The relevance of the Quality in the German stock market.

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Abstract

I develop a strategy that combines 13 measures of stock's quality for the German stock market. This ALL-IN strategy is an average of 13 individual long-short strategies, which in the period between 2005 and 2018 resulted in a Shape ratio of 2.18. This is twice as high than the one by any of the 13 individual strategies, four times as high as the standard Quality minus Junk strategy, and contrasts sharply to a stock market Sharpe ratio of 0.40. ALL-IN has limited negative returns and consistent performance through time. Several robustness checks are performed and it is shown that common factors from a 5 Fama-French factor model do not explain the performance of the strategy. Additionally, the performance is derived mostly from small but not penny stocks.

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1. Introduction

In recent years, the asset pricing anomaly of quality investing has been researched extensively. Investors earn high abnormal returns by buying profitable, safe, and growing stocks, and selling stocks that are unprofitable, unsafe and not growing.

However, researchers fail to agree upon a risk-based explanation for these abnormal returns. How can safe, profitable, and growing firms be riskier than firms that are unsafe, unprofitable and not growing?

In a risk-reward universe, higher prices should mechanically result in lower expected returns. Therefore, the abnormal return of quality stocks is an asset pricing puzzle.

The goal of this work is to examine long-short strategies based on quality for the German stock market. I constructed a QMJ factor as the equally weighted average of the main three components of the quality: profitability, growth, and safety. According to this factor, I sorted all the stocks into ten deciles; and then I formed a portfolio that is long on the top decile of quality and that short on the bottom quality. Besides analysing the dimensions of profitability and safety in separate, I combine all the three quality components, forming a new QMJ portfolio equally capable of beating the market but presenting a lower Sharpe Ratio.

I decided to use only 13 different variables to measure the three quality components, and according to each variable alone I constructed a QMJ factor. At this point, I decided to break the mould and to go against the previous literature. In fact, 10 out of 13 portfolios, were going long on the top decile firms and short on the bottom decile firms; but this process changed when I considered Price to book value, Accruals and the three-years growth in the cash flow. For these variables, to get positive returns, I had to invert the reasoning: the portfolio was going long on bottom decile firms and was going short on top decile firms. Of all these portfolios, only three presented a Sharpe Ratio lower than the market's one.

For this reason, I decided to combine all these portfolios in one and that is how I constructed the ALL-IN strategy.

In this thesis, I contribute to the existing literature on the quality anomaly. I extend the research of Asness et al. (2019) on QMJ, attempting to find a possible explanation of the abnormal returns of the strategy. The ALL-IN portfolio, formed combining all the 13 portfolios, presented a Sharpe Ratio equal to 2.18, 4 times bigger than the Sharpe Ratio related to the QMJ portfolios mentioned above. This strategy turned out to be mainly driven by the returns associated to the ROA, which was the variable presenting the highest Sharpe Ratio if considered alone, giving new light to the relevance of the ROA in the quality anomaly studies.

This is related to literature on how industry effects and sector effects can explain the cross-section of expected returns. Moreover, analysing the composition of the ALL-IN portfolio, I found that the sectors more involved in the ALL-IN strategy were the Services, Financial, Electronics and Construction one. The latter seem to be the industries where the "high quality" stocks are more present.

This thesis is also related to the literature on how we can use statistical tools and properties in financial modelling. Cont (2001) presented a list of pros and cons of each statistical tool used to analyse assets' returns explaining that most currently existing models fail to reproduce all these statistical features at once, showing that they are indeed very constraining. Following this conclusion, I deeply analysed the ALL-IN strategy, finding out that ignoring the returns of the portfolio formed considering only PTBV, the Sharpe Ratio of the ALL-IN strategy decreased by the highest amount, achieving the value of 1.90. This result gave me the idea to check each possible combination among the 13 variables presented in this work. I found out that the best combination is given by ROA and PTBV together, whose portfolio presents a Sharpe Ratio equal to 2.50; while the worst combination is given by CFOA and the three-year grow of cash flow, whose portfolio presents a Sharpe Ratio equal to 0.67. Following this reasoning it was clear that the variable that had the largest correlation with the ALL-IN strategy's returns was the ROA; but more than anything, the study of correlations and of combinations clarified what makes this strategy a winning one: the ability to limit the minimum values of the returns. In fact, combining all the portfolios together, it was possible to balance the worst returns associated to some of the variables.
Further, each month, I am more buying than selling stocks; and especially I am buying firms characterized by a larger cap and a higher book-to-market compared to the companies that I am selling.

For complete information, I tried to analyse the impact of the penny stocks in the ALL-IN strategy; this impact, anyway, was not so significant but what I wanted to do was to check if the returns of this strategy were driven by a particular type of stocks.

The rest of paper is organised as follows. Section 2 presents my data, my quality measures, and the details about the construction of each one of them. Section 3 is dedicated to the methodology used to form the QMJ portfolios and the quality sorted portfolios, considering each quality measure alone. Section 4 presents the main strategy of this work, the ALL-IN strategy, showing a complete analysis of its composition, characteristics, and features. Section 5 shows how ignoring penny stocks the ALL-IN returns could change. Section 6 is about the robustness tests done on the ALL-IN strategy. Section 7 concludes.

2. Data

This study uses monthly stock returns data and annual accounting data from Thomson Reuters DataStream database.

The sample consists of all available stocks in the Germany stock market and runs from 31 January 2001 to 31 December 2018. However, results begin from January 2005, because three years of data are required for some quality characteristics. All missing and not reliable data are removed from the main sample.

This thesis is constructed on a total of 122304 observations, with a monthly average of 690 observations. All returns are in Euro. Germany Government Bond 10 years yield is used as the proxy for the risk-free rate.

2.1 Quality Score

Following the method of Asness, Frazzini, and Pedersen (2019), this work constructs the quality factor as a combination of profitability, growth, and safety. Each of the three quality components is calculated by taking an average of a set of individual measures' z-scores.

The z-scores are computed as:

$$z_i = ((r_i - \bar{r}_i))/(\sigma(r_i)) \quad (1)$$

Where r_i, $\bar{r}_i$ and $\sigma(r_i)$ are the ranks of each measure, mean of the ranks and standard deviation of the ranks, respectively. The rank, mean and standard deviation are all cross sectional.

In order to reduce noise and to avoid focusing on a particular side of each quality component, I used different variables to measure profitability, growth and safety.

$$\text{Profitability} = z(z_{gpoa} + z_{roe} + z_{ptbv} + z_{cfoa} + z_{gmar} + z_{acc}) \quad (2)$$

The measures contained within the profitability component are gross profits over assets (GPOA), return on equity (ROE), price to book value (PTBV), cash flow over assets (CFOA), gross margin (GMAR), and the fraction of earnings composed of cash, that is accruals (ACC).
I calculated these variables according to the Thomson Reuters DataStream availability:

$$\text{Return on equity (ROE)} = \frac{\text{Net income} - \text{Bottom Line} - \text{Preferred dividend}}{\text{Average of last year's and current year's Common Equity}} \quad (3)$$

$$\text{Price to book value (PTBV)} = \frac{\text{Share price}}{\text{Book value per share}} \quad (4)$$

$$\text{Gross profit over asset (GPOA)} = \frac{\text{Revenues} - \text{Costs of goods sold}}{\text{Total Asset}} \quad (5)$$

$$\text{Cash flow over asset (CFOA)} = \frac{\text{Net income + Depreciation} - \Delta\text{WorkingCapital} - \text{Capital Expenditures}}{\text{Total Asset}} \quad (6)$$

where ΔWorkingCapital is the annual change in the working capital value.

$$\text{Gross Margin (GMAR)} = \frac{\text{Revenues} - \text{Costs of goods sold} - \text{Depreciation}}{\text{Sales}} \quad (7)$$

$$\text{Accruals (ACC)} = \frac{\text{Depreciation} - \text{Change in Working Capital}}{\text{Total Asset}} \quad (8)$$

Similarly, I measure growth as the three-year growth in per-share profitability measures, excluding accruals and price to book value.

$$\text{Growth} = (z_{\Delta gpoa} + z_{\Delta roe} + z_{\Delta roa} + z_{\Delta cfoa} + z_{\Delta gmar}) \quad (9)$$

In particular, the three- year growth in residual gross profit over asset (ΔGPOA) is equal to:

$$[(GP_t - rf \times TA_{t-1}) - (GP_{t-4} - rf \times TA_{t-5})] / TA_{t-4} \quad (10)$$

where GP (Gross Profit) = $\frac{\text{Revenues} - \text{Costs of goods sold}}{\text{Shares Outstanding}}$; rf = risk free ; and Total asset per share (TA) = $\frac{\text{Total Asset}}{\text{Shares Outstanding}}$;

the three-year growth in residual return on equity (ΔROE) is equal to:

$$[(\text{NET INCOME}_t - rf \times BE_{t-1}) - (\text{NET INCOME}_{t-4} - rf \times BE_{t-5})] / BE_{t-4} \quad (11)$$

there NET INCOME = $\frac{\text{Net Income}}{\text{Shares Outstanding}}$; rf = risk free; BE = $\frac{\text{Book Equity}}{\text{Shares Outstanding}}$;

the three-year growth in residual return on asset (ΔROA) is equal to:

$$[(\text{NET INCOME}_t - rf \times TA_{t-1}) - (\text{NET INCOME}_{t-4} - rf \times TA_{t-5})] / TA_{t-4} \quad (12)$$

where NET INCOME and TA as the same defined above.

The three-year growth in residuals cash flow over asset (ΔCFOA) is equal to:

$$[(CF_t - rf \times TA_{t-1}) - (CF_{t-4} - rf \times TA_{t-5})] / TA_{t-4} \quad (13)$$

where CF = Net income + Depreciation – Change in Working Capital – Capital Expenditures.

rf = risk free and TA defined previously.

The three-year growth in gross margin (ΔGMAR) is equal to:

$$(GP_t - GP_{t-4})/SALE_{t-5} \tag{14}$$

where GP is the same defined above; and SALE = $\frac{\text{Sales}}{\text{Shares Outstanding}}$.

Further, I considered as safe, the firms that have a low bankruptcy risk. I decided to use the Altman's Score to measure the safety component:

$$\text{Safety} = (z_{\text{Altman}}) \tag{15}$$

I calculated the Altman's score in the following way:

(16)

$$\text{Altman's Score} = 1.2\times\frac{\text{WC}}{\text{Total Asset}} + 1.4\times\frac{\text{RE}}{\text{Total Asset}} + 3.3\times\frac{\text{EBIT}}{\text{Total Asset}} + 0.6\times\frac{\text{MKTCAP}}{\text{Total Liabilities}} + 1.0\times\frac{\text{SALES}}{\text{Total Asset}}$$

where WC = Working Capital, RE = retained earnings, EBIT = Earnings before interests and taxes, MKTCAP = Market capitalization, and SALES = Total sales.

Finally, the quality score is constructed by combining all three components:

$$\text{Quality} = z\,(\text{Profitability} + \text{Growth} + \text{Safety}) \tag{17}$$

3. Methodology

3.1 QMJ Portfolios

Each month, I constructed a QMJ factor, that is an equally weighted combination of the rescaled ranks based on the variables presented in the data section of this work. I tried to isolate the profitability and the safety components from the growth ones. Doing so, I constructed a QMJ factor using only the following variables: return on asset, gross margin, return on equity, gross profits over assets, accruals, cash flow over assets and Altman's score. According to this QMJ factor, I

sorted the stocks in 10 deciles each month and then I formed a portfolio going long on stocks that belong to the top decile and short on stocks that belong to the bottom decile.

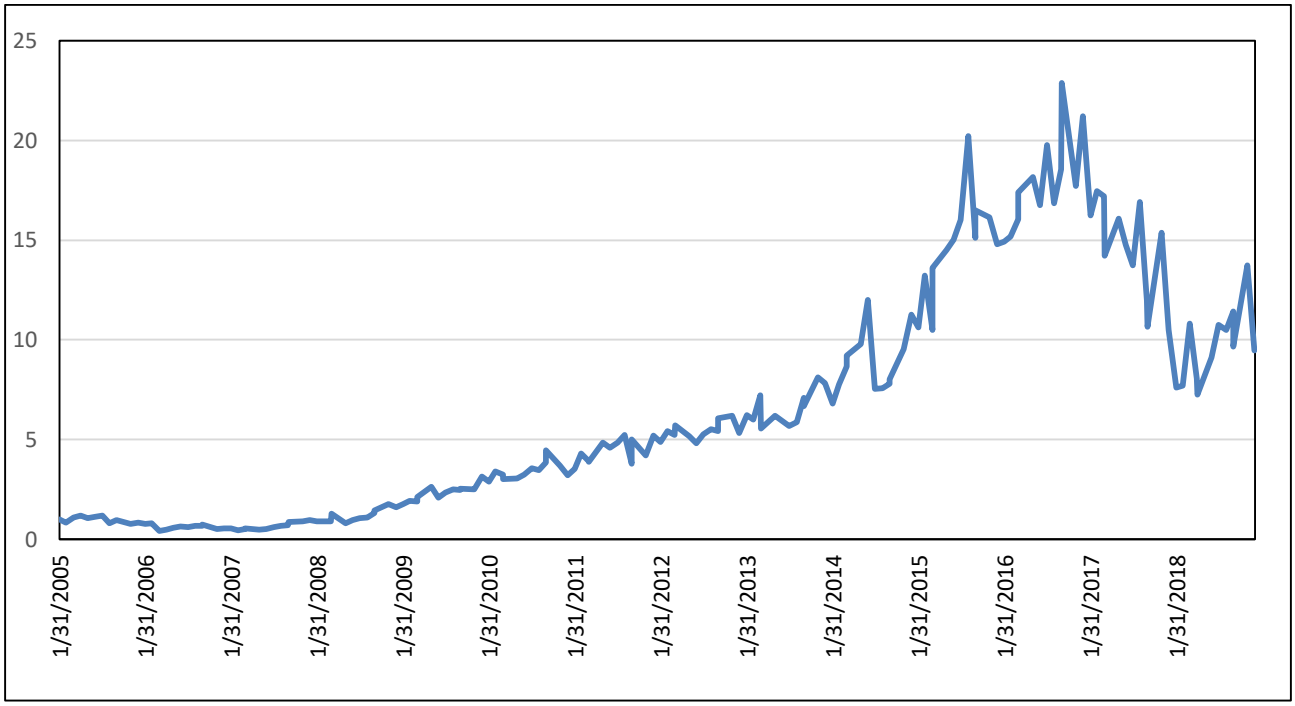

Figure 1: Cumulative returns of the QMJ portfolio from 2005 until 2018 (NO growth measures).

Statistics	QMJ Portfolio	CRSP EW
Mean (%)	2.77	0.58
St. Dev (%)	16.57	4.80
Sharpe Ratio	0.58	0.43

Table 1: QMJ Portfolio vs CRSP EW

Comparing the QMJ strategy to the market, we can see that even if the former beats the latter, the Sharpe Ratio is too low. This strategy seems to work until its maximum, at the end of 2016. After that, the graph shows a downward trend, but it seems to increase from 2017 onwards. Anyway, it is easy to see that there is no constant trend (upward or downward), that is why the standard deviation it is so high.

In total, this strategy involves about 10000 different stocks, 5500 are assigned to the bottom decile of the QMJ factor according to their quality score, then the portfolio goes short on them; the remaining 4500 are assigned to the top decile, that is, these are the stocks that are bought. In this case, the percentage of the long positions is higher than the one of short positions. To better understand what exactly the structure of this QMJ portfolio is, I decided to stress out to which sectors these firms belong; highlighting the top four industry represented in this QMJ strategy:

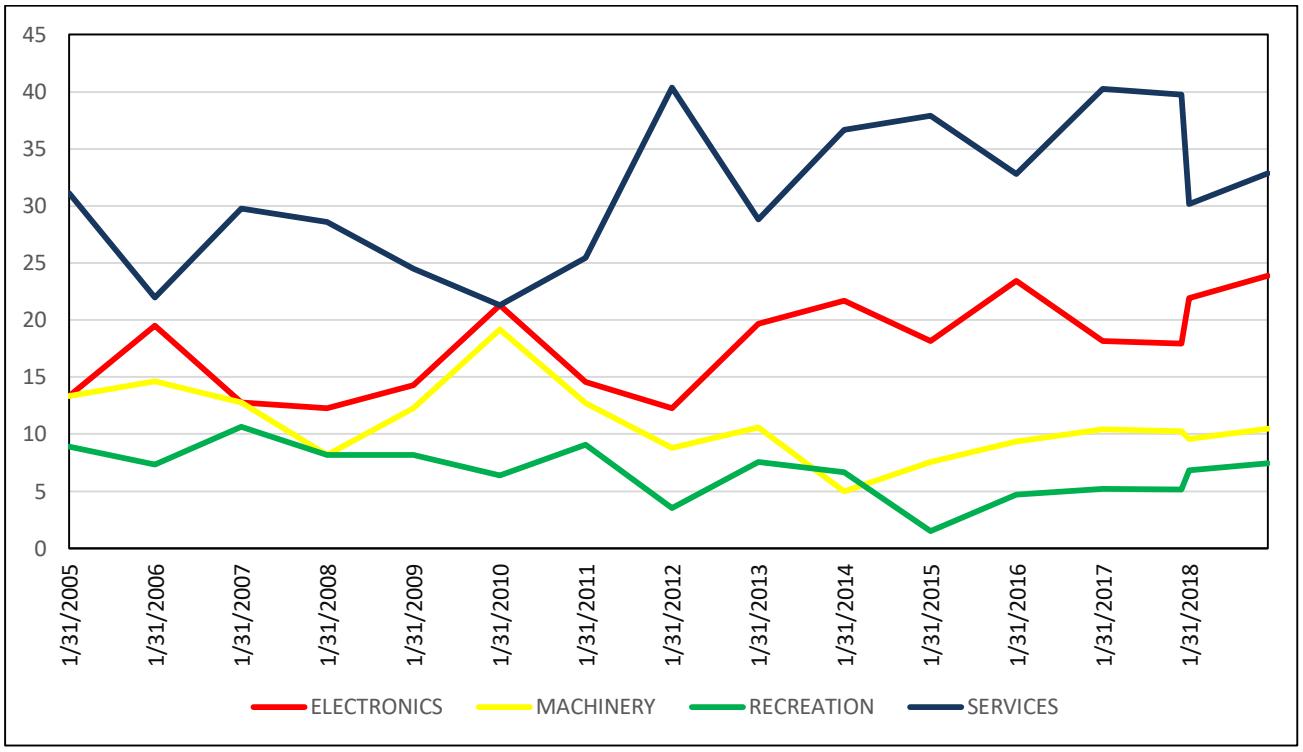

Figure 2: Percentages of the top 4 sectors involved in the QMJ strategy.

The highest number of stocks turned out to belong to the Services sector, which is followed by the Electronics one, the Machinery, and the Recreation for last. Actually, the Services sector dominates during the whole period, with the maximum percentage equal to 41%, that is, 4000 out of the total 10000 stocks belong to firms that offer Services and the remaining 6000 are collocated in 12 different sectors, that I don't present here in order to avoid confusion.

Further, I tried to understand the impact of another measure of quality: the growth. Following the same process that I mentioned above, I constructed a QMJ factor combining the rescaled ranks of: return on equity, return on asset, gross profit over asset, accruals, cash flow over asset, gross profit,

Altman's score and adding the three-years growth of profitability measures. According to this new QMJ factor I sorted the stocks in ten deciles each month and I formed a portfolio going long on stocks that belong to top decile and going short on stocks that belong to the bottom decile.

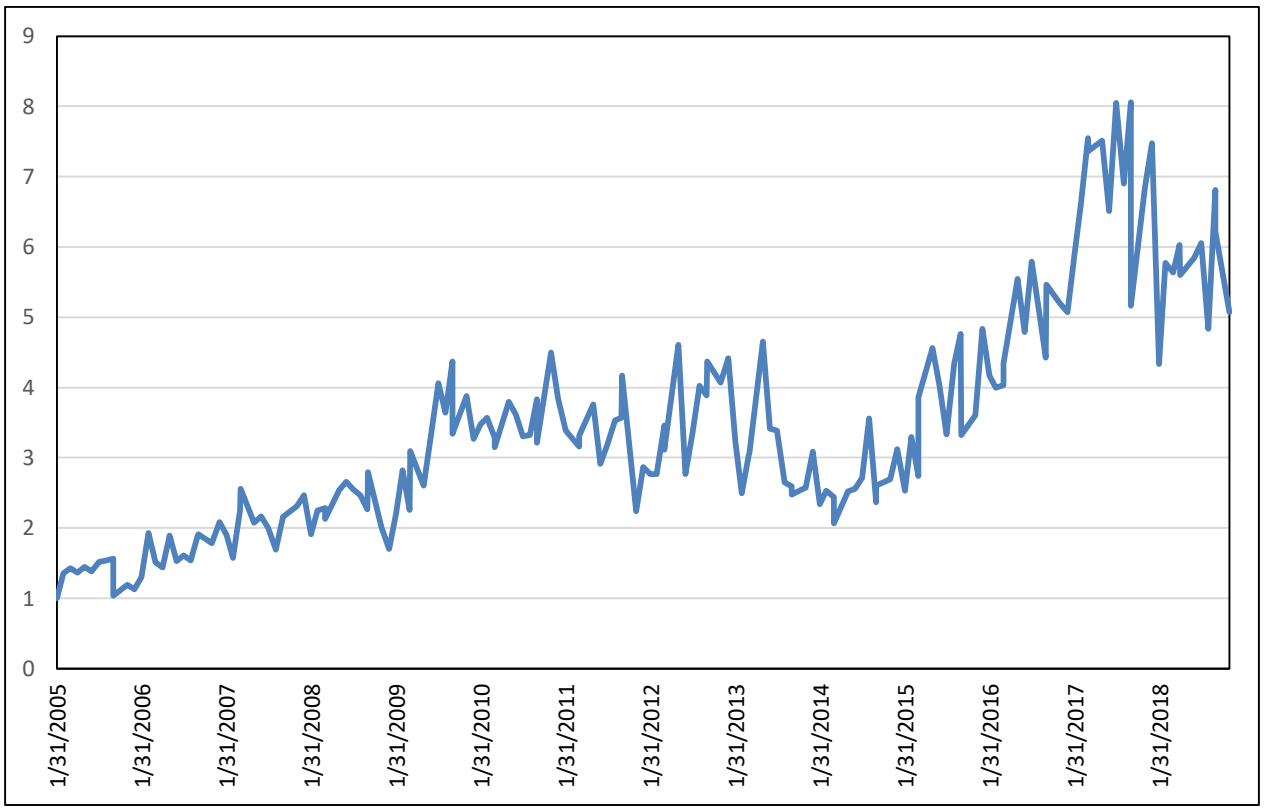

Figure 3: Cumulative returns of the QMJ strategy and the impact of the growth on it.

Statistics	QMJ Portfolio	CRSP EW
Mean (%)	2.34	0.58
St. Dev (%)	18.40	4.80
Sharpe Ratio	0.48	0.43

Table 2: QMJ Portfolio #2 vs CRSP EW

Adding the growth measures, the Sharpe Ratio decreases such that this strategy can barely beats the market. This graph presents an even more inconstant trend throughout the time, showing an upward trend just for few years, from 2013 until 2017.

This strategy turned out to consider a lower number of stocks. that is, about 8500. In this case, long and short positions are more balanced, in fact, 4300 are the stocks that belong to the bottom decile of the QMJ factor and 4200 are the ones that belong to the top decile of the QMJ factor. This means that I am buying and selling almost the same amount of stocks.

Also, for this strategy, I decided to check which sectors are the most representative ones:

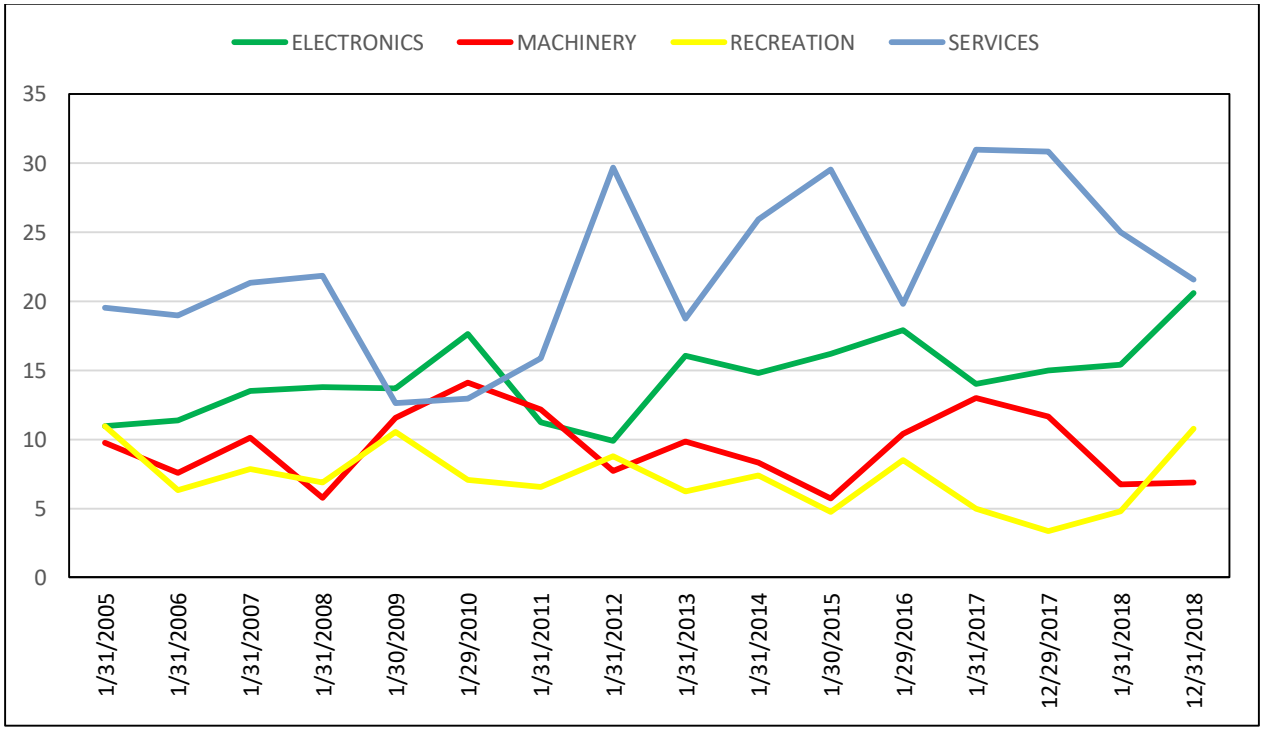

Figure 4: % of the top 4 sectors involved the QMJ strategy considering the growth measures.

As well as for the other QMJ strategy presented above, the top 4 sectors turned out to be the same:

1. Services
2. Electronics
3. Machinery
4. Recreation

Even if these two QMJ portfolios seem to be also well diversified, they will not make you rich but, at least, they will let you make money as well as the market would do.

3.2 Quality sorted Portfolios

Firstly, I constructed quality sorted portfolios considering each measure, of all the three quality components, by itself. Each month, I ranked the profitability/growth/safety variable "x" in ascending order, then I rescaled the ranks to have a zero cross-sectional mean and a cross-sectional standard deviation of one.

Each month, I constructed a Quality minus Junk (QMJ) factor based on the ranks already mentioned and according to the QMJ factor, I assigned stocks to ten deciles. Finally, I formed a portfolio going long on top decile and short on bottom decile. I applied this process for all 13 variables mentioned in the previous paragraph, except for price to book value, accruals, and the growth of cash flow. For these three variables, to get positive returns, I formed a portfolio going long on bottom decile and short on top decile. The table[1] below will show the results of each strategy:

Statistics	**ROA**	**PTBV**	**ROE**	**ΔROA**	**ALT**	**ΔGPOA**	**ACC**	**GPOA**	**ΔGP**	**GMAR**
Mean (%)	4.37	3.97	4.29	2.46	2.91	2.10	2.47	1.56	1.53	1.67
St. Dev (%)	8.27	8.67	10.56	7.97	9.85	8.11	9.74	7.57	9.03	10.13
Sharpe Ratio	1.83	1.58	1.41	1.07	1.02	0.89	0.88	0.72	0.58	0.57

Table 3: Quality-sorted portfolios based on each variable alone

To fully understand the magnitude of these returns, I decided to compare the Sharpe ratio of each one of these strategies to the CRSP equally weighted portfolio's returns, considering the latter a proxy for the market.

Taking in consideration the same time span, the table below will show the summary statistics for the market:

[1] The Sharpe Ratios are annualized.

Statistics	CRSP EW
Mean (%)	0.58
St. Dev (%)	4.80
Sharpe Ratio	0.43

Table 4: the market

As everyone can see, all the Portfolios constructed on a single measure of the three components of the quality score, seem to beat the market. Anyway, there are three of them that do not beat the market and they are the following:

Statistics	ΔCF	CFOA	ΔROE
Mean (%)	1.58	1.38	0.23
St. Dev (%)	14.88	12.15	15.11
Sharpe Ratio	0.37	0.40	0.08

Table 5: Portfolios that are not able to beat the market

It is possible to notice that even if the average return is not so bad (except for the growth of the ROE), what makes the Sharpe Ratio low is a remarkably high standard deviation. This implies these three variables presented in the table above are the ones which involve more risk respect to the other variables presented in the previous table (the portfolios that can beat the market).

4 ALL-IN STRATEGY

What will happen if I form a portfolio which collects all the portfolios based on each single variable mentioned in the previous paragraph?

Each month I would have a portfolio going long on a certain amount of "winner" stocks based on different criteria (ROE, ROA, PTBV, ALTMAN, CFOA, etc) and going short on a certain amount of "loser" stocks based on the same collection of criteria.

I already showed the returns of each portfolio formed considering one variable at a time and I already know that 10 out of 13 portfolios present a good Sharpe Ratio, higher than the benchmark, that is the CRPS equally weighted portfolio.

Based on these positive assumptions, starting from the simplest idea that anyone could have, one can consider the portfolios related to each one of the profitability, safety and growth measures and can create a unique portfolio.

Let's analyse the average of monthly returns of this new portfolio and the relative cumulative returns during the sample period:

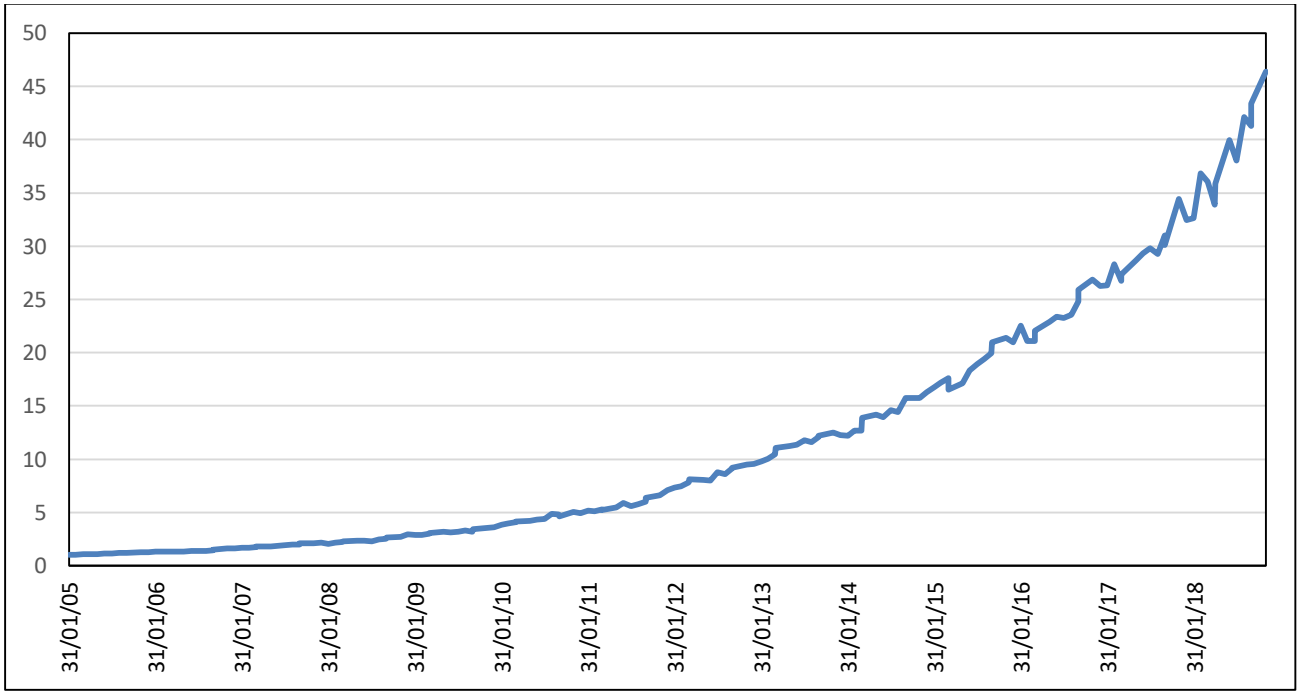

Figure 5: Cumulative returns of the ALL-IN portfolio from 2005 to 2018

The relative graph showing the cumulative returns of this strategy presents an increasing upward trend during all the period considered.

Moreover, checking few characteristics of this strategy, one can easily realize how much it is winning respect to the ones mentioned above:

Statistics	ALL-IN Strategy
Mean (%)	2.35
St. Dev (%)	3.73
Sharpe Ratio	2.18

Table 6: Summary statistics of the ALL-IN portfolio

The annualized Sharpe Ratio is almost four times bigger than the Sharpe Ratio of the QMJ portfolios, and it is associated to a slower standard deviation which allows the trend of the graph to keep growing. This strategy strongly beats the market and it could even make you rich. Considering the lower value of standard deviation, that is the volatility and so the risk, investors with higher risk aversion should prefer this last strategy to the other ones.

What makes this strategy so winning? Which variable has the strongest link with the portfolio's returns?

To answer this question, I analysed the relationship between the Sharpe Ratios relative to the portfolios constructed on each variable used to measure profitability, safety, and growth.

Using as benchmark the ALL-IN strategy, I tried to understand how its Sharpe Ratio changes considering all the variables but one, finding out that the price to book value is actually the variable which has the highest impact on the Portfolio's returns respect to all the other variables considered. In fact, ignoring the returns of the portfolio formed considering only the price to book value as a profitability measure, the Sharpe Ratio of the ALL-IN strategy decreases up to 1.90. In general, all other variables do not have a strong impact on the returns, reducing the benchmark Sharpe Ratio by only few percentage points. Two are the variables that instead have a negative relationship with the returns, and these are the gross margin and the gross profit over asset. Ignoring the latter, the ALL-IN Sharpe Ratio increases up to 2.29, that is it rises by few decimals.

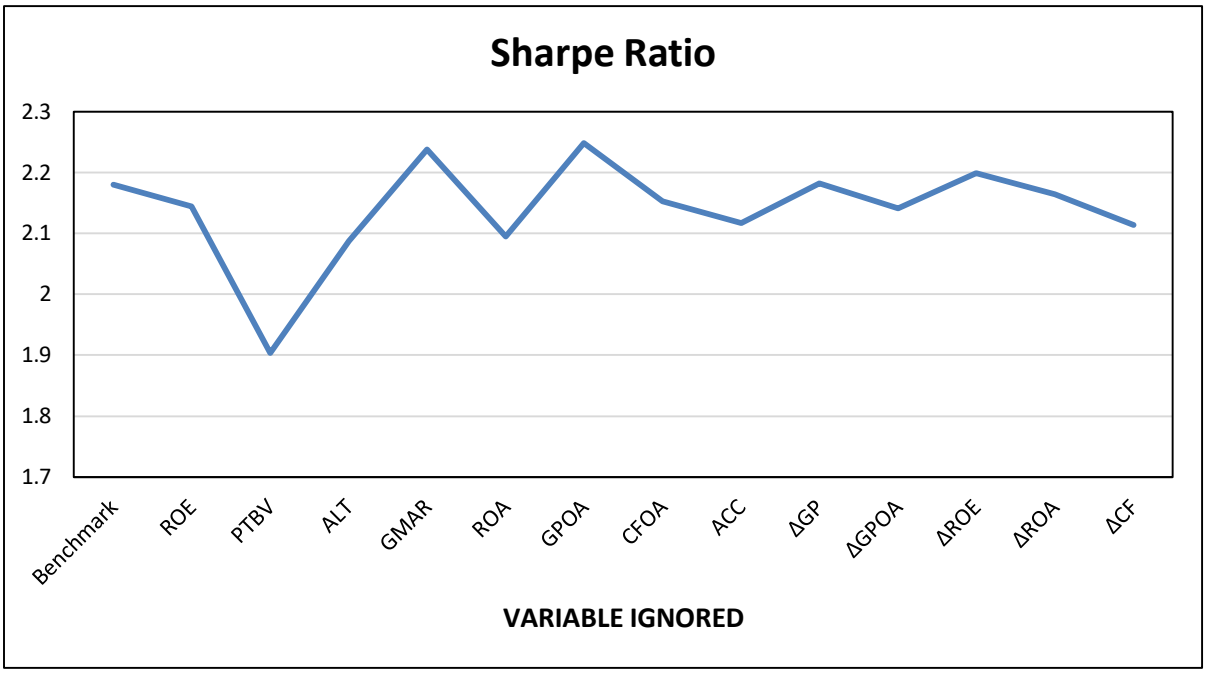

Figure 6: The relationship between the ALL-IN portfolio returns and each single variable

Another way to stress out the relationship between all the variables considered is to analyse their correlation. The two variables with the highest negative correlation are cash flow over asset (CFOA) and the three-years growth of cash flow (ΔCF), while the two variables with the highest positive correlation are return on asset (ROA) and return on equity (ROE). The returns of the ALL-IN strategy are highly correlated to the return on asset (ROA), which is also the variable which gives the highest Sharpe Ratio if it is considered by itself.

To deeply understand what allows the investors to make money with the benchmark strategy, I tried to combine all the variables 1:1, 2:2 and so on, and I found out that the combination that gives me the highest Sharpe Ratio among all is the one related to the returns on asset (ROA) and the price to book value (PTBV). In fact, doing a simple average between the portfolios' returns associated to these two variables, I got an annualized Sharpe Ratio equal to 2.50. Any another combination overcomes this value and it is not by chance that return on asset and price to book value are the two variables with the highest returns when considered alone.
The most interesting thing is that to the two variables with the highest negative correlation (CFOA and ΔCF) is associated the lowest minimum value of the portfolio's returns.

Statistics	PTBV + ROA	CFOA + ΔCF
Max (%)	21.86	21.51
Min (%)	-9.92	-29.66
Sharpe Ratio	2.50	0.67

Table 7: Best combination vs worst combination

What this tells us? The answer is that what makes the ALL-IN strategy a winning one is the ability to limit the minimum values of the returns associated to some variables considered in the strategy. Combining all the variables in a single portfolio allows investors to not suffer much from the sudden and strong falls of the returns related to the portfolio calculated considering only one specific variable. Considering all the variables together allows the strategy to balance all the possible minimum returns' values, and to present a good Sharpe Ratio at the end.

Now, let's try to understand not the relationship among the variables, but the link that the returns of the ALL-IN strategy have with each variable considered.

In other words, what I would like to find out is which is the variable that mainly drives the returns of the ALL-IN strategy. To answer to this question, I calculated the correlation between the monthly average returns of the ALL-IN strategy and the returns of each portfolio formed considering a single measure at a time:

Correlation	ROE	PTBV	ALT	GMAR	ROA	GPOA
ALL-IN	0.65	0.11	0.36	0.47	0.69	0.57

Correlation	ΔROE	ΔGPOA	ΔROA	CFOA	ACC	ΔGP	ΔCF
ALL-IN	0.18	0.38	0.51	0.25	0.36	0.36	0.22

Table 8: Correlation between ALL-IN strategy and each variable alone

As anyone can see, the variable most correlated to the results of the ALL-IN strategy is the return on asset (ROA), that is also that one with the highest Sharpe Ratio if it is considered alone.

What could seem strange is the fact that the less correlated variable is the price to book value, that was the variable that combined with the return on asset, gave the highest Sharpe Ratio possible. How could this be possible? The answer is to find again in the minimum. In fact, the portfolio formed considering only the price to book value present the lowest minimum value among all the other variable present in the table above.

4.1 Inside the ALL-IN strategy

Let's analyse the composition of the ALL-IN strategy from the inside.
How many stocks I am buying and how many stocks I am selling each month? On average, I am more buying or selling?

To answer these questions, I considered the net position of the portfolio in each month, and then I constructed a variable whose value was:

- 1 if the net position was positive, that is, if at the end of each month I had a long position on that stock.
- 0 if the net position was equal to 0, that is, if at the end of the month my long and short positions cancel out each other out, so that that stock is not in my portfolio anymore.
- -1 if the net position was negative, that is, if at the end of each month I had a short position on that stock.

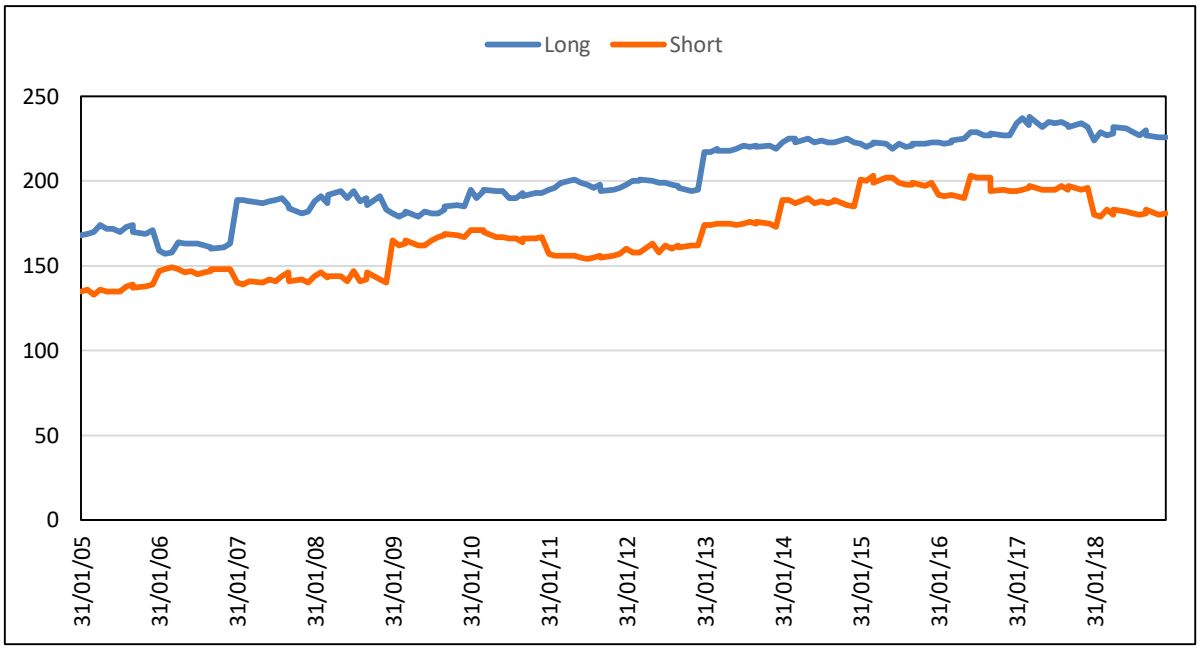

Figure 7: The monthly number of long and short positions owned from 2005 until 2018

The previous graph lets us know that during all the period considered in this work, the number of the long positions is bigger than the number of short positions.

This means that throughout the time span, I am more buying than selling. Moreover, the number of both long and short positions is increasing for most of the months, that is, when an investor realize that a strategy lets him to get positive returns, he keeps investing on it.

In total, in 168 months, the ALL- IN strategy involves the purchase of almost 34000 stocks and the sale of 28000 stocks, that is, this strategy is based on 63000 stocks.

Statistics	Long	Short	Long + Short
Max	238	203	435
Min	157	133	303
Mean	202	167	370
Total	33970	28223	62193

Table 9: Summary statistics of the amount of positions involved in the ALL-IN portfolio

On average, each month I bought 202 stocks and at the same time I sold 167 stocks, with a positive net position made of 35 long positions. The average monthly amount of stocks that I buy or sell in a month is 370, not a small number for sure.

The month in which one can find the smallest amount of stocks bought is February 2006 (157) , while the month with the highest number of stocks bought is April 2017 (238) , this confirms that the amount of long positions increases over time.

On another hand, the minimum number of stocks is sold in March 2005(133), while the maximum number of stocks is sold in June 2016 (203), also in this case, this confirms the upward trend of the number of the short positions until this date, followed by a slightly decrease until the 2018.

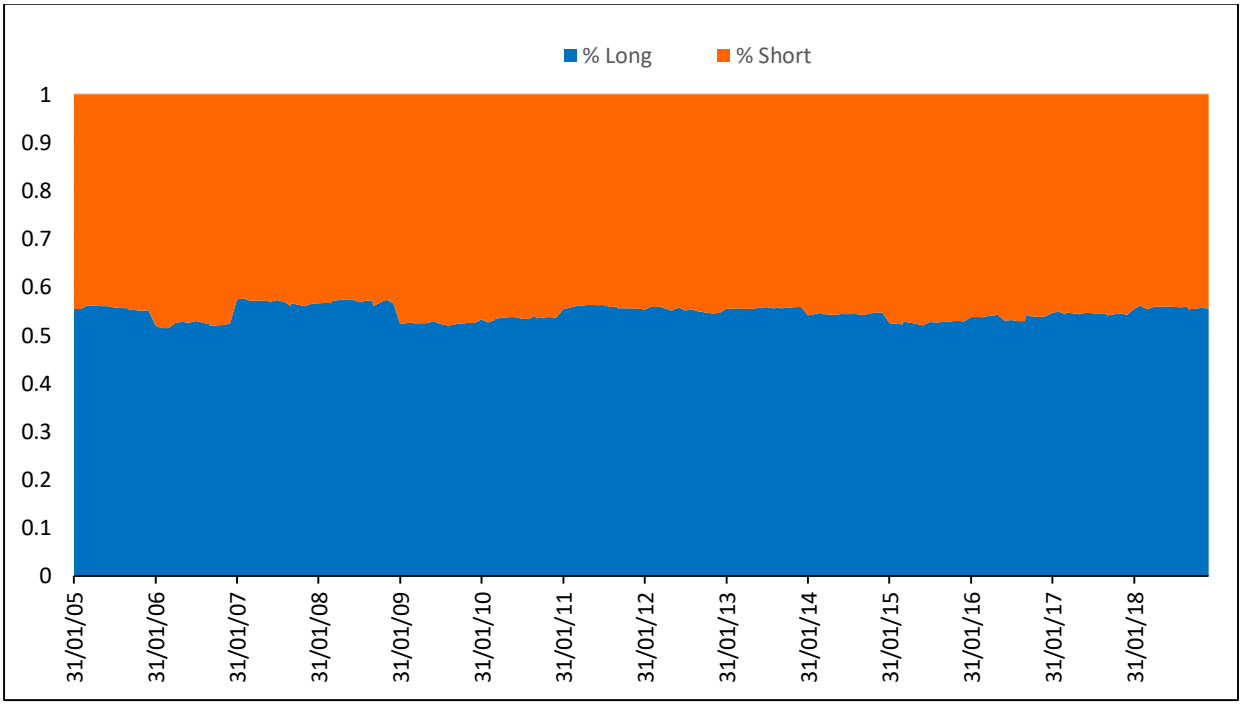

Figure 8: monthly percentage of long positions vs monthly percentage of short positions

Each month, on average, 55% of stocks is bought and the remaining 45% is sold. There just one month in which these two percentages are close, and it is March 2006, where 51% of stocks is bought and 49% of them is sold.

One can find the highest percentage of stocks bought in February 2007, that is 59%; while the highest percentage of stocks sold, as mentioned in the previous paragraph, is March 2006.

4.2 Characteristics

Now that is clearer how many stocks are bought and how many stocks are sold each month, it is necessary to understand the characteristics of stocks that the strategy is considering.

First, are we talking about big companies or small companies? Undervalued or overvalued companies? Moreover, which sectors these firms belong to?

To evaluate if we are talking about small or big companies, I decided to use the value of the market capitalization as a proxy for the size of each company.

To have an idea of the value of each firm considered in this strategy, I decide to use the book-to-market ratio to determine the market value of a company relative to its actual worth. I constructed the book to market ratio dividing the difference between total asset and total liabilities (i.e. shareholders' equity) by the market capitalization:

$$\text{Book-to-market} = \frac{\text{Shareholders'Equity}}{\text{Market Cap}}$$

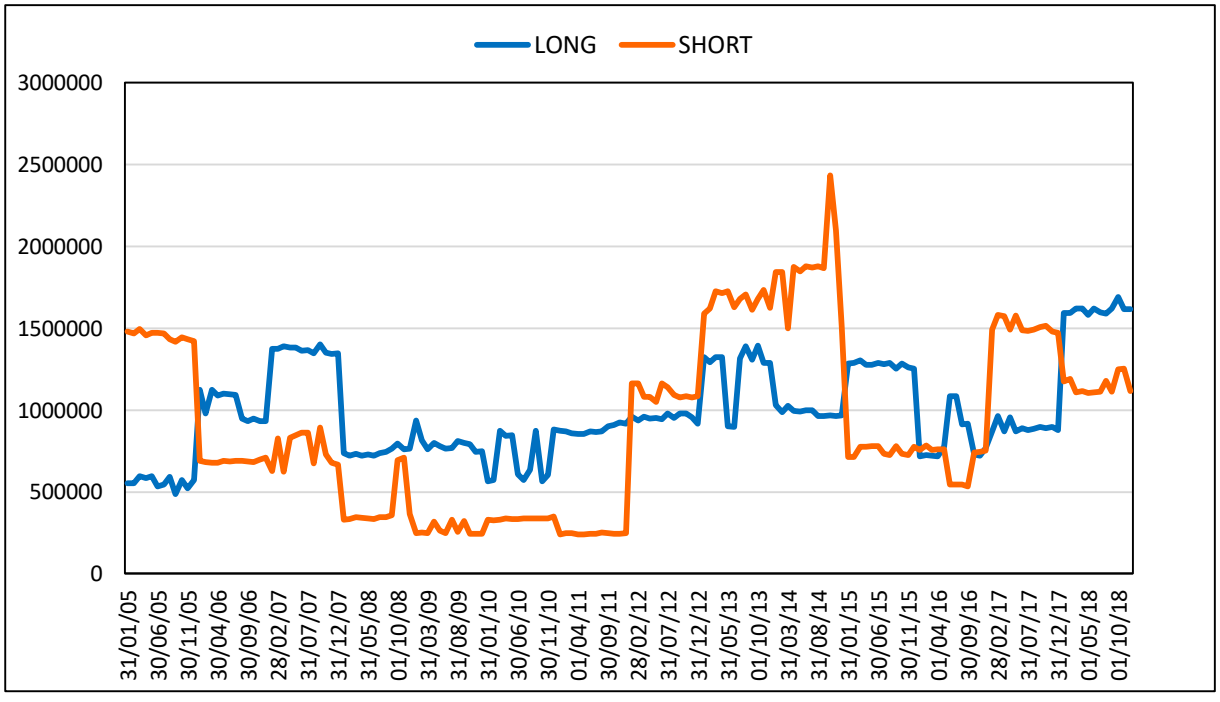

Figure 9: Size of the companies involved in the ALL-IN portfolio

This graph shows the values of longs' and shorts' size during the time. On average, the firms on which the portfolio goes long are bigger than the ones on which the portfolio goes short. This

means that bigger firms are bought, and smaller ones are sold, except for three periods: 2005, from 2013 to 2014 and 2017. During these three years, the situation is opposite: bigger firms are sold, and smaller ones are bought. There is no- stable trend during all the time span, with extreme points far away from the average. The strategy changes its investing decisions several time during the time span, sometimes preferring some bigger firms and other times smaller firms: and rebalancing it each month.

The following graph presents how the value of the firms involved in the ALL-IN strategy changes over time. As well as for the size, on average, the firms' value on which the portfolio goes long is higher than the firms' value on which the portfolios goes short. The situation is opposite in three years: 2010, 2011 and 2017. This graph shows an even less stable trend than the one which presents the size; in fact, also in this case the extreme points are far away from the average.

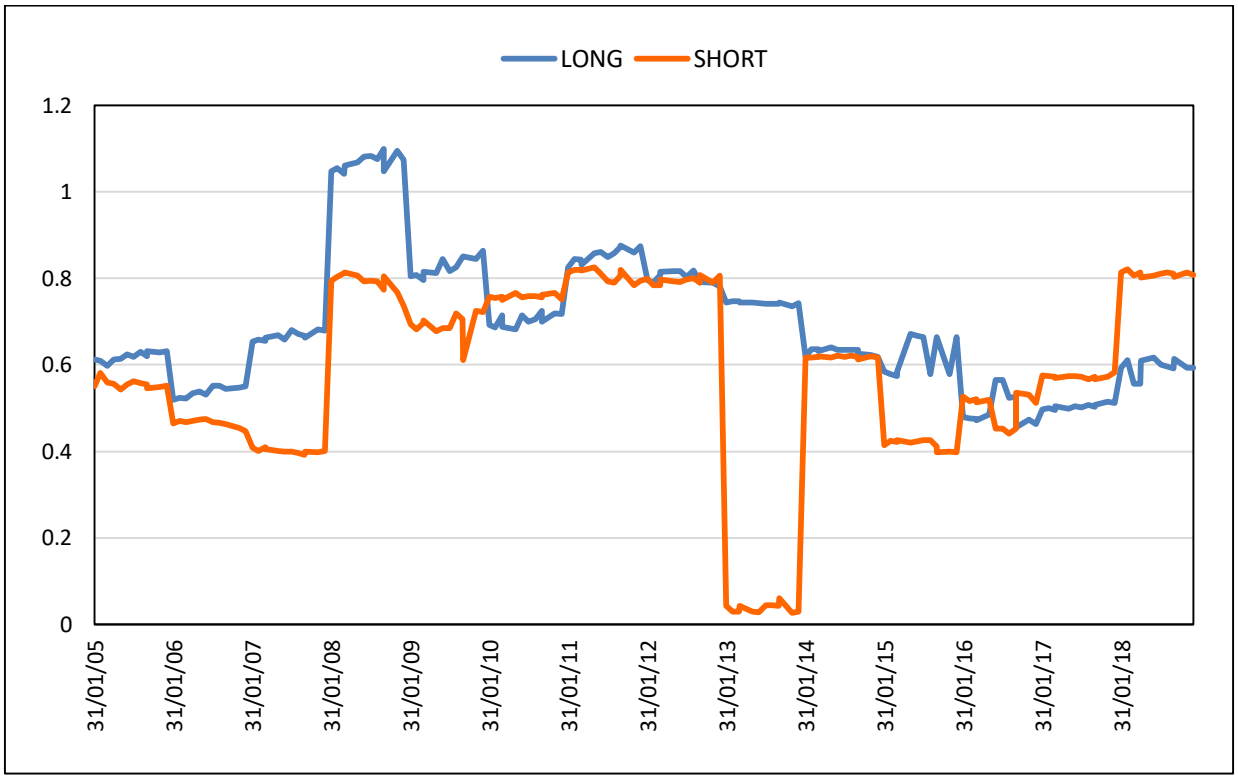

Figure 10: Value of the companies included in the ALL-IN portfolio

To evaluate how much big or small, under or overvalued, these firms are, I decided to compare the average size and the average value to a benchmark. The DAX 30 (Deutsche Aktienindex 30) is a

stock index that represents 30 of the largest and most liquid German companies that trade on the Frankfurt Exchange. The DAX index is considered by many analysts to be a gauge for the health of the German economy. The companies listed in the DAX are multinational companies that influence the domestic German economy and the global economy as well.

Characteristic	Long	Short	DAX 30
Size	1001756	928330	14079870
Value	0.69	0.58	0.32

Table 10: ALL-IN portfolios vs DAX 30 index

This tables presents the average size and the average value of firms considered in the ALL-IN strategy.

In the last row, I considered the average of minimum values of all 30 firms included in the DAX30 index. As anyone can see, compared to the index, firms involved in the ALL-IN strategy, seem to be exceedingly small but they have a higher book-to-market ratio.

Let's try to understand what this means. Small-cap companies tend to be riskier investments than large-cap companies. They have greater growth potential and tend to offer better returns over the long-term, but they do not have the resources of large-cap companies, making them more vulnerable to negative events and bearish sentiments. This vulnerability is reflected in the volatility of small-cap companies, which has historically been higher than that of large-cap companies. They are an especially risky investment during a period of economic contraction, as they are less well-equipped than large-cap companies to cope with sharply decreasing demand.

Consequently, according to the market capitalization, the ALL-IN strategy does not seem to have a conservative approach and orientation.

About the book-to-market ratio, If the market value of a company is trading higher than its book value per share, it is overvalued. If the book value is higher than the market value, analysts consider the company to be undervalued. In basic terms, if the ratio is above 1 then the stock is undervalued; if it is less than 1, the stock is overvalued. A ratio above 1 indicates that the stock price of a company is trading for less than the worth of its assets. A high ratio is preferred by value managers who interpret it to mean that the company is a value stock, that is, it is trading cheaply in the market

compared to its book value. A book-to-market ratio below 1 implies that investors are willing to pay more for a company than its net assets are worth. This could indicate that the company has healthy future profit projections and the investors are willing to pay a premium for that possibility. A normal investor would look at this as an investment opportunity. The basic assumption behind this is most businesses have a higher market value compared to their book values. For a majority, the assumption is also true, and the reason is simple. The books of accounts record assets at their purchase price. A business having purchased an asset, say a piece of land or a building 20 years ago, must have much higher market realizable values, due to the appreciation in real estate prices. In the balance sheet, the balance is shown at the purchase price, so the book value is nowhere close to the real fair market value of the business. Apart from these, there are intangible assets that the business has created over the course of time. Most businesses have not valued them in their books. The firms involved in the ALL-IN strategy belong to the latter category, even if their book to market ratio is closer to 1 than to 0. In conclusion, the portfolio is composed by small firms with potential growth opportunities, that is, this strategy is winning but it has its risk.

4.3 Sectors

The last question to be answered is: which sectors do the firms involved in the ALL-IN strategy belong to?

According to the components list of DAX 30 index, the automotive industry is the country's largest sector, but Germany also retains other specialized sectors, including mechanical engineering, electric and electronic equipment, and chemical products. Moreover, about 99% of German companies are small and medium sized.

To answer to the question mentioned above, I considered the industry classification given by Thomson Reuters DataStream and I calculated the monthly percentage of stocks invested in each different sector every month.

In general, considering both long and short positions the top four sectors in which the strategy is investing are:

1. Services: Advertising Agencies, Medical Services, Services Organization, Customer Service.

2. Financial: Commercial Banks, Investment Companies, Commercial Finance Companies, Insurance Companies, Land and Real Estate, Securities Brokerage Firms, Real Estate Investment Trust Companies, Personal Loan Company, Rental and Leasing, Holding Companies.
3. Electronics: Appliances & Consumer Products, Industrial & Commercial Electrical Equipment, Power Transmission Equipment, Automatic Controls, Electronic Data Processing Equipment, Government & Defence Electronic Systems, Instruments, Gauges & Meters, Radio, T.V. & Phonograph Manufacturers.
4. Construction: Cement Products, Construction Aggregates, Construction Machinery, Plumbing, Heating & Air Conditioning, Prefabricated & Mobile Home Builders, Brick, Clay & Refractory Products, Builders' Metal Products, Home Builders, Engineering & Contracting Services.

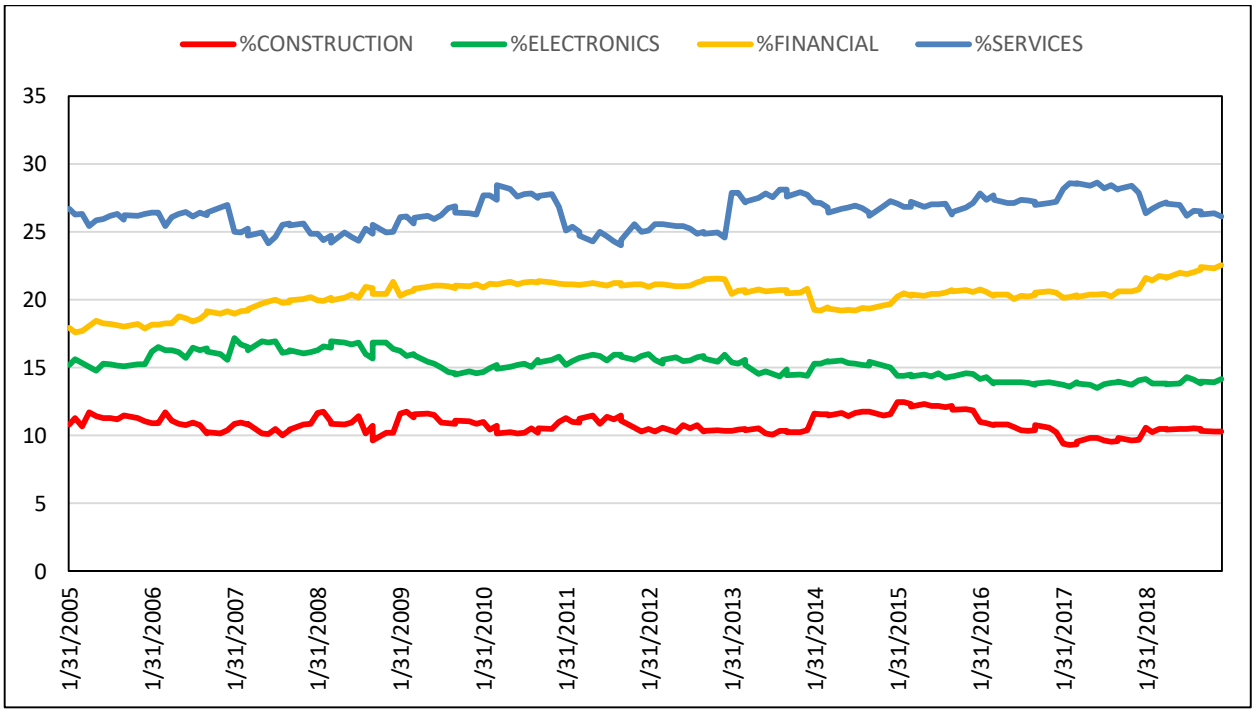

Figure 11: Percentages of top 4 sectors that are represented in the ALL-IN strategy

These four sectors are followed by:

- Chemicals: Household Chemicals, Industrial Chemicals & Gases Manufacturers, Paint & Resin Manufacturers, Rubber & Tire Manufacturers, Sulphur Producers, Synthetic Fibers.

- Healthcare.
- Recreation; Games & Toys, Motion Picture Producers & Distributors, Musical Instruments, Photographic Equipment & Supplies, Radio & T.V. Broadcasts, Restaurants & Fast Food Franchisers, Sporting Goods.
- Utilities: Electric Power Companies, Natural Gas Distributors, Water Companies.
- Transportation: Airlines, Freight Forwarders, Railroads, Railroad Holding Companies, Shipping, Trucking.
- Food: Bakers, Canners & Processors, Confectionery Goods, Dairy Products, Grain, Flour & Cereal, Meat Packers, Sugar Producer.
- Retailers: Apparel Store Chains, Department Store Chains, Discount Stores, Drug Store Chains, Local Food Store Chains, Shoe Retailers.
- Textiles: Apparel Fabrics, Home Furnishings.
- Publishing: Book Publishers, Magazine Publishers, Newspaper Publishers, Printers.
- Beverage: Brewers, Distillers, Soft Drink Producers & Bottlers.
- Apparel: Apparel Manufacturers, Hosiery Manufacturers, Shoe Manufacturers.

Analysing the long side of the ALL-IN strategy, the top four sectors change a little; that is the fourth sector according to the volume of stocks on which the portfolio goes long is Machinery and not Construction anymore:

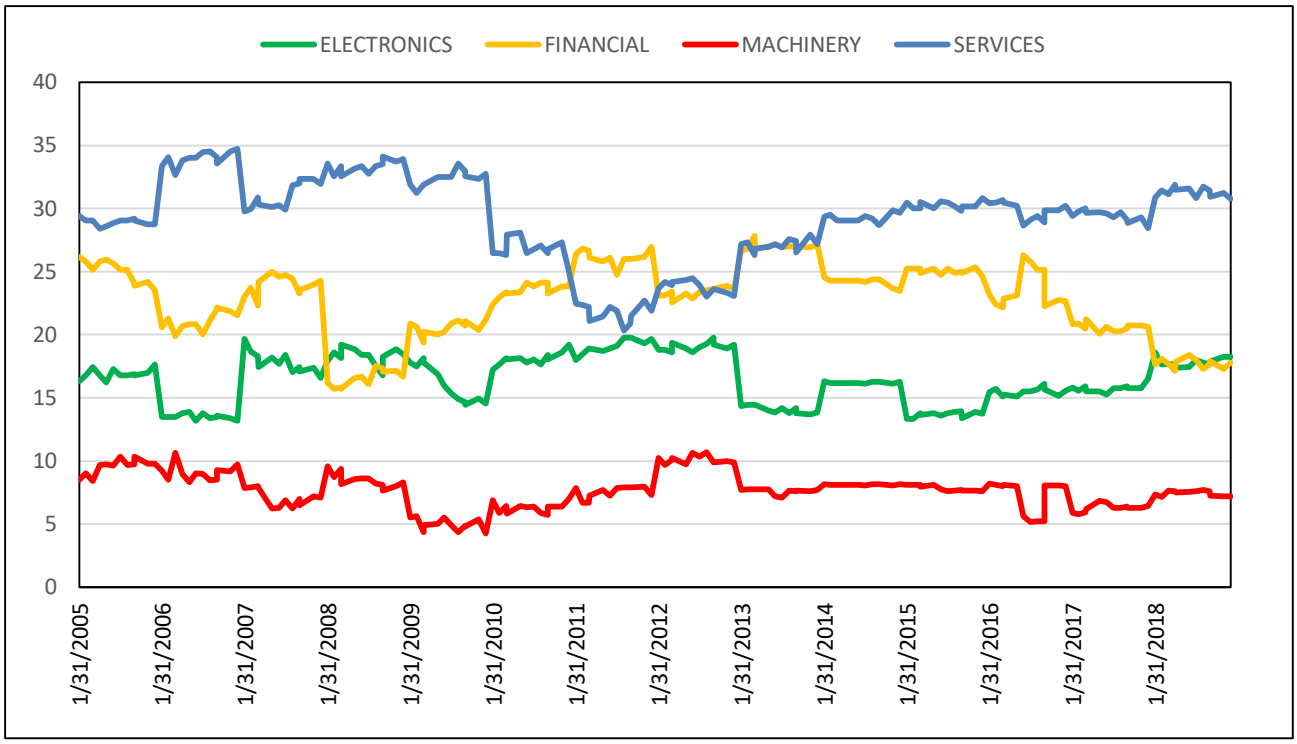

Figure 12: Percentages of top 4 sectors of ALL-IN portfolio's long positions

Actually, this graph shows us there is not a clear top 4 of sectors for the long positions. Services sector is the second biggest one in 2011 and 2012, while it is as important as the Financial sector in 2013. The Financial sector seems to be the less stable: it is the second most important until 2008, losing a position in 2009; and then raising again until it is becoming the first from 2011 until 2013. The Electronics sector keeps being the third, except in 2008 when it becomes the second one. The most stable importance is given to the Machinery sector which keeps its position during the entire time.

The same thing happens looking at the short side of the portfolio; in fact, the only sector that changes over time is the one in fourth position: Healthcare instead of Construction. Here it is the relative graph:

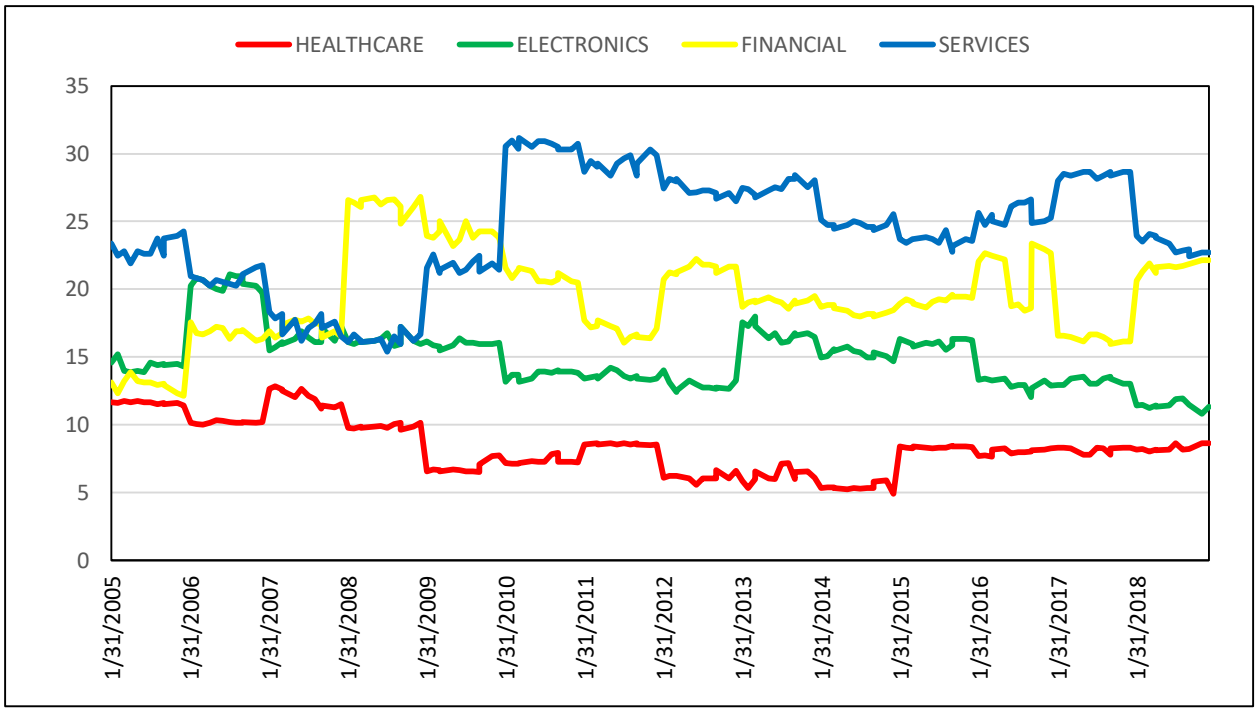

Figure 13: Percentages of top 4 sectors of ALL-IN portfolio's short positions

In this case, the situation is even less clear. Not only there is not a stable top 4 among the sectors, but for mostly of the years, the percentages of stocks belonging to two or more sectors are so close that is hard to understand which is the most important one. For sure, the Services sector is the one that results to be the first one for the highest number of years; in fact, it becomes second just from 2008 until the end of 2009. Less stable is the analysis for the Financial sector, which is the third most important one at the beginning of the period considered but later on its importance keeps raising until it achieves the first position in 2008 and 2009; from 2009 onwards the Financial sector results to be the second most important sector according to the number of stocks sold.
The importance of the Electronics sector varies a lot during the first four years: also becoming as important as the Services and the Financial sectors; but later on, it keeps being the third sector according to the number of stocks sold. Also, in this case, as well as for the long positions, the fourth most important sector keeps its position for the entire time span considered.

It is not surprising that there are no stocks belonging to the automotive sector involved in the ALL-IN strategy. In fact, even if the automotive sector is the biggest one in Germany, we saw that the companies included in this strategy are really small, while some automotive German companies

such as Volkswagen and BMW are in the top 10 of the largest companies in Germany, but also globally.

Instead, in the ALL-IN strategy the Electronics sector has an important weight; and in fact, it is also the third most important sector in Germany according to the components list of DAX 30 index, as I already mentioned above.

In conclusion, one can see that the ALL-IN portfolio results well diversified among several sectors, which are not correlated to each other, avoiding suffering from the sudden potential collapse of a sector. Moreover, maybe, this differentiation is what allows this strategy to limit the minimum values that the portfolios' returns can achieve (because we saw that is "limiting the minimum" that makes Sharpe Ratio high), resulting winning during the whole period considered with a upward shape that does not seem to want to decrease anytime soon.

4.4 Volume

In the paragraph 3.1, I stated that, on average, the ALL-IN portfolio is formed by 200 long positions and almost 170 short positions, each month. What someone could ask is if every month, the portfolio keeps going long or short on the exact same companies.

For example, if in January 2005 I buy a stock of the company "X" and I sell a stock of the company "Y", the following month, that is February 2005, I'll buy again the stock of company "X" and sell the stock of the company "Y", or maybe, I'll do the opposite thing?

In other words, I previously settled down that the ALL-IN portfolio goes long on stocks considered "winning" according to the QMJ factor constructed on each single measure of quality, so, a company that results to belong to the top decile of the QMJ factor in one month, it's going to belong to the top also in the following month, or maybe, it's going to result "loser" and belong to the bottom decile of QMJ factor?

Considering the portfolio's net position in each month, I constructed a variable which

- take value of 1 if the net position was positive, that is, if that stock is bought
- take value 0 if the net position was 0, that is, if that stock is not involved in the portfolio in that month
- take value of -1 if the net position was negative, that is, if that stock is sold in that month.

Further, I count for how many stocks, in each month, this variable keeps the same value for two consecutive months, so that I could understand the percentage of stocks that keeps being bought or sold during the time.

Unfortunately, as I said before, for this work, I used annual accounting data, this means that the portfolio is rebalanced at beginning of each year, more precisely in January, and not each month. Anyway, the reasoning is the same explained before, with the difference that, for fairly understand on how many stocks the portfolios goes long for one or more months consecutively, one has to consider only what happen in each January of the time span used for the construction of the ALL-IN strategy. In fact, during each year, considering the process mentioned above month by month, the 97% of stocks resulted to keep being bought (sold) throughout the period.
Considering only what happens in each January, I got these results:

Statistics	Long	Short	Long + Short
Max	76%	72%	74%
Min	60%	55%	59%
Mean	70%	62%	66%

Table 11: Summary statistics of Long and Short positions

The first thing that one can notice is that the percentage for the long positions is higher than for short ones. This means that the long positions are more stable than the short ones, stable in the sense that if in January 2005 I bought a stock, most likely, in January 2006, I am going to buy that stock again.

To have a clearer idea it is better to see how these percentages change during the time:

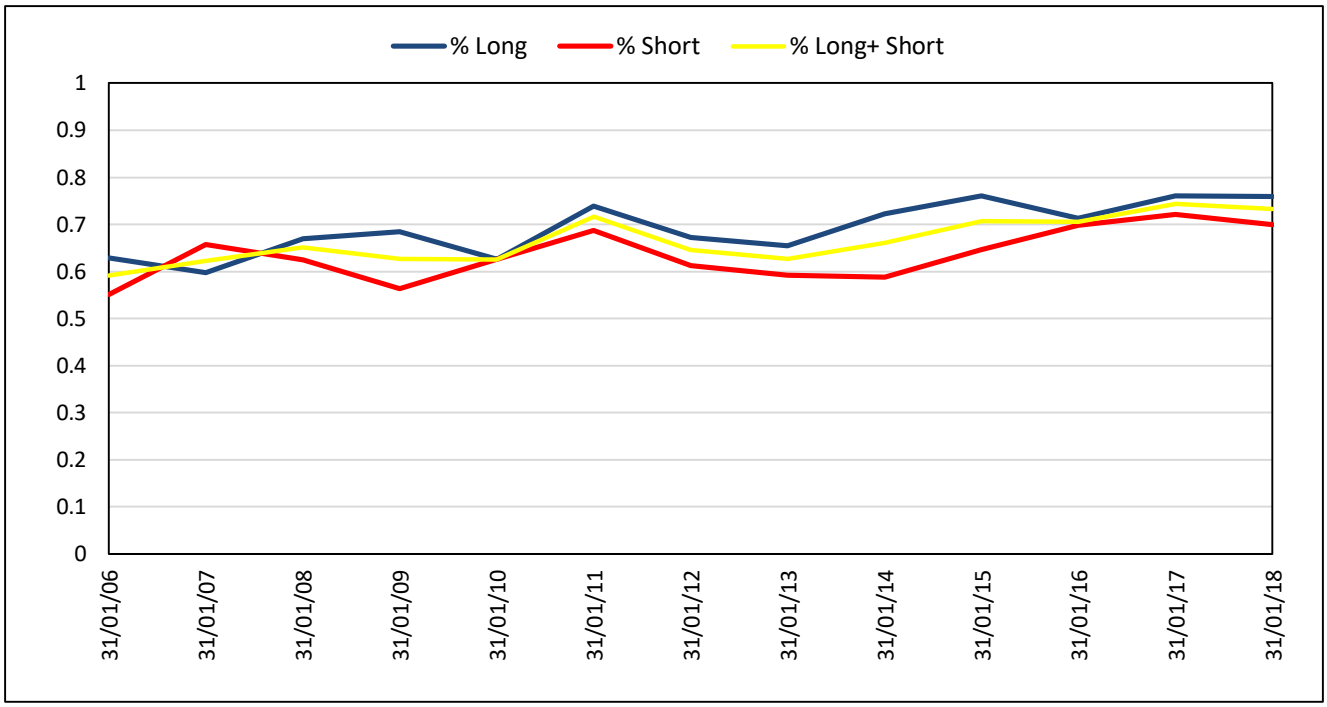

Figure 14: the persistence of Long and Short positions (in %)

On average, only the 30 % of long positions are going to "transform" in short positions. This means that, among the 200 long positions that the portfolio involves on average, on 140 stocks the portfolios is going to go long again a year later, while on the remaining 60, the portfolios is going to be short. The month in which one can find the highest percentage of long positions that were long also in the previous year is January 2018, the last year of the period considered in this work, and also the year in which one can find the highest portfolio's return.

The situation is slightly different for the short positions. The latter seem to change more during the years, achieving the max value in the 2018, the last year as for the long positions. The 72% is an outlier, in fact, the average is 10 percentage points lower. In this case, among the 170 short positions that the portfolios has on average, 100 stocks are going to be sold in the current year and also in the following one; while the remaining 70 are going to be sold in the current year but are going to be bought in the following year.

2018 seems to be the year in which the strategy is more stable respect to all the other years, like if the perfect equilibrium between long and short positions is finally found.

5. Penny Stocks

So far, the ALL-IN strategy was presented without applying any kind of filter, nor on the exchange market, nor on the sector to which the stocks can belong to and so on. This could seem a good idea because the portfolio presents a Sharpe Ratio equal to 2.18 and the relative graph of the cumulative returns presents a continuously upward shape. In order to be more precise, and to check that these results are not driven by the small cap that characterized the stocks included in this strategy, I decide to cut off the stocks that, broadly speaking, are considered as "Penny stocks".

First, let's clarify what these stocks are, how they are considered by the investors, and why I decided to check what could happen without consider them in the ALL-IN strategy.

The basic definition for these kind of stocks defines them as common shares of small public companies that trade for less than one dollar per share. This is the technical characteristic that tells investors what is a penny stocks, but what this definition implies, why they are important?

Investors with high risk tolerances often turn to penny stocks because, considering that such stocks may trade for less than $1, this could allow investors to hold thousands of shares for relatively small amounts of capital. And when the price spikes to multi-dollar levels, investors stand to gain handsomely. But such stocks could just as easily fall to zero. Not surprisingly, penny stocks are generally considered to be highly speculative because of large bid-ask spreads, small market capitalization, and lack of liquidity. This tendency makes the penny stock market volatile, that is, the higher is the volatility, the greater the risk lies in investing in these said securities.

I already showed that, the ALL-IN strategy is actually constructed using really small cap companies that could actually be defined as penny stocks, then, probably, excluding these type of stocks the performance of the portfolio could improve because of a lowering of the risk. To give an answer to my doubts, I put a filter on my sample, and I decided to consider only the stocks whose trade price was higher than 1. After that, I followed the same process that I illustrated for the ALL-IN strategy and studying the relative resulting portfolio I got these results:

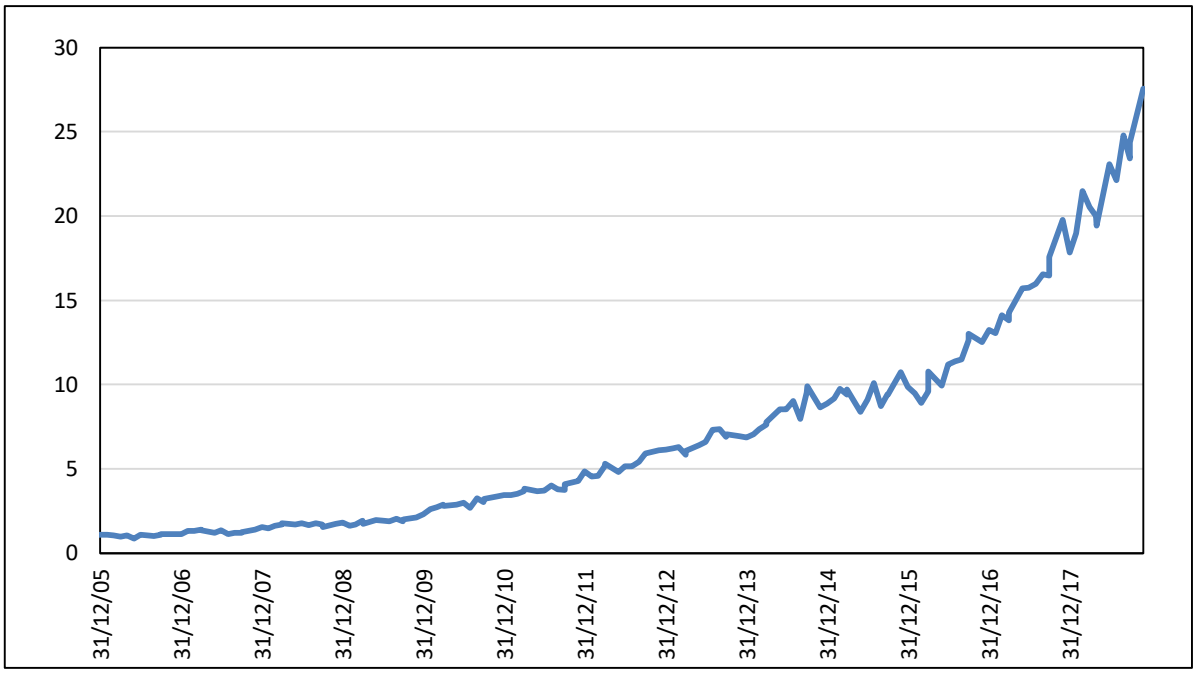

Figure 15: NO penny stocks strategy's cumulative returns

Statistics	NO Penny stocks	ALL-IN Strategy
Mean (%)	2.74	2.35
St. Dev (%)	4.25	3.73
Min (%)	-9.54	-7.04
Max (%)	15.03	14.25
Sharpe Ratio	2.24	2.18

Table 12: Filtered ALL-IN portfolio vs Original ALL-IN portfolio

Looking at these two tables, one can immediately see that, applying a filter on the ALL-IN strategy does not cause a relevant difference. The Sharpe Ratio increase by 0.06, a value that it is not important, economically speaking.

The fact that there is not a big difference should not be very surprising. The stocks that are considered in the ALL-IN strategy belong to small cap companies, with a book-to-market ratio

below 1, with potential growth in the future. This is remarkably similar to the definition of what penny stocks are, this means that just cutting off the stocks whose trade price is lower than 1, does not change the composition of the portfolio so much. In other words, the only difference between the latter two categories of stocks is only the price because on average, all the other characteristics used to measure the quality and then to construct the QMJ factor are very similar among the two categories.

One thing that maybe should be highlighted is that, from 2014 until 2015, the graph presenting the returns of the ALL-IN strategy filtered (no penny stocks) seems to have a less increasing shape respect to the original ALL-IN strategy. In fact, the latter does not present any flat or less increasing portion as the former does.

6. 5FF Analysis

The final step of my thesis was to be sure that the abnormal returns of the ALL-IN strategy were not driven by any common factors, but only by the strategy itself. Following the Fama and French 5 factors model I constructed the following regression model:

$$R_{it} = \alpha_i + \beta_i(RM_t - RF_t) + \beta_i SMBt + \beta_i HMLt + \beta_i RMWt + \beta_i CMAt + e_{it} \qquad (18)$$

where:

- R_{it} is the monthly ALL-IN portfolio return.
- $RM_t - RF_t$ is the excess return value-weight return of all CRSP firms incorporated in the US and listed on the NYSE, AMEX, or NASDAQ
- SMB is the return spread between small capitalization stocks and large capitalization stocks.
- HML is the return spread between high book-to-market companies and low book-to-market companies.
- RMW is the returns spread between profitable and unprofitable companies.
- CMA is the return spread between companies that invest conservatively versus companies that invest aggressively.

	CAPM	3FF	5FF	Carhart
Alpha (%)	28.801	28.200	28.850	28.775
	0.00	*0.00*	*0.00*	*0.00*
Market	0.0003	0.0004	0.0005	0.0003
	0.61	*0.56*	*0.48*	*0.66*
Size		-0.001	-0.001	-0.001
		0.46	*0.49*	*0.45*
Value		-0.0004	-0.001	-0.0008
		0.77	*0.43*	*0.62*
Investment			0.001	
			0.69	
Profitability			-0.002	
			0.55	
Momentum				-0.0006
				0.55
R^2 (%)	0.16	0.54	2.75	0.76

Table 13: Regression results of ALL-IN strategy

Note: p-value in italics

The alpha of Fama-French five factors model ($\alpha_{i,t}$) denotes the excess return that an active portfolio manager achieves above the expected return due to market, size, value, profitability and investment risk factors. The table above presents a positive alpha, statistically significant; that is the ALL-IN portfolio generates positive returns even after controlling for the 5 factors. Moreover, all the other coefficients are not statistically significant, then it's not surprising that the R^2 is really low, as a proof of the fact that the ALL-IN strategy keeps being a winning one even after a 5FF analysis,

that is, market, size, value, profitability and investment factor have no relationship with my portfolio. To completeness of information, I run 3 additional robustness tests, the CAPM model, the 3 Fama and French factor model and the Carhart model. The latter is constructed using ad explanatory variables the 3-common factor of Fama and French model, plus the Momentum factor.

These 3 additional models gave me the same results of the 5FF analysis, testifying once again that market, size, value, profitability, investment and momentum factor can't explain the ALL-IN portfolio's returns.

7. Conclusion

I asked to myself which variable should be considered as an individual ingredient of quality. I considered a high-quality firm if it is profitable, growing, and safe. I used 13 different measures to capture these three quality's components and I averaged them out into a single quality z-score. Based on the latter, I assigned every single German firm in a decile, and I formed a portfolio that went long on the firms that belonged to the top decile and went short on the firms that belonged to the bottom decile. This is how I constructed the two QMJ portfolios presented in this work. Both strategies turned out to be successful, in the sense that they both beat the market. The latter was evaluated through the CRSP equally weighted portfolio.

The difference between these two QMJ portfolios was given by the combination of variables used to construct the QMJ factor: one involved profitability and safety measures, while the second involved the growth measures too. The "more winning" one is the former, with a Sharpe Ratio equal to 0.58.

Moreover, I formed as many portfolios as there are variables used to measure quality, that is 13. The return on asset (ROA) turned out to be the variable that allows to achieve the greatest portfolio's returns, showing a Sharpe Ratio equal to 1.83. ROA is followed by PTBV, ROE, the growth of ROA and the Altman's score. In general, 10 out of the 13 variables considered in this work allowed to form a portfolio that beats the market. The three worst were: the growth of the ROE, CFOA, and the growth of the ROE.

Based on these results, I decided to form a portfolio including all the portfolios mentioned in the paragraph above; that is how I created the ALL-IN strategy. The latter turned out to be a winning strategy with an associated Sharpe Ratio equal to 2.18. The ALL-IN portfolio goes long on the stocks that resulted to be "winning" for all the variables with which the quality is measured, and it goes short on the stocks that turned out to be "losers" according to the same variables. Therefore, the strategy presents a Sharpe Ratio 4 times higher than the ones of the QMJ portfolios. In the ALL-IN strategy I am not assigning each firm to a decile based on the QMJ, simply, I already know which stocks are the best ones and the worst ones, so I use them to create a unique portfolio.

Moreover, the firms included in the ALL-IN portfolio turned out to be characterized by a small cap and a book-to-market ratio below 1; that is, we are talking about really small companies but with great potential growth according to what investors think. In fact, these stocks belong mainly to the Services, Financial, Electronics and Construction sectors, that are not the largest sectors in Germany. This confirms that the portfolio is not investing in big and well-known firms.

For completeness of arguments, I wanted to check the impact of the penny stocks on the ALL-IN strategy. To do that, I ignored the stocks whose share price was below 1 and I re-constructed my portfolio. The results do not change significantly, but this was not a surprise for me. In fact, the stocks involved in the original portfolio and the "penny stocks" are not that different, in fact, they presented some common characteristic.

In conclusion, this work confirmed what that the quality is an important feature in the stock market if it is measured using the proper variables.

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