EVIDENCE ON AGGREGATE VOLATILITY RISK PREMIUM FOR THE FRENCH STOCK MARKET

ABSTRACT

This study examines alternative six and seven factor equity pricing models directed at capturing a new factor aggregate volatility; in addition to the market, size, book to market, profitability, investment premiums of the Fama and French (2015) and the seven factor one is the Fama and French (2018) aggregate volatility augmented model. The models are tested using a time-series regression and the Fama Macbeth (1973) methodology. The new six and seven factor models provide by far a better description of the average excess returns for the French stock market. The investment risk premium seems to be better priced than the profitability factor. The momentum factor is negatively related to excess returns. There is some evidence that the aggregate volatility factor is systematically priced. Moreover, periods with downward market movements tend to coincide with high volatility. Inconsistent with theoretical predictions, we cannot talk about an asymmetric relation between aggregate volatility and stock returns for the French stock market.

JEL classification:
G12

Keywords:
Asset pricing models
Fama and French (2018)
Seven factor model
Aggregate volatility
Implied Volatility (VCAC)

1. *Introduction*

There is general evidence among researches that multifactor models poorly explain average excess returns. Moreover, numerous studies as Kan and Robotti (2008), Michou, Stark and Mouselli (2014) provide inconclusive results about the performance of the Fama and French (1993) model by finding some unexpected returns and therefore, validate the assumption of additional risk factors. With hindsight, many authors such as Lewellen, Nagel and Shanken (2010), Fama and French (2016)…argue that other anomalies known to cause problems for the Fama and French (1993) model are not considered by the Fama and French (2015) five factor model especially the momentum premium of Jagadeesh and Titman (1993) and the aggregate volatility risk factor of Ang et al. (2006)… Thus, many researches combine different anomalies including, Fama and French (2018) adding the momentum factor, Stambaugh-Yuan (2017) 4-factor model, Hou-Xue-Zhang (2018) q^5-factor model, Daniel-Hirshleifer-Sun (2018) three factor model… including the behavioral dimension.

In this study we examine two new augmented Fama and French (2015,2018) factor models that integrate the aggregate volatility risk factor. The tests related to the aggregate volatility risk premiums still limited to the Fama and French (1993) and the Carhart (1997) over the US, Australian and other markets. The Paris bourse represents an ideal out of the sample market for testing this model giving its size and importance in the global market context. To our knowledge, there is no study that examines the French stock returns by a Fama and French (2015, 2018) volatility augmented model. We adopt a time-series regression and the Fama Macbeth (1973) methodology to estimate the models; over a long period from July 2000 to June 2016 characterized by a succession of economic and financial crisis. We then examine if the factors' behavior is related to market conditions and to the sovereign debt crisis in Europe. We test also the asymmetry of the volatilit'y risk factor by estimating its increasing (decreasing) price.

We contribute to the related literature in several ways. First, we test two new empirical six and seven-factor model and we compare them to the Fama and French (2018) model. Second, we give new evidence about the VCAC using it for the first time to our knowledge to construct a volatility risk premium.

We show that both six and seven factor model best explain average excess returns on the French stock market. In fact, they outperform the Fama and French (2018) model. Furthermore, a Fama and French (2015) aggregate volatility augmented model provide a complete description of the average excess returns for the size-momentum portfolios in the French stock market. The investment risk factor seems to be better priced in the French stock market than the profitability factor as it has globally significant coefficients. The momentum slopes are globally significant with a negative relation with the excess returns. We use sensitivity of aggregate volatility of a stock VCAC as a proxy to construct the aggregate volatility risk factor. The spanning tests suggest that the Fama and French (1993,2015,2018) and the Carhart (1997) models do not explain the aggregate volatility risk factor FVCAC. The results show that the FVCAC factor earns significant alphas across the different multifactor models and even after controlling for the exposure to all the other in the Fama and French (2018) model. The asset pricing tests show that it is systematically priced. Market conditions affect four risk factors: the market, size, value and aggregate volatility. The European sovereign debt crisis affects only market, value and the aggregate volatility risk premiums. While previous researches provide evidence for the relations between different factors as size, value, leverage… and stock returns; we find a robust relation between stock returns and aggregate volatility on the Paris Bourse contributing by the way to the existing literature on the foundation of the cross-section returns and asset pricing anomalies in France. Furthermore, our paper represents guidance for further asset-pricing researches.

This paper is organized as follow. Section 2 presents a literature review. Section 3 outlines the data and the methodology adopted, section 4 discusses the results. We present robustness tests in section 5 and finally section 6 concludes the paper.

2. Literature review

Fama and French (2015) build a five-factor model on the original Fama and French (1993) three factor model, by including two new factors related to the profitability and the investment characteristics of a stock. They find that a five-factor model is better than the Fama and French (1993) three-factor one but still imperfect in explaining portfolio average excess returns. Moreover, Nichol and Dowling (2014) compare the Fama and French (2015) to the Fama and French (1993) and Chen et al (2011) models on the UK stock market based on the Fama and MacBeth (1973) methodology. They argue that the Fama and French (2015) five-factor model seems to be the least bad and constitutes a marginal improvement over the two models. In addition, Zaghouani and Hmaied (2019), Qi Lin (2017) confirm the results of Fama and French (2015) that the five-factor model consistently outperforms the three-factor one for the French and Chinese equity markets respectively.

Besides the different market anomalies presented across the different Fama and French (1993, 2015) multifactor models; many researches study other risk premium such as the momentum. Jegadeesh and Titman (1993) argue that a momentum factor built through a strategy that buys winners and sells losers gives significant monthly returns over the consecutive few months. Carhart (1997) augments the Fama and French (1993) model by adding the momentum premium to examine the mutual fund performance. Therefore, the momentum factor and especially the Carhart (1997) model is generally accepted as a standard across the literature. Fama and French (2016) find that a Fama and French (2015) model that integrate the momentum factor better performs than a five factor one. Thus, Fama and French (2018) include the momentum factor to the Fama and French (2015) model.

Aggregate volatility risk premium

Many considerable researches argue that the cross-section of stock returns is affected by systematic volatility. Time-varying stock returns' volatility influences the investment opportunities so that investors' investment choices will vary by changing their future market returns' prediction or by changing the risk-return arbitrage. Based on their multifactor models Merton (1973), Ross (1976), Adrian and Rosenberg (2008) imply that if market volatility is a systematic risk factor, it should be priced in the stock returns' cross-section. Coval and Shumway (2001) and other studies based on the volatility of options find a negative relation between volatility and stock returns using options on individual stocks or on aggregate market index. Ang et al. (2006) confirm these results using changes in the implied volatility (VIX) as a proxy for aggregate volatility. Moreover, many researchers as Frijns et al. (2010a), Chewie et al. (2016) find that the VIX is the best predictor of the future market volatility. In addition, other authors support higher predictive power for a two factors model composed by market and risk aversion factors than the Fama and French (1993) three factor model (see Nyberg and Wilhelmsson (2010) for exemple).

3. Data and methodology

3.1. *Data*

The data set includes all stocks listed on the Paris Bourse except financial institutions. We examine monthly returns from July 2000 to June 2016. Data relative to financial statements, monthly stock prices, market equity (number of outstanding shares times stock prices), the one-month Treasury Bills rate, VCAC implied market volatility index are all collected from the Thomson Reuters database DataStream. We exclude stocks with missing data from the sample. In other words to be included in a portfolio a company must have all the data for December$_{t-2}$, December$_{t-1}$ and June$_{t}$.

3.2. Methodology

We estimate and compare three asset-pricing models; the six factor Fama and French (2018) model, a six and a seven factor models based on the Fama and French (2015, 2018) aggregate volatility augmented respectively. The factors are constructed as in Fama and French (2018) and Ang et al. (2006).

The Fama and French (2018), the six and the seven factor models are presented by equations (1), (2) and (3) respectively.

$$R_{pt} - R_{ft} = \alpha_p + \beta_p\left[R_{Mt} - R_{ft}\right] + s_p SMB_t + h_p HML_t + r_p RMW_t + c_p CMA_t + w_p WML_t + \varepsilon_{pt} \quad (1)$$

$$R_{pt} - R_{ft} = \alpha_p + \beta_p\left[R_{Mt} - R_{ft}\right] + s_p SMB_t + h_p HML_t + r_p RMW_t + c_p CMA_t + \boldsymbol{f_p FVCAC_t} + \varepsilon_{pt} \quad (2)$$

$$R_{pt} - R_{ft} = \alpha_p + \beta_p\left[R_{Mt} - R_{ft}\right] + s_p SMB_t + h_p HML_t + r_p RMW_t + c_p CMA_t + w_p WML_t + \boldsymbol{f_p FVCAC_t} + \varepsilon_{pt} \quad (3)$$

Where R_{pt} is the return on portfolio p for period t, R_{ft} is the risk-free return measured by the one-month Treasury Bills Rate, R_{Mt} is the return on the value-weight market portfolio, SMB_t is the size factor measured by the market equity, HML_t is the value factor measured by the book to market ratio. RMW_t is the factor related to the profitability measured by the operating profitability, which is equal to the earnings before income taxes to the book equity. CMA_t is the investment factor measured by the change of total asset. WML_t is the momentum factor measured by prior 2-12 returns. The $FVCAC_t$ is the aggregate volatility factor measured from the VCAC index. The factor loadings are β_p, s_p, h_p, r_p, c_p, w_p and f_p. ε_{pt} is a zero-mean residual.

We follow Ang et al. (2006) to construct the FVCAC factor. In fact, we obtain the sensitivity measure by regressing daily excess returns on the market excess return and innovations in volatility VCAC (ΔVCAC) over a two months' period, re-estimated every one-month:

$$R_{i,t} = \alpha_i + \beta_{MKT,i} MKT_t + \beta_{\Delta VCAC,i} \Delta VCAC_t + \varepsilon_{i,t} \quad (4)$$

Where $R_{i,t}$ is the excess returns for stock i on day t, MKT_t is the market excess return on the day t, $\Delta VCAC_t$ is the innovation in volatility VCAC from day t-1 to the end of the day t, $\varepsilon_{i,t}$ is the error term. $\beta_{MKT,i}$ and $\beta_{\Delta VCAC,i}$ are loadings on the market return and innovations in VCAC for each stock and every month. We must specify that we do not include other risk factors such as size or value premiums and thus to avoid unnecessary noise in the estimation of the aggregate volatility risk $\beta_{\Delta VCAC.}$ In addition, we create the FVCAC factor related to the sensitivity to ex-post aggregate volatility risk at the monthly level based on the five quintile portfolios sorted on $\beta_{\Delta VCAC.}$ We start first to construct the daily FVCAC as follow:

$$\Delta VCAC_t = \alpha_i + \gamma_1 R_{1,t} + \gamma_2 R_{2,t} + \gamma_3 R_{3,t} + \gamma_4 R_{4,t} + \gamma_5 R_{5,t} + \varepsilon_{i,t} \qquad (5)$$

Using the equation (5), we regress daily change in the VCAC against the daily excess returns from the five quintiles portfolios with a one-month rolling window. Where $\Delta VCAC_t$ is the daily changes in VCAC and R_{it} is the daily excess returns from the $\beta_{\Delta CVAV}$ five quintiles portfolios. Finally, we cumulate the daily returns over the month to construct the aggregate volatility risk factor FVCAC at the monthly frequency:

$$FVCAC_t = \widehat{\gamma_1} R_{1,t} + \widehat{\gamma_2} R_{2,t} + \widehat{\gamma_3} R_{3,t} + \widehat{\gamma_4} R_{4,t} + \widehat{\gamma_5} R_{5,t} \qquad (6)$$

The factors are constructed based on portfolios formed using Fama and French (2018) 2 x 3 sorts. For each month from July of year t to June of year t+1 two independent sorts are conducted. First, stocks are assigned to two size groups using the $June_t$ market capitalizations breakpoints (50%). Then the same stocks are sorted into three book to market, profitability, investment and prior return groups respectively using the $June_t$ 30^{th} and 70^{th} percentiles. SMB_5 is the average return on the nine small stock portfolios minus the average return on the nine big stock portfolios HML is the average return on the two value portfolios minus the average return on the two growth portfolios. RMW is the average return on the two robust operating profitability portfolios minus the average return on the two weak operating profitability portfolios. CMA is the average return on the two conservative investment portfolios minus the average return on the two aggressive investment portfolios. WML is the is the average return on the two high prior return portfolios minus the average return on the two low prior return portfolios.

The 25 (5 x 5) test portfolios are constructed the same way as the 2 x 3. The 25 β_{MKT} and $\beta_{\Delta VCAC}$ portfolios 5 x 5 β_{MKT} and $\beta_{\Delta VCAC}$ which we obtain from equation (4); we then compute the value-weight returns within each portfolio.

4. Results[1]

[1] To save space we only provide the size book to market portfolio details (Tables 5, 6 and 7) the other portfolio results are nearly the same and are available upon request.

4.1 Summary statistics

Table 1 reports summary statistics for factor returns; from July 2000 to June 2016, 192 months. Panels A and C show means, standard deviations and t-statistics of the risk factors at the daily and monthly levels. FVCAC has higher significant means and standard deviations compared to ΔVCAC at the daily and monthly levels. At the daily level the average return and the standard deviation of FVCAC are 1.14 and 2.7 respectively. However, at the monthly level the mean and standard deviation grow largely and significantly for the FVCAC factor to achieve 24.779 and 32.409 respectively compared to ΔVCAC that has higher insignificant mean value 0.019 with decreasing standard deviation value 0.02. This may be not surprising since the monthly factor FVCAC results from a daily returns accumulation (equation 6). The momentum factor WML (Panel C) presents higher positive significant average return compared to the American stock market (0.035, 0.0069) but lower standard deviation (0.027, 0.0422) respectively. The factors SMB, SMB_5, HML and RMW have positive average returns 0.0261%, 0.0094%, 0.1411%, 0.142% respectively.RM –Rf and CMA have negative average returns -1.2%, -0.4919% respectively.

Panels B and D of **Table 1** present correlations among FVCAC and ΔVCAC as well as correlations of these variables with other cross-sectional factors SMB_5, HML, RMW, CMA, WML. We denote ΔVCAC the daily first difference in the VCAC and $\Delta_{(m)}$VCAC the monthly first difference in the VCAC. At the daily level, mimicking volatility factor FVCAC is significantly highly correlated with the change in volatility ΔVCAC with the correlation of 0.5570. However, at the monthly level, the correlation between FVCAC and $\Delta_{(m)}$VCAC is significantly lower at 0.1379. The highest correlation is between FVCAC and the market factor $R_M - R_f$ with significantly negative value (-0.3116) meaning that when the volatility increases the market returns are low. Our findings are consistent with Whaley (2000) that the VCAC index is as « the investor fear gauge » of the French stock market. This correlation seems to be lower than the correlations reported in the American market by Ang et al. (2006) and Mai et al. (2016) (-0.66 and -0.42) respectively. The correlations between FVCAC and the other factors (SMB_5, HML, RMW, CMA, WML) are low. The momentum factor is significantly correlated with the value and the investment risk premiums (HML= 0.1929^{***} and CMA= -0.1630^{**}). The correlations between WML and the market, SMB_5, RMW are insignificantly low.

Table 1 also presents the variance inflation factor (VIF). In our case, the VIF-test shows that multicolinearity is not a serious issue, in other words, the different factors presented above can be included together in a multiple linear regression frameless estimation bias.

Table 2 reports the results of regressions of the aggregate volatility risk factor returns on standard factor models: The Fama and French (1993) three-factor model (FF3), the Carhart (1997) four-factor model

(Carhart4), the Fama and French (2015) five-factor model (FF5) and the Fama and French (2018) six-factor model. The significant intercepts from the Fama and French (1993,2015,2018) and the Carhart (1997) models suggest that they do not explain the aggregate volatility risk factor FVCAC. In addition, the results show that the FVCAC factor earns significant alphas across the different multifactor models and even after controlling for the exposure to all the other in the Fama and French (2018) model (α= 21.16, t-statistic= 5.75).

Table 3 shows the results of regressions of other factors on the aggregate volatility risk premium FVCAC. The FVCAC factor fully explains 3 out of 5 factors we examine: the size SMB_5, the value HML and the profitability RMW premiums. The exceptions are the investment and the momentum premiums. Furthermore, **Table 4** shows the estimated coefficients of each factor on the other six. Fama and French (2018) confirm the evidence of Huberman and Kandel (1987) that suggests that the HML factor is redundant as its intercepts are indistinguishable from zero. It is then interesting to examine whether these results exist or other factors are redundant in the French stock market over the period of 2000-2016. Our results show that the factors seem to be not redundant in the French stock market. In addition, in the HML regression; the RMW slope is significantly positive (same results in the Fama and French (2018) study) even if value stocks tend to be less profitable. CMA slope is significantly negative (not in line with Fama and French (2018)) which is not in line with the fact that high book to market stocks tend to little invest. This means that high book to market value stocks tend to be more profitable and tend to do big investments on the French market. In the market regression the FVCAC slope is significantly negative confirming our previous results and the results of several studies and especially of Ang et al. (2006).

Table 5 shows the Gibbons, Ross and Shanken (1989) statistic test (GRS) for factors of regression (1), (2) and (3); and the summary statistics for the intercepts of each regression. We examine the three factor model (FF3), the five factor model (FF5), the Fama and French (2018) six-factor model that integrates the momentum factor to the Fama and French (2015) model (FF6), a six factor model that combines in addition to the FF5 model premiums the aggregate volatility premium FVCAC (FF5+FVCAC) and a seven factor model that combine the seven factors (FF6+ FVCAC).[2] As reported in the table 6 all p-values are zeros; the different combinations of the models give incomplete description of expected returns. Fama and French (2018) argue that asset pricing models are simplified propositions about expected returns that are rejected in tests with power. Therefore, we do not concentrate on whether the

[2] We do not provide results (**Table 6**) of the different combinations of the factors generating four models that combine the size and profitability or investment or momentum or aggregate volatility factors respectively, eight four-factor models that combine RM – Rf and SMB_5 with pairs of HML, RMW, CMA, WML and FVCAC. Details exist upon request.

models are rejected but we are interested to study their relative performance and thus to identify the best model that describes the average portfolio returns. Otherwise, the FF5+FVCAC and the FF6+FVCAC models appear to be better in explaining the excess returns in the French stock market than the other different combinations of multifactor models and especially the FF6; the GRS statistic largely falls from the three (five) (six)-factor models 8.81 (7.05) (3.55) to the FF5+ FVCAC and the seven-factor one 2.93 and 2.12. The average intercept and the mean-adjusted R^2 also improve in a remarkable way from the FF3 to both the FF5+ FVCAC and FF6+FVCAC models. In addition, the mean-adjusted R^2 increase from the FF3 to the FF5+FVCAC and the FF6+FVCAC. In addition, the SR(α) is lower for the seven factor model compared to the FF3, FF5 and FF6 factor ones indicating a greater precision in estimating the intercepts generated by the seven factor model. We must also specify that overall the lowest SR(α) is for the FF5+FVCAC model. According to these results we can say that the FF5+FVCAC and the FF6+FVCAC models outperform both Fama and French (2015) and Fama and French (2018) models.

4.2 Time series regression details

In this section we only provide details about the Fama and French (2018) and the seven factor models to save space. We do not show results about our FF5+ FVCAC model because they are nearly the same compared to the seven factor one which will be confirming the fact that a momentum premium added to the Fama and French (2015) model do not largely improve the results compared to our Fama and French (2015, 2018) aggregate volatility augmented models.

Size-book to market portfolios

Table 6 shows results of the six and seven-factor model regressions for portfolios formed on 25 size and book to market groups. Panel A shows results of the Fama and French (2018) six factor model. Panel B shows results of the seven-factor model composed by the six-factor model augmented by the aggregate volatility premium.

For both Panels (A and B) all the intercepts αi are significant; so we reject the null hypothesis; the six and seven-factor models give incomplete description of expected returns. However, microcap extreme value portfolio of the Panel B presents an insignificant intercept meaning that in the French market a seven-factor model gives a complete description of microcap extreme value portfolio sorted by size and book to market. In addition, we cannot say; as in Fama and French (1993, 2015); that the microcap extreme growth portfolio is problematic. The six-factor model intercept for the microcap extreme growth stocks is -0.01 per month (p-value= 0.000) (in contrast to the results of Fama and French (2015) (intercept is -0.49)). However, we can say that extreme growth stocks are a challenge because the size effect does not clearly appear between small and large stocks. The seven factor model intercepts largely improve and reduce this challenge, but still negative; the intercept for the microcap extreme growth stocks rises 0.4 points to -0.006 per month (p-value=0.025). All the different factor slopes decrease from the six to the seven-factor model. SMB_5 slopes are all significant (except for the large stocks) and higher for small stocks; this confirms the size effect; small stocks are related to higher returns. HML slopes are globally significant and increase with book to market ratio; it is the value effect. For the six factor model only the megacap extreme growth is significant, however; for the seven factor model the three largest microcap extreme growth portfolios are significant. For the six factor model RMW slopes are negative and not significant except for the megacap extreme growth portfolio. Nevertheless, for the seven factor model the slopes are all negative except for the microcap extreme value which presents a positive value; they are globally significant. They increase non-monotonically with the book to market ratio. For both models CMA slopes are all positive and globally significant. They decrease as the book to market rises. These results mean that unprofitable low book to market stocks invest conservatively and profitable high book to market stocks invest aggressively (in contrast with the findings of Fama and French (2015) for the US market); except for the last lines. For both models the momentum factor presents significant negative relation with the excess returns only for two and four –portfolios respectively.

The aggregate volatility factor FVCAC has significant and negative relation with the excess returns. However, we must specify that the intercept values are negligible.

Panel C presents the R^2 and the AIC-test statistic for both models. The R^2 indicate a higher informational content with higher values for the seven factor model than the Fama and French (2018). Therefore, the seven factor model outperforms the six-factor one, providing a better predictive power.

In addition, the use of AIC-test allows us to choose between both models by determining the most relevant combination that maximize the information content of the different risk premiums. Overall, our results show that the seven factor model combination is the most relevant.

4.3 Fama Macbeth regression details

Table 7 details the second stage Fama-Macbeth (1973) regression for the Fama and French (2018) six-factor model (FF6), the Fama and French (2015) aggregate volatility augmented model (FF5+FVCAC) and the Fama and French (2018) aggregate volatility augmented-model (seven factor model). Panel A shows results for size- book to market portfolios. The intercepts are negative and significant for the different models. This confirms the GRS test results that the models give incomplete description of expected returns. RMW does not seem to be significant. In fact, this confirms the results of the time series regression that the investment premium is better priced than the profitability factor in the French stock market. In addition, the results of the F-statistic test for the different models show that we can reject the null hypothesis of jointly significant pricing errors. Moreover, both models FF5+FVCAC and the seven factor better perform in explaining monthly excess returns giving the R^2 that increases, in addition, the regression standard error presented in the Table 7 is nearly the same presented in the model performance Table 5. Thus adding the new factor related to volatility to the FF5 and FF6 models improves the results. However, although the aggregate volatility FVCAC risk premium has consistent significant and negative relation with the excess returns across the time series regressions it does not seem to be well priced in the cross-section of stock returns in the French stock market.

5. *Robustness tests*

5.1. Market conditions

We follow Pettengill et al. (1995) and measure up and down-markets by the sign of the excess return. When the realized return on the market exceeds (lower than) the risk free rate it is up market (down market). Table 8 shows summary statistics of the 7 factors $R_M – R_f$, SMB_5, HML, RMW, CMA, WML and FVCAC in up and down market conditions. Positive market excess returns represent 41% (79 of 192 months) of the observation. Our previous results related to the inverse relationship between market and volatility premiums are validated according to table 8. In fact, the market premium provides negative mean value that increases from down to up market conditions and becomes positive; the aggregate volatility factor FVCAC mean values decrease from down to up market conditions. In fact, according to French, Schwert and Stambaugh (1987), Campbell and Hentschel (1992), Ang et al. (2006) and others periods with downward market movements tend to coincide with high volatility. The market condition effect influences the FF3 model factors. The market, size, value and aggregate volatility factors' compounded mean values are significantly different from zero at 1%.

Table 8: Summary statistics for 7 factors $R_M – R_f$, SMB_5, HML, RMW, CMA, WML and FVCAC in up and down market conditions, from July 2000 to June 2016, 192 months.

	R_M- R_f	SMB_5	HML	RMW	CMA	WML	FVCAC
Panel A: douwn market conditions (N= 113 observations)							
Mean	-0.043***	0.0017*	0.004***	0.003	-0.005***	0.035***	35.85***
Standard deviation	0.037	0.011	0.013	0.021	0.015	0.024	35.49
T mean	-12.36	1.74	3.45	1.53	-3.17	15.46	10.74
	(0.0000)	(0.0839)	(0.0008)	(0.1281)	(0.0020)	(0.0000)	(0.0000)
Panel B up market conditions (N= 79 observations)							
Mean	0.032***	-0.002**	-0.003	-0.001	-0.005**	0.035***	8.95***

1. Standard deviation	0.026	0.01	0.016	0.013	0.02	0.030	18.23
T mean	11.11	-1.97	-1.59	-0.55	-2.44	10.24	4.36
	(0.0000)	(0.0524)	(0.1169)	(0.5828)	(0.0169)	(0.0000)	(0.0000)
Compounded means	-0.01	0.000	0.001	0.001	-0.005	0.000	-26.90***
Two-sample t test	-15.61	2.61	3.39	1.44	0.32	0.05	-6.19
	(0.0000)	(0.0097)	(0.0009)	(0.1512)	(0.7502)	(0.9558)	(0.0000)

5.2. European sovereign debt crisis

We consider two sub-periods:

i. Pre-crisis: from July 2000 to December 2009

ii. Post-crisis: from October 2012 to June 2016.

Table 9 shows summary statistics for $R_M - R_f$, SMB_5, HML, RMW, CMA, WML and FVCAC over the two sub-periods. From the pre to the post crisis periods SMB_5, HML, WML and FVCAC mean values decrease with negative signs (except for WML). Once again, our previous results related to the inverse relationship between market and volatility premiums are confirmed. Lower standard deviation registered after the crisis period are for $R_M - R_f$, HML, RMW, CMA, WML and FVCAC which means that the market has absorbed the shock. The European sovereign debt crisis affects significantly only market, value and aggregate volatility factors of the seven factor model with compounded significant means -0.01, 0.002 and 44.74 respectively.

Table 9 : Summary statistics for $R_M - R_f$, SMB_5, HML, RMW, CMA, WML, FVCAC over the two sub-periods, from July 2000 to June 2016, 192 months.

	R_M- R_f	SMB_5	HML	RMW	CMA	WML	FVCAC
Panel A: Pre-crisis (114 observations)							
Mean	-0.03***	0.001	0.003**	-0.002	-0.006***	0.036***	40.94***
Standard deviation	0.05	0.01	0.02	0.02	0.02	0.03	32.43
T mean	-5.33	0.7	2.41	0.88	-3.34	12.41	13.48
	(0.0000)	(0.4875)	(0.0175)	(0.3822)	(0.0011)	(0.0000)	(0.0000)
Panel B Post-crisis (45 observations)							

Mean	0.01**	-0.001	-0.002	0.002**	-0.002	0.032***	-3.81***
Standard deviation	0.03	0.01	0.01	0.006	0.01	0.01	5.23
	R_M- R_f	SMB_5	HML	RMW	CMA	WML	FVCAC
T mean	2.44	-0.5	-1.07	2.26	-1.62	16.62	-4.88
	(0.0186)	(0.6203)	(0.2912)	(0.0285)	(0.1120)	(0.0000)	(0.0000)
Compounded means	-0.01	0.000	0.002	0.002	-0.005	0.004	44.74***
Two-sample t test	-4.59	0.79	2.02	-0.065	-1.3	0.89	9.19
	(0.0000)	(0.4298)	(0.0454)	(0.9483)	(0.1937)	(0.3735)	(0.0000)

5.3. Asymmetric aggregate volatility risk factor

Several studies as Ang et al. (2006), Delisle et al. (2011), Van Anh et al. (2016) document an asymmetric relation between aggregate volatility risk and stock returns. To examine if the pricing of aggregate volatility risk is asymmetric we perform the robustness test by dividing the sample into positive $FVCAC^+$ and negative $FVCAC^-$ aggregate volatility and zero otherwise.

Table 10: increasing and decreasing market volatility.
Panel A presents the time series regression, Panel B presents the Fama Macbeth two step regression. Inter is the intercepts of each regression, $FVCAC^+$ ($FVCAC^-$) is the positive (negative) aggregate volatility, and zero otherwise. The different factors are the market $R_M – R_f$, size SMB_5, value HML, profitability RMW, investment CMA and momentum WML. We also present the different portfolios size-book to market, size-profitability, size-investment, size-momentum and β_{MKT} and $\beta_{\Delta VCAC.}$ Coefficients, cross-sectional R² and F-statistic test for pricing error jointly to zero are presented. P- value in parentheses. * ** ***, significant coefficients respectively at 10%, 5% and 1%.

Panel A: Time series

	Size book to market	Size profitability	Size investment	Size momentum	$\beta_{MKT}\beta_{\Delta VCAC}$
Inter	-0.002	-0.004*	-0.002	-0.01***	0.009
	(0.542)	(0.098)	(0.416)	(0.000)	(0.239)
$FVCAC^+$	**-0.0003*** **	**-0.0003*** **	**-0.0003*** **	**-0.0003*** **	0.0002
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	(0.210)

FVCAC^{-}	**0.001***	0.001	**0.001***	**0.001***	**-0.003*****
	(0.069)	(0.464)	**(0.099)**	**(0.094)**	**(0.007)**

Table 10 (continuation)

$(R_M - R_f)$	0.19***	0.18***	0.22***	0.14***	1.36***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SMB_5	0.55***	0.31***	0.68***	0.19**	2.78***
	(0.000)	(0.003)	(0.000)	(0.053)	(0.000)
HML	-0.12	0.11	-0.11	0.07	0.43
	(0.308)	(0.259)	(0.278)	(0.449)	(0.160)
RMW	-0.12	-0.11*	-0.16**	-0.07	-0.02
	(0.132)	(0.088)	(0.016)	(0.243)	(0.915)
CMA	0.21**	0.14*	-0.15*	0.32***	0.46*
	(0.033)	(0.071)	(0.088)	(0.000)	(0.073)
WML	-0.05	-0.07*	-0.04	-0.01	-0.20
	(0.298)	(0.084)	(0.389)	(0.758)	(0.123)

Panel B : Fama-Macbeth regression

	FVCAC^{+}	FVCAC^{--}	SE. reg	R^2	F-statistic
Size book to market	15.33	0.32	0.001	0.54	2.39*
	(0.179)	(0.853)			(0.07)
Size profitability	-5.26	0.4	0.0006	0.41	1.36
	(0.362)	(0.676)			(0.28)
Size investment	16.52	2.23	0.001	0.58	2.81**
	(0.126)	(0.423)			(0.04)
Size momentum	-56.87	3.47	0.007	0.84	10.40***
	(0.124)	(0.286)			(0.00)
β_{MKT} and $\beta_{\Delta VCAC}$	12.74	0.36	0.008	0.98	131.61***
	(0.158)	(0.622)			(0.00)

Table 10 presents increasing and decreasing market volatility. Panels A and B show the time series regression and the Fama Macbeth (1976) regression respectively. To save space and to avoid repetition, we do not present all the coefficients for each regression[3]. In Panel A, we can see across the different sorts (except the sort β_{MKT} and $\beta_{\Delta VCAC}$) that FVCAC^{+} (FVCAC^{-}) is significantly negatively (positively) related to stock returns. The relation between FVCAC^{-} and stock returns is significantly negative for the β_{MKT} and $\beta_{\Delta VCAC}$ portfolio. In contrast to Van Anh et al. (2016) our results suggest that aggregate volatility risk factor explains very well the average excess returns when the aggregate volatility increases. This relation exists also when the aggregate volatility decreases but only for the size book to market, size and investment, size and momentum and β_{MKT} and $\beta_{\Delta VCAC}$ sorts. Therefore, in contrast to the American and the Australian markets, the asymmetric relation between aggregate volatility and stock returns is not confirmed for the French stock market. In addition, the cross-section regression results (Panel B) show insignificant coefficients across the different sorts for FVCAC^{+} and FVCAC^{-}, confirming the fact that the aggregate volatility FVCAC risk premium does not seem to be well priced in the cross-section of stock returns in the French stock market.

[3] The tables are available upon request.

6. Conclusion

This paper examines the validity of two multifactor models the six factor and the seven factor model for the French market by comparing them to the Fama and French (2018) six factor model. The six factor model includes a new factor related to the aggregate volatility, in addition to, the market, size, book to market, profitability, investment premiums of the Fama and French (2015) model, the seven factor model is the Fama and French (2018) aggregate volatility augmented model. The pricing models are tested using a time-series and the Fama-Macbeth (1976) methodologies. We examine regularities in the factor's behavior related to the market conditions and to the sovereign debt crisis in Europe. We then test the asymmetry of the volatility risk premium by estimating its increasing (decreasing) price. The results show that the Fama and French (2015, 2018) aggregate volatility augmented models better explains the variation of the portfolio returns than the Fama and French (2018) model. We show that the aggregate volatility factor is systematically priced. In fact, we find a consistent significant and negative (positive) relation between the aggregate volatility risk premium and the excess returns in the French stock market when it is rising (falling). This is in line with previous researches (Ang et al. (2006), Van Anh et al. (2016) …), according to the multifactor models studies investors hedge the aggregate volatility risk, since the increase of aggregate volatility weaken their investment opportunities. The increase in demand for hedging, pushes up asset prices positively correlated with global volatility and thus causes the decrease of the average excess returns. Therefore, the price of the aggregate volatility will be negative. The Fama-Macbeth (1973) two-step regression results confirm the regression details and model performance results and show that overall factors are significant for the Paris bourse. The market conditions and the European sovereign debt crisis significantly affect the FF3 and the aggregate volatility risk premiums. We cannot talk about an asymmetric relation between aggregate volatility and stock returns in the French stock market.

Table 1

Summary statistics for factors returns; from July 2000 to June 2016, 192 months.

Panel A reports the summary statistics of first differences in VCAC, FVCAC at the daily level. Panel B reports the summary statistics of first differences in VCAC, FVCAC at the monthly frequency with various factors. $R_M - R_f$, SMB_5, HML, RMW, CMA, WML are the market, size, the value, the profitability, the investment and the momentum factors of the Fama and French (2018) model. ΔVCAC ($\Delta VCAC_{(m)}$) represents the daily (monthly) change in the VCAC index, and FVCAC is the mimicking aggregate volatility risk factor.

Panel A : Means, standard deviation and t-statistics form daily returns			
	Means	Standard deviation	t-statistics

ΔVCAC	0.0002	1.786	0.0078 (0.9938)
FVCAC	1.14***	2.7	27.3592 (0.0000)

Panel B : daily correlation

	ΔVCAC
FVCAC	0.5570 (0.0000)

Panel C : Means, standard deviation and t-statistics form monthly returns

	Means	Standard deviation	t-statistics
WML	0.035***	0.027	18.1101
			(0.0000)
FVCAC	24.779***	32.409	10.5940
			(0.0000)
$\Delta_{(m)}$VCAC	0.019	0.2	1.2934
			(0.1974)

Panel D correlation between the different factors

	$R_M - R_f$	SMB_5	HML	RMW	CMA	WML	FVCAC	$\Delta_{(m)}$VCAC
WML	-0.0184	0.1092	0.1929***	-0.0132	-0.1630**	1.0000	0.0267	0.0763
	(0.8005)	(0.1315)	(0.0073)	(0.8559)	(0.0239)		(0.7131)	(0.2927)
FVCAC	-0.3116 ***	-0.0765	0.0857	-0.0202	-0.0258	0.0267	1.0000	0.1379*
	(0.0000)	(0.2916)	(0.2371)	(0.7809)	(0.7224)	(0.7131)		(0.0564)
$\Delta_{(m)}$VCAC	-0.6343***	0.1074	0.2837***	0.0292	-0.0136	0.0763	0.1379*	1.0000
	(0.0000)	(0.1382)	(0.0001)	(0.6881)	(0.8520)	(0.2927)	(0.0564)	
VIF-test	1.57	1.06	1.79	1.15	1.66	1.05	1.23	

Table 2: Factor Regressions of aggregate volatility on Other Factors

This table reports time-series regressions of aggregate volatility risk premium on standard factor models: (1) the Fama-French (1993) three-factor model (FF3), (2) the Carhart (1997) four-factor model (Carhart4), (3) the five-factor model of Fama and French (2015) and (4) the six-factor model of Fama and French (2018). The sample period is from **,** from July 2000 to June 2016, 192 observations, depending on data availability.

	Mean	**Models**	**α**	**R_M-R_f**	**SMB5**	**HML**	**RMW**	**CMA**	**WML**	**R^2**
FVCAC	24.779*** (10.594)	FF3	21.03*** (5.82)	-295.8*** (-6.25)	-316.42 (-1.54)	-141.18 (0.378)				0.18

Carhart4	21.03***	-295.8***	-316.42	-141.18			12.53	0.18
	(5.82)	(-6.25)	(-1.54)	(-0.88)			(0.15)	
FF5	21.58***	-306.4***	-323.2	-147.09	-163.4	0.34		0.19
	(9.16)	(-6.17)	(-1.58)	(-0.77)	(-1.30)	(0.00)		
FF6	21.16***	-306.8***	-325.76	-150.65	-163.7	1.74	12.3	0.19
	(5.75)	(-6.15)	(-1.58)	(-0.78)	(-1.29)	(0.01)	(0.15)	

Table 3: Factor Regressions of Other Factors on the volatility premium FVCAC

This table reports time-series regressions of other factors on the volatility premium FVCAC. SMB5, HML, RMW, CMA, WML are the size, value, profitability, investment and momentum factors. The sample period is, from July 2000 to June 2016, 192 observations, depending on data availability.

	Mean	**A**	**FVCAC**	**R^2**
SMB5	0.0094	0.000	-0.000	0.002
	(0.1227)	(0.47)	(0.537)	
HML	0.1411	0.000	0.000	0.01
	1.3206	(0.748)	(0.233)	
RMW	0.142	0.002	-0.000	0.0003
	1.0858	(1.00)	(-0.23)	
CMA	-0.4919***	-0.005***	0.000	0.002
	-3.9575	(-3.50)	(0.60)	
WML	0.035***	0.03***	0.000	0.0000
	18.1101	(14.38)	(-0.07)	

Table 4: Regression of each factor on the other four, from July 2000 to June 2016, 192 observations.

RM – Rf is the return on the value-weight market portfolio of all sample stocks minus the one month treasury bill rate. SMB, HML, RMW, CMA, WML are the size, the value, the profitability, the investment and the momentum factors and FVCAC is the aggregate volatility risk factor. Int is the regression intercepts or the average returns unexplained by the other factors.

	Int	**$R_M - R_f$**	**SMB_5**	**HML**	**RMW**	**CMA**	**WML**	**FVCAC**	**R^2**
$R_M - R_f$	-0.002		-0.6**	-1.5***	-0.24	-0.71***	0.07	-0.001***	0.36
t-statistic	(-0.32)		(-2.16)	(-6.32)	(-1.43)	(-3.38)	(0.65)	(-6.15)	

SMB_5	-0.001	-0.04**		0.04	-0.02	-0.04	0.04	-0.000	0.06
t-statistic	(-0.56)	(-2.16)		(0.54)	(-0.37)	(-0.68)	(1.16)	(-1.58)	
HML	-0.004**	-0.12***	0.04		0.09*	-0.47***	0.05*	-0.000	0.44
t-statistic	(-2.51)	(-6.32)	(0.54)		(1.82)	(-9.25)	(1.70)	(-0.78)	
RMW	0.003	-0.04	-0.04	0.2*		0.39***	0.01	-0.000	0.13
t-statistic	(1.53)	(-1.43)	(-0.37)	(1.82)		(4.48)	(0.23)	(-1.29)	
CMA	-0.004**	-0.08***	-0.06	-0.68***	0.25***		-0.03	0.000	0.4
t-statistic	(-2.36)	(-3.38)	(-0.68)	(-9.25)	(4.48)		(-0.80)	(0.01)	
WML	0.03***	0.03	0.21	0.29*	0.03	-0.11		0.000	0.05
t-statistic	(13.40)	(0.65)	(1.16)	(1.70)	(0.23)	(-0.80)		(0.15)	
FVCAC	21.16***	-306.77***	-325.76	-150.65	-163.68	1.74	12.3		0.19
t-statistic	(5.75)	(-6.15)	(-1.58)	(0.78)	(-1.29)	(0.01)	(0.15)		

Table 5

Summary statistics for tests of the three, five and other combinations of multifactor models composed by the different premiums related to size (SMB), value (HML), profitability (RMW), investment (CMA), momentum (WML), aggregated volatility (FVCAC) in addition to the market factor, from July 2000 to June 2016, 192 observations.

The table shows the ability of these different asset pricing models in explaining the average monthly returns on the 25 portfolios; Panel A shows 25 portfolios formed on size and book to market. The GRS tests whether the estimated intercepts of the 25 portfolios are jointly zero. $A|\alpha_i|$ is the average absolute value of the intercepts. P-values, mean adjusted R^2, the average standard error $S(\alpha)$ and the maximum Sharp ratio $SR(\alpha)$.

	GRS	$A\|\alpha_i\|$	p-value	Mean adj-R^2	$S(\alpha)$	$SR(\alpha)$
Panel A 25 size book to market portfolios						
FF3	8.81	0.012	0	0.55	0.0011	1.19
FF5	7.05	0.011	0	0.56	0.0012	1.15
FF6	3.55	0.010	0	0.56	0.018	1.27
FF5+ FVCAC	2.93	0.007	0	0.65	0.001	0.9
FF6+ FVCAC	2.12	0.005	0.002	0.65	0.002	1.07

Table 6

Regression details for 25 size-book to market test portfolios.

Dependent variables are the monthly excess returns on the 25 size book to market portfolios. The independent variables are SMB_5, HML, RMW and CMA and WML constructed using 2 x 3 sorts on size and each of book to market, profitability, investment and 2-12 prior returns groups. The FVCAC refers to the aggregate volatility risk factor constructed following Ang et al. (2006). Panel A shows five factor model slopes and Panel B shows seven factor model slopes. Panel C presents the R^2 and the AIC-test.

Panel B Six Factor model SIZE-BOOK TO MARKET portfolios										
	Low	2	3	4	High	Low	2	3	4	High

			A					B		
Small	-0.01	-0.01	-0.01	-0.01	-0.008	0.29	0.27	0.31	0.27	0.35
	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2	-0.009	-0.01	-0.01	-0.01	-0.009	0.32	0.29	0.33	0.36	0.37
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
3	-0.008	-0.01	-0.01	-0.01	-0.008	0.34	0.35	0.3	0.33	0.4
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
4	-0.009	-0.009	-0.01	-0.008	-0.009	0.39	0.35	0.38	0.32	0.46
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Big	-0.009	-0.01	-0.01	-0.01	-0.01	0.32	0.36	0.32	0.34	0.37
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
			s					h		
Small	0.69	0.53	0.52	0.44	0.64	-0.08	0.07	0.08	0.16	0.42
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.547)	(0.529)	(0.341)	(0.119)	(0.005)
2	0.57	0.58	0.67	0.62	0.66	-0.02	0.09	0.12	0.22	0.41
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.871)	(0.339)	(0.173)	(0.013)	(0.000)
3	0.67	0.71	0.52	0.68	0.69	-0.14	0.01	0.11	0.06	0.51
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.156)	(0.907)	(0.213)	(0.458)	(0.000)
4	0.58	0.48	0.58	0.48	0.57	-0.11	0.09	0.07	0.19	0.73
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.220)	(0.289)	(0.449)	(0.032)	(0.000)
Big	-0.04	0.16	0.15	0.07	0.08	-0.32	-0.04	0.11	0.25	0.51
	(0.699)	(0.077)	(0.111)	(0.436)	(0.344)	(0.001)	(0.629)	(0.190)	(0.004)	(0.000)
			r					c		
Small	-0.06	-0.07	-0.06	-0.08	-0.12	0.17	0.17	0.16	0.18	0.21
	(0.457)	(0.313)	(0.269)	(0.242)	(0.223)	(0.104)	(0.058)	(0.029)	(0.026)	(0.016)
2	-0.04	-0.04	-0.09	0.03	-0.04	0.21	0.24	0.13	0.18	0.05
	(0.600)	(0.488)	(0.145)	(0.607)	(0.464)	(0.016)	(0.002)	(0.096)	(0.015)	(0.468)
3	-0.067	-0.08	-0.024	-0.05	-0.017	0.24	0.06	0.14	0.022	0.099
	(0.292)	(0.167)	(0.683)	(0.410)	(0.773)	(0.003)	(0.438)	(0.073)	(0.755)	(0.194)
4	-0.053	-0.054	-0.005	0.008	-0.37	0.24	0.20	0.043	0.06	0.19
	(0.384)	(0.352)	(0.937)	(0.886)	(0.540)	(0.002)	(0.007)	(0.553)	(0.412)	(0.012)
Big	-0.119	-0.07	-0.09	-0.029	-0.081	0.055	0.19	0.074	0.085	0.25
	(0.062)	(0.205)	(0.118)	(0.612)	(0.134)	(0.494)	(0.007)	(0.306)	(0.235)	(0.000)
			w							
Small	-0.05	-0.07	-0.02	0.011	-0.001					
	(0.328)	(0.117)	(0.531)	(0.794)	(0.987)					
2	-0.07	-0.05	-0.02	-0.05	0.01					
	(0.138)	(0.216)	(0.591)	(0.153)	(0.838)					
3	-0.06	-0.06	-0.07	-0.039	-0.054					
	(0.116)	(0.141)	(0.075)	(0.305)	(0.163)					
4	-0.01	-0.053	-0.057	-0.097	-0.002					
	(0.792)	(0.162)	(0.134)	(0.011)	(0.961)					
Big	-0.054	-0.023	-0.03	-0.042	-0.04					
	(0.195)	(0.513)	(0.427)	(0.252)	(0.264)					

Table 6 (continuation)

Panel B Seven Factor model SIZE-BOOK TO MARKET portfolios										
	Low	2	3	4	High	Low	2	3	4	High
			A					B		
Small	-0.006	-0.005	-0.008	-0.008	-0.004	0.21	0.18	0.24	0.22	0.28
	(0.025)	(0.007)	(0.000)	(0.000)	(0.230)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

2	-0.005	-0.005	-0.006	-0.004	-0.007	0.25	0.21	0.25	0.29	0.31
	(0.015)	(0.001)	(0.000)	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
3	-0.003	-0.005	-0.005	-0.006	-0.003	0.27	0.28	0.23	0.26	0.34
	(0.056)	(0.003)	(0.004)	(0.000)	(0.040)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
4	-0.005	-0.005	-0.005	-0.003	-0.005	0.33	0.29	0.32	0.24	0.4
	(0.005)	(0.006)	(0.002)	(0.055)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Big	-0.005	-0.006	-0.007	-0.006	-0.005	0.25	0.3	0.25	0.27	0.30
	(0.011)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
			s					h		
Small	0.61	0.44	0.45	0.38	0.57	-0.12	0.02	0.05	0.13	0.39
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.329)	(0.786)	(0.518)	(0.172)	(0.008)
2	0.50	0.50	0.6	0.55	0.59	-0.05	0.05	0.09	0.19	0.38
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.605)	(0.516)	(0.262)	(0.016)	(0.000)
3	0.6	0.65	0.44	0.6	0.62	-0.17	-0.02	0.08	0.03	0.48
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.046)	(0.812)	(0.322)	(0.698)	(0.000)
4	0.51	0.41	0.51	0.40	0.50	-0.14	0.06	0.04	0.15	0.69
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.089)	(0.423)	(0.641)	(0.041)	(0.000)
Big	-0.11	0.09	0.07	0.00	0.01	-0.36	-0.07	0.08	0.22	0.47
	(0.216)	(0.238)	(0.368)	(0.989)	(0.887)	(0.000)	(0.353)	(0.290)	(0.004)	(0.000)
			r					c		
Small	-0.10	-0.12	-0.10	-0.11	0.15	0.17	0.17	0.16	0.19	0.1
	(0.180)	(0.056)	(0.044)	(0.080)	(0.101)	(0.078)	(0.028)	(0.012)	(0.017)	(0.410)
2	-0.07	-0.08	-0.12	-0.008	-0.08	0.21	0.24	0.13	0.18	0.05
	(0.258)	(0.120)	(0.016)	(0.878)	(0.148)	(0.008)	(0.000)	(0.054)	(0.005)	(0.416)
3	-0.10	-0.12	-0.06	-0.09	-0.05	0.24	0.06	0.14	0.02	0.1
	(0.064)	(0.034)	(0.235)	(0.078)	(0.335)	(0.001)	(0.389)	(0.040)	(0.708)	(0.146)
4	-0.09	-0.09	-0.04	-0.03	-0.07	0.24	0.20	0.04	0.06	0.2
	(0.123)	(0.103)	(0.482)	(0.521)	(0.198)	(0.001)	(0.003)	(0.509)	(0.330)	(0.005)
Big	-0.16	-0.10	-0.13	-0.06	-0.12	0.06	0.19	0.07	0.08	0.25
	(0.006)	(0.040)	(0.010)	(0.197)	(0.012)	(0.439)	(0.003)	(0.230)	(0.173)	(0.000)
			w					f		
Small	-0.05	-0.07	-0.02	0.01	0.002	-0.0003	-0.0003	-0.0002	-0.0002	-0.0002
	(0.319)	(0.085)	(0.523)	(0.735)	(0.979)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2	-0.06	-0.05	-0.02	-0.05	0.01	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
	(0.121)	(0.179)	(0.593)	(0.119)	(0.763)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
3	-0.06	-0.06	-0.07	-0.036	-0.05	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
	(0.091)	(0.120)	(0.050)	(0.265)	(0.138)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
4	-0.01	-0.05	-0.05	-0.09	0.001	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
	(0.825)	(0.141)	(0.113)	(0.004)	(0.986)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Big	-0.05	-0.02	-0.03	-0.04	-0.04	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
	(0.168)	(0.512)	(0.402)	(0.221)	(0.224)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 6 (continuation)

Panel C: R^2 and AIC-test statistic

	Six factor model					Seven factor model				
	Low	2	3	4	High	Low	2	3	4	High
					R^2					
Small	0.40	0.41	0.57	0.43	0.36	0.49	0.56	0.68	0.51	0.41

2	0.52	0.52	0.58	0.61	0.63	0.6	0.65	0.69	0.71	0.70
3	0.62	0.61	0.52	0.61	0.65	0.70	0.68	0.63	0.72	0.72
4	0.67	0.62	0.66	0.56	0.68	0.73	0.69	0.72	0.69	0.74
Big	0.62	0.67	0.58	0.58	0.63	0.70	0.74	0.7	0.68	0.73
						AIC				
	-955.22	-1027.20	-1104.33	-1055	-899.42	-984.55	-1082.4	-1159.29	-1080.81	-913.44
	-1037.8	-1088	-1091	-1097	-1096.61	-1069.8	-1143.3	-1144.42	-1150.4	-1136.9
	-1070	-1077.86	-1083	-1101.9	-1088.44	-1115.19	-1114.7	-1134.09	-1163.21	-1129.59
	-1079.8	-1099.16	-1096.76	-1101.6	-1080.8	-1115.04	-1136.5	-1134.62	-1163.93	-1118.59
	-1064.8	-1120.46	-1107.22	-1110.6	-1126.46	-1108.29	-1162.3	-1166	-1160.63	-1185.94

Table 7
Second stage Fama-Macbeth [1973] regression for size- book to market, size profitability, size investment, size momentum and β_{MKT} and β_{VCAC} portfolios: from July 2000 to June 2016, 192 months.

The Fama Macbeth [1973] involves two-step regressions. The first step consists in estimating risk exposure (β) by time series regression. The second stage regression estimates risk premium and test model consistency by a cross sectional regression:

$$R_{i,t} = \gamma_{T,0} + \gamma_{n,1}\beta_{n,F1}F_{1,t} + \gamma_{n,2}\beta_{n,F2}F_{2,t} + \cdots + \gamma_{n,m}\beta_{n,Fm}F_{m,t} + \varepsilon_{n,t}$$

Where Ri,t is the return on test portfolios, γT,0 is a constant, $\gamma i,j$ is a vector used to calculate the cross sectional risk premium, βi, j is determined in the first step regression and it is a vector of the estimating risk exposure. Dependent variables are constructed using 25 (5 x 5) sorts on size and book to market, size and profitability, size and investment, size and momentum and β_{MKT} and β_{VCAC} groups. Independent variables are R_M-R_f, SMB_5, HML, RMW, CMA, WML and FVCAC. Coefficients, standard error (SE), t-statistic, cross-sectional R² and F-statistic test for pricing error jointly to zero are presented. P- value in parentheses. ** ***, significant coefficients respectively at 10%, 5% and 1%..

	α	β-MKT	β-SMB5	β-HML	β-RMW	β-CMA	β-WML	β-FVCAC	SE.reg	R^2	F-statistic
Panel A: Size Book to market											
FF6 model											
	-0.02*** (0.000)	0.01*** (0.013)	0.001 (0.253)	0.002 (0.186)	-0.007 (0.415)	-0.003 (0.202)	0.001 (0.755)				
SE	0.001	0.004	0.001	0.001	0.01	0.002	0.004		0.001	0.47	2.68** (0.05)
t-statistic	-14.38	2.76	1.18	1.37	-0.83	-1.33	0.32				
FF5 + FVCAC											
	-0.02*** (0.000)	0.01* (0.09)	0.001 (0.201)	0.002 (0.115)	-0.007 (0.451)	-0.003 (0.214)		12.35** (0.03)			
SE	0.002	0.003	0.001	0.001	0.01	0.002		5.18	0.001	0.52	3.19** (0.03)
t-statistic	-9.20	1.79	1.32	1.66	-0.77	-1.29		2.38			
Seven factor model											
	-0.01*** (0.000)	0.005 (0.149)	0.001 (0.207)	0.002 (0.111)	-0.01 (0.37)	-0.002 (0.226)	-0.006 (0.47)	17.61 (0.133)			
SE	0.002	0.003	0.001	0.001	0.01	0.002	0.01	11.16	0.000	0.53	2.75** (0.04)
t-statistic	-6.65	1.51	1.31	1.68	-0.92	-1.26	-0.74	1.58			

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