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Bachelor Thesis in Finance

On the robustness of the CAPM, Fama-French Three-Factor Model and the Carhart Four-Factor Model on the Dutch stock market.

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Abstract

The aim of this paper is to evaluate which asset-pricing model best explains the variation in stock returns on the Dutch stock market for the period January 2004 to January 2014. Fama and French (1993) found that adding the factors firm size and book-to-market-equity ratio, as an extension to the CAPM, does a better job in explaining stock returns. Carhart (1997) had found that adding a fourth factor would further improve the explanatory power of the model. In view of these findings, we will test all three models on the Dutch stock market to see whether the results found on the U.S. stock market apply to the Dutch stock market. Monthly portfolio returns are regressed on different factors. The results show that the Fama and French Three-Factor Model and the Carhart Four-Factor Model can contribute to explain the value effect, which cannot be captured by the CAPM. The momentum factor captured by the four-factor model did not seem to be a significant improvement to the three-factor model in explaining stock returns. Negative excess market returns are observed and are likely a result of the economic turmoil that has taken place for a major part in the sample period. In contrast to the small firm effect observed by Fama and French (1996), a big firm effect was found. The value effect observed is consistent with the findings in the U.S. market. It is recommended to further test the models across large time periods in order to check their true validity on the Dutch stock market before safe conclusions can be drawn.

1. Introduction

On the stock market investors seek to determine the appropriate rate of return of a particular asset. By using asset-pricing models, a theoretical appropriate required rate of return can be calculated[1]. The capital asset pricing model (henceforth: CAPM) of William Sharpe (1964) and John Lintner (1965) marks the birth of asset pricing theory[2]. The CAPM was the first asset-pricing model with reliable predictions about risk and return. Even today, the CAPM is still widely used to estimate the cost of equity capital and portfolio performance.

The CAPM is an ex-ante, one-period model. The model builds on the portfolio theory developed by Harry Markowitz (1959). A straightforward assumption of the CAPM is that the higher the beta, the higher should be the expected return. The CAPM remains attractive due to its simplicity and its capability to measure risk and the relation between expected return and risk. However, perhaps due to its simplicity, its robustness in empirical tests reflects failings and fundamental explanatory errors.

According to the CAPM, the relation between an asset's risk and return is:

$$E(R_i) = R_f + \beta_i \, [E(RM) - R_f]$$

where

R_f	is the risk free rate of return
$E\ (RM)$	is the expected market rate of return
β_i	is the sensitivity of asset's i return to market return $\left(\frac{Cov\ i,M}{\sigma^2\ M}\right)$
$E\ (R_i)$	is the asset's i expected rate of return

Eugene Fama and Kenneth French, henceforth Fama and French, published their findings on asset-pricing models[3]. In the 1990s Fama and French found that firm size and financial leverage could explain excess returns. As a result of this insight, Fama and French created an extension to the CAPM model, which solely includes beta. The extension model is called the

[1] French, Craig W. (2003). The Treynor Capital Asset Pricing Model. *Journal of Investment Management 1 (2),* 60–72.
[2] Fama, E. F., & French, K. R. (2004). The capital asset pricing model: theory and evidence. *Journal of Economic Perspectives*, 25-46.
[3] Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, 33(1), 3-56.

Fama and French Three Factor Model. The most prominent discovery embedded in their analysis is the negative relation between average returns and firm size. Conversely, they found a positive relation between average returns and (BE/ME) ratios. The fact that high (BE/ME) stocks have higher average excess returns appears counterintuitive. Indeed, high (BE/ME) stocks are traditionally considered undervalued for the reason that they offer high book value at a discount. This seemingly logical assumption is however debunked by modern finance principles, which tell us that book value is representing the historical cost of the firm's capital rather than the forward-looking cost. Thus, one should focus on market value. This represents investor's best estimate of the future cash flows of the firm. In this light, high book-to-market firms appear in distress due to their low market value relative to their book value. As a consequence, investors want more compensation for including high (BE/ME) value stocks in their portfolio. The Fama and French Three-Factor Model includes this distress premium in their model by assuming that small value (SV) firms display subpar performance and are (more) likely to default and become financially distressed compared to their larger counterparts.

Despite its strengths the Three-Factor Model has also received some doubts about whether the outperformance tendency of small value firms is a result of market efficiency or a result of market inefficiency. The debate opposes two conflicting theories about the outperformance tendency. On the efficiency side of the debate, the outperformance is generally explained by the excess risk that value and small cap stocks face as a result of their higher cost of capital and greater business risk. On the inefficiency side, the outperformance is explained by market participants mispricing the value of these companies, which provides the excess return in the long run as the value adjusts [4].

The following formula denotes the Fama and French Three Factor Model:

$$r = r_{ft} + \alpha_i + \beta_i\,(r_{Mt} - r_{ft}) + s_i SMB_t + h_i\,HML_t + e_{it}$$

where

r	is the portfolio's expected rate of return
$r_{Mt} - r_{ft}$	is the market risk premium for month *t*
SMB_t	is the SMB factor for each month *t*
HML_t	is the HML factor for each month *t*

[4] Bhole, L.M., & Mahakud, J. (2009) *Financial Institutions and Markets: Structure, Growth and Innovations 5th ed.* Tata McGraw-Hill

Jegadeesh and Titman (1993) had found that stocks that perform the best (worst) over a three- to 12-month period tend to continue to perform well (poorly) over the subsequent three to 12 months[5]. Carhart (1997) further explored the effect of momentum and found similar results. Carhart added the fourth factor of momentum to the three-factor model. The Carhart Four-Factor Model is as follows:

$$r = r_{ft} + \alpha_i + \beta_i\,(r_{Mt} - r_{ft}) + s_i SMB_t + h_i\,HML_t + m_i\,MOM + e_{it}$$

where

r	is the portfolio's expected rate of return
$r_{Mt} - r_{ft}$	is the market risk premium for month *t*
SMB_t	is the SMB factor for each month *t*
HML_t	is the HML factor for each month *t*
MOM	is the MOM factor for each month *t*

The aim of this paper is to evaluate the role the different factors play in explaining average excess returns on the Dutch stock market and to see which model has the best explanatory power. Multiple regressions are run for each model and various data is summarized in tables for comparison sake. The regressions give insight in the robustness of the different models by looking at their intercept (alpha). The smaller the intercept, the better the model can explain excess stock returns[6].

The results suggest that particularly the CAPM model does a poor job in explaining excess stock returns. The cross-section (second-step) regression yields coefficients that confirm the shortcomings of the CAPM. Adding the factors SMB and HML to the analysis yields better results. The intercept is notably closer to zero and thus the factors seem to confirm that beta alone does not help to explain average excess stock returns. By adding the momentum factor, which is found in the four-factor model, no real differences are found compared to the three-factor model. Another important finding is that - contrary to the risk-return trade-off - big firms outperform small firms, with a volatility (standard deviation) that does not differ significantly across big and small portfolios.

[5] Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of Finance*, 48(1), 65-91.

[6] Ross, S. A. (1976). The arbitrage theory of capital asset pricing. *Journal of economic theory*, 13(3), 341-360.

The first part of the thesis consists of an explanation of the methodology used, which includes the data gathering process. The second part covers the empirical results of all three models. The portfolio formation procedure is explained and the regressions are summarized and discussed. In the final part of the thesis the results are evaluated to see which model best explains stock returns. Limitations of the research are pointed out and recommendations are given.

2. APPLICATION TO THE DUTCH STOCK MARKET

I will apply the three asset-pricing models to the Dutch stock market and see if there exists a preferred dominant model in explaining stock returns. Clearly, the three-factor and four-factor models do not give clear insight in risk and return variables since its factors are merely a proxy of the true state variables. Testing the models will mainly serve to evaluate which model is most consistent and reliable in explaining returns on the Dutch stock market. Findings on each model will be presented in later chapters. For comparison sake I have tested the models for a ten-year period from 2004 to 2014 with monthly observations. Monthly data is used since it accounts for speed in arbitrage adjustments. Moreover, it is able to mitigate potential drawbacks of microstructure issues related to price formation and price discovery, transaction and timing cost, information and disclosure, and market maker and investor behavior. A total of 120 observations are used to construct portfolios, with model specific technicalities taken into account. The sample period contains cyclical economic movements with epochs of fluctuating market volatility.

2.1. Data

All required data for the analysis is obtained from the DATASTREAM database. The data relevant for the empirical research are the active primary-quoted stocks on the Euronext Amsterdam. The latter consists of 126 currently active stocks. However, to omit the exposure to sample selection bias, I have eliminated all stocks with insufficient market data. Moreover, only stocks that trade continuously over the ten-year period are included. Finally, I did not use stocks with negative (BE/ME) to prevent distortion of the results. After this process 78 stocks remain eligible for analysis.

To compute stock returns the monthly price adjusted-default stock returns (RI) for every firm during 120 months are collected. It is preferred over the regular stock return for it takes into account (reverse) stock splits, stock dividends, and right issues. The price-adjusted returns assume dividends are re-invested and used to purchase additional stocks. Important to note is that, as a consequence of the lognormal property of stock returns, the return of a given stock from time *t-1* to time *t* is: ln (*t-1* / *t*), which is the natural logarithm of the return of a particular stock at time *t-1* divided by its return at time *t.* This is not the excess return, which is computed by subtracting the risk-free rate. Market Value (MV) is used for portfolio categorization in size for the multifactor models. Similarly, data is drawn on market-to-book-value (MTBV). Its inverse, the book-to-market equity ratio (BE/ME) is used for the value factor in the multifactor models. Finally, the market return and the risk free rate are obtained. The market return is simply the return on the Euronext Amsterdam for the firms of interest over the sample period. The risk free rate is calculated using the monthly yield on the 10-year Dutch government bond. Alternatively, the interbank rates could have been used. However, these are typically unavailable to investors.

2.2. Methodology

The same methodology Fama and French (1993) used in their research paper to construct distinct portfolios is applied in this thesis. Although for every model a more detailed explanation will be given in later chapters, a brief introduction to the generalized method is presented in this paragraph.

The CAPM and the multifactor models require a different approach to the construction of portfolios. The relevant variable in the CAPM model is the corresponding *beta* of every one portfolio at time *t*. In the Fama and French model however, the monthly return on stocks are regressed on return to a market portfolio of stocks and mimicking portfolios for size and book-to-market ratio. For the Carhart Four Factor model the six value-weighted portfolios formed on size and prior 12 month returns are used to construct the momentum factor.

3. EMPIRICAL RESULTS

In this section the empirical results of the first-pass regression (also known as time-series regression) and second pass regression (also known as cross-sectional regression) are presented. The different models will undergo an array of statistical tests to measure their reliability as an asset-pricing model on the Dutch stock market. Supporting data will be presented to contribute to the statistical findings and the results are contrasted to the theory. In a later chapter, conclusions are drawn as to which model is most robust in rigorous empirical testing and which model shows clear signs of empirical deficiencies.

3.1. CAPM

Portfolio formation

In order to run the two pass technique regressions, a set of nine portfolios must be constructed as the intersection of the size dimension and beta coefficient for every firm in the sample period. The latter procedure serves to prevent distortions in the results and error-in-variable problems. To obtain company specific beta, a regression is run for every firm at every time t, where the dependent variable is the excess return on the firm stock and the independent variable is the excess return on the market as a whole. The size dimension for the portfolio formation process is simply arranged on a continuum ranging from small capitalization firms to large capitalization firms. A total of 78 firms for which there is consistent and sufficient data, are included in the nine portfolios. In table 1 the characteristics of the nine distinct portfolios are presented. Every one portfolio is the result of the intersection of firms that overlap on any two dimensions, beta and size. For this process I have used a 'Venn diagram' to alleviate sorting issues. Alternatively, the sorting can be done manually. Quite arguably however, this sorting method is prone to mistakes and therefore not recommended.

Rather intuitively, we find that relatively large firms, in general, have a lower standard deviation. This observation is a result of the straightforward assumption that, given their nature, small firms tend to be more risky and hence more volatile. At the same time we find that the standard deviation of average returns of high beta firms is relatively high. Conversely, the contrary holds for firms for which the beta is low. Lastly we find that the average return of portfolios is highest among large firms. In the sake of clarity, the definition of beta is shortly described and a brief explanation is given on the interpretation of beta estimates.
The beta of the market portfolio is always equal to 1. The beta of a security or a portfolio compares the volatility of its returns to the volatility of the market returns.

$\beta = 1.0$ - the security has the same volatility as the market as a whole
$\beta > 1.0$ - the security has more volatility than the market as a whole
$\beta < 1.0$ - the security has less volatility than the market as a whole

Note that the values above relate to absolute values and not to exact values (where positive and negative numbers are distinguished) and could therefore also be denoted as: β = |1.0|, β > |1.0| and β < |1.0| respectively.

Table 1: Nine portfolios sorted on beta and size with its corresponding average return and standard deviation. The average returns are excess returns for every one portfolio during the sample period (2004-2014)

Characteristic		**HIGH BETA**	**MEDIUM BETA**	**LOW BETA**
AVERAGE	**LARGE SIZE**	0,49%	0,72%	0,50%
STANDARD DEVIATION		10,05%	7,06%	6,51%
AVERAGE	**MEDIUMSIZE**	0,10%	0,66%	0,37%
STANDARD DEVIATION		12,52%	9,80%	7,45%
AVERAGE	**SMALL SIZE**	-1,37%	-0,17%	0,41%
STANDARD DEVIATION		15,07%	10,08%	7,48%

First-pass regression

As previously mentioned, the first step in the two-pass technique is the time-series regression. In this time-series estimation the security returns are regressed against a market index. For every portfolio *i* and every month *t* the following regression is run:

$$r_{it} - r_{ft} = \alpha_i + \beta_i (r_{Mt} - r_{ft}) + e_{it}$$

where

$r_{it} - r_{ft}$ is the excess return of portfolio *i* for month *t*

$r_{Mt} - r_{ft}$ is the market risk premium for month *t*

The results are drawn with a rearranged version of the CAPM model and yield beta estimates for every one portfolio that was constructed previously. An overview of this can be found in table 2. This information can be used in the second step of the two-pass technique, the cross-sectional regression. As we can see, the obtained beta estimates are the coefficients of the market risk premium in the model above.

Naturally, we find that high beta stocks result in high beta estimates. The results show no clear evidence of a positive relation between beta and firm size. One would expect small size firms to have a beta estimate equal or larger than large firms due to their riskier nature. This is however only the case in the middle segment of the beta ordering. For the high and low beta estimates it appears that large firms have a higher beta. In fact, medium size firms are affected most by high beta estimates across all three beta-portfolio-categorizations. For every portfolio also the alpha estimate is included. These alpha estimates are all very close to zero. This implies that the CAPM does well in explaining stock returns. In the subsequent paragraphs we will run alternative analysis to see if the above conclusion based on time-series regression holds.

Table 2: beta coefficients for the nine different portfolios in the time-series regression

COEFFICIENT		HIGH BETA	MEDIUM BETA	LOW BETA
b (beta)	**LARGE SIZE**	1,3567	0,8015	0,5223
alpha		0,01866	0,01441	-0,0149
b (beta)	**MEDIUM SIZE**	1,4422	0,8780	0,5954
alpha		0,03802	-0,02967	0,01513
b (beta)	**SMALL SIZE**	1,2354	0,8763	0,3178
alpha		0,01444	0,01421	-0,00506

Second-pass regression

The second step in the two-pass technique is the cross-sectional regression[7]. In cross-sectional estimation the estimated CAPM-beta from the first pass is related to average return. The dependent variable remains unchanged and is the portfolio excess return. The regression of the second step regression denotes:

$$r_{pt} - r_{ft} \; = \; \lambda_{0t} \; + \lambda_{1t}\hat{\beta}_p \; + e_{pt}$$

where

$r_{pt} - r_{ft}$	is the excess return of portfolio *i* for month *t*
$\hat{\beta}_p$	is the beta estimate obtained earlier

Running the above regression for each month consists of nine pairs of beta coefficients that relate to the number of portfolios.

To draw conclusions from the findings in table 3, the following hypothesis is used[8]:
Hypothesis 1: $\lambda_0 = 0$. If true, no other factors than the beta affect the CAPM.
Hypothesis 2: $\lambda_1 > 0$. If true, there is a positive linear relationship between systematic

[7] Fama, E. F. and French, K. R. (1992), The Cross-Section of Expected Stock Returns. *The Journal of Finance*, 47: 427–465.
[8] Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *The Journal of Political Economy*, 607-636.

risk and expected return.

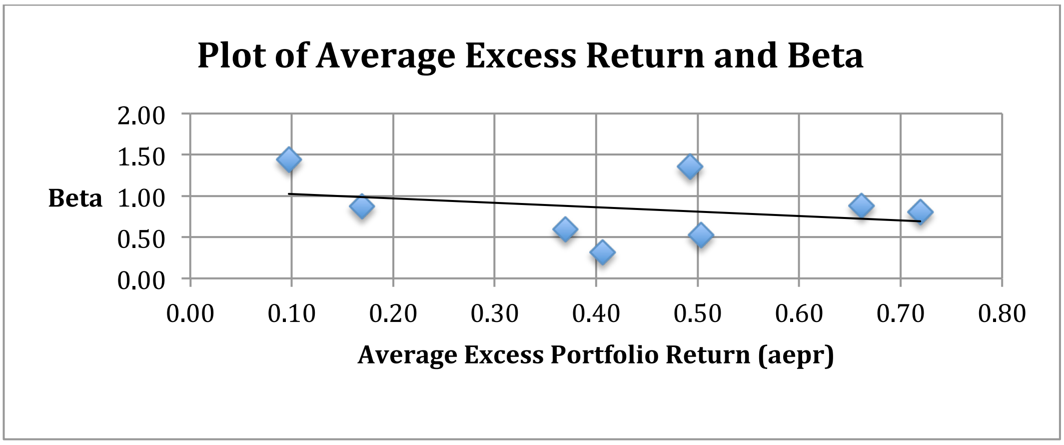
Hence, if the CAPM is correct, then λ_0 must be zero. In my estimate, λ_0 is larger than zero. The above, however, must hold for the CAPM to be correct since it accounts for the assumption that solely beta explains stock returns. Clearly, the CAPM is not able to explain returns fully. Moreover, if the CAPM is correct a predictor, then λ_1 must be larger than zero. Again, this does not hold in the empirical testing on the Dutch stock market. A summary of the results is found below in table 3. In figure 1 the finding that $\lambda_1 < 0$ is confirmed. In other words, there exists a negative relationship between systematic risk and expected return for the sample period.

Table 3: Cross-sectional regression statistics of the total sample period

Statistic (January 2004 - January 2014)	*Λ0*	*Λ1*
Average	0,81776	-0,6618
t-statistic of average	1,50294	-1,17198
p-value of average	0,17656	0,27954

As mentioned previously, it is expected that when average excess returns is plotted against beta, a positive linear relationship can be found. This implies systematic risk is compensated with excess return in the market. If the actual excess return of the stock is different from the value calculated by CAPM, there will be an intercept, which implies that the fundamentals of the CAPM will be violated. Figure 1 serves to confirm the findings in the cross-sectional regression: the CAPM is not able to proof that it is able to provide results that could validate its use. The main reason is likely that the assumption of risk-return trade-off found by Fama and MacBeth (1973) is not found for the sample period on the Dutch stock market. Therefor the results are likely to be erroneous.

Figure 1: Plot of average excess portfolio returns on beta. Clearly a negative relation is found, contrary to what the CAPM theory tries to prove: systematic risk must be compensated with excess return in the market.



Alternative testing of the CAPM

Fama and French (1993) conducted an alternative testing procedure in which they constructed portfolios for the CAPM according to size and value, as opposed to sorting portfolios on beta and size. One of their findings is that the alpha (intercept) of low (BE/ME) firms is generally lower than firms with a high (BE/ME). Moreover, they argued that the t-statistic increases in the same pattern. That is, growth firms tend to have larger absolute t-statistics compared to value firms. The most important takeaway from their findings is that if they appear to hold, it serves to proof that the CAPM does not do so well. Clearly, the alternative testing of the CAPM confirms the limitations of the model found in previous paragraphs. In table 4 the data is summarized.

Table 4: Data on six value-weighted portfolios to measure CAPM validity

	SMALL			**BIG**		
	VALUE	NEUTRAL	GROWTH	VALUE	NEUTRAL	GROWTH
CAPM						
ALPHA	0,2988	-0,4736	-0,7902	-0,2140	0,1587	-0,2788
Standard Error	0,3768	0,3273	0,4055	0,3635	0,1832	0,1962
T Statistic	0,7929	-1,4470	-1,9485	-0,5887	0,8664	-1,4210

Conclusion

The CAPM is one of the first asset pricing models to be applied in security valuation[9]. It has been exposed to extensive testing throughout the past decades, which is followed by much criticism. In the above empirical tests: the time-series regression, the cross-sectional regression and the alternative testing presented by Fama and French, it has become clear that the results suggest that the standard CAPM is not able to provide results which could validate its use as a robust model on the Dutch stock market. The main reasons for the limitations are likely a result of the violation of the risk-return trade-off found in the sample period. Moreover, the sample size is perhaps too small and may distort the results. In the subsequent chapters two alternative multi-factor models are presented and their empirical findings are discussed.

[9] Shaikh, S. A. Testing Capital Asset Pricing Model on KSE Stocks. *Journal of Managerial Sciences* Volume VII Number, 2, 282.

3.2. Fama-French Three Factor Model

Portfolio formation

The portfolio formation procedure for the Fama and French Three Factor model is somewhat different from the one that is used for the CAPM. It involves two additional factors Fama and French found to be, at least partially - yet significantly - explaining security returns. These factors are: SMB, which denotes the return of **S**mall-**M**inus-**B**ig firms, and HML, which denotes the return of **H**igh-**M**inus-**L**ow firms. Six portfolios are constructed through the intersection of both Size (SMB) and Value (HML). The result is the following set of portfolios: Small Value, Small Neutral, Small Growth, Big Value, Big Neutral and Big Growth. Again, a Venn diagram is used to alleviate sorting issues.

In order to calculate the SMB and HML factor for each time period *t* in the sample period, the following method is applied[10]:
1. Categorize all stocks included in the sample in order of size. The 50% largest firms are labeled BIG and the 50% smallest firms are labeled SMALL.
2. Categorize all stocks included in the sample based on the book-to-market equity ratio (BE/ME). Rank the stocks in three groups. The largest 30% is labeled Value, the middle 40% is labeled Neutral and the remaining 30% is labeled Growth.
3. For each year, the following six portfolios are constructed: Big Growth (BG), Big Neutral (BN), Big Value (BV), Small Growth (SG), Small Neutral (SN) and Small Value (SV). These are a product of the intersection of any two factors size and value.
4. For each time t in the sample period, the factor SMB_t is computed: ⅓ (SV + SN + SG) - ⅓ (BV + BN + BG)
5. Similarly, the factor HML_t is computed as follows: ½ (SV + BV) - ½ (SG + BG)

In table 5, the number of companies in portfolios formed on Size and Value are summarized. A noteworthy observation is that small size firms on average tend to have a larger number of high (BE/ME) firms, whereas large size firms on average tend to include more neutral to low (BE/ME) firms. As expected, the number of small stock portfolios is similar in size to the number of large stock portfolios. Indeed, the division point is the median.

[10] Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, 33(1), 3-56.

On average, there are an equal number of portfolios across small and large firms sorted on (BE/ME). However, a negative relationship seems to hold for Value and Growth portfolios across Size, where the SV portfolio holds an average of 13 firms, whereas the BV portfolio holds an average of 10 portfolios. On the contrary, the SG portfolio holds an average of only 9 firms, whereas the BG portfolio holds an average of 14 firms. When we assume that high book-to-market equity ratios signal an elevated risk of financial distress, the above results indicate that small size firms tend to be more in distress. Alternatively, the relative large number of firms in the SV may indicate that, indeed, small firms are more undervalued than their larger counterparts.

Table 5: Number of Companies in portfolios sorted on Size and Value

YEAR	SV	SN	SG	BV	BN	BG
2013-2014	17	15	7	6	17	16
2012-2013	15	14	10	8	18	13
2011-2012	15	15	9	8	17	14
2010-2011	14	15	10	9	17	13
2009-2010	11	15	13	12	17	10
2008-2009	12	18	9	11	14	14
2007-2008	11	19	9	12	13	14
2006-2007	12	17	10	11	15	13
2005-2006	12	18	9	11	14	14
2004-2005	15	16	8	8	16	15
AVERAGE	**13**	**16**	**9**	**10**	**16**	**14**

Fama and French offer an extensive database for different portfolio dimensions and characteristics, including all factors required to compute multifactor model output[11]. Unfortunately, there is no Dutch database available on their website. Since the factors are market specific, I had to manually compute all two factors for every month *t* across the portfolios. That sums to a total of 240 factor variables.

Table 6 presents further insights in the actual magnitude of the book-to-market ratio and the size of the firms represented in each one portfolio. As can be observed, the average market capitalization of small firms is around € 200 million. The dispersion is relatively minor, as opposed to the dispersion across big firms. Here we can see that the dispersion is relatively large. Furthermore, it is clear that large firms with a low (BE/ME) ratio have the lowest average firm size. Clearly, the firms included in BV portfolios have an above average

[11] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html

(BE/ME) ratio, whereas the firms included in the BG portfolios have a very low (BE/ME) ratio.

Table 6: Average firm size in millions of euros and average book-to-market ratio across the six different portfolios for the sample period.

			BOOK TO MARKET EQUITY			
SIZE	**VALUE**	**NEUTRAL**	**GROWTH**	**VALUE**	**NEUTRAL**	**GROWTH**
	AVERAGE FIRM SIZE (MILLION €)				*AVERAGE (BE/ME)*	
SMALL	189,9172	212,8694	199,8040	1,6325	0,8504	0,3183
BIG	9771,7898	11934,4001	7274,2338	1,4953	0,7289	0,3654

The mean monthly excess returns of the six different portfolios are presented in table 7. Note that only three out of six portfolios yield positive excess returns during the sample period. Arguably, the reason is the economic downturn from 2007 to 2011 that is incorporated fully in the computation of the sample period excess returns.
With the exception of the BV portfolio, large firms heavily outperform small firms during the sample period. This finding is inconsistent with the findings of Fama and French (1993) who argue that small firms are more risky thus yield higher expected excess returns. There is no notable difference in the standard deviations across portfolios. This implies that big firms offer a higher return at equal volatility. This particular finding concludes that there is no clear risk/return trade-off or implies irrationality in investing behavior. In the last row of the table the finding of the big firm effect is confirmed. Indeed, BN and BG firms do better than their small counterparts. Interestingly, the standard deviations of BV and BN firms are larger than their small counterparts.

Table 7: Average excess portfolio returns and the corresponding standard deviations for the sample period for all six portfolios. In the last row the difference between small and big size portfolios is represented.

			BOOK TO MARKET EQUITY			
SIZE	VALUE	NEUTRAL	GROWTH	VALUE	NEUTRAL	GROWTH
		MEANS			STANDARD DEVIATIONS	
SMALL	0,46%	-0,31%	-0,60%	5,73%	5,58%	6,47%
BIG	0,01%	0,37%	-0,10%	6,97%	5,81%	5,14%
δ (S-B)	0,44%	-0,68%	-0,51%	-1,23%	-0,23%	1,33%

If we look in table 8, we see that the SMB factor, which measures the big size effect, is negative. This is inconsistent with findings on the U.S. stock market where it was found that small firms outperformed big firms. Furthermore, the value for the mean excess market return is quite low. The economic turmoil in Europe and across the globe is most likely to be the main cause. The value effect shown by the HML factor is consistent with findings of Fama and French (1993). They found that high book-to-market ratio firms have higher returns compared to their lower counterparts. The reason can be attributed to the riskiness inhibited by the former firms.

Table 8: Mean and Standard Deviation for the three factors for the sample period

Name	Mean	Std.
RM-RF	0,22	5,50
SMB	-0,25	2,96
HML	0,58	3,78

Summarizing, the above implies the following for the Dutch stock market during the sample period: Risk loving investors, who seek additional risk, should invest in big firms. Similarly, risk-averse investors should opt to invest in big firms as well. Interestingly, the big firm effect is present, which contrasts to Fama and French, who argue that small firms offset higher risk with higher returns. This is surely not the case for the sample period. The value effect found does align with findings of Fama and French and is consistent with the assumption of the Value premium found on the U.S. stock market.

Lastly, table 9 consists of the tests of the correlations coefficients of all three factors for the entire sample period. This test is done to compare against the correlation effects found by Fama and French. The correlation structure of the explanatory variables clearly indicates that the risk factors SMB and HML have an effect on market betas. Fama and French find the same results.

Table 9: Correlation coefficients of the Market, Size and Value factor for the sample period.

	RM-RF	SMB	HML
RM-RF	1,00	-	-
SMB	0,32	1,00	-
HML	0,05	0,16	1,00

Regression analysis

The purpose of running the regression is to obtain the estimate coefficients on alpha, RM-RF, SMB and HML. These estimates tell us something about the exposure to the various dimensions. The regression is denoted as:

$$r_{it} - r_{ft} = \alpha_i + \beta_i (r_{Mt} - r_{ft}) + s_i SMB_t + h_i HML_t + e_{it}$$

where

$r_{it} - r_{ft}$	is the excess return of portfolio *i* for month *t*
r_{Mt} - r_{ft}	is the market risk premium for month *t*
SMB_t	is the SMB factor for each month *t*
HML_t	is the HML factor for each month *t*

Table 10: Sample statistics for the six weighted portfolios for the entire sample period. For each coefficient estimate a corresponding p-value is denoted. In the bottom part of the table the adjusted R^2 is summarized.

SIZE	VALUE	NEUTRAL	GROWTH	VALUE	NEUTRAL	GROWTH
		α			**P-Value**	
SMALL	0,08121	-0,3086	-0,36615	0,65174	0,23432	0,196
BIG	-0,58748	0,13408	-0,14013	0,05217	0,47327	0,42249
		b			**P-Value**	
SMALL	0,8757	0,9196	1,0354	0,E+0	0,E+0	0,E+0
BIG	0,9982	0,9939	0,8385	0,E+0	0,E+0	0,E+0
		s			**P-Value**	
SMALL	0,9923	0,8109	0,9574	0,E+0	1,587E-14	3,330E-16
BIG	-0,1459	0,0174	-0,111	0,17535	0,79414	0,07703
		h			**P-Value**	
SMALL	0,7389	0,0095	-0,386	0,E+0	0,88944	0,E+0
BIG	0,5943	0,049	-0,2809	1,486E-11	0,32275	0,E+0
		Adj. R^2				
SMALL	0,88565	0,7501	0,77867			
BIG	0,78434	0,87999	0,86586			

The results of this regression are summarized in table 10. We can find that the alpha estimates differ from zero. This does not necessarily imply that the robustness of the model can be refuted. Note that if the factors would perfectly explain excess returns, the alpha coefficient will be indistinguishable from zero. When we include all three factors in the regression we

can see that most of the intercepts are no larger than 0,59 and relatively close to zero. The intercept is particularly useful as a benchmark to compare against other models.
When we look at the beta estimate of excess market returns it becomes clear that these coefficients are positive and close to one. If we look at the p-values we find statistical significance at the 5% level. Further down the line we find the coefficient estimates for the SMB factor. Four out of six take positive values. Interestingly, all three small size portfolios take positive values. The estimates for big size portfolios are either negative or basically zero. Fama and French had shown that small firms load positively and big firms load negatively on SMB. Thus, this finding is consistent with their research. Moreover, the small size portfolios show statistical significance for the s coefficient at the 5% level. Lastly, the coefficient estimates for the HML factor. Here we find statistical significance for all but two portfolios. SN and BN portfolios have a factor loading on the HML factor that is insignificant at the 5% level. This finding corresponds to prior findings of Fama and French who show that high book-to-market ratio firms load positively and low book-to-market firms load negatively on HML.

Further support of the robustness of the model is found in the R^2 statistic. This will give some information about the goodness of fit of a model. In regression, the R^2 coefficient of determination is a statistical measure of how well the regression line approximates the real data points. An R^2 of 1.0 indicates that the regression line perfectly fits the data. The adjusted R^2, which is used as a tool for measurement in this thesis, is merely a slight modification of R^2 that adjusts for the number of explanatory terms in the model. The adjusted R^2 in the regression analysis is anywhere in the range of 0,75 to 0,89. This implies that, on average, the model explains approximately 83% of the variation.

In order to better understand the true validity of the regression analysis, every one portfolio is regressed on the three factors. That is, the excess returns for the whole period for every portfolio is the dependent variable. The factors MKT-RF, SMB and HML serve as independent variables in the analysis. Also, regressions are carried out for three sub periods of the sample period.

Table 11: Whole period and sub-period regressions of excess returns on factors with their corresponding standard error and t-statistic.

FF3FM (total)	**SV**	**SN**	**SG**	**BV**	**BN**	**BG**
ALPHA	0,081	-0,309	-0,366	-0,587	0,134	-0,140
Standard Error	0,179	0,258	0,282	0,299	0,186	0,174
T Statistic	0,453	-1,196	-1,301	-1,962	0,720	-0,805

FF3FM SP	SV	SN	SG	BV	BN	BG
(SUBPERIODS FF3FM)						
Jan 2004 - April 2007						
ALPHA	-0,283	0,713	-0,093	0,260	0,006	0,070
Standard Error	0,297	0,362	0,491	0,465	0,384	0,297
T Statistic	-0,953	1,973	-0,190	0,560	0,016	0,236
May 2007 – Au 2010						
ALPHA	0,189	-0,588	-0,972	-1,361	0,189	-0,199
Standard Error	0,398	0,571	0,514	0,626	0,384	0,368
T Statistic	0,476	-1,029	-1,893	-2,174	0,492	-0,541
Sep 2010 - Dec 2013						
ALPHA	-0,215	-0,665	-0,319	-0,702	0,102	-0,598
Standard Error	0,305	0,422	0,534	0,476	0,313	0,300
T Statistic	-0,705	-1,573	-0,597	-1,474	0,325	-1,992

In the table above we find that the t-statistics for all but one portfolio regression is smaller than two. Indeed, Fama and French argue that there are not many portfolios for which the t-statistic is larger than 2 when using the Fama and French Three Factor Model compared to the CAPM. In fact, all but one t-statistic is significantly smaller for the Three Factor Model compared to the CAPM.

Conclusion

The Fama and French Three-Factor Model proves to be slightly better in predicting results compared to the CAPM. We can see that the explanatory variables SMB and HML that have been added to the CAPM can do a better job in explaining the excess stock returns. The intercepts of the Three-Factor model are clearly lower and thus, adding Size and Value as an extension to the CAPM does better explain effects on average excess stock returns in the sample period.

In the following paragraph the last multifactor model is discussed. A similar analysis is run and findings are compared to the CAPM and Fama and French Three-Factor Model to see if the momentum factor is of any use in better explaining excess stock returns.

3.3 The Carhart Four Factor Model

Jegadeesh and Titman (1993) had found that stocks with higher returns in the previous twelve months have a tendency to set forth this trend for the subsequent periods. The Fama and French Three Factor Model cannot capture the so-called momentum effect. Carhart (1997) created an extension to the Three-Factor Model by adding a fourth factor called momentum. In the following paragraphs we will see what results this added factor, as an extension to the Three-Factor model will have.

Portfolio formation

The portfolio formation procedure is as follows: six weighted portfolios are formed on Size and prior 12-month returns. This differs from the formation procedure of the Three-Factor model in that Value instead of Prior Returns is used. The six portfolios are the result of the intersection of three portfolios formed on prior returns and two portfolios are formed on size. The breakpoints for prior returns are 0% to 30%, 30% to 70% and 70% to 100% respectively. The size breakpoints remain the same is the median of the entire sample. The UMD, also known as the momentum (mom) factor is computed in the following way[12]:

$$UMD = \tfrac{1}{2}\,(S / U + B / U) - \tfrac{1}{2}\,(S / D + B / D)$$

This computation can be interpreted as the average return on two high prior return portfolios minus the average return on the two low prior return portfolios. Once the MOM factor is computed, we can continue in the same way as we did for the Three-Factor Model procedure. That is, the same six portfolios based on Size and Value is used to run regressions. Note that the formation procedure is merely done to compute the MOM factors, and not to run the regression. If this would be true, the regression results would not make any sense. Hence, in the sake of comparison we follow the same procedure as Fama and French did.

If we look in table 12, we see a replication of data found in the previous chapter. In the sake of clarity only the MOM factor will be briefly discussed, which is new to this table.
The mean of 0,84 of the MOM factor indicates that, for the sample period, there has been a notable difference in the average returns on the two up-monthly and down-monthly portfolios within a 12-month period. Furthermore it indicates that stocks do well relative to the market

[12] Carhart, M. M. (1997). On persistence in mutual fund performance. *The Journal of finance*, 52(1), 57-82

over the last 12 months and have a tendency to continue doing so for the subsequent periods. Conversely, stocks that do poor relative to the market over the last 12 months have a tendency to continue doing so for the subsequent periods. This finding is promising since is aligns with findings of Carhart (1997) and Jegadeesh and Titman (1993) however not sufficient yet to support claims of the Four-Factor superiority to the Three-Factor Model.

Table 12: Mean and Standard Deviation for the four factors for the sample period

Name	Mean	Std.
RM-RF	0,22	5,50
SMB	-0,25	2,96
HML	0,58	3,78
MOM	0,84	4,00

Lastly, before analyzing the coefficient estimates, we take a look at the correlation structure of the different factors. Here is it found that the risk factors SMB and MOM have an effect on market betas; a similar finding compared to Fama and French.

Table 13: Correlation coefficients of the Market, Size, Value and Momentum factor for the sample period.

	RM-RF	SMB	HML	MOM
RM-RF	1,00	-	-	-
SMB	-0,32	1,00	-	-
HML	0,05	-0,16	1,00	-
MOM	-0,35	0,01	-0,40	1,00

Regression analysis

The purpose of running the regression is to obtain the estimate coefficients on alpha, RM-RF, SMB, HML and MOM. These estimates tell us something about the exposure to the various dimensions. The regression is denoted as:

$$r_{it} - r_{ft} = \alpha_i + \beta_i (r_{Mt} - r_{ft}) + s_i SMB_t + h_i HML_t + m_i MOM_t + e_{it}$$

where

$r_{it} - r_{ft}$ is the excess return of portfolio *i* for month *t*

$r_{Mt} - r_{ft}$ is the market risk premium for month *t*

SMB_t is the SMB factor for each month *t*

HML_t is the HML factor for each month *t*

MOM_t is the MOM factor for each month *t*

The results of the regression analysis are presented in table 14. Again, we see that the alpha is not exactly zero. The largest absolute value of alpha is no more than 0,57. Now that all four factors are included in the regression analysis we have laid a foundation to compare against the alternative models. The intercept will be used as a benchmark for comparison.
The beta estimate of excess market returns is positive and close to one. The p-values reveal statistical significance at the 2% level. Three out of six SMB estimate coefficients take positive values. Not surprisingly, the three small size portfolios take on positive values, where the three big size portfolios don't. The same result is found for the regressions on the Fama and French Three Factor model. This corresponds to previous findings that small firms load positively and big firms load negatively on SMB. We continue on to discuss the coefficient estimates for the HML factor. Here we find statistical significance for all but two portfolios. SN and BN portfolios have a factor loading on the HML factor that is insignificant at the 5% level. This finding corresponds to prior findings of Fama and French who show that high book-to-market ratio firms load positively and low book-to-market firms load negatively on HML. Lastly, we take a look at the newly added momentum factor as an extension to the Three-Factor model. It is found that there exists some momentum effect in excess stock returns, however surprisingly minor. In fact, it is arguable whether the present momentum effect can be justified and, more specifically, is sufficient a proof to say that the explanatory power of the Four-Factor model is more robust.

To complete the regression analysis we discuss about the goodness of fit of the model. The adjusted R^2 for the four factor regressions ranges from 0,75 to 0,89. The four-factor model compared to the three-factor model explains an approximately similar variation.

Table 14: Sample statistics for the six weighted portfolios for the entire sample period. For each coefficient estimate a corresponding p-value is denoted. In the bottom part of the table the adjusted R^2 is summarized.

SIZE	VALUE	NEUTRAL	GROWTH	VALUE	NEUTRAL	GROWTH
		α			P-Value	
SMALL	0,10803	-0,21539	-0,27477	0,56923	0,42835	0,35499
BIG	-0,51306	0,26119	-0,13026	0,10639	0,17833	0,47975
		b			P-Value	
SMALL	0,86885	0,8957	1,012	0,E+0	0,E+0	0,E+0

BIG	0,97916	0,96137	0,83602	0,E+0	0,E+0	0,E+0
		s			P-Value	
SMALL	0,98655	0,79092	0,93779	0,E+0	1,159E-13	2,442E-15
BIG	-0,16184	-0,00982	-0,11309	0,141	0,8834	0,07815
		h			P-Value	
SMALL	0,7282	-0,02765	-0,42245	0,E+0	0,71659	0,E+0
BIG	0,56456	-0,00167	-0,28479	0,	0,9754	0,
		m			P-Value	
SMALL	-0,02454	-0,08531	-0,08363	0,64588	0,26578	0,31747
BIG	-0,06811	-0,11634	-0,00903	0,44438	0,03425	0,86169
		Adj. R2				
SMALL	0,88486	0,75064	0,77869			
BIG	0,78358	0,8836	0,86473			

In order to better understand the true validity of the regression analysis, every one portfolio is regressed on the four factors. That is, the excess returns for the whole period for every portfolio is the dependent variable. The factors MKT-RF, SMB, HML and MOM serve as independent variables in the analysis. Also, regressions are carried out for three sub periods of the sample period.

We can see that t-statistics are generally below 1 and no larger than 2,2 in one instance. The absolute alpha (intercept) values are at no point larger than 1 but generally below 0,5.

Table 15: Whole period and sub-period regressions of excess returns on the four factors with their corresponding standard error and t-statistic for the Carhart Four-Factor Model

C4FM (total)	**SV**	**SN**	**SG**	**BV**	**BN**	**BG**
ALPHA	0,108	-0,215	-0,275	-0,513	0,261	-0,130
Standard Error	0,189	0,271	0,296	0,315	0,193	0,184
T Statistic	0,571	-0,795	-0,929	-1,627	1,354	-0,709

C4FM SP	**SV**	**SN**	**SG**	**BV**	**BN**	**BG**
(SUBPRDS C4FM)						
Jan 2004 - Apr 2007						
ALPHA	-0,320	0,542	-0,509	-0,113	-0,251	0,077
Standard Error	0,337	0,405	0,533	-0,320	0,424	0,336
T Statistic	-0,949	1,339	-0,955	0,352	-0,592	0,229
May 2007 - Au 2010						
ALPHA	0,197	-0,559	-0,938	-1,328	0,221	-0,193
Standard Error	0,401	0,548	0,471	0,598	0,329	0,371
T Statistic	0,492	-1,020	-1,992	-2,219	0,673	-0,519

Sp 2010 - Dec 2013						
ALPHA	-0,123	-0,520	-0,104	-0,465	0,201	-0,483
Standard Error	0,324	0,449	0,565	0,498	0,333	0,318
T Statistic	-0,379	-1,159	-0,185	-0,932	0,602	-1,518

Conclusion

The added momentum factor to the three-factor model appears to very marginally contribute to the explanatory power of the Carhart Four-Factor Model. In the regressions it has become clear that the momentum factor is present across all portfolios. It is found that there exists some momentum effect in excess stock returns, however surprisingly minor. The intercept (alpha) tells us that, relative to the Three-Factor model, the Four-Factor model does only slightly better. This contrast to the findings of Carhart (1997) in the U.S. stock market who argued that the momentum factor would significantly improve the results. The reason may be the negative loading of the SMB factor, which contrast previous findings. Since MOM is present across all portfolios for the sample period, the SMB factor may distort the results as Carhart (1997) had tested the model in absence of the big firm effect, which is present in this sample period analysis.

4. CONCLUSION

The aim of this thesis has been to evaluate the robustness of the CAPM, the Fama and French Three-Factor Model and the Carhart Four-Factor Model. In view of past asset-pricing research literature on the U.S. stock market a same method is applied to the Dutch stock market to see how each of the models performs in explaining excess returns. The sample covers 120 monthly observations for the sample period January 2004 to January 2014. In this study it is found that, contrary to what Fama and French (1993) found, big firms outperform small firms. In other words, investors holding large cap stocks seem to enjoy higher returns than investors holding small cap stocks. This so-called 'big firm premium' contradicts the small firm premium found on the U.S. stock market. Furthermore, there appears to be a positive value effect. Firms with a high (BE/ME) perform better than firms with a low (BE/ME). This finding is consistent with the findings of Fama and French (1993) and the findings of Carhart (1997) on the U.S. stock market. The momentum factor, which cannot be explained by the three-factor model or the CAPM, appears to be present on the Dutch stock market for the sample period.

Based on previous empirical testing it is expected that the alpha of the (multi-factor) models is anywhere in the range of zero. The latter would imply that the model as a whole explains the expected returns well. The empirical findings of this thesis prove however, that the alphas are not (close to) zero. This especially holds for the CAPM model and to a lesser extent for the multi-factor models. The second-pass regression of the CAPM yields coefficient results that question the power of the model. This can be explained by the negative relationship between beta (risk) and average return for stocks on the Dutch stock market. The Fama and French Three-Factor model does slightly a better job in explaining the excess stock returns than the CAPM does. The intercept estimates across all portfolios are lower than those found using the CAPM. Furthermore, Fama and French argue there are not many portfolios for which the t-statistic is larger than 2 when using the Fama and French Three Factor Model compared to the CAPM. In fact, all but one t-statistic is significantly smaller for the Three Factor Model compared to the CAPM. Nonetheless, the three-factor model did not perform as expected. The distortion of results is mainly caused by the inverse relationship of firm size and excess stock returns. By including the last fourth factor called momentum, it is found that across all portfolios a momentum tendency is present. This coincides with previous findings of Carhart (1997) and Jegadeesh and Titman (1993) who had shown that the four-factor model was able to capture the effect of the continuation of short-term excess returns. Despite the fact that the momentum factor has been included, the alphas across the weighted portfolios only slightly decreased compared to the three-factor model.

There are many warning signs about the validity of the results and their appropriateness for investment decisions. Through this thesis, it is found that the four-factor model is only slightly better than the three-factor model. The CAPM ranks last in explaining excess returns for the sample period. The most serious contradiction is the fact that beta and return are negatively related for the sample period. The findings about the risk premium appear to suggest that there is time-period bias or a data-fishing bias in the data. Data-fishing may be caused by the use of multiple factors in the model. A possibility is that there is no true causal relation in the series, which makes the regression illegitimate. Moreover, the big market effect contradicts previous literature, which implies that on average, small firms do better. The above contradictions and inverse risk-return relationship seem to distort the robustness of the models in explaining excess stock returns. Therefore, further testing in different sub periods is necessary. It is also recommended to use a larger sample size in order to prevent time-period bias. Lastly, it is worth mentioning that these models were tested on the U.S. stock market, which is significantly larger. The relative small size of the Dutch stock market in terms of firms compared to the U.S. stock market is also likely to distort the results.

5. REFERENCES

- Bhole, L.M., & Mahakud, J. (2009) *Financial Institutions and Markets: Structure, Growth and Innovations 5th ed.* Tata McGraw-Hill

- Carhart, M. M. (1997). On persistence in mutual fund performance. The Journal of finance, 52(1), 57-82.

- Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *The Journal of Political Economy*, 607-636.

- Fama, E. F., & French, K. R. (2004). The capital asset pricing model: theory and evidence. *Journal of Economic Perspectives*, 25-46.

- Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, 33(1), 3-56.

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

- French, Craig W. (2003). The Treynor Capital Asset Pricing Model. *Journal of Investment Management 1 (2),* 60–72.

- Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of Finance*, 48(1), 65-91.

- Ross, S. A. (1976). The arbitrage theory of capital asset pricing. *Journal of economic theory*, *13*(3), 341-360.

- Shaikh, S. A. Testing Capital Asset Pricing Model on KSE Stocks. *Journal of Managerial Sciences* Volume VII Number, 2, 282.

6. APPENDIX

Firms	
AALBERTS INDUSTRIES	HES - BEHEER
ACCELL GROUP	HOLLAND COLOURS
AEGON	HYDRATEC INDUSTRIES
AFC AJAX	ICT AUTOMATISERING
AHOLD KON.	ING GROEP
AIR FRANCE-KLM	KARDAN N V
AKZO NOBEL	KAS BANK
AMSTERDAM COMMODITIES	KENDRION
AND INTL.PUBLISHERS	KPN KON
ARCADIS	LAVIDE HOLDING
ASM INTERNATIONAL	MACINTOSH RETAIL
ASML HOLDING	MTY HOLDINGS
BALLAST NEDAM	NEDAP
BAM GROEP KON.	NEDSENSE ENTERPRISES
BATENBURG TECHNIEK	NEWAYS ELEC.INTL.
BE SEMICONDUCTOR	NIEUWE STEEN INV.
BETER BED HOLDING	NUTRECO
BEVER HOLDING	ORDINA
BINCKBANK	PHILIPS ELTN.KONINKLIJKE
BOSKALIS WESTMINSTER	PORCELEYNE FLES
BRILL (KON.)	RANDSTAD HOLDING
BRUNEL INTL.	REED ELSEVIER (AMS)
CORBION	ROODMICROTEC
CORIO	ROYAL DUTCH SHELL A
CROWN VAN GELDER	ROYAL IMTECH
CTAC NM	SAINT GOBAIN
DOCDATA	SBM OFFSHORE
DPA GROUP	SLIGRO FOOD GROUP
DSM KONINKLIJKE	TELEGRAAF MEDIA GROEP
EUROCOMMERCIAL	TEN CATE
EXACT HOLDING	TKH GROUP
FUGRO	UNIBAIL-RODAMCO
GEMALTO	UNILEVER CERTS.
GRONTMIJ	UNIT 4
GROOTHANDELSGEB.	USG PEOPLE
HAL TRUST	VASTNED RETAIL
HEIJMANS	VOPAK
HEINEKEN	WERELDHAVE
HEINEKEN HLDG.	WOLTERS KLUWER

COEFFICIENT		VALUE	NEUTRAL	GROWTH
b(MKT-RF)	BIG	0,9982	0,9939	0,8385
s(SMB)		-0,1459	0,0174	-0,111
h(HML)		0,5943	0,049	-0,2809
b(MKT-RF)	SMALL	0,8757	0,9196	1,0354
s(SMB)		0,9923	0,8109	0,9574
h(HML)		0,7389	0,0095	-0,386

COEFFICIENT		VALUE	NEUTRAL	GROWTH
b(MKT-RF)	BIG	0,97916	0,96137	0,83602
s(SMB)		-0,16184	-0,00982	-0,11309
h(HML)		0,56456	-0,00167	-0,28479
m(MOM)		-0,06811	-0,11634	-0,00903
b(MKT-RF)	SMALL	0,86885	0,8957	1,012
s(SMB)		0,98655	0,79092	0,93779
h(HML)		0,7282	-0,02765	-0,42245
m(MOM)		-0,02454	-0,08531	-0,08363