Amina Javaid :

BI Norwegian Business School- Thesis

Macroeconomic risk and stock market anomalies in Norway

Examination code:

GRA 19002, Final thesis

Study Program:

Msc in Business and Economics

Supervisor:

Richard Priestly

Date of submission:

01.09.2011

Place of Study:

Oslo

Abstract

The primary goal of this thesis has been to explore the feasibility of macroeconomic factors as proxy for risks that might explain the size effect, book-to-market effect and the momentum effect in Norway. The multifactor model suggested by Chen, Roll and Ross (1986) was applied with the following factors: industrial production, oil price, unexpected inflation, change in expected inflation, term premium and an equally weighted market index (Oslo stock Exchange). The results revealed that no factors other than inflation-related variables were significantly important for explaining the cross-section of returns. From the FF-4 test, only SMB was found to have significant risk premium whereas CAPM is rejected altogether. The difference between average expected returns and the actual returns were statistically insignificant, suggesting risk-based explanations for the effects being analyzed, macroeconomic variables being the source of that risk.

Table of content

1. Introduction

According to the efficient market hypothesis a stock must be priced in accordance with its exposure to risk which is, by the diversification argument, the systematic risk. Several empirical studies seemingly document violation of the efficient market hypothesis in the CAPM- framework of Sharpe (1964) and Lintner (1965). Researchers have identified several patterns in average stock returns which confirm the existence of stock market anomalies such as the size effect, book-to-market effect and momentum effect, among others. These phenomena have shown persistence across markets and over time and have been observed in the Norwegian market as well.

Banz (1981) and Reinganum (1981) showed that small-capitalization firms on the NYSE earned higher average returns than it was predicted by the Sharpe (1964) – Lintner (1965) capital asset-pricing model (CAPM) from 1936–75. Stattman (1980) and Rosenborg, Reid, and Lanstein (1985) and Fama and French (1992) have found that companies with highest B/M ratios have higher return than companies with low B/M ratio. Fama and French (1992, 1993) argued that size and value represent two risk factors that are missing from the CAPM. Jegadeesh and Titman (1993) provided evidence on momentum effect in the short-term.

Many researchers have extended on the previous work on anomalies and attempted to provide risk-based explanations for these effects in the context of economic theory. Chen, Roll and Ross (1986) tested the macroeconomic factors in a multifactor APT framework to find whether innovations in macroeconomic variables could explain the cross-section of stock returns. They suggested a set of macroeconomic factors as proxy for risks that were later employed in several other studies in one or another form, thereby Liew and Vassalou (2000), Chordia and Shivakumar (2002), Griffin, Ji and Martin (2003), Petkova and Zhang (2005), Shanken and Weinstein (2006), Liu and Zhang (2008) and Næs, Skjeltrop and Ødegaard (2009).

Chordia and Shivakumar (2002) found that the profits to momentum strategies were explained by common macroeconomic variables related to the business cycle. Similarly, Petkova and Zhang (2005) argued that default premium, term premium and the short-term Treasury bill rate are more precise measures of business cycles. Further Liew and Vassalou (2000) show that SMB and HML contain information about future GDP growth. The fundamental question then is where does that information stem from? An important implication of their result is that SMB and HML proxy for risk that could be assumed to originate from the economic risk, thereby laying the ground for testing those risk factors. The underlying sources of risk that drive these proxies are still not very well defined for the Norwegian market. Further analysis on whether macro factors are the underlying sources of risk may therefore seem plausible.

Taking the risk-based argument as a point of departure, I will investigate further the issue of anomalies with the following economic problem:

Can macroeconomic risk explain the size effect, the book-to-market effect and the momentum effect?

The essential goal is to explore the time-series and cross-sectional properties of macroeconomic risk factors. The idea is to find macro factors that serve as proxy for systematic risk able to explain differences in the average stock returns. Most of the studies have focused on the US markets and less attention has been given to the European markets, particularly the Norwegian stock market. Therefore this study will extend on the international research by providing direct links between macro economy and market anomalies.

The macroeconomic factors I will employ in this study are: industrial production (MP), change in oil price (OIL), term premium (UTS), unexpected inflation (UI) and change in expected inflation (DEI). As Norway is a large oil producer and several of the largest companies at OSE are oil-related, it is a common belief that the Norwegian stock market is oil-driven. Thus an equal emphasis is put on exploring oil price along with other macro variables. Næs, Skjeltrop and Ødegaard (2009) and Bjørnland (2009) found that oil price changes affect stock returns in Norway. In the latter study, the effect of oil price changes on unemployment, inflation, exchange rates and short-term interest rates are also documented. On the other hand, Chen, Roll and Ross (1986) examined the impact of oil price changes on asset pricing and found no overall effect. Thus there may be good reasons to believe that the effects of oil price changes are already embedded in the other macroeconomic variables in one way or another.

Fama and French (1993, 1995, 1996) identified additional characteristics, such as size and book-to-market ratio, that are important for the asset pricing because they proxy for systematic risk factors in returns. Similarly, WML is based on the momentum effect and was identified to capture WML-related risk. I test the Fama-French multifactor model and the CAPM to examine whether they provide improvements over the macroeconomic model in the ability to capture size, book-to-market and momentum effect. Because risk of the FF factors is considered to originate from economic risk it is plausible to investigate whether FF-4 or the CAPM support the findings of the macro model of CRR.

The rest of the thesis report is organized as follows: section 2 will briefly present the anomalies and macro variables used in my analysis. Section 3 reviews previous literature related to the problem at hand. Section 4 will describe the data and explains the methodology applied. Section 5 provides the empirical results and section 6 finally concludes.

2. Background and literature

2.1 Macroeconomic variables

There exist a number of models that provide a framework for study of the link between macroeconomic variables and stock market returns. One approach which was adopted by Chen, Roll and Ross (1986) is the present value model, equation (1), which relates the stock price to future expected cash flows and future discount rate of these cash flows. So, all macroeconomic factors that influence future expected cash flows or discount rate should have an influence on the stock price as well.

Stock price is given by:

$$(1)\ p = \frac{E\,(c)}{k}$$

where c is the future expected cash flows and k is the discount rate

Many authors have found that corporate cash flows are related to a measure of aggregate output such as GDP or the industrial production. Changes in the industrial production will therefore affect returns through future cash flows. Further, changes in the expected rate of inflation would influence nominal expected cash flows as well as nominal interest rates. Changes in unanticipated inflation may directly influence real stock prices and may affect discount rates. The rate of interest is supposed to influence prices through its impact on the expected discount rate. Strong positive correlation of interest rate with discount rates suggests that increase in interest rates will have negative effect on stock returns. The oil price changes may affect returns through both channels - the cash flows and discount rate as suggested by Ødegaard *et al.* (2009). An unexpected increase in the oil price may therefore lead to a reduction in future expected cash flows.

2.2 Anomalies

The size effect was first documented by Banz (1980) who used the US data in period 1936-1975. The result of his study showed that the common stock of small firms had on average higher risk-adjusted returns than the common stock of large firms, hence indication of the CAPM being misspecified. Further he presented a possible explanation of size effect, linking information availability to the size of a company and arguing that lack of information about small firms will lead to limited diversification and therefore higher return for the undesirable stocks of small firms. Banz (1980) however fails to determine whether market value per se matters or whether size is only a proxy for unknown true additional factors correlated with market value, thus, leaving the question of why size effect exists, remain unanswered.

Several researchers, thereby Stattman (1980) and Rosenborg, Reid, and Lanstein (1985) and Fama and French (1992) find that companies with highest book-to-market ratios have systematically higher return than companies with low book-to-market ratio. Fama and French (1992, 1996) interpret the book-to-market ratio as an indicator of "value" versus "growth" stocks, and the HML risk factor as reflecting "distress risk". They argue that stock risks are multidimensional and those dimensions of risk are proxied by size and book-to-market ratio. They find that using a three factor model with a size factor and a BM factor almost removes the anomalies. Another potential explanation of the book-to-market effect is the notion of time-varying risk, in other words the risk of HML strategies is high in bad times when the expected premium for risk is high and low in good times when the expected risk premium is low.

Jegadeesh and Titman (1993) provide evidence on momentum effect and show that a strategy of buying winners (stocks that have performed well in the past) and selling losers (stocks that have performed poorly) gives excess returns over 3 to 12 month holding period. However, their study does not clarify whether profitability of this trading strategy is a result of systematic risk factors. On the contrary, they interpret momentum profits as behavioral underreaction to firm specific information. Fama and French (1996) have also shown that their three factor model cannot explain the momentum either.

2.3 Literature review

Chen, Roll and Ross (1986) argue that some underlying exogenous influences may cause the co movement of assets' prices and therefore test whether innovations in macroeconomic variables can be a proxy for the systematic risk in the market. A multifactor APT framework was employed and the main findings were that over the entire sample period only MP, UPR and UI were significantly priced while UTS was marginally so. When the market index was added to the macro factor model, they found no statistically significant effect on pricing. Similarly no evidence was found concerning oil factor being a priced risk factor in the market. Their overall conclusion was that stock returns are exposed to systematic economic news and that they are priced according to their exposure thus claiming to have found some evidence of the efficient market hypothesis. They do not show whether any link exists between systematic risk, stemming from innovations in macroeconomic variables, and the stock market irregularities that seem to contradict EMH. However, their study provides an adequate reference point in order to explore further the role of macro economy to understand risk-return relationships in the stock market.

Later, in a paper by Shanken and Weinstein (2006) their study was subject to some modifications. It was shown that the CRR (Chen, Roll and Ross) model produced different results when the post-ranking returns were used to estimate betas in contrast to using the previous 5 year beta estimates. Only the industrial production and market index were then found to have strong pricing evidence.

The study of Griffin, Ji and Martin (2003) used the same set of variables as CRR but failed to find evidence of pricing in contrast with Chen, Roll and Ross (1986). The sample consists of a sample of 40 countries, including Norway, in which they investigated whether momentum profits internationally can be explained by the macroeconomic risk factors. Their findings suggest that momentum profits are large and there is weak co movement between the countries which indicates that if momentum is driven by risk, the risk is mostly country-specific. Further, they provide evidence that internationally momentum profits tend to reverse soon after the investment period.

An important part of their analysis was to examine whether momentum profits could be explained through risk arising from macroeconomic states as proxied by GDP growth and aggregate stock market movement. Even though no such evidence was found, Griffin, Ji and Martin (2003) suggested that there might still be risk associated with macro economy that would provide risk-based explanations for momentum, but claimed that it is unclear what such risks look like or how they behave.

The work of Liu and Zhang (2008) also linked momentum profits with the macroeconomic risk. They focus on the growth rate of industrial production (MP) as a common risk factor which is compensated in the market as shown by Chen, Roll and Ross (1986).Using the Fama-MacBeth (1973) two-stage regression they showed that MP is a priced risk factor offering mostly significant risk premiums and explained more than half of the momentum profits.

Liu and Zhang (2008) employ a similar framework as Griffin, Ji and Martin (2005), but added the extending window and full- sample regression in the first-stage estimation along with rolling-window regression. This testing framework clearly improved the results producing findings quite different from Griffin, Ji and Martin (2005). Moreover, since their research provided direct evidence of risk that drives momentum profits, it stands in contrast with the conclusion provided by Jegadeesh and Titman (1993).

Liew and Vassalou (2000) investigated the forecasting ability of SMB, HML and WML and tested whether profitability of those factors can be linked to future GDP growth. As a point of departure, they take the hypothesis of Fama and French (1992, 1993, 1995, and 1996) that SMB, HML and WML act as state variables in the context of CAPM. Their analysis reveals that returns of SMB and HML contain significant information about future GDP and that information is independent from the information contained in the market factor. Even in the presence of other business cycle variables (Treasury bill, Dividend yield, Term premium, and growth in industrial production) SMB and HML were found to perform well. WML however did not appear to have similar properties. The predictability was to some extent found to be country-specific. Liew and Vassalou (2000) accordingly suggested that a risk-based explanation of SMB and HML returns is likely however, not identifying or proposing what the relevant risk sources could be.

Næs, Skjeltrop and Ødegaard (2009) have done an extensive analysis of the Oslo Stock Exchange (OSE) in period 1980-2006. An important goal of their work has been to see whether asset pricing results from the Norwegian stock market are similar to the ones from the other countries. They find significant evidence of size effect, BM effect and momentum effect, though very weak signs of the latter.

The equity pricing theory is indicative of the fact that stock price is the present value of all cash flows a company generates. Based on that, an important part of their analysis was to understand which of the two channels; cash flows or the risk premium, causes the stock prices at OSE to change. Similar to Chen, Roll and Ross (1986), they look for risk factors among macroeconomic variables and argue that these can affect many companies' cash flows at the same time, while also affecting market risk premium and risk-free rates. Since those factors were found to exhibit only weak evidence of being priced in the Norwegian market, they concluded that cash flows could be the most reasonable channel for this affect.

Similar results are found when oil prices were investigated. In the first place, oil prices were found to have significant effect on returns in many industry sectors; however they did not find any support for a hypothesis that oil prices are systematic risk factors in the Norwegian market, thus concluding that company's cash flow might be the relevant channel for this effect. Ødegaard *et al.* (2009) also tested the FF-factors and CAPM for the Norwegian market. Their results reveal that market index is not priced whereas SMB and HML are found to be priced with these portfolio sorts.

Bjørnland (2009) analyzed the effects of oil price shocks on stock returns in the Norwegian Stock Exchange. The paper also examined the role of oil prices and its impact on the macroeconomic behavior in an oil exporting country, i.e. Norway. The results of her analysis showed that following a 10% increase in oil prices, stock returns increase by 2,5%. In addition, higher oil prices decreased unemployment rate and increased the inflation leading to an increase in the interest rates in a response to increased economic activity.

Her study offers quite a different way of looking at the stock return variations providing indications of variables that are affected by oil prices and that serve as the intermediate channels for effect on returns. These also suggests that there might be other macroeconomic variables that respond to oil price changes and are important for stock returns but that have not yet been identified. Bjørnland (2009) however does not provide a direct link between the macroeconomic changes and the stock returns as a result of oil price changes.

3. Data and methodology

3.1 Data

All the relevant data was obtained from the website of Bernt Arne Ødegaard and the software program DataStream. The analysis will be conducted on a sample period of 16 years (1993-2008). Returns series of the Norwegian stock market were downloaded, grouped in 30 portfolios; 10 portfolios sorted on size, 10 on Book-to-market ratio and 10 on momentum. Size portfolio 1 is the portfolio with the smallest market cap while size 10 is with highest market cap. Book-to-market portfolio 1 has the lowest book-to-market ratio. Momentum portfolio 1 contains firms that are short-term past looser and portfolio 10 contains short-term past winner firms.

All portfolios are one-way sorted and compositions are re-balanced at the end of the year. Calculations use the stocks satisfying the "filter" criteria due to Fama and French (1992). Within each portfolio, returns are calculated as the equally weighted averages of the included stocks. In addition, returns on the equally weighted market index (Oslo stock exchange) were also downloaded.

The following macroeconomic data were gathered: consumption index, return on one month government bill (NIBOR), return on ten 10-year government bond, industrial production index and oil prices. Using DataStream ensures the use of reliable financial information in my research.

Having obtained the relevant macroeconomic data, I will then construct time series of unanticipated movements, as given in the multifactor model of Chen, Roll and Ross (1986). The following series will be derived:

Monthly growth in industrial production: $MP(t) = \log [IP(t)/IP(t-1)]$

Unexpected inflation: $UI(t) = I(t) - E[I(t)|t-1]$

Changes in expected inflation: $DEI(t) = E[I(t)|t+1] - E[I(t)|t-1]$

Term structure: $UTS = LGB(t) - TB(t-1)$

Growth rate in oil prices: $OIL = \log [OIL(t)/OIL(t-1)]$

The series of expected inflation *E [I(t)]* is obtained from Fama and Gibbons (1984). Chen, Roll and Ross (1986) used risk premium on corporate bonds to measure the degree of risk aversion. However, I will not be able to use this variable in my analysis due to the fact that in Norway long time- series of credit spreads are not available. "Because of smoothing and averaging effect", Chen, Roll and Ross (1986) point out that most macroeconomic series, in short holding periods as one month, cannot be expected to capture all information available to the market. Stock prices on the other hand do have this property i.e. they respond quickly to public information. Due to this, I will include the equally weighted market index in my analysis.

Fama and French factors; SMB, HML and WML, were downloaded from the website of Bernt Arne Ødegaard. Factors portfolios were calculated using the Norwegian data.

3.2 Methodology

The goal of my analysis was primarily to find whether macroeconomic risk could explain the cross section of returns. In order to do that, an APT model by Ross (1976) was used. Methodology developed by Fama and Macbeth (1973) was employed in a two-stage framework following Chen *et.al* (1986) and Shanken and Weisntain (2006).

Monthly returns on the 30 portfolios were regressed on the series constructed from macroeconomic variables and the market index. The factor model of equation (1), which will be referred as the macro model or the CRR (due to Chen, Roll and Ross, 1986) model, was estimated from which we obtained portfolios' exposures to the state variables. The individual beta estimates will then be tested for significance to find whether they could explain time-series variation of the average stock-returns.

(1) $R_{it} = a_i + b_{iEW} EW_t + b_{iMP} MP_t + b_{iUI} UI_t + b_{iDEI} DEI_t + b_{iUTS} UTS_t + b_{iOIL} OIL_t + \epsilon_{it}$

R_{it} = return on portfolio i

b_{iEW} = portfolio i's exposure to the equally weighted market index

b_{iMP} = portfolio i's exposure to growth rate of industrial production

b_{iUI} = portfolio i's exposure to unexpected inflation

b_{iDEI} = portfolio i's exposure to change in expected inflation

b_{iUTS} = portfolio i's exposure to term premium

b_{iOIL} = portfolio i's exposure to change in oil price

ϵ_{it} = error term

For the entire period there were 192 observations. I have only considered the full period regressions in the first stage estimation because of constant factor loadings and the fact that I have a relatively small sample period. Chen, Roll and Ross (1986) used previous five years to estimate the betas. Shanken and Weinstein (2006) however disagree with this practice and argue that it gives biased assessment of the true risk beyond the ranking date of portfolios because the risk characteristics are not constant.

The risk premiums were estimated from the cross-sectional regression with factor betas being the independent variable. In addition to the Fama and Macbeth (1973) method in which we obtain monthly risk premiums (equation 2), I have employed another approach in which the average returns on portfolios are regressed on the factor loadings so as to obtain the average risk premium on the factors (equation 3).

$$(2)\ \overline{r_t} = \gamma_{0t} + \hat{b}_{i\,mp}\,\gamma_{MPt} + \hat{b}_{i\,EW}\,\gamma_{EWt} + \hat{b}_{i\,OIL}\,\gamma_{OILt} + \hat{b}_{i\,UTS}\,\gamma_{UTSt} + \hat{b}_{i\,UI}\,\gamma_{UIt} + \hat{b}_{i\,DEI}\,\gamma_{DEIt}$$

$\overline{r_t}$ = Return of thirty portfolios in period t

$\hat{b}_i$ = The estimated coefficient from first stage regression on portfolio i

γ_t= The estimated risk premium in period i

$$(3)\ \overline{r_i} = \gamma_0 + \hat{b}_{i\,mp}\,\gamma_{MP} + \hat{b}_{i\,EW}\,\gamma_{EW} + \hat{b}_{i\,OIL}\,\gamma_{OIL} + \hat{b}_{i\,UTS}\,\gamma_{UTS} + \hat{b}_{i\,UI}\,\gamma_{UI} + \hat{b}_{i\,DEI}\,\gamma_{DEI}$$

$\overline{r_i}$ = Average returns of thirty portfolios

$\hat{b}_i$ = The estimated coefficient from first stage regression on portfolio i

γ = The average estimated risk premium

Equation (2) was run for the entire sample period from which I got a series of risk premiums. The mean values of the monthly risk premiums and their p-values were same as coefficients and p-values obtained from the average regressions of equation (3). For this reason, it is sufficient to use the average estimates from equation (3) for further analysis. A hypothesis test was performed to evaluate the statistical significance of risk premiums.

Fama and French (1992, 1993, 1996) argued that SMB and HML are state variables that are related to the fundamental risks in the economy. Based on this argument as well as following Liu and Zhang (2008), I hope to find a significant relationship between macro factors from Chen, Roll and Ross (1986), including oil prices, and portfolio returns sorted on size, book-to-market ratio and momentum. Further, consistent with the risk-based explanations in several previous studies, I hope to find evidence of significant risk premiums on these macro factors.

Further to in order to assess the performance of the Fama-French three factor model and CAPM (Capital Asset Pricing Model), the analysis was repeated for the full sample period (1993-2008). In their model Fama and French (1992, 1993, 1996) used SMB, HML and the market factor to capture the cross-section of average returns. I have added the WML factor (winner minus looser) into the three factor model because there may be risk associated with WML in the portfolios which SMB, HML and the market factor may not be able to capture. Thus I tested FF-4 model and the CAPM which could be considered as just a version of the APT model.

In the first stage the following regressions were run:

FF-4:

$$R_{it} = a_i + b_{iEW} EW_t + b_{iSMB}\, SMB_t + b_{iHML}\, HML_t + b_{iWML}\, WML_t + \epsilon_{it}$$

b_{iEW} = portfolio i's exposure to the equally weighted market index

b_{iSMB} = portfolio i's exposure to the SMB factor

b_{iHML} = portfolio i's exposure to the HML factor

b_{iWML} = portfolio i's exposure to the WML factor

ϵ_{it} = error term

CAPM:

$$R_{it} = a_i + b_{iEW} EW_t + \epsilon_{it}$$

In the second stage average risk premiums were estimated by the following regressions:

FF- 4:

$$\overline{r_i} = \gamma_0 + \hat{b}_{i\,EW}\, \gamma_{EW} + \hat{b}_{i\,SMB}\, \gamma_{SMB} + \hat{b}_{i\,HML}\, \gamma_{HML} + \hat{b}_{i\,WML}\, \gamma_{WML}$$

CAPM:

$$\overline{r_i} = \gamma_0 + \hat{b}_{i\,EW}\, \gamma_{EW}$$

where

$\overline{r_i}$ = Average returns of thirty portfolios

$\hat{b}_i$ = The estimated coefficient from first stage regression on portfolio i

γ = Average estimated risk premium

The intercept computed in the cross sectional regressions must not be confused with the risk premiums of a risk free portfolio or pricing errors of the respective models for any given portfolio. Instead it is to be interpreted as the expected value of risk free-assets because the dependent variables are the total portfolio returns and not the excess returns.

The analysis above provides the necessary information to determine whether macroeconomic model or the alternative models can better explain size effect, BM effect and momentum. The average expected return on portfolio i is the product of the estimated portfolio beta and the estimated average risk premium which was compared and tested against the average observed return on portfolio i.

There is an important distinction between a one factor model like CAPM and a multifactor pricing model such as is as the FF-4 or the Macro model. CAPM describes the expected return as a function of the market risk only and which has to be systematic in nature. For the multifactor models on the other hand, the expected return is the sum of relative contributions each factor makes according to its risk.

Macro model:

$$E(r_i) = \gamma_0 + \hat{b}_{i\,MP}\,\hat{\gamma}_{MP} + \hat{b}_{i\,EW}\,\hat{\gamma}_{EW} + \hat{b}_{i\,OIL}\,\hat{\gamma}_{OIL} + \hat{b}_{i\,UTS}\,\hat{\gamma}_{Uts} + \hat{b}_{i\,UI}\,\hat{\gamma}_{UI} + \hat{b}_{i\,DEI}\,\hat{\gamma}_{DEI}$$

FF-4:

$$E(r_i) = \gamma_0 + \hat{b}_{i\,EW}\,\hat{\gamma}_{EW} + \hat{b}_{i\,SMB}\,\hat{\gamma}_{SMB} + \hat{b}_{i\,HML}\,\hat{\gamma}_{HML} + \hat{b}_{i\,WML}$$

CAPM:

$$E(r_i) = \gamma_0 + \hat{b}_{i\,EW}\,\hat{\gamma}_{EW}$$

The following set of hypothesis was tested for all three models:

H_0: $E(r_i)$= observed r_i

$H_{alternative}$: $E(r_i) \neq$ observed r_i

The null hypothesis was that the difference between the expected and observed return is zero in which case the respective models would be able to explain the returns of portfolios sorted on anomalies.

4. Results

4.1 Macroeconomic model

Table 1 displays correlations among the macro variables. We know that strong correlations may mitigate the individual abilities of respective factors to explain the portfolio returns. Most of the correlations are not very strong except a) between the two inflation variables DEI and UI because they include series of expected inflation; and b) between UTS and UI, probably because both series contain the short term t-bill returns. The high collinearity is likely to dampen the individual effects of these variables. The industrial production is negatively correlated with UI. Further we find weak correlations between oil price changes and other factors. The negative correlation between UI and DEI suggests an inverse relationship between current-period inflation and the expected inflation for next period.

Table 1

Correlations among the variables

			1993-2008			
	EW	MP	OIL	UI	DEI	UTS
EW	1					
MP	0.0356	1				
OIL	0.0872	0.0812	1			
UI	0.1685	-0.1121	-0.0398	1		
DEI	-0.0018	0.1444	0.0373	-0.6710	1	
UTS	0.0110	0.0715	0.0708	-0.5816	0.3869	1

A further investigation on correlations was done to explore which macro variable (excluding market return for now) has the highest correlations across portfolios. The correlation results between factors from our multifactor model and the thirty portfolios are reported in table 1 in the appendix. The interesting finding is that for the entire sample period, seven-eight out of ten portfolios of each sort have the highest correlation with UI which may allow for the possibility of unexpected inflation to explain returns of these portfolios. We will later in the analysis see the time-series properties of the factors.

All portfolios exhibit high positive correlations with the market as one would expect. Specifically, we observe that firms with low BM ratio have the highest correlation with the market returns and firms with high BM ratio have lowest correlation. The correlation difference between lowest and highest momentum portfolio is however negligible. Small size firms on the other hand seem to exhibit lowest correlation with the market in the full sample period. This suggest that the market risk does not play an important role concerning the higher perceived risk of small size and large BM firms and therefore it should not be important for pricing. These findings may corroborate the interpretation of empirical results.

A multifactor model from equation (1) was estimated and the resulting beta exposures and the corresponding p-values are reported in table 2. The bold numbers in the table are the estimated coefficients. Most of the loadings for the overall period are positive and relatively stable exposure to market risk, as one would expect; several portfolios exhibiting highest exposures relative to other factor in the regression. Across the ten portfolios for each effect, loadings don't exhibit a monotonic pattern and mostly vary randomly. However, the interesting findings are that highest BM firms have UI and DEI- betas above 1. Small size firms have highest betas on UI only, while high momentum firms show high sensitivity to UTS factor. Below we will test whether these loadings are significant.

One would expect higher sensitivities of portfolios that yield relatively higher return (BM10, MM10 and Size1), to the macro factors. This is confirmed by findings from first stage estimations that show higher loadings on market, OIL and both inflation variables (UI and DEI) while only MM10 and Size1 has higher exposures to UTS. The Wald test was conducted in order to test whether the betas on extreme portfolios were significantly different. The resulting p-values are reported in table 2. Most of the time-series variations in portfolios returns are explained by the market factor; however we note that the firms having higher returns are highly exposed to rather other type of risks, mainly risk coming from UI, DEI and UTS. Loadings of unexpected inflation, market index and changes in expected inflation on extreme portfolios sorted by BM and size are significantly different (p-value from Wald $< 5\%$), while MM10 has a significantly higher exposure than MM1 to only the UTS and UI factors.

Table 2

Factor loadings on size, book-to-market and momentum portfolios

Period: 1993-2008

	BM1	BM2	BM3	BM4	BM5	BM6	BM7	BM8	BM9	BM10	P_{wald}
MP	0.089	0.137	0.059	-0.010	-0.028	0.073	0.123	0.026	0.017	-0.087	
P-value	0.547	0.316	0.560	0.926	0.782	0.524	0.239	0.814	0.891	0.468	0.233
EW	0.902	0.911	0.742	0.656	0.685	0.678	0.643	0.661	0.616	0.506	
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OIL	-0.027	0.014	0.017	0.048	0.027	-0.010	0.042	0.030	0.029	0.022	
P-value	0.488	0.696	0.525	0.090	0.319	0.751	0.129	0.303	0.383	0.491	0.210
UTS	0.397	0.452	0.133	0.357	0.514	0.404	0.220	0.195	0.198	0.322	
P-value	0.164	0.087	0.498	0.078	0.008	0.068	0.274	0.357	0.413	0.166	0.792
UI	-0.046	0.246	0.224	0.467	0.379	0.365	0.535	0.048	0.883	1.897	
P-value	0.900	0.463	0.370	0.069	0.123	0.193	0.037	0.858	0.004	0.000	0.000
DEI	-0.264	0.007	0.078	0.217	0.213	-0.079	0.360	-0.206	0.484	1.019	
P-value	0.259	0.974	0.629	0.189	0.177	0.662	0.029	0.236	0.015	0.000	0.000
P_{F-stat}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
R^2	47 %	53 %	57 %	52 %	56 %	48 %	52 %	48 %	42 %	46 %	

	MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8	MM9	MM10	P_{wald}
MP	0.091	0.131	0.069	-0.016	0.104	0.036	0.012	-0.029	0.099	-0.069	
P-value	0.473	0.461	0.534	0.866	0.293	0.683	0.899	0.757	0.287	0.604	0.206
EW	0.831	0.883	0.646	0.594	0.633	0.603	0.592	0.592	0.733	0.862	
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.610
OIL	-0.038	-0.006	0.026	0.006	0.048	0.016	0.038	0.008	0.014	0.022	
P-value	0.266	0.906	0.378	0.820	0.069	0.479	0.116	0.759	0.568	0.543	0.080
UTS	0.044	0.273	0.122	0.119	-0.028	0.127	0.450	0.381	0.497	0.985	
P-value	0.858	0.424	0.571	0.509	0.881	0.450	0.011	0.038	0.006	0.000	0.000
UI	0.183	1.488	0.724	0.331	0.621	0.489	0.792	-0.073	0.595	0.879	
P-value	0.554	0.001	0.008	0.150	0.011	0.041	0.001	0.753	0.010	0.008	0.025
DEI	0.010	0.401	0.210	0.425	0.329	0.344	0.096	-0.130	0.097	0.176	
P-value	0.962	0.153	0.231	0.004	0.036	0.013	0.502	0.386	0.509	0.405	0.405
P_{F-stat}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
R^2	51 %	44 %	49 %	52 %	54 %	56 %	56 %	49 %	63 %	54 %	

	SIZE1	SIZE2	SIZE3	SIZE4	SIZE5	SIZE6	SIZE7	SIZE8	SIZE9	SIZE10	P_{wald}
MP	-0.106	0.250	0.112	0.058	0.011	-0.020	0.012	0.056	0.067	0.008	
P-value	0.357	0.023	0.258	0.577	0.923	0.827	0.910	0.595	0.557	0.963	0.323
EW	0.354	0.602	0.671	0.657	0.749	0.720	0.708	0.770	0.925	0.819	
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OIL	0.005	0.001	0.054	0.058	0.018	0.030	0.013	0.036	-0.064	-0.008	
P-value	0.879	0.979	0.043	0.038	0.550	0.219	0.647	0.207	0.036	0.852	0.671
UTS	0.551	0.198	0.086	0.237	0.090	0.453	0.296	0.231	0.406	0.424	
P-value	0.013	0.347	0.651	0.240	0.674	0.011	0.143	0.259	0.065	0.188	0.564
UI	0.961	1.464	0.625	1.435	0.526	0.744	0.110	0.003	-0.047	-0.351	
P-value	0.001	0.000	0.010	0.000	0.055	0.001	0.669	0.992	0.867	0.390	0.000
DEI	0.090	0.855	0.285	0.483	0.275	0.495	-0.199	-0.069	-0.154	-0.363	
P-value	0.620	0.000	0.068	0.004	0.118	0.001	0.228	0.680	0.390	0.169	0.013
P_{F-stat}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
R^2	27 %	53 %	57 %	58 %	54 %	63 %	53 %	56 %	61 %	36 %	

It can be noticed that short-term past winners/ high BM/small size firms yield returns that are inversely related to MP, in other word, these firms will have a worsened effect on the profitability as the growth in industrial production will increase. Chan, Chen and Hsieh (1985) however showed that small sized firms were more exposed to production risk and changes in risk premiums, the latter is somewhat supported by our results.

Over the entire sample period only coefficients on the market index are statistically significant at 5 % level for all 30 portfolios (see table 2). All MP loadings are insignificant (except for size2). We would expect a positive and significant effect of oil price changes on portfolio returns because Norway is an oil-producing country and many of the largest companies at OSE are related to oil. The oil price growth tends to increase the cash flows of oil-producing firms which in turn increase their stock prices. However, this seems not to be the case; despite of positive loadings, OIL is significant for only size portfolios 3, 4 and 9 at 5% level. Ødegaard *et al.* (2009) find that oil price changes have significant effect on several industry sectors so we could assume that our size portfolios contain firms in those industry sectors.

UI has significant exposures for seven MM portfolios and six size portfolios (size 6 significant at 10% level). In addition, relatively high BM firms, particularly BM portfolio 7, 9 and 10 have significant risk to UI and DEI. Previously, we reported UI to be highly correlated with all thirty portfolios. Results from the first stage regression however show that UI is especially important for the momentum portfolios. DEI shows some explanatory power probably because it was found to be highly correlated with the UI variable.

The adjusted R-squared mostly seem to be reasonable (adjusted R > 50%). However, we note very low R-squared for the extreme size-sorted portfolios (29% for size1 and 38% for size 10) implying that the macro model may not be able to account for a very large degree of time-series variations in returns of these two portfolios. From the F-test we can conclude that the hypothesis that coefficients on all five factors are jointly zero is rejected at 5% level (p-values = 0) for each of the thirty regressions indicating that jointly the chosen variables do have explanatory power. However, the low individual statistical power of most of the factors can be due to the fact that macroeconomic variables used in my analysis are noisy proxies.

Following the statement of the rational pricing one could say that the higher returns on these portfolios are a result of higher risk that they are facing relative to the low returns portfolios. However, one should keep in mind that if the risk is a systematic risk, ie. if it offers risk premium, only then the argument might be applicable, thus we cannot conclude on the bases of the betas because it captures only the time-series variation in returns. Therefore, we estimated the risk premiums on the macro factors using Fama and Macbeth (1973) cross-sectional regressions to examine whether risk factors important in the long-run are systematic in nature. The goal is to investigate whether the macroeconomic risk is priced in the Norwegian market. I have estimated the risk premiums using both the monthly returns on 30 portfolios and the average returns on 30 portfolios which were then regressed on the estimated factor betas.

Table 3

Average risk premiums for macroeconomic factors and the corresponding p-values

	C	MP	OIL	EW	UTS	UI	DEI	R^2	$P_{F\text{-stat}}$
Estimate	0.013	0.002	-0.019	0.002	-0.192	0.916	-0.701	40 %	
P-value	0.006	0.881	0.451	0.773	0.572	0.000	0.001		0.005

Results from cross-sectional estimation are reported in table 3 along with their corresponding p-values. 40% (adjusted R-squared) of the cross- sectional variations in returns are accounted for by the macro factors. The F-test reveals that jointly, macro factors do have significant explanatory power. The point estimate of the intercept is significantly positive (0.013) and is considerably below the actual average NIBOR rate in the period 1993-2008. In addition, risk compensations offered in absolute values by UI and DEI are quite high (0,92% and -0,70% respectively). We find that only risk premiums on unexpected inflation and changes in expected are significantly different from zero at 5% level and all other macro factors are unable to exhibit significant pricing evidence. In contrast to Chen et al.(1986) and Liu and Zhang (2008), MP does not appear to be important in the Norwegian market , neither for explaining time-series returns nor pricing of MP risk.

Consistent with Chen, Roll and Ross (1986), we find negative risk premium for DEI in Norway. This implies that firms with higher risk exposure to DEI will experience higher returns when expected inflation increases leading to lower prices. Investors would prefer stocks that are positively related to expected inflation so they would be willing to accept lower returns given that they are hedged, hence negative risk premium, implying a higher expected return. UI on the other hand offers a positive risk premium since investors require higher compensation when investing in firms that are positively related to the inflation risk, hence positive risk premium. The negative correlation between current inflation and expected seem to be responsible for the opposite signs of risk premiums. Having observed the high inflation at the end of a period, the investor will expect a lower inflation the next period and thus will want to invest in stocks with negative exposure to hedge against the downside risk.

A possible explanation for the negative UTS premium as suggested by Chen, Roll and Ross (1986) is that stocks whose returns are inversely related to increases in long rates over short rates are more valuable. Similarly, the fact that risk premium on OIL is negative, insignificant though, may indicate that firms that do better when the oil price changes are high, will have relatively lower expected return than firms with negative oil exposure. Findings are in line with Chen *et al.* (1986) and Ødegaard *et al.* (2009) who show that oil price risk is not systematic risk.

Bjørnland (2009) finds that oil price shock of 10% immediately increases stock returns by 2,5%, and returns gradually increases until 14-15 months after oil shock from where it gradually dies out. Inflation is also positively affected by the oil price shock; gradual increase until month 20 after the shock from where it gradually falls. This may explain lack of explanatory power of OIL as shown above; either the effect of oil price is subsumed by the market index (proxied by all share index at Oslo Stock Exchange) and inflation or the oil factor is linked to stock returns in such a way that the estimation method that I have used (OLS) is not sufficient to capture the long run effect of oil on returns.

Further, the market index showed significant ability to capture time-series variations of portfolio returns. However, it lacks evidence of being a systematic risk factor which, as suggested by Chen *et al.*, could mean that the explanatory power of the market index may not be subject to economic interpretation, rather it may deal with the statistical aspect.

Moreover, we assess the economic significance of macroeconomic variables in explaining the firm size effect, B/M effect and momentum effect. For this purpose, magnitudes associated with each variable were calculated as a product of the estimated risk premiums and factor loadings. The predicted returns implied by the model from equation 4 were tested against the observed returns on each portfolio.

$$(4)\ E(r_i) = \gamma_0 + \hat{b}_{i\,MP}\,\hat{\gamma}_{MP} + \hat{b}_{i\,EW}\,\hat{\gamma}_{EW} + \hat{b}_{i\,OIL}\,\hat{\gamma}_{OIL} + \hat{b}_{i\,UTS}\,\hat{\gamma}_{Uts} + \hat{b}_{i\,UI}\,\hat{\gamma}_{UI} + \hat{b}_{i\,DEI}\,\hat{\gamma}_{DEI}$$

Table 4 reports the calculated expected profits, unexplained return as a percentage of observed portfolio returns and p-values from the test of difference between expected returns and observed returns. The negative unexplained percentage just means that the model predicted higher returns than what was observed, but it is more relevant to look at the absolute values. There exists no specific pattern; nonetheless, we can note that almost 99% of the observed returns on low BM firms are explained by macroeconomic risk, also reflected in the high p-value. The second largest size portfolio, on the other hand, seems to attribute more than half of the observed returns (58%) to factors not present in the model. Results from the hypothesis tests conclude that differences between observed and expected returns are all insignificant so that the macroeconomic risk, modeled by APT, will have ability to explain the anomalies, the main source being the systematic risk from unexpected inflation which accounts for most of the predicted returns mainly due to the higher compensation it offers to take on the risk.

Table 4

Average expected portfolio returns vs. observed returns

	1993-2008			
	Observed return	$E(r_p)$	Unexplained return as % of the actual return	*P-value*
BM1	0.0162	0.0164	-1.1 %	0.977
BM2	0.0151	0.0164	-8.2 %	0.832
BM3	0.0134	0.0158	-17.6 %	0.605
BM4	0.0142	0.0157	-11.0 %	0.724
BM5	0.0174	0.0151	13.3 %	0.600
BM6	0.0188	0.0181	3.7 %	0.882
BM7	0.0201	0.0159	20.8 %	0.343
BM8	0.0192	0.0156	18.9 %	0.416
BM9	0.0198	0.0183	7.4 %	0.760
BM10	0.0203	0.0234	-15.3 %	0.517
MM1	0.0225	0.0173	22.9 %	0.335
MM2	0.0285	0.0256	9.9 %	0.684
MM3	0.0174	0.0191	-9.6 %	0.713
MM4	0.0116	0.0142	-22.5 %	0.511
MM5	0.0145	0.0172	-18.5 %	0.530
MM6	0.0141	0.0156	-10.6 %	0.998
MM7	0.0157	0.0195	-24.4 %	0.345
MM8	0.0150	0.0138	8.2 %	0.752
MM9	0.0148	0.0184	-24.9 %	0.413
MM10	0.0228	0.0194	14.9 %	0.561
SIZE1	0.0236	0.0209	11.3 %	0.496
SIZE2	0.0234	0.0219	6.4 %	0.748
SIZE3	0.0174	0.0173	0.6 %	0.982
SIZE4	0.0196	0.0229	-17.0 %	0.485
SIZE5	0.0219	0.0172	21.5 %	0.333
SIZE6	0.0160	0.0166	-3.5 %	0.901
SIZE7	0.0160	0.0163	-1.7 %	0.951
SIZE8	0.0154	0.0143	7.3 %	0.812
SIZE9	0.0104	0.0163	-56.8 %	0.274
SIZE10	0.0117	0.0136	-16.5 %	0.753

4.2 CAPM and Fama-French 4-Factor model

In this section, findings from the Fama-French model and the CAPM will be presented. Fama and French (1993, 1992 and 1996) have shown that their three-factor model is better able to explain the size and BM anomaly than the APT model by Chen, Roll and Ross (1986). After having tested the macro model, it is appropriate to investigate the FF-4 model and the CAPM, using the same set of testing portfolios, in order to explore the merits of these two models and their cross-sectional pricing characteristics relative to CRR.

Firstly, table 5 exhibits the correlations between returns on the SMB, HML and WML factors and portfolio returns. We can observe that HML has negative correlations with both SMB and WML, and returns on all three factors are negatively correlated with the market returns. Correlations are not high though, thus multicollinearity should not to be a problem. Table 1 in the appendix shows correlation of FF factor with the thirty portfolios. WML is negatively correlated with almost all portfolios whereas the highest BM and lowest size portfolio have positive and relatively high correlations to both, the HML and SMB factors (see appendix, table 1). Correlations with macro factors are not high either.

Table 5

Correlations among FF-factors and macro factors

	EW	DEI	UI	MP	OIL	UTS	SMB	HML	WML
SMB	-0,106	0,140	0,106	0,019	0,051	-0,103	1		
HML	-0,060	0,003	0,105	-0,043	0,025	-0,093	-0,129	1	
WML	-0,162	-0,019	-0,100	-0,009	0,107	0,134	0,031	-0,021	1

In the first stage regression, exposures for both models were obtained on the respective factors. These are reported in table 6 along with their p-values and adjusted R-squared estimates. As expected, returns of firms sorted on size, BM and momentum are in particular significantly explained by the factors constructed from their related firm characteristics. SMB and HML significantly explain almost all of the size and BM portfolios, respectively.

Surprisingly, we note that HML indeed has equal importance in explaining momentum returns as for BM returns because it explains more of the momentum-related returns than what WML does, a factor which is mainly included to capture the momentum effect. However, winner and looser firms are found to be exposed to same level of HML risk (inverse relationship) suggesting that HML should not be important for explaining the dispersion in momentum returns hence leading us back to the same conclusion as provided in previous studies, Fama and French (1992, 1993, 195, 1996), that the three factor model consisting of SMB, HML and market cannot explain the cross-section of momentum, emphasizing the need of including a momentum factor WML.

The spread of the beta estimates between extreme portfolios is very large and loadings mostly change signs moving from first to the tenth deciles. SMB loads positively on small firms and negatively on large firms, indicating significantly higher risk associated with small firms relative to large (p-value from Wald=0). Chan and Chen (1991) argue that having firms of small size do not automatically imply higher risk, rather the underlying characteristics may explain the risk. HML and EW- exposures on small firms are also positive (0,298 and 0,426 respectively) and significantly different from exposure on size 10 (p-value from Wald test=0).

Further, we note that high BM firms are significantly exposed to higher risk (p-value from Wald test=0) from HML than low BM firms. This seems in line with Fama and French (1992), who relate earning/profitability to the B/M ratio and show that HML proxy for distress risk. So, the negative slopes of firms on HML can be explained by higher profitability of firms with low BM ratio such that they are less prone to distress risk.

Researchers believe that FF- factors are related to firm-characteristics which capture sensitivity to risk factor in the macro economy and therefore it is reasonable to emphasize a risk-related link between macro factors and FF-factors. The macro model analyzed above seems to support this as it was found that high BM firms were significantly more exposed to UI and DEI. This can be supported by Liew and Vassalou (2000) who show that HML and SMB contain information that is similar in nature to the widely used business cycle variables and that some overlap exists in that information content. So we could hypothesize that the HML and SMB factor represents risk from inflation as well as changes in interest rates.

Table 6

Factor loadings on size, book-to-market and momentum portfolios

Panel A: Factor loadings from CAPM

	BM1	BM2	BM3	BM4	BM5	BM6	BM7	BM8	BM9	BM10	P-Wald
EW	0.899	0.929	0.757	0.688	0.709	0.697	0.679	0.669	0.666	0.603	0.000
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
$P_{F\text{-stat}}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
R^2	48 %	54 %	59 %	52 %	55 %	48 %	51 %	48 %	41 %	34 %	

	MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8	MM9	MM10	P-Wald
EW	0.836	0.960	0.687	0.611	0.672	0.629	0.639	0.590	0.768	0.911	0.193
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
$P_{F\text{-stat}}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
R^2	53 %	41 %	48 %	51 %	53 %	56 %	54 %	49 %	62 %	53 %	

	SIZE1	SIZE2	SIZE3	SIZE4	SIZE5	SIZE6	SIZE7	SIZE8	SIZE9	SIZE10	P-Wald
EW	0.403	0.680	0.713	0.739	0.778	0.762	0.717	0.777	0.916	0.802	0.00
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
$P_{F\text{-stat}}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
R^2	23 %	45 %	56 %	52 %	55 %	62 %	54 %	58 %	62 %	37 %	

Panel B: Factor loadings from FF-4 model

	BM1	BM2	BM3	BM4	BM5	BM6	BM7	BM8	BM9	BM10	P-Wald
EW	0.859	0.914	0.733	0.687	0.693	0.674	0.673	0.663	0.695	0.635	0.000
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
SMB	-0.073	0.069	-0.184	-0.126	-0.079	-0.185	-0.098	-0.129	0.149	0.313	0.000
P-value	0.380	0.420	0.007	0.081	0.253	0.017	0.155	0.067	0.053	0.000	
HML	-0.681	-0.425	-0.114	0.062	-0.056	0.055	0.237	0.273	0.481	0.587	0.000
P-value	0.000	0.000	0.049	0.311	0.341	0.398	0.000	0.000	0.000	0.000	
WML	-0.014	-0.002	-0.042	0.042	-0.064	-0.103	-0.086	-0.079	-0.036	-0.151	0.067
P-value	0.850	0.977	0.498	0.512	0.311	0.137	0.169	0.214	0.608	0.024	
$P_{F\text{-stat}}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
R^2	66 %	61 %	61 %	53 %	56 %	51 %	56 %	55 %	55 %	58 %	

	MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8	MM9	MM10	P-Wald
EW	0.808	0.945	0.660	0.604	0.683	0.619	0.654	0.580	0.767	0.926	0.039
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
SMB	0.057	0.283	0.024	-0.011	0.070	-0.058	-0.036	-0.269	-0.150	-0.073	0.115
P-value	0.487	0.018	0.748	0.860	0.305	0.323	0.572	0.000	0.019	0.414	
HML	-0.244	0.220	0.101	0.170	0.171	0.108	0.130	0.091	-0.070	-0.252	0.910
P-value	0.001	0.030	0.107	0.002	0.003	0.032	0.016	0.083	0.193	0.001	
WML	-0.166	-0.370	-0.276	-0.115	-0.025	-0.083	0.089	0.041	0.105	0.263	0.000
P-value	0.027	0.001	0.000	0.045	0.688	0.119	0.122	0.463	0.067	0.001	
$P_{F\text{-stat}}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
R^2	57 %	47 %	54 %	55 %	55 %	58 %	56 %	55 %	64 %	58 %	

	SIZE1	SIZE2	SIZE3	SIZE4	SIZE5	SIZE6	SIZE7	SIZE8	SIZE9	SIZE10	P-Wald
EW	0.426	0.720	0.728	0.738	0.785	0.783	0.704	0.747	0.857	0.718	0.000
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
SMB	0.207	0.455	0.272	0.229	0.129	0.050	-0.203	-0.253	-0.415	-0.795	0.000
P-value	0.007	0.000	0.000	0.003	0.091	0.442	0.004	0.000	0.000	0.000	
HML	0.298	0.193	-0.022	0.009	-0.032	0.056	0.069	-0.009	-0.104	-0.126	0.000
P-value	0.000	0.003	0.699	0.889	0.614	0.307	0.246	0.873	0.086	0.132	
WML	-0.052	-0.013	-0.027	-0.147	-0.003	0.119	-0.010	-0.094	-0.192	-0.167	0.098
P-value	0.448	0.841	0.651	0.032	0.962	0.043	0.872	0.139	0.003	0.061	
$P_{F\text{-stat}}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
R^2	32 %	55 %	60 %	55 %	56 %	63 %	57 %	61 %	69 %	54 %	

The F-test concludes that jointly all four factors in the FF model do have explanatory power (p-value=0). The risk from market index in CAPM decreases in presence of FF-factors or the macro factors suggesting that these factors take away some of the risk. A noticeable observation is that inclusion of FF-factors or the macro factors into the CAPM does not affect the individual explanatory power of the market. However, R-squared obtained from time-series regressions revealed that inclusion of the FF-factors improves the explanatory power of the model as whole to capture variations in the extreme portfolios' returns when sorted on BM and size hence supporting the result of Fama and French that FF model has superiority over CRR model in explaining BM and size to the extent of capturing time-series variations.

Adding more explanatory variables usually tend to increase the R-squared but this seems not to be quite the case here since market factor alone accounts for a somewhat similar degree of time-series variations in returns as macroeconomic variables and market jointly do. One could estimate the macro model without the market factor. Since we cannot distinguish between the explanatory power of the market and the five macro factors from the results we have, it is unclear whether this is due to CAPM being better to explain the long-run relationships or a statistical error related with the method used fit the model to real data. It also be because the market risk in the long-run could already be comprised of some of the macroeconomic risk such that adding those particular risks does not leave room for more explanatory power or because the macroeconomic variables appear to be noisy proxies, the latter being more intuitive.

Table 7 shows average risk premiums from cross-section regressions that were run on the 30 portfolios. The market portfolio is not a priced risk factor in any of the two models, also consistent with the APT model considered above. Thus it is obvious that adding the FF-4 factors into CAPM does not affect the pricing of the market index. The negative estimate of R-squared from CAPM indicates the inability of the market index to price the 30 portfolios and that there is more in the residuals than what market can explain. This is consistent with findings of Ødegaard et al. (2009) who rejects the CAPM and find no pricing evidence of market index.

The FF-4 model on the other hand exhibits reasonable R-squared (41%) and a significant F-statistic. However, the individual pricing abilities of HML and WML are insignificant whereas SMB do have significant risk premiums. The added risk coming from investing in low-cap firms entail risk that investor would want to require compensation for, hence a positive risk premium so that the expected return will be relatively higher. Fama and French (1992, 1993) point that existence of common risk factors in returns related to size and BM may results in rational pricing. For the Norwegian market, given that SMB appears to be a systematic risk factor explaining cross-sectional differences in returns, one could cautiously suggest evidence of rational pricing.

Table 7

Estimated coefficients of risk premiums for period 1993-2008

FF-4							
	C	EW	SMB	HML	WML	R^2	$P_{F\text{-stat}}$
Estimate	0.0101	0.0103	0.0100	0.0035	-0.0029	49 %	
P-value	*0.0621*	*0.1534*	*0.0009*	*0.3086*	*0.5709*		0.0015
CAPM							
	C	EW				R^2	$P_{F\text{-stat}}$
Estimate	0.0171	0.0007					
P-value	*0.0015*	*0.9181*				-3.5%	0.9181

Table 8 presents returns implied by the CAPM and FF-4, the unexplained returns and the corresponding p-values. A hypothesis that there is no difference between expected and realized return cannot be rejected at 5% level for both models. We see that CAPM generally have high unexplained percentages, specifically the market index is unable to explain up to 70% of observed returns.

The fact that CAPM is not able to price the portfolios implies that the market index is not sufficient to capture the cross sectional differences in the average returns of those portfolios. Since the CAPM assumes only the market index as a common risk factor in stock returns, the lack of pricing evidence clearly dismiss the theoretical and economical validity of this model in accurately explaining variations in observed returns even though it predicts portfolio returns that are statistically equal to the observed returns. The expected returns are solely attributable to the high point estimate of the intercept that reflects the statistical error trying to fit the data to the actual return.

Fama and French factors explain a bit more of the actual returns of high BM firms compared to CRR (see table 4) but explain less than CRR the returns on extreme size portfolios which could be due to the pricing abilities of UI and DEI. However, generally both models; CRR and FF-4, seem to predict returns in somewhat similar fashion implying that they are likely to explain observed returns equally well which should in fact not be surprising as the links between macro variables and FF factors, based on firm characteristics, have been documented in several studies.

Hahn and Lee (2005) suggest term structure as having an effect on HML hence act as a proxy for the interest rate risk. Liew and Vassalou (2000) show link between FF factors and confirm the hypothesis that they act as state variables because they find evidence of that SMB and HML contain information about future state of macro economy. One could therefore ask whether results obtained from the macroeconomic model and from the FF-4 model are just two sides of the coin. These findings suggest that FF-4 and APT are better models than CAPM to provide risk-based explanations, especially stemming from macroeconomic innovations, for anomalies in the Norwegian market.

Table 8

Average expected portfolio returns vs. observed returns

Panel A:

CAPM: 1993-2008				
	Observed return	$E(r_p)$	Unexplained return as % of the actual return	*P-value*
BM1	0.0162	0.0177	-8.88 %	*0.810*
BM2	0.0151	0.0177	-17.05 %	*0.660*
BM3	0.0134	0.0176	-31.04 %	*0.364*
BM4	0.0142	0.0175	-23.53 %	*0.451*
BM5	0.0174	0.0175	-0.80 %	*0.975*
BM6	0.0188	0.0175	6.51 %	*0.792*
BM7	0.0201	0.0175	12.79 %	*0.559*
BM8	0.0192	0.0175	8.76 %	*0.705*
BM9	0.0198	0.0175	11.47 %	*0.638*
BM10	0.0203	0.0175	13.84 %	*0.558*
MM1	0.0225	0.0176	21.52 %	*0.364*
MM2	0.0285	0.0177	37.78 %	*0.121*
MM3	0.0174	0.0175	-0.54 %	*0.983*
MM4	0.0116	0.0175	-51.01 %	*0.136*
MM5	0.0145	0.0175	-20.37 %	*0.489*
MM6	0.0141	0.0175	-23.97 %	*0.383*
MM7	0.0157	0.0175	-11.66 %	*0.651*
MM8	0.0150	0.0175	-16.19 %	*0.532*
MM9	0.0148	0.0176	-19.05 %	*0.532*
MM10	0.0228	0.0177	22.40 %	*0.381*
SIZE1	0.0236	0.0176	26.45 %	*0.113*
SIZE2	0.0234	0.0177	25.24 %	*0.208*
SIZE3	0.0174	0.0175	-0.61 %	*0.981*
SIZE4	0.0196	0.0175	10.20 %	*0.676*
SIZE5	0.0219	0.0175	19.54 %	*0.378*
SIZE6	0.0160	0.0175	-9.71 %	*0.729*
SIZE7	0.0160	0.0175	-9.48 %	*0.736*
SIZE8	0.0154	0.0175	-14.17 %	*0.645*
SIZE9	0.0104	0.0176	-69.88 %	*0.179*
SIZE10	0.0117	0.0177	-50.87 %	*0.332*

Panel B:

FF-4: 1993-2008				
	Observed return	$E(r_p)$	Unexplained return as % of the actual return	*P-value*
BM1	0.0162	0.0159	2.16 %	*0.953*
BM2	0.0151	0.0187	-23.81 %	*0.539*
BM3	0.0134	0.0155	-15.81 %	*0.643*
BM4	0.0142	0.0160	-12.82 %	*0.681*
BM5	0.0174	0.0164	5.61 %	*0.825*
BM6	0.0188	0.0157	16.38 %	*0.508*
BM7	0.0201	0.0171	14.79 %	*0.499*
BM8	0.0192	0.0168	12.39 %	*0.593*
BM9	0.0198	0.0205	-3.76 %	*0.877*
BM10	0.0203	0.0222	-9.69 %	*0.681*
MM1	0.0225	0.0186	17.13 %	*0.470*
MM2	0.0285	0.0245	13.97 %	*0.565*
MM3	0.0174	0.0183	-4.83 %	*0.854*
MM4	0.0116	0.0171	-48.01 %	*0.161*
MM5	0.0145	0.0185	-27.02 %	*0.359*
MM6	0.0141	0.0165	-17.02 %	*0.536*
MM7	0.0157	0.0167	-6.39 %	*0.804*
MM8	0.0150	0.0136	9.59 %	*0.711*
MM9	0.0148	0.0159	-7.99 %	*0.793*
MM10	0.0228	0.0173	24.23 %	*0.343*
SIZE1	0.0236	0.0177	24.78 %	*0.137*
SIZE2	0.0234	0.0227	2.94 %	*0.883*
SIZE3	0.0174	0.0203	-16.40 %	*0.517*
SIZE4	0.0196	0.0204	-4.48 %	*0.854*
SIZE5	0.0219	0.0194	11.46 %	*0.605*
SIZE6	0.0160	0.0185	-15.51 %	*0.580*
SIZE7	0.0160	0.0156	2.69 %	*0.924*
SIZE8	0.0154	0.0155	-0.63 %	*0.984*
SIZE9	0.0104	0.0150	-43.89 %	*0.398*
SIZE10	0.0117	0.0096	17.56 %	*0.738*

5. Summary and conclusion

From the perspective of the efficient market hypothesis, all assets must be priced according to their risk exposures in the framework of capital asset pricing model. Several studies have documented evidence that seem to violate the efficient market hypothesis. The observed irregularities may indicate either market inefficiency, in the form of profit opportunities, or inadequacies in the underlying asset-pricing model. Researchers have proposed various explanations for these effects such as; time-varying risk, distress risk, information unavailability and behavioral underreaction, among others. Fama and French (1993,1995,1996) identified additional characteristics, such as size and book-to-market ratio (SMB and HML), important for the asset pricing because they proxy for systematic risk factors in returns not captured by the CAPM beta.

This issue has been further explored in my thesis where the goal has been to find whether macroeconomic variables are the source of systematic risk and if that can explain three of the most common market anomalies, namely size effect, book-to-market effect and the momentum effect. In addition, the relative merits of CAPM and FF-4 model were examined. Fama and Macbeth (1973) two-stage approach was applied for the Norwegian stock market for an estimation period from 1993-2008.

For the macroeconomic model the following results were obtained; unexpected inflation and expected inflation changes showed some explanatory power in the time-series returns as well as the cross-sectional of average returns. This implies that these two factors proxy for significant systematic risk hence being reasonable candidates for factors to explain the anomalies. None of the other factors were found to be important in the Norwegian market. The results appear to be in line with findings of Ødegaard et al. (2009). They found no evidence of oil price changes being compensated in the Norwegian market and document very weak evidence of other macro factors having significant risk premiums. Specifically, we have noted that macroeconomic risk is quite noisy and lack explanatory power however unexpected inflation and expected inflation are found to contain systematic risk that explain the spread. The expected returns were statistically equal to the observed returns for all portfolios at 5% level suggesting feasibility of the macro model to explain return.

In order to assess the relative performance of the CAPM and Fama- French three factor model augmented by WML factor, the analysis was repeated for the full sample period from 1993-2008. SMB explained most of the size portfolios and WML explained mainly the momentum portfolios. The HML factor, in addition to having significant exposures on BM portfolios, was also found to significantly explain many of the momentum portfolios.

Results from the cross-section regressions revealed that SMB offered significant risk premiums. However, the risk associated with the market, HML and WML risk were not priced despite of having obtained significant exposures. In addition, adding macro factors or the FF-4 factors in the CAPM clearly seem not to have any effect on the pricing of equity market index; it remained insignificant in all models, consistent with the findings of Ødedgaard *et al.* (2009), Chen *et al.* (1986). From the hypothesis tests of difference between expected and actual returns, all p-values were insignificant for CAPM and FF-4 model. However, since the CAPM is rejected altogether, the results do not reflect economical applicability.

Results suggest that FF-factors perform somewhat better in explaining the time-series portfolios returns because the FF factors seem to capture a richer and wider set of information from macro economy. The pricing evidence is generally low but consistent for both models as the same type of risk were found to have risk premiums. Specifically, UI and DEI that could represent risks of SMB, were priced in the Norwegian market. Expected returns explain actual returns in a somewhat similar fashion and neither of the two models, the FF-4 and CRR, seems to considerably outperform each other but they apparently perform better than CAPM.

The Macro model and FF-4 may therefore comprise of factor that contain same type of information and that capture same type of risk; from macro economy. In this sense these factors appear to be an intermediate channels transmitting the macroeconomic news to returns. So, we can conclude that macroeconomic risk has ability to explain the anomalies but it still remain unclear which factors provide direct links to pricing

This thesis provides a better understanding of the risk-returns relationships in the Norwegian stock market and the role of macro economy for the stock market. Shanken and Weinstein (2006) found that the pricing of the macro variables were strongly sensitive to alternative procedures to generate portfolio returns and estimating the betas. This may lead us to believe that empirical results from analysis conducted above are affected by the use of methodology and treatment of the data. Further, the sample period is relatively small, consisting of only 16 years, thus limiting the generalization ability of the results. A longer sample period will account for the fluctuations caused by the IT-bubble at the end of 90's and the financial crisis from 2008.

For future studies, a wider set of macroeconomic variables could be employed to test the impact on cross-section of returns with a stronger emphasis on indentifying less noisy proxies. The relationship between FF factors and macroeconomic variables are supported by several researchers. In this context, the FF model dominates the APT to the extent of explaining the long-term risk characteristics of different firms because they act as more compact variables and therefore it is especially more relevant to direct test links between the macroeconomic factors and the SMB, HML and WML for the Norwegian market as Liew and Vassalous (2000) find that these factors contain information that is country- specific to some extent. In addition, there is need to define more accurately the firm characteristics that causes firms to react differently to new information and systematically affects returns.

6. References

Banz, R., 1981. "The relationship between return and market value of common stocks." Journal of Financial Economics 9(1): 3-18.

Bjørnland, H. C., 2009. "Oil price shocks and stock market booms in an oil-exporting country." Scottish journal of political economy 56: 232-254.

Chan, K.C., Chen, N.-F., 1991. "Structural and returns characteristics of small and large firms." The Journal of Finance 46(4):1467-1484.

Chan, K.C., Chen, N.-F., Hsieh, D.A., 1985. "An explanatory investigation of the firm size effect." Journal of Financial Economics 14: 451-471.

Chen, N.-F., Roll, R., Ross, S., 1986. "Economic forces and the stock market." Journal of Business 59(3): 383-403.

Chordia, T., Lakshmanan, S., 2002. "Momentum, Business Cycle, and Time-varying Expected Returns." Journal of Finance 57(2): 985-1019.

Fama, E. F., French, K. R., 1992. "The Cross Section of Expected Stock Returns." The Journal of Finance 47(2): 427-465.

Fama, E. F., French, K. R., 1993. "Common Risk Factors in the Returns of Stocks and Bonds." Journal of Financial Economics 33(1): 3-56.

Fama, E. F., French, K. R., 1995. "Size and book-to-market factors in earnings and returns." Journal of finance 50: 131-156.

Fama, E. F., French, K. R., 1996. "Multifactor explanations of asset pricing anomalies." Journal of finance 51(1): 55-84

Griffin, J. M., Ji, X., Martin, J. S., 2003. "Momentum Investing and Business Cycle Risk: Evidence from Pole to Pole." Journal of Finance 58(6): 2515-2547.

Hahn, J., Lee, H., 2005. "Yield spreads as alternative risk factors for size and book-to-market". Journal of Financial and Quantitive Analysis 41(2): 245-269.

Jagadeesh, N., Titman, S., 1993. "Return to buying winners and selling losers: implications of stock market efficiency." Journal of finance 48(1): 65-91.

Liew, J., Vassalou, M., 2000. "Can book-to-market, size and momentum be risk factors that predict economic growth?" Journal of financial economics 57: 221-245.

Lintner, J. 1965. "The valuations of risk assets and the selection of risky investments in stock potfolios and capital budgets." Review of economics and statistics 47: 13-37.

Liu, L. X., Zhang, L., 2008. "Momentum profits, Factor pricing and Macroeconomic risk." Reveiw of Financial Studies 21(6): 2417-2448.

Næs, R., Skjeltorp, J. A., Ødegaard, B.A., 2009. "What factors affect the Oslo Stock Exchange?." Working Paper: 1-61.

Petkova, R., Zhang, L., 2005. "Is value riskier than growth?" Journal of financial economics 78: 187-202.

Reinganum, M. R., 1981. "A Misspecification of Capital Asset Pricing: Empirical Anomalies Based on Earnings Yields and Market Values." Journal of Financial Economics 9(1): 19-46.

Rosenberg, B., Reid, K., Lanstein, R., 1985. "Persuasive Evidence of Market Inefficiency." Journal of Portfolio Management 11(3): 9-17.

Sharpe, W., 1964. "Capital asset prices: a theory of market equilibrium under conditions of risk." Journal of finance 19: 425 - 442.

Stattman, D. 1980. "Book Values and Stock Returns." The Chicago MBA 4: 25-45.

7. Appendix

Table 1

Correlations between macro variables, FF factors and portfolios returns

	1993-2008								
	EW	MP	OIL	UI	DEI	UTS	SMB	HML	WML
BM1	0.6958	0.0498	0.0307	0.1068	-0.0370	0.0728	-0.0549	-0.4558	-0.1085
BM2	0.7340	0.0789	0.0916	0.1096	0.0111	0.0858	-0.0049	-0.3163	-0.1117
BM3	0.7651	0.0569	0.0992	0.1451	0.0053	0.0252	-0.1944	-0.1192	-0.1538
BM4	0.7194	0.0314	0.1509	0.1332	0.0369	0.0741	-0.1713	0.0195	-0.0872
BM5	0.7429	0.0270	0.1196	0.0861	0.0700	0.1353	-0.1292	-0.0819	-0.1687
BM6	0.6955	0.0484	0.0480	0.1706	-0.0547	0.0527	-0.2048	0.0216	-0.1915
BM7	0.7142	0.0982	0.1447	0.1305	0.0752	0.0466	-0.1729	0.1672	-0.1890
BM8	0.6959	0.0317	0.1159	0.1493	-0.0692	0.0307	-0.1956	0.1988	-0.1814
BM9	0.6397	0.0352	0.1018	0.1920	0.0396	-0.0082	-0.0217	0.3176	-0.1390
BM10	0.5833	-0.0167	0.0761	0.3133	0.0571	-0.0677	0.0791	0.3929	-0.2132
SIZE1	0.4758	-0.0602	0.0431	0.2732	-0.1182	0.0139	0.0753	0.2305	-0.1289
SIZE2	0.6705	0.1405	0.0620	0.2571	0.0856	-0.0468	0.2098	0.0706	-0.1193
SIZE3	0.7466	0.0847	0.1618	0.2075	0.0091	-0.0217	0.1144	-0.0882	-0.1389
SIZE4	0.7180	0.0424	0.1509	0.3494	-0.0582	-0.0844	0.0710	-0.0531	-0.2195
SIZE5	0.7432	0.0328	0.0919	0.1828	0.0150	-0.0104	0.0070	-0.0803	-0.1211
SIZE6	0.7848	0.0348	0.1261	0.1348	0.1028	0.0954	-0.0539	-0.0083	-0.0388
SIZE7	0.7367	0.0243	0.0886	0.1568	-0.0686	0.0490	-0.2261	0.0317	-0.1310
SIZE8	0.7589	0.0581	0.1319	0.1014	0.0031	0.0703	-0.2467	-0.0278	-0.1923
SIZE9	0.7844	0.0482	-0.0178	0.0981	-0.0061	0.0931	-0.3148	-0.0812	-0.2492
SIZE10	0.6070	0.0238	0.0492	0.0439	-0.0208	0.1046	-0.4598	-0.0538	-0.1940
MM1	0.7268	0.0537	0.0085	0.1583	-0.0221	-0.0084	-0.0223	-0.2133	-0.2179
MM2	0.6422	0.0474	0.0444	0.2876	-0.0659	-0.0675	0.0407	0.0672	-0.2875
MM3	0.6960	0.0500	0.1027	0.2442	-0.0419	-0.0445	-0.0717	0.0441	-0.3205
MM4	0.7152	0.0357	0.0772	0.0758	0.1347	0.0588	-0.1075	0.1199	-0.2194
MM5	0.7269	0.0812	0.1505	0.2154	0.0139	-0.0526	-0.0469	0.0977	-0.1414
MM6	0.7506	0.0575	0.1016	0.1376	0.0792	0.0294	-0.1416	0.0667	-0.1987
MM7	0.7334	0.0235	0.1373	0.2621	-0.0754	0.0261	-0.1206	0.0767	-0.0486
MM8	0.7012	0.0137	0.0842	0.0574	0.0047	0.1327	-0.3005	0.0723	-0.0839
MM9	0.7902	0.0724	0.0998	0.1879	-0.0173	0.0743	-0.1789	-0.0929	-0.0486
MM10	0.7247	0.0025	0.0978	0.1527	0.0021	0.1402	-0.0924	-0.2022	0.0398

Name: Amina Javaid

Preliminary thesis report

Anomalies and macroeconomic risk in the Norwegian stock market

Supervisor:

Richard Priestley

Hand- in date:

15.01.2011

Exam code and name:

GRA 19002 preliminary thesis report

Campus & Program:

Norwegian School of Management, BI Oslo

Master of Science in Business and Economics

Major:

Finance

Table of content

Introduction

There are lots of empirical studies that seemingly document violation of efficient market hypothesis in the CAPM- framework of Sharpe (1964) and Lintner (1965). Researchers have identified several patterns in average stock returns which confirm the existence of stock market anomalies such as the size effect, B/M effect and momentum effect, among others. The observed irregularities indicate either market inefficiency, in the form of profit opportunities, or inadequacies in the underlying asset-pricing model.

Banz (1981) and Reinganum (1981) showed that small-capitalization firms on the NYSE earned higher average returns than is predicted by the Sharpe (1964) – Lintner (1965) capital asset-pricing model (CAPM) from 1936–75. Stattman (1980) and Rosenborg, Reid, and Lanstein (1985) and Fama and French (1992) have found that companies with highest B/M ratios have higher return than companies with low B/M ratio. Fama and French (1992, 1993) have argued that size and value represent two risk factors that are missing from the CAPM. Jegadeesh and Titman (1993) provided evidence on momentum effect in the short-term.

Many researchers have extended on the previous work on anomalies and devoted efforts to provide risk-based explanations for these effects in the context of economic theory. Chen, Roll and Ross (1986) tested whether innovations in macroeconomic variables could explain the stock market returns. They suggested a set of macroeconomic factors as proxy for risks and that were also used in several other studies in one or another form, thereby Liew and Vassalou (2000), Chordia and Shivakumar (2002), Griffin, Ji and Martin (2003), Petkova and Zhang (2005), Liu and Zhang (2008) and Næs, Skjeltrop and Ødegaard (2009).

Chordia and Shivakumar (2002) found that the profits to momentum strategies are explained by common macroeconomic variables that are related to the business cycle. Similarly, Petkova and Zhang (2005) argue that default premium, term premium and the short-term Treasury bill rate are more precise measures of business cycles. Liew and Vassalou (2000) show that SMB and HML contain information about future GDP- growth. The fundamental question then is where does that information stem from? An important implication of their result is that SMB and HML proxy for risk that could be assumed to originate from the economic risk, thereby laying the ground for testing those risk factors. Further investigation on whether macro factors are the underlying sources of anomalies in the Norwegian market may therefore seem plausible.

Researches have, to a large extent, agreed on the findings that SMB, HML and WML are the factors that can serve as appropriate proxy for priced risk in the stock market. However, the underlying sources of risk that drive these proxies are still not very well defined for the Norwegian market. Taking the risk-based argument as a point of departure, I will investigate further the issue of anomalies and link it to the macroeconomic risk factors. An important part of the analysis will be to find whether the respective factors are priced in the market or not. My economic problem is the following:

Can macroeconomic risk explain the size effect, the B/M effect and the momentum effect?

Most of the studies have focused on the US markets and less attention has been given to the European markets, particularly the Norwegian market. Næs, Skjeltrop and Ødegaard (2009) document evidence of size effect, B/M effect and momentum in Norway as well as importance of oil prices for the stock market. However, they do not explicitly identify the underlying factors. Therefore this study will extend on the international research. I will make an attempt to fill the gap in Norwegian studies and add to it by providing direct links between macro economy and anomalies.

An important part of my analysis will deal with oil prices. As Norway is a large oil producer and several of the largest companies at OSE are oil-related, it is a common belief that the Norwegian stock market is oil-driven. Næs, Skjeltrop and Ødegaard (2009) and Bjørnland (2009) found that oil price changes affect stock returns in Norway. In the latter study, the effect of oil price changes on unemployment, inflation, exchange rates and short-term interest rates are also documented. On the other hand, Chen, Roll and Ross (1986) examined the impact of oil price changes on asset pricing and found no overall effect. It is possible that the effects of oil price changes are already embedded in the other macroeconomic variables in one way or another.

Fama and French (1992, 1993, 1996) argue that SMB and HML are state variables that are related to the fundamental risks in the economy. Based on this argument as well as following Liu and Zhang (2008), I hope to find a significant relationship between macro factors from Chen, Roll and Ross (1986), including oil prices, and SMB, HML and WML. Further, consistent with the risk-based explanations in several previous studies, I hope to find evidence of significant risk premiums on these macro factors.

In the following report I will present the three anomalies I wish to analyze. Further I will go through previous literature related to the problem at hand and then briefly present the data and methodology that will be used in my analysis.

Anomalies

The size effect was first documented by Banz (1980) who used the US data in period 1936-1975. The result of his study shows that the common stock of small firms has on average higher risk-adjusted returns than the common stock of large firms, hence indication of the CAPM being misspecified. He also shows that the size effect is not linear in market proportion but most pronounced for the smallest firms in the sample. Further he presents a possible explanation of size effect, linking information availability to the size of a company and arguing that lack of information about small firms will lead to limited diversification and therefore higher return for the undesirable stocks of small firms.

Banz (1980) however fails to determine whether market value per se matters or whether size is only a proxy for unknown true additional factors correlated with market value, thus, leaving the question of why size effect exists, remain unanswered.

Several researchers, thereby Stattman (1980) and Rosenborg, Reid, and Lanstein (1985) and Fama and French (1992) find that companies with highest book-to-market ratios have systematically higher return than companies with low book-to-market ratio. Fama and French interpret the book-to-market ratio as an indicator of "value" versus "growth" stocks, and the HML risk factor as reflecting "distress risk". In their tests, firms with high book-to-market ratios or risk sensitivities are often firms whose value has fallen recently because of bad performance. These firms are more likely to suffer financial distress costs in future periods if further bad news hits. They argue that stock risks are multidimensional and those dimensions of risk are proxied by size and book-to-market ratio. Fama and French (1992, 1996) find that using a three factor model with a size factor and a BM factor almost removes the anomalies.

A potential explanation of this effect, given by Petkove and Zhang (2005), is the notion of time-varying risk, in other words the risk of HML strategies is high in bad times when the expected premium for risk is high and low in good times when the expected risk premium is low.

Jegadeesh and Titman (1993) provide evidence on momentum effect and show that a strategy of buying winners (stocks that have performed well in the past) and selling losers (stocks that have performed poorly) gives excess returns over 3 to 12 month holding period. However, their study does not clarify whether profitability of this trading strategy is a result of systematic risk factors. On the contrary, they interpret momentum profits as behavioral underreaction to firm-specific information. Fama and French (1996) have also shown that their three factor model cannot explain the momentum either.

Literature review

Chen, Roll and Ross (1986)

Chen, Roll and Ross (1986) model the relationship between the stock market, taken as endogenous, and the macroeconomic variables. They test whether state variable innovations can be a proxy for the systematic risk in the market and whether that risk is priced or not. They argue that some underlying exogenous influences may cause the co movement of assets prices. By doing so, they provide an insight into systematic risks that exist in the economy other than the market risk.

Following the financial theory, they identify the following set of economic variables from which systematic factors are constructed to proxy for risks: Monthly growth rate in industrial production (MP), changes in expected inflation (DEI), unexpected inflation (UI), unexpected changes in default premiums (UPR) and unexpected changes in the term premium (UTS). In addition to the above factors, they examine the oil prices to test the common view that oil prices serve as a systematic factor that influences stock returns and pricing.

Their findings suggest that only industrial production, risk premium on corporate bonds and unanticipated inflation are the factors that have explanatory power. Further, they find no influence of oil prices on the asset returns. So, their conclusion is that stock returns are exposed to systematic economic news and that they are priced according to their exposure. They argue to have found some evidence of the efficient market hypothesis however they do not show whether any link exists between systematic macroeconomic risks and the CAPM-anomalies that contradict EMH.

Liew and Vassalou (2000)

Liew and Vassalou (2000) test whether the profitability of SMB, HML and WML can be linked to future GDP growth. As a point of departure, they take the hypothesis of Fama and French (1992, 1993, 1995, 1996) that SMB, HML and WML act as state variables in the context of CAPM. International data from ten countries were used to investigate whether the three CAPM-anomalies were able to predict future economic growth. Their analysis reveals that SMB and HML contain significant information about future GDP, even in presence of other business cycle variables (Treasury bill, Dividend yield, Term premium, and growth in industrial production). Liew and Vassalou (2000) accordingly suggest that a risk-based explanation of SMB and HML returns is likely however, not identifying or proposing what the relevant risk sources could be.

Griffin, Ji and Martin (2003)

Their study consists of a sample of 40 countries, including Norway, in which they investigate whether momentum profits internationally can be explained by the macroeconomic risk factors given by Chen, Roll and Ross (1986). The findings suggest that momentum profits are large and there is weak co movement between the countries which indicate that if momentum is driven by risk, the risk is mostly country-specific. Further, they provide evidence that internationally momentum profits tend to reverse soon after the investment period.

An important part of their analysis was to examine whether momentum profits could be explained through risk arising form macroeconomic states as proxied by GDP growth and aggregate stock market movement. Unfortunately, no such evidence is found. These results clearly contradict the findings of Chordia and Shivakumar (2002). Neither the macroeconomic model of Chen, Roll and Ross (1986) nor the conditional forecasting model of Chordia and Shivakumar (2002) were able to explain momentum profits. Griffin, Ji and Martin (2003) suggest that there might still be risk associated with macroeconomy that would provide risk-based explanations for momentum, but argue that it is unclear what such risk look like or how they behave.

Liu and Zhang (2008)

The work of Liu and Zhang (2008) will perhaps be the most important in my research because they linked momentum profits with the macroeconomic risk. They focus on the growth rate of industrial production (MP) as a common risk factor which is compensated in the market as shown by Chen, Roll and Ross (1986).

Their main findings are that winners have temporarily higher loadings on MP than losers and that the combined effect of MP loadings and risk premiums account for more than half of the momentum profits. This suggests that MP-related risk is particularly important when understanding cross-section of expected stock returns. They have also shown that the multifactor macroeconomic model of Chen, Roll and Ross (1986) and Fama-French model (1993) with MP produce somewhat similar results.

Their sample contains monthly observations from January 1960- December 2004. Using the Fama-MacBeth (1973) two-stage regression they show that MP is a priced risk factor which offers mostly significant risk premiums. Momentum portfolios were constructed using the framework of Jegadeesh and Titman (1993). More specifically, thirty testing portfolios were used with ten size, ten book-to market and ten momentum portfolios based on one-way sorts, to analyze how much of the variation in returns was due to the MP factor and whether it offered a risk premium or not.

Liu and Zhang (2008) employ a similar framework as Griffin, Ji and Martin (2005), however they chose to use not only rolling-window regression, but also added the extending window and full- sample regression in the first-stage estimation. This testing framework clearly improves the results and gives conclusions different from Griffin, Ji and Martin (2005). Moreover, since their research provides direct evidence of risk that drives momentum profits, it contrasts with the conclusion provided by Jegadeesh and Titman (1993).

Næs, Skjeltrop and Ødegaard (2009)

Næs, Skjeltrop and Ødegaard (2009) have done an extensive analysis of the Oslo Stock Exchange (OSE) in period 1980-2006. An important goal of their work has been to see whether asset pricing results from other countries carry over to the Norwegian stock market.

They investigate whether the three CAPM anomalies; size effect, B/M effect and momentum effect exist in the Norwegian stock market or not. As expected, evidence of anomalies was found.

The equity pricing theory is indicative of the fact that stock price is the present value of all cash flows a company generates. Based on that, an important part of their analysis was to understand which of the two channels; cash flows or the risk premium, causes the stock prices at OSE to change. Similar to Chen, Roll and Ross (1986), they look for risk factors among macroeconomic variables and argue that these can affect many companies' cash flows at the same time, while also affecting market risk premium and risk-free rates. Since those factors were found to exhibit only weak evidence of being priced in the Norwegian market, they concluded that cash flows could be the most reasonable channel for this affect.

Similar results are found when oil prices were investigated. In the first place, oil prices are found to have significant effect on returns in many industry sectors, however they do not find any support for a hypothesis that oil prices are systematic risk factors in the Norwegian market, hence supporting the hypothesis that company's cash flow might be the relevant channel for this effect.

Their study will be highly relevant for my research due to the fact that they have examined the Norwegian stock market while other studies have focused on the US stock market. A limitation of their analysis is however that they are unable to make a clear distinction between the channels (cash flow or risk premium) through which returns are explicitly affected. Consequently, it still remains an area of further research.

Bjørnland (2009)

Bjørnland (2009) analyzes the effects of oil price shocks on stock returns in the Norwegian Stock Exchange. This paper also examines the role of oil prices and its impact on the macroeconomic behavior in an oil exporting country, i.e. Norway. The results of her analysis shows that following a 10% increase in oil prices, stock returns increase by 2,5%. In addition, higher oil prices decrease unemployment rate and increases the inflation leading to an increase in the interest rates in a response to increased economic activity.

This study offers quite a different way of looking at the stock return variations providing indications of variables that are affected by oil prices and that serve as the intermediate channels for effect on returns. This also suggests that there might be other macroeconomic variables as well that respond to oil price changes and that have not yet been identified. Bjørnland (2009) however does not provide a direct link between the macroeconomic changes and the stock returns as a result of oil price changes.

Data

To undertake my analysis I will use a selection of necessary Norwegian data in the period 1980-2009. The sample period of 29 years is chosen to ensure consistency with other data I will use in the analysis. The following macroeconomic data will be gathered: inflation, return on three month government bill, return on ten 10-year government bond, industrial production index and oil prices. All the macro data will be downloaded from DataStream which will make sure the use of reliable financial information in my research.

From the website of Bernt Arne Ødegaard, I will download average portfolio returns sorted on size, book-to-market and momentum. There will be 10 portfolios for each effect. For each portfolio the value of the characteristic the previous year-end has been used to group the stocks on the OSE. Calculations use the stocks satisfying the "filter" criteria Fama and French (1992).

In addition, I will also need the pricing factors SMB (small minus big), HML (high minus low) Fama and French (1996) and WML (winners minus looser) Carhart (1997) which will also be obtained from Bernt A. Ødegaard's website. Within each portfolio, returns are calculated as the value weighted average of the included stocks.

Methodology

Having obtained the relevant macroeconomic data, I will then construct time series of unanticipated movements, as given in the multifactor model of Chen, Roll and Ross (1986). The following series will be derived:

Monthly growth in industrial production: $MP(t) = \log [IP(t)/IP(t-1)]$

Unexpected inflation: $UI(t) = I(t) - E[I(t)|t-1]$

Changes in expected inflation: $DEI(t) = E[I(t)|t+1] - E[I(t)|t-1]$

Term structure: $UTS = LGB(t) - TB(t-1)$

Changes in oil prices: $OG = \log [OG(t)/OG(t-1)]$

Chen, Roll and Ross (1986) used risk premium on corporate bonds to measure the degree of risk aversion. However, I will not be able to use this variable in my analysis due to the fact that in Norway long time- series of credit spreads are not available. Petkova and Zhang (2005) used default premium, term premium and short-term treasury bill rate to capture the macroeconomic risk.

To investigate and test the relationship between macro factors and anomalies I will follow Liu and Zhang (2008). More specifically, I will run regressions on macro factors using returns of the ten size, B/M and momentum portfolios in the following way:

$R_{it} = a_i + b_i MP_t + b_i UI_t + b_i DEI_t + b_i UTS_t + b_i OG_t + U_{it}$

I will then perform hypothesis test to evaluate the statistical significance and infer from that which factor explain the respective anomalies across portfolios. A version of the Fama and MacBeth two-step approach (1973) will be employed to estimate risk premiums as well as to quantify the profits. I will use the 30 portfolios (ten for each effect) and find the exposure of macro factors.

Risk premiums on all factors will be estimated from the following regression equations:

$$\overline{r_i} = a_i + \widehat{b_i}\gamma_{MP} + \widehat{b_i}\gamma_{UI} + \widehat{b_i}\gamma_{DEI} + \widehat{b_i}\gamma_{UTS} + \widehat{b_i}\gamma_{OG}$$

Returns on WML, HML and SMB will be regressed on explanatory variables in each period using rolling-window regression as well as the extending window and full- sample regression in the first-stage estimation following Liu and Zhang (2008). I will also investigate how much of variation in SMB, HML and WML is explained by macro factors.

$$r_{it}= a_i+ b_i\, MP_t+ b_i UI_t+ b_i DEI_t+ b_i UTS_t+ b_i OG_t + U_{it}$$

$$\overline{r_i} = a_i + \widehat{b_i}\gamma_{MP} + \widehat{b_i}\gamma_{UI} + \widehat{b_i}\gamma_{DEI} + \widehat{b_i}\gamma_{UTS} + \widehat{b_i}\gamma_{OG} + U_i$$

$$E(r_i^{BM}) = \sum_{i=1}^{k} \hat{b}\hat{\gamma}_i$$

References

Banz, R., 1981. "The relationship between return and market value of common stocks." Journal of Financial Economics 9(1): 3-18.

Bjørnland, H. C., 2009. "Oil price shocks and stock market booms in an oil-exporting country." Scottish journal of political economy 56: 232-254.

Chen, N.-F., Roll, R., Ross, S., 1986. "Economic forces and the stock market." Journal of Business 59(3): 383-403.

Chordia, T., Lakshmanan, S., 2002. "Momentum, Business Cycle, and Time-varying Expected Returns." Journal of Finance 57(2): 985-1019.

Fama, E. F., French, K. R., 1993. "Common Risk Factors in the Returns of Stocks and Bonds." Journal of Financial Economics 33(1): 3-56.

Fama, E. F., French, K. R., 1996. "Multifactor explanations of asset pricing anomalies." Journal of finance 51(1): 55-84.

Fama, E. F., French, K. R., 1992. "The Cross Section of Expected Stock Returns." The Journal of Finance 47(2): 427-465.

Griffin, J. M., Ji, X., Martin, J. S., 2003. "Momentum Investing and Business Cycle Risk: Evidence from Pole to Pole." Journal of Finance 58(6): 2515-2547.

Jagadeesh, N., Titman, S., 1993. "Return to buying winners and selling losers: implications of stock market efficiency." Journal of finance 48(1): 65-91.

Liew, J., Vassalou, M., 2000. "Can book-to-market, size and momentum be risk factors that predict economic growth?" Journal of financial economics 57: 221-245.

Lintner, J. 1965. "The valuations of risk assets and the selection of risky investments in stock potfolios and capital budgets." Review of economics and statistics 47: 13-37.

Liu, L. X., Zhang, L., 2008. "Momentum profits, Factor pricing and Macroeconomic risk." Reveiw of Financial Studies 21(6): 2417-2448.

Næs, R., Skjeltorp, J. A., Ødegaard, B.A., 2009. "What factors affect the Oslo Stock Exchange?." Working Paper: 1-61.

Petkova, R., Zhang, L., 2005. "Is value riskier than growth?" Journal of financial economics 78: 187-202.

Reinganum, M. R., 1981. "A Misspecification of Capital Asset Pricing: Empirical Anomalies Based on Earnings Yields and Market Values." Journal of Financial Economics 9(1): 19-46.

Rosenberg, B., Reid, K., Lanstein, R., 1985. “Persuasive Evidence of Market Inefficiency.” Journal of Portfolio Management 11(3): 9-17.

Sharpe, W., 1964. “Capital asset prices: a theory of market equilibrium under conditions of risk.” Journal of finance 19: 425 - 442.

Stattman, D. 1980. “Book Values and Stock Returns.” The Chicago MBA 4: 25-45.