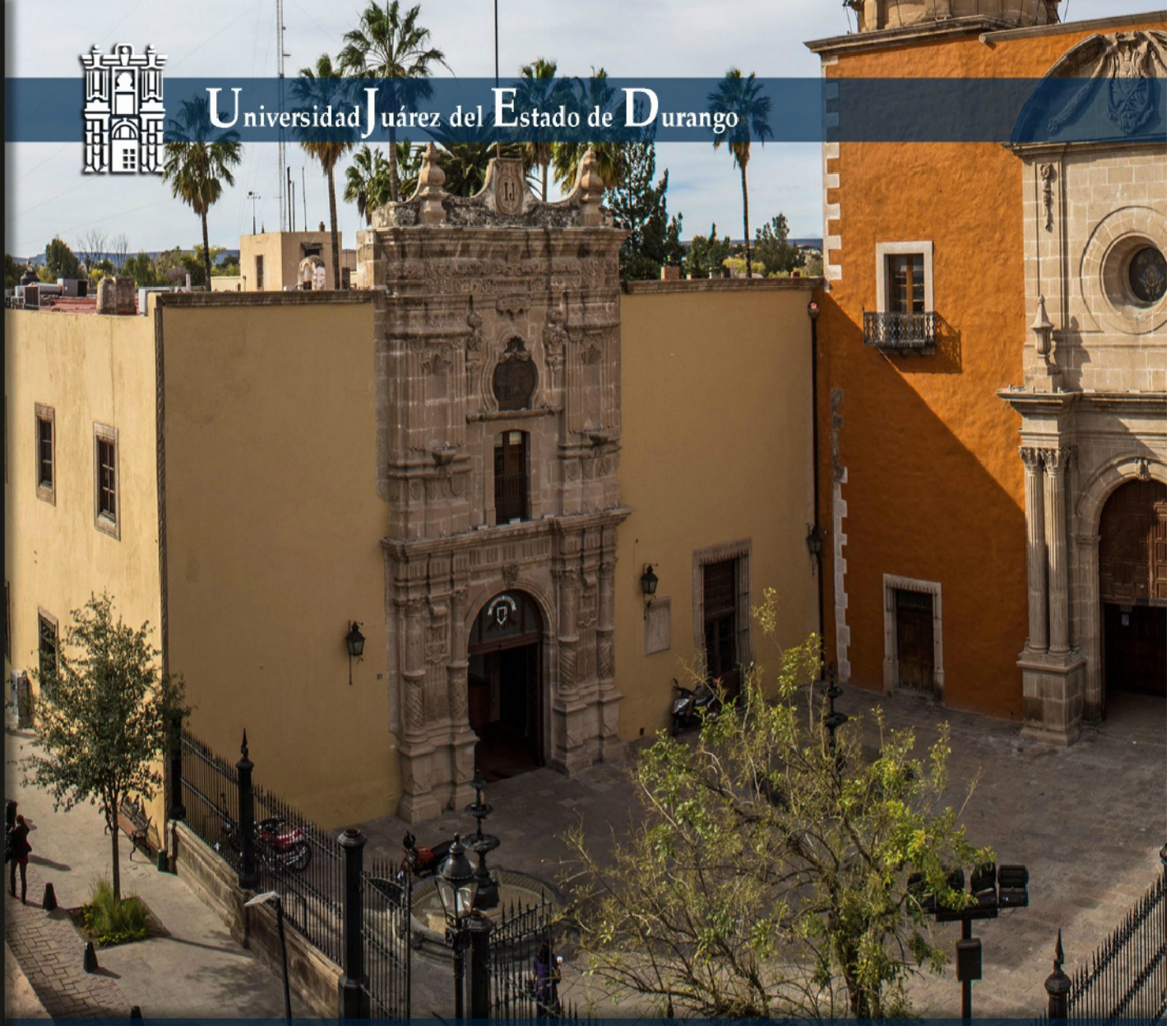

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XIX Congreso Internacional

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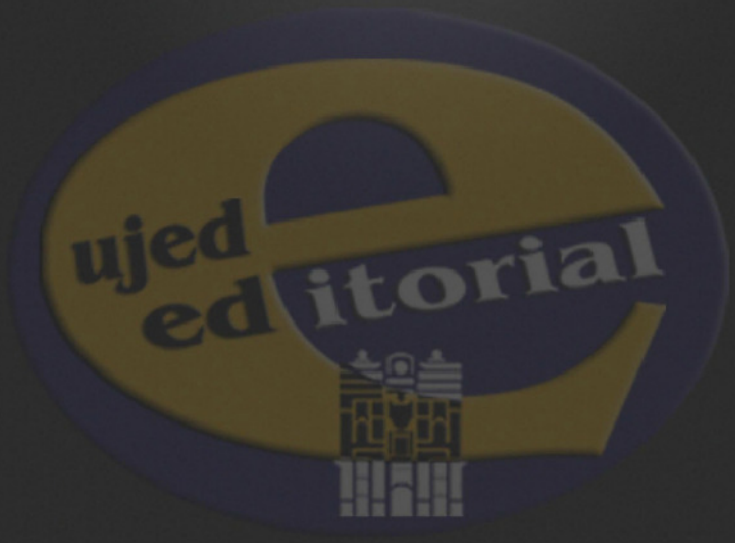

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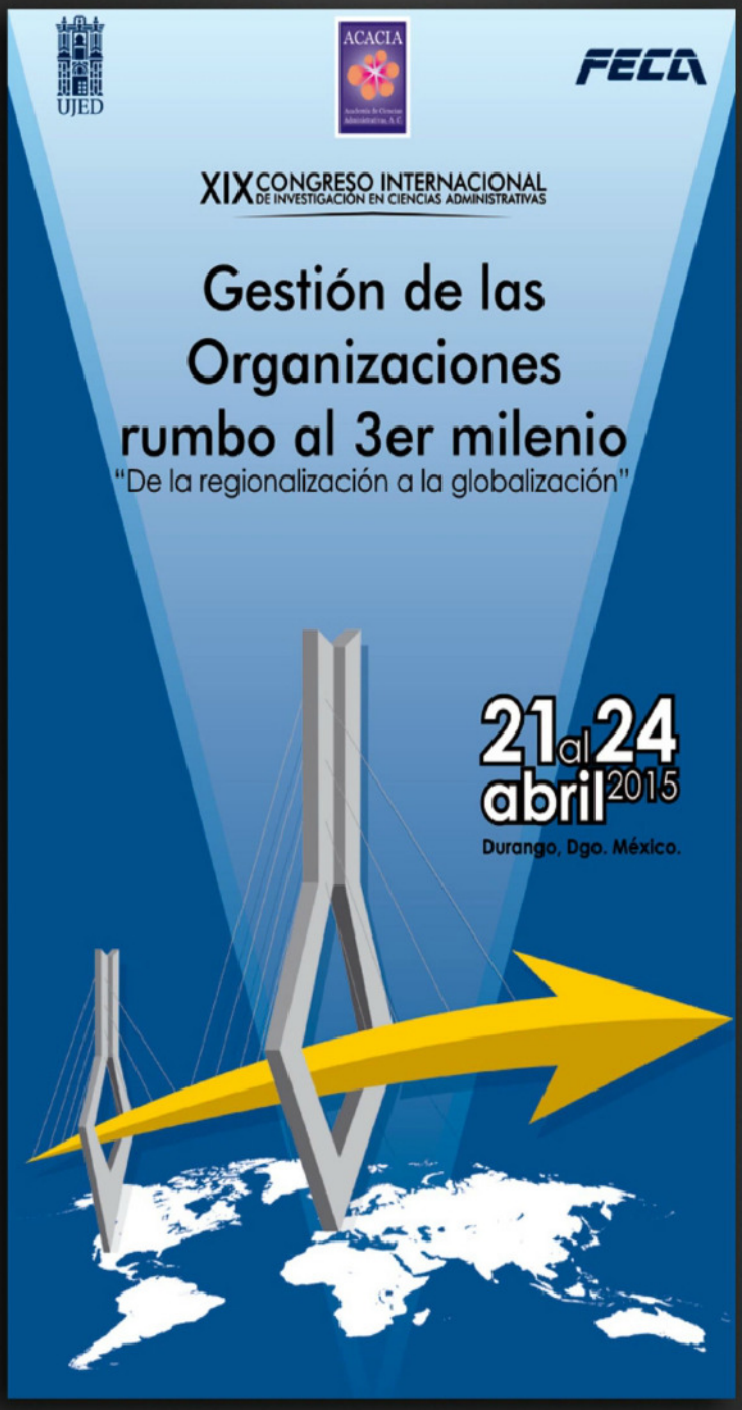
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XIX CONGRESO INTERNACIONAL DE INVESTIGACIÓN EN CIENCIAS ADMINISTRATIVAS

Los cambios impulsados en la actualidad por la globalización, son tan profundos que cambiaron la forma de concebir toda la vida de la sociedad. Sin duda la transformación de la cual somos testigos, trae como consecuencia entre muchas otras cosas una alta competitividad donde sólo sobrevivirán las organizaciones que den respuesta a un entorno incierto.

El gran reto que se presenta el día de hoy a los estudiosos de las ciencias administrativas, consiste en crear organizaciones que respondan al nuevo paradigma de la globalización y la competitividad, que gesten organizaciones capaces de transitar de los mercados regionales a los mercados globales. Este es el tema del XIX congreso Internacional de ACACIA 2015, y los congresistas con los trabajos que presentan y ahora se recopilan en esta obra, dejaran constancia del esfuerzo por parte de los académicos e investigadores, no solo por diseñar organizaciones aptas para la posmodernidad, sino además capaces de sobrevivir a un mundo globalizado.

José Gerardo Ignacio Gómez Romero

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EMPIRICAL TEST TO SINGLE AND MULTIFACTOR MODEL OF CAPM IN THE PORTUGUESE STOCK EXCHANGE.

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ABSTRACT

The objective of this paper is to test if the single-factor CAPM model is valid in the Portuguese stock exchange, when compared with the multifactor CAPM proposed by Fama and French-Carhart. Using the methodology of Fama and French (1993; 1996), for a period of 10 years through analysis of 10 active stocks from different sectors, using the risk factors developed by French (2014). The results suggest that, for the period under analysis the multifactor CAPM applied the Lisbon stock exchange is not statistically sufficient to reject the single-factor CAPM.

The results suggest that the risk market factor is influential and important part in explaining the expected average return in the Eurozone.

Keywords: CAPM, market risk, multifactor model.

INTRODUCTION

The success of finance, while social science, is in recognition of risk associated with an outcome that remunerate the investment. Financial theory and common sense tells us that the investments that are riskier must produce higher yields to compensate for the risk, so an investment without risk is when the real yield is always equal to expected return (Damodaran, 2012). In the sequence of Markowitz´s seminal paper (1958), Sharpe (1964) and Lintner (1965) developed a model for valuing financial assets, known as the Capital Asset Pricing Model (CAPM), which assumes that there is only a single factor can explain the expected return on an asset - market risk and argues that, in equilibrium (no arbitration), the market compensates investors in accordance with the market risk level given in its investment and, part of the total risk of an asset can be eliminated in diversification. However, it quickly became apparent the existence of problems with the sample matrix of expected variance-covariance of returns, which produces market portfolio with selling short position and the beta risk market's inability to explain the expected returns (Disatnik & Benninga, 2007). Sharpe (1964) recognized that the assumptions of the model are undoubtedly highly restrictive and unrealistic, however, the test suggests that the assumptions of the model is accepted in view of the lack of alternative models that lead to practical results similar to the model.

Five decades after its appearance, despite the "death sentence", CAPM is assumed as (i) the most widely used in corporate finance to estimate the cost of capital and portfolio valuation; according to Graham and Harvey (2001; 2010; 2013), indicate that 74% of American companies use the CAPM. According to Brounen, Jong and Koedijk (2004), 45% of European companies use the CAPM; (ii) Fama and French (2004) recognize that it is still the central element in post graduate courses in corporate finance, about 75% of finance professors recommends the use of CAPM to estimate the cost of capital (Welch, 2008).

This work has as aim to test whether the single-factor CAPM is valid in the Portuguese stock exchange, compared with the multifactor CAPM model proposed by Fama and French. To do so it will be applied the Fama and French's methodology (1993, 1996) to 10 stocks from different sectors and used risk factors developed by French (2014) for a period of 10 years of analysis.

The paper is organized as follows. The next section set up briefly a theoretical framework on CAPM model (single-factor and multi-factor model), then it is described the methodological process adopted, namely the objectives and research hypotheses. In the fourth section exhibits and discusses the results. Finally it concludes by summarizing the main results and considerations on it, identifying the limitations of this research and making some suggestions for further research.

2. THE SINGLE-FACTOR AND MULTI-FACTOR CAPM MODEL

Markowitz (1952) pioneered the analysis process of risk-return function and had developed a methodology based on the maximum expected utility and proposed a general solution to the selection of the portfolio. Onward Tobin (1958), sought to show that, under certain conditions, the model of Markowitz (1952) involves a process of choice of investments that can be divided into two phases: (i) the choice of an ideal combination of risky assets on mean variance; (ii) independent application of funds between this ideal combination of risky assets and a single risk-free asset. From this analysis derived a powerful tool that can simplify the risk function - profitability and became "cornerstone" of modern finance - the Capital Asset Pricing Model (CAPM), proposed independently by Sharpe (1964) and Lintner (1965).

The CAPM assumes that there is only a single factor that can explain the expected return on an asset - market risk and argues that, in equilibrium (no arbitration), the market compensates investors in accordance with the market risk level assumed in your investment and, part of the total risk of an asset may be disposed of diversification according to the following equation (equation 1):

$$E(R_i) = R_f + \beta_i (R_m - R_f), \text{where } \beta_i = \frac{Cov(R_i, R_m)}{\sigma^2_m} \qquad (1)$$

Being, $E(R_i)$: Expected rate of return on an asset i; R_m: expected return rate on market's portfolio M; R_f : rate of return on riskless assets; β_i: systematic risk of asset i; $Cov(Ri, Rm)$: covariance between return on assets i and return of the market's portfolio.

The CAPM (equation 1) can be tested by simple linear regression equation, where the value of the beta coefficient is obtained from the excess return over the risk-free rate (Fama & French, 2004; Marcelo, Quirós & Quirós, 2010). The resulting straight line of this model is known as security market line (SML).

$$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + \varepsilon_{it}, \text{ with } \alpha = 0 \quad (2).$$

Being, R_{it} - R_{ft}: excess return of asset i at time t; $\beta_i (R_{mt} - R_{ft})$: market risk premium of asset i.

The difference between the CAPM model (equation 1) and the linear regression model (equation 2) comes from the value of the alpha coefficient; α> 0, indicates a higher yield than suggested by its market risk, meaning that income is above the SML; on the other hand, α <0 indicates a lower yield than suggested by its market risk, implies that the return is below the SML. According to Marcelo, et al., (2010), in both cases (α> 0, α <0), contrary to the theoretical condition of market equilibrium implies that market values should be located along the line setting the regression model, i.e. the SML.

However, the lack of an efficient portfolio has attracted a great interest in research by searching of a method able to explain the behavior of the market portfolio. Fama and French (2004) rescued studies published since the 1970s up to 2002, updated and summarized the evidence of empirical failures to invalidate the way the model is applied and reinforce the call for the use of the CAPM three-factor model proposed in 1993. The authors emphasize the proposal of the three-factor model of expected return as the one-factor CAPM, also called single-factor model (based solely on market risk as measured by beta coefficient) is not sufficient to explain the expected return, adding two more factors: firm size (market value or market capitalization) and book-to-market index (which in the future it will simply denote by B/M ratio), which may explain unobserved risk factors. This argument starts by the Fama and French's evidence, that in a time series test using 25 different portfolios based on size and B/M ratio, found that many alphas coefficients are significantly different from zero, when the single-factor CAPM is used, unlike the 25 portfolios' alpha coefficients of the three factors model (which are not significantly different from zero). Accordingly, Fama and French (1993, 1996) proposed the three-factor CAPM model based on market risk, size and B/M ratio, represented by the following equation (equation 3):

 (3)

Where, SMB_t (Small minus Big): is the difference between the returns on diversified portfolios of small and big stocks; HML_t (High minus Low): is the difference between the returns on diversified portfolios of high and low (B/M ratios) stocks; and β_i: The risk-factor sensitivities; $(R_{it} - R_{ft})$: stocks' excess return to risk free rate; $(R_{mt} - R_{ft})$: market risk premium.

Fame and French (1993; 1996; 2004) states that on the equation (3) of tri-factor model, the intercept αi of the time series regression is zero for all asset i according to the following equation (equation 4):

$$R_{it} - R_{ft} = \alpha_i + \beta_{im}(R_{im} - R_{ft}) + \beta_{is}(SMB_t) + \beta_{ih}E(HML_t) + \varepsilon_{it}, \text{with } \alpha = 0 \qquad (4)$$

Jegadeesh and Titman (1993) observed a behavior pattern related to assets with high/low returns' yields produced in the past that tend to present higher/lower than average for a certain period of time. Jegadeesh and Titman (1993) found that this behavior may be due to the arrival of new information to the market capable of estimating or temporarily underestimate asset prices. Charhart (1997) confirmed the evidence of Jegadeesh and Titman (1993) and proposes to add to the three-factor model the momentum factor resulting from the difference between high and low yields' returns of the assets of the last 3-12 months (reported by Win Minus Lose - WML) which seems to capture much of the variation in profitability of mutual funds, whose CAPM single-factor and tri-factor models are not able to explain, represented by the following equation (equation 5):

[redacted] (5)

Where, $(R_{it} - R_{ft})$: stocks' excess return to risk free rate; $(R_{mt} - R_{ft})$: market risk premium; SMB_t (Small minus Big): is the difference between the returns on diversified portfolios of small and big stocks; HML_t (High minus Low): is the difference between the returns on diversified portfolios of high and low (B/M ratios) stocks; $\mathrm{WML_t}$ (Win Minus Lose): difference between winner returns stocks and losers return stocks over the last 6-12 months; and β_i:The risk-factor sensitivities.

As the equations (2) and (4), to all assets i, the intercept from the time-series regression, α_i, is zero for the four-factor CAPM, resulting in the following equation (equation 6):

$$R_{it} - R_{ft} = \alpha_i + \beta_{im}(R_{im} - R_{ft}) + \beta_{is}(SMB_t) + \beta_{ih}E(HML_t) + \beta_{iw}E(WML_t) + \varepsilon_{it}, \text{ with } \alpha = 0 \qquad (6)$$

Fama and French (1996, 2004) recognized that the three-factor CAPM model cannot explain the abnormal behavior called momentum, that is defined as momentum effect, and that they consider useful in applications whose goal is to abstract themselves from known patterns of returns means that reveal associated effects to certain information. However, these authors classify irrelevant this effect to estimate the cost of capital.

3. METHODOLOGY OF RESEARCH AND DATABASE

The objective of this work is to verify that the CAPM is valid in the Portuguese stock market. To this end, it is proposed to test the CAPM model that best describes the expected returns for a sample of ten stocks of the PSI 20 index[1] from different sectors for a period of 10 years on a monthly basis by applying the methodology proposed by Fama and French (1993; 1996; 2004), which consists in a time series test, through the estimation of simple and multiple linear regression models to validate the CAPM model for one, three and four risk factors using the risk factors developed by French (2014).

The CAPM states that the expected value of returns in excess of an asset is fully explained by its expected risk premium. Thus, the alpha coefficient in a time series regression model is zero (Fama & French, 1993). This approach is also valid for the three and four factors CAPM models when added other risk factors. In line was proposed the following research hypotheses for the time series of test:

H1: The market risk explains the expected returns, whereby alpha is different from zero.
H2: Risk factors such as SMB, HML and WML provide average expected returns not explained by single –factor CAPM.

To calculate the descriptive statistics (mean and standard deviation), the calculation of Pearson correlation (R) matrix between risk factors (risk premium, SMB, HML and WML) and for the application of hypothesis tests will be used Microsoft Excel 2010® software tools. For the calculation of the return, the logarithmic return formula, also known as continuous return, was used. According to Marcelo, et al. (2010), this is the most widely used in empirical studies due to its statistical properties.

Historical data for the euro zone risk factors (RM - RF, SMB, HML and WML) were obtained from the French (2014) database through the web page http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/. The data for the ten stocks traded on Euronext Lisbon stock exchange was obtained from http://finance.yahoo.com/.

[1] The market index of the Portuguese stock exchange - the Euronext Lisbon.

At the stage of CAPM models validation, it will be undertaken time-series tests, through the estimation of simple and multiple linear regression models, using the method of ordinary least squares, to check the alpha coefficient behavior in relation to CAPM models for one, three and four risk factors, using the equations (2), (4) and (6) based on the methodology presented by Fama and French (1993). For these hypothesis tests the following conditions were imposed: (i) two-tailed test, confidence level of 95%, 5% significance level, critical t equal to 2; (ii) to the alpha coefficient value be considered equal to zero, the absolute value of the t test should be less than 2 to CAPM be consistent, that is, if the intercept value is non-zero and statistically significant (5%), the CAPM failure in the forecast of risk premium. To the coefficient of risk factors be significant, the respective t values should be greater than 2. It will be used the statistical software GNU Regression, Econometrics and Time-series Library - Gretl version 1.9.14, to apply the tests on the presence of residual autocorrelation, heteroscedasticity and multicollinearity of the explanatory variables. The tests to be applied are Breusch-Godfrey test, Breusch-Pagan test and VIF (Variance Inflation Factor) statistics, respectively. The Chow test will be applied to check the behavior (change or structural stability) of the intercept and the slope parameters of the regression model in the period - February 2001 to July 2014[2]. The heteroscedasticity errors and autocorrelation identified will be corrected by the robust Newey-West standard error estimator also known as Heteroscedasticity and autocorrelation consistent – HAC - standard errors, that is consistent with the heteroskedasticity and autocorrelation.

The explanatory power of risk factors for the return expected for each model will be defined by adjustment coefficient R^2, so the comparison between models will be made using the R^2 values adjusted (R^2a). The significance of the models will be verified by statistical F test, while the significance of each parameter intercept and slope (alpha and beta) risk factors (RM-RF), SMB, HML and WML are assessed by t-test, following the methodology Fama and French (1993).

[2] Arghyrou and Kontonikas (2012) pointed out March 2009 as the beginning period in which the global financial crisis turned into sovereign financial crisis for the eurozone countries. Taking this date (March 2009) as a reference, a stability test shall be used to verify the behavior (change / structural stability) of the intercept and the slope parameters of the regression model.

4. PRESENTATION, DISCUSSION AND ANALYSIS OF RESULTS

In this section it presents and discusses the results for the tests of hypotheses concerning the search for a model that best explains the average expected returns as a market portfolio average variance, as a starting point, analyzing the mean and standard deviation and correlation matrix between risk factors (explanatory variables). For models in analysis, it was confirmed absence of multicollinearity by VIF statistics.

For the choice of risk factor variables, Fama and French (1993) took as a criterion the fact that the variables are not redundant as the expected return. Table 1 shows the statistics of the risk factors and the R Pearson correlation matrix between the independent variables. It was found that the correlation between the variables is low, which indicates absence of multicollinearity (Gujarati & Porter, 2009). The market risk premium for the euro area is 0.5%, the risk premium size was 0.20%, that is, small businesses do not offer risk premium *ex ante* than large firms with same level of risk as to Fama and French (1993) noted a premium of 0.27% per month. The risk premium B/M ratio was 0.5% higher than that by Fama and French (1993), which was 0.40% for the US market.

Table 1: Statistics monthly risk premium and correlation of risk factors Matrix.
Fama and French - Carhart, from February 2001 to July 2014

	Statistics			Correlation Matrix			
	Average	*standard deviation*	*T Stat*	*RM-RF*	*SMB*	*HML*	*WML*
RM-RF	0,005	0,058	0,086	1			
SMB	0,002	0,020	0,100	-0,090	1		
HML	0,005	0,024	0,208	0,293	0,047	1	
WML	0,010	0,046	0,217	-0,508	0,106	-0,104	1

T Stat: Statistics t; SMB: difference between returns of diversified portfolios of small firms (low market capitalization) compared with large firms; HML: difference between returns of diversified portfolios of high and low B/M ratio; WM: difference between winner returns and losers' returns over the last 6-12 months, and (RM – RF): market risk premium.

From the analysis of Table 1, based on the t-test with 95% confidence interval, the averages are significantly equal to zero as checked Fame and French (1993). This test suggests that there is no evidence of risk premium for the period under review. That is, large companies have higher than expected performance is likely due to the low transaction costs for these

firms, contrary to small businesses or due to underestimation of the respective betas (Pires, 2008).

Then is showed the results for each model, taking into account the result of the statistical t-test, and values of R^2 determination coefficients of each stock and adjusted R^2, which will be the reference for comparing the performance of risk factors that best fit to the models in question, as Fama and French (1993; 1996). The Table 2 exhibits the results of simple regression whose explanatory variable is the market risk (RM-RF), for ten Portuguese stocks belonging to PSI20 for the period of February 2001 to July 2014. As can be seen, two stocks (20%) present alphas statistically significant different from zero, that suggests effective higher returns than expected. The factor market risk is statistically significant for all active indicating that the risk of market perfectly explains the average expected return. The adjusted coefficient of determination R^2a lies between 16.20% and 33.5%, and the average value of 26.03%. The average coefficient of determination (R^2) is 26.48%. Chow-test Statistics indicates that for the CAPM single-factor model, for all the stocks, there are not structural changes of sample parameters.

Table 2: Regression Model for the single-factor CAPM

Stocks	*Alfa*	*T Stat*	*RM-RF*	*T Stat*	*R^2*	*R^2a*	*Chow-Stat*	*P-value Chow*
BCP	-0,031	-3,683	1,032	7,087	0,239	0,234	0,503	0,605
BPI	-0,012	-1,555	0,983	7,064	0,29	0,286	0,029	0,971
EDP	-0,002	-0,609	0,559	8,223	0,297	0,293	0,24	0,786
EGL	0,002	0,287	0,918	8,051	0,288	0,284	0,442	0,643
IPR	-0,014	-1,416	1,277	5,971	0,252	0,248	2,448	0,089
JMT	0,004	0,816	0,748	6,272	0,259	0,254	2,724	0,069
PTC	-0,014	-2,333	0,645	3,744	0,167	0,162	1,691	0,188
PTI	0,003	0,553	0,660	8,351	0,304	0,299	0,537	0,585
SEM	0,002	0,480	0,550	6,584	0,213	0,208	0,014	0,986
SON	-0,007	-0,960	1,073	7,793	0,339	0,335	1,163	0,315

T Stat: t-test statistic; RM-RF: risk premium on the market euro area; R^2: adjustment coefficient of the regression model; R^2a: adjusted coefficient of determination; Stat-Chow: Chow test statistic.

For the three factors CAPM model (see Table 3), which includes the SMB and HML risk factors in addition to market risk premium (RM-RF), it is observed that three stocks (30%) exhibit statistically significant (for a level of significance of 5%) alpha coefficients. Market risk factor behavior keeps statistically significant for all assets, that is the market risk perfectly explains the average expected return. Regarding the SMB risk factor, it is statistically

significant for three stocks (30%). In relation to HML risk factor, it is statistically significant for four stocks (40%). The determination coefficient is between 17.7% and 36.5%, with an average of 30.21%, with an average of coefficients of determination (R^2) of 30.42%. It is also observed that according to the Chow-test statistic, six stocks (60%) show no structural changes in the sample parameters.

Table 3: Regression Model for the three factors CAPM

$$R_{it} - R_{ft} = \alpha_i + \beta_{im}\left(R_{im} - R_{ft}\right) + \beta_{is}\left(SMB_t\right) + \beta_{ih}E\left(HML_t\right) + \varepsilon_{it} \qquad \alpha = 0$$

Stocks	*BCP*	*BPI*	*EDP*	*EGL*	*IPR*	*JMT*	*PTC*	*PTI*	*SEM*	*SON*
Alfa	-0,037	-0,018	-0,003	-0,003	-0,020	0,007	-0,011	0,001	0,001	-0,009
T Stat	-4,448	-2,727	-0,654	-0,452	-2,080	1,390	-1,668	0,201	0,109	-1,254
RM-RF	0,935	0,846	0,537	0,855	1,297	0,819	0,686	0,650	0,534	1,107
T Stat	6,291	7,021	7,495	7,378	7,508	6,754	4,510	7,850	6,109	7,181
SMB	0,752	0,477	-0,175	0,749	2,073	0,054	-0,451	0,360	0,356	0,746
T Stat	1,870	1,461	-0,901	2,389	4,434	0,1626	-0,913	1,609	1,505	2,717
HML	1,014	1,270	0,136	0,722	0,390	-0,584	-0,463	0,185	0,228	-0,081
T Stat	2,798	4,318	0,775	2,554	0,925	-2,317	-1,710	0,915	1,067	-0,223
F Stat	21,876	31,836	22,881	27,545	27,273	17,535	7,678	24,714	15,826	20,488
P-value F	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
R^2	0,293	0,377	0,303	0,343	0,341	0,283	0,192	0,319	0,231	0,360
$R^2 a$	0,28	0,365	0,289	0,331	0,328	0,269	0,177	0,306	0,216	0,347
Stat Chow	1,541	7,695	1,721	1,151	6,569	0,768	1,610	2,716	2,059	10,017
P-value Chow	0,193	0,000	0,148	0,335	0,000	0,547	0,174	0,032	0,089	0,000

T Stat: t-test statistic; RM-RF: risk premium on the market euro area; R^2: adjustment coefficient of the regression model; R^2a: adjusted coefficient of determination; Stat-Chow: Chow test statistic.

Finally we present below, in Table 4, the results of multiple regression for the four factors CAPM of Fama-French-Cahart. Two stocks (20%) suggest an effective average return higher than expected, since alpha is statistically significant at the 5% significance level. Market risk factor (RM-RF) keeps statistically significant for all stocks. The SMB risk factor is statistically significant for three stocks (30%), while for the risk factors HML and WML there is statistical significance for four stocks (40%), respectively. The adjusted coefficient of determination (R^2a) is between 18% and 38.6%, and the average value of 30.02%. The average coefficient of determination is 31.81%. The Chow-test statistic indicates that, six stocks (60%) do not present structural changes of sample parameters.

Table 4: Regression model for the four-factor CAPM

Stocks	*BCP*	*BPI*	*EDP*	*EGL*	*IPR*	*JMT*	*PTC*	*PTI*	*SEM*	*SON*
Alfa	-0,033	-0,014	0,000	-0,001	-0,019	0,011	-0,009	0,003	0,001	-0,002
T Stat	-3,830	-2,072	-0,071	-0,194	-1,859	1,943	-1,157	0,685	0,285	-0,303
RM-RF	0,793	0,706	0,455	0,798	1,250	0,691	0,598	0,567	0,501	0,879
T Stat	4,664	5,137	5,570	5,975	6,267	5,357	4,154	5,989	4,974	5,356
SMB	0,796	0,521	-0,149	0,767	2,087	0,094	-0,423	0,387	0,366	0,818
T Stat	1,988	1,610	-0,773	2,439	4,445	0,286	-0,894	1,734	1,542	3,126
HML	1,044	1,300	0,153	0,734	0,400	-0,557	-0,444	0,202	0,234	-0,033
T Stat	2,894	4,459	0,882	2,591	0,946	-2,427	-1,641	1,007	1,096	-0,113
WML	-0,345	-0,343	-0,200	-0,139	-0,115	-0,313	-0,217	-0,202	-0,079	-0,556
T Stat	-1,674	-2,060	-2,021	-0,860	-0,477	-2,220	-1,244	-1,761	-0,648	-3,095
R^2	0,306	0,393	0,321	0,346	0,342	0,304	0,201	0,333	0,233	0,402
R^2 *ajustado*	0,288	0,378	0,303	0,329	0,325	0,285	0,180	0,315	0,213	0,386
F Stat	17,296	25,429	18,517	20,810	20,411	15,608	5,946	19,558	11,931	22,583
P-value F	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Stat Chow	1,731	5,152	1,121	0,763	6,072	0,682	1,356	1,847	2,337	5,972
P-value Chow	0,131	0,000	0,351	0,578	0,000	0,638	0,244	0,107	0,044	0,000

T Stat: t-test statistic; RM-RF: risk premium on the market euro area; R^2: adjustment coefficient of the regression model; R^2a: adjusted coefficient of determination; F Stat:F-statistic; Stat-Chow: Chow test statistic.

5. CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH

Having proposed as objective of this paper to check if CAPM is valid in the Euronext Lisbon stock exchange, sought to validate the CAPM model that best describes the expected returns of ten Portuguese stocks that belongs to PSI20 for a period of 10 years (from February 2001 to July 2014), testing the CAPM models having as risk factors proposed by Fama and French (1993, 1996) and Carhart (1997) and developed by French (2014). It was observed that for the ten assets of the PSI20 index in the period under analysis, for the single-factor CAPM model, the obtained determination coefficients were relatively significant when compared to the models of three and four factors models. However, the increase in risk factors SMB, HML and WML as explanatory variables had little influence on the behavior of the average expected return because the coefficient of adjustment, R^2, presented a relatively very low explanatory power in explanatory variables set (25.44%).

The results suggest that the risk factors proposed by Fama and French (1993) and Carhart (1997), are not statistically sufficient to explain the expected average return, according to research hypothesis 1 (H1) - The market risk explains the expected returns, whereby alpha is different from zero, it cannot be rejected. This is in line with the arguments of Fama and

French (1993) which advocates the use of risk factors in any application that requires estimating future performance, as to guide (a) portfolio selection, (b) evaluating portfolio performance (c) calculate abnormal returns in event studies, and (d) estimate the cost of capital, if the risk factors capture the average return, the single-factor CAPM cannot explain. That is, the risk factors proposed by Fama and French - Carhart, for the period under analysis does not capture the average return that the market risk factor cannot explain.

On the other hand, it must be said that given the sample size and the analyzed period, characterized by a global financial crisis with consequences for the euro zone stock markets (the Chow test suggests that there is structural break in alpha and beta's parameters over the period) are limitations that may confines the conclusions draw here. As future research suggestions it should expand the time period of analysis and number of stocks.

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