ERASMUS UNIVERSITY ROTTERDAM

Erasmus School of Economics

Bachelor Thesis Financial Economics

'The effectiveness of the Fama and French Three-Factor model for portfolio allocation.'

Name Student: Thomas Loeve

Student Number: 481986

Supervisor: dr. R. Quaedvlieg

Second Assessor: dr. R. de Bliek

Date final version: 7th July 2020

Abstract

This thesis investigates whether the Fama French three-factor model is an effective tool for portfolio allocation. This is tested by analysing historical returns of ten stocks listed in the Dutch AEX index, and constructing a set of portfolios based on historical returns, a set of portfolios based on values estimated by the three-factor model and a set of hybrid portfolios using a combination of the two. The out-of-sample portfolio performance is compared, and the research shows that the Fama French model is useful for minimizing the volatility of a portfolio, but not maximizing the return. Risk-averse investors could benefit from using this model by estimating the minimum variance portfolio based on the covariances estimated by the model rather than the historical covariances.

Contents

1 Introduction

Since the birth of the stock exchange, economist and investors have tried to explain and predict the stock prices. If an investor could predict that the price will go up or down, he could use this information in investment strategies and benefit from it. However, as stated by the Efficient Market Hypothesis (EMH) proposed by Malkiel and Fama [1970], if this information is available to all participants rather than just that one investor, then this information should already be incorporated in the price of the stock and therefore nullify any investment opportunities. Still, the EMH remains an hypothesis and is often disputed. Investors such as Warren Buffett have consistently beaten the market with positive investment portfolio returns, which should be impossible according to the strong from of the EMH. This could be due to the fact that average investors cannot react to all available information due to high searching costs, creating limits to arbitrage. Therefore, stock returns might not be as unpredictable as stated by Malkiel and Fama.

A straightforward method to predict stock returns is looking at historical returns. If a company performs poorly, this might suggest that it will continue to perform poorly in the short-term. Jegadeesh and Titman [1993] have proven that an investment strategy which consist of short-selling poor performing stocks and buying well performing stocks in the short-term yields an abnormal return of 1% on average. This so-called price momentum phenomenon suggests that historical returns hold information for the near future, which is an anomaly with respect to the weak form of the EMH. De Bondt and Thaler [1985] also found this anomaly for the long-term in their research. Therefore, an investment portfolio based on historical returns is not as naive as it may seem.

An alternative way of looking at stock returns is using risk. This way of thinking is pioneered by Markowitz [1952] in the Modern Portfolio Theory (MPT). Markowitz stated that high returns can only be achieved if the investor accepts a higher degree of risk. This means that a low stock price accounts for a higher degree of risk, rather than the stock being mispriced or undervalued, as proposed by Lakonishok et al. [1994]. One of the first attempts to model this risk is the Capital Asset Pricing Model (CAPM), proposed by Sharpe [1964] and Lintner [1975]. This model describes expected stock returns as a function of the stocks sensitivity to the expected market return, also know as the beta.

Fama and French [1992] found that the CAPM does not explain all cross sectional variation in stock returns, and Fama and French [1993] proposed a three-factor model adding a size factor and value factor, which accounts for the size and the performance of a stock respectively. This model captures a significant part of the cross sectional stock returns, and can therefore also be used to estimate expected returns and covariances.

This thesis will test if a portfolio allocated using expected returns and covariances predicted by the Fama French model performs better than a portfolio that is allocated using estimates of those same quantities based on historical averages. The research question is formally defined as: *'How effective is the Fama and French three-factor model for the purpose of portfolio allocation?'* A subsequent question is if the size and/or value of a stock is relevant for the allocation of a portfolio. Furthermore, this thesis will allocate portfolio's using four different strategies, and can therefore test if one strategy is consistently better than others. Answering these questions will give an interesting insight on portfolio allocation using the Fama French model, and portfolio allocation in general.

2 Theoretical Framework

The following section will examine the Fama French model in greater detail, and how it is useful for portfolio allocation. Furthermore, the different strategies for portfolio allocation will be discussed and why they are chosen for this research. Lastly, the hypotheses will set up and defined how they correspond with the analysis.

2.1 The Fama French Model

As aforementioned, one of the first attempts to model the risk of a stock was made by Sharpe [1964] and Lintner [1975] in their Capital Asset Pricing Model. They found a relationship between the systematic risk and expected returns for stocks, which is captured by the beta of the stock. They formulated their findings in the following model:

$$E(R_i) - R_f = \alpha_i + \beta_i(E(R_m) - R_f) \tag{1}$$

This shows that a stocks expected excess return can be explained by the expected excess market return multiplied by its beta factor.

Fama and French [1992], Fama and French [1993] and Fama and French [1995] did further research on cross sectional stock returns and found that the CAPM does not explain all variation in returns. In fact, they observed two events that were not captured by the CAPM. They noticed that small caps stocks and stocks with a high book-to-market ratio, so-called value stocks, both outperform the market on average, which is not captured in the CAPM. Therefore, in 1993 they expended the CAPM by adding two factors that account for these two observations, and they derived the following three-factor model:

$$E(R_i) - R_f = \alpha_i + \beta_i(E(R_m) - R_f) + s_i(SMB) + h_i(HML) + \varepsilon_i \tag{2}$$

The beta in this model expresses the same beta as in the CAPM, and the two factors added are the small-minus-big and high-minus-low factor, which represents the size and value premium respectively. Fama and French retrieve the beta, SMB and HML factors by estimating the regression equation above for 25 portfolios with differences in size and book-to-market values. They post their factor estimates on their website which will be used for the purpose of this thesis. This will be clarified in the Data and Methods section later on.

Even though the work of Fama and French was a major break though in their field, there were many researchers who argued about their results. One question was whether the observed returns patters where an anomaly with respect to the CAPM, as stated by Fama and French themselves, or an anomaly with respect to the EMH, defended by Lakonishok, Shleifer, and Vishny [1994]. Lakonishok et al. conjectured that value stocks have a low price due to an underestimation of its earnings potential, rather than it having a higher degree of risk. However, they found no empirical support for their claims.

Despite the criticisms, the Fama French model performs relatively well in explaining stock returns, and is therefore considered useful for portfolio allocation. This will be further tested in this thesis.

2.2 Portfolio Allocation

The allocation of the investment portfolio weights is the most important step in the investment process, and allows investors to focus their aim on achieving high returns or diversify their portfolio with the least amount of risk. In order to provide consistency for this research, four of the most common and effective strategies will be considered and compared to test whether the results are consistent between the different strategies.

2.2.1 The 1/N Strategy

The first strategy is the often referred to as naive 1/N strategy. The strategy implies that the weight for every asset considered is equal, so there is no room to account for differences in risk or expected return. This strategy is defended in the paper by DeMiguel, Garlappi, and Uppal [2009], where they find that there is no other strategy that can consistently beat the 1/N strategy.

However, Kirby and Ostdiek [2012] criticise this conclusion and prove that mean-variance optimisation often outperforms the 1/N strategy. They mention that DeMiguel et al. [2009] obtained inaccurate results due to their research design, which focused on portfolios that are subject to high estimation risk and extreme turnover. Nevertheless, because of its simplicity, this strategy will be used as a benchmark to test whether the other strategies in fact perform better.

2.2.2 The Standard Mean-Variance Portfolio

As aforementioned, Kirby and Ostdiek [2012] found that mean-variance portfolios outperforms the naive strategy, and therefore this strategy will also be included. This method is further defined by Markowitz and Todd [2000], and boils down to diversifying you portfolio such that it achieves the maximum amount of return for a given amount of risk, or minimize the variance for a given amount of return. This is a common strategy among investors, because it gives freedom in the amount of risk an investor is willing to accept, or the amount of return he wishes to achieve. However, there might be an inconsistency between the amount of specified risk/return, and the actual out-of-sample risk/return of the portfolio. This strategy uses the expected return and covariance estimates that will be obtained by both looking at historical returns and with the Fama French model, and therefore allows for testing which method of estimating returns and covariances yields the highest return for the same amount of risk.

2.2.3 The Tangency Portfolio

Perhaps the most common and easy tool to measure portfolio performance is the Sharpe-ratio (Sharpe [1966]). This ratio is formally defined as follows:

$$S = \frac{E(R_p - R_f)}{\sigma_p} \tag{3}$$

This ratio weights the expected excess return of the portfolio against its risk, and therefore the higher the Sharpe-ratio, the better the performance of the portfolio.

The tangency portfolio aims to construct a portfolio with the highest Sharpe-ratio, i.e. the portfolio on the efficient frontier where it is tangent to the Sharpe-ratio line in the MPT (see Figure 1 in Appendix). This strategy can be effective, however it does not have a variance limit such as the mean-variance portfolio. This could cause the return to become very high, but so does the variance. Therefore, for an investor who is risk averse, the tangency portfolio might not be his best bet. Because the expected returns and covariances differ between the two methods of estimating, this investment strategy allows to test which of the to methods performs better out-of-sample when constructing a tangency portfolio.

2.2.4 The Global Minimum Variance Portfolio

The fourth method of portfolio allocation that will be considered is the global minimum variance portfolio, as stated by Jagannathan and Ma [2003] and DeMiguel et al. [2009]. This strategy aims to minimise the variance of the portfolio without a required expected return. This is one of the safer methods of investing, and is therefore a quite popular strategy among risk averse investors. This method will give an interesting insight on which method of estimating expected returns yields the highest out-of-sample return with the least amount of variance. Furthermore, because this method does not take into account the expected returns, it will give an interesting insight whether the Fama French model performs better in terms of estimating covariances.

2.3 Short Sale Constraints

The short sale of a stock implies that an investor sells a stock which he does not own. He receives the money, but is obligated to buy the stock back at a later point in time. Because the investor does not own the stock himself, he has to borrow it from someone who does own the stock. This process is often more costly than straight up buying a stock from the market.

Jones and Lamont [2002] investigated the cost of short selling, and concluded that stocks which are expensive to short yield low subsequent returns, which is in line with their overpricing hypothesis. Because short selling can be costly, the assumption of having no short sale constraints is not always valid. This fact will also be taken into account in this research. Moreover, if short sale constraints are present, investors cannot perfectly benefit from negative expected returns, which could affect the performance of the portfolio. This hypothesis will also be tested.

2.4 Hypotheses

Below is an overview of the hypotheses to be tested, which will help set up the research and answer the research question.

- H_1: 'The out-of-sample average returns and Sharpe-ratios are higher for the portfolios allocated with expected returns and covariances derived from the Fama French model than for the portfolios allocated with the same quantities based on historical returns for all strategies considered.'

- H_2: 'The 1/N portfolio yields a lower out-of-sample average return and Sharpe-ratio than the portfolios constructed using the other strategies considered.'

- H_3: 'The portfolios estimated without short sale constraints have a higher out-of-sample average return and Sharpe-ratio than the portfolios with short sale constraints.'

3 Data and Methodology

3.1 Data

The data that will be used are daily returns from 2006 up to and including 2019, from ten different stocks listed in the Amsterdam Exchange Index. These companies are varying in size and sector so that a well balanced and diversified portfolio will be possible. The companies in question are Aegon, Ahold Delhaize, Galapagos, ING Group, KPN, Phillips, Randstad, Royal Dutch Shell, Unilever and Wolters Kluwer. This data will be retrieved from Datastream [2020].

It is interesting to note that the data is from Dutch stocks only. Because the Fama French model is initially based on U.S. markets, it is interesting to see how the model holds up in an European market. Moreover, not all AEX stocks are being considered for the investment portfolio. This is due to the fact that there are multiple stocks that are very similar in terms of size, value and type of company. Therefore, the ten most diverse stock types are selected for this research, however this is difficult to determine ex-ante.

Furthermore, in order to estimate the expected returns using the three-factor model, the factor values for SMB, HML and R_f are needed. The values used are the daily "Fama/French European 3 Factors", and are retrieved from the Kenneth R. French - Data Library [2020]. The data used for R_m is the total daily return of the AEX index, and is also retrieved form Datastream [2020].

3.2 Methodology

The methodology of this research consists of the following three steps, which will be further explained in the section below. The first step is to estimate the expected return and the covariance matrix. These estimates will be based on the first nine years of the sample, from the begin 2006 until the end of 2014. The second step is to allocate the portfolio weights according to the different strategies discussed based on the return and covariance estimates. Finally, the last step is to calculate the out-of-sample performance of those portfolios over the following five year period, and compare which portfolios performed better in terms of return, risk and the Sharpe-Ratio.

3.2.1 Estimating Expected Returns and Covariances

In order to determine the optimal portfolio weights at the end of 2014, an estimate of the expected returns $E(R_i)$ and the covariance matrix Σ is needed. For the benchmark, the $E(R_i)$ will be estimated using the mean daily return over the nine year sample period, yielding the following $E(R_i)$ vector:

$$E(R_i)_{hist} = \begin{bmatrix} \mu(r_1) \\ \mu(r_2) \\ \vdots \\ \mu(r_{10}) \end{bmatrix} \tag{4}$$

The corresponding covariance matrix Σ will be estimated using the variances and covariances based on the historical returns over the same nine year sample period, which results in the following matrix:

$$\Sigma_{hist} = \begin{bmatrix} \sigma_1^2 & \sigma_{1,2} & \cdots & \sigma_{1,10} \\ \sigma_{1,2} & \sigma_2^2 & \cdots & \sigma_{2,10} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{1,10} & \sigma_{2,10} & \cdots & \sigma_{10}^2 \end{bmatrix} \tag{5}$$

For the estimation of the stock returns using the Fama French model, the following model is used, as stated by Fama and French [1993]:

$$(R_i - R_f) = \alpha_i + \beta_i(R_m - R_f) + s_i(SMB) + h_i(HML) + \varepsilon_i \tag{6}$$

The β_i represents the market risk loading, the s_i the size risk loading, and h_i the value risk loading of stock i, with the ε_i representing the corresponding error term . The values for R_f, R_m, SMB and HML are retrieved from the Kenneth R. French - Data Library, and therefore the $E(R_i)$ can be estimated by performing an Ordinary Least Squares (OLS) regression of the model. First, the coefficients for $\hat{\alpha_i}$ $\hat{\beta_i}$, $\hat{s_i}$ and $\hat{h_i}$ are estimated over the nine year sample period. Then, to estimate the $E(R_i)$, the following formula will be filled in at the beginning of 2015, using the average values of $R_m - R_f$, SMB and HML for 2014:

$$\mu_{i,FF} = \hat{\alpha_i} + R_f + \hat{\beta_i}(R_m - R_f) + \hat{s_i}(SMB) + \hat{h_i}(HML) \tag{7}$$

Using the coefficient estimates from the regression, the variances and covariances can be estimated as follows: Let $B_i = \begin{bmatrix} \beta_i & s_i & h_i \end{bmatrix}$ be a vector of regression estimates, and let $\Sigma_{factors}$ be the covariance matrix of factors, which is estimated using the covariances between the historical $R_m - R_f$, SMB and HML values. Then, the model implies that:

$$\sigma^2(r_i) = B_i \Sigma_{factors} B_i' + \sigma^2(\epsilon_i) \tag{8}$$

$$Cov(r_i, r_j) = B_i \Sigma_{factors} B_j' \tag{9}$$

For the covariance, B_j is the vector of parameter estimates for stock j. These equations will be used to estimate the $E(R_i)_{FF}$ vector and Σ_{FF} matrix, which will be used to allocate the portfolio weights.

3.2.2 Homoskedasticity, Autocorrelation and Exogeneity

Because the Fama French model is estimated using an OLS regression, there are a couple of assumptions which need to hold. Three of which are the most important and will be briefly discussed. Homoskedasticity implies that the variance of the regression errors are constant and finite. This assumption can be tested using a White test (White [1980]). This test is performed for the regressions of all ten stocks, and shows to be highly significant for all ten. Therefore the null-hypothesis of homoskedasticity is rejected and can not be assumed. The residuals prove to be heteroskedastic, and this will be corrected by using White standard errors throughout the research.

Another assumption is the assumption that the residuals of the regressions are not correlated. This research uses daily returns, which are characterised by being not correlated. This is further justified by the EMH. The last assumption is that the regression is exogenous, meaning that the model includes all variables which explain the dependant variable, which is hard to justify. Even though Fama and French performed extensive research regarding risk factors of stocks, it is plausible that there other risk factors which are not included in the model. However, this matter is beyond the scope of this research.

3.2.3 Allocating Portfolio Weights

As aforementioned, the second step in the methodology is the construction of the portfolios using the expected returns and covariance estimates form the previous step. The first portfolio that will be constructed is the 1/N portfolio, which does not use any of the obtained estimates. This strategy allocates the same portfolio weight to each asset, and will be used as a benchmark for the other portfolios to compare with.

The next portfolios will be the four standard mean-variance portfolios, with two using the return and covariance estimates based on historical returns and the other two using those estimates based on the Fama French model. For this strategy, the target variance will be the variance of the market return over the sample period, creating a maximized return (MR) portfolio, and the target return will be the average return of the market over the sample period, creating a minimized variance (MV) portfolio. Therefore, it is interesting to test whether the mean-variance portfolios can achieve a higher return than the market with the same variance, or the same return with lower variance.

Another four portfolios will be two portfolios using the global-minimum-variance strategy (GMV), and two tangency portfolios. Again, for each strategy one portfolio will be using the return and covariance estimates based on historical return and the other will use those estimates based on the Fama French model.

Since the Fama French model is more focused on estimating risk rather than expected return, it is likely that the expected returns predicted by the model are not as accurate as the expected returns based on historical values. Therefore, there will be another set of hybrid portfolios using the expected returns vector based on historical returns, but the covariance matrix based on the Fama French model. This will give another two standard mean-variance portfolios and a tangency portfolio.

Next, the seven portfolios using the expected returns and/or covariances of the Fama French model will be estimated a second time, but without the insignificant regression coefficients. If stocks do not significantly load on certain risk factors, the expected return vector and covariance matrix will be different, yielding different portfolios. If some coefficients prove to be insignificant, it might be best to not include them at all, which will be tested by this method.

Finally, because for every portfolio it is assumed that there are no constraints to short-selling, this process will be repeated but with a restriction on short-selling. This implies that the weights must sum up to one, but cannot be negative. This will yield an interesting insight on the effect of short sell constraints on portfolio performance.

3.2.4 Evaluating Portfolio Performance

In total, there will be thirty-seven different portfolios which are constructed at the last day of 2014. In order to test the portfolio performance, all portfolios will be held for a five year out-of-sample period, from the first day of 2015 up to and including the last day of 2019. This holding period will yield an average out-of-sample annualized return and standard deviation for each portfolio. Next, those average returns and standard deviations will be compared between portfolios based on historical returns, those based on the Fama French model and the hybrid portfolios. Furthermore, the Sharpe-Ratio will also be compared between the portfolios. Next, there will be a comparison between the results with and without short sale constraints. With this comparison, the hypotheses can be tested which in turn helps to answer the research question.

4 Results

4.1 Fama French Regressions

In table 1 is an overview of the results of the Fama French regressions over the sample period. Because of their irrelevance for this research, the standard error is not mentioned. All coefficients are significant at 95% confidence, except for those with a star. The significance is based on White standard errors, because the null hypothesis of the White test is rejected for all regressions, which implies that the residuals are heteroskedastic (White [1980]).

	Aegon	**Ahold**	**Galap.**	**ING**	**KPN**	**Phill.**	**Rand.**	**Shell**	**Unil.**	**Wolt.**
β_i	1.455	.502	.907	1.804	.436	1.037	1.406	.753	.582	.675
s_i	-.001*	.000*	.012	.003*	-.003	.000*	.006	-.004	-.004	.000*
h_i	.016	-.003	.002*	.019	-.001*	.002*	.003	-.007	-.006	.000*

*Not significant at 95% confidence

Table 1: Results of the Fama French regressions for the sample period.

It is interesting to note that the beta coefficient is significant for all regressions, indicating that the CAPM captures a large segment of variation in returns. The SMB and HML coefficients vary widely in significance, therefore the Fama French model might not always be more suitable than the original CAPM. The constant factor shows to be insignificant for all regressions, and can be assumed to be zero.

4.2 Portfolio Estimation and Performance

As aforementioned in the methodology, all portfolios are estimated at the end of 2014, and held for a five year out-of-sample period. Firstly, for the portfolios without short sale constraints, the annualized average out-of-sample daily return, volatility, and Sharpe-ratio are stated in table 2.

As seen from table 2, the performance of the portfolios differs substantially from each other, with Sharpe-ratios ranging from .34 all the way up to 1.61. The majority of the portfolios have a Sharpe-ratio higher than 1, and therefore outperform the 1/N strategy. However, the results show that the portfolios using expected returns based on historical returns perform relatively bad when using the minimized variance mean-variance strategy. These portfolios do perform relatively good for all other strategies considered, with the

	Portfolio	Return (%)	Volatility (%)	Sharpe-Ratio
	1/N	12.34	16.34	0.76
Historical Based	**MV**	7.47	16.28	.46
	MR	36.26	22.51	1.61
	GMV	15.66	15.36	1.02
	Tangency	42.91	28.53	1.50
Fama French Based	**MV**	26.93	20.23	1.33
	MR	2.51	21.66	.12
	GMV	16.27	15.58	1.04
	Tangency	7.10	18.67	.38
Fama French Based (Sig. Only)	**MV**	24.56	19.95	1.23
	MR	7.45	22.01	.34
	GMV	15.95	15.53	1.03
	Tangency	8.61	18.46	.47
Hybrid Portfolios	**MV**	7.60	16.48	.46
	MR	28.80	21.62	1.33
	Tangency	38.62	25.67	1.50
Hybrid Portfolios (Sig. Only)	**MV**	7.38	16.48	.45
	MR	29.77	21.90	1.36
	Tangency	38.10	25.45	1.50

Table 2: Portfolio Performance Without Short Sale Constraints.

tangency portfolios having the highest Sharpe-ratio.

The Fama French based portfolios only perform well regarding the minimization of variance. When the expected returns are taken into account for the MV and tangency portfolios, the out-of-sample return is relatively low. Moreover, the difference between the Fama French portfolios in- and excluding insignificant values is small, and differs between slight increases and decreases in return and volatility. For the hybrid portfolios, the differences are even smaller.

Table 3 shows the results of the same portfolios as stated in table 2, but with short sale constraints. The results are similar, however the performance is slightly worse for almost all portfolios. The returns are slightly lower and the volatilities are slightly higher, negatively influencing the Sharpe-ratios.

	Portfolio	Return (%)	Volatility (%)	Sharpe-Ratio
	1/N	12.34	16.34	0.76
Historical Based	**MV**	4.74	16.18	.29
	MR	33.00	23.26	1.42
	GMV	13.34	15.09	.88
	Tangency	21.45	18.31	1.17
Fama French Based	**MV**	31.22	25.55	1.22
	MR	1.57	21.05	.07
	GMV	13.80	15.13	.91
	Tangency	4.12	17.84	.23
Fama French Based (Sig. Only)	**MV**	19.35	24.33	.80
	MR	1.53	21.11	.07
	GMV	14.00	15.15	.92
	Tangency	4.12	17.84	.23
Hybrid Portfolios	**MV**	4.94	16.14	.31
	MR	32.41	23.05	1.41
	Tangency	20.84	17.90	1.16
Hybrid Portfolios (Sig. Only)	**MV**	4.87	16.15	.30
	MR	32.97	23.25	1.42
	Tangency	20.99	17.92	1.17

Table 3: Portfolio Performance With Short Sale Constraints.

4.3 Hypotheses

The first hypothesis stated that 'the out-of-sample average returns and Sharpe-ratios are higher for the portfolios allocated with expected returns and covariances derived from the Fama French model than for the portfolios allocated with the same quantities based on historical returns for all strategies considered.' Looking back at the results, the average returns and Sharpe-ratios from the Fama french based portfolios are in fact much lower than for the portfolios based on historical returns. Only the global minimum variance portfolio performs slightly better. The standard deviations of the mean-variance and tangency Fama French based portfolios are much lower than for those portfolios based on historical returns. The hybrid portfolios have a similar performance as the historical based portfolios, and does not prove to be superior. Even so, the first hypothesis proves to be incorrect, and the Fama French based portfolios are not superior over the historical based portfolios regarding average return and Sharpe-ratio.

The second hypothesis stated that 'the 1/N portfolio yields a lower out-of-sample average return and Sharpe-ratio than the portfolios constructed using the other strategies considered.' This statement is true regarding the portfolios based on historical returns, except for the MV portfolio. Whilst the 1/N portfolio does have low out-of-sample risk, the returns and Sharpe-ratios are higher for the other three portfolios based on historical returns. However, for the portfolios based on the Fama French model the same cannot be said. Due to the bad performance of the MR and tangency portfolio, only the global minimum variance portfolio performs better than the the 1/N portfolio. Concluding, the second hypothesis is false for both the portfolios based on historical returns and the portfolios based on the Fama French model.

The third hypothesis stated that 'The portfolios estimated without short sale constraints have a higher out-of-sample average return and Sharpe-ratio than the portfolios with short sale constraints.' Following from the differences between table 2 and 3, this hypothesis proves to be true, and including short sale constraints has a negative effect on the performance of a portfolio.

5 Conclusion and Discussion

5.1 Conclusion

This thesis investigated whether the Fama and French three-factor model can be an effective tool considering portfolio allocation, and the main question of this research was: 'How effective is the Fama and French three-factor model for the purpose of portfolio allocation?' In order to provide an answer to this question, three hypotheses were set up and evaluated in the results. The first hypothesis, stating that: 'the out-of-sample average returns and Sharpe-ratios are higher for the portfolios allocated with expected returns and covariances derived from the Fama French model than for the portfolios allocated with the same quantities based on historical returns for all strategies considered,' proved not to be true. The Fama French based global minimum variance portfolio was the only portfolio which performed better regarding return and Sharpe-ratio than its historical based counterpart. However, the risk of the Fama French based portfolio was consistently lower than the historical based portfolios. Only when expected returns were taken in to account for the estimation of the portfolios, those portfolios performed poorly. Therefore, this indicates that the expected returns vector retrieved from the Fama French model is inaccurate compared to the historical based expected returns. The covariances however seem to be more accurate for the Fama French model due to the consistently low out-of-sample risk.

The second hypotheses stated that 'The 1/N portfolio yields a lower out-of-sample average return and Sharpe-ratio than the portfolios constructed using the other strategies considered.' This hypothesis is also not true regarding both the historical based portfolios and the Fama French based portfolios. However, there are multiple portfolios that do outperform the 1/N strategy, and thus it can be said that the 1/N strategy is not the best strategy, and diversification does improve the risk and return of a portfolio. This is contradicting with the research done by DeMiguel et al. [2009], however this research only considered one portfolio estimate and sample period, so the results might not be consistent when more periods are taking into account.

The third hypothesis stated that 'The portfolios estimated without short sale constraints have a higher out-of-sample average return and Sharpe-ratio than the portfolios with short sale constraints.' This hypothesis proved to be true, and not being able to short sell has a negative effect on the performance of the portfolio. Therefore, even if short-selling might bring along costs, it could be worth the expense due to the better out-of-sample portfolio performance.

Concluding, the Fama French model can be considered effective regarding portfolio allocation, but only for the purpose of minimizing risk. The Fama French model performs well in predicting covariances, but worse when estimating expected returns. It seems that the size and value of a stock holds information about its risk, and accounting for this risk in the model improves the volatility of the portfolio, even if the regression coefficients are not always significant. For a risk-averse investor, the Fama French model is a great tool to estimate a global minimum variance portfolio. If an investor would want to estimate a mean-variance or tangency portfolio, it might be best to use the expected returns vector based on historical returns, and the covariance matrix based on the Fama French model, since these portfolios yield similar results as the historical based portfolios, but with lower risk.

5.2 Discussion

Their are several potential improvements for further research. The first and most significant of all is the portfolio holding period. This research estimated the portfolios in one point in time and held them for a five year period. Stock prices are likely to change and fluctuate all the time, so holding a portfolio for five consecutive years might not be the best strategy. Instead, one could re-balance its portfolio every year or every month, taking into account the new data form the past year or month in a so-called rolling window. This research method was initially intended, however due to time and resource constraints proved not to be feasible. Therefore, further research could investigate whether a periodically re-balanced portfolio performs better or worse. This could also benefit the reliability of the research.

Another improvement could be made by adding more stock markets to test the research question. Instead of looking only at the Netherlands, it might be interesting to see whether the conclusions are consistent between markets such as Asian or American markets. Furthermore, one could also extend the amount of assets to be considered for a specific market such as the Netherlands, rather than looking at ten stocks only. If more stocks are taken into account, a larger degree of diversification is possible which could improve the portfolio performance.

For further research it could be interesting to consider more different portfolio allocation strategies, and different expected returns and covariance estimation methods. This would broaden the scope of the research, and could yield interesting insights about which estimation method is best for which portfolio allocation strategy. Furthermore, it could be interesting to extend the range of assets beyond stocks and include bonds for instance, and look at the five-factor model (Fama and French [1993]) and see how it can be used to optimize an investment portfolio.

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7 Appendix

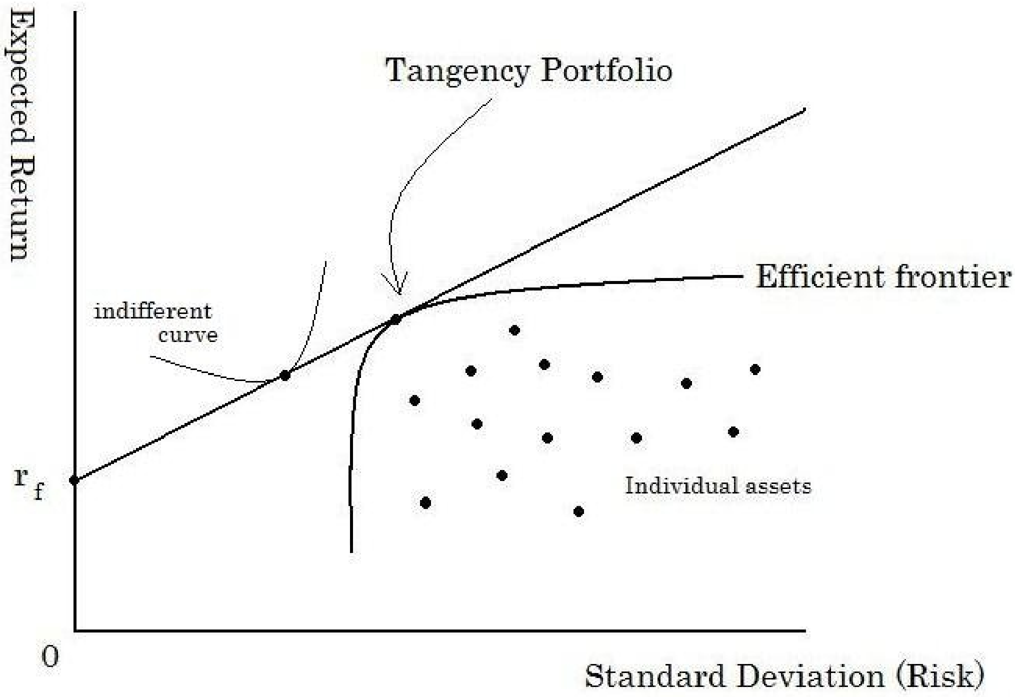

Figure 1: The Tangency Portfolio