New factors in asset pricing

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M. Sc. Thesis in Accounting & Financial Management

Abstract

The purpose of this thesis is to study the relationship between the different risk factors of the Fama and French (2015) five-factor model on Northern European data from 1985 to 2014. We find that their five-factor model for cross-sectional asset pricing, including market return, size, book-to-market equity (B/M), profitability and investment as factors of return, only performs slightly better than their three-factor model. We also test one of their findings: that adding investment and profitability removes the explanatory power of the B/M factor and find no such evidence. In fact, the B/M factor is vital for the model. Contradictory to previous research, we also observe that big stocks have outperformed small stocks. Moreover, we observe that the significance of the size factor is lost with the inclusion of the book-to-market factor.

Keywords: Fama and French five-factor model, investments, profitability, book-to-market equity, size effect

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Presentation: December 14th 2015

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Acknowledgements

We would like to thank our tutor, Assistant Professor Henrik Andersson for his generous help and guidance. We would also like to thank Professor Kenth Skogsvik for his valuable advice.

Introduction

In 2015 Eugene Fama and Kenneth French published a paper expanding their famous three-factor asset pricing model from 1992 by adding two new factors: profitability and investment. Fama and French (2015) found that this extended model performed better than the three-factor model in explaining return. An additional interesting finding was that when the profitability and investments factors were added, the explanatory power of the book-to-market equity (B/M) factor was significantly reduced. It appears these factors could provide a substitute for B/M. However, the roles of all the different factors, size, B/M, investment and profitability as risk factors may differ from market to market as well as from time period to time period. Thus, the purpose of our study is to test the risk factors again, but on a Northern European set of data ranging from 1985-2014.

Would a test on different data show the same result? To summarise, this study attempts to answer the following questions:

How does the Fama and French five-factor model perform in a northern European setting in general and how does the relation between the different factors in the model look in particular?

The results found in this study are somewhat intriguing when compared to those of Fama and French (2015). Contrary to their observation, the five-factor model does not perform noticeably better than the three-factor model. Furthermore, the explanatory power of the model is considerably reduced when the B/M factor is removed. When the B/M is added to a four-factor model with the other factors, the explanatory power of size is lost. Contrary to many similar studies, we also observed a return premium for big stocks, i.e. stocks with a high market capitalization.

In the first section of this study, 1. Previous research, the reader is presented with the research behind some of the fundamental aspects of these types of asset pricing models. As such, the section describes the research of the domain in more detail to set the stage for the reader. Next, in the second section, 2. Data, we describe the data used and the methods of obtaining and constructing the dataset. The third section, 3. Method, describes how we construct the portfolios and factors and perform regression tests. In the fourth section, 4. Empirical results, we describe the results and analysis of the performed tests. The fifth section, 5. Discussion and conclusions, extends the analysis by drawing conclusions on the most interesting results as well as provides possible explanations for the results. Finally, the sixth section, 6. Further research, suggest issues that may be appropriate subjects for future research given the results in this paper.

1. Previous research

1.1 Modern portfolio theory and CAPM

"Asset pricing" is the wider term for the subject, and the "cross section" of asset prices is the study of how and why prices differ across different assets at one point in time, as opposed to studying asset prices across time series.

Whether one studies cross-sectional asset pricing or time serial asset pricing, researchers may be divided into proponents of two very fundamentally different views: *modern portfolio theory* (MPT) or the study of behavioural finance.

Both the CAPM model and Fama French's multifactor asset pricing models are products of *modern portfolio theory*, an idea dating back to Markowitz (1952) of the RAND Corporation. He is known as one of the important pioneers of portfolio theory and is still frequently cited since his 1952 article.

Before explaining the developments that followed Markowitz, some of the important assumptions that the portfolio theory relies on should be presented. One assumption is that the return of an asset follows a normal or elliptical distribution. Another is that investors are risk averse and rational in the sense that they seek to maximise return given a level of risk. Also, the market is assumed to be efficient and thus without transaction costs or taxes. Worth noting is that the assumption of rational investors is a vast area of theory in itself, involving various models on consumption preferences and utility curves. However, for the scope of this study, we believe it is not necessary to develop this further. Most importantly, investors can only demand compensation for risk that does not go away by diversifying. They should minimise risk by holding diversified portfolios and hold the portfolio with the highest return given a certain amount of risk (in terms of variance in expected return) or vice versa. When no more risk may be reduced by diversification, the investor holds an efficient portfolio.

The early cross-sectional asset pricing models suggested the market portfolio as an efficient portfolio. Given this, prices of assets would be determined by the spread between the expected return of a risk-free asset and that of the market portfolio. In other words, the fluctuation of the entire market would be the risk factor. Following closer scrutiny, the model was updated with new ideas on efficient portfolios and risk factors. The challenge when adopting the MPT approach is to observe, rank by importance and explain these risk factors.

Proponents of behavioural finance reject this view and argue that the market is inherently inefficient, with investors behaving irrationally. Nevertheless, some of them admit a high level of accuracy of MPT methods, despite reaching very different theoretical conclusions on what is observed.

Sharpe (1964), among others, were inspired by Markowitz' theory on efficient portfolios and contributed to the CAPM model. This model recognises one *efficient portfolio,* the market portfolio. An efficient portfolio has only systematic risk, which is risk that may not be reduced by diversifying further. Another common term used is a *mean-variance efficient portfolio*. Sharpe explains how an investor stays on the *capital market line* by holding this combination of assets.

The beta of asset *i* is the covariance of the asset *i*'s return, with the expected return of the market portfolio, *M*. Equation (1) shows the CAPM model. The * indicates that the value in question is expected.

(1) $$R_{i,t}^{*} = R_{Ft} + \beta_i\left(R_{M,t}^{*} - R_{F,t}\right)$$

The CAPM was subject to criticism from many researchers and several studies were conducted to test the CAPM empirically. Fama and Macbeth (1973) devised a test that became widely accepted as a standard, mainly because their approach overcame the problem of cross-sectional correlation among stocks.

Among the critics of CAPM was Roll (1977), who pointed out an important problem. For the model to properly explain the return required of an asset, the market portfolio would, in the purest theoretical form, have to comprise all assets traded in the world. In reality, it is only possible to observe proxies of the market portfolio.

Numerous studies such as Basu (1977) and Banz (1981) pointed towards there being other factors than just the expected return on the market portfolio to explain the differences in expected returns across assets. These factors are often referred to as *anomalies*.

Basu (1977) investigates whether the performance of stocks is related to the price-earnings ratio. Having studied the period 1957-1970 for NYSE listed equity, he is able to conclude that this is the case, namely that low P/E stocks had higher returns. Moreover, he concludes that the market is not entirely semi-strong form efficient - if it had been, the P/E information would have been more rapidly reflected in the security prices. However, this conclusion rests upon the asset pricing model being assumed valid.

Banz (1981), also studying NYSE listed equity, has studied the effect of the firm size on the return. He finds that there was a particularly strong effect for smaller firms. Smaller firms had a larger risk-adjusted return than average or large sized firms. However, he is not able to determine whether size is actually a proxy for something else.

1.2 Multifactor models of cross-sectional asset pricing

In 1992, Eugene Fama and Kenneth French were published for the article" The cross-section of expected stock returns", in which they challenged the CAPM by applying new data and the previous research on anomalies. In the article, they presented one of the first multi-factor models, and it has become highly influential in the domain of asset pricing.

A multi-factor model is similar to the CAPM, but instead of relying on one efficient portfolio, one uses a collection of different portfolios with different properties to compute several factors (the betas). The SMB, "Small-Minus-Big", factor, as named in Fama and French (1992), for instance, is the return of a portfolio with small stocks (in terms of market capitalisation) minus the return of a portfolio made up by large stocks.

A multi-factor model tests the roles of for example, market beta, company size (in terms of market capitalisation), leverage, price-to-earnings ratio (P/E) and book-to-market ratio (B/M) in the expected stock returns. Fama and French (1992) test market return, size and B/M equity over the years 1963-1990. The data used in the study was collected from the Centre for Research in Security Prices, CRSP, and consisted of stock and accounting data from American listed companies.

They found that the size and book-to-market factors best capture the risk in stock returns, and that the market beta was a weak factor, if not irrelevant in the periods after the 1960's. The price-earnings ratio and leverage were relevant factors according to previous research, although the book-to-market factor was found to absorb them.

The key product of their efforts is the three-factor model for predicting average stock returns that we described above, equation (2), consisting of market beta, B/M and size.

(2) $$R_{it} = R_{Ft} + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + \mathrm{e}_{\mathrm{it}}$$

The two variables SMB and HML are the return of the "Small-Minus-Big" factor and the return of the "High-Minus-Low" (B/M) factor respectively. The factor betas are b, s and h, while the letter *i*, as previously mentioned, denotes the particular security.

The Fama and French three-factor model, as presented in *The Cross-Section of Expected Stock Returns* (1992) is one of the most influential pieces of research in finance, but over the years it has been challenged by several publications. Fama and French have, since then, produced more work where they have tested and extended their model, for example Fama and French (1996), where they investigate how well the three-factor model may capture other closely related anomalies.

1.3 New potential anomalies: profitability and investment

Several researchers have observed and paid attention to the potential importance of profitability as a risk factor, including Fama and French (2006). Based on valuation theory, there should be a connection between book-to-market equity, investment, profitability and expected return. Even after this theoretical connection is controlled for, Fama and French (2006) do discover a connection between profitability and expected return. Moreover, they investigate what proxy for profitability that would be the most appropriate.

Novy-Marx (2013) argues that *gross profit* is the appropriate measure, for a number of reasons. Any measure further down the income statement would be subject to accounting judgements, such as the decision whether or not to capitalise R&D expenditures. Naturally, the gross profit itself not being a ratio, it is scaled against total assets. In addition, Novy-Marx carries out a Fama MacBeth (1973)-test that shows the advantage of gross profit in comparison to a selection of other profitability measures, such as earnings.

An important observation by Novy-Marx is the connection and contradictory findings on gross profit and firm characteristics, in terms of value vs. growth firms. The firms with observed high gross profit ratio did resemble growth firms although the high gross profit should imply a higher valued firm. Novy-Marx carries out a large number of tests on different trading strategies, and the result is intriguing. He claims that a gross profitability factor adds explanatory power to a B/M strategy (value strategy).

Why would then gross profit add explanatory power? Novy-Marx investigates whether it may be derived from one of the components that make up gross profit, according to the DuPont model, equation (3).

(3) $$\frac{Gross\ profits}{Assets} = \frac{Sales}{Assets} * \frac{Gross\ profits}{Sales}$$

The division into its components do not add more information, in fact, the gross profit itself has a higher explanatory power than the two dimensions separately.

Next, the other candidate for important anomaly is the level of investment in the company of the stock. High capital expenditures can be viewed both favourably and unfavourably from an investor point of view, depending on the circumstances around the capital expenditure. For instance, high capital expenditure could be a positive sign and indicate confidence from the capital market and availability of good opportunities. However, it is less favourably looked upon when financed by issuance of equity. Also, managers may incur the capital expenditure out of prestige or a vested interest in the company growing, so-called empire-building.

Titman, Wei and Xie (2004) observed a connection between abnormally high capital expenditures and lower returns that would follow. They studied a five year period and based their judgement of performance on a set of benchmark portfolios, assembled after the characteristics B/M, size and momentum effect. Their data is American stock data obtained from CRSP, with similar delimitations as Fama and French (1992).

Their measure of capital expenditure is the "Capital expenditures", as shown in the statement of cash flows. The measure of abnormally high investments is computed as shown in equation (4). A CI greater than zero indicates an abnormally high capital investment.

(4) $$CI_{t-1} = \frac{CE_{t-1}}{(CE_{t-2}+CE_{t-3}+CE_{t-4})/3} - 1$$

To control for other risk factors of return, the authors apply the Carhart four-factor model (1997) (the three-factor model extended with the momentum factor). Overall, they test their findings on CI thoroughly. The risk factors are discovered not to explain the lower stock returns that follow companies with a high CI over the succeeding five years.

Titman et al. find evidence that firms with high capital expenditures later underperform, and that investors underestimate the empire-building tendencies of the companies' managements.

1.4 The Fama and French five-factor model

Motivated by the anomaly findings of Novy-Marx (2013) and Titman, Wei and Xie (2004), Fama and French presented an extended five-factor model, published in 2015. The extended model now includes the additional variables: i) difference between the returns on diversified portfolios of stocks with robust and weak profitability (Robust minus Weak, or RMW) and ii) the difference between the returns of conservatively and aggressively investing firms (Conservative minus Aggressive, or CMA). The study is based on American stock data for 1963-2013.

In contrast to Novy-Marx (2013), Fama and French do not use *gross profit* as a profitability measure, but their own measure of operating profit (revenue minus COGS, selling and administration costs and interest expense, all divided by the book value of equity).

Fama and French have chosen not to include some additional factors, one example being the Carhart momentum factor, due their negligible effect on the regression.

They are able to conclude that the additional factors profitability and investment enhance the performance of the model, but also that when added; the B/M factor becomes redundant. However, they also raise suspicions that this result may not reoccur, should a different set of data be tested.

Regarding the size factor, several studies have found that the effect might not be as important as found in the Fama and French (1992) and other similar studies. Horowitz, Loughran and Savin (2000) found that small stocks did have higher returns in the period before 1980. However, for the period between 1981 and 1997, incidentally a period starting around the time when Banz published his famous paper on the size effect, big stocks performed slightly better than small stocks in terms of return. Similarly, Schwert (2002) found that the size effect had disappeared, or at least diminished in importance for the period after 1982. Reinganum (1999) found that while small stocks have higher returns on average, the small-cap return premium not constant and that in some economic climates, big stocks outperform small stocks.

2. Data

This study is based on stock market data from the main markets of the Nordics and northern Europe, more precisely the main markets of the Nordic capitals, London and Frankfurt. Key priorities in the search for data were the ability to construct adequately sized portfolios for the tests and to cover a time span of sufficient length. The data source used is Thomson Reuters DataStream, a service of accounting and stock data covering 50 years of information from 75 000 active and 30 000 inactive companies in 175 countries.

In short, the data collected includes the variables price of stock, number of shares outstanding (NOSH), total assets, total liabilities, capital expenditure, dividends paid and EBIT on a monthly basis (where applicable) from January 1st 1985 to December 31st 2014. The raw data collection resulted in a total of around 120 000 observations for a total of around 21 000 unique companies. The data is collected pre-converted to pound sterling. This is necessary, since the construction of the size factor is dependent on the absolute company sizes being comparable.

In order to measure excess return, a risk-free asset with a safe return valid for the entire time period needs to be defined. For this study, the risk-free asset is the three-month Swedish government bond yield, collected from the Swedish Central Bank. The rationale behind using the Swedish three-month government bond is to adopt a Swedish investor perspective.

Although widely used and comprehensive, Thomson Reuters DataStream is not without gaps and errors. The data collected from this service included some unreasonably high or low values, obviously caused by error. Such data points were excluded from the sample to avoid the tests being distorted. The data set also has some unexplainable gaps in terms of months without data for all variables.

3. Method

The objective of this study is to compare the explanatory power of the different factors on the expected return. This is carried out with the use of the treated data and six regressions on the return in eleven panels of portfolios. Firstly, the variables included in the regressions need to be assigned appropriate proxies. This is partly based on previous research, although judgements need still be made due to practical reasons, such as data constraints. Secondly, different sets of efficient portfolios are constructed. Thirdly, the panels of regressions are performed, based on different asset pricing factors. Lastly, the explanatory power of the regression panels is compared.

For reference, Table (A1) in the appendix displays the closer definitions of the components.

3.1 Variable definitions

The return of a share includes the dividend paid and the price increase. Since the timing of the dividend payment varies across the different stocks, an average dividend payment for each month is used. More precisely, the dividend payment of the year is distributed evenly across the twelve months of the year. Equation (5) shows how the return of asset *i* is computed for month *t*. Unreasonably high returns are excluded from any further tests.

Equation (5) $R_{i,t} = \frac{Div_t + P_t}{P_{t-1}} - 1$

Next, the market excess return for the test is based on the total data collected. Another common proxy for the market portfolio would be a total index relevant for the market studied. However, this study has not identified an appropriate index available that dates back to 1985, and therefore uses the value weighted return of the total sample minus the risk free rate.

The size variable is simply the market capitalization computed with the retrieved number of shares outstanding and price, which is in line with common practice. Book-to-market (B/M) is defined in line with Fama and French (2015) as the book value of equity divided by the market capitalization.

Moving on to one of the potentially important anomalies, investment, there are again data constraints. Although Titman et al. (2004) defines abnormally high investments as *capital expenditure* exceeding its previous four year average, Fama and French (2015) defines it as the increase in total assets. Since capital expenditure is a cash flow analysis item related to fixed assets, this measure may have different implications for a particular company than just the change of the size of the balance sheet. This study adopts a slightly different definition due to problems with abnormal values when using the change in total assets. Investment is here defined as the capital expenditure item in relation to opening balance total assets.

Similarly to Fama and French (2015), this study uses EBIT, in relation to total assets, as a profitability proxy. Although Novy-Marx strongly advocates the use of gross profitability, this study judges EBIT to be more compatible with the variety of firms.

3.2 Portfolios

The observations are sorted into portfolios for eleven different variable sorts, see Table (1) for an overview. The variables used for the sorts are: size, book-to-market (B/M), profitability and investments, see 3.1 Variable definitions above for more information. The variable median is used to construct the portfolios in all sorts. This implies that observations are sorted into portfolios depending on whether they are above or below the median for that particular variable. The breakpoint between high/low book-to-market equity, robust/weak profitability or conservative/aggressive investment is the respective median, hence the "2x" sort. The return for each portfolio is then calculated as the equally weighted return of all stocks in the portfolio.

Using this method will increase the size of the portfolios at the cost of level of detail. Fama and French (2015) use broader sorts, not only using the median as a breakpoint. Since we are investigating the major relations between the different factors in the models, we believe that the level of detail achieved with more detailed sorts (e.g. quartiles, deciles) is not necessary and would not add value to the report.

The different portfolios are named with letters indicating which side of the variable median the observations within the portfolio belongs to. These letter are derived directly from the factor names, see 3.3 Factor construction for more information about factors.

The first category of sorts, 2x2, constructs portfolios on the median of two variables, using all possible combinations of variables. Consequently, there are six different sorts with four portfolios per sort. The two other categories of sorts, 2x2x2 and 2x2x2x2, construct portfolios the same way as the first category, and also with all possible combinations of variables. Consequently, there are four sorts and eight portfolios per sort in for the 2x2x2 and one sort and 16 portfolios for the 2x2x2x2.

This method of using all possible combinations for sorting is also slightly different from the method of Fama and French, who used size as a variable in each different sort. As stated above, the aim with this thesis is to investigate the relationships between factors, we believe that investigating all possible combinations is necessary.

Table (1)

Overview of the portfolio sorts

The observations are sorted into portfolios over eleven different sorts. All portfolios are constructed based on the median for each variable.

2x2, 6 sorts 4 portfolios per sort	**2x2x2,** 4 sorts 8 portfolios per sort	**2x2x2x2,** 1 sort 16 portfolios per sort
Size B/M	B/M Profitability Investments	B/M Size Investments Profitability
Size Profitability	B/M Profitability Size	
Size Investments	Size Profitability Investments	
B/M Profitability	Size B/M Investments	
B/M Investments		
Investments Profitability		

3.3 Factor construction

The factor returns are constructed in a similarly to the portfolios, by using the median. The section on variable proxies describes more closely how the variables are defined. The factors are constructed by dividing the companies into two portfolios per variable and subsequently taking the return of the expectedly “good” portfolio minus the “bad” portfolio. For the size factor, SMB (Small minus Big), for example, this implies the average monthly return of all stocks below the median size, minus the average monthly return of all stocks above the median size.

Unlike Fama and French (2015) and others, who form portfolios once per year, this study has chosen to construct factor returns on a monthly basis. This is not likely to have any notable impact on the results, since the accounting information used for this study is taken from the annual reports, and thus updated yearly.

Equation (6), (7), (8) and (9) show how the factors are constructed with the help of the 2x2x2x2 and 2x2x2 sorts set of portfolios.

(6) $$\mathrm{SMB} = {(\mathrm{SHRC} + \mathrm{SHRA} + \mathrm{SHWC} + \mathrm{SHWA} + \mathrm{SLRC} + \mathrm{SLRA} + \mathrm{SLWC} + \mathrm{SLWA})}/{8} - {(\mathrm{BHRC} + \mathrm{BHRA} + \mathrm{BHWC} + \mathrm{BHWA} + \mathrm{BLRC} + \mathrm{BLRA} + \mathrm{BLWC} + \mathrm{BLWA})}/{8}$$

(7) $$\mathrm{HML} = \frac{(\mathrm{HRC}+\mathrm{HRA}+\mathrm{HWC}+\mathrm{HWA})}{4} - \frac{(\mathrm{LRC}+\mathrm{LRA}+\mathrm{LWC}+\mathrm{LWA})}{4}$$

(8) $$\mathrm{RMW} = \frac{(\mathrm{HRC}+\mathrm{HRA}+\mathrm{LRC}+\mathrm{LRA})}{4} - \frac{(\mathrm{HWC}+\mathrm{HWA}+\mathrm{LWC}+\mathrm{LWA})}{4}$$

(9) $$\mathrm{CMA} = \frac{(\mathrm{HRC}+\mathrm{HWC}+\mathrm{LRC}+\mathrm{LWC})}{4} - \frac{(\mathrm{HRA}+\mathrm{HWA}+\mathrm{LRA}+\mathrm{LWA})}{4}$$

3.4 Regressions

Having defined the variables and constructed the factors, the next step is to begin the regression tests. To begin with, the regressions performed are shown in equation (10) to (15).

(10) $$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + e_{it}$$

(11) $$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + c_i CMA_t + e_{it}$$

(12) $$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + e_{it}$$

(13) $$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + h_i HML_t + c_i CMA_t + r_i RMW_t + e_{it}$$

(14) $$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + r_i RMW_t + c_i CMA_t + e_{it}$$

(15) $$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it}$$

The first regression is the ordinary three-factor model as in Fama and French (1992), the last is the five-factor model as in Fama and French (2015). The rest of the regressions are variations on four factors.

The choice of regressions has been made in line with the Fama and French (2015) regressions, with the intent to explore all the potential roles and relations between the factors. In the equations, $R_{it} - R_{Ft}$ is the monthly return for portfolio *i* in excess of the risk-free rate, for this study the three-month Swedish government bond. The factor exposures for portfolio i are the b_i, h_i, s_i, r_i, c_i and lastly, the residual, e_{it} , is a zero-mean.

From the regressions, the R-square value is the primary result studied and compared, but a Gibbons, Ross and Shanken (1989) test is also done on each regression panel. This test relates to the intercepts of the regressions.

4. Empirical results

4.1 Portfolio returns

In Table (2), the portfolio returns for the first category of sorts are reported. Looking at the different variables we can see that most variables behave as expected, but one surprising observation is that the return is higher for bigger stocks than for smaller in our dataset. This is the contrary to what most other studies on the subject has found. For example, Fama and French (2015) found that smaller stocks outperform bigger stocks in terms of return. One possible explanation for this could be that our time period does include an unusually high number of financial crises. Financial crises have been found to hurt the return of smaller firms to a larger extent than bigger firms. Reinganum (1999) is an example of those who has found that big firms outperform small firms in economic crises. He also criticise the idea of superior performance for small stocks, see section 4.3 Regressions for more information about this.

Higher book-to-market is associated with higher returns, which points towards lower valued stocks generating higher excess returns. This is in line with several previous research findings. Stocks with aggressive investments have lower returns than those with conservative, which was also expected. Lastly, also in line with previous research, in general portfolios consisting of stocks with robust profitability show higher returns than those made up of stocks with weaker profitability. However, a few portfolios show contrary results, see below.

In *Sort 1*, we can observe a large difference in return for high and low B/M for the smaller stocks, while bigger stocks seem to have similar returns regardless of the B/M. Hence, the effect of B/M appears stronger for smaller stocks. This relationship can also be observed for the 2x2x2 and 2x2x2x2 portfolio sorts.

Given that smaller stocks give lower returns than bigger stocks in this dataset, unsurprisingly, the least performing portfolio is the SLWA (of *Sort 11*, Small/Low/Weak/Aggressive). In this portfolio, the stocks on the lower side of every variable breakpoint are included, showing an excess monthly return of -3.38%. Reciprocally, the best performing portfolio is the inverse of the SLWA, namely the BHRC, which has an excess monthly return of 2.20%. Worth noting is that the gap between the worst to second worst portfolio is greater than from the best to the second best. Since the portfolios of *Sort 11* are formed in the most specific manner regarding stock characteristics, observing the highest and lowest returns in this portfolio sort is expected.

Looking at the different combinations of variables in the 2x2 sorts, it is observed that the most important characteristic for excess return seems to be having a large size. For each 2x2 portfolio sort involving size (*Sort 1*, *Sort 2* and *Sort 3*), the portfolios with big stocks outperform those with small stocks.

An unexpected and quite counterintuitive observation is that the HWB portfolio (*Sort 8*, High/Weak/Big) outperforms the HRB (*Sort 8*, High/Robust/Big) portfolio in terms of excess monthly return by 0.19 percentage points. This is not in line with either previous research, or our overall observations, in which stocks with high profitability outperform stocks with weak profitability. For instance, comparing with other portfolio sorts, one sees that for the 2x2 sort on size and profitability, *Sort 2,* the BR portfolio (Big/Robust) shows higher returns than the BW portfolio (Big/Weak). This implies that there may be higher excess returns for stocks with higher profitability, which would be both logical and intuitive. However, in the 2x2x2x2 sort (*Sort 11*) we get a similar result, where BHWA outperforms BHRA and the BRA portfolio only slightly outperforms the BWA portfolio. This relationship is not observed for any other portfolios. In essence, only for big stocks with a high B/M is profitability a negative characteristic. A possible explanation to this may be that the profit for companies deemed to have less favourable prospects, hence the high B/M, is perceived to be short term and come at the expense of future profit.

Table (2)

Overview and returns for portfolio sorts, 2x2

January 1st 1985 – December 31st 2014, 360 months. The Table displays monthly excess returns for six panels of 2x2 sort portfolios. The portfolios are formed monthly, although most of the accounting data only changes yearly. The stocks are assigned to different portfolios depending on whether they are below or above the median

Portfolio		Mean return
Sort 1: 2x2, size and B/M		
SH	Small, High B/M	0.62%
SL	Small, Low B/M	-1.51%
BH	Big, High B/M	1.65%
BL	Big, Low B/M	1.41%
Sort 2: 2x2, size and profitability		
SR	Small, robust profitability	0.92%
SW	Small, weak profitability	-0.71%
BR	Big, robust profitability	1.55%

BW	Big, weak profitability	1.39%
Sort 3: 2x2, size and investment		
SC	Small, conservative investment	0.15%
SA	Small, aggressive investment	-0.27%
BC	Big, conservative investment	1.69%
BA	Big, aggressive investment	1.30%
Sort 4: 2x2 B/M and profitability		
HR	High B/M, robust profitability	1.54%
HW	High B/M, weak profitability	0.50%
LR	Low B/M, robust profitability	1.12%
LW	Low B/M, weak profitability	-0.36%
Sort 5: 2x2 B/M and investment		
HC	High B/M, conservative investment	1.14%
HA	High B/M, aggressive investment	0.74%
LC	Low B/M, conservative investment	0.62%
LA	Low B/M, aggressive investment	0.37%
Sort 6: 2x2Investment and profitability		
CR	conservative investments, robust profitability	1.57%
CW	conservative investments, weak profitability	0.40%
AR	aggressive investments, robust profitability	1.11%
AW	aggressive investments, weak profitability	-0.23%

Table (3)

Overview and returns for portfolio sorts, 2x2x2

January 1st 1985 – December 31st 2014, 360 months. The Table displays monthly excess returns for three panels of 2x2x2 sort portfolios. The portfolios are formed monthly, although most of the accounting data only changes yearly. The stocks are assigned to different portfolios depending on whether they are below or above the median size, B/M, profitability or investment.

Portfolio		Mean return
Sort 7: 2x2x2, B/M profitability and investment		
HRC	High B/M, robust profitability, conservative investment	1.88%
HRA	High B/M, robust profitability, aggressive investment	1.33%
LRC	Low B/M, robust profitability, conservative investment	1.36%
LRA	Low B/M, robust profitability, aggressive investment	0.93%
HWC	High B/M, weak profitability, conservative investment	0.79%
HWA	High B/M, weak profitability, aggressive investment	-0.46%
LWC	Low B/M, weak profitability, conservative investment	-0.11%
LWA	Low B/M, weak profitability, aggressive investment	-0.07%

Sort 8: 2x2x2, B/M, profitability and size		
HRS	High B/M, robust profitability, small	1.54%
HRB	High B/M, robust profitability, big	1.55%
HWS	High B/M, weak profitability, small	0.03%
HWB	High B/M, weak profitability, big	1.74%
LRS	Low B/M, robust profitability, small	-0.28%
LRB	Low B/M, robust profitability, big	1.55%
LWS	Low B/M, weak profitability, small	-2.48%
LWB	Low B/M, weak profitability, big	1.16%
Sort 9: 2x2x2, Size, profitability and investment		
SRC	Small, robust profitability, conservative investment	1.11%
SRA	Small, robust profitability, aggressive investment	0.78%
SWC	Small, weak profitability, conservative investment	-0.32%
SWA	Small, weak profitability, aggressive investment	-1.30%
BRC	Big, robust profitability, conservative investment	1.89%
BRA	Big, robust profitability, aggressive investment	1.32%
BWC	Big, weak profitability, conservative investment	1.50%
BWA	Big, weak profitability, aggressive investment	1.25%
Sort 10: 2x2x2, Size, B/M and investment		
SHC	Small, high B/M, conservative investment	0.77%
SHA	Small, high B/M, aggressive investment	0.46%
SLC	Small, low B/M, conservative investment	-1.10%
SLA	Small, low B/M, aggressive investment	-2.01%
BHC	Big, high B/M, conservative investment	2.05%
BHA	Big, high B/M, aggressive investment	1.29%
BLC	Big, low B/M, conservative investment	1.54%
BLA	Big, low B/M, aggressive investment	1.30%

Table (4)

Overview and returns for portfolio sorts, 2x2x2x2

January 1st 1985 – December 31st 2014, 360 months. The Table displays monthly returns in excess of the Swedish 3-month government bond yield for one panel of 2x2x2x2 sort portfolios. The portfolios are formed monthly, although most of the accounting data only changes yearly. The stocks are assigned to different portfolios depending on whether they are below or above the median size, B/M, profitability or investment.

Portfolio		Mean return
Sort 11: 2x2x2x2, size, B/M, profitability and investment		
SHRC	Small, high B/M, robust profitability, conservative investment	1.70%
SHRA	Small, high B/M, robust profitability, aggressive investment	1.44%
SHWC	Small, high B/M, weak profitability, conservative investment	0.38%
SHWA	Small, high B/M, weak profitability, aggressive investment	-0.46%
SLRC	Small, low B/M, robust profitability, conservative investment	0.20%
SLRA	Small, low B/M, robust profitability, aggressive investment	-0.71%

SLWC	Small, low B/M, weak profitability, conservative investment	-1.90%
SLWA	Small, low B/M, weak profitability, aggressive investment	-3.38%
BHRC	Big, high B/M, robust profitability, conservative investment	2.20%
BHRA	Big, high B/M, robust profitability, aggressive investment	1.14%
BHWC	Big, high B/M, weak profitability, conservative investment	1.95%
BHWA	Big, high B/M, weak profitability, aggressive investment	1.48%
BLRC	Big, low B/M, robust profitability, conservative investment	1.79%
BLRA	Big, low B/M, robust profitability, aggressive investment	1.39%
BLWC	Big, low B/M, weak profitability, conservative investment	1.22%
BLWA	Big, low B/M, weak profitability, aggressive investment	1.08%

4.2 Factor data

Table (B1) in the appendix shows monthly factor returns for the entire time period. These are the mean returns for the entire time period in our sample. The most surprising finding is the largely negative return of SMB at -1.54% per month. In Fama and French (2015) they found a positive return of around 0.3% for SMB. As touched upon above in 4.1 Portfolio returns, this underperformance of small stocks can potentially be due to the time frame of our sample which includes several major financial crises in the regions in our sample. These are expected to hurt smaller stocks to a larger extent than bigger stocks. The standard deviation for SMB is similar in both our sample and the sample in Fama and French (2015).

The market return in our sample is around half of that in Fama and French (2015), at 0.29% per month. The return itself is not unrealistic, and the deviation from the more “expected” market return of around 0.5% per month has several possible explanations. As mentioned, the time span of our sample includes an unusual amount of financial crises, and this naturally has an impact on the average return of the market. One other possible explanation is the unusually high rate of the 3-month Swedish bonds used as risk free rate in the earlier years of the sample. In theory, this should correspond to a higher market return. But there is highly likely some room for lag in the markets, which could lead to a lower mean excess return depending on the sample time frame.

We get very similar results to Fama and French (2015) for both HML and CMA, with 0.31% per month for both factors. HML is defined similarly in both studies, but as stated above, we used a slightly differently definition of CMA (CAPEX / total assets as opposed to growth in total assets). The standard deviation of RMW is higher in our sample, especially compared to the 2x2 and 2x2x2x2 sorts in Fama and French (2015). HML has a higher standard deviation in our sample, however, the *t*-statistic for HML is significantly lower.

RMW has been defined in the same way in both our report and Fama and French (2015), but we still observe a large difference in the factor return, up to seven times higher for their 2x2 sorts, 1.08% compared to 0.17%. The spread in return of profitable companies compared to less profitable companies in our sample is a lot greater than in Fama and French's (2015) sample. This can be either a product of geographical differences between northern Europe and the United States, or a difference between the time periods from our data is from.

In general, we see similar *t*-statistics than Fama and French (2015), except in HML which is significantly lower in our sample than in their report, for all the sorts they present statistics on.

Table (5)

Summary statistics for monthly factor returns

January 1985- December 2014, 360 months. The mean returns and standard deviations displayed in panel A are percentages.

Panel A: *Statistics*	$E(R_M) - R_F$	SMB	HML	RMW	CMA
Mean	0.29	-1.54	0.31	1.08	0.31
Std. Dev.	1.77	2.94	3.38	2.73	2.37
t-statistic	3.01	-9.76	1.71	7.35	2.45
Panel B: *Correlations*					
	$E(R_M) - R_F$	SMB	HML	RMW	CMA
$E(R_M) - R_F$	1				
SMB	-0.2046	1			
HML	-0.1465	0.4212	1		
RMW	-0.0806	-0.4009	-0.0812	1	
CMA	-0.0462	0.1187	0.0678	-0.2002	1

In general, we observe lower correlations between the market return and the other factors than in Fama and French (2015). The correlations between SMB and the market return are of similar magnitude but are negative in our sample. This negative correlation between SMB and market return is surprising and not consistent with our theory that high number of crises would hurt smaller stocks. Small stocks usually have higher market betas than bigger stocks, which would imply that the correlation should be positive. However, looking at the correlation, as well as the figures in Table (6), where we have performed regressions of each factor on the other factors, we see this is not the case in our data sample. The negative coefficient in the regression is significant at a magnitude of -0.429 in the regression of SMB on the other factors. This implies that the spread in return between small and big stocks would shift in favour of small stocks when the market return goes down.

Table (6)

Regressions of each factor regressed on the other factors

This table shows the outcome of regressions on each factor return against the others.

	Int	$E(R_M) - R_F$	SMB	HML	CMA	RMW	R^2
$E(R_M) - R_F$							
Coef.	0.001		-0.189	-0.014	-0.004	-0.155	0.12
p-Value	0.00		0.00	0.00	0.08	0.00	
SMB							
Coef.	-0.011	-0.429		0.311	-0.010	-0.432	0.35
p-Value	0.00	0.00		0.00	0.00	0.00	
HML							
Coef.	0.010	-0.053	0.513		0.076	0.232	0.18
p-Value	0.00	0.00	0.00		0.00	0.00	
CMA							
Coef.	0.005	-0.008	-0.009	0.042		-0.164	0.04
p-Value	0.00	0.08	0.00	0.00		0.00	
RMW							
Coef.	0.006	-0.360	-0.442	0.144	-0.185		0.23
p-Value	0.00	0.00	0.00	0.00	0.00		0.00

SMB and HML have a strong positive correlation in our dataset contrasted to the weaker negative correlation in Fama and French’s (2015) sample. When either of the factors increases, the other increases significantly as a result. This is also apparent in Table (6). Coefficients for both HML and SMB on their counterpart are strongly positive, even stronger for SMB on HML. We look deeper into the relation between SMB and HML in section 4.3 Regressions where we observe that SMB loses significance when HML is added as a factor in the models.

Similarly to the results in Fama and French (2015), we find a strong negative correlation between SMB and RMW. This is not very surprising as many smaller firms are “growth firms” with lower profitability focusing more growing sales than improving margins.

The correlation between RMW and HML is close to zero, similar to what Fama and French (2015) found in two of their sorts, 2x3 and 2x3. In their 2x2x2x2 sort, the correlation increases to 0.63. However, according to the authors, this correlation is an artificial product of the way they constructed the factors in the 2x2x2x2 sort.

Whereas HML and CMA have a very strong positive correlation in Fama and French we observe a weak correlation (see also Table (6)). They argue that their finding is not very surprising since high B/M firms tend to be low investment. Thus our finding is all the more surprising. Our finding implies that there is no strong relation at all between the level of investment and B/M which is somewhat contrary to what they found in their study.

RMW and CMA have weak to medium negative correlation in our dataset as well as in Fama and French's (2015) dataset, except for their 2x2x2x2 sort where the correlations increases to medium positive. This is quite surprising as we expected to see at least a positive correlation between conservative investments and robust profitability.

4.3 Regressions

A total of eleven regression panels are presented with six different regressions in each. The first regression is the ordinary three-factor model as in Fama and French (1992), the last is the five-factor model as in Fama and French (2015). The rest of the regressions are variations on four factors, constructed with the intent to observe what happens to the model when factors are added or removed.

The first major observation is that the R-square values are lower than most other studies on the subject. This can have many possible explanations, one being that our data sample stretches over a time period with an unusually high number of economic crises. Another aspect that could affect our R-square is the fact that we use data from several different markets and the market return in our model is defined as the average value weighted excess return of all stocks in our dataset. To illustrate, the return on, for example, the London stock exchange should have lower explanatory for stocks in listed on the Stockholm stock exchange than the market return for the Stockholm exchange. Thus, the explanatory power of our market return, which is a mix of the return on all markets in our sample, should be lower. However, the main goal is not investigate the overall performance of the five factor model. It is rather to investigate the relationship between the model factors in a northern European setting, thus it is more important to look at the changes in R-square than its magnitude.

The six panels of 2x2 sorts show visibly higher R-square values than for the other sorts. This is expected because the portfolios in this sort are larger, which should lead to an increased explanatory power of the market return as a factor. Fama and French (2015) found that the five-factor model performed better than the three-factor model. Looking at the average R-squares from our regressions we can only observe a slight increase moving from the three-factor model to the five-factor model.

One of the most remarkable observations is the clear drop in R-square when the HML is excluded. This tendency is observed across all panels. The deteriorated explanatory power caused by removing the B/M factor is very different from the findings of Fama and French (2015). As described above, they found that adding HML to the model did not increase the explanatory power of the model and that the factor was insignificant. Not only do we find that HML is a very important factor for the model, but as HML is added to the model, the significance of the size coefficient decreases from high to insignificant for regression in all sorts. This is a very interesting result which differs considerably from Fama and French's findings. In 4.2 Factor data, we presented the correlation between the factors and saw that the correlation between HML and SMB is high at 0.42. When SMB is regressed on the other factors we can see that the coefficient of HML is a lot higher than what Fama and French (2015) found, 0.31 (see Table (6)) in our sample compared to at most 0.13 for the 2x2x2x2 sort in their sample. Furthermore, the R-square of the SMB regression in our sample is around twice as high at 0.35. Regressing SMB on HML solely, we see an R-square of 0.17 which states that quite a high amount of the variation in SMB can be explained by HML. Similarly, Fama and French (2015) found very high R-square when HML was regressed on the other factors.

There are several studies that are in line with our findings on the size effect. For example Horowitz, Loughran and Savin (2000) found that small stocks had much higher returns than big stocks in the period 1963-1981, but between 1981 and 1997 this size premium disappeared and big stocks had slightly higher returns. Similar results were founds by Schwert (2002), who found that the size effect seems to have disappeared or at least diminished in importance for the period after 1982.

In Table (8), with 2x2x2 sorted portfolios, we find very similar regression results with regard to R-square can be observed. The average R-square for each panel of portfolios is clearly reduced when the B/M factor is removed. Moreover, the five-factor regressions also here show the highest explanatory power.

The final Table (9) panel shows very similar results. Again, the overall R-square is lower, as the portfolios are smaller. The five-factor model still provides the highest explanatory power and the removal of the B/M factor still has a clearly diminishing effect on the R-square.

For each regression panel, a Gibbons, Ross and Shanken (1989) test is done. We find much higher GRS statistics than Fama and French (2015). The GRS statistics in our sample are high for all regressions, except those where the B/M factor has been removed. The p-value then increases to the point where it is problematic.

Below, table (7), (8) and (9) display the regressions on each panel of portfolios and the outcome.

Table (7)

Summary statistics for tests of models for 2x2 portfolio sorts

January 1st 1985 – December 31st 2014, 360 months. Six regressions are performed on six panels with four portfolios, each of 2x2 sorts. The regressions are the Fama French three-factor model, the five-factor model and four different four-factor models. $A(R^2)$ is the average R-squared for the regressions. A GRS test is also performed on each regression to test whether the intercepts are indistinguishable from zero and the degree of their respective significance.

	GRS	p-Value	$A\|a_i\|$	$A(R^2)$
Sort 1: 2x2, size and B/M				
$E(R_M) - R_F$ SMB HML	29.77	0.00	0.008	0.1898
$E(R_M) - R_F$ SMB HML CMA	21.84	0.00	0.007	0.2029
$E(R_M) - R_F$ SMB HML RMW	33.80	0.00	0.009	0.1940
$E(R_M) - R_F$ HML CMA RMW	29.52	0.00	0.008	0.2049
$E(R_M) - R_F$ SMB CMA RMW	2.99	0.084	0.003	0.1216
$E(R_M) - R_F$ SMB HML CMA RMW	24.40	0.00	0.008	0.2050
Sort 2: 2x2, size and profitability				
$E(R_M) - R_F$ SMB HML	47.47	0.00	0.010	0.2143
$E(R_M) - R_F$ SMB HML CMA	36.95	0.00	0.009	0.2278
$E(R_M) - R_F$ SMB HML RMW	51.38	0.00	0.010	0.2172
$E(R_M) - R_F$ HML CMA RMW	52.63	0.00	0.010	0.2281
$E(R_M) - R_F$ SMB CMA RMW	7.71	0.01	0.004	0.1364
$E(R_M) - R_F$ SMB HML CMA RMW	38.96	0.00	0.009	0.2290
Sort 3: 2x2, size and investment				
$E(R_M) - R_F$ SMB HML	44.44	0.00	0.009	0.2134
$E(R_M) - R_F$ SMB HML CMA	34.03	0.00	0.008	0.2279
$E(R_M) - R_F$ SMB HML RMW	47.92	0.00	0.010	0.2160
$E(R_M) - R_F$ HML CMA RMW	45.99	0.00	0.009	0.2284
$E(R_M) - R_F$ SMB CMA RMW	6.16	0.01	0.004	0.1350

$E(R_M) - R_F$ SMB HML CMA RMW	35.60	0.00	0.009	0.2288
Sort 4: 2x2 B/M and profitability				
$E(R_M) - R_F$ SMB HML	36.80	0.00	0.009	0.1939
$E(R_M) - R_F$ SMB HML CMA	28.23	0.00	0.008	0.2057
$E(R_M) - R_F$ SMB HML RMW	40.28	0.00	0.009	0.1968
$E(R_M) - R_F$ HML CMA RMW	39.87	0.00	0.009	0.2065
$E(R_M) - R_F$ SMB CMA RMW	5.68	0.02	0.004	0.1290
$E(R_M) - R_F$ SMB HML CMA RMW	30.18	0.00	0.008	0.2069
Sort 5: 2x2 B/M and investment				
$E(R_M) - R_F$ SMB HML	44.05	0.00	0.009	0.2124
$E(R_M) - R_F$ SMB HML CMA	34.11	0.00	0.008	0.2255
$E(R_M) - R_F$ SMB HML RMW	47.77	0.00	0.010	0.2152
$E(R_M) - R_F$ HML CMA RMW	46.64	0.00	0.009	0.2262
$E(R_M) - R_F$ SMB CMA RMW	6.43	0.01	0.004	0.1334
$E(R_M) - R_F$ SMB HML CMA RMW	36.03	0.00	0.009	0.2266
Sort 6: 2x2Investment and profitability				
$E(R_M) - R_F$ SMB HML	45.40	0.00	0.008	0.2239
$E(R_M) - R_F$ SMB HML CMA	35.43	0.00	0.010	0.2363
$E(R_M) - R_F$ SMB HML RMW	48.93	0.00	0.009	0.2265
$E(R_M) - R_F$ HML CMA RMW	47.77	0.00	0.009	0.2370
$E(R_M) - R_F$ SMB CMA RMW	6.04	0.01	0.004	0.1365
$E(R_M) - R_F$ SMB HML CMA RMW	37.18	0.00	0.009	0.2373

Table (8)

Summary statistics for tests of models for 2x2x2 sorts

January 1st 1985 – December 31st 2014, 360 months. Six regressions are performed on three panels with eight portfolios, each of 2x2x2 sorts. The regressions are the Fama French three-factor model, the five-factor model and four different four-factor models. $A(R^2)$ is the average R-squared for the regressions. A GRS test is also performed on each regression to test whether the intercepts are indistinguishable from zero and the degree of their respective significance.

	GRS	p-Value	$A\|a_i\|$	$A(R^2)$
Sort 7: 2x2x2, B/M profitability and investment				
$E(R_M) - R_F$ SMB HML	60.42	0.00	0.009	0.1524
$E(R_M) - R_F$ SMB HML CMA	46.93	0.00	0.008	0.1614
$E(R_M) - R_F$ SMB HML RMW	64.94	0.00	0.010	0.1542
$E(R_M) - R_F$ HML CMA RMW	63.08	0.00	0.009	0.1619
$E(R_M) - R_F$ SMB CMA RMW	10.44	0.00	0.004	0.1005
$E(R_M) - R_F$ SMB HML CMA RMW	49.10	0.00	0.008	0.1621

Sort 8: 2x2x2, B/M, profitability and size				
$E(R_M) - R_F$ SMB HML	46.20	0.00	0.009	0.1405
$E(R_M) - R_F$ SMB HML CMA	34.43	0.00	0.008	0.1500
$E(R_M) - R_F$ SMB HML RMW	50.58	0.00	0.009	0.1425
$E(R_M) - R_F$ HML CMA RMW	48.39	0.00	0.008	0.1505
$E(R_M) - R_F$ SMB CMA RMW	6.01	0.01	0.003	0.0935
$E(R_M) - R_F$ SMB HML CMA RMW	36.72	0.00	0.008	0.1507
Sort 9: 2x2x2, Size, profitability and investment				
$E(R_M) - R_F$ SMB HML	70.17	0.00	0.010	0.1764
$E(R_M) - R_F$ SMB HML CMA	54.69	0.00	0.008	0.1864
$E(R_M) - R_F$ SMB HML RMW	75.52	0.00	0.010	0.1785
$E(R_M) - R_F$ HML CMA RMW	77.33	0.00	0.010	0.1866
$E(R_M) - R_F$ SMB CMA RMW	10.41	0.00	0.004	0.1093
$E(R_M) - R_F$ SMB HML CMA RMW	57.33	0.00	0.009	0.1872
Sort 10: 2x2x2, Size, B/M and investment				
$E(R_M) - R_F$ SMB HML	37.86	0.00	0.008	0.1376
$E(R_M) - R_F$ SMB HML CMA	29.17	0.00	0.007	0.1435
$E(R_M) - R_F$ SMB HML RMW	42.77	0.00	0.009	0.1402
$E(R_M) - R_F$ HML CMA RMW	40.34	0.00	0.008	0.1449
$E(R_M) - R_F$ SMB CMA RMW	4.48	0.03	0.003	0.0877
$E(R_M) - R_F$ SMB HML CMA RMW	32.66	0.00	0.008	0.1450

Table (9)

Summary statistics for tests of models for 2x2x2x2 sorts

January 1st 1985 – December 31st 2014, 360 months. Six regressions are performed on a panel with 16 2x2x2x2 sorted portfolios. The regressions are the Fama French three-factor model, the five-factor model and four different four-factor models. $A(R^2)$ is the average R-squared for the regressions. A GRS test is also performed on each regression to test whether the intercepts are indistinguishable from zero and the degree of their respective significance.

	GRS	p-Value	$A\|a_i\|$	$A(R^2)$
Sort 11: 2x2x2x2, size, B/M, profitability and investment				
$E(R_M) - R_F$ SMB HML	53.95	0.00	0.008	0.1017
$E(R_M) - R_F$ SMB HML CMA	41.51	0.00	0.007	0.1062
$E(R_M) - R_F$ SMB HML RMW	59.30	0.00	0.009	0.1030
$E(R_M) - R_F$ HML CMA RMW	60.61	0.00	0.008	0.1065
$E(R_M) - R_F$ SMB CMA RMW	6.37	0.01	0.003	0.0654
$E(R_M) - R_F$ SMB HML CMA RMW	44.76	0.00	0.008	0.1068

5. Discussion and conclusions

As a first concluding remark, we can say that we find no support for a lost explanatory power of HML when RMW and CMA are added as risk factors in the model. Fama and French's (2015) reasoning that this might be due to their dataset seems like a reasonable explanation in that respect. Our results point towards an opposite conclusion, that HML is the single most important factor in the model (albeit with the exception of market return). This is potentially linked to the high explanatory power we found of HML on SMB. This implies that a lot of the effect of the size seems to be captured by the book-to-market (B/M) factor.

Usually, the multifactor models should explain more of the excess returns than what we found in our sample. At the outset of the study we expected higher R-square values, at least around 0.4 across all panels, but in our sample the highest hardly exceeded half of it. However, we argue that the low R-square values that came out of the regression panels are partly due to our inclusion of markets from multiple countries in our dataset. It is natural that the stock markets in one country will have lower correlation to the market return of other markets. In this respect, our method is inferior for testing the validity of the five-factor model. However, the scope of this study has been to look at the behaviour of the different factors in relation to each other. We believe that the definition of market return in our model should have limited, if any, impact on the relation between the other factors.

As stated above, Fama and French (2015) draw the conclusion that HML could be a redundant factor when profitability and investment are added. Given our result, we cannot confirm this conclusion. However, as we discussed above in 4.3 Regressions, a similar conclusion can be drawn for the SMB factor instead for our set of data. Adding SMB to the model does not increase the explanatory power of the model. Ever since Banz (1981), for instance, size is often cited as a factor of high importance in explaining stock return. The theory is well known; smaller firms have lower financial strength, and thus higher risk. In efficient markets, higher risk is rewarded with higher returns. Thus, size was expected to be of high importance for return, and small stocks were expected to outperform big stocks in terms of return. Our result could have its cause in the differences in the northern European market compared to the US markets.

As we stated above in section 4.3 Regressions, there are several studies that have found a diminished effect of size on profitability for later years, for example Reinganum (1999), Horowitz, Loughran and Savin (2000) and Schwert (2002). One possible explanation of the diminished size effect could be that after Banz's (1981) discovery of the small cap premium, more investors have invested in them, thus increasing the general price levels of small stocks and therefore lowered the return. This could be viewed as the markets correcting themselves after a period of undervaluation of small stocks in the pre-1980 era. This aspect will most likely have had a noticeable impact even if it might not have been able to explain the entire shift in the size effect.

Another possible explanation, although somewhat less clear, could be that the importance of size for risk has "diminishing returns to scale". In other words, for a very small firm increasing size would have a big impact on the risk, but for larger companies a relatively equal increase in size would have a much lower impact on the risk of the company. Possibly, this is not a linear progression, and there might be a threshold size after which increases in size would barely lower the risk of the firm. An extension of this reasoning is that increases in size beyond a certain point also increases the complexity of the firm. The lower financial risks might then be offset by higher operational risk. This would particularly apply to firms that are increasing their size through expansions to other geographical markets or even industries.

The unexpected finding that some robust profitability portfolios have lower returns than weak profitability portfolios, e.g. the higher returns of HWB compared to HRB and BHWA compared to BHRA, merits further comment. The profitability of high B/M stocks are probably viewed by the market as more risky than the profitability of low B/M stocks. Our definition of profitability is EBIT/Total assets for the year t-1. Profitability for year t-1 can be risky as a predictor for profitability the year after, i.e. the year in which the returns are calculated. One possible explanation that we discussed is that the higher profitability in the previous years is viewed to have been generated at the expense of the future profit, hence the low B/M (which is updated each month).

6. Further research

Fama and French speculate that the data could be a potential explanation behind the lost explanatory power of the book-to-market equity, and this study has attempted to test this. Thus, the study is a comparison between the stock markets in northern Europe and the USA. One interesting extension would be to look at Europe as a whole or Scandinavia alone. It would be useful to look at both and compare the result in order to validate the result for our "mix" of markets.

The most unexpected finding in our study, the loss of explanatory power for the size factor, needs to be investigated further. Is this a geographical or sample time period characteristic? We provide some examples of previous studies which argue that the importance of size as a factor to explain return has been diminishing since early 1980's. Fama and French (2015) and many other studies that have found a strong size effect, study longer time periods including many years before 1980. If the effect of size on return has diminished in the years after 1980, it is complicated to compare the size effect found in those studies to the effect that we find in our study, which looks at data from 1985-2014. Furthermore, one aspect of the diminishing effect of size is our finding that SMB is explained to a large extent by the other factors (with an R-square of 0.35). Does this mean that other firm characteristics be used to determine the size of a company in the modern stock markets? The explanatory power of HML on SMB seemed to be especially high, with an R-square 0.17. This finding suggests that the correlation between HML and SMB should be investigated closer and on additional markets.

The lower R-squares across the board could be potentially investigated further by comparing the explanatory power of multi-country studies with single-country studies. Our theory is that the market return will have lower explanatory power in the studies where markets from many different countries than when studying only one country.

Lastly, we would like to see studies on the firm characteristics in the HWB, HRB, BHWA and BHRA portfolios to investigate why profitability seems to be have adverse effect on return. Can it be because of timing differences in the measures for profitability and B/M or are there some underlying factors that cause the effect?

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8. Appendices

Appendix A: Definitions

Table (A1) below lists the definitions of the factors and other regression components.

Table (A1)

Definitions

R_{it}	The return of portfolio i at time t
R_{Ft}	The risk-free rate at time t
a_i	The intercept; the difference between the return according to the model and the actual return of a portfolio. This should be zero or very close to zero if all other factors are assumed to explain everything else
b_i	The sensitivity of a stock to the market return; the market-beta coefficient
$E(R_M)$	The expected return of a value-weighted market portfolio
s_i	The size factor coefficient
SMB_t	The return of a portfolio of small stocks minus the return of a portfolio with large stocks
h_i	The B/M factor
HML_t	The return of a portfolio of high B/M stocks minus the return of a portfolio of low B/M stocks
r_i	The profitability factor
RMW_t	The return of a portfolio with weak profitability minus the return of a portfolio with robust profitability
c_i	The investment rate factor
CMA_t	The return of a portfolio with low investment rate minus the return of a portfolio with high investment rate
e_{it}	Regression residual (assumed to be zero)

Appendix B: Factor returns

Table (B1)

Mean monthly returns over all five factors

January 1st 1985 – December 31st 2014. The dataset is non-complete over the entire period with some missing months.

Year-Month	$E(R_M) - R_F$	SMB	HML	CMA	RMW
1986-01	-5.81	5.04	6.02	5.03	-4.53
1986-02	-0.08	0.43	5.98	-1.99	3.83
1986-03	2.33	3.66	0.98	4.69	-2.90
1986-04	3.72	-5.74	-14.96	1.48	7.13
1986-05	2.82	2.83	1.60	-2.57	-6.59
1986-06	-1.08	2.65	-0.87	-3.38	1.99
1986-07	-0.06	-2.14	-3.15	2.03	-1.19
1986-08	-2.02	7.92	6.72	6.98	-7.54
1986-09	0.98	-3.66	1.27	1.47	5.29
1986-10	13.89	2.90	1.21	-5.09	0.16
1986-11	2.67	-4.03	1.16	0.96	-4.87
1986-12	5.56	0.04	12.10	0.09	-2.21
1987-01	-1.15	-4.07	-2.41	-1.99	-2.06
1987-02	1.83	-7.10	-3.52	-3.78	0.65
1987-03	2.29	-1.97	-2.27	-0.82	0.14
1987-04	2.63	-0.87	4.76	-0.73	0.91
1987-05	1.03	-0.56	0.58	0.11	0.96
1987-06	-0.38	5.61	0.57	0.74	-2.56
1987-07	2.33	0.53	-2.40	0.58	-0.86
1987-08	4.24	-0.61	-1.58	-0.34	2.51
1987-09	-1.50	4.84	4.39	-2.65	-5.23
1987-10	2.32	-0.90	-1.11	0.21	-1.00
1987-11	-5.84	8.26	9.97	1.48	-5.12
1987-12	-3.51	-1.28	2.55	-3.59	2.36
1988-01	0.76	-3.67	-3.86	-6.33	1.48
1988-02	1.22	1.10	-3.18	-2.01	1.63
1988-03	1.58	-0.59	0.48	1.25	-0.89
1988-04	-0.54	-0.75	-0.83	1.30	0.00
1988-05	-3.57	0.45	-2.06	-1.90	-0.12
1988-06	-2.24	-2.02	-1.09	1.16	-0.05
1988-07	6.95	-1.08	-0.27	0.08	-2.38
1988-08	0.53	0.81	-0.65	1.13	0.03
1988-09	0.40	0.42	2.74	0.99	0.38
1988-10	-1.51	-1.56	-2.23	0.00	0.70
1988-11	-1.95	3.08	2.54	-0.88	-0.19
1988-12	-1.49	0.60	3.90	1.08	1.11
1989-01	-0.99	0.65	2.87	-2.05	-0.68
1989-02	1.28	-4.13	-1.31	0.16	0.35
1989-03	0.30	-0.25	0.47	-0.04	-0.56
1989-04	2.04	-0.21	3.50	-2.04	1.45
1989-05	12.32	-2.06	1.56	1.02	-1.85
1989-06	3.30	-0.28	1.75	0.88	-2.13
1989-07	2.31	-2.38	1.59	-1.56	1.46
1989-08	1.45	0.36	0.28	-0.28	-1.92

1989-09	0.95	-3.29	3.53	1.85	-0.36
1989-10	-0.59	1.56	4.59	2.53	-1.13
1989-11	-1.37	-1.17	7.32	0.87	-0.98
1989-12	0.51	-3.22	1.89	2.42	3.29
1990-01	-1.66	0.85	1.39	-2.19	2.06
1990-02	-0.92	-0.48	1.11	-1.10	3.22
1990-03	-1.59	-0.65	-1.09	-0.21	1.79
1990-04	-0.70	-0.16	2.01	-0.26	-1.70
1990-05	-1.51	0.38	0.94	-0.19	-0.81
1990-06	1.12	-4.91	-0.08	-2.06	2.02
1990-07	-0.91	-0.61	-1.74	-0.72	1.88
1990-08	-0.64	-0.54	2.89	0.45	-0.30
1990-09	-2.02	3.37	2.77	1.37	-0.07
1990-10	-1.98	-1.23	1.96	0.62	0.50
1990-11	-0.83	-2.60	-3.96	3.67	1.43
1990-12	-0.32	-3.87	-0.17	2.19	0.69
1991-01	-0.80	-1.24	-1.26	0.84	2.10
1991-02	-0.50	-4.19	2.19	-2.33	-0.36
1991-03	2.48	-4.53	-2.28	1.09	3.77
1991-04	1.09	-2.24	-4.86	0.85	3.12
1991-05	0.24	-1.62	0.02	-0.86	-0.01
1991-06	0.11	-3.01	3.93	-0.12	1.52
1991-07	0.62	-0.09	-0.59	1.18	0.84
1991-08	1.45	-1.24	0.46	0.93	1.65
1991-09	0.12	-3.27	-4.74	0.05	3.93
1991-10	-0.37	-1.47	-2.87	0.91	4.15
1991-11	-0.55	-1.33	0.63	0.84	1.92
1991-12	-1.11	-0.38	1.24	3.13	-0.14
1992-01	-1.02	3.62	2.65	-1.53	0.58
1992-02	0.65	-3.32	1.86	-2.39	2.13
1992-03	-0.33	-0.10	-0.57	-1.05	0.35
1992-04	-1.45	-0.82	3.60	0.26	0.49
1992-05	1.49	-5.51	-6.77	1.72	3.88
1992-06	-0.07	-0.34	-3.43	1.14	1.04
1992-07	-2.12	2.13	1.00	0.16	1.94
1992-08	-2.12	0.18	2.53	-0.71	3.62
1992-09	-2.20	-0.11	-1.36	-0.86	0.59
1992-10	1.46	-6.69	-3.83	0.25	0.30
1992-11	0.96	-5.38	0.53	-1.45	2.17
1992-12	-0.23	-0.88	-2.85	0.93	0.38
1993-01	0.49	-5.38	-5.86	-0.63	0.68
1993-02	0.95	-4.10	-0.14	3.20	-0.11
1993-03	4.57	-1.01	4.23	-1.38	-0.81
1993-04	-0.03	1.33	2.05	0.40	1.64
1993-05	0.47	-0.14	2.51	3.31	-1.96
1993-06	0.97	-2.93	4.13	3.77	-0.19
1993-07	1.15	-2.28	2.69	-1.30	0.83
1993-08	0.99	-1.32	5.59	-0.95	-0.57
1993-09	0.56	1.40	-2.33	2.10	-0.13
1993-10	0.34	-1.58	-0.94	0.98	-0.13
1993-11	1.99	-0.59	5.17	0.68	-1.95

1993-12	0.28	2.62	2.25	-0.77	-0.38
1994-01	2.47	-1.08	-0.18	2.12	-0.74
1994-02	1.34	5.10	4.24	0.13	-0.02
1994-03	-0.90	3.44	2.10	0.74	1.27
1994-04	-1.00	0.71	1.87	2.36	2.91
1994-05	0.46	-0.17	2.63	-0.07	2.27
1994-06	-0.95	2.55	3.56	1.55	-2.50
1994-07	-0.54	2.29	1.42	2.17	0.31
1994-08	0.77	-2.20	1.42	0.40	0.69
1994-09	1.03	-3.22	-1.95	0.42	0.71
1994-10	-1.49	0.74	3.45	1.81	-2.26
1994-11	-0.35	-0.47	0.50	0.90	1.58
1994-12	-0.24	1.00	2.19	-1.09	-0.38
1995-01	0.69	-0.26	0.81	1.09	0.41
1995-02	-1.48	3.05	2.37	0.79	-0.37
1995-03	0.25	-0.82	1.73	0.23	2.23
1995-04	0.16	-1.13	-2.35	-1.21	3.12
1995-05	0.10	-2.63	-0.62	-0.58	2.56
1995-06	0.79	-3.16	-1.90	-0.16	1.27
1995-07	-0.28	-0.31	1.42	0.07	1.73
1995-08	0.48	-1.12	-0.92	-0.16	1.51
1995-09	0.01	-0.17	-1.52	-0.55	-0.28
1995-10	0.22	-0.66	-0.54	-1.02	1.29
1995-11	-0.43	0.37	-0.86	1.29	0.09
1995-12	0.19	-2.19	-1.78	-0.59	-0.83
1996-01	-0.27	-0.94	-0.59	-1.68	0.71
1996-02	0.82	-0.62	3.82	1.26	-1.54
1996-03	0.58	-0.81	-1.64	0.04	2.21
1996-04	0.24	2.12	0.55	0.17	-1.16
1996-05	0.19	2.00	-2.28	-0.38	-0.19
1996-06	0.12	-0.19	0.67	0.96	-0.09
1996-07	0.42	-1.43	2.91	-1.47	1.45
1996-08	-0.55	1.37	3.88	2.26	-0.29
1996-09	-0.13	0.70	-1.34	1.10	-0.36
1996-10	1.89	-0.46	-0.22	1.48	0.41
1996-11	0.80	1.40	0.92	4.08	-1.53
1996-12	0.96	0.27	-0.12	-3.17	3.11
1997-01	0.69	1.22	7.29	1.53	1.42
1997-02	0.35	-0.25	3.16	0.27	0.15
1997-03	-0.10	-3.00	0.85	1.42	-1.61
1997-04	0.25	1.61	1.22	0.86	0.51
1997-05	-0.09	0.10	-0.04	-0.32	-0.73
1997-06	0.17	-1.74	0.38	3.63	1.17
1997-07	0.09	2.31	5.43	-0.51	-0.65
1997-08	-0.13	3.79	7.12	0.05	-3.64
1997-09	-0.06	-1.64	0.50	0.10	-0.67
1997-10	5.13	-3.68	-2.70	-1.08	1.08
1997-11	-0.28	-3.63	-4.86	0.50	2.14
1997-12	0.77	1.19	0.54	0.01	-0.02
1998-01	1.31	-3.92	-0.27	1.85	-1.92
1998-02	0.53	-1.04	-0.25	-0.92	1.04

1998-03	0.15	-2.09	0.32	1.91	1.64
1998-04	0.47	-5.16	0.21	-1.81	2.74
1998-05	0.57	-1.11	-2.11	1.51	0.90
1998-06	-0.32	-1.44	-3.39	-1.30	4.48
1998-07	-0.07	-1.09	-1.95	0.48	0.13
1998-08	-0.33	-0.16	-0.33	-0.09	-0.64
1998-09	-0.72	4.75	3.57	3.38	-0.33
1998-10	0.07	-3.77	0.64	-0.31	2.37
1998-11	-0.10	-1.37	-1.35	-2.30	-0.01
1998-12	-0.01	1.60	-1.15	-0.65	-1.06
1999-01	0.20	-1.30	-1.19	4.67	4.03
1999-02	-0.02	1.81	2.88	-1.61	0.77
1999-03	0.76	-1.22	0.61	2.13	-0.67
1999-04	1.10	-5.21	-3.17	-2.13	1.36
1999-05	0.63	-3.79	-1.00	-3.25	3.46
1999-06	-0.43	1.21	1.52	0.58	-0.02
1999-07	0.07	-2.35	-1.04	0.27	2.34
1999-08	-0.15	-1.81	-7.03	-0.30	-1.78
1999-09	0.00	-3.14	-2.86	-3.51	3.47
1999-10	0.77	-1.43	-3.93	1.58	-4.63
1999-11	-0.17	-3.75	-3.11	-0.51	2.76
1999-12	0.32	-4.79	-1.80	0.20	2.07
2000-01	16.25	-9.04	-4.20	1.50	-2.07
2000-02	0.46	-3.64	-2.15	2.36	-1.99
2000-03	0.21	-7.42	-8.18	2.42	-5.70
2000-04	0.22	-1.35	-1.47	1.14	-0.74
2000-05	-0.08	0.44	2.84	-4.64	7.48
2000-06	-0.14	1.61	6.03	-0.42	3.56
2000-07	0.70	-5.56	-2.93	6.05	-1.21
2000-08	0.09	-2.29	0.07	1.49	-0.62
2000-09	0.62	-5.64	-1.03	1.76	-0.06
2000-10	-0.05	-0.48	2.76	2.26	5.54
2000-11	0.14	0.29	4.87	-0.46	0.19
2000-12	-0.23	-0.16	3.91	-1.11	3.49
2001-01	0.43	-6.93	-1.01	0.70	7.66
2001-02	0.27	-1.17	1.12	-0.96	1.28
2001-03	-0.26	-5.05	7.35	3.22	9.40
2001-04	-0.40	-6.38	3.91	1.96	8.96
2001-05	0.35	-5.82	-3.23	-0.68	0.08
2001-06	0.09	-2.90	1.26	-0.91	0.71
2001-07	-0.11	0.72	4.68	-2.15	-0.21
2001-08	-0.13	-3.54	8.31	-1.12	5.53
2001-09	-0.25	-2.47	3.68	2.97	4.77
2001-10	-0.60	3.35	9.57	3.07	2.87
2001-11	0.07	1.42	-0.28	4.81	-3.74
2001-12	0.28	-2.60	-0.06	0.45	-2.45
2002-01	0.28	-2.57	4.20	2.81	0.37
2002-02	-0.28	-2.45	4.19	1.59	2.62
2002-03	-0.84	-3.64	2.16	0.03	6.14
2002-04	0.80	-2.98	1.75	1.82	2.48
2002-05	-0.91	-4.79	2.58	2.24	5.12

2002-06	-0.21	-5.66	6.19	0.01	8.68
2002-07	-1.85	-2.08	5.08	0.29	5.12
2002-08	-1.19	4.43	5.62	-0.89	-0.77
2002-09	-0.01	-0.23	4.58	0.11	4.15
2002-10	-1.40	-0.26	6.42	-0.88	3.04
2002-11	0.69	-1.50	2.24	-0.18	4.47
2002-12	2.06	-1.26	-2.25	2.55	-3.90
2003-01	-1.33	-1.76	0.65	-0.78	1.78
2003-02	0.46	2.33	0.60	-1.13	-0.18
2003-03	-0.15	-2.06	2.17	-1.56	2.91
2003-04	-0.22	2.57	1.95	3.02	1.92
2003-05	0.66	3.88	-0.28	-0.39	-3.23
2003-06	1.77	-5.01	-1.25	5.04	-3.28
2003-07	-0.24	-0.92	-3.88	1.84	-1.48
2003-08	0.98	-4.27	-2.10	2.50	0.17
2003-09	1.46	-2.53	-4.83	-2.51	-0.20
2003-10	-0.46	-0.06	0.58	3.52	-0.51
2003-11	1.64	-2.71	-2.53	-2.29	0.05
2003-12	0.22	-0.68	-1.30	-2.20	0.72
2004-01	0.43	-0.85	0.22	-3.34	-1.53
2004-02	2.59	1.35	1.86	4.34	-3.67
2004-03	-0.13	-4.19	-3.88	2.35	2.58
2004-04	-1.52	0.19	-1.18	2.40	-0.95
2004-05	-0.08	-3.92	-1.90	-2.62	5.78
2004-06	-0.46	-0.83	1.82	1.85	-0.13
2004-07	0.94	-2.98	-3.53	-3.47	2.59
2004-08	-1.53	-0.71	1.25	-4.86	5.52
2004-09	0.37	-2.12	1.57	0.30	4.08
2004-10	0.55	-1.13	-0.25	-0.02	1.51
2004-11	0.11	-1.47	-2.27	-1.40	-0.65
2004-12	0.39	-4.97	2.33	2.89	3.85
2005-01	0.30	-6.25	-0.52	1.33	1.50
2005-02	-0.23	-5.10	-1.81	1.21	3.31
2005-03	-0.34	-3.12	-4.90	0.86	0.06
2005-04	0.01	-1.80	-0.01	4.98	5.12
2005-05	-0.53	2.86	-1.97	-1.08	2.22
2005-06	1.54	-1.73	1.74	-1.41	4.52
2005-07	0.29	0.10	5.98	0.59	1.56
2005-08	0.34	-2.14	4.38	-0.59	4.22
2005-09	-0.06	-0.64	0.23	-1.26	-0.55
2005-10	0.62	0.60	5.21	5.90	-1.24
2005-11	-0.36	0.81	0.54	0.26	-0.39
2005-12	0.17	-2.59	1.86	2.29	1.10
2006-01	0.26	2.15	1.22	1.20	-2.45
2006-02	0.42	-6.19	-1.80	-6.16	2.51
2006-03	1.25	-8.48	-0.72	-0.36	7.00
2006-04	0.80	-8.69	-4.47	-0.44	2.28
2006-05	-0.42	-3.91	2.31	0.74	3.34
2006-06	-0.37	3.67	0.34	0.68	3.44
2006-07	0.01	-2.63	-1.35	-6.99	2.32
2006-08	-0.41	-6.29	0.54	-3.82	3.41

2006-09	0.36	-1.76	2.07	-2.69	0.84
2006-10	0.29	-3.15	-0.96	0.68	4.21
2006-11	0.25	-2.49	-0.49	-0.52	0.39
2006-12	0.00	-1.31	0.19	2.90	3.32
2007-01	0.55	0.55	-0.66	2.12	-1.74
2007-02	0.30	-1.12	0.08	0.21	5.75
2007-03	-0.06	-3.40	-1.73	-3.89	2.57
2007-04	0.03	-4.15	-1.78	-4.56	4.29
2007-05	0.06	-1.58	-0.95	-3.76	6.43
2007-06	0.63	-10.61	-7.94	1.80	3.94
2007-07	-0.04	-3.77	-4.68	-1.37	-0.97
2007-08	-0.10	2.76	2.74	-4.19	2.09
2007-09	0.01	-2.00	2.37	-1.90	0.48
2007-10	-0.08	-3.18	2.91	-2.72	2.91
2007-11	0.02	-2.21	-1.31	-2.48	2.69
2007-12	-0.21	-0.40	3.69	-3.71	-0.96
2008-01	0.98	-4.73	0.65	-1.53	-1.79
2008-02	-0.23	-1.14	5.37	3.85	-2.03
2008-03	0.03	-5.34	-0.07	0.93	0.72
2008-04	-0.08	-0.89	-0.35	-0.09	-1.16
2008-05	0.12	-7.22	3.88	-2.22	2.49
2008-06	0.01	-1.74	6.70	-4.54	1.65
2008-07	-0.20	-2.93	-1.13	-2.42	0.44
2008-08	-0.18	-2.25	10.16	3.44	3.07
2008-09	-0.04	2.24	2.12	1.58	-1.59
2008-10	-0.18	-0.09	4.93	0.22	-0.09
2008-11	-0.24	-3.10	2.94	2.09	1.72
2008-12	-0.09	-9.88	-0.33	-1.05	2.85
2009-01	-0.14	-1.02	2.02	1.28	-2.28
2009-02	-0.13	2.47	5.64	2.86	3.00
2009-03	-0.12	-3.03	8.23	-0.36	0.44
2009-04	0.13	-1.97	1.23	2.20	-3.73
2009-05	0.15	-3.69	2.12	7.07	4.13
2009-06	0.04	0.39	5.65	1.33	-5.80
2009-07	0.21	-6.43	-4.51	-3.95	8.19
2009-08	0.33	-5.82	0.87	1.06	-1.67
2009-09	0.34	-3.75	-4.50	2.83	2.16
2009-10	0.25	0.91	-8.84	6.78	-1.79
2009-11	0.10	-4.72	-6.85	-1.86	3.82
2009-12	0.23	-6.36	-2.38	-2.57	3.96
2010-01	0.18	0.96	1.07	-0.85	2.43
2010-02	0.10	-0.68	-1.24	1.31	0.35
2010-03	0.14	-4.34	2.38	0.95	6.34
2010-04	0.27	-0.76	2.06	8.45	-0.82
2010-05	0.03	3.90	2.79	0.84	-1.40
2010-06	0.05	-2.21	-0.67	2.33	2.83
2010-07	0.19	-2.77	2.79	-2.57	1.03
2010-08	0.09	-5.57	-2.20	-3.16	6.64
2010-09	0.06	-6.77	-2.57	-4.72	0.13
2010-10	0.25	-6.47	-3.56	-1.35	1.99
2010-11	0.25	-5.93	-0.76	-2.67	5.29

2010-12	0.18	-6.98	-1.78	-0.68	5.12
2011-01	0.48	-0.15	0.27	0.22	1.25
2011-02	0.27	-6.70	-3.92	-2.49	0.98
2011-03	0.20	-6.71	-8.19	5.63	6.68
2011-04	0.06	-0.98	-3.32	0.57	1.30
2011-05	0.24	-1.75	-7.15	1.64	1.84
2011-06	0.10	-6.28	-0.66	-2.66	6.22
2011-07	0.10	-3.63	-9.03	0.96	-2.51
2011-08	0.00	-7.15	-2.83	0.96	5.67
2011-09	-0.12	-2.32	-0.78	-2.75	1.72
2011-10	-0.17	0.10	-0.97	-0.29	1.66
2011-11	-0.02	-0.45	3.58	2.07	2.15
2011-12	0.09	-0.73	-3.49	-1.24	4.30
2012-01	0.00	0.46	1.16	-0.96	-3.06
2012-02	0.21	1.48	-1.03	-0.70	3.52
2012-03	0.12	0.52	-0.92	-0.53	0.90
2012-04	0.05	-0.59	1.09	1.85	1.07
2012-05	0.05	-3.63	0.36	-3.87	3.24
2012-06	-0.02	-1.89	3.71	3.70	4.19
2012-07	0.03	-2.90	-1.04	-1.84	4.06
2012-08	0.14	-1.08	-2.52	-0.71	3.30
2012-09	0.18	-2.53	-5.72	2.64	1.90
2012-10	0.15	1.25	-2.93	-1.50	-2.75
2012-11	0.14	-3.02	-1.23	-0.62	5.28
2012-12	0.10	-5.55	-3.20	0.76	6.21
2013-01	0.09	-6.16	-0.26	1.00	-2.63
2013-02	0.37	-7.04	-1.81	0.58	4.58
2013-03	0.20	-3.37	-2.04	-0.25	2.94
2013-04	0.25	-3.22	2.40	2.69	3.13
2013-05	0.12	-6.49	-1.07	0.01	-0.07
2013-06	0.36	-3.19	-6.86	2.44	2.78
2013-07	0.10	-3.18	1.09	-0.43	-0.31
2013-08	0.53	-6.03	-5.44	0.97	0.17
2013-09	0.06	2.33	-5.35	1.99	-4.63
2013-10	0.29	-2.16	-4.39	6.83	2.99
2013-11	0.46	-4.81	-1.92	-0.18	-2.07
2013-12	0.15	0.63	1.52	4.61	3.39
2014-01	0.39	-3.21	-1.49	-3.31	5.66
2014-02	0.17	-0.54	-2.40	4.17	4.00
2014-03	0.44	-2.58	1.87	2.13	-3.76
2014-04	0.15	-5.97	1.61	6.46	3.38
2014-05	0.05	-2.47	-2.82	2.88	-7.06
2014-06	0.07	1.96	1.43	0.31	3.54
2014-07	-0.05	-4.05	2.45	6.30	2.44
2014-08	-0.23	5.34	2.32	2.64	-0.88
2014-09	0.12	1.84	1.56	2.25	1.44
2014-10	-0.28	0.52	0.88	5.39	-0.52
2014-11	0.12	-3.04	-3.39	-4.48	4.67
2014-12	-0.06	2.99	4.04	2.66	1.93