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Master Thesis – HEC Paris 2017

A 5-Factor Risk Model for European Stocks

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“The wise man listens to meaning; the fool only gets the noise”

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Abstract

The objective of this master thesis is to calculate a five-risk factor model for the European stock market by replicating Fama and French (2015). Consistent with Fama and French (2015) results, this research shows that value, profitability and investment risk factors play an important role in assessing the expected return of an asset. These results shed light on the relation between the risk factors in North America and the risk factors in Europe.

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Introduction

1. Motivation

According to the efficient markets hypothesis (EMH), current stock prices reflect all available information about the firm value, or equivalently, one cannot earn excess profits by using this information. The informational efficiency of market prices is an important concept to a portfolio manager and to the whole finance industry. When markets are truly efficient, thorough analysis and security selection using public information does not lead to positive risk-adjusted returns. In a perfectly efficient market, investors should choose passive investment strategies as active investment strategies tend to underperform because of transaction costs and management fees. However, active management can generate positive risk adjusted returns when prices are inefficient. Abnormal profit calculations are often used to test market efficiency. To calculate abnormal profits, the expected return for a trading strategy is calculated given its risk, using a model of expected returns. If returns are, on average, greater than equilibrium expected returns, we can reject the hypothesis of efficient prices with respect to the information on which the strategy is based. (Schweser Notes 2015)

Sharpe (1964) and Lintner (1965) are the first to introduce the CAPM, one of the most known and used model to calculate expected returns. CAPM allows to calculate the expected return of a stock or portfolio given its volatility or systematic risk, or equivalently its market beta. CAPM's major flaw is its inability to explain the observed market returns of small and value stocks. Stocks with these characteristics show persistently higher returns than CAPM can explain.

These anomalies are problematic to the finance community. Fama and French (1992) demonstrate that size, earning-price, debt-to-equity, and book-to-market ratios can complement market factor (beta introduced by CAPM) and provide a better explanation of expected stocks returns than that provided by market beta alone. The three-factor model explains the abnormal higher returns of value and small companies. Nevertheless, evidence shows the three-factor model does not explain certain anomalies in expected returns related to profitability and investment.

Fama-French (2015b) develop the five-factor model to explain these anomalies. The five factor model includes two new factors: profitability and investment. Fama and French (2015b) focus their results on the North American market. The five-factor model allows to calculate the expected return of a stock or portfolio as a combination of its exposure to value, size, profitability, investment and market factor. We believe that extending Fama and French five risk factor analysis of the North American stocks to the European investment scenario is essential.

Investors rely on active managers to outperform the market and earn superior returns on their investments. However, data suggests that overall, the active management industry does not outperform the market – not even before fees, (Fama and French 2010). For instance, in Spain the average return of the investment funds over the past 15 years (1.90%) was lower than that of the Spanish main index, IBEX 35 which returned an average 4.6%. From the 632 existing investment funds in Spain with more than 15 years, only 18 managed to beat the return of the Spanish 15-year government bonds, 27 beat the IBEX 35 and 82 had a negative return. (Pablo Fernandez 2016).

In order to obtain above-average returns, investors should choose the right manager, one who has been able to beat the market and other managers consistently. However, an underlying question is whether the managers that have been able to beat the market have done so as a result of their skill or by simple chance. In light of this fact, Fama and French compared the performance of US fund managers from 1984 to 2006 to the performance of some simulated random portfolios. Their research shows that managers who focus in value and small-cap portfolios consistently outperform the market. For this reason, they claim that a manager's historical outperformance can be explained by two factors – *value* and *size.*

In finance there exist two main schools of thought: the rational school (an important exponent of which is Eugene Fama) and the behavioral school (an important exponent of which is Robert Shiller). These two schools provide different explanations for the outperformance of the size and value factors. According to the rational view, investors are sophisticated, informed and make rational decisions. Under this scenario, financial

markets are efficient and investors cannot earn excess risk adjusted returns or equivalently, it is not possible to earn *alpha*. This school of thought states that fund managers are only able to achieve higher returns by taking on higher risks. Fama and French share this view. According to them, the outperformance of small value firms can be explained in terms of risk. Higher expected returns are a direct result of the greater risks to which these firms are subject to.

However, higher risk was never found or accounted for when investing in firms with low market capitalization. According to Eugene Fama: *"'I've spent a good part of the last 40 years testing those [asset pricing] models. And a result of a lot of that is the so-called Fama-French three-factor model. It's widely used both by academics and in industry. [He chuckles.] I'm laughing because the theoretical basis for the model is quite shaky.' (New York Times 2013)*.

On the other hand, proponents of the *behavioral* school of thought believe that humans tend to form biased beliefs. For instance, Kahneman and Tversky (1979) argue that utility theory is not an adequate descriptive model to account for choice under risk. This school of thought documents numerous psychological biases – confirmation bias, conservatism bias, halo effect, availability bias and so forth - which impede the rational behavior of investors and thus bring inefficiencies to the financial markets. According to this school of thought, the outperformance of certain firms cannot be explained just on their exposure to risk. There exist numerous bias which bring inefficiency to the financial market. Experienced investors can exploit these inefficiencies to earn superior returns.

Shiller (2003) states that markets are not perfectly efficient, but instead reflect irrational human behavior. The outperformance of value and small-cap stocks could be an example of a skillful exploitation of these inefficiencies. In fact, the smaller a company, the less analyst are following it and thus more difficult it is for the market to incorporate any information about its operations or business model into the share price. Hence, there is an explanation as to why would small firms deliver returns above the market, and the reason for this is not linked to a higher risk but to a lack of awareness most analyst have of small firms, the universe of firms is simply to vast to cover them all.

Introduction of the Euro currency affected the market efficiency of 10 of the most developed European stock markets and may have led to a less efficient market than the one in the US. This may allow active managers to outperform the European market by exploiting these inefficiencies. In order to exploit these inefficiencies, it is necessary to first develop a model with which to calculate the expected return of European stocks. Throughout the following pages, we introduce our results concerning the development of a five-risk factor model in Europe. This model sets the basis to calculate the expected return on European stocks and compare those results with their true returns.

2. Contribution

The objective of this report is twofold: to estimate the risk factors that allow to capture the size, value, profitability and investment patterns/risk factors in the European investment universe which allow to exploit market inefficiencies and to compare the correlation of the risk factors obtained for Europe and the risk factors calculated in Fama and French (2015b) for North America.

To achieve the objectives, we analyze from January 2001 until December 2016 more than 1,300 companies in 7 European countries (United Kingdom, Germany, France, Spain, Denmark, Sweden and Portugal). The factors are then obtained following the same methodology Fama and French use in their 2015 paper.

Regarding the first objective, our main findings concern value and investment patterns. These two factors, not only possess the highest correlation, but also are significantly higher than their equivalents in the U.S. This suggests that the European market might have more inefficiencies than the American and may allow active managers to beat the European indexes by loading on these factors. Furthermore, to test the robustness of the results, we conduct a second study by dividing the sample in two different periods: the first one from January 2001 to December 2007 and the second one from January 2008 to December 2016. For the first sample, the most relevant factors are value and investment whereas for the second sample, profitability is the only significant factor.

Regarding the second objective, the highest correlation in Europe is between value and investment factors suggesting that firms with low book to market value ratio have more

difficulties to invest. On the other hand, the lowest correlation is between size and profitability. When comparing the correlation between Europe and North America, we observe a strong link between value, investment and market return factors which reduces the diversification possibilities for fund managers.

All in all, our contribution indicates that the risk factors in Europe are similar to the ones calculated by Fama and French (2015b) for North America as we reach to related conclusions.

3. Literature Review

Throughout this section we introduce Modern Portfolio Theory, Capital Asset Pricing Theory (CAPM), Arbitrage Pricing Theory, Fama and French 3 factors model. These models share a rational view of financial markets and investors and are used to explain the relationship between risk and return. Fama and French (2015b) use these models as the base for the five-factor risk model. Cakici (2015) examines the results for the five-factor model in North America, Europe and Global Markets. Our research paper takes Fama and French (2015b) as a basis but unlike Cakici (2015) we focus our results in the European investment universe.

Modern Portfolio Theory is developed in Markowitz (1952). Modern Portfolio Theory states that investors should focus on selecting portfolios and not individual securities. According to Markowitz (1952), investors should focus on the risk reward characteristics of the entire portfolio when selecting securities and avoid analyzing them on an individual basis. Markowitz treats securities as random variables and assigns them standard deviations, expected returns and correlations. Standard deviation and expected return are treated as a proxy of risk-reward. According to Modern Portfolio Theory, there exist optimal portfolios that offer the best relationship of risk-return. This set of portfolios comprise the efficient frontier of portfolios. An investor should select a portfolio that belongs to this set. Investors are rational and select the portfolio that provides the highest expected return for their given appetite for risk.

Tobin (1958) complements Markowitz work by including the risk-free asset into the analysis. Given that a risk-free asset has zero standard deviation and no correlation of

returns with a risky portfolio, a portfolio that combines the risk-free asset and the risky portfolio will have a standard deviation proportional to the weight and the standard deviation of the risky portfolio. Increasing the weight of the risk free asset leads to portfolios with lower risk and returns than the portfolios on the efficient frontier whereas increasing the weight on the risky portfolio allows forming portfolios the outperform those on the efficient frontier.

Sharpe (1964) and Lintner (1965) use Portfolio Theory as the base to develop the Capital Asset Pricing Model (CAPM). CAPM establishes that expected returns on securities are proportional to beta, a factor which reflects the volatility or systematic risk of a security or a portfolio in comparison to the market as a whole. Unsystematic risk is not rewarded with greater expected returns since it can be eliminated through diversification. The Capital Asset Pricing Model allows to calculate the expected return of a stock or portfolio given its beta. This model establishes a relationship between expected return and risk of a security or portfolio.

Ross (1976) develops the Arbitrage Pricing Theory (APT). APT explains the expected return of securities as a linear function of various factors. These factors can be statistical, financial (yield curves), economic (GDP, inflation rates) or fundamentals (price earnings ratio). The factors sensitivities are estimated using regressions or time series techniques. APT calculates the asset prices through a linear factor model in which returns are a sum of risk factor returns.

According to Fama and French (1993), the cross-section of average returns on U.S common stocks shows little relation to CAPM model of Sharpe (1964) and Lintner (1965). Fama and French (1992) show that firms with low market capitalization and stocks of firms with a high book to market ratio do better than the market. Fama and French (1993) develop a model that uses market factor size and value factor to calculate expected returns. According to Fama and French (1993) market, size and value are the three main risks that allow to calculate the expected return of an asset. Fama and French (1993) believe that investors are concerned about three risk factors and not just one, as CAPM establishes.

However, exposure to these three factors does not completely explain the expected returns of a stock or portfolio. In order to solve this issue, Fama and French (2015b) develop a five-factor model that captures the size, value, profitability and investment patterns in stocks. This five-factor model offers better results than the three factor model. The Main conclusion of the five-factor model is that when the profitability and investment factors are included, the value factor becomes redundant.

Cakici (2015) examines Fama and French five-factor model in 23 developed stock markets from 1992 to December 2014. The results for the five factor model in North America, Europe and Global Markets are similar to the results for the U.S stock market. However, the profitability and investment factors are much weaker in Japan and Asia Pacific region. Results also imply that markets are still not fully integrated given that regional models perform better than global models. In contrast to Fama and French (2015b), with the addition of the profitability and investment factors, the value factor still remains significant in all regions.

Asness, Moskowitz and Pedersen (2013) find consistent value and momentum excess return across eight diverse markets and classes. Their results indicate the presence of common global risks. The strong correlation between value and momentum strategies and the high return premium of a global diversified value and momentum portfolio are hard to reconcile under current asset pricing theories.

Data and Methodology

1. Descriptive statistics of the data

The stock data is retrieved using *DataStream* software. Due to the high number of stock exchange indexes in Europe we conduct an analysis to include the most relevant. We first divide Europe in three geographical areas: North, Center and South and sort each area by GDP (highest to lowest). From this list, we select only the countries which have a GDP higher than €200 billion. Due to data availability we are not able to include Italy, Russia, Netherlands, Switzerland, Turkey, Poland, Belgium, Austria, Norway, Ireland and Finland. However, we include countries from the three areas to accurately reflect the behavior of the whole European region. Among the countries chosen, as we are not able to include all the firms, we select indexes which include large, mid and small capitalization companies. The final countries and indexes are the following:

- United Kingdom: FTSE
- France: SBF120 which includes the CAC40 and the following 80 largest stocks)
- Germany: DAX (large-cap), MDAX (mid-cap) and SDAX(small-cap)
- Spain: Bolsa de Madrid
- Denmark: *Københavns Fondsbørs*
- Sweden: Stockholmbörsen
- Portugal: PSI20

The stock data is obtained monthly with a sample period of 16 years ranging from January 2001 to December 2016. In order to homogenize and enable us to perform a fair comparison, all the data set is expressed in Euros (€).

Table 1 summarizes the main descriptive statistics of the stock data year by year. It also provides overall averages of number of firms, average book-to-market, average market capitalization. The average market capitalization is €4.32 billion. The average price-to-book value is 2.5 and the average number of firms is 1,345.

The number of firms between 2001 and 2006 differs as for that period the number of firms in the Portuguese index change throughout those years and the number of firms included in the German small capitalization index(SDAX) is higher in 2001 and 2002.

Table 1: Average statistics of the sample

For the sample firms between January 2001 and December 2016 in seven European countries, this table displays the average number of firms (Nb of firms), average market capitalization (Market Cap), average price to book value (PTBV), average profit margin and average increase in assets (Inc. Assets)

	Nb of firms	Market Cap	PTBV	Profit Margin	Inc. Assets
Average	**1,345**	**4,317**	**2.5**	**3.3%**	**12%**

Table 2: Descriptive statistics of the sample

For the sample firms between January 2001 and December 2016 in seven European countries, this table displays the average number of firms (Nb of firms) per year, average market capitalization (Market Cap) per year, average price to book value (PTBV) per year, average profit margin per year and average increase in assets (Inc. Assets) per year used to build the portfolios and calculate the risk factors.

Year	Nb of firms	Avg Market Cap (€m)	Avg PTBV	Avg Profit Margin (%)	Avg Inc. Assets (%)
2001	1,349	7,395	3.2	13.9	Na
2002	1,476	3,333	2.4	-28.1	Na
2003	1,328	2,501	1.5	4.5	5.1
2004	1,328	2,862	2.5	8.9	5.9
2005	1,341	3,371	0.3	5.4	22.3
2006	1,336	4,250	3.1	3.2	37.9
2007	1,336	5,199	3.2	11.8	17.4
2008	1,336	5,478	2.8	-42.3	22.3
2009	1,336	3,172	1.76	-22.6	-0.3
2010	1,336	4,520	2.5	22.5	6.5
2011	1,336	3,756	2.3	0.6	5.3
2012	1,336	3,485	1.9	1.3	3.2
2013	1,336	4,145	1.9	22.6	17.2
2014	1,336	5,162	3.16	14.8	8.6
2015	1,336	5,549	3.35	13.2	8.7
2016	1,336	4,891	4.0	23.1	7.8

2. Factor Justification

The selection of which and how many factors is an important topic. There are three common ways of dealing with this issue:

- The first approach to identifying factors uses theory and economic intuition (Goyal 2011). The most celebrated asset pricing model using this approach is the capital asset pricing model of Sharpe (1964), Linter (1965a) and Mossin (1966). This model suggests that the return on the market portfolio is the only factor that allows to calculate the expected return.
- The second approach is statistical. This approach yields estimates of factor exposures as well as returns to underlying factors and is motivated by the arbitrage pricing theory of Ross (1976). Moreover, factor analysis can be used to analyze the covariance of structure of returns.
- The third approach is to create factors based on firm characteristics. The most famous example of this approach is the three-factor model of Fama and French (1993), based on size and value anomaly.

In this research paper, the asset pricing factors are calculated following Fama and French (2015b). This decision is based on the intuition that there must be a close link between the firms' characteristics and their expected return.

Analogously to Fama-French, the asset pricing factors include:

- Market factor (R_m)
- SMB factor (small minus big)
- HML factor (high minus low)
- RMW factor (robust minus weak)
- CMA factor (conservative minus aggressive)

Small minus Big (SMB), accounts for the spread in returns between small- and large-sized firms, which is based on the company's market capitalization. This factor is referred to as the "small firm effect", as smaller firms tend to outperform large ones. Smaller companies are said to have a higher amount of growth opportunities than their biggest counterparties. Small cap companies also tend to have a more volatile business environment which should be compensated by higher expected returns.

High minus low (HML), also known as the value factor accounts for the spread in returns between value and growth stocks and implies that companies with low book-to-market ratios (growth stocks), underperform those with higher book-to-market figures (value stock). Much has been discussed about whether this increase in return is nothing but a direct application of the risk-reward relationship.

Robust minus Weak (RMW) accounts for the difference in returns between the firms with robust and weak profitability. In line with the definition of Hou, Xue and Zhang (2015) and Fama and French (2015), profitability corresponds to the revenues minus cost of goods sold, minus selling, general, and administrative expenses, minus interest expense all divided by book equity. Novy – March (2012) has identified a proxy for expected profitability that is closely linked to average return. For Novy-Marx (2012), HML factor of a firm is a kind of leverage effect. Usual ”value” strategies are long- finance of under-valued assets by selling over-valued assets. Novy-Marx (2013) considers profitability strategies based on financing the acquisition not on under-valued assets but on productive assets by selling unproductive assets. As stated by the author, those two effects are closely related and partially explain why Fama and French consider their value factor (HML) as redundant when operating profitability is added in the model. Finally, it should be noted that a positive value in RMW factor means that firms with higher profitability earn better results, not too counter-intuitive.

Conservative minus Aggressive (CMA) stands for the difference in returns between firms with low and high investment policies. Conservative firms are those that have low investment policies whereas aggressive firms show a higher degree of investment. Following the methodologies of Fama and French (2015) and Hou, Xue and Zhang (2015) the investment factor corresponds to the annual change in gross property, plant, and

equipment plus the annual change in inventories all divided by the book value of total assets.

Finally, the market factor or market risk premium is the difference between the expected return on the market and the risk-free rate. This is the only factor that appears in CAPM.

One important conclusion of the capital market theory is that equilibrium security returns depend on a stock´s or portfolio's systematic risk, not its total risk as measured by standard deviation. One of the assumptions of the model is that diversification is free. The reasoning is that investors will not be compensated for bearing risk that can be eliminated at no cost. The implications of this conclusion are very important to asset pricing. The riskiest stock, with risk measured as standard deviation does not necessarily have the greatest expected return. If the high risk of the firm is due to firm-specific factors (i.e a new drug being developed by a biotech company still uncertain of its effectiveness), the firm will have a high unsystemic risk for which it will not be compensated. On the other hand, if all of the firm's risk is systemic, the market will require a higher expected return.

3. Factor calculation

Firstly, 15 portfolios are formed (one per year) with all the European companies included in the stock exchange indexes selected, which are the major stock indexes of the countries listed in the previous section.

Each portfolio is built on the first day of June of the corresponding year. For instance, the first portfolio includes the companies that were part of the selected indexes on June 2001, the next portfolio (portfolio 2) includes the companies that were listed in the selected indexes on June 2002 and so forth. The portfolios are determined annually.

Within each portfolio, the stocks are classified in two groups according to their market capitalization. The first group contains the stocks that account for 90% of the total market capitalization of the portfolio. The second group includes the remaining firms, which together account for the remaining 10% of the portfolio's market capitalization. By proceeding in this way, the portfolio is divided in two groups of stocks with very different sizes.

The market factor is computed by calculating the return on the value weighted market minus risk-free rate. Given that Germany is the most riskless country of the Eurozone, we have used the German one-month government bond rate as the risk-free rate.

To compute the HML factor the 30% growth, 40% neutral and 30% value breakpoints for the Price to Book Value (PTBV) ratio are determined for each of the groups, both the big and small firms are chosen to match. These break points follow Fama and French (1993).

The stocks with the 30% higher PTBV are categorized as growth stocks, those within the 70^{th} and 100^{th} percentiles are classified as value stocks. Neutral stocks are those with PTBV ranging from percentile 30^{th} to 70^{th}. These classifications allow to form six value-weighted portfolios which are denoted by BG, BN, BV, SG, SN, SV (where B and S refer to big and small and G, N, V refer to growth, neutral and value). Afterwards, the value minus growth returns for the big stocks (HML_B=BV-BG) and for the small stocks (HML_S=SV-SG) are computed. Finally, the HML factor is computed performing the average of HML_B and HML_S. The size factor, SMB based on HML is the average of the 3

small stock portfolios minus the 3 big stock portfolios. The SMB factor is calculated once all the other risk factors have been obtained, since each of them contributes to the SMB factor.

The computation of the RMW factor is identical to HML factor except that the breakpoints are not made based on Price to Book Value but on the Operating Profit Margin. The higher the operating profit margin, the more robust the company is. Six value weighted portfolios are formed BR, BN, BW, SR, SN, SW (where B and S refer to big and small and R, N, W refer to robust, neutral and weak). Returns for robust minus weak within the big stocks (RMW_B=BR-BW) and the small stocks (RMW_S=SR-SW) are calculated. The final RMW factor is then obtained by averaging RMW_B and RMW_S. The size factor, SMB based on RMW is the average of the 3 small stock portfolios minus the 3 big stock portfolios.

For the CMA factor the second classification is not done based on PTBV or Operating Profit Margin, but on the prior year's investment (increase in total assets year on year). The lower the increase in assets, the more conservative a stock is. Six value weighted portfolios BC, BN, BA, SC, SN, SA are formed. Conservative minus aggressive returns for big stocks (CMA_B=BC-BA) and for small stocks (CMA_S=SC-SA) are calculated. CMA factor is then computed averaging CMA_B and CMA_S. The size factor, SMB based on CMA is the average of the 3 small stock portfolios minus the 3 big stock portfolios.

The final SMB factor is computed by averaging the returns of the SMB portfolios based on HML, RMW and CMA contributions to the size factor

Results

1. Statistics of the factors

Table 3 contains the summary statistics of the risk factors. Monthly average returns are 0.532% for HML, 0.298% for RMW, 0.432% for CMA and 0.493% for the market factor. Summary statistics for factor returns suggest that the factor that has more weight on the return of European stocks is the value factor, followed by the market factor and by the investment and profitability factors in that order.

Table 3: Summary statistics for risk factors: January 2001 - December 2016, 192 months

Means, standard deviations and t-values of the risk factor models calculated for Europe. The portfolios are built by sorting the stocks two times. First stocks are divided per market capitalization (big and small) Then each group is sorted into three subsequent groups based on different criteria according to the corresponding factor: price to book value for HML group, operating profit margin for RMW, increase in assets for CMA. Market − Rf is the return on the value weighted market minus the German one-month government bond rate. SMB is the small minus big factor, HML is the high minus low factor, RMW is the robust minus weak, CMA is the conservative minus aggressive. S and B stand for small and big stocks respectively: for example, HMLs is the value factor for small stocks and HML_b is the value factor for big stocks.

	HML_S	HML_B	HML	RMW_S	RMW_B	RMW	CMA_S	CMA_B	CMA	SMB	Mkt-R_F
Mean	0.624	0.439	0.532	0.412	0.184	0.298	0.497	0.368	0.432	0.325	0.493
Std Dev	3.451	3.132	2.758	2.571	2.289	1.691	2.465	2.392	2.022	2.234	3.965
t-statistic	2.505	1.943	2.670	2.220	1.113	2.442	2.794	2.129	2.962	2.015	1.723

Before starting our analysis, we define that a factor is significant at a 95% confidence level if the t-statistic value is greater than 1.96. In other words, if the factor value is at least 1.96 standard errors from zero.

From Table 3 we can observe that the impact of the risk factors is greater and more significant (in terms of t-statistic) for small-firm stocks. This is a direct consequence of the small firm effect. If smaller firms tend to outperform big firms (as it can be seen from the positive value of the SMB factor), we expect small value firms to outperform big value firms. The same rationale applies for the remaining risk factors.

Results show an expected profitability and investment premiums for small stocks as the average values of RMW_S and CMA_S are at least 2.20 standard errors from zero. The average profitability (RMW) premium is larger for small stocks than for big stocks, but the evidence that the expected premium is larger is weak as seen by the fact that the average value of RMW_B is just 1.11 standard errors from zero.

Moreover, the average return for firms engaging in conservative investment policies (CMA) is higher than that of profitable firms (as measured by RMW) and very close to the results of HML. This average investment premium is, as in the case of the profitability factor, larger for small stocks than for big stocks. However in this case, both small and big firms present results which are at least 2.20 standard deviations away from the mean, making both results statistically significant.

Evidence also suggests that the HML has the highest impact in the expected return of the portfolios with an average excess returns of 0.53% per month, which leads to a 6.36% when extended to 12 months. The premium is larger again for small stocks than for big stocks. This result is statistically significant for both universe stock (small and big) given that means for HML factors are at least 1.94 times their standard deviations whatever the size of the stocks analyzed.

Overall, all four factors have a positive contribution on the expected return which only means that small, value, profitable and firms with conservative investment strategies earn higher returns than their big, growth, unprofitable and aggressive investing counterparties. Moreover, all four factors are statistically significant at the 95% level, with the minimum t-statistic being 2.015 (for SMB factor).

To conclude, summary statistics for factor returns suggest that the factors for Europe are very similar to the results in the U.S in Fama and French (2015b). The main differences lie HML and CMA factor which are significantly higher in the European investment universe. This result suggests that value and conservative firms have an even greater premium in their returns than they would have in U.S stock universe. This fact may be due to the greater inefficiency of the European markets.

To test the robustness of the results obtained, we have done a second study in which we divide the sample in two different periods: The first period ranges from January 2001 to December 2007 whereas the second period starts in January 2008 and ends in December 2016. We calculate each risk factor again for both periods in the same way we described before.

Results of this second study are summarized in table 4.

Table 4: Summary statistics for risk factors for two different periods - January 2001 to December 2007 (Panel A) and January 2008 to December 2016 (Panel B)

Means, standard deviations and t-values of the risk factor models calculated for Europe in two different periods: Panel A, from January 2001 to December 2007 and Panel B from January 2008 to December 2016. The portfolios are built by sorting the stocks two times. First, stocks are divided per market capitalization (big and small). Then each group is sorted into three subsequent groups based on different criteria according to the corresponding factor: price to book value for HML group, operating profit margin for RMW, increase in assets for CMA. Market − Rf is the return on the value weighted market minus the German one-month government bond rate. SMB is the small minus big factor, HML is the high minus low factor, RMW is the robust minus weak, CMA is the conservative minus aggressive. S and B stand for small and big stocks respectively: for example, HMLs is the value factor for small stocks and HML_b is the value factor for big stocks.

Panel A: 2001 - 2007

	HML_S	HML_B	HML	RMW_S	RMW_B	RMW	CMA_S	CMA_B	CMA	SMB	Mkt-R_F
Mean	1.636	1.328	1.482	0.079	0.052	0.066	0.767	0.693	0.730	0.517	0.785
Std Dev	3.569	3.222	2.838	1.667	1.479	1.773	2.315	2.477	2.574	2.500	4.437
t-statistic	4.202	3.778	4.788	0.434	0.323	0.339	3.034	2.565	2.599	1.895	1.621

Panel B: 2008 - 2016

	HML_S	HML_B	HML	RMW_S	RMW_B	RMW	CMA_S	CMA_B	CMA	SMB	Mkt-R_F
Mean	-0.148	-0.120	-0.134	0.557	0.364	0.461	0.237	0.211	0.224	0.190	0.289
Std Dev	3.138	2.868	2.504	1.530	1.530	1.617	1.350	2.194	1.492	2.025	3.594
t-statistic	-0.432	-0.384	-0.491	3.335	2.182	2.610	1.606	0.883	1.375	1.030	0.737

The main conclusions that we draw from table 4 are that for Panel A the profitability factor is no longer relevant and that the value and investment factors are more relevant than they were in our first study (table 3). Moreover, for Panel B, the value, size and investment factor are no longer statistically significant whereas the profitability factor has a 2.6 t-statistic. For panel B, the value factor is negative, meaning that in that period growth stocks showed a greater expected return than value stocks. However, this result is not significant from a statistically point of view, thus we cannot reject the hypothesis that the value factor is zero. In fact, for panel B the only factor that is significant is the profitability factor. The remaining risk factors have low t-statistics. This result is significantly different from the one obtained in the first study, where all the factors where relevant.

2. Correlation among Factors

The correlations of the five factors are presented in Table 5.

Table 5: Correlations between the five risk factors in Europe

Correlations between Mkt -R_F, SMB, HML, RMW and CMA for Europe. Data period for returns is from January 2001 to December 2016

	Mkt-RF	***SMB***	***HML***	***RMW***	***CMA***
Mkt-RF	1	-0.104	0.199	-0.405	-0.294
SMB	-0.104	1	-0.067	0.051	-0.160
HML	0.199	-0.067	1	-0.527	0.591
RMW	-0.405	0.051	-0.527	1	-0.148
CMA	-0.294	-0.160	0.591	-0.148	1

For European portfolios, the highest correlation is between HML and CMA. This result is consistent to the common belief that firms with high book to market value tend to be firms with a conservative investment strategy.

The correlation of the value factor with the profitability factor is significantly negative. This result may not come as a surprise given that in general value stocks, with high book to market value, are so because of their dim future. Most investors would be willing to pay a higher market price for profitable firms than they would for non-profitable firms. Thus, non-profitable firms are likely to be value oriented. Benjamin Graham already explained this correlation in his book *Securities Analysis* where he talks about deep value investing – investing in firms with a book to market ratio greater than 2 in the aftermath of the 1929 crisis delivered high returns.

Another interesting result can be extracted from the correlation between the size and profitability factors. The size factor is only positively correlated with the profitability factor, which reinforces the idea that small and medium sized firms are generally the most profitable.

Finally, the correlation between profitability and investment is negative, which would seem intuitive given that according to this result, the most profitable firms tend to be more aggressive when investing. However, this result may suffer of what is commonly called *survivor bias*: Of all the firms that engage in aggressive investment strategies, only those that manage to be profitable survive.

Overall, correlations among the factors are not too high, suggesting that they are not redundant. This is a main difference with the results observed by Fama and French (2015b). According to their research, the HML was highly redundant when the other risk factors were incorporated. "*The average HML return is captured by the exposures of HML to other factors. Thus, in the five-factor model, HML is redundant for describing average returns, at least in U.S. data for 1963–2013". (Fama and French 2015b)*

We have also studied the correlation between the risk factors in North America and in Europe. We have compared the results obtained by Fama and French (2015b) with the ones we obtained for Europe.

Data for North American factors has been taken directly from French's website. We have run a linear correlation between the North American risk factors and the European risk factors obtained in table 3.

By studying the correlation between the risk factors in North America and Europe we try to determine whether if any of the risk factors behaves in a similar way at a global level. This study is inspired in the research paper by Asness, Moskowitz and Pedersen "Value and momentum everywhere" (2013). Their results indicate the presence of a strong correlation structure among value and momentum strategies across diverse asset classes and geographies.

From the results (Table 6 Panel A), we can observe that there are strong correlations both for the value factor and for the investment factor. However, size and profitability factor show low correlation between Europe and North America. The market factor shows the highest correlation. Correlations are 63% for the value factor, 62% for the investment factor and 32%, 27% and 87 % for the size, profitability and market factor respectively.

Table 6 also shows the correlation for risk factors between North America and Europe when the sample divided in two different periods: The first period ranges from January 2001 to December 2007 (Panel B) whereas the second period starts in January 2008 and ends in December 2016 (Panel C). The subsamples are selected in this way to make sure the euro crisis (2012) and the financial crisis (2008) fall in the same subsample. Dividing the sample in this way we obtain a period (Panel B) free of economic crisis in Europe and a second sample (Panel C) that includes two economic crisis.

Correlation values for Panel B resemble the ones of the entire period (Panel A), with the highest correlation for the market factor, strong correlation for the value investment factor and low correlation in size and profitability factor. Correlations are 70% for the value factor, 64% for the investment factor and 43%, 22% and 82 % for the size, profitability and market factor respectively.

Panel C shows a higher market and profitability factor correlation than for the entire sample (Panel A). However, the size value and investment factors show lower correlation than in table 6. Correlations are 55% for the value factor, 29% for the investment factor and 15%, 48% and 90 % for the size, profitability and market factor respectively.

Table 6: Correlation of the risk factors between North America and Europe

Correlations between North America and Europe of the risk factors Mkt -R_F, SMB, HML, RMW and CMA in three different samples: Panel A includes data from January 2001 to December 2016, Panel B and Panel C are subsamples: Panel B includes data from January 2001 to December 2007 and Panel C includes data from January 2008 to December 2016.
Data for the risk factors in North America is taken from K. French website - http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Panel A: 2001 - 2016

Mkt	*SMB*	*HML*	*RMW*	*CMA*
0.867	0.320	0.626	0.268	0.619

Panel B: 2001 - 2007

Mkt	*SMB*	*HML*	*RMW*	*CMA*
0.824	0.426	0.695	0.216	0.641

Panel C 2007 - 2016

Mkt	*SMB*	*HML*	*RMW*	*CMA*
0.902	0.152	0.547	0.476	0.290

Conclusions

The main conclusion of the study is that the risk factors calculated for Europe are very similar to the risk factors reported by Fama and French (2015b). The contribution of each factor to the return of the stock follows the same trend in both studies.

The value factor has a higher contribution in the expected return of the stocks than the market factor, as opposed to the results reported in Fama and French (2015b) in which the market factor has the greater impact in expected return. For European firms, market factor is secondary to the value factor. This result corroborates what other research papers had already explained, buying stocks that appear to be cheap in terms of book to market value is a sound strategy, or one that should be compensated with better returns.

The profitability factor is the one that contributes less to the overall excess return for European stocks. This result seems counterintuitive; an investor would expect future returns to be linked to past profitability. However, another interpretation would be that investors require less expected return to compensate for these firms given that they have already proven themselves as being profitable. Lower risk, lower expected return. An investor would require a lower expected return of a firm of *high* quality.

All factors have a positive sign from which we conclude that holding small value profitable firms with a high correlation with the market and conservative investment strategies is rewarded with higher expected returns.

The results obtained for the factors are significant from a statistical point of view at the 95% confidence interval. This means that the contribution of any of this factors is different for zero in more than 95% of the cases. This confidence interval increases up to 99% for HML and CMA factors.

Nevertheless, as stated in the results section, when we divide the sample in two different time periods (panel A and panel B) and analyze each of this new sample independently, the statistical significance of the factors changes substantially.

In panel A as the profitability and market factor are no longer statistically significant, we cannot reject the null hypothesis. However, the remaining risk factors for panel A, value investment and size, are more significant now.

Panel B shows a different result: the only significant factor is the investment factor. Panel B includes data for both the financial crisis of 2008 and the Greek crisis of 2012, we believe this events distorted the common behavior of financial markets in Europe.

In terms of correlations, the highest one is among value and investment risk factors: most value firms have a low book to market value because of their financial difficulties. In such scenario, it would be difficult for them to engage in an aggressive investment strategy.

Value and profitability factors also show a high correlation, negative in sign, which may be explained by the fact that most profitable firms have a high book to value ratio. Usual value strategies finance under-valued assets purchases by selling over-valued assets. Profitability strategies allow to finance the acquisition on productive assets by selling unproductive assets. These two effects are closely related.

The lowest correlation is seen between size and profitability, i.e. size is not linked with profitability.

Despite the high correlation of HML with two factors, it is our opinion that the value contribution still adds information and helps account for returns in a different way to the other four factors. If one is interested in the portfolios tilt toward size, value, profitability and investment the five-factor model is the choice.

Results from the correlation between the risk factors calculated in Europe and in North America show that there exists a strong link between value, market returns and investment factors between the two regions, mainly for the period ranging from January 2001 to December 2007. This reduces diversification possibilities for fund managers in the same way that having a greater correlation with the market returns implies greater systemic risk.

Further study could be performed to determine whether this correlation exist at a global level or just between Europe and North America. On the other hand, investment and size factor show low correlation among both regions.

Overall, stocks that leverage on small value profitable and with a conservative investment strategy will deliver higher returns than big growth unprofitable and aggressively investment stocks. This results hold both for Europe and North America and the correlation of the factor returns in both geographies is high for the value and conservative factor.

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