole business.

Loughran and Wellman (2011) found that, controlling for size, low EV/EBITDA firms outperformed high EV/EBITDA firms by more than 5% per year during the 1963 – 2009 time period.

By excluding depreciation, the cost of previously purchased property, plant and equipment is also excluded. This weakness could be substituted by dividing the EV by EBIT but the results in backtests were similar.

Table 9 Enterprise Value to EBITDA

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	13.55	10.54	5.62	2.52	-0.39	6.22
Active CAGR (%)	12.73	9.71	5.04	1.96	-1.70	6.22
Average Turnover (%)	29.31	45.30	48.59	43.15	30.27	N.A.
Information Ratio	0.88	0.66	0.41	0.11	-0.18	N.A.
Volatility	16.23	17.56	15.84	16.47	21.61	12.54
Tracking Error (%)	12.87	14.14	10.42	10.32	13.99	N.A
Hit Ratio (%)	51.15	50.40	49.98	48.49	45.20	N.A
Quantile Hit Ratio (%)	66.67	60.87	55.07	53.62	42.03	N.A
Number of Securities	467	466	466	466	466	500
Maximum Drawdown (%)	-62.39	-58.49	-58.42	-61.42	-72.40	-56.78

Source: Own simulations (Bloomberg)

EV/EBITDA strategy performed well in backtests. Besides linear and strong returns, this strategy has low average turnover and low volatility for the top quintile. Although the volatility is not linear, the top and bottom quintiles stand in contrast to each other. The bottom quintile would make a good starting point for a short selling strategy due to its negative return.

This strategy had the highest IR of all one-factor strategies. The annualized active return was the third highest of one-factor strategies and volatility was also not high. Furthermore, two thirds of stocks in the top quintile outperform the market, one of the highest numbers.

4.3. Negative Enterprise Value

Investing in stocks with negative enterprise value is a difficult strategy. Negative enterprise value stocks are hard to find and if they are found, it happens mostly in stressed markets after large bear markets.

Negative enterprise value is a result of two complementing factors:

1) Very low market capitalization
2) High net cash position

High net cash position is a result of very low or no debt on company's balance sheet and a large (or at least substantial) amount of cash and cash equivalents on the balance sheet. Stocks with negative enterprise value were abundant at the beginning of a large bull market in the 1950s but continually disappeared as the market reached high valuations. In today's market (fall 2013), there are almost no such stocks to find.

Once found, negative enterprise value stocks represent deep value, contrarian opportunities for investors to profit from. Unfortunately, the upside potential is

difficult to capture by the FTS since the system is not capable to sell different holdings in different times.

4.4. Price to Earnings

Price to earnings (P/E ratio) is the most used valuation ratio because of its simplicity. However, it has many caveats. Current price divided by current fiscal year earnings per share or by trailing twelve months earnings per share might be misleading. The reason is manipulation or extraordinary items such as divestitures, asset sales and other items that do not properly measure the true profitability of the company. In a group of stocks, such complications should not distort the informative function of the ratio. In order to more properly reflect the real telling value of the P/E ratio, two tests will be conducted:

1) P/E ratio calculated as current price divided by trailing twelve months earnings per share
2) P/E ratio calculated as current price divided by the average earnings per share for the past five years

As proposed by Graham (1996), investors should calculate P/E ratios by using normalized earnings. Normalized EPS averages the earnings for the past several years. The reason to this modification is straightforward. An economy moves in cycles and companies themselves go through cycles as well. Taking into consideration earnings for one year might overstate the P/E ratio (making it lower) because at the top of its cycle, the company earns more than on average, and understate the P/E ratio (making it higher) because at the bottom of the cycle, the company earns less than on average.

Table 10 Price to Earnings

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	12.93	6.85	4.74	3.26	2.03	6.22
Active CAGR (%)	11.69	6.10	4.24	2.87	1.21	6.22
Average Turnover (%)	31.02	47.25	49.75	44.83	33.39	N.A.
Information Ratio	0.76	0.46	0.33	0.21	0.03	N.A.
Volatility	15.89	14.57	14.45	15.70	19.54	12.54
Tracking Error (%)	13.53	11.51	10.67	9.94	11.94	N.A
Hit Ratio (%)	52.18	50.66	49.84	48.67	46.77	N.A
Quantile Hit Ratio (%)	66.67	56.52	57.97	53.62	53.62	N.A
Number of Securities	574	574	574	574	574	500
Maximum Drawdown (%)	-65.03	-60.09	-54.11	-55.92	-60.64	-56.78

Source: Own simulations (Bloomberg)

The P/E ratio backtest worked well, producing strong and linear returns. But again, a problem was discovered in the top quintile. The group of lowest price to earnings stocks suffered from the largest drawdown. One possible explanation for the large drawdown of this group of stocks may be that they are ranked into the quintile during the fall of their price, which produces the large drawdown. The information ratio is satisfactory, as well as volatility. Two thirds of stocks in the top quintile outperformed the market.

The P/E using 5-year average earnings per share did not test well quantitatively. Although using normalized earnings is meaningful in non-computerized approach to investing, quantitatively, the poor results did not exhibit what was expected. As a starting point to create a FTS, a simple P/E is preferable.

4.5. Price to Book Value

Book-to-market (an inverse ratio of Market to Book or Price to Book) anomaly has been described above.

Table 11 Price to Book Value

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	14.48	6.62	4.73	1.87	1.27	6.22
Active CAGR (%)	12.52	5.78	4.12	1.25	0.22	6.22
Average Turnover (%)	24.25	40.22	42.74	38.13	22.54	N.A.
Information Ratio	0.44	0.37	0.27	0.02	-0.06	N.A.
Volatility	36.54	14.72	15.70	17.33	20.55	12.54
Tracking Error (%)	42.12	12.23	11.03	10.73	12.68	N.A
Hit Ratio (%)	47.33	49.05	48.36	47.59	46.90	N.A
Quantile Hit Ratio (%)	55.07	49.28	53.62	52.17	49.28	N.A
Number of Securities	778	778	778	778	777	500
Maximum Drawdown (%)	-80.41	-61.13	-59.5	-59.24	-72.36	-56.78

Source: Own simulations (Bloomberg)

The anomaly was further confirmed by the backtest. It is notable that the top quintile had a very large drawdown (the largest of all drawdowns for top quintiles) as was the case of low P/E stocks. The large drawdown is also accompanied by a high volatility. High returns combined with very high volatility result in low Sharpe ratios. A large drawdown further points to a low Sortino ratio. Such a simple strategy, although with very promising returns is not desirable since an 80% drawdown is difficult to overcome.

4.6. Summary Statistics

Table 12 Valuation - Summary Statistics

Factor	P/E	P/B	FCF/P	EV/EBITDA
QSpread Ann Active Return (%)	2.42	4.73	1.39	5.46
Cumulative QSpread Return (%)	368.63	579.83	416.49	691.41
Security Count	2870	3888	1921	2331
Average Turnover (%)	37.30	31.78	44.99	34.89
Average IC	0.0451	0.0175	0.0318	0.0579
QSpread IR	0.09	0.15	0.06	0.19
QSpread Sharpe	0.55	0.58	0.67	0.76
QSpread Volatility	9.79	12.02	8.01	8.92
Q1 Hit Ratio (%)	52.18	47.33	50.46	51.15
Q5 Hit Ratio (%)	46.77	46.90	47.54	45.20
QSpread Max Drawdown (%)	59.11	66.24	39.85	56.92

Source: Own simulations (Bloomberg)

A long/short QSpread portfolio of EV/EBITDA strategy quintiles has good results. QSpread annualized active return is high and accompanied by the reasonably high average information coefficient. Low volatility and high returns resulted in a good QSpread Sharpe ratio of 0.76.

In general, valuation strategies confirmed their strength and usefulness. All had linear and strong results accompanied by very high information ratios and largest percentage of stocks outperforming in the top quintiles. Also, all strategies had a positive annualized active QSpread return, which is a good sign of strong factors.

5. Cash Flow

Cash flow is considered the most useful metric. It is because cash is used to pay dividends and interest, buy back shares, repay loans, and make acquisitions. The cash flow also relates more to the reality since earnings do not represent “all the dollars the company has made”.

5.1. Free Cash Flow to Operating Income

The companies with high levels of free cash flow for each dollar of accounting earnings are said to have high-quality earnings (Sloan (1996)). The larger the difference between earnings and cash, the larger the accruals and the less cash the company makes.

Free cash flow is arrived at by subtracting capital expenditures from operating cash flow (OCF). CAPEX represents a nondiscretionary expense that the company must incur to maintain its manufacturing and other operating capabilities. Without capital expenditures, the company could not remain competitive.

Free cash flow to operating income strategy did not test well. Returns were not linear and volatility with maximum drawdown were distributed accordingly – the highest return accompanied by a high volatility. The worst returns were recorded by the bottom quintile that returned 0.56% annually and had a drawdown of -82.95%, which makes it a good starting point for a short selling strategy.

5.2. Cash Return on Invested Capital (CFROIC)

Return on invested capital is defined as free cash flow (instead of NOPAT in the case of ROIC) divided by total invested capital. CFROIC uses cash flow measure in relation to balance sheet values.

Table 13 Cash Return on Invested Capital

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	14.65	7.50	4.15	4.00	-0.56	6.22
Active CAGR (%)	14.14	7.12	3.60	2.99	-3.60	6.22
Average Turnover (%)	27.92	42.43	43.76	40.69	26.90	N.A.
Information Ratio	0.51	0.64	0.27	0.16	-0.02	N.A.
Volatility	30.88	15.75	15.66	18.15	35.19	12.54
Tracking Error (%)	34.86	10.3	10.77	14.12	36.17	N.A
Hit Ratio (%)	51.15	49.84	48.2	46.28	41.14	N.A
Quantile Hit Ratio (%)	72.46	63.77	53.62	44.93	43.48	N.A
Number of Securities	638	638	637	638	637	500
Maximum Drawdown (%)	-54.95	-57.89	-61.55	-66.02	-82.50	-56.78

Source: Own simulations (Bloomberg)

As well as ROIC, CFROIC a factor was one of the best performing. The top quintile returned 14.65% per annum with a very low average turnover and the lowest maximum drawdown. The bottom quintile had the highest volatility, the largest drawdown and the lowest annualized return. The results show that companies which can produce a lot of cash flow from their capital are more stable than companies struggling with cash profitability. Also, the top quintile in this factor had the highest quintile hit ratio.

Due to a high volatility, IR is lower for the top quintile compared to the second quintile. Buying high cash profitable companies therefore does not produce as good risk adjusted results as buying less cash profitable companies as a whole. On the other hand, the highest quantile hit ratio of all one-factor strategies means that if investors devote time to careful stock selection, they might expect good returns.

A combination with other criteria (as shown in Section 10) might further enhance returns.

5.3. Free Cash Flow as Percentage of Operating Cash Flow

Free cash flow to operating cash flow (OCF) measures how much cash flow has the company at its discretion after spending on capital expenditures. Companies with operations that are not CAPEX-heavy enjoy large inflows of free cash that can be used to enhance shareholder value, either through dividend payments or share buybacks.

Free cash flow to operating income produced very strange results. The logic behind the strategy is clear, but the returns seem to be less clear. Over the period of almost 20 years, the companies that are spending too little on CAPEX become less competitive. Too little capital expenditures results in a large free cash flow to operating cash flow ratio. Such stocks are ranked in the top quintile. Although as much free cash flow as possible is welcomed by investors, it seems that investors can discriminate between companies spending too little on capital expenditures and between those that spend enough on CAPEX. Companies ranked in the third quintile then probably have enough capital expenditures – not too much, not too little.

The top quintile had very low information ratio, quite high volatility, very little percentage of stocks outperforming the benchmark and the largest maximum drawdown (-82.52%) of the top quintiles of all one-factor tests.

5.4. Net Income as Percentage of Operating Cash Flow

The difference between net income and operating cash flow is explained by different items that measure the cash flow related to the operating business such as paid taxes, depreciation and amortization, changes in working capital and so on.

In many cases, net income is lower than the operating cash flow because of the abovementioned items that are added to the net income. Sloan (1996) found that current earnings performance is less likely to persist if it is attributable primarily to the accrual component of earnings as opposed to the cash flow component. Therefore, the larger the difference between operating cash flow and net income, the higher the quality of earnings. Sloan divides net operating accruals (net income – operating cash flow – cash from investing activities) by average total assets. This test only measures the difference between net income and operating cash flow.

The difference between operating cash flow and net income did not prove to be a reliable factor on its own. Returns were neither linear, nor strong. The best returns were achieved by the second and fourth quintiles. The top quintile recorded the lowest annualized return and the second highest maximum drawdown. Information ratio was random as well as volatility. Overall, this factor was very weak. However, it will have its place in the FTS described in Part III.

5.5. Free Cash Flow per Share Growth

Free cash flow per share growth was the strongest and most linear from the backtests focused on growth. FCF per share growth compares this year's free cash flow per share to the previous year's free cash flow per share and then ranks the companies from highest to lowest. Tortoriello (2009) uses in his backtests a slightly modified approach. He ranks the stocks based on growth and linearity into an index (Tortoriello, 2009, p. 184). Unfortunately, this type of backtest is not replicable with Portfolio123 or Bloomberg. A simple growth will be backtested.

This strategy failed to produce the hoped for results. The companies that grew free cash flow the most returned less than the overall market and recorded the largest maximum drawdown and had the second highest volatility. The best returns were achieved by companies that ranked in the fourth quintile, i.e. not the fastest cash flow per share growers. One of the reasons might be, as with other ratios, that companies ranking in the top quintiles contain extreme values. That is why investors are aware of such a fact and do not bid up prices of such companies. The mixed results therefore not make this factor a good starting point in creating FTS.

5.6. Summary Statistics

Table 14 Cash Flow - Summary Statistics

	FCF to Operating Income	**CFROIC**	**FCF/OCF**	**Net Income to OCF**	**FCF per Share Growth**
QSpread Ann Active Return (%)	-2.58	6.73	-9.22	-8.97	-9.87
Cumulative QSpread Return (%)	60.70	647.32	-29.60	-18.78	-22.39
Security Count	2911	3188	3222	3652	2682
Average Turnover (%)	36.83	33.62	31.13	34.67	64.10
Average IC	0.0559	0.0923	-0.0399	0.0215	-0.0002
QSpread IR	-0.08	0.18	-0.46	-0.39	-0.51
QSpread Sharpe	0.24	0.56	-0.01	-0.04	-0.21
QSpread Volatility	10.53	13.19	9.23	5.70	3.04
Q1 Hit Ratio (%)	48.04	51.15	42.07	46.03	47.84
Q5 Hit Ratio (%)	41.46	41.14	46.88	44.04	47.72
QSpread Max Drawdown (%)	38.97	52.98	66.07	40.05	34.22

Source: Own simulations (Bloomberg)

Cash flow factors did not perform very well, as was already proven by Tortoriello (2009). The only exploitable factor of those backtested in this section is cash flow return on invested capital. The annualized active QSpread return is positive and high enough. Average information coefficient is very high, which makes this factor especially strong. Hit ratio in the top quintile is the highest of all factors in this section, although not the highest.

6. Capital Allocation

The strongest factors relating to capital allocation (i.e. the use of cash in financing the company's business) are one year reduction in shares and external financing to assets. Both strategies show strong and linear results.

6.1. 1 Year Reduction in Shares

This strategy compares the number of shares outstanding for current quarter with the number of shares outstanding four quarters ago. Share repurchase programs are often welcome by investors since deploying cash through buybacks has tax advantages for shareholders. However, there are contradicting findings by some researches. Gumport (2011) found that from 2000 to 2011, shares bought back were worth 8.8% more than their cost, and buybacks in total have contributed 2.9% to the group's (the group that bought back shares, which was 69.8% samples companies) current stock price. On the other hand, the typical company's stock price saw a -5.7% contribution from buyback. The large difference in numbers is due to large repurchases by large companies that had positive effect on share price, as compared to smaller buybacks by smaller companies.

Eberhart, Siddique (2004) found that an average firm from the study sample (7079 buybacks from 1981 to 1995) increases its shares outstanding by 23.73%, which contradicts logic. The study also found that firms by selling and buying their shares increase their stock's liquidity and this explains the positive stock price reaction to buyback announcements.

1year reduction in shares is modestly performing strategy. There are both linearity in returns and decreasing performance through quintiles. Information ratio is decreasing from the top to the bottom quintile. Also maximum drawdown is not very large and it exhibits increasing tendency towards the bottom quintiles.

Table 15 1Year Reduction in Shares

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	8.81	7.73	6.94	6.39	3.29	6.22
Active CAGR (%)	8.38	6.98	6.22	5.39	0.69	6.22
Average Turnover (%)	26.55	34.53	43.52	35.28	28.89	N.A.
Information Ratio	0.53	0.29	0.42	0.37	0.13	N.A.
Volatility	18.76	26.12	16.84	21.12	37.80	12.54
Tracking Error (%)	15.32	30.51	11.36	12.68	40.46	N.A
Hit Ratio (%)	50.54	48.16	48.54	47.42	43.92	N.A
Quantile Hit Ratio (%)	63.77	59.42	55.07	56.52	42.03	N.A
Number of Securities	706	794	588	696	696	500
Maximum Drawdown (%)	-58.20	-73.41	-61.38	-63.07	-71.56	-56.78

Source: Own simulations (Bloomberg)

The share repurchase strategy is more sensible as an additional factor in FTS or as a complement in qualitative analysis. Dedication of companies' managements should be studied in the broader context of the companies' financial position. As mentioned above, the returns to companies repurchasing their shares might lead to unexpected outcomes.

6.2. External Financing to Assets

The external financing strategy brings the net debt reduction and net share repurchase strategy into a single factor. This test is calculated as the past 12 month cash received from share issuance and long-term debt issuance minus cash paid out for share repurchase and debt reduction plus change in short-term debt. Companies that have the highest amount of net cash paid out for share repurchase, long-term debt reduction and short-term debt reduction are put into the top quintile.

External financing to total assets factor ranks among the strategies that did not test well. Although the information ratio was the largest in the top quintile, the quintile's return was overshadowed by the return of adjacent quintiles. On the other hand, the bottom quintile might serve as a good starting point for short selling strategy. The unsatisfactory results might be caused by insufficient data. Out of nearly 5000 stocks in the universe only a little more than 2000 were ranked in the screen. For the rest of the stocks the database did not contain sufficient amount of data.

6.3. Summary Statistics

Table 16 Capital Allocation - Summary Statistics

Factor	1 Year Reduction in Shares	External Financing to Assets
QSpread Ann Active Return (%)	-2.96	-2.49
Cumulative QSpread Return (%)	45.34	105.89
Security Count	3480	2123
Average Turnover (%)	31.47	33.59
Average IC	0.0618	0.0584
QSpread IR	-0.09	-0.08
QSpread Sharpe	0.23	0.33
QSpread Volatility	11.80	9.08
Q1 Hit Ratio (%)	50.54	49.74
Q5 Hit Ratio (%)	43.92	44.08
QSpread Max Drawdown (%)	71.28	60.57

Source: Own simulations (Bloomberg)

Out of only two capital allocation factors, the useful one was share repurchase strategy (which will be further developed). External financing to assets factor's results would not lead to a good FTS. It is worth noting that 1year reduction in shares factor has negative annualized active QSpread return. This is a result of not very high active return of the top quintile and not very low active return of the bottom quintile. QSpread Sharpe and QSpread IR therefore do not look very impressive.

7. Red Flags

Many stocks that are found in the bottom quintile might be there for a reason. Investors performing quantitative analysis should not overlook the problems that might be discovered through looking at financial statements more critically. Although some future drawbacks cannot be expressed merely by the numbers in income statement, balance sheet or cash flow statement, many of them could, at least from a quantitative point of view. Therefore, an investor has to check the quality of earnings and potential earning manipulation as was stated in several parts in the text above.

This section will examine some common "red flags" that might convey more critical and truer picture of company's financials.

7.1. Operating Cash Flow to Capital Expenditures

Operating cash flow to CAPEX looks at how much cash from operating activities a company has available to fund capital expenditures. This ratio very well relates to the free cash flow ratios described in this thesis, since free cash flow is a result of subtracting capital expenditures from operating cash flow.

Companies that do not generate sufficient operating cash flow to meet capital spending requirements (operating cash flow is lower than CAPEX) may have very limited financial flexibility and run the risk of becoming noncompetitive.

Table 17 Operating Cash Flow to Capital Expenditures

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	12.31	8.05	6.18	4.44	-0.57	6.22
Active CAGR (%)	11.46	7.76	5.65	3.50	-3.89	6.22
Average Turnover (%)	26.48	38.37	40.43	35.36	27.75	N.A.
Information Ratio	0.43	0.71	0.44	0.23	-0.03	N.A.
Volatility	30.21	16.03	15.82	17.75	36.08	12.54
Tracking Error (%)	34.91	10.17	10.61	13.11	37.28	N.A
Hit Ratio (%)	50.21	50.14	48.89	46.97	40.54	N.A
Quantile Hit Ratio (%)	68.12	66.67	59.42	49.28	42.03	N.A
Number of Securities	635	635	634	635	634	500
Maximum Drawdown (%)	-60.04	-56.19	-58.59	-64.04	-83.58	-56.78

Source: Own simulations (Bloomberg)

Free cash flow as percentage of operating cash flow was a poor strategy, which does not apply to operating cash flow to capital expenditures strategy. This is a little bit surprising since both strategies are theoretically two sides of one coin. The first factor should favor companies whose free cash flow is the highest in relation to the operating cash flow – which means low capital expenditures. The second strategy favors companies which have the highest ratio of operating cash flow to capital expenditures. But companies with high OCF/CAPEX ratio have high free cash flow. Nevertheless, it seems that how the investors slice the problem has a great impact on results.

One of the benefits of this factor is its high return in the top quintile. The accompanying volatility makes its IR a little bit lower than the IR of the second quintile. However, this factor recorded the third highest percentage of stocks in the first quintile that outperformed the market.

7.2. Free Cash Flow to Long-Term Debt

This ratio indicates how long it might take a company to pay back its outstanding debt. Companies with no debt or with very high free cash flow (those with very

large operating cash flow in relation to capital expenditures) compared to debt are put into the top quintile. As mentioned previously, companies generating large amounts of free cash flow have enough resources to pay dividends, repay debt or repurchase shares outstanding.

Table 18 Free Cash Flow to Long-Term Debt

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	9.73	7.34	5.07	4.81	-2.09	6.22
Active CAGR (%)	9.54	6.89	4.43	3.33	-4.54	6.22
Average Turnover (%)	27.59	36.94	38.61	36.37	29.99	N.A.
Information Ratio	0.84	0.62	0.34	0.18	-0.03	N.A.
Volatility	16.15	15.70	15.68	23.99	36.29	12.54
Tracking Error (%)	10.64	10.02	11.00	21.67	39.82	N.A
Hit Ratio (%)	50.75	50.08	48.93	46.45	41.97	N.A
Quantile Hit Ratio (%)	65.22	56.52	53.62	46.38	39.13	N.A
Number of Securities	518	518	518	518	517	500
Maximum Drawdown (%)	-53.64	-58.02	-64.87	-68.31	-83.66	-56.78

Source: Own simulations (Bloomberg)

Free cash flow to long-term debt factor achieved the third highest information ratio (after EV/EBITDA and FCF/P factors). This is a combination of quite high annualized return and a low volatility. On the other metrics, this factor show good results. Quantile hit ratio for the top quintile is one of the highest. The top quintile also does not suffer from a large drawdown and the drawdown is increasing through the quintiles from the lowest in the top quintile to the highest in the bottom quintile. The bottom quintile had the lowest annualized return of all one-factor strategies presented in this part[19] and the second largest drawdown.

7.3. Days Sales Outstanding

Revenues are significant indicator of company's success. Although earning positive income is necessary, achieving appropriately large sales is necessary as well. Since revenues are the top line of the income statement and many other items relate to it, it is also a driver of company's profitability.

Due to the nature of Wall Street that needs to see beating analyst estimates, companies sometimes desperately condescend to manipulating accounting numbers. One of such ways is to manipulate revenues.

[19] Only dividend yield strategy recorded lower return in the bottom quintile (-9.04%). Dividend yield strategy is described in Part III.

Table 19 Days Sales Outstanding

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	8.03	5.80	7.71	5.36	3.57	6.22
Active CAGR (%)	6.95	4.92	6.92	4.41	2.03	6.22
Average Turnover (%)	19.07	34.35	41.48	39.95	26.71	N.A.
Information Ratio	0.38	0.31	0.44	0.25	0.06	N.A.
Volatility	21.21	17.36	18.35	18.00	22.19	12.54
Tracking Error (%)	18.41	11.77	12.98	11.81	18.63	N.A
Hit Ratio (%)	47.99	47.83	48.07	47.50	45.86	N.A
Quantile Hit Ratio (%)	49.28	52.17	59.42	52.17	47.83	N.A
Number of Securities	584	583	583	583	583	500
Maximum Drawdown (%)	-60.75	-61.33	-61.62	-59.08	-65.87	-56.78

Source: Own simulations (Bloomberg)

DSO factor did not produce great results but it was included as a check. Investors in general should avoid companies with suspiciously high or quickly growing days sales outstanding. This factor should not be used alone or as a key input in FTS but rather as a check or a component of minority importance. If not included, investors trying to add a little bit of subjective factor into the FTS can consider checking this factor.

7.4. Summary Statistics

Table 20 Red Flags - Summary Statistics

Factor	FCF to Long-term Debt	CFO to CAPEX	DSO
QSpread Ann Active Return (%)	3.34	4.39	-4.02
Cumulative QSpread Return (%)	524.77	368.41	89.52
Security Count	2588.00	3173.00	2917.00
Average Turnover (%)	30.90	31.21	29.14
Average IC	0.08	0.09	0.02
QSpread IR	0.11	0.11	-0.15
QSpread Sharpe	0.69	0.44	0.33
QSpread Volatility	8.90	14.59	7.08
Q1 Hit Ratio (%)	50.75	50.21	47.99
Q5 Hit Ratio (%)	41.97	40.54	45.86
QSpread Max Drawdown (%)	35.65	61.18	41.92

Source: Own simulations (Bloomberg)

CFO to CAPEX factor's linearity and a large difference between the returns of the top and bottom quintiles results in a positive and moderate QSpread annualized active return. Very positive is the fact that the factor has a predictive power (a high average IC). The QSpread maximum drawdown slightly degrades the strategy, which results in not very impressive cumulative QSpread return. On the other hand, the FCF to long-term debt factor has a quite low QSpread maximum drawdown which leads to better cumulative QSpread return even though this

factor has a lower QSpread annualized active return than the CFO to CAPEX factor. The lower QSpread volatility (8.90%) leads to better QSpread Sharpe ratio of 0.69.

8. Two-factor Backtests

These two-factor backtests take the most profitable and strongest single factors and combine them together. As FTS are composed of more than one factor, two-factor backtests are one of the steps to creating profitable and strong systems.

8.1. Return on Invested Capital and Cash Return on Invested Capital

Both of these ratios use the same denominator – invested capital. The idea of combining ROIC and CFROIC is that in the top quintile, companies should have the highest profitability when measured on accrual accounting (ROIC) and cash accounting (CFROIC) basis.[20]

Table 21 Return on Invested Capital and Cash Return on Invested Capital

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	14.40	7.44	5.96	3.67	2.84	6.22
Active CAGR (%)	12.98	7.08	5.51	3.09	2.04	6.22
Average Turnover (%)	27.01	42.48	47.57	46.34	36.00	N.A.
Information Ratio	0.42	0.62	0.46	0.24	0.12	N.A.
Volatility	36.41	15.98	15.11	14.34	14.53	12.54
Tracking Error (%)	46.51	10.17	10.55	11.07	12.27	N.A
Hit Ratio (%)	52.07	51.19	49.67	48.95	47.91	N.A
Quantile Hit Ratio (%)	69.57	65.22	56.52	53.62	55.07	N.A
Number of Securities	351	351	351	351	350	500
Maximum Drawdown (%)	-58.17	-56.01	-57.4	-57.22	-62.57	-56.78

Source: Own simulations (Bloomberg)

8.2. Price to Book and Economic Profits

Although this two-factor test performed well in Tortoriello's (2009) study and showed strong results, it is unfortunately not replicable either with Portfolio123 or Bloomberg.

[20] Because income statement values are based on accrual accounting, an accounting method that matches expenses and revenues they generate, income statement results often differ significantly from actual cash inflows or outflows.

Table 22 Price to Book and Economic Profits

Annual Rebalance			**Quintile**			
1990 – 2007	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
CAGR (%)	18.70	11.80	11.00	6.90	-1.70	12.00
Average Excess Return vs. Universe (%)	8.10	2.00	-1.10	-3.10	-9.90	1.50
Standard Deviation of Returns (%)	0.22	0.17	0.13	0.20	0.35	0.14
Sharpe Ratio	0.74	0.58	0.50	0.23	-0.06	0.64

Source: Tortoriello (2009, p. 145)

The backtest worked reasonably well, showing good linearity in excess returns and a justifiable standard deviation resulting in above average Sharpe ratio of 0.74. This might also serve as one of many confirmations that buying low price to book stocks delivers outperformance.

8.3. Free Cash Flow per Share Score and Enterprise Value to EBITDA

As with return on invested capital and cash return on invested capital, this test combines cash flow-based growth metric (FCF per share score) and accrual accounting-based valuation metric. This combination is important because low value of EV/EBITDA ensures that the investor does not overpay for growth. The growth factor ensures that the company with low valuation is not a value trap (i.e. that the company is not cheap because it has bad fundamentals but that the market is too pessimistic about its future). The backtest results presented below are not based exactly on free cash flow score but on a change in free cash flow per share.

Table 23 Free Cash Flow per Share Score and Enterprise Value to EBITDA

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	9.80	10.52	5.52	3.39	2.49	6.22
Active CAGR (%)	8.99	9.72	4.88	2.83	1.49	6.22
Average Turnover (%)	68.94	70.99	73.48	70.40	59.24	N.A.
Information Ratio	0.71	0.68	0.44	0.21	0.04	N.A.
Volatility	18.43	19.38	17.64	18.17	21.05	12.54
Tracking Error (%)	11.26	13.94	9.41	9.57	11.25	N.A
Hit Ratio (%)	50.40	50.63	49.82	48.67	46.52	N.A
Quantile Hit Ratio (%)	63.77	62.32	53.62	53.62	50.72	N.A
Number of Securities	328	327	327	327	327	500
Maximum Drawdown (%)	-63.46	-60.03	-60.66	-59.69	-64.76	-56.78

Source: Own simulations (Bloomberg)

8.4. Two Year Capital Expenditures Growth and Free Cash Flow to Price

Interrelation in factor test leads to outperformance and good overall results. The interrelation is this backtest lies in the use capital expenditures. Because capital expenditures require large cash outlays, any change in CAPEX significantly changes the level of free cash flow. If the change in capital expenditures is negative (i.e. the CAPEX is declining), the company has more free cash flow to use. A rising free cash flow then increases the FCF/P measure (assuming the price remains the same) which makes the stock cheaper. The top quintile of this strategy contains companies that are lowering capital expenditures and that are because of this reason trading at lower multiples of free cash flow to price.

Table 24 Two Year Capital Expenditures Growth and Free Cash Flow to Price

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	14.01	9.81	8.47	2.48	3.96	6.22
Active CAGR (%)	13.31	9.44	8.16	1.50	2.92	6.22
Average Turnover (%)	51.70	67.30	68.43	67.74	61.10	N.A.
Information Ratio	0.88	0.79	0.68	0.12	0.18	N.A.
Volatility	19.09	16.61	17.01	20.40	25.84	12.54
Tracking Error (%)	15.95	10.94	10.82	14.13	19.92	N.A
Hit Ratio (%)	50.43	53.35	53.16	47.61	46.48	N.A
Quantile Hit Ratio (%)	69.70	71.21	71.21	60.61	53.03	N.A
Number of Securities	309	309	309	309	308	500
Maximum Drawdown (%)	-67.48	-55.59	-53.17	-53.48	-58.03	-56.78

Source: Own simulations (Bloomberg)

8.5. Enterprise Value to EBITDA a Free Cash Flow to Operating Income

This strategy again combines valuation metric with cash flow factor. The denominator in both strategies is fairly similar – operating earnings before depreciation (EBITDA) and operating earnings after depreciation (operating income). The characteristic of this two-factor test lies in paying a low price (low EV/EBITDA) for very profitable companies that generate more than a dollar of cash (FCF) for each dollar of accounting earnings (operating income).

Table 25 Enterprise Value to EBITDA and Free Cash Flow to Operating Income

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	10.30	7.31	6.63	9.92	3.55	6.22
Active CAGR (%)	9.39	6.68	6.22	9.57	2.56	6.22
Average Turnover (%)	45.49	57.34	59.43	54.81	40.73	N.A.
Information Ratio	0.68	0.56	0.55	0.66	0.13	N.A.
Volatility	17.33	16.75	16.60	18.41	19.35	12.54
Tracking Error (%)	12.21	10.59	9.87	13.83	12.09	N.A
Hit Ratio (%)	50.21	50.30	50.59	50.18	47.28	N.A
Quantile Hit Ratio (%)	62.12	56.06	57.58	60.61	50.00	N.A
Number of Securities	404	403	403	403	403	500
Maximum Drawdown (%)	-63.05	-60.29	-58.44	-59.04	-67.91	-56.78

Source: Own simulations (Bloomberg)

8.6. Free Cash Flow to Operating Income and Price to Sales

Free cash flow in relation to operating income ensures that the strategy selects only companies with quality income that generate earnings as well as cash. The valuation metric (P/S) ensures that the stocks are purchased at a low price in relation to revenues. This strategy had consistent returns, large outperformance for top quintile and large underperformance for the bottom quintile.

Table 26 Free Cash Flow to Operating Income and Price to Sales

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	8.70	8.66	8.25	8.15	1.58	6.22
Active CAGR (%)	7.45	8.03	7.82	7.30	-0.53	6.22
Average Turnover (%)	41.16	53.61	56.26	51.84	34.68	N.A.
Information Ratio	0.48	0.67	0.63	0.36	0.04	N.A.
Volatility	17.53	16.30	16.15	24.12	33.01	12.54
Tracking Error (%)	14.35	11.26	11.01	20.69	33.18	N.A
Hit Ratio (%)	48.65	50.92	50.48	48.10	44.23	N.A
Quantile Hit Ratio (%)	54.55	56.06	60.61	54.55	45.45	N.A
Number of Securities	579	578	578	578	578	500
Maximum Drawdown (%)	-69.01	-61.91	-56.24	-59.61	-84.40	-56.78

Source: Own simulations (Bloomberg)

8.7. EBITDA – Capital Expenditures to Invested Capital and Free Cash Flow to Price

In this test, profitability and valuation are used together. And again, income statement and cash flow statement measures are employed. On the one hand, the strategy subtracts capital expenditures from profitability ratio (EBITDA – CAPEX), on the other hand, it is working with capital expenditures in FCF/P ratio. This

backtest measures the strength of the company to generate cash flow and that this strength is bought at a low price.

Table 27 EBITDA - Capital Expenditures to Inveted Capital and Free Cash Flow to Price

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	13.25	11.49	9.92	5.59	5.21	6.22
Active CAGR (%)	13.20	11.24	9.59	5.02	4.40	6.22
Average Turnover (%)	33.31	50.71	56.57	55.29	51.78	N.A.
Information Ratio	1.18	0.99	0.82	0.40	0.30	N.A.
Volatility	17.16	16.80	16.88	16.14	18.46	12.54
Tracking Error (%)	10.31	10.22	10.56	10.68	11.40	N.A
Hit Ratio (%)	53.04	52.02	50.84	48.77	47.50	N.A
Quantile Hit Ratio (%)	71.21	63.64	66.67	53.03	54.55	N.A
Number of Securities	311	311	311	311	310	500
Maximum Drawdown (%)	-56.43	-57.23	-58.86	-58.07	-59.55	-56.78

Source: Own simulations (Bloomberg)

All seven tests in this part fared very well. The reason for good performance lies in the combination of factors. Buying profitable companies, or companies that generate a lot of free cash flow in relation to other metric at low valuation multiples, leads to better returns than in each strategy alone. It is because in the case of individual strategy, companies trading at low FCF/P, EV/EBITDA and other multiples might deserve their valuations. Adding quality criteria helps find companies that should not be that cheap. This is well underlined by the quantile hit ratios for top quintiles of these strategies. Nearly in all of the two-factor strategies, more than 2/3 of companies in the top quintile outperformed. These results were not that common in one-factor backtests.

Part III – FTS and Criteria to Enhance Alpha or Beta

Investment returns are mostly divided into two separate categories – alpha and beta. These measures relate to the CAPM of Sharpe (1964) and Lintner (1965). Beta represents a degree to which a stock price co-moves with the overall market. Stocks with beta higher than 1 are considered riskier, stocks with beta lower than 1 are considered less risky.[21] As a part of standard deviation (the price change of a financial instrument during a period of time), beta represents the so called market (systematic) risk. The rest of standard deviation is explained by idiosyncratic (firm-specific risk) that is diversifiable. According to Efficient Market Hypothesis, additional return is only achievable by undertaking more risk (a steeper SML). Stocks with higher beta should be returning higher percentage to reflect their higher riskiness. But according to findings by French and Fama (1992), the relation between beta and average return (for 1941 to 1990 period) is weak, perhaps nonexistent, even when beta is the only explanatory variable.

Alpha is an abnormal return that does not correspond with the riskiness of the stock as measured by the beta. According to the theory, stocks earning positive returns should be quickly discovered and the mispricing should be corrected. As will be presented in the section below, the backtested strategies not only had lower beta then the market in many cases, but managed to deliver better risk-adjusted returns than the market.

Many strategies are built around an idea. Piotroski's strategy (not replicated in this thesis) uses criteria regarding high profitability, high margins, quality of earnings and improved fundamentals – higher return on assets from year to year, higher gross margin from year to year. It also uses share buybacks as a check of the strength of a company.

Another well known "strategy"[22] was devised by Altman. His Z score focuses on the financial stability of a company. The common theme is comprised of company's liquidity, quality of its balance sheet and leverage.

In both aforementioned cases, the companies that would pass the screen have to fulfill strict criteria that combine well. In Piotroski's strategy, a company's improved return on assets must come from improved margins rather than from lower assets and furthermore, the model sets a condition of earnings quality in a form of operating cash flow that must be larger than net income.

[21] The beta of the market is 1.

[22] Altman's Z score was not constructed as a strategy and is not meant to be thought of as one.

Own strategies developed and researched in this part will follow similar logic. Strong and fundamentally consistent strategies need to have a thought, a combination of factors that complement each other and together point to strong and healthy companies.

1. Dividend and Buyback FTS

Two ways how a company might benefit its shareholders are by paying dividend and repurchasing outstanding shares. A research by Goldman Sachs shows[23] that companies involved in large buybacks outperformed the market by an average of 5.3% per year for the last two decades and on total cash return (buybacks plus dividends) these companies averaged 6.23% outperformance a year.[24]

As shown in Part II, Section 7, 1year reduction in shares outstanding (a buyback) is a strong one-factor strategy. Four quintiles earn a decent return while the companies buying back the largest amounts of shares earn the largest return.

Table 28 Dividend Yield

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	5.66	3.59	2.43	-1.93	-9.04	6.22
Active CAGR (%)	4.59	2.92	1.17	-3.15	-10.22	6.22
Average Turnover (%)	15.63	22.81	17.49	8.29	8.17	N.A.
Information Ratio	0.32	0.22	0.07	-0.14	-0.44	N.A.
Volatility	15.90	15.49	21.81	8.14	11.04	12.54
Tracking Error (%)	14.17	10.52	18.47	18.40	20.89	N.A
Hit Ratio (%)	50.03	48.70	40.32	12.77	8.42	N.A
Quantile Hit Ratio (%)	60.81	63.51	48.65	45.95	36.49	N.A
Number of Securities	504	764	1169	61	20	500
Maximum Drawdown (%)	-63.85	-61.05	-71.01	-30.88	-58.29	-56.78

Source: Own simulations (Bloomberg)

The dividend yield strategy (results in Table 28) is relatively weaker, but shows more linear results. One striking fact is that the top quintile does not beat the market. The underlying problem is that stocks which ranked highest recorded extremely high (50% and more) dividend yields. Very high yields are unsustainable. Investors are aware of the fact and might shun away from such

[23] Valuewalk.com. Large Buybacks Outperform S&P 500 by 5 Percent Per Annum [online]. c2013 [quoted on November 4, 2013]. Available on: <http://www.valuewalk.com/2013/10/large-buybacks-outperform-sp-500/> and Mebanefaber.com. The Problem With Buybacks [online]. c2013 [quoted on November 4, 2013]. Available on: <http://www.mebanefaber.com/2013/10/24/the-problem-with-buybacks/>

[24] See Picture 1 in Appendix

stocks. Even if investors know that in the longer term the yield has to diminish, they will not buy baskets of very high dividend yield stocks. One way to decrease the dividend yield is through price appreciation (which the investors would welcome). The other way is through dividend cut (which the investors worry).

Malkiel (2003) notes that buying high dividend yield stocks does not have to earn high rate of return. A popular strategy called "Dogs of the Dow" which involves buying the 10 stocks in the Dow Jones Industrial Average with the highest dividend yield did well over many years. However, in the second half of the 1990s the strategy underperformed the market averages. In a period since the mid-1980s the use of dividends to predict future returns has been ineffective.

Portfolio123 backtest of buying top quintile of stocks by dividend yield rebalanced quarterly returned 10.03% annually. Detailed results are in the table below.

Table 29 Dividend and Buyback FTS Backtest 1

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	308.98	10.03	-61.61	0.25	0.31	24.28	0.88	0.77	0.85	7.31
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

Buying top quintile of companies that repurchased stocks led to slightly better returns, lower maximum drawdown, but a higher standard deviation. Alpha of this strategy (although simple) is not very impressive, especially with respect to a high beta. The strategy should thus be improved.

Table 30 Dividend and Buyback FTS Backtest 2

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	417.71	11.80	-60.88	0.30	0.39	25.99	0.92	0.85	0.95	9.20
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

A combined strategy (the top quintile of stocks paying dividends and the top quintile of companies repurchasing shares) worked worse than each strategy on its own. The return was only 9.54%, maximum drawdown increased to -62.94% and Sortino ratio decreased to 0.28. Since the share repurchase strategy worked better (in Portfolio123 and in Bloomberg backtest) it will be further developed.

However, limiting the total number of shares bought to 30 and using valuation criteria from Part II, Section 7, and ranking the stocks by the price to earnings ratio shows the best results. The return increases to 12.37%. Nevertheless, the maximum drawdown increases to -67.04% and the standard deviation reaches 31.25%. The improvement in return is strong enough to increase Sortino ratio to 0.36. Ranking by price to book value and free cash flow yield returned subpar performance.

Although the dividend yield strategy combined with share repurchase did not result in a good performance, adding dividend increases (from current quarter to four quarters ago) to share repurchase strategy further improves the performance. The condition of increased dividends does not conflict with the omission of high dividend yield. Investors do not appreciate high dividend yields (as mentioned above), but favor large dividend increases. The strategy returns 14.48% annually with a maximum drawdown of -61.10% and a standard deviation of 29.70%. This results in Sortino ratio of 0.46.

The reasons for improved performance are: investors like to see increasing dividends and they like to see them constantly. Companies not increasing or even decreasing or omitting the dividend are excluded, which especially helps the portfolio during the crisis, since only profitable companies with healthy fundamentals can increase dividends.

Extending the rebalancing period to one year further increases returns to 17.10%. Although the standard deviation is higher at 28.34% as well as maximum drawdown of -63.24%, the strategy records a Sortino ratio of 0.59. Furthermore, alpha increased by almost 50% compared to the simple buyback strategy, and beta decreased a little.

Table 31 Dividend and Buyback FTS Backtest 3

Rebalance: Annually	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	924.58	17.10	-63.24	0.46	0.59	28.34	0.82	0.67	0.93	14.24
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

This modification of buyback strategy might yield better returns because of two reasons: lower commissions due to less rebalancing (once a year instead of four times a year in the case of quarterly rebalanced strategy) and longer time period for upside realization. A quarter may be too short to reflect the effect of a buyback and dividend increase on the stock price.

The complete strategy criteria are as follows:

1) Universe(nootc)
2) Country("CHN")=false
3) Universe($ADR)=false
4) Price*Vol10DAvg>0.1
5) FRank("EqPurchTTM")>80
6) DivPS(0,QTR)>DivPS(4,QTR)

Rules number 1) to 3) are in line with stock selection criteria in the methodology section of Part I, rule number 4) is the price-volume condition. Rule number 5) ranks companies repurchasing their shares and selects the top quintile (i.e. the top 20%) and rule number 6) shortlists stocks that have a larger dividend per share in the current quarter than four quarters ago. Then the stocks are lined up according to their price to earnings ratios and 30 with the lowest P/E are selected to the portfolio. This is repeated every year.

2. Value FTS

2.1. Graham Defensive

One of very simple strategies was devised by Benjamin Graham (2006). His value screen for defensive investors contains following criteria (Graham, 2006, pp. 348 – 349):

1) Adequate size of the enterprise
2) A sufficiently strong financial condition
3) Earnings stability
4) Dividend record
5) Earnings growth
6) Moderate price to earnings ratio
7) Moderate ratio of price to assets

Regarding rule number 1), Jason Zweig in the commentary to the chapter specifies that at the beginning of the new century, investors might include only companies with market capitalization larger than $2 billion. Rule 2) relates to the current ratio that must be larger than 2. Earnings stability ensures that only companies with a profit in the past ten years are included. Dividend record is described by Graham as “Uninterrupted payments for at least the past 20 years.” (Graham, 2006, p. 348) As for earnings growth, Graham required 1/3 increase in per-share earnings in the past 10 years using three-year averages at the beginning and end. This will be replaced by a simpler criterion of EPS in current year 33% larger than

an EPS 10 years ago. Moderate price to earnings ratio ensures buying only stocks with P/E lower than 15. The last rule requires buying stocks with price to book ratio of less than 1.5. A composite measure can be used. A multiplication of P/E and P/B should be less than 22.5.[25]

Table 32 Graham Defensive Backtest 1

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	774.39	15.55	-65.41	0.30	0.41	38.89	0.70	0.49	1.09	13.04
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

The strategy did not perform badly. It is not very correlated with the market, but it has a large drawdown. This might be the result of not many stocks in portfolio. Between years 2000 and 2005, the strategy held less than 10 stocks at each instance. But since 2007 more stocks passed the screen and in 2009 it was almost fully invested.

Several attempts to modify the strategy did not improve returns. Allowing lower capitalization stocks, which should be in line with academic studies' findings that small market capitalization stocks outperform the market, or eliminating companies with EPS larger by 33% nowadays than 10 years ago did not lead to satisfactory results.

Limiting the number of stocks held in portfolio to 10 and ranking them by their P/E ratio helped produce better returns. Annual return increased to 18.06%, but standard deviation and maximum drawdown increased. Despite the fact, Sortino ratio reached 0.47. Results improved because 20 stocks that could be included were the 30-stock portfolio enabled, were higher valuation companies. Therefore the system chooses cheaper (and probably more undervalued) companies, which results in increased returns.

Table 33 Graham Defensive Backtest 2

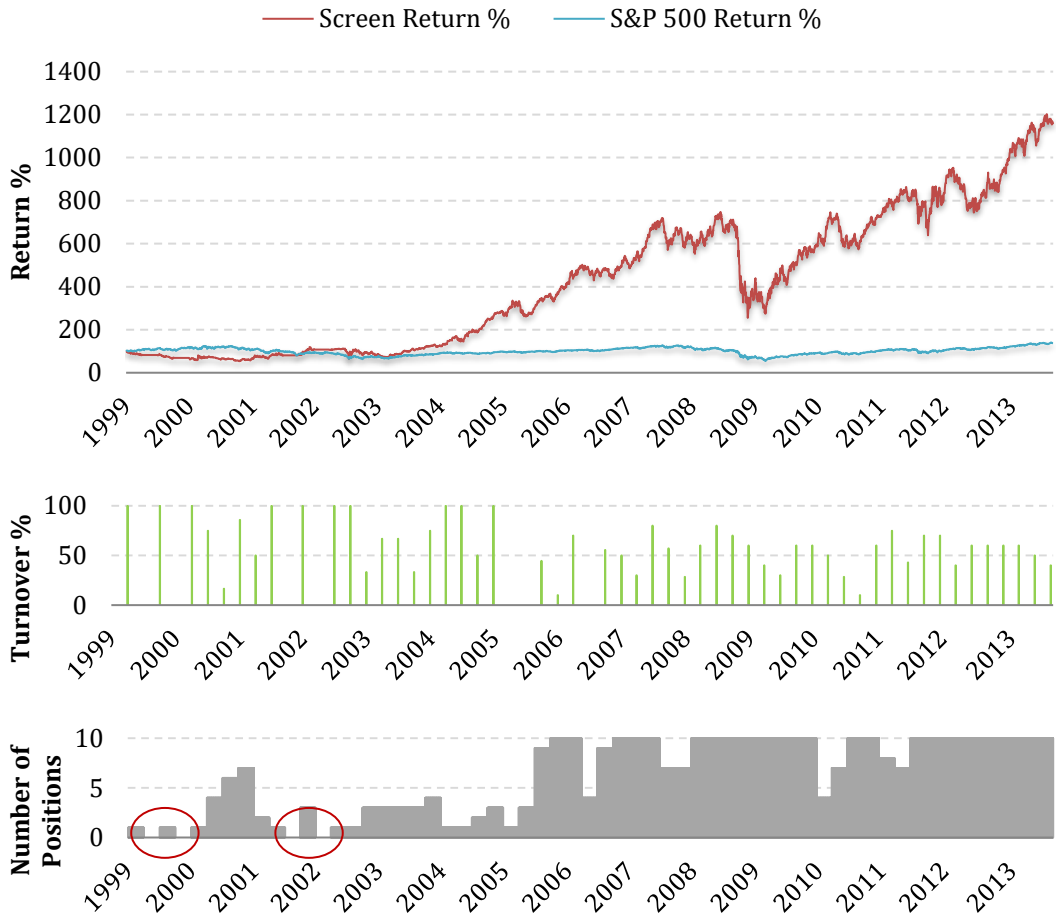
Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	1,055.21	18.06	-65.97	0.34	0.47	40.72	0.70	0.50	1.14	15.55
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

[25] A stock with P/E 10 and P/B 2 might be considered since the result is 20, or a stock with P/E 20 and P/B 1 might also be considered since the result is 20 and thus less than 22.5.

The improved strategy comes with higher alpha, but quite a high beta. Adjustments to the strategy, most notably its simplification and ranking did not help reduce beta. An alpha of 15.50% with such a beta of 1.14 is not a very welcome result.

Chart 1 Graham Defensive



Source: Own simulations (Portfilo123)

Large drawdown in 2008 and high volatility diminish risk-adjusted returns. One of the shortcomings of the strategy is that it underperformed the market from 1999 to 2002 – a screen equity curve is below the benchmark's equity curve.

The period between 1999 and 2002 represents a time around the market top that was accompanied by irrational behavior and large overvaluations. In such extreme conditions value stocks tend to have worse returns than the market – a high tracking error of value investing. The other reason for underperformance is that at market tops, there are not enough undervalued companies and only few stocks pass Graham's strict criteria. The supporting argument can be found in the lowest chart. At four instances between 1999 and 2003, the strategy was not invested at all (four small dents in red circles).

The complete strategy criteria are as follows:

1) Universe(nootc)

2) Country("CHN")=false
3) Universe($ADR)=false
4) Price*Vol10DAvg>0.1
5) MktCap>2000
6) CurRatioQ>2
7) EPS#Positive
8) Yield>0
9) EPSExclXor(0,ANN,FALLBACK)>1.33*EPSExclXor(10,ANN,FALLBACK)
10) (PEExclXorTTM*Pr2BookQ)<22.5

Rules 1) to 4) were already defined, rule number 5) chooses only tocks with capitalization larger than $2 billion (the MktCap value is stated in millions, therefore 2000 is the limit of $2 billion). Rule number 6) is the current ratio for the most recent quarter, rule number 7) selects the stocks with the largest number of positive earnings (instead of just earnings in the last 10 years). Rule number 8) selects stocks that pay at least some dividend – this condition is less strict than the Graham's one of paying dividends for at least the past 20 years.[26] Rule number 9) means that the EPS[27] in the current year is 33% larger than EPS 10 years ago. The last rule multiplies the price to earnings[28] with the price to book ratio in the most current quarter and the result must be lower than 22.5.

2.2. Graham Enterprising

Another Graham's strategy is little bit more aggressive and was devised for an "enterprising" investor. The criteria are (Graham, 2006, pp. 385 – 386):

1) Current assets at least 1.5 times current liabilities
2) Debt no more than 110% of net current assets
3) No deficit in the last five years
4) Some current dividend
5) Last year's earnings more than those of 5 years ago[29]
6) Price less than 120% net tangible assets

[26] Portfolio123 does not contain data for such a long period of time.
[27] EPSExlXor means EPS excluding extraordinary items. 0 is set for the current year, ANN means using annual values and FALLBACK relates to handling of N/A values. If there is not a value for a certain parameter, the database contains N/A field. If the system runs into N/A value and is told to FALLBACK, it uses the value from the previous period (i.e. if the EPS is N/A for 2005, it will use EPS of 2004 instead).
[28] Excluding extraordinary items
[29] The original vision is: Last year's earnings more than those of 1966. Benjamin Graham was writing the modified edition in 1971. 1966 was 5 years ago, therefore the condition of 6 years is used in the green hereby presented.

Table 34 Graham Enterprising Backtest 1

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	649.36	14.64	-66.02	0.37	0.51	28.82	0.77	0.60	0.89	11.81
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

This strategy shows better results than the strategy for defensive investors. It is less volatile (standard deviation is only 28.82% instead of 38.89% in the first strategy), which leads to better Sortino ratio. Limiting further the maximum number of positions to 30 and ranking the stocks by price to earnings ratio shows a little improved results: annualized return of 14.76%, maximum drawdown improves to -65.60%, but a standard deviation increases a to 29.19%. Stretching the rebalance period to one year did not lead to improved returns.

Further decreasing the number of stocks held in portfolio to 10 increases returns. The reasons are similar to those stated in the backtest of the previous strategy. Lesser stocks ranked by P/E ratio may mean more undervalued companies with higher upside potential, which is reflected in the performance. Similar to the case of portfolio with 30 stocks, extending a rebalance period to one year did not improve results. The standard deviation increased together with maximum drawdown which reached -75.59%. In conclusion, this strategy works very well with quarterly rebalance. It is because it is composed mainly of factors based on quarterly data.

Table 35 Graham Enterprising Backtest 2

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	1,176.79	18.86	-65.27	0.45	0.61	33.03	0.73	0.53	0.96	16.00
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

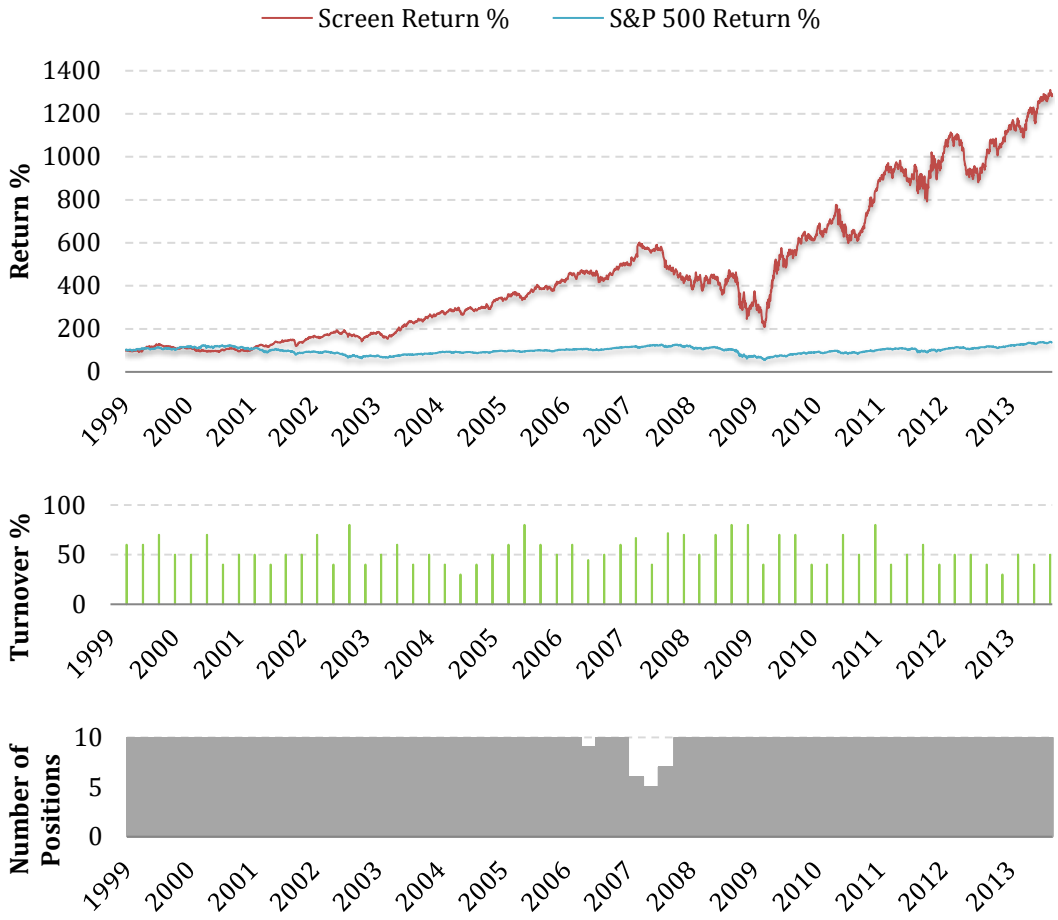
Source: Own simulations (Portfilo123)

In contrast to Graham's more conservative strategy, the version for enterprising investor showed improved overall results. CAGR increased, leading to much better alpha, and a standard deviation of returns decreased. A lower beta is accompanied by a higher alpha together with lower correlation with the benchmark.

Positive for the strategy's performance is relatively low turnover. This result does not correspond to other strategies with annual rebalance periods. The lower turnover is supportive of the fact that one quarter is a period not long enough for a

significant change of a fundament. Furthermore, the strategy recorded a period in which it was not fully invested, which was at the market top in 2007 and in one quarter in 2006. Under such conditions, there were not enough companies passing the relatively strict condition of very low price to book multiple.

Chart 2 Graham Enterprising



Source: Own simulations (Portfilo123)

The complete strategy criteria are as follows:

1) Universe(nootc)
2) Country("CHN")=false
3) Universe($ADR)=false
4) Price*Vol10DAvg>0.1
5) CurRatioQ>1.5
6) DbtTotQ<=((CurAstQ-CurLiabQ)*1.10)
7) Yield>0
8) ItemA(EPSFX,0)>0 and ItemA(EPSFX,1)>0 and ItemA(EPSFX,2)>0 and ItemA(EPSFX,3)>0 and ItemA(EPSFX,4)>0 and ItemA(EPSFX,5)>0
9) Pr2BookQ<1.2

Rule number 5) is the same as “current assets at least 1.5 times current liabilities” condition. Rule number 6) concerns the limitation of debt as percentage of net

current assets. Rule number 7) selects stocks paying at least some dividend. Rule number 8) states that earnings per share excluding extraordinary items have to be positive for a current year and each of the previous five years. The last rule selects stocks that trade at less than 1.2 price to book ratio.

2.3. Graham Medical

A much simpler strategy was devised by Graham in 1976 issue of Medical Economics Journal. This strategy buys only stocks that trade at P/E below 7 and that have equity to assets ratio larger than 50%. Buying only 30 stocks into portfolio ranked on the price to earnings ratio from the lowest to the highest yields better returns than both previous Graham's strategies.

Table 36 Graham Medical Backtest 1

Rebalance: Annually	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	830.26	16.34	-51.41	0.44	0.59	28.23	0.61	0.38	0.70	13.09
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

This strategy has the highest return so far and the lowest maximum drawdown. Although the standard deviation is not the lowest, the Sortino ratio reaches 0.59. Correlation with the benchmark is the lowest so far. One of the important features of the strategy is its very low beta, low correlation with benchmark, and a satisfactory alpha. Graham's much "complicated" strategy using more criteria lead to an alpha of 11.81% and beta of 0.89. A strategy of only two criteria is, from a quantitative point of view, more preferable. This is supported by its low beta and high (in relation to beta) alpha.

In order to further improve the results, the maximum number of stocks to be held in portfolio was capped at 10. A quick ranking method was used – ranking by EPS growth, where the higher the growth, the better. Results are shown Table 37.

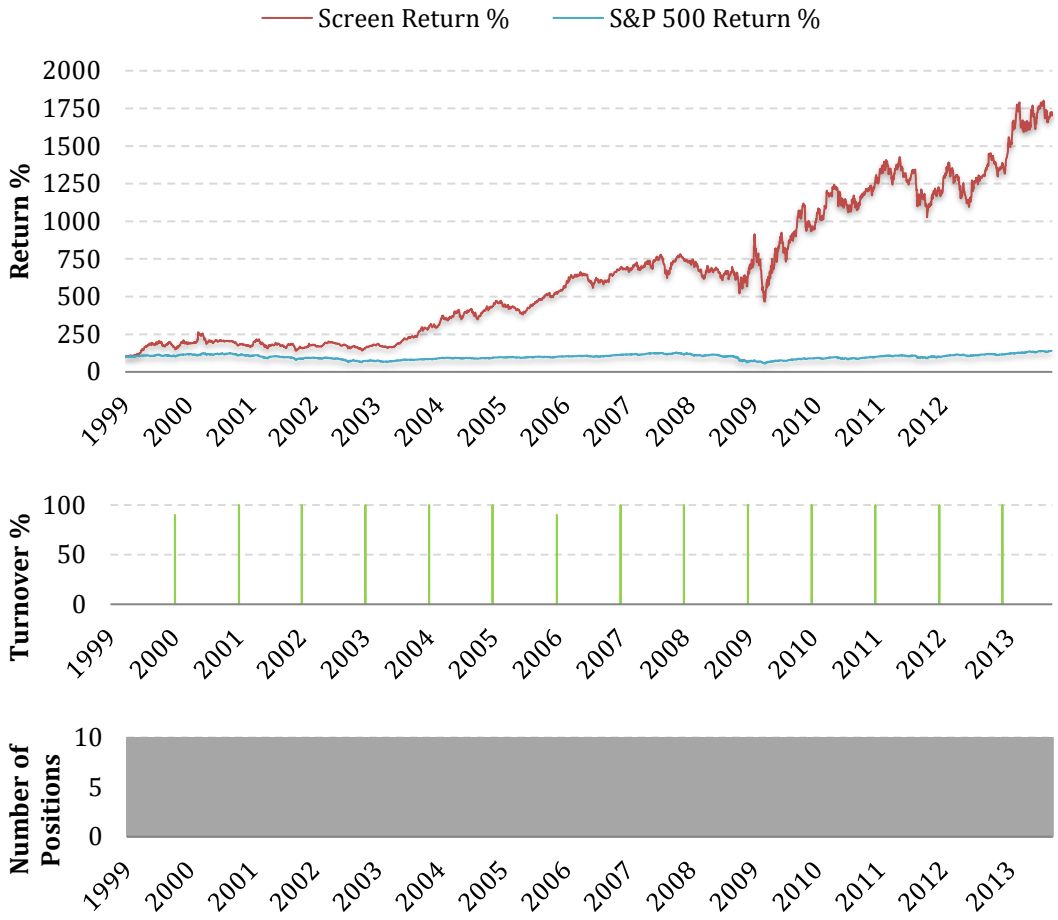
Table 37 Graham Medical Backtest 2

Rebalance: Annually	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	1,597.32	21.18	-48.89	0.51	0.75	33.49	0.57	0.32	0.76	17.86
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

Results of this strategy are very promising. High annualized return with low maximum drawdown and low volatility lead to a satisfactory Sortino ratio and a low beta and high alpha. The linearity in the strategy and not a disastrous drawdown in 2008 translate into low correlation.

Chart 3 Graham Medical



Source: Own simulations (Portfilo123)

The complete strategy is as follows:

1) Universe(nootc)
2) Country("CHN")=false
3) Universe($ADR)=false
4) Price*Vol10DAvg>0.1
5) PEExclXorTTM<7
6) EqTot(0,ANN,FALLBACK)/AstTot(0,ANN,FALLBACK)>0.5

Rule number 5) selects stocks that trade at less than 7 times earnings in the trailing twelve months. Rule number 6) is a formula for selecting stocks with equity to assets ratio of more than 0.5.

Simplicity makes this strategy very strong. A long holding period and no constant maintenance are its advantages. Before the implementation of this strategy in real-

life portfolio management, an out-of-sample test would be necessary to confirm or falsify the value of selected criteria in the long term.

3. Own Strategies

3.1. Strategy I

This strategy presented below is built around an idea of growth and financial statements improvement. It uses the some common themes tested in Part II and in the Piotroski's strategy.

One of the key points of this strategy is its focus on undervalued small capitalization companies. The size of the eligible stocks is capped at $500 million and the strategy only includes stocks ranked in the top quintile of the EPS multiple. The idea is clear from the tests from Part II. Small capitalization stocks performed well and buying stocks of companies in the top quintile of the price to earnings strategy resulted in a strong outperformance.

Another key metric that was used is the idea of margin expansion. Margin expansion was expressed as an EPS growth that was larger than sales growth (i.e. net margin increase) and this growth was recorded in the previous quarter. Margin expansion was crucial in the post-market-crash period. In this period, the strategy recorded the highest annualized return – 46.53%.

Financial statements improvement is expressed by two metrics. The first is the increase in the return on assets. No ranking was used in this case. The mere condition of the improvement of ROA was satisfactory. The idea of net margin expansion translates well into another factor – current ratio – which is arrived at by dividing current assets by current liabilities. The current ratio improvement is of significant importance to the strategy's idea. Growth in sales goes hand in hand in growth in assets. When sales grow, items included in current assets and liabilities grow almost accordingly. If net margin increases together with the improvement of current ratio, the company significantly improves its operations. More money is earned from a dollar of sales and this translates to improved operating cash flow. If the company does not spend much more on CAPEX, dividends, debt repayment or stocks repurchase, and does not increase borrowings from the previous year by a large percentage, the net change in cash is positive, which in the end increases current assets. The criterion of stock buybacks also fits into this strategy very well. Increased earnings lead to increased cash flow, which the company uses to repurchase some shares. And still the current ratio is improved.

The strategy's returns are presented in a table below. One of important features of the strategy is its low correlation with the benchmark. The lower correlation is a result of good performance at the beginning of the new century when many fundamental strategies underperformed (mostly value strategies which have high tracking error), and from the large outperformance from 2009. The strategy also comes with a low beta and satisfactory alpha.

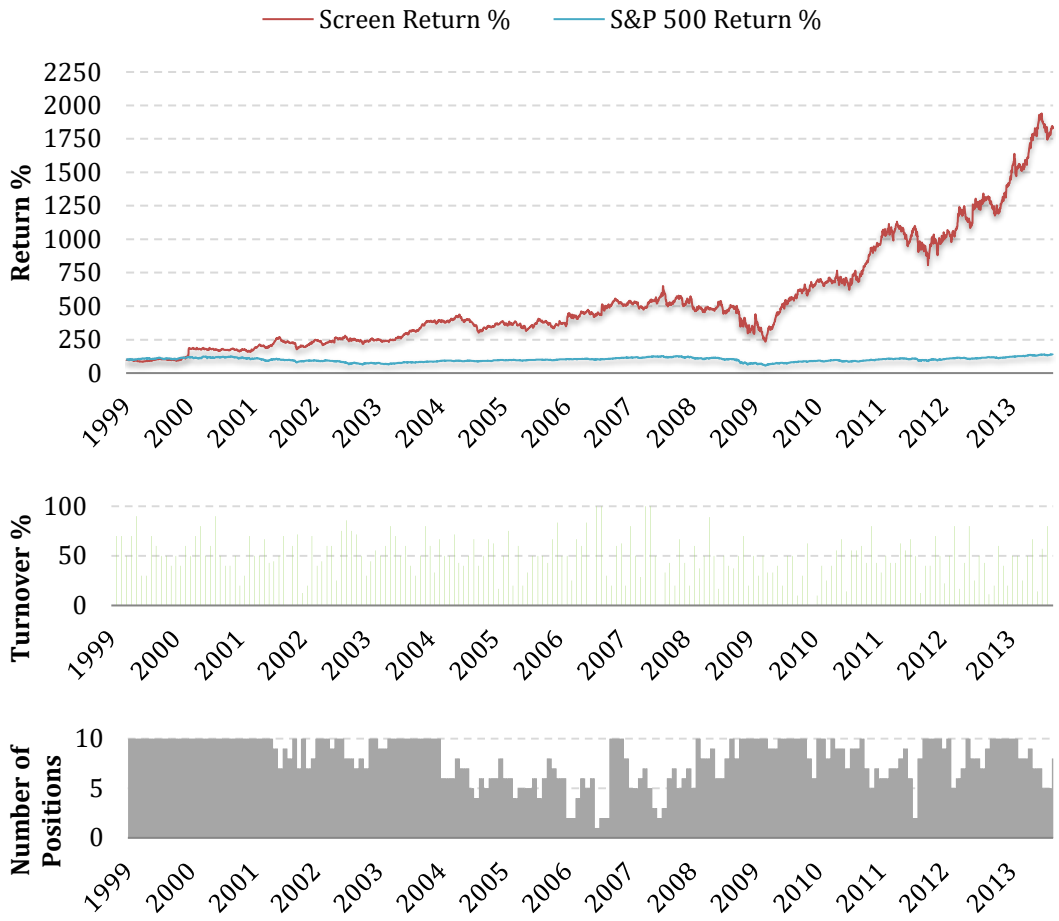
Table 38 Strategy I Backtest 1

Rebalance: Monthly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	1,722.69	21.77	-63.73	0.49	0.74	36.14	0.58	0.34	0.84	18.58
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

Turnover is not very high, reaching 100% only in times when the strategy is invested only in handful of stocks. The number of stocks passing the screen is also significant since not many companies pass the quite tough criteria. Although this might point to under-diversification, this should not be a headwind. With only one month holding period, the fact of holding few stocks does not pose a big problem because such strategy is manageable manually.

Chart 4 Strategy I



Source: Own simulations (Portfilo123)

The complete strategy is as follows:

1) Universe(nootc)
2) Country("CHN")=false
3) Universe($ADR)=false
4) Price*Vol10DAvg>0.1
5) MktCap<500
6) FRank("PEExclXorTTM",#Universe,#ASC)>(100-20)
7) EPS%ChgPQ>Sales%ChgPQ
8) ROA%TTM>ROA%PTM
9) CurRatioQ>CurRatioPYQ
10) EqPurchQ>0

The first four criteria have already been described in other strategies. Rule number 5) limits market capitalization of eligible companies to $500 million. The next rule ranks stocks in the universe by price to earnings ratio and selects the top quintile. Rule number 7) shortlists only those companies whose net margin increased from quarter to quarter. Rule number 8) selects companies with return on assets higher in the trailing twelve months (TTM) period than in the prior twelve months (PTM)

period. Rule number 9) further selects companies with improved current ratio and the last rule eliminates companies that did not repurchase shares.

3.2. Strategy II

A strategy presented below is based on much simpler idea than the just described strategy. It focuses on undervalued companies with a reasonable level of debt and whose profitability is improving. Again, the conditions of this strategy combine well both quantitatively and fundamentally. From a fundamental point of view, the first part of the idea is buying companies close or under their book value, which makes it very conservative and risk-averse (Graham (1996), Klarman (1991)).

The second part of the idea is that the shortlisted companies should have the lowest possible debt. Stocks that rank in the top quintile often have no debt or very little debt. The last part of the idea is profitability improvement. If the company's net margin improves (here expressed as a faster growth in net income in relation to the revenue) it is a good sign. The more money the company earns, the more can be used to repay debt, repurchase shares, reinvest back into the business, acquire other companies or pay dividends. Combining these criteria together leads to good results.

From a quantitative point of view, a strategy of buying low price to book stocks was one of the best performing one-factor strategies. Simply buying the top quintile of low P/B stocks yielded 7.75%[30] per annum for the backtested period with a huge drawdown in 2008 and a high volatility. Furthermore, the number of stocks passing the screen ranged from around 350 to 700. Adding a criterion of low indebtedness increased the annual return to 11.93% and decreased maximum drawdown and the standard deviation. A strong influence on the return had the introduction of growth factor: earnings per share growth over the past year that is larger than the sales growth (which is the same as a growth in net margin). After this adjustment, the return increased to 20.92% per annum. Maximum drawdown decreased as well as volatility. The Sortino ratio stood at 0.72. The system still selected too many stocks (between 15 and close to 60).

The final adjustment was made by ranking the stocks by the change in EPS over the past year, where higher number was preferred (i.e. the largest growth). Maximum amount of stocks was limited to 10. Adding these criteria increased the return to 22.13% per annum. On the other hand, maximum drawdown increased (to -60.41%) and the standard deviation was also quite high (39.44%). A possible explanation of the fact might be the EPS growth ranking and the reaction of the

[30] This return was a result of backtest with Portfolio123 in a period from January 1999 to September 2013. Therefore it differs from the performance stated in Part II, Section 4. because these tests covered different periods.

market to the announcement. If the growth of EPS is very large, the market might overreact and push up the price of the stock. After some time, the price might decline. In the three-month holding period, the market might have enough time to correct the initial post-earnings reaction. If the holding period is shorter, the stock market may not have enough time to readjust the price.

Decreasing the holding period to one month further increases the return. Much of the improved performance is attributable to the period from 2009. From 2011 the system did not work well. The reason of outstanding performance between 2009 and 2011 lies in the combination of factors. In 2009, many good quality companies traded at depressed prices, some of them under their book value. This was an unjust valuation for companies with low or no debt and improving operations. As soon as market panic waned, investors realized that those companies were undervalued and quickly corrected this mistake in valuation. This correction led to a great outperformance in those years.

To corroborate the findings, it is worth noting that the large run-up in price from 2009 to 2011 is also the result of mean reversion in corporate earnings. During the crisis corporate earnings declined but revived in a short period of time. Investors dumped shares in panic because of temporarily depressed earnings, and then started buying these shares after the panic went off, which led to the strong performance between the years 2009 and 2011. Unfortunately, from 2011 on, the strategy performed badly and on September 30, 2013 ended with lower return than at the beginning of 2011, meaning that from 2011 it went through a money loosing period (a line ending lower in Chart 5).

Table 39 Strategy II Backtest 1

Rebalance: Monthly	**Total Return**	**CAGR (%)**	**Max DD (%)**	**Sharpe Ratio**	**Sortino Ratio**	**STD (%)**	**Correlation**	**R^2**	**Beta**	**Alpha (%)**
Screen	2,793.81	25.65	-56.44	0.58	0.87	37.58	0.58	0.34	0.88	22.37
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

Extending the rebalance period to one year led to surprisingly good results. The strategy's return rose by nearly 5.5 percentage points, but the most important improvement concerns maximum drawdown and standard deviation. This total improvement led to higher Sortino and Sharpe ratios, lower correlation, lower beta and a high alpha.

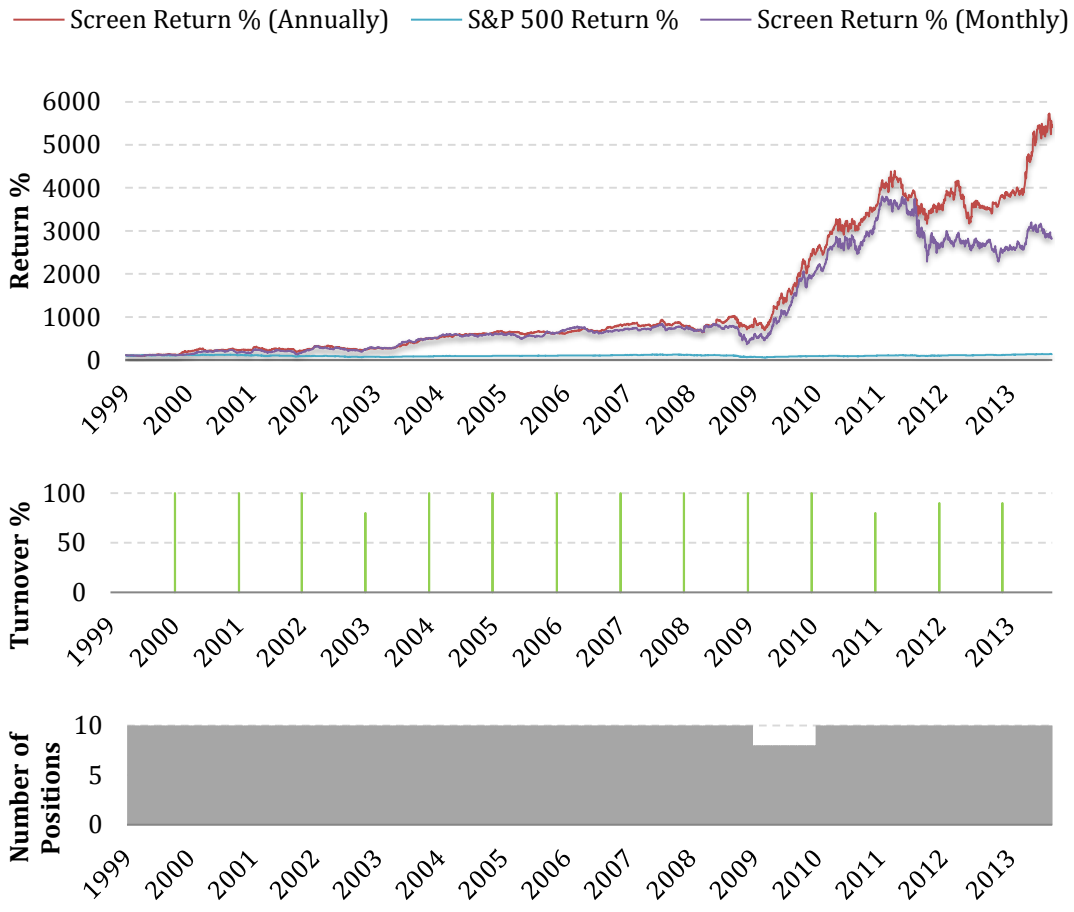
Table 40 Strategy II Backtest 2

Rebalance: Annually	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	5,290.13	31.07	-39.10	0.78	1.23	34.46	0.49	0.25	0.68	27.23
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

Because of one year holding period, this strategy has almost 100% turnover because many stocks that passed at the beginning of the period do not qualify at the next rebalance. The strategy is fully invested nearly through the whole period with exception of 2009 when only 8 stocks were held in portfolio.

Chart 5 Strategy II



Source: Own simulations (Portfilo123)

The complete strategy is as follows:

1) Universe(nootc)
2) Country("CHN")=false
3) Universe($ADR)=false
4) Price*Vol10DAvg>0.1

5) FRank("Pr2BookQ",#Universe,#ASC)>(100-20)
6) FRank("DbtTot2EqQ",#Universe,#ASC)>(100-20)
7) EPS%ChgPYQ>Sales%ChgPYQ

Rule number 5) ranks stocks according to the P/B ratio and selects the top quintile. Rule number 6) ranks stocks according to the debt to equity ratio and selects the top quintile. The last rule selects into portfolio only companies that improved their net income margin.

3.3. Strategy III

The following strategy builds on the previous findings and backtests in Part II. The main idea is a search for potentially undervalued companies that have high returns on invested capital. These companies need to have the highest net profit margin in the universe and this profit margin must be increasing. Furthermore, the increased net income, which is a result of improved net profit margin, must be lower than operating cash flow (see Part II, Section 5. Net Income as Percentage of Operating Cash Flow for explanation). The increased operating cash flow must not be eaten up by capital expenditures and the difference between operating cash flow and capital expenditures (see Part II, Section 7. Operating Cash Flow to Capital Expenditures for explanation) must be widening, which is translated to increased free cash flow in the TTM period compared to the free cash flow in the PTM period.

The core of the strategy is composed of EV/EBITDA and ROIC factors that showed one of the best results. This two-factor strategy worked quite well, but additional factors improved the performance. Namely net margin improvement and free cash flow growth led to the largest improvements. A simple ranking by EV/EBITDA was used.

Rebalancing period was set to three months and the number of stocks was limited to 30. The results were further improved by extending the rebalance period to one year. CAGR reached 22.45%. Standard deviation at 31.47% with a reasonable return led to Sortino ratio of 0.85. Beta stood at 0.90 and alpha reached a value of 19.35%.

Limiting the maximum number of stocks to 10 further increased returns that reached 26.19%. Maximum drawdown on the other hand increased to -42.18% and standard deviation increased a little as well. But the improved return outweighed risk factors. The difference in Sharpe ratio was only 0.05 points, lower than the difference in Sortino ratio of 0.08, meaning that the volatility increased only on the upside, not the downside. Beta of the improved strategy increased to 0.93 and alpha increased to 22.19%.

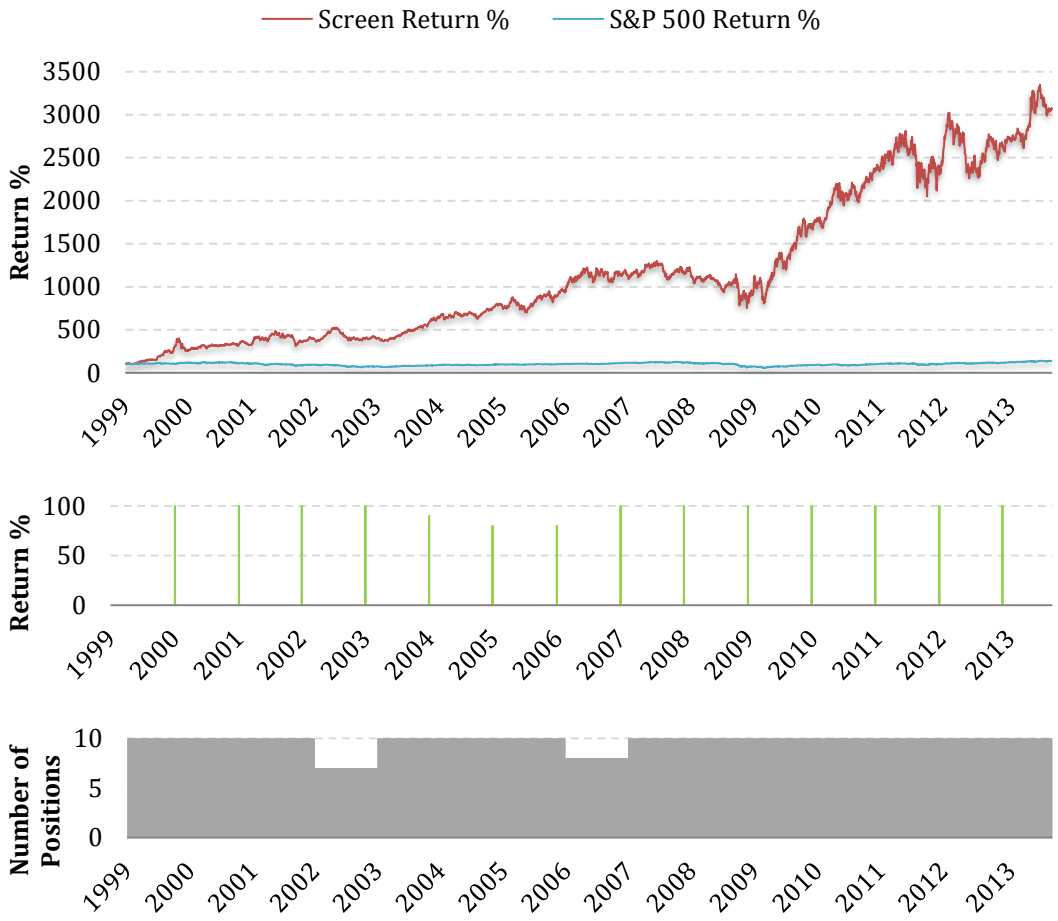
Table 41 Strategy III Backtest 1

Rebalance: Anually	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	2,981.64	26.19	-42.18	0.64	0.93	34.86	0.67	0.45	0.93	22.99
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

The strategy was not fully invested through the whole period. In 2002 only 7 stocks were bought into the portfolio and in 2006 eight stocks were included. The annual rebalance resulted in almost 100% turnover.

Chart 6 Strategy III



Source: Own simulations (Portfilo123)

The complete strategy is as follows:

1) Universe(nootc)
2) Country("CHN")=false
3) Universe($ADR)=false
4) Price*Vol10DAvg>0.1
5) FRank("$ROIC",#Universe,#DESC)>(100-20)

6) FRank("NPMgn%TTM",#Universe,#DESC)>(100-20)
7) EV/EBITDATTM<7
8) DbtTot2EqQ<0.5
9) EPS%ChgPYQ>Sales%ChgPYQ
10) OperCashFlTTM>NetIncBXorTTM
11) FCFTTM>FCFPTM

Rule number 5) is used to rank stocks in the universe by ROIC and select the top quintile. Rule number 6) selects the top quintile of stocks ranked by their net income margin in the trailing twelve month period. Rule number 7) is a valuation criterion. The value was chosen randomly, but EBITDA multiple of 7 is largely a "proxy" of private market valuations since most private companies are sold for EV/EBITDA multiples around 7. Rule number 8) shortlists only stocks with debt to equity ratio lower than 50%. Rule number 9) was used in previous strategies and represents margin expansion. Rule number 10) represents earnings quality check – operating cash flow over the TTM period has to be larger than the net income excluding extraordinary items over the same period. The last rule represents free cash flow growth.

3.4. Strategy IV

The last strategy uses the two-factor backtest presented by Tortoriello (2009), EBITDA – capital expenditures to invested capital and price to free cash flow. The first factor captures approximately a value that was called "owner earnings" by Warren Buffett in 1986.[31] The owner earnings more accurately represent what an owner of the business earns. Although Buffett's exact version requires only maintenance CAPEX subtraction, an approach presented here is more conservative and can serve the purposes of a quantitative system well.

Price to free cash flow is used to include only companies that are valued at low multiples of free cash flow. Similar to EBITDA – capital expenditures to invested capital is a CFROIC ratio. The difference in CFROIC and EBITDA – capital expenditures to invested capital lies in the items not included in EBITDA – CAPEX and included in free cash flow. EBITDA does not include non-operating items (if arrived at as operating income plus depreciation and amortization) and does not subtract changes in working capital, taxes and interest. On the other hand, free cash flow (as a difference between operating cash flow and capital expenditures) includes non-operating items because the calculation of operating cash flows starts with net income that already includes these items. Depreciation and amortization is added back to the net income together with changes in working capital, taxes

[31] Buffett, W. E. 1986. Shareholder Letters. Berkshire Hathaway Inc. [online]. c1986 [quoted on November 20, 2013]. Available on:
<http://www.berkshirehathaway.com/letters/1986.html>

and interest. These slight differences had strong influence on the performance of the system.

Similarly to previous systems, inclusion of margin expansion had a large positive impact of strategy's return. At first, only 30 stocks were set as a limit and the stocks were ranked by price to free cash flow. The results were already quite satisfactory. Return of 24.91% per annum, maximum drawdown of -56.92% and standard deviation of 29.48%. The strategy had a beta of 0.89 and alpha of 21.69%.

After decreasing the maximum holdings to 10, returns improved, but volatility and maximum drawdown worsened a little. The return was 27.53% p.a., maximum drawdown increased slightly to -57.72% and standard deviation rose to 34.80%. Beta of the improved strategy decreased by 0.01 point to 0.88 and alpha rose to 24.19%.

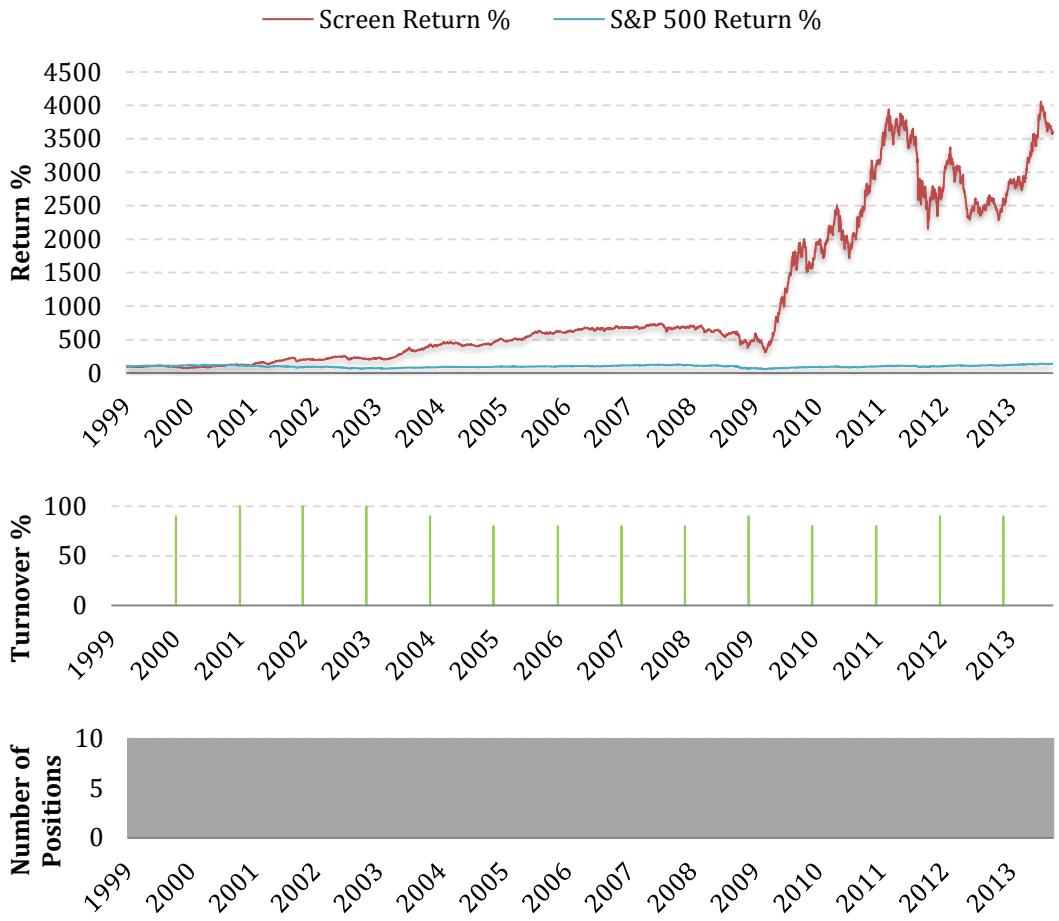
The strategy's best results were recorded in the period from 2009 to 2011, until 2008 the returns were not satisfactory. In the first nine years from 1999 to 2008 the strategy returned approximately 750% cumulatively, but Strategy III returned a little over 1100% cumulatively in the same period, making it more desirable.

Table 42 Strategy IV Backtest 1

Rebalance: Anually	**Total Return**	**CAGR (%)**	**Max DD (%)**	**Sharpe Ratio**	**Sortino Ratio**	**STD (%)**	**Correlation**	**R^2**	**Beta**	**Alpha (%)**
Screen	3,501.64	27.53	-57.72	0.68	0.96	34.80	0.64	0.41	0.88	24.19
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-

Source: Own simulations (Portfilo123)

Chart 7 Strategy IV



Source: Own simulations (Portfilo123)

This strategy is fully invested through the whole period since the criteria are fewer than in some of the previous strategies. The turnover is also a little lower, which means that some stocks are held in portfolio more than one year.

The complete strategy is as follows:

1) Universe(nootc)
2) Country("CHN")=false
3) Universe($ADR)=false
4) Price*Vol10DAvg>0.1
5) FRank("((EBITDATTM-CapExTTM)/$InvestedCapital)",#Universe,#DESC)>(100-20)
6) FRank("Pr2FrCashFlTTM",#Universe,#ASC)>(100-20)
7) FRank("$CFROIC",#Universe,#DESC)>(100-20)
8) EPS%ChgPYQ>Sales%ChgPYQ

Rule number 5) and 6) rank companies based on the two main criteria and select the top quintile. Rule number 7) is the cash flow return on invested capital and it also selects the top quintile of companies based on this criterion. The last rule is the margin expansion.

Part IV – Screening and Ranking and the Influence of Their Combination on Performance

There are two main approaches to create FTS – screening and ranking. Screening is an approach that only shortlists stocks, and this process is mainly random. On the other hand, ranking works similarly but the stocks are ranked based on predefined preferences.

Portfolio123 enables three types of ranking:

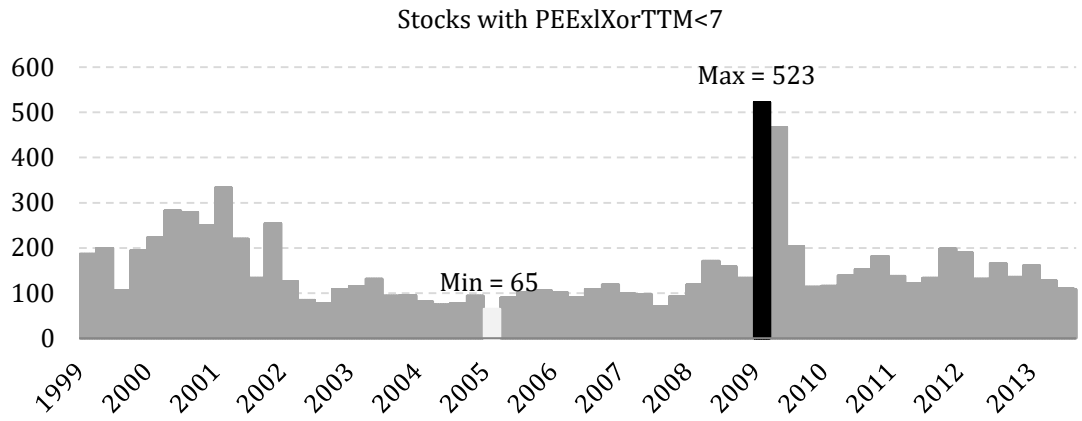
1) Ranking based on screening factors
2) Simple ranking as the final step
3) Advanced ranking

1. Ranking Based on Screening Factors

The first type of ranking is similar to the one used in backtests performed with Bloomberg. Portfolio123 enables choosing stocks not only by strictly set criteria (such as PEExclXorTTM less than 7) but also by FRank function. Using limitations in form of numbers (PEExclXorTTM<7) is less flexible than the FRank function.

The use of FRank adds flexibility since the top quintile in different stages of the market may contain stocks with different values of selected criteria. This fact concerns mostly valuation criteria. There were more stocks valued below P/E of 7 at market bottoms (around 2001 and 2009) and less at market peaks – the strict condition becomes too lose around market bottoms and too strict at market peaks. Furthermore, the average P/E of stocks in each bucket will be lower around market bottoms since more stocks trade at lower valuations, and higher around market peaks where stocks trade at higher valuations. For example, the highest P/E in the top quintile in 2009 might have been 6 since there were a lot of cheap companies, and 10 in 2007 when the stock market was expensive and only few stocks traded at low multiples. The amounts of stocks trading below P/E of 7 are shown in Chart IV.1.

Chart 8 Number of Stocks with PEExlXorTTM<7



Source: Own simulations (Portfilo123)

FRank function shortlists stocks based on selected factor and this process is repeated for each function. For example, in Strategy III:

1) FRank("$ROIC",#Universe,#DESC)>(100-20)

This function ranks the whole universe (hence the condition "#Universe") by return on invested capital in descending order (#DESC)[32] and choses the top quintile (hence the condition ">(100-20)").

2) FRank("NPMgn%TTM",#Universe,#DESC)>(100-20)

The second function in the strategy ranks the whole universe in descending order (i.e. higher values are ascribed higher rank) by net profit margin and selects the top quintile.

Ranking stocks this way may at times lead to zero stocks in portfolio. In the case of ranking by ROIC and net profit margin, there is a higher probability that high net margin companies will also be high ROIC companies. If the logic of two factors and the same type of ordering (both descending or both ascending) is fundamentally correct, the system will not shortlist zero companies.[33] In other cases, different ordering might be used, in which case portfolios may contain no stocks. For example, ranking companies by ROIC and price to book value. In the case of ROIC, the most favorable is to have the highest ROIC companies, while in the case of P/B,

[32] Ranking in descending order sorts all stocks based on their ROIC and higher values are ascribed higher rank. In a universe of 100 stocks a company with the highest ROIC achieves 100% rank. A company with the second highest ROIC achieves 99% rank etc. Ranking in ascending order is used for factors where lower values are preferable – such as P/E, P/B, debt to equity, etc.

[33] Fundamentally incorrect ranking would use the top quintile of ascending sorting by debt to equity and by EBIT to interest ratios. Low debt to equity is preferable, but low EBIT to interest ratio is not. Assuming companies with at least some debt (i.e. debt to equity ratio ≠ 0), where debt is defined as short-term debt + long-term debt + current portion of long-term debt, they have to pay interests on debt, then low interest coverage (low EBIT/interest expense) is a sign of weakness.

it is desirable to have the lowest P/B companies. Combination of these factors may result in no stocks being included in the portfolio since oftentimes low P/B stocks tend to be stocks with poor fundamentals, hence low ROIC. This fact does not have to be limiting if using quintiles, but might pose problems if using deciles.

2. Simple Ranking as the Final Step

In the case of a simple Graham's system using only P/E and equity to assets ratios the final selection of stocks is arrived at by selecting only stocks that have P/E lower than 7 and at the same time equity to assets ratio larger than 0.5. The group of stocks passing the screen is very large. All possible candidates for inclusion into portfolio are an intersection of the two criteria. Limiting the maximum number of stocks to 10 helped the returns but the final choice of stocks was random.

Simple ranking improved the stock selection process. This approach ranked (as the final step) passing stocks by P/E, EPS change, EV/EBITDA, and P/FCF, and then selected up to 10 stocks into portfolio. This type of ranking uses the factor and a condition of priority. In the case of P/E, EV/EBITDA, and P/FCF lower numbers were preferable, in the case of EPS growth, higher numbers were preferable. If 60 stocks pass the screen and only 10 can be bought into portfolio and ranking on P/E is used, the system sorts all stocks that pass the screening process from the lowest to the highest P/E and then selects 10 stocks with the lowest price to earnings ratio to the portfolio. The same process is run for EPS change but in this case stocks are ranked with the higher values getting higher priority and 10 stocks with the highest EPS growth are chosen.

The table below compares returns of selected strategies from Part III to the results achieved by strategies with and without simple ranking. The number in parentheses in the 7th column is the difference in percentage points of returns between strategies with and without ranking. In all cases, the addition of a simple ranking condition improved returns and Sortino ratios. This is a favorable finding since, despite the fact that without ranking some strategies recorded lower maximum drawdowns and standard deviations, better Sortino ratios in strategies with ranking mean that these strategies are superior to strategies without ranking on the risk adjusted basis.

Table 43 Screening and Simple Ranking

Name of Strategy	Ranking Criterion	Number of Stocks	Rebalance Period	With Ranking		Without Ranking	
				Return %	Sortino Ratio	Return %	Sortino Ratio
Graham Defensive	P/E	10	3 Months	18.06	0.47	15.57 (-2.47)	0.41
Graham Enterprising	P/E	10	3 Months	18.86	0.61	14.56 (-4.30)	0.52
Graham Medical	EPS % change	10	1 Year	21.18	0.75	12.19 (-8.99)	0.38
Strategy I	EPS % change	10	1 Month	21.77	0.74	20.17 (-1.60)	0.69
Strategy II	EPS % change	10	1 Year	31.07	1.23	20.66 (-10.41)	0.70
Strategy III	EV/EBITDA	10	1 Year	26.19	0.93	19.97 (-6.22)	0.68
Strategy IV	P/FCF	10	1 Year	27.53	0.96	17.95 (-9.58)	0.57

Source: Own simulations (Portfilo123)

3. Advanced Ranking

More advanced ranking can use multiple criteria instead of a single one as was the case of simple ranking. This process should lead to improved returns because of different weightings of factors than in screening.

Advanced ranking does not work like screening where a stock is either included or excluded. Instead, every stock will be included and it will be placed somewhere on the best-to-worst scale. In the case of, for example, current ratio the companies will be sorted from best to worst on the condition that higher values are preferable. Portfolio123 then ascribes a rank based on where each company stands in the best-to-worst scale. Then the rank is translated into standardized ranks from 1 to 100. A stock that is located exactly at the midpoint will have a score of 50. A stock at the top of the universe with only 5% of stocks being better will have a score of 95 etc. This process is repeated for each factor included in the ranking. Weights of all factors in the ranking must add up to 100%.

A given company may have a score of 85% on current ratio, 28% on debt to equity, and 50% on P/E ratio, etc. This is the outcome of screening. Screens treat all factors as if they were equally important. Ranking enables ascribing different weights to each factor based on a chosen importance.

3.1. Graham Defensive

Graham's strategy for defensive investors was transformed into several ranking setups. The first setup is presented in the table below.

Table 44 Graham Defensive Setup 1

Main Node		
100% Graham Defensive		
Weight	**Factor**	**Ranking**
10%	MktCap>2000	0/1
10%	CurRatioQ	⇧
10%	EPS#Positive	⇧
10%	Yield	⇧
20%	EPSImprovement	0/1
40%	P/E*P/B	0/1

Source: Portfilo123 Ranking Builder

The first four criteria were given weight 10% each. Ranking by market capitalization is devised as pass/not pass (0/1). If the market capitalization is higher than $2 billion, the stock passes, if the market capitalization is lower than $2 billion, the stocks does not pass and is further not worked with. The same applies for EPS improvement. If the EPS in the current year is at least 33% higher than 10 years ago (see definitions of strategy criteria in Part III, Section 2. Value FTS) the stock passes. The EPS improvement was assigned weight of 20%. A valuation criterion in the form of P/E multiplication by P/B was given weight of 40%. This factor was also ranked with pass/not pass condition where the stock in order to pass needed to have a P/E*P/B lower than 22.5. Larger weights for valuation and EPS improvement were chosen in order to choose cheap companies that are growing their earnings per share. Other criteria used ranking from the highest to the lowest values (⇧).

Combining the first setup with screening did not lead to improved results. Annualized return (14.56%) was lower than the return of the strategy without ranking (15.57%) and with simple ranking (18.06%). The results of screening and advanced ranking are shown in the second line of the table under the line.

Table 45 Graham Defensive Setup 1 Backtest

Rebalance: Quarterly	**Total Return**	**CAGR (%)**	**Max DD (%)**	**Sharpe Ratio**	**Sortino Ratio**	**STD (%)**	**Correlation**	**R^2**	**Beta**	**Alpha (%)**
Screen	1,055.21	18.06	-65.97	0.34	0.47	40.72	0.70	0.50	1.14	15.55
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	641.63	14.56	-65.27	0.27	0.37	39.07	0.70	0.49	1.09	12.09

Source: Own simulations (Portfilo123)

The second setup will use ranking by all criteria (instead of pass/not pass condition for market capitalization, EPS improvement, and P/E*P/B).

Table 46 Graham Defensive Setup 2

Main Node		
100% Graham Defensive		
Weight	**Factor**	**Ranking**
10%	MktCap	⇩
10%	CurRatioQ	⇧
10%	EPS#Positive	⇧
10%	Yield	⇧
20%	EPSImprovement	⇧
40%	P/E*P/B	⇩

Source: Portfilo123 Ranking Builder

Conditions in the second setup were changed in order to fully comply with the idea of ranking. Stocks were ranked by market capitalization from the highest to the lowest (to avoid buying micro capitalization stocks). Stocks were ranked from the lowest to the highest values by current ratio, number of years with positive earnings, and dividend yield.

The pass/not pass feature allowed using factors in the same form as in screening. In the second setup, EPS improvement d and P/E*P/B used actual ranking rather than pass/not pass condition. The mere ranking on best-to-worst scale uses criteria in numerical form. The changes are described in the table below.

Table 47 Change in Criteria

	EPSImprovement	P/E*P/B
Setup 1	EPSExclXor(0,ANN,FALLBACK)>1.33*EPSExclXor(10,ANN,FALLBACK)	(PEExclXorTTM*Pr2BookQ)<22.5
Setup 2	EPSExclXor(0,ANN,FALLBACK)–1.33*EPSExclXor(10,ANN,FALLBACK)	PEExclXorTTM*Pr2BookQ

Source: Portfilo123 Ranking Builder

The first setup requires that EPS in the most current year is 33% higher than 10 years ago. The second setup takes the EPS in the current year and subtracts from it the EPS from 10 years ago multiplied by a factor of 1.33. If the EPS in the current year is more than 33% higher than 10 years ago, the number will be positive, if it is lower, the number will be negative. The numbers are ranked from the highest to the lowest, therefore giving higher preference to companies that grew their EPS the most.

P/E and P/B multiplication in the first setup is the same as in ranking. If the multiplication of both factors is less than 22.5, the stock passes. The second setup ranks stocks on the multiplication of both factors and then ranks the values from the lowest to the highest. This might lead to the inclusion of stocks for which the

multiplication of the P/E and P/B ratios is higher than 22.5, but there is no other way to circumvent this shortcoming.

The second setup showed better results but failed to improve them beyond those achieved with simple ranking. Although the performance with advanced ranking is better than performance without ranking, it is worse than a simple ranking as the final step. Results of the second setup are presented in the table below.

Table 48 Graham Defensive Setup 2 Backtest

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	1,055.21	18.06	-65.97	0.34	0.47	40.72	0.70	0.50	1.14	15.55
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	853.46	16.53	-70.03	0.30	0.40	41.15	0.70	0.50	1.16	14.11

Source: Own simulations (Portfilo123)

3.2. Graham Enterprising

Criteria of Graham's strategy were also transformed into ranking. The first setup used equal weighting of all factors. Except of price to book, stocks were ranked from the highest to the lowest values by the remaining factors.

Table 49 Graham Enterprising Setup 1

Main Node		
100% Graham Enterprising		
Weight	**Factor**	**Ranking**
20%	CurRatioQ	⇧
20%	Yield	⇧
20%	Debt to working Capital	⇧
20%	Net Income in the Past 5 Years	⇧
20%	Pr2BookQ	⇩

Source: Portfilo123 Ranking Builder

The outcome of this ranking was very poor. The complete results are presented in the table below. The top part shows results of screening + simple ranking, the bottom part shows results of screening + advanced ranking.

Table 50 Graham Enterprising Setup 1 Backtest

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	1,176.79	18.86	-65.27	0.45	0.61	33.03	0.73	0.53	0.96	16.00
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	662.82	14.78	-62.90	0.35	0.50	30.72	0.68	0.46	0.83	11.85

Source: Own simulations (Portfilo123)

Since valuation factors proved to be one of the best performers, in the second setup, the highest importance was ascribed to the price to book factors and the remaining factors were ascribed the same importance of 15% each.

Table 51 Graham Enterprising Setup 2

Main Node

100% Graham Enterprising

Weight	Factor	Ranking
15%	CurRatioQ	⇧
15%	Yield	⇧
15%	Debt to working Capital	⇧
15%	Net Income in the Past 5 Years	⇧
40%	Pr2BookQ	⇩

Source: Portfilo123 Ranking Builder

The results of the modified ranking are similar to those of the first setup. The negligible increase in annualized return and small increases in maximum drawdown and standard deviation make this setup worse out of the two setups tested. Standard deviation is lower in both setups than it was without the advanced ranking, but the disappointing performance speaks for the use of a simple ranking as the last step than for the use of advanced ranking.

Table 52 Graham Enterprising Setup 2 Backtest

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	1,176.79	18.86	-65.27	0.45	0.61	33.03	0.73	0.53	0.96	16.00
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	667.77	14.83	-63.89	0.35	0.49	31.27	0.67	0.45	0.84	11.90

Source: Own simulations (Portfilo123)

After the subpar returns achieved with the combination of the screening and advanced ranking, a simpler ranking was used. Instead of ranking stocks on all criteria, ranking by price to book and dividend yield with equal weights (50%

each) was used. The combination of screening with this simpler ranking lead to worse returns than in the cases of more complex rankings presented above.

Table 53 Graham Enterprising Setup 3 Backtest

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	1,176.79	18.86	-65.27	0.45	0.61	33.03	0.73	0.53	0.96	16.00
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	538.86	13.41	-69.00	0.29	0.41	32.55	0.67	0.45	0.87	10.60

Source: Own simulations (Portfilo123)

The simpler ranking led to even worse performance that was achieved without ranking (14.56%). Low CAGR combined with a larger drawdown and standard deviation more or less in line with the standard deviation of the screen with simple ranking resulted in a weak alpha of 10.60%.

3.3. Graham Medical

The simplest Graham's strategy that recorded the best returns from all Graham's strategies backtested in this thesis did not combine well with more advanced ranking. Returns as well as other metrics were very weak and damaged the otherwise great performance of the strategy.

In the first setup, ranking used the two criteria with pass/not pass condition of which both were ascribed the same weight. In the second setup stocks were ranked from the lowest to the highest by P/E ratio and from the highest to the lowest by equity to assets ratio. Again, 50% weights were ascribed to the criteria.

Table 54 Graham Medical Setup 1

Main Node		
100% Graham Medical		
Weight	**Factor**	**Ranking**
50%	EqTot(0,ANN,FALLBACK)/AstTot(0,ANN,FALLBACK)>0.5	0/1
50%	PEExclXorTTM<7	0/1

Source: Portfilo123 Ranking Builder

Ranking stocks only on these two criteria with the pass/not pass condition resulted in a significant worsening of the strategy's returns. Annualized return halved and maximum drawdown significantly increased. Worsening of these metrics then explains the poor Sharpe and Sortino ratios, not to mention weak alpha and increased beta.

Table 55 Graham Medical Setup 1 Backtest

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	1,597.32	21.18	-48.89	0.51	0.75	33.49	0.57	0.32	0.76	17.86
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	341.99	10.61	-69.51	0.20	0.30	32.36	0.64	0.41	0.83	7.82

Source: Own simulations (Portfilo123)

The second setup used the ranking by both factors, which is a more sensible approach in the case of this simple strategy than the pass/not pass condition. As will be shown in backtests below, decreasing the number of ranking criteria increased returns to the strategies. This hypothesis was not confirmed in the case of Graham's Medical two-factor strategy.

Table 56 Graham Medical Setup 2

Main Node

100% Graham Medical

Weight	Factor	Ranking
50%	EqTot(0,ANN,FALLBACK)/AstTot(0,ANN,FALLBACK)	⇧
50%	PEExclXorTTM	⇩

Source: Portfilo123 Ranking Builder

Results of the second setup shown in the table below are somewhat better than those of the first setup but are still much worse than the original strategy with simple ranking. The driver behind better performance of the screening with simple ranking was the EPS change that was used as a ranking method. It could be said that the returns to this strategy are explained by introducing other factor than by the factors of the strategy alone. This fact is confirmed by the performance of this strategy with ranking based on the original factors.

Table 57 Graham Medical Setup 2 Backtest

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	1,597.32	21.18	-48.89	0.51	0.75	33.49	0.57	0.32	0.76	17.86
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	526.56	13.26	-50.10	0.31	0.44	29.94	0.51	0.26	0.60	9.97

Source: Own simulations (Portfilo123)

3.5. Conclusion

Combining screening with advanced ranking did not lead to improved returns in any of the three strategies devised by Benjamin Graham. Screening with simple ranking as a final step showed superior performance, most notably the Medical strategy. Several attempts (not presented herein) to improve the promising Medical strategy failed because of inexplicable reasons.

Using different weights of ranking criteria is prone to data fitting, therefore the weighting was not altered very much between different setups to make the results as much realizable as possible. In the cases of rankings with more criteria, other than equal weights were used in order to give preference to criteria that proved to be strong (especially valuation) as was shown in the preceding parts.

3.6. Strategy I

Strategy I consisted of six criteria: market capitalization, P/E ratio, net margin improvement, ROA improvement, current ratio improvement, and share buybacks. The "improvement" factors were stated as follows:

1) EPS%ChgPQ>Sales%ChgPQ – net margin improvement
2) ROA%TTM>ROA%PTM – ROA improvement
3) CurRatioQ>CurRatioPYQ – current ratio improvement

In order to use the factors in ranking they must have been adjusted to numerical form as follows:

1) NPMgn%TTM-NPMgn%PTM – net margin improvement
2) ROATTM-ROAPTM – ROA improvement
3) CurRatioQ-CurRatioPYQ – current ratio improvement

If the ROA in the TTM period was 20% and 15% in the PTM, then the difference is 5%. The ranking process compares these differences across all stocks in the universe and then ranks them from highest to lowest. The same process is applied to all improvement factors in this and following backtests.

This strategy was thoroughly backtested using a total of six different setups. The process started by assigning the same weight to all factors (results in Table 59) and continually adjusting the weights until arriving at a very simple ranking composed of only two factors. The outcome of setup 6 is thought to be at the edge of possible achievable returns from the strategy. Achieving the best results with the simplest ranking eliminates data mining bias because of the mere simplicity. Other setups with varying weights were created carefully in order to eliminate

possible data mining as much as possible. Low weight was ascribed to market capitalization from setup 2 on in order to eliminate the small capitalization anomaly.

Table 58 Strategy I Setup Set 1

Main Node 100% Strategy I	**Setup 1**		**Setup 2**		**Setup 3**	
Factor	Weight	Ranking	Weight	Ranking	Weight	Ranking
MktCap	16.67%	⇩	5%	⇩	5%	⇧
PEExlXorTTM	16.67%	⇩	20%	⇩	20%	⇩
MarginImprovement	16.67%	⇧	18.75%	⇧	18.75%	⇧
ROAImprovement	16.67%	⇧	18.75%	⇧	18.75%	⇧
CurrentRatioImprovement	16.67%	⇧	18.75%	⇧	18.75%	⇧
EqPurchQ	16.67%	⇧	18.75%	⇧	18.75%	⇧

Source: Portfilo123 Ranking Builder

Setups 2 and 3 differ only in the ranking by market capitalization factor. Setup 2 ranks stocks by market capitalization from the lowest to the highest, and setup 3 does the opposite. Results of these two setups are presented in the table below in the third (setup 2) and fourth (setup 3) line. Giving preference to larger capitalization stocks led to better annualized return (21.28% vs. 21.07%) as well as to lower maximum drawdown (61.91% vs. 64.02%), but a slightly higher volatility (36.16% vs. 36.04%). Overall, the alpha of setup 3 is better than of the first two setups, but lower than alpha of the original strategy with simple ranking. However, Sortino ratios of setup 3 and the original strategy are approximately the same.

Table 59 Strategy I Setup Set 1 Backtest

Rebalance: Monthly	**Total Return**	**CAGR (%)**	**Max DD (%)**	**Sharpe Ratio**	**Sortino Ratio**	**STD (%)**	**Correlation**	**R^2**	**Beta**	**Alpha (%)**
Screen	1,722.69	21.77	-63.73	0.49	0.74	36.14	0.58	0.34	0.84	18.58
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	1,483.97	20.62	-65.23	0.46	0.70	36.14	0.59	0.35	0.85	17.49
Screen	1,573.43	21.07	-64.02	0.47	0.72	36.04	0.59	0.35	0.86	17.93
Screen	1,618.40	21.28	-61.91	0.48	0.73	36.16	0.60	0.36	0.86	18.15

Source: Own simulations (Portfilo123)

Setups 4 and 5 used only three factors and setup 6 used only two factors. There are many possible setups that can be created this way, but those presented herein are supportive of the fact that improving margins and profitability are strong factors driving stock returns. The results of setups four to six are presented in Table 61, lines two to four.

Table 60 Strategy I Setup Set 2

Main Node 100% Strategy I						
	Setup 4		**Setup 5**		**Setup 6**	
Factor	Weight	Ranking	Weight	Ranking	Weight	Ranking
MktCap	0%	⇩	0%	⇩	0%	⇩
PEExlXorTTM	30%	⇩	40%	⇩	50%	⇩
MarginImprovement	40%	⇧	40%	⇧	50%	⇧
ROAImprovement	30%	⇧	20%	⇧	0%	⇧
CurrentRatioImprovement	0%	⇧	0%	⇧	0%	⇧
EqPurchQ	0%	⇧	0%	⇧	0 %	⇧

Source: Portfilo123 Ranking Builder

At first, greater importance was ascribed to the margin improvement with P/E ratio and ROA improvement being ascribed the same importance. After increasing the importance of P/E (from 30% to 40%) and decreasing the importance of ROA improvement (from 30% to 20%) the results worsened a little. The annualized performance decreased from 21.84% to 21.40%. In the end, P/E and net margin improvement were used with the same weights. This setup resulted in a better performance (22.18%) than in the previous five setups and in the original strategy (21.77%). Besides annualized returns, maximum drawdown and standard deviation improved as well compared to the original strategy.

Table 61 Strategy I Setup 2 Backtest

Rebalance: Monthly	**Total Return**	**CAGR (%)**	**Max DD (%)**	**Sharpe Ratio**	**Sortino Ratio**	**STD (%)**	**Correlation**	**R^2**	**Beta**	**Alpha (%)**
Screen	1,722.69	21.77	-63.73	0.49	0.74	36.14	0.58	0.34	0.84	18.58
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	1,739.12	21.84	-62.03	0.49	0.75	36.00	0.60	0.36	0.86	18.68
Screen	1,643.29	21.40	-61.64	0.48	0.73	36.10	0.60	0.36	0.86	18.26
Screen	1,815.03	22.18	-61.64	0.50	0.77	36.09	0.60	0.36	0.86	19.00

Source: Own simulations (Portfilo123)

3.7. Strategy II

Ranking in this strategy was based on only three factors. Stocks were ranked from the lowest to the highest by price to book ratio, from lowest to the highest by debt to equity ratio and from highest to the lowest by net margin improvement. Again, as in the previous backtests, net margin improvement was adjusted to a numerical form.

The first setup ascribed equal weights to all three factors and yielded the best results of all setups. Setups 2 and 3 used different weights of valuation and net margin improvement.

Table 62 Strategy II Setup Set 1

Main Node 100% Strategy II	**Setup 1**		**Setup 2**		**Setup 3**	
Factor	Weight	Ranking	Weight	Ranking	Weight	Ranking
Pr2BookQ	33.33%	⇩	40%	⇩	30%	⇩
DbtTot2EqQ	33.33%	⇩	20%	⇩	20%	⇩
MarginImprovement	33.33%	⇧	40%	⇧	50%	⇧

Source: Portfilo123 Ranking Builder

Setup 1 yielded the best results (line 2 in Table 63) of all setups, but a little worse than the original strategy with simple ranking. The only negative outcome is the worsened maximum drawdown and standard deviation. On the other hand, the maximum drawdown remained below the maximum drawdown of the overall market, which is a positive trait.

Setups 2 and 3 recorded lower returns (lines 3 and 4 in Table 63), higher drawdowns and higher volatility. Especially setup 3 had the worst drawdown, which negatively influenced the Sortino ratio. Although alphas of all setups in this strategy are the highest of all strategies presented in this thesis, the original strategy with simple ranking was the best compared to its own variations and other strategies.

Table 63 Strategy II Setup Set 1 Backtest

Rebalance: Annually	**Total Return**	**CAGR (%)**	**Max DD (%)**	**Sharpe Ratio**	**Sortino Ratio**	**STD (%)**	**Correlation**	**R^2**	**Beta**	**Alpha (%)**
Screen	5,290.13	31.07	-39.10	0.78	1.23	34.46	0.49	0.25	0.68	27.23
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	5,274.07	31.04	-51.75	0.75	1.22	35.86	0.46	0.21	0.66	27.16
Screen	4,376.03	29.42	-51.65	0.70	1.11	36.36	0.45	0.20	0.66	25.61
Screen	3,788.01	28.19	-60.84	0.67	1.05	36.30	0.45	0.21	0.66	24.43

Source: Own simulations (Portfilo123)

3.8. Strategy III

Strategy III was tested in six different setups and with varying factors. The strategy uses a total of seven factors of which net margin improvement, earnings quality and free cash flow improvement were transformed into numerical form. The numerical form of net margin improvement was already described in the part dedicated to the backtest of Strategy I with advanced ranking. The remaining two criteria (earnings quality and free cash flow improvement) were adjusted as follows:

1) OperCashFlTTM-NetIncBXorTTM – earnings quality
2) FCFTTM-FCFPTM – free cash flow improvement

The earnings quality (following Sloan (1996)) was expressed as a difference between operating cash flow in the trailing twelve months period and net income in the trailing twelve months period. This adjustment was used only in the first setup, and the remaining setups used the pass/not pass condition which used the earnings quality factor in the same form as in the backtest of screeners (OperCashFlTTM>NetIncBXorTTM).

Table 64 Strategy III Setup Set 1

Main Node 100% Strategy III						
	Setup 1		**Setup 2**		**Setup 3**	
Factor	Weight	Ranking	Weight	Ranking	Weight	Ranking
ROIC	14.29%	⇧	14.29%	⇧	20%	⇧
NPMgn%TTM	14.29%	⇧	14.29%	⇧	12%	⇧
EV/EBITDA	14.29%	⇩	14.29%	⇩	20%	⇩
DbtTot2EqQ	14.29%	⇩	14.29%	⇩	12%	⇩
NetMarginImprovement	14.29%	⇧	14.29%	⇧	12%	⇧
OCF>NetIncome	14.29%	⇧	14.29%	0/1	12%	0/1
FCFImprovement	14.29%	⇧	14.29%	⇧	12%	⇧

Source: Portfilo123 Ranking Builder

In the first setup, all factors were ascribed equal weight. The results were a little worse than the original strategy with simple ranking (line 2 in Table 65). Setup 2 (line 3 in Table 65) used the same weights as setup 1, but the only difference was the pass/not pass criterion used for earnings quality factor. The outcome was worse than in the first setup. This adjustment created a difference of 1.5 percentage points in performance (compared to the returns of setup 1) but a much larger difference in maximum drawdown. Setup 3 (line 4 in table 65) put a larger importance of valuation (EV/EBITDA) and profitability (ROIC) factors. The outcome was slightly better than in setup 2. However, the difference in returns is not large enough to make any definitive statements about the importance of the highlighted factors.

Table 65 Strategy III Setup Set 1 Backtest

Rebalance: Annually	**Total Return**	**CAGR (%)**	**Max DD (%)**	**Sharpe Ratio**	**Sortino Ratio**	**STD (%)**	**Correlation**	**R^2**	**Beta**	**Alpha (%)**
Screen	2,981.64	26.19	-42.18	0.64	0.93	34.86	0.67	0.45	0.93	22.99
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	2,206.35	23.73	-44.03	0.55	0.81	35.78	0.69	0.48	0.99	20.72
Screen	1,827.55	22.23	-51.45	0.51	0.75	35.40	0.69	0.47	0.97	19.25
Screen	1,909.47	22.58	-50.27	0.52	0.76	35.46	0.68	0.47	0.97	19.58

Source: Own simulations (Portfilo123)

Setups 4 through 6 limited the number of used factors to three in the last setup. It was surprising to find that a ranking that put even larger importance on valuation and profitability factors than in setup 3 ended with worse returns. Both EV/EBITDA and ROIC were one of the best one-factor strategies, but their strength did not materialize when used as ranking factors.

Table 66 Strategy III Setup Set 2

Main Node 100% Strategy III						
	Setup 4		**Setup 5**		**Setup 6**	
Factor	Weight	Ranking	Weight	Ranking	Weight	Ranking
ROIC	30%	⇧	30%	⇧	30%	⇧
NPMgn%TTM	8%	⇧	0%	⇧	0%	⇧
EV/EBITDA	30%	⇩	30%	⇩	40%	⇩
DbtTot2EqQ	8%	⇩	0%	⇩	0%	⇩
NetMarginImprovement	8%	⇧	30%	⇧	30%	⇧
OCF>NetIncome	8%	0/1	0%	0/1	0%	0/1
FCFImprovement	8%	⇧	10%	⇧	0%	⇧

Source: Portfilo123 Ranking Builder

The best results were achieved with setup 5 that ascribed 30% weights to ROIC, EV/EBITDA and net margin improvement and 10% to free cash flow improvement. The last setup using only three factors recorded only the second best result of all setups.

Table 67 Strategy III Setup Set 2 Backtest

Rebalance: Annually	**Total Return**	**CAGR (%)**	**Max DD (%)**	**Sharpe Ratio**	**Sortino Ratio**	**STD (%)**	**Correlation**	**R^2**	**Beta**	**Alpha (%)**
Screen	2,981.64	26.19	-42.18	0.64	0.93	34.86	0.67	0.45	0.93	22.99
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	1,779.00	22.02	-47.99	0.51	0.75	34.96	0.68	0.46	0.94	19.00
Screen	2,820.88	25.73	-43.56	0.61	0.88	35.69	0.69	0.47	0.98	22.63
Screen	2,339.15	24.20	-45.64	0.56	0.82	35.86	0.68	0.47	0.98	21.16

Source: Own simulations (Portfilo123)

Limiting the number of factors used in ranking improved returns compared to weaker advanced rankings but did not improve returns and other characteristics compared to the original strategy. The original strategy was superior on risk-adjusted basis as well as on other criteria. Strategies with advanced ranking recorded higher betas and lower alphas, as well as higher maximum drawdowns and higher standard deviations. Backtests of Strategy III with advanced ranking once again provided support for simple ranking rather than advanced ranking systems used in combination with screening.

3.9. Strategy IV

There was no need to adjust any factors in the last strategy. A total of seven setups were backtested with varying levels of importance ascribed to each factor. The last two setups (setup 6 and 7) used only two factors whose use led to very good results.

Table 68 Strategy IV Setup Set 1

Main Node 100% Strategy IV						
	Setup 1		**Setup 2**		**Setup 3**	
Factor	Weight	Ranking	Weight	Ranking	Weight	Ranking
(EBITDA-CAPEX)/InvestedCap	25%	⇧	20%	⇧	10%	⇧
Pr2FrCashFlTTM	25%	⇩	30%	⇧	40%	⇧
CFROIC	25%	⇧	30%	⇩	30%	⇩
NetMarginImprovement	25%	⇧	20%	⇧	20%	⇧

Source: Portfilo123 Ranking Builder

Setup 1 ascribed equal weights to all factors and the results (line 2 in Table 69) were very poor. Increasing the importance of valuation factor (price to free cash flow) markedly improved the returns (setup 2, line 3 in Table 69) but further increasing the weight of the factor and decreasing the weight of (EBITDA-CAPEX)/invested capital did not improve results (line 4 in Table 69).

Table 69 Strategy IV Setup Set 1 Backtest

Rebalance: Annually	**Total Return**	**CAGR (%)**	**Max DD (%)**	**Sharpe Ratio**	**Sortino Ratio**	**STD (%)**	**Correlation**	**R^2**	**Beta**	**Alpha (%)**
Screen	3,501.64	27.53	-57.72	0.68	0.96	34.80	0.64	0.41	0.88	24.19
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	694.82	15.10	-73.26	0.29	0.40	38.02	0.63	0.40	0.95	12.37
Screen	1,078.03	18.22	-72.41	0.38	0.54	37.45	0.62	0.38	0.92	15.31
Screen	928.01	17.13	-69.24	0.36	0.50	36.58	0.64	0.40	0.93	14.27

Source: Own simulations (Portfilo123)

Setup 4 switched weights, ascribing higher weight to the (EBITDA-CAPEX)/invested capital factor and lower weight to the net margin improvement factor. The outcome was much better. Annualized returns improved more than 5 percentage points and maximum drawdown decreased by 4 percentage points (line 2 in Table 71).

Table 70 Strategy IV Setup Set 2

Main Node						
100% Strategy IV						
	Setup 4		**Setup 5**		**Setup**	
Factor	Weight	Ranking	Weight	Ranking	Weight	Ranking
(EBITDA-CAPEX)/InvestedCap	20%	⇧	30%	⇧	50%	⇧
Pr2FrCashFlTTM	40%	⇩	40%	⇧	50%	⇧
CFROIC	30%	⇧	30%	⇩	00%	⇩
NetMarginImprovement	10%	⇧	0%	⇧	00%	⇧

Source: Portfilo123 Ranking Builder

Setups 5 and 6 continually eliminated the number of employed factors. Using only the first two factors significantly improved results. Although maximum drawdown and standard deviation were worse than in the original strategy, the much larger annualized performance led to very high alpha of 29.84%.

Table 71 Strategy IV Setup Set 2 Backtest

Rebalance: Annually	**Total Return**	**CAGR (%)**	**Max DD (%)**	**Sharpe Ratio**	**Sortino Ratio**	**STD (%)**	**Correlation**	**R^2**	**Beta**	**Alpha (%)**
Screen	3,501.64	27.53	-57.72	0.68	0.96	34.80	0.64	0.41	0.88	24.19
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	1,960.48	22.79	-65.25	0.51	0.72	36.71	0.64	0.41	0.94	19.74
Screen	2,476.40	24.66	-65.70	0.57	0.81	36.51	0.64	0.40	0.93	21.51
Screen	6,812.36	33.30	-69.83	0.76	1.08	38.48	0.61	0.38	0.94	29.84

Source: Own simulations (Portfilo123)

The last setup kept 50% ascribed to valuation factor and put 50% weight on CFROIC factor. Despite the fact that this setup did not produce better results than setup 6, the returns and alpha improved compared to the original strategy with simple ranking.

Table 72 Strategy IV Setup 7

Main Node		
100% Strategy IV (Setup 7)		
Weight	**Factor**	**Ranking**
0%	(EBITDA-CAPEX)/InvestedCap	⇧
50%	Pr2FrCashFlTTM	⇩
50%	CFROIC	⇧
0%	NetMarginImprovement	⇧

Source: Portfilo123 Ranking Builder

The positive trait of the last backtest is the lowest maximum drawdown of all setups (-61.10%) and one of the lowest betas. On the risk-adjusted basis the last setup exhibited the second best Sortino ratio.

Table 73 Strategy IV Setup 7 Backtest

Rebalance: Quarterly	Total Return	CAGR (%)	Max DD (%)	Sharpe Ratio	Sortino Ratio	STD (%)	Correlation	R^2	Beta	Alpha (%)
Screen	3,501.64	27.53	-57.72	0.68	0.96	34.80	0.64	0.41	0.88	24.19
S&P	36.92	2.16	-56.78	-0.07	-0.10	25.06	-	-	-	-
Screen	4,354.46	29.38	-61.10	0.67	0.95	37.84	0.61	0.37	0.92	26.04

Source: Own simulations (Portfilo123)

3.10. Conclusion

Backtests of the four own strategies showed perplexing results. The initial expectation was to see improved performance of screening with advanced ranking but the reality is very different. The simpler the ranking used, the better the results. This fact proved to be true throughout all strategies. Oftentimes, no complicated ranking was able to "beat" the original strategy with simple ranking.

In very few cases, advanced ranking showed better results. In order for the advanced ranking to prove usable in real life, it should exhibit constant behavior and similar returns over all strategies and backtests. Investors making real-time decisions that are pointed into the future do not have the option to see what will work and what will not. Therefore, using only a simple ranking as a final step in a form of EPS change, P/E ratio or other metric is the most desirable approach to follow.

Part V – Evaluation and Conclusion

In the introduction to this thesis, four expectations (or hypotheses) were laid:

1) Tests of one-factor strategies will confirm previous findings

It can be said that the backtests of strategies which were expected to perform well confirmed the expectation. Despite the fact that two-factor strategies are not discussed by the academic research, Part II also included backtests of a few two-factor strategies. Those strategies showed good performance.

2) FTS built on the well-performing factors will perform well

The second expectation was also confirmed. As has been shown, fundamental strategies developed by Benjamin Graham and own strategies did exceptionally well. Many of such strategies used very few criteria, all bought very few stocks into portfolio and most rebalanced on a yearly basis. The best performing strategies were the simples ones – of Benjamin Graham's strategies the Medical strategy that used only 2 factors (annualized return – 21.18%) and of own strategies Strategy II that used only 3 factors (annualized return – 31.07%). Most notably, these results were achieved in a period when Standard & Poor's 500 Index returned 2.16% annually. Also worth mentioning, Strategy II was the only strategy that achieved Sortino ratio higher than 1.

3) Simple ranking will improve the returns to strategies

This expectation was confirmed as well. Simple ranking proved very powerful and significantly improved returns. The impact on returns ranged from 1.60% p.a. in the case of Strategy I to 10.41% p.a. in the case of Strategy II.

4) Advanced ranking will improve the returns to strategies beyond those achieved by simple ranking

Unfortunately, this expectation failed to confirm. Advanced ranking did not improve returns. Nearly in all cases, returns to screening with advanced ranking were lower than those to screening with simple ranking. Only setups 6 and 7 of Strategy IV showed meaningfully larger returns. In a few other cases, on the one hand, returns to screening with advanced ranking were higher than those of screening with simple ranking, but on the other hand, the difference was very small in order to be exploitable.

Occam's razor dictates that if there are two ways of which one is simpler, the simpler should be used. Therefore, it is recommended to use only simple ranking rather than advanced ranking.

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Appendix

Shortcuts

TTM – Trailing Twelve Months

PTM – Prior Twelve Months

P/E – Price to earnings ratio

P/E = Price/Earnings per Share

P/B – Price to book ratio

P/B = Price/Book value per Share

OCF – Operating Cash Flow (also Cash Flow from Operating Activities or Cash Flow from Operations)

CAPEX – Capital Expenditures

FCF – Free Cash Flow

FCF = Operating Cash Flow – Capital Expenditures

Change in FCF

Change in FCF = (Free Cash Flow TTM/Free Cash Flow PTM) – 1

Total Invested Capital

Invested Capital = Book Value + Long-term Debt + Preferred Shares + Minority Interest

FCF/P – Free Cash Flow to Price (also called Free Cash Flow Yield)

EV – Enterprise Value

EV = Market Capitalization + Long- and short-term Debt + Minority Interest – Cash and Cash Equivalents

EBITDA – Earnings Before Interest, Taxes, Depreciation and Amortization

EBITDA = Net Income + Interest Expense + Taxes + Depreciation and Amortization

OIBDA – Operating Income Before Depreciation and Amortization

OIBDA = Operating income + Depreciation and Amortization

Gross Income

Gross Income = Sales – Cost of Goods Sold

Gross Margin

Gross Margin = Gross Income/Sales

Operating Margin

Operating Margin = Operating Income/Sales

EBITDA Margin

EBITDA Margin = EBITDA/Sales

Net Margin

Net Margin = Net Income/Sales

OCF Margin

OCF Margin = Operating Cash Flow/Sales

Total Debt

Total Debt = Short-term Debt + Long-term Debt + Current Portion of Long-term Debt

Ranking Preferences

The table describes ranking preferences of backtests. Preference of higher means that higher value of a ratio is preferred, i.e. companies with the highest ratios are put into the top quintile and companies with the lowest ratios are put into the bottom quintile (such as in case of margins, return on invested capital etc.). Preference of lower means that lower value of a ratio is preferred, i.e. companies with the lowest ratios are put into the top quintile and companies with the highest ratios are put into the bottom quintile (such as in case of price to earnings, COGS as percentage of sales etc.).

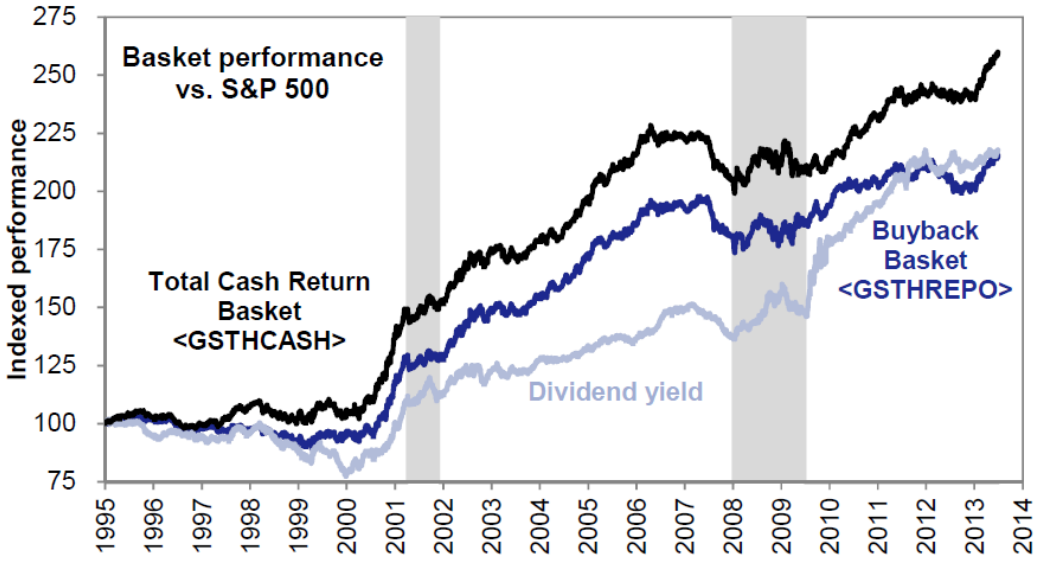
Category	Factor	Preference
Profitability		
	Gross Margin	Higher
	EBITDA Margin	Higher
	Operating Margin	Higher
	Net Margin	Higher
	Return on Invested Capital	Higher
Valuation		
	Free Cash flow to Price	Higher
	Enterprise Value to EBITDA	Lower
	Price to Earnings	Lower
	Price to Book Value	Lower
Cash Flow		
	FCF to Operating Income	Higher
	Cash Return on Invested Capital	Higher
	Free Cash Flow as Percentage of Operating Cash Flow	Higher
	Net Income in Relation to Operating Cash Flow	Lower
	Free Cash Flow per Share Growth	Higher
Capital Allocation		
	1Year Reduction in Shares	Lower
	External Financing to Assets	Lower
Red Flags		
	Operating Cash Flow to Long-term Debt	Higher
	Free Cash Flow to Long-term Debt	Higher
	Days Sales Outstanding	Lower
Other Factors – Income Statement		
	SG&A as Percentage of Sales	Lower
	COGS as Percentage of Sales	Lower
Other Factors – Balance Sheet		
	Cash Ratio	Higher
	Current Ratio	Higher
	Quick Ratio	Higher

Cash as Percentage of Total Assets	Higher
Current Assets as Percentage of Total Assets	Higher
Total Debt as Percentage of Assets	Lower
PP&E as Percentage of Total Assets	Higher
Change in Working Capital	Lower

Pictures

Picture 1

Exhibit 3: Total cash return outperforms both dividend and buyback strategies
as of August 31, 2013 based on trailing 4-quarter shareholder yield with semi-annual rebalance



Source: Compustat and Goldman Sachs Global Investment Research.

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List of Income Statement Income Statement Factors

Cost of Goods Sold as Percentage of Sales

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	10.40	11.24	6.06	4.63	3.65	6.22
Active CAGR (%)	8.90	9.54	5.21	3.70	2.10	6.22
Average Turnover (%)	20.72	29.74	33.54	32.92	25.35	N.A.
Information Ratio	0.42	0.33	0.33	0.18	0.15	N.A.
Volatility	26.55	35.56	17.46	16.70	35.67	12.54
Tracking Error (%)	21.67	43.56	11.42	12.89	40.85	N.A
Hit Ratio (%)	47.49	48.52	47.75	47.20	45.35	N.A
Quantile Hit Ratio (%)	50.72	59.42	56.52	49.28	39.13	N.A
Number of Securities	527.00	526.00	526.00	526.00	526.00	500
Maximum Drawdown (%)	-58.28	-58.73	-61.64	-62.62	-82.03	-56.78

Selling, General & Administrative Costs as Percentage of Sales

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	7.29	6.15	6.17	4.68	2.88	6.22
Active CAGR (%)	6.00	5.09	5.37	3.70	1.25	6.22
Average Turnover (%)	41.00	43.98	48.83	42.82	35.26	N.A.
Information Ratio	0.37	0.31	0.33	0.23	0.02	N.A.
Volatility	19.93	20.23	19.40	18.47	18.40	12.54
Tracking Error (%)	14.22	13.16	13.33	12.44	14.11	N.A
Hit Ratio (%)	47.64	44.74	46.54	44.43	42.32	N.A
Quantile Hit Ratio (%)	56.52	56.52	59.42	53.62	40.58	N.A
Number of Securities	204.00	204.00	204.00	204.00	203.00	500
Maximum Drawdown (%)	-68.84	-66.11	-62.12	-58.08	-68.01	-56.78

List of Balance Sheet Factors

Cash Ratio

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	7.96	5.64	9.08	5.97	3.50	6.22
Active CAGR (%)	4.81	4.29	8.17	5.08	2.34	6.22
Average Turnover (%)	17.50	30.15	36.84	38.43	26.04	N.A.
Information Ratio	0.22	0.21	0.44	0.22	0.12	N.A.
Volatility	33.69	19.38	20.38	28.61	19.98	12.54
Tracking Error (%)	34.53	13.07	17.62	32.31	18.55	N.A
Hit Ratio (%)	45.02	47.24	48.40	48.15	47.04	N.A
Quantile Hit Ratio (%)	50.72	55.07	60.87	55.07	50.72	N.A
Number of Securities	669	669	669	669	668	500
Maximum Drawdown (%)	-80.97	-61.13	-59.45	-77.64	-65.89	-56.78

Current Ratio

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	6.57	5.34	7.13	6.91	6.13	6.22
Active CAGR (%)	3.98	4.13	6.16	5.99	5.24	6.22
Average Turnover (%)	19.45	30.62	32.82	30.35	19.62	N.A.
Information Ratio	0.19	0.23	0.38	0.31	0.23	N.A.
Volatility	32.68	19.06	17.30	19.64	31.31	12.54
Tracking Error (%)	33.85	12.38	13.22	17.24	35.45	N.A
Hit Ratio (%)	44.84	47.30	47.93	48.54	47.26	N.A
Quantile Hit Ratio (%)	47.83	53.62	47.83	53.62	46.38	N.A
Number of Securities	671	670	670	670	670	500
Maximum Drawdown (%)	-76.29	-60.48	-62.72	-61.09	-77.32	-56.78

Quick Ratio

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	7.53	5.37	7.28	8.35	3.62	6.22
Active CAGR (%)	4.60	4.11	6.40	7.40	2.58	6.22
Average Turnover (%)	18.42	30.49	34.61	33.94	22.85	N.A.
Information Ratio	0.21	0.21	0.40	0.30	0.13	N.A.
Volatility	33.37	19.23	17.05	30.93	19.88	12.54
Tracking Error (%)	34.23	12.82	13.16	34.47	18.72	N.A
Hit Ratio (%)	44.86	47.32	48.26	48.53	46.90	N.A
Quantile Hit Ratio (%)	49.28	55.07	53.62	53.62	49.28	N.A
Number of Securities	670	670	670	670	669	500
Maximum Drawdown (%)	-80.01	-60.65	-61.03	-77.74	-64.17	-56.78

Cash as Percentage of Total Assets

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	9.33	8.08	5.18	3.90	3.26	6.22
Active CAGR (%)	6.67	7.10	4.38	3.11	2.31	6.22
Average Turnover (%)	22.05	36.41	40.28	38.70	25.71	N.A.
Information Ratio	0.28	0.36	0.28	0.18	0.13	N.A.
Volatility	31.02	21.28	16.03	27.19	15.31	12.54
Tracking Error (%)	31.12	16.80	12.90	28.87	12.60	N.A
Hit Ratio (%)	45.62	48.11	48.26	47.87	47.92	N.A
Quantile Hit Ratio (%)	52.17	57.97	49.28	53.62	50.72	N.A
Number of Securities	816	816	816	816	815	500
Maximum Drawdown (%)	-74.61	-60.16	-60.62	-77.3	-65.96	-56.78

Current Assets as Percentage of Total Assets

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	10.07	7.54	4.86	3.37	6.19	6.22
Active CAGR (%)	7.50	6.24	3.98	2.54	5.26	6.22
Average Turnover (%)	15.25	22.17	23.02	20.96	13.17	N.A.
Information Ratio	0.29	0.25	0.23	0.15	0.29	N.A.
Volatility	31.92	32.76	16.79	16.26	20.11	12.54
Tracking Error (%)	33.72	35.03	11.96	11.69	17.50	N.A
Hit Ratio (%)	45.66	46.94	47.52	47.55	48.20	N.A
Quantile Hit Ratio (%)	47.83	55.07	55.07	49.28	52.17	N.A
Number of Securities	671	671	670	671	670	500
Maximum Drawdown (%)	-65.08	-77.32	-62.18	-58.86	-60.95	-56.78

Total Debt as Percentage Total Assets

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	6.70	7.51	5.74	4.95	4.65	6.22
Active CAGR (%)	5.06	6.55	5.17	4.12	3.37	6.22
Average Turnover (%)	14.86	21.66	24.10	22.75	15.32	N.A.
Information Ratio	0.30	0.28	0.24	0.23	0.18	N.A.
Volatility	20.85	27.30	25.74	18.11	19.85	12.54
Tracking Error (%)	14.96	29.39	26.85	15.34	16.58	N.A
Hit Ratio (%)	46.52	47.36	48.53	48.34	47.04	N.A
Quantile Hit Ratio (%)	53.62	55.07	55.07	52.17	44.93	N.A
Number of Securities	819	818	818	818	818	500
Maximum Drawdown (%)	-63.97	-58.66	-74.13	-63.2	-69.94	-56.78

Property, Plant & Equipment as Percentage of Total Assets

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	9.77	4.60	8.99	10.93	2.79	6.22
Active CAGR (%)	8.53	3.30	7.91	8.96	1.88	6.22
Average Turnover (%)	33.53	36.46	40.02	37.66	33.39	N.A.
Information Ratio	0.45	0.18	0.49	0.33	0.15	N.A.
Volatility	22.10	18.57	20.03	34.16	18.96	12.54
Tracking Error (%)	19.22	14.37	13.92	37.65	14.33	N.A
Hit Ratio (%)	49.78	44.65	49.45	46.08	45.16	N.A
Quantile Hit Ratio (%)	60.87	49.28	52.17	50.72	52.17	N.A
Number of Securities	462	462	462	462	461	500
Maximum Drawdown (%)	-61.26	-63.81	-63.12	-63.36	-66.18	-56.78

Change in Working Capital

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	10.16	9.64	7.82	7.42	1.31	6.22
Active CAGR (%)	8.14	8.19	7.23	6.71	0.13	6.22
Average Turnover (%)	38.75	47.91	50.34	49.28	44.26	N.A.
Information Ratio	0.32	0.39	0.53	0.45	-0.05	N.A.
Volatility	45.47	23.64	16.75	18.65	21.35	12.54
Tracking Error (%)	56.06	19.79	11.08	12.77	14.48	N.A
Hit Ratio (%)	46.18	47.16	48.46	48.37	46.18	N.A
Quantile Hit Ratio (%)	55.07	49.28	59.42	62.32	47.83	N.A
Number of Securities	563	564	564	564	564	500
Maximum Drawdown (%)	-80.80	-62.84	-57.01	-60.23	-62.54	-56.78

List of Strategies by 1st Quintile Return

Cash Return on Invested Capital

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	14.65	7.50	4.15	4.00	-0.56	6.22
Active CAGR (%)	14.14	7.12	3.60	2.99	-3.60	6.22
Average Turnover (%)	27.92	42.43	43.76	40.69	26.90	N.A.
Information Ratio	0.51	0.64	0.27	0.16	-0.02	N.A.
Volatility	30.88	15.75	15.66	18.15	35.19	12.54
Tracking Error (%)	34.86	10.3	10.77	14.12	36.17	N.A
Hit Ratio (%)	51.15	49.84	48.2	46.28	41.14	N.A
Quantile Hit Ratio (%)	72.46	63.77	53.62	44.93	43.48	N.A
Number of Securities	638	638	637	638	637	500
Maximum Drawdown (%)	-54.95	-57.89	-61.55	-66.02	-82.5	-56.78

Price to Book Value

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	14.48	6.62	4.73	1.87	1.27	6.22
Active CAGR (%)	12.52	5.78	4.12	1.25	0.22	6.22
Average Turnover (%)	24.25	40.22	42.74	38.13	22.54	N.A.
Information Ratio	0.44	0.37	0.27	0.02	-0.06	N.A.
Volatility	36.54	14.72	15.70	17.33	20.55	12.54
Tracking Error (%)	42.12	12.23	11.03	10.73	12.68	N.A
Hit Ratio (%)	47.33	49.05	48.36	47.59	46.90	N.A
Quantile Hit Ratio (%)	55.07	49.28	53.62	52.17	49.28	N.A
Number of Securities	778	778	778	778	777	500
Maximum Drawdown (%)	-80.41	-61.13	-59.5	-59.24	-72.36	-56.78

Enterprise Value to EBITDA

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	13.55	10.54	5.62	2.52	-0.39	6.22
Active CAGR (%)	12.73	9.71	5.04	1.96	-1.70	6.22
Average Turnover (%)	29.31	45.30	48.59	43.15	30.27	N.A.
Information Ratio	0.88	0.66	0.41	0.11	-0.18	N.A.
Volatility	16.23	17.56	15.84	16.47	21.61	12.54
Tracking Error (%)	12.87	14.14	10.42	10.32	13.99	N.A
Hit Ratio (%)	51.15	50.40	49.98	48.49	45.20	N.A
Quantile Hit Ratio (%)	66.67	60.87	55.07	53.62	42.03	N.A
Number of Securities	467	466	466	466	466	500
Maximum Drawdown (%)	-62.39	-58.49	-58.42	-61.42	-72.4	-56.78

Free Cash Flow to Price

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	13.06	9.91	6.60	5.63	3.19	6.22
Active CAGR (%)	12.17	9.53	6.25	5.37	2.58	6.22
Average Turnover (%)	35.84	53.15	56.86	56.41	51.54	N.A.
Information Ratio	0.87	0.81	0.56	0.49	0.16	N.A.
Volatility	16.79	15.02	15.22	16.37	18.60	12.54
Tracking Error (%)	13.73	10.85	9.91	9.46	11.17	N.A
Hit Ratio (%)	50.46	51.41	50.75	49.58	47.54	N.A
Quantile Hit Ratio (%)	63.77	66.67	62.32	63.77	49.28	N.A
Number of Securities	385	384	384	384	384	500
Maximum Drawdown (%)	-69.43	-56.96	-54.51	-53.02	-57.89	-56.78

Price to Earnings

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	12.93	6.85	4.74	3.26	2.03	6.22
Active CAGR (%)	11.69	6.10	4.24	2.87	1.21	6.22
Average Turnover (%)	31.02	47.25	49.75	44.83	33.39	N.A.
Information Ratio	0.76	0.46	0.33	0.21	0.03	N.A.
Volatility	15.89	14.57	14.45	15.7	19.54	12.54
Tracking Error (%)	13.53	11.51	10.67	9.94	11.94	N.A
Hit Ratio (%)	52.18	50.66	49.84	48.67	46.77	N.A
Quantile Hit Ratio (%)	66.67	56.52	57.97	53.62	53.62	N.A
Number of Securities	574	574	574	574	574	500
Maximum Drawdown (%)	-65.03	-60.09	-54.11	-55.92	-60.64	-56.78

Operating Cash Flow to Capital Expenditures

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	12.31	8.05	6.18	4.44	-0.57	6.22
Active CAGR (%)	11.46	7.76	5.65	3.50	-3.89	6.22
Average Turnover (%)	26.48	38.37	40.43	35.36	27.75	N.A.
Information Ratio	0.43	0.71	0.44	0.23	-0.03	N.A.
Volatility	30.21	16.03	15.82	17.75	36.08	12.54
Tracking Error (%)	34.91	10.17	10.61	13.11	37.28	N.A
Hit Ratio (%)	50.21	50.14	48.89	46.97	40.54	N.A
Quantile Hit Ratio (%)	68.12	66.67	59.42	49.28	42.03	N.A
Number of Securities	635	635	634	635	634	500
Maximum Drawdown (%)	-60.04	-56.19	-58.59	-64.04	-83.58	-56.78

Return on Invested Capital

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	12.21	7.46	5.77	4.09	5.20	6.22
Active CAGR (%)	11.15	7.05	5.26	3.51	4.55	6.22
Average Turnover (%)	21.81	32.04	36.01	34.77	28.03	N.A.
Information Ratio	0.40	0.59	0.40	0.26	0.31	N.A.
Volatility	33.41	16.08	15.10	13.77	13.74	12.54
Tracking Error (%)	39.91	10.45	10.90	11.42	12.05	N.A
Hit Ratio (%)	51.69	51.13	49.79	49.00	49.19	N.A
Quantile Hit Ratio (%)	69.57	66.67	57.97	53.62	62.32	N.A
Number of Securities	423	423	423	423	422	500
Maximum Drawdown (%)	-55.66	-56.03	-57.29	-58.43	-61.58	-56.78

Market size Effect

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	12.01	6.37	3.75	3.01	2.32	6.22
Active CAGR (%)	10.00	5.14	2.94	2.59	2.13	6.22
Average Turnover (%)	19.88	26.45	24.71	19.32	10.44	N.A.
Information Ratio	0.39	0.29	0.17	0.17	0.14	N.A.
Volatility	35.88	16.05	18.22	16.94	16.89	12.54
Tracking Error (%)	41.64	13.34	11.51	10.17	9.14	N.A
Hit Ratio (%)	44.04	47.22	48.27	49.40	50.09	N.A
Quantile Hit Ratio (%)	55.41	52.70	55.41	59.46	60.81	N.A
Number of Securities	773	773	773	773	772	500
Maximum Drawdown (%)	-79.17	-63.34	-63.63	-58.31	-58.74	-56.78

EBITDA Margin

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	11.05	8.21	6.45	6.01	3.86	6.22
Active CAGR (%)	9.71	7.74	5.80	4.96	-0.18	6.22
Average Turnover (%)	12.92	20.78	25.31	25.00	18.26	N.A.
Information Ratio	0.36	0.61	0.45	0.29	0.10	N.A.
Volatility	34.32	18.33	17.26	17.06	40.22	12.54
Tracking Error (%)	41.57	11.67	10.42	11.94	43.53	N.A
Hit Ratio (%)	50.58	49.94	49.05	46.91	41.62	N.A
Quantile Hit Ratio (%)	63.77	62.32	57.97	57.97	46.38	N.A
Number of Securities	549	549	549	549	548	500
Maximum Drawdown (%)	-59.96	-58.04	-60.24	-65.41	-83.63	-56.78

Cost of Goods Sold as Percentage of Sales

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	10.40	11.24	6.06	4.63	3.65	6.22
Active CAGR (%)	8.90	9.54	5.21	3.70	2.10	6.22
Average Turnover (%)	20.72	29.74	33.54	32.92	25.35	N.A.
Information Ratio	0.42	0.33	0.33	0.18	0.15	N.A.
Volatility	26.55	35.56	17.46	16.70	35.67	12.54
Tracking Error (%)	21.67	43.56	11.42	12.89	40.85	N.A
Hit Ratio (%)	47.49	48.52	47.75	47.20	45.35	N.A
Quantile Hit Ratio (%)	50.72	59.42	56.52	49.28	39.13	N.A
Number of Securities	527.00	526.00	526.00	526.00	526.00	500
Maximum Drawdown (%)	-58.28	-58.73	-61.64	-62.62	-82.03	-56.78

Change in Working Capital

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	10.16	9.64	7.82	7.42	1.31	6.22
Active CAGR (%)	8.14	8.19	7.23	6.71	0.13	6.22
Average Turnover (%)	38.75	47.91	50.34	49.28	44.26	N.A.
Information Ratio	0.32	0.39	0.53	0.45	-0.05	N.A.
Volatility	45.47	23.64	16.75	18.65	21.35	12.54
Tracking Error (%)	56.06	19.79	11.08	12.77	14.48	N.A
Hit Ratio (%)	46.18	47.16	48.46	48.37	46.18	N.A
Quantile Hit Ratio (%)	55.07	49.28	59.42	62.32	47.83	N.A
Number of Securities	563	564	564	564	564	500
Maximum Drawdown (%)	-80.80	-62.84	-57.01	-60.23	-62.54	-56.78

Current Assets as Percentage of Total Assets

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	10.07	7.54	4.86	3.37	6.19	6.22
Active CAGR (%)	7.50	6.24	3.98	2.54	5.26	6.22
Average Turnover (%)	15.25	22.17	23.02	20.96	13.17	N.A.
Information Ratio	0.29	0.25	0.23	0.15	0.29	N.A.
Volatility	31.92	32.76	16.79	16.26	20.11	12.54
Tracking Error (%)	33.72	35.03	11.96	11.69	17.50	N.A
Hit Ratio (%)	45.66	46.94	47.52	47.55	48.20	N.A
Quantile Hit Ratio (%)	47.83	55.07	55.07	49.28	52.17	N.A
Number of Securities	671	671	670	671	670	500
Maximum Drawdown (%)	-65.08	-77.32	-62.18	-58.86	-60.95	-56.78

Cash as Percentage of Total Assets

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	9.33	8.08	5.18	3.90	3.26	6.22
Active CAGR (%)	6.67	7.10	4.38	3.11	2.31	6.22
Average Turnover (%)	22.05	36.41	40.28	38.70	25.71	N.A.
Information Ratio	0.28	0.36	0.28	0.18	0.13	N.A.
Volatility	31.02	21.28	16.03	27.19	15.31	12.54
Tracking Error (%)	31.12	16.80	12.90	28.87	12.60	N.A
Hit Ratio (%)	45.62	48.11	48.26	47.87	47.92	N.A
Quantile Hit Ratio (%)	52.17	57.97	49.28	53.62	50.72	N.A
Number of Securities	816	816	816	816	815	500
Maximum Drawdown (%)	-74.61	-60.16	-60.62	-77.3	-65.96	-56.78

Operating Margin

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	9.79	5.94	7.49	6.58	2.32	6.22
Active CAGR (%)	8.79	5.57	6.90	5.65	-1.55	6.22
Average Turnover (%)	15.58	23.40	27.64	27.03	20.44	N.A.
Information Ratio	0.36	0.48	0.54	0.35	0.05	N.A.
Volatility	29.65	16.27	16.88	16.57	37.57	12.54
Tracking Error (%)	34.56	9.64	11.37	11.80	38.03	N.A
Hit Ratio (%)	50.32	50.10	49.44	47.20	41.46	N.A
Quantile Hit Ratio (%)	57.97	65.22	59.42	55.07	46.38	N.A
Number of Securities	681	681	681	681	680	500
Maximum Drawdown (%)	-55.69	-58.16	-59.14	-65.23	-85.05	-56.78

Property, Plant & Equipment as Percentage of Total Assets

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	9.77	4.60	8.99	10.93	2.79	6.22
Active CAGR (%)	8.53	3.30	7.91	8.96	1.88	6.22
Average Turnover (%)	33.53	36.46	40.02	37.66	33.39	N.A.
Information Ratio	0.45	0.18	0.49	0.33	0.15	N.A.
Volatility	22.10	18.57	20.03	34.16	18.96	12.54
Tracking Error (%)	19.22	14.37	13.92	37.65	14.33	N.A
Hit Ratio (%)	49.78	44.65	49.45	46.08	45.16	N.A
Quantile Hit Ratio (%)	60.87	49.28	52.17	50.72	52.17	N.A
Number of Securities	462	462	462	462	461	500
Maximum Drawdown (%)	-61.26	-63.81	-63.12	-63.36	-66.18	-56.78

Free Cash Flow to Long-Term Debt

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	9.73	7.34	5.07	4.81	-2.09	6.22
Active CAGR (%)	9.54	6.89	4.43	3.33	-4.54	6.22
Average Turnover (%)	27.59	36.94	38.61	36.37	29.99	N.A.
Information Ratio	0.84	0.62	0.34	0.18	-0.03	N.A.
Volatility	16.15	15.70	15.68	23.99	36.29	12.54
Tracking Error (%)	10.64	10.02	11.00	21.67	39.82	N.A
Hit Ratio (%)	50.75	50.08	48.93	46.45	41.97	N.A
Quantile Hit Ratio (%)	65.22	56.52	53.62	46.38	39.13	N.A
Number of Securities	518	518	518	518	517	500
Maximum Drawdown (%)	-53.64	-58.02	-64.87	-68.31	-83.66	-56.78

Net Margin

Quarterly Rebalance			**Quintile**			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	9.70	7.01	6.64	5.57	0.82	6.22
Active CAGR (%)	8.96	6.64	6.09	4.68	-2.77	6.22
Average Turnover (%)	27.25	41.83	46.14	44.12	35.22	N.A.
Information Ratio	0.38	0.52	0.46	0.26	-0.02	N.A.
Volatility	26.54	15.62	15.26	15.77	34.24	12.54
Tracking Error (%)	29.57	10.62	11.07	11.94	33.94	N.A
Hit Ratio (%)	50.28	50.17	49.51	47.09	41.20	N.A
Quantile Hit Ratio (%)	60.87	62.32	57.97	56.52	47.83	N.A
Number of Securities	805	805	805	805	804	500
Maximum Drawdown (%)	-58.26	-56.51	-57.09	-62.01	-83.47	-56.78

1Year Reduction in Shares

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	8.81	7.73	6.94	6.39	3.29	6.22
Active CAGR (%)	8.38	6.98	6.22	5.39	0.69	6.22
Average Turnover (%)	26.55	34.53	43.52	35.28	28.89	N.A.
Information Ratio	0.53	0.29	0.42	0.37	0.13	N.A.
Volatility	18.76	26.12	16.84	21.12	37.80	12.54
Tracking Error (%)	15.32	30.51	11.36	12.68	40.46	N.A
Hit Ratio (%)	50.54	48.16	48.54	47.42	43.92	N.A
Quantile Hit Ratio (%)	63.77	59.42	55.07	56.52	42.03	N.A
Number of Securities	706	794	588	696	696	500
Maximum Drawdown (%)	-58.20	-73.41	-61.38	-63.07	-71.56	-56.78

Gross Margin

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	8.50	10.97	6.08	5.78	2.55	6.22
Active CAGR (%)	7.37	9.26	5.23	4.85	1.00	6.22
Average Turnover (%)	20.33	29.97	33.48	32.86	25.24	N.A.
Information Ratio	0.51	0.32	0.33	0.21	0.03	N.A.
Volatility	20.05	35.60	17.45	32.63	22.30	12.54
Tracking Error (%)	11.90	43.68	11.47	38.53	19.60	N.A
Hit Ratio (%)	47.81	48.53	47.69	47.18	45.37	N.A
Quantile Hit Ratio (%)	53.62	57.97	56.52	50.72	37.68	N.A
Number of Securities	520	520	520	520	519	500
Maximum Drawdown (%)	-58.06	-59.60	-61.22	-79.77	-67.64	-56.78

Days Sales Outstanding

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	8.03	5.80	7.71	5.36	3.57	6.22
Active CAGR (%)	6.95	4.92	6.92	4.41	2.03	6.22
Average Turnover (%)	19.07	34.35	41.48	39.95	26.71	N.A.
Information Ratio	0.38	0.31	0.44	0.25	0.06	N.A.
Volatility	21.21	17.36	18.35	18.00	22.19	12.54
Tracking Error (%)	18.41	11.77	12.98	11.81	18.63	N.A
Hit Ratio (%)	47.99	47.83	48.07	47.50	45.86	N.A
Quantile Hit Ratio (%)	49.28	52.17	59.42	52.17	47.83	N.A
Number of Securities	584	583	583	583	583	500
Maximum Drawdown (%)	-60.75	-61.33	-61.62	-59.08	-65.87	-56.78

Cash Ratio

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	7.96	5.64	9.08	5.97	3.50	6.22
Active CAGR (%)	4.81	4.29	8.17	5.08	2.34	6.22
Average Turnover (%)	17.50	30.15	36.84	38.43	26.04	N.A.
Information Ratio	0.22	0.21	0.44	0.22	0.12	N.A.
Volatility	33.69	19.38	20.38	28.61	19.98	12.54
Tracking Error (%)	34.53	13.07	17.62	32.31	18.55	N.A
Hit Ratio (%)	45.02	47.24	48.40	48.15	47.04	N.A
Quantile Hit Ratio (%)	50.72	55.07	60.87	55.07	50.72	N.A
Number of Securities	669	669	669	669	668	500
Maximum Drawdown (%)	-80.97	-61.13	-59.45	-77.64	-65.89	-56.78

External Financing to Assets

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	7.76	10.41	8.81	1.16	1.77	6.22
Active CAGR (%)	7.14	9.67	6.58	0.00	-0.38	6.22
Average Turnover (%)	30.81	41.06	43.75	41.41	30.52	N.A.
Information Ratio	0.39	0.35	0.30	-0.01	0.01	N.A.
Volatility	21.95	32.64	36.32	19.79	28.89	12.54
Tracking Error (%)	19.30	38.10	47.00	16.91	24.93	N.A
Hit Ratio (%)	49.74	46.65	46.05	43.84	44.08	N.A
Quantile Hit Ratio (%)	55.07	56.52	53.62	46.38	42.03	N.A
Number of Securities	442	408	425	425	424	500
Maximum Drawdown (%)	-57.29	-77.37	-61.04	-66.50	-76.33	-56.78

Quick Ratio

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	**1st**	**2nd**	**3rd**	**4th**	**5th**	**S&P 500**
Annualized Active Return (%)	7.53	5.37	7.28	8.35	3.62	6.22
Active CAGR (%)	4.60	4.11	6.40	7.40	2.58	6.22
Average Turnover (%)	18.42	30.49	34.61	33.94	22.85	N.A.
Information Ratio	0.21	0.21	0.40	0.30	0.13	N.A.
Volatility	33.37	19.23	17.05	30.93	19.88	12.54
Tracking Error (%)	34.23	12.82	13.16	34.47	18.72	N.A
Hit Ratio (%)	44.86	47.32	48.26	48.53	46.90	N.A
Quantile Hit Ratio (%)	49.28	55.07	53.62	53.62	49.28	N.A
Number of Securities	670	670	670	670	669	500
Maximum Drawdown (%)	-80.01	-60.65	-61.03	-77.74	-64.17	-56.78

Selling, General & Administrative Costs as Percentage of Sales

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	7.29	6.15	6.17	4.68	2.88	6.22
Active CAGR (%)	6.00	5.09	5.37	3.70	1.25	6.22
Average Turnover (%)	41.00	43.98	48.83	42.82	35.26	N.A.
Information Ratio	0.37	0.31	0.33	0.23	0.02	N.A.
Volatility	19.93	20.23	19.40	18.47	18.40	12.54
Tracking Error (%)	14.22	13.16	13.33	12.44	14.11	N.A
Hit Ratio (%)	47.64	44.74	46.54	44.43	42.32	N.A
Quantile Hit Ratio (%)	56.52	56.52	59.42	53.62	40.58	N.A
Number of Securities	204.00	204.00	204.00	204.00	203.00	500
Maximum Drawdown (%)	-68.84	-66.11	-62.12	-58.08	-68.01	-56.78

Total Debt as Percentage Total Assets

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	6.70	7.51	5.74	4.95	4.65	6.22
Active CAGR (%)	5.06	6.55	5.17	4.12	3.37	6.22
Average Turnover (%)	14.86	21.66	24.10	22.75	15.32	N.A.
Information Ratio	0.30	0.28	0.24	0.23	0.18	N.A.
Volatility	20.85	27.30	25.74	18.11	19.85	12.54
Tracking Error (%)	14.96	29.39	26.85	15.34	16.58	N.A
Hit Ratio (%)	46.52	47.36	48.53	48.34	47.04	N.A
Quantile Hit Ratio (%)	53.62	55.07	55.07	52.17	44.93	N.A
Number of Securities	819	818	818	818	818	500
Maximum Drawdown (%)	-63.97	-58.66	-74.13	-63.2	-69.94	-56.78

Current Ratio

Quarterly Rebalance	Quintile					
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	6.57	5.34	7.13	6.91	6.13	6.22
Active CAGR (%)	3.98	4.13	6.16	5.99	5.24	6.22
Average Turnover (%)	19.45	30.62	32.82	30.35	19.62	N.A.
Information Ratio	0.19	0.23	0.38	0.31	0.23	N.A.
Volatility	32.68	19.06	17.30	19.64	31.31	12.54
Tracking Error (%)	33.85	12.38	13.22	17.24	35.45	N.A
Hit Ratio (%)	44.84	47.30	47.93	48.54	47.26	N.A
Quantile Hit Ratio (%)	47.83	53.62	47.83	53.62	46.38	N.A
Number of Securities	671	670	670	670	670	500
Maximum Drawdown (%)	-76.29	-60.48	-62.72	-61.09	-77.32	-56.78

Free Cash Flow to Operating Income

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	6.47	8.14	10.67	8.00	0.56	6.22
Active CAGR (%)	5.59	7.96	10.00	7.10	-2.33	6.22
Average Turnover (%)	34.96	45.37	48.57	44.57	29.63	N.A.
Information Ratio	0.39	0.72	0.39	0.38	0.01	N.A.
Volatility	16.58	15.42	29.44	22.16	33.47	12.54
Tracking Error (%)	12.63	9.88	33.49	18.14	34.33	N.A
Hit Ratio (%)	48.04	50.95	50.76	47.80	41.46	N.A
Quantile Hit Ratio (%)	53.62	60.87	62.32	56.52	43.48	N.A
Number of Securities	583	582	582	582	582	500
Maximum Drawdown (%)	-66.69	-57.22	-56.06	-59.76	-82.95	-56.78

Free Cash Flow per Share Growth

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	4.76	4.04	6.73	14.14	6.14	6.22
Active CAGR (%)	4.09	3.39	5.31	11.26	5.22	6.22
Average Turnover (%)	74.05	71.90	73.75	72.34	72.90	N.A.
Information Ratio	0.20	0.23	0.27	0.37	0.28	N.A.
Volatility	31.19	18.20	28.01	42.14	21.84	12.54
Tracking Error (%)	33.08	11.11	24.66	58.16	16.84	N.A
Hit Ratio (%)	47.84	47.58	47.25	47.40	47.72	N.A
Quantile Hit Ratio (%)	52.17	49.28	47.83	55.07	53.62	N.A
Number of Securities	537	537	536	537	536	500
Maximum Drawdown (%)	-77.17	-63.82	-62.40	-64.89	-63.16	-56.78

Net Income as Percentage of Operating Cash Flow

Quarterly Rebalance			Quintile			
03.1995 – 09.2012	1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	4.03	8.04	6.54	8.05	4.52	6.22
Active CAGR (%)	2.61	7.59	6.22	7.22	2.40	6.22
Average Turnover (%)	31.99	35.38	41.55	41.58	36.96	N.A.
Information Ratio	0.13	0.61	0.54	0.31	0.12	N.A.
Volatility	18.65	15.22	15.24	37.42	24.27	12.54
Tracking Error (%)	12.58	10.68	10.16	42.54	20.21	N.A
Hit Ratio (%)	46.03	49.92	50.17	48.27	44.04	N.A
Quantile Hit Ratio (%)	52.17	62.32	63.77	57.97	47.83	N.A
Number of Securities	731	730	730	730	730	500
Maximum Drawdown (%)	-71.62	-60.02	-56.69	-72.71	-67.26	-56.78

Free Cash Flow as Percentage of Operating Cash Flow

Quarterly Rebalance 03.1995 – 09.2012	Quintile 1st	2nd	3rd	4th	5th	S&P 500
Annualized Active Return (%)	1.92	6.50	11.68	6.51	2.66	6.22
Active CAGR (%)	-1.09	6.03	10.93	5.98	1.69	6.22
Average Turnover (%)	28.46	29.23	38.19	39.00	32.49	N.A.
Information Ratio	0.06	0.43	0.43	0.48	0.06	N.A.
Volatility	35.61	16.98	29.73	15.84	16.90	12.54
Tracking Error (%)	36.30	12.40	33.87	10.64	11.90	N.A
Hit Ratio (%)	42.07	47.98	50.24	48.98	46.88	N.A
Quantile Hit Ratio (%)	42.03	59.42	66.67	60.87	55.07	N.A
Number of Securities	651	638	644	645	644	500
Maximum Drawdown (%)	-82.52	-59.88	-55.96	-58.88	-65.03	-56.78

Correlation Matrices

Profitability

	Gross Margin	EBITDA Margin	Operating Margin	Net Margin	ROIC
Gross Margin	1.00	0.39	0.37	0.34	0.19
EBITDA Margin	0.39	1.00	0.89	0.68	0.09
Operating Margin	0.37	0.89	1.00	0.79	0.15
Net Margin	0.34	0.68	0.79	1.00	0.12
ROIC	0.19	0.09	0.15	0.12	1.00

Valuation

	P/E	P/B	FCF/P	EV/EBITDA
P/E	1.00	0.42	0.44	0.62
P/B	0.42	1.00	0.42	0.39
FCF/P	0.44	0.42	1.00	0.44
EV/EBITDA	0.62	0.39	0.44	1.00

Cash Flow

	FCF to Operating Income	CFROIC	FCF/OCF	Net Income to OCF	FCF per Share Growth
FCF to Operating Income	1.00	0.34	0.01	0.28	0.07
CFROIC	0.34	1.00	0.05	0.1	0.08
FCF/OCF	0.01	0.05	1.00	-0.1	0.09
Net Income to OCF	0.28	0.1	-0.1	1.00	-0.03
FCF per Share Growth	0.07	0.08	0.09	-0.03	1.00

Capital Allocation

	1 Year Reduction in Shares	External Financing to Assets
1 Year Reduction in Shares	1.00	0.45
External Financing to Asset	0.45	1.00

Red Flags

	FCF to Long-term Debt	CFO to CAPEX	DSO
FCF to Long-term Debt	1.00	0.82	0.03
CFO to CAPEX	0.82	1.00	0.05
DSO	0.03	0.05	1.00

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