Formal Information

Study Programme: Master of Science in Business - Major Finance

Working Title: *Price changes in stock market in relation to idiosyncratic volatility and variance risk premium: A study of Oslo Stock Exchange.*

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Introduction

In finance, the assumption that the relationship between the risk and expected return of any securities is positive is widely accepted. In 1952 Harry Markowitz introduced his paper on Portfolio Selection which gave a foundation for portfolio management. Based on his work, the Capital Asset Pricing Model (CAPM) was introduced independently by Sharpe (1964), Lintner (1965), Mossin (1966). The CAPM predicts that the expected return increases by risk, and thus, all investors should invest in the security that gives the most expected return relative to its risk. A commonly used measure for return given risk is the Sharpe ratio.

Although the theory of CAPM and the work of Markowitz (1952) have been commonly accepted in the world of finance, recent studies have found empirical evidence that this in fact does not hold. Ang et al. (2006) finds that US firms with high idiosyncratic volatility, defined as the standard deviation of the error term in the Fama French 3-factor model, tend to have lower return that those with low idiosyncratic volatility. Also in their international study, Ang et al. (2009) finds that this hold. Other studies, such as Moreira and Muir (2017) finds that managing portfolios in regard to volatility will give high risk-adjusted returns, i.e. they decrease exposure to risk when volatility is high, and increase exposure to risk when volatility is low. Several other studies have found similar results such as Frazzini and Pedersen (2011), Clarke, de Silva & Thorley (2006) and more. We will discuss these in more detail, as well as studies that have found the opposite in our literature review.

The study of the relationship between risk and return have been very important in finance and the assumption of its positive relationship has had a great impact of how investors invest and how students are taught. However, in recent years, more and more studies have found evidence that support the opposite, i.e. a negative relationship. According to Baker et al. (2011), the long-term success of low-volatility and low-beta stock portfolios could be considered a candidate for one of the greatest anomalies there is. However, there is little research on this for the Norwegian market, and given the increase of focus on this matter, we find it very appropriate to study this on the Norwegian market. Also, as most studies are to be find on an international base, or US, we are also curious to see if a smaller market,

which is less liquid, also has this effect. Based on our results we will then analyze why the results are what they are.

The objective of this thesis is to gather whether it holds that the relationship between risk and expected return is negative in Norway or not. Then we will seek out why this is so and how one could exploit this, i.e. making portfolio strategies. We will then also look at other factors which may affect the return and volatility, such as liquidity.

To do this we have gathered daily, monthly and yearly data of stock returns and liquidity measures from the Oslo Stock Exchange from 1980 to the present. We will implement this by using the methodology of Ang et al. (2006) and also look at the approach of Moreira and Muir (2017).

Working Research Question
 "How does low-volatility stocks perform in relation to high-volatility stocks on the Oslo Stock Exchange?"

Literature Review

Our thesis is developed with the previously explained anomaly between risk and return in mind. As there has been considerable research devoted to examine the time-series relation between volatility of the market and the expected return on the market (Ang et al.,2006), this paper will examine the pricing of aggregate volatility risk in the cross-section of stock return in the Norwegian market. Thus, we will focus on the researchers which has contributed to the discovery of this anomaly, mainly Ang. et al (2006). Although our thesis foundation will be constructed with the contribution from Ang. et al (2006) as main contributor, the discovered anomaly has been subjected to debate. Thus, we find it is necessary to examine contributions from researchers such as Moreira and Muir (2017) to increase our knowledge of the subject at hand.

Ang. et al (2006) examines the pricing of aggregate volatility risk in the cross-section of stock returns. The first objective of their paper is to provide a systematic investigation of how stochastic volatility of the market is priced in the cross-section of expected stock returns. Thus, they want to determine whether the volatility of the market is a priced risk factor and to estimate the price of aggregate volatility risk. The second objective of their paper is to examine the cross-sectional relationship between idiosyncratic volatility and expected returns, where the idiosyncratic volatility is defined relative to the standard Fama and French (1993) model. They argue for the use of the Fama-French model as the model should provide the same average returns independent of whether the portfolios are formed by sorting on idiosyncratic volatility or not. Additionally, they argue, if the Fama-French model is false, the particular sorting will potentially provide a set of assets that may have different exposures to aggregate volatility and hence different average returns.

Ang. et al (2006) finds that innovations in aggregate volatility has a statistically significant negative price of risk of approximately -1% per annum. Which, they argue, can be explained by several economic theories. However, Ang. et al (2006) also discover that stocks with high idiosyncratic volatility have low average returns. Moreover, there is a strongly significant difference of -1.06% per month between the average returns of the quintile portfolio with the highest idiosyncratic

volatility stocks and the quintile portfolio with the lowest idiosyncratic volatility stock. Their results are robust when controlling for value, size, liquidity, volume, dispersion of analyst´s forecasts, and momentum effects. They also show that the effect is preserved in bull and bear markets, volatile and stable periods, and recessions and expansions. Thus, their findings are in contrast with some earlier economic theories and researchers such as Malkiel and Xu (2002) which suggest that idiosyncratic volatility should be positively related to expected returns.

Ang. et al (2009) conduct a more detailed analysis of the U.S market and examine if their findings of the anomalous relation between lagged idiosyncratic volatility and future average returns in the U.S market, can be identified in the international markets. They do this to uncover if the discovered anomaly could have some underlying economic source, or if the anomaly is just due to a small data sample.

By conducting the more detailed analysis of the U.S market, Ang. et al (2009) is able rule out market frictions, information dissemination, and option pricing as reasons for the discovered relation between high idiosyncratic volatility and low average returns in the U.S. They also find that the same negative relation between lagged idiosyncratic volatility and future average returns observed in the U.S market, is observed across a large sample of international developed markets. Additionally, they discover that the negative spread in returns between stocks with high and low idiosyncratic volatility in the international market co-moves with the spread between stock with high and low idiosyncratic volatility in the U.S market.

Other studies have found similar anomalies as Ang et al. (2006;2009). Clarke, de Silva & Thorley (2006) constructed minimum-variance portfolios using large sets of U.S equity securities, to examine the realized risk and return statistics over several decades. They find that realized standard deviation is lowered by roughly one-fourth, and risk as measured by market beta is lower by roughly one-third, compared with the capitalization-weighted market benchmark, if one use minimum-variance portfolios that do not rely on any specific expected return theory or return forecasting signal. The researchers also acknowledge the consistency between their results and the results of Ang et al. (2006) findings. However, Clarke, de Silva &Thorley (2006) points out that the minimum-variance

portfolios tend to have value and small-size bias. But, that these biases can be controlled using stock characteristics or factor return sensitivities, ex ante.

Ang et al. (2006) discovery of the relationship between lagged idiosyncratic volatility and future average returns, has also been a subject of debate. Fu (2009) argues that the idiosyncratic volatility is time-varying and, in order to capture this property, uses the exponential GARCH model and out-of-sample data to estimate expected idiosyncratic volatility. Fu (2009) finds a significantly positive relation between the estimated conditional idiosyncratic volatilities and expected returns, and argues that Ang. et al (2006) findings are largely explained by the return reversal of a subset of small stocks with high idiosyncratic volatilities. However, Guo, Kassa, & Ferguson (2014) argues that Fu (2009) results are unreliable due to the look-ahead bias created by the exponential GARCH idiosyncratic volatility methodology Fu (2009) applies in the research.

Bali and Cakici (2008) also examines the cross-sectional relation between idiosyncratic volatility and expected stock returns. In addition to further clarify the existence and significance of the relation between idiosyncratic risk and expected return, Bali and Cakici (2008) wish to look at the methodological difference between the previous studies. Bali and Cakici (2008) identifies the data frequency used to estimate the idiosyncratic volatility, weighting scheme on the portfolio returns, the breakpoints used to sort the quintile portfolios and the exclusion process of smallest, lowest priced, and least liquid stocks from sample, as factors which explains the difference in presence and significance level of a cross-sectional relation between idiosyncratic risk and expected return. Bali and Cakici (2008) shows that if the portfolios are equally weighted there is no statistically significant link between idiosyncratic volatility and expected return. Thus, they conclude that there is no robust evidence for a significant relation between idiosyncratic risk and the cross section of expected return. However, Doran et al. (2012) discovered that, there is in fact a negative relation between idiosyncratic volatility and stock return, regardless of the equally weighted portfolios, if one only look at non-January months.

As previously stated there has been considerable research regarding the time-series relation between volatility of the market and the expected return on the market. Because of the debate regarding the cross-section relation, we still find it relevant to illuminate recent research regarding the time-series relation.

Moreira and Muir (2017) construct portfolios which they define as volatility-managed portfolios. The portfolios are constructed so that they scale monthly returns by the inverse of their previous month´s realized variance, increasing risk exposure when variance has been recently low and vice versa. Moreira and Muir (2017) states that there is little relation between lagged volatility and average returns, but that there exists a strong relation between lagged volatility and current volatility. They explain that this relation implies that mean-variance investors should take on more risk when volatility is low, and less risk when volatility is high. Moreira and Muir (2017) finds that their managed portfolios yield large risk-adjusted return for the market, momentum, profitability, return on equity, betting-against-beta factors (see Frazzini and Pedersen (2014)), and value.

Moreira and Muir (2017) results are interesting as they show that managed portfolios which take less risk when volatility is high, produces large alphas and increase Sharpe ratios. Additionally, their portfolio strategy liquidates almost completely the position held in times of recession.

Methodology

We base our methodology of that is found in Ang et al. (2006), where they calculate the idiosyncratic volatility as the variance of the error term of the Fama French 3-factor model, i.e. the standard deviation of ε_i in the following regression formula:

$$r_i - r_f = \alpha + \beta^i_{(r_m - r_f)}(r_m - r_f) + \beta^i_{SMB}SMB + \beta^i_{HML}HML + \varepsilon_i$$

Formula 1: Fama French 3-factor model.

After calculating the idiosyncratic volatility, we move on to assessing the relationship between this volatility and return. We start by making a trading strategy such as Ang et al. (2006) did, where we will classify portfolios by their idiosyncratic from low to high, by quintiles. Ang et al. (2006) describes a portfolio formation strategy where they base an estimation period of L months, a waiting period of M months and a holding period of N months. They call this a L/M/N strategy, where at month t they calculate the idiosyncratic volatility from daily data for L months, from time t- L – M to t-M. Then at month *t* they construct value-weighted portfolios given the idiosyncratic volatility that is calculated and then holding these portfolios for N months. Ang et al. (2006) focuses mostly on their 1/0/1 portfolio, i.e. estimation period of 1 month, no waiting period and holding for 1 month.

Using this strategy type we allow ourselves to rebalance and test whether our hypothesis that lower volatility increases return is true. We will thus use the L/M/N strategy and when rebalancing we will compare the return of the portfolios in the different quintiles and also look at the Sharpe ratio.

We will then go on to control our results in the same fashion as Ang et al. (2006) did, however, we have not gotten that far yet as to look closely to what they did and looking at our possibilities given our data. Ang et al. (2006) also mention that they looked at momentum, which we find interesting, although we have not had time to look any closer into this.

Another approach we have been discussing would be to follow the methodology of Moreira and Muir (2017), however, we wish to carefully discuss this with our supervisor before making any decisions.

Data

We collect our data for daily, monthly and quarterly return from the Oslo Børs Information (OBI), gathered through BI Library and Bernt Arne Ødegaard. Our data reaches back to 1980 and up to 2015[1]. As we will use Ang et al. (2006) method to gather the idiosyncratic volatility, we must construct a Fama French 3-factor model. In the construction of the Fama French model we will gather High minus Low (HML) and Small minus Big (SMB) from Ødegaards website, as well as risk free rates. Ødegaards data dates back to 1980, and therefore fits well with our return data. The HML and SMB factor is calculated such as Fama French did, and are gathered in daily and monthly data. More information surrounding this can be found on Ødegaards (2017) description of data.

Ødegaard has also constructed several portfolios on his website, such as equal weighted, momentum and industry portfolios among others. As of now we have not yet gotten as far as started analyzing the data, and therefore have not looked at strategy making and thus have not gathered the portfolios from Ødegaards website. We plan, however, to compare portfolios from low to high idiosyncratic volatility as discussed in our methodology chapter.

As Ødegaard (2017) explains, we might have to exclude some data that are outliers in our set, such as 'penny-stocks', stocks that are seldom traded and firms with low market capitalization. This might make our data sample rather small. Therefore, if time permits, and data is available, we also want to have a look at other countries such as Sweden and Denmark.

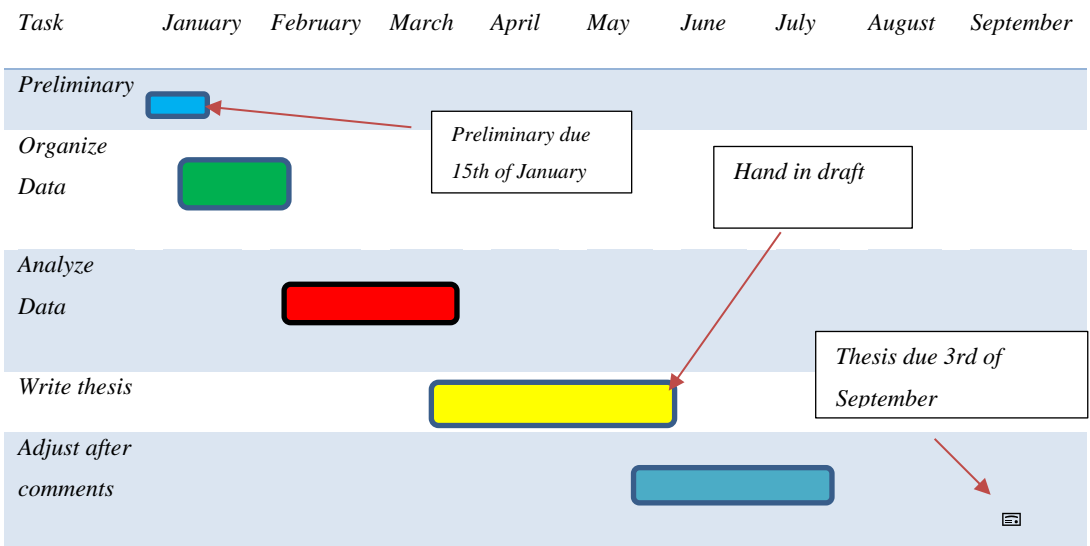[1] May be subject to change as data is updated twice a year.

Road ahead

In this section we will discuss how we are going to organize our work in the following months to finish by the deadline 3rd of September and lay out a timeline for this.

Ahead of us we must finish gathering and organize all our data, which we expect to be done with by the end of January, and thus we expect to start analyzing our data in February, and finish during March. We then will start writing our thesis in March/April, and finish our draft by the end of May, which will then be sent to our supervisor Paul Ehling for comments. We therefore expect to hand in our thesis in July.

After handing in this preliminary on the 15th of January, we will have a meeting with our supervisor to discuss both our preliminary thesis and if there need to be made any changes to our thesis. We will discuss our methodology as we may explore if the methodology of Moreira and Muir (2017) may be more reasonable for our research question.

Timeline

Task	January	February	March	April	May	June	July	August	September
Preliminary									
Organize Data									
Analyze Data									
Write thesis									
Adjust after comments									

Preliminary due 15th of January

Hand in draft

Thesis due 3rd of September

References

Ang, A., Hodrick, R., Xing, Y., & Zhang, X. (2006). The Cross-Section of Volatility and Expected Returns. *The Journal of Finance*, pp. 259-299.

Ang, A., Hodrick, R., Xing, Y., & Zhang, X. (2009). High Idiosyncratic volatility and low returns; International and further U.S. evidence. *Journal of Financial Economics*, pp. 1-23.

Baker, M., Bradley, B., & Wurgler, J. (2011). Benchmarks as limits to arbitrage: Understanding the Low-Volatility Anomaly. *Financial Analysts Journal*, pp. 40-54.

Bali, T. G., & Cakici, N. (2008). Idiosyncratic Volatility and the Cross Section of Expected Returns. *Journal of Financial and Quantitative Analysis*, pp. 29-58.

Clarke, R., Silva, H. d., & Thorley, S. (2006). Minimum-Variance Portfolios in the U.S. Equity Market. *Journal of Portfolio Management*, p. 10.

Doran, J. S., Jiang, D., & Peterson, D. R. (2012). Gambling Preference and the New Year Effect of Assets with Lottery Features. *Review of Finance*, pp. 685-731.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, pp. 3-56.

Frazzini, A., & Pedersen, L. H. (2014). Betting against beta. *Journal of Finance*, pp. 1-25.

Fu, F. (2009). Idiosyncratic risk and the cross-section of expected stock returns. *Journal of Financial Economics* , pp. 24-37.

Guo, H., Kassa, H., & Ferguson, M. F. (2014). On the Relation between EGARCH Idiosyncratic Volatility and Expected Stock Returns. *Journal of Financial and Quantitative Analysis*, pp. 271-296.

Lintner, J. (1965). The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *Review of Economics and Statistics*, pp. 13-37.

Malkiel, B. G., & Xu, Y. (2002). Idiosyncratic Risk and Security Returns, wokring paper. *The University of Texas Dallas*.

Markowitz, H. (1952). Portfolio Selection. *The Journal Of Finance*, pp. 77-91.

Moreira, & Muir. (2017). Volatility-Managed Portfolios. *The Journal of Finance*, pp. 1611-1644.

Mossin, J. (1966). Equilibrium in a Capital Asset Market. *Econometrica*, pp. 768-783.

Sharpe, W. (1964). Capital Asset Prices: A Theory of Market Equilibrium. *Journal of Finance*, pp. 425-442.

Ødegaard, B. A. (2017). *Empirics of the Oslo Stock Exchange. Basic, descriptive, results 1980-2016.*