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Higher Moments and the Cross-Sectional Predictability of Equity on an Intermediate Formation period

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Abstract

I use daily data from all the Spanish listed companies from January 1990 to December 2021 to compute realized moments for 3 different time formation periods and study their cross-section properties. The realized volatility revealed a negative relation with returns, as buying the lowest realized volatility quintile and selling the ones in the highest generated a Sharpe-ratio of 0.72 for the full formation period, 0.77 for the intermediate formation period and 0.62 for the recent formation period with T-statistics of 4.02, 4.28 and 3.40 respectively. The relation between realized skewness and returns is positive or negative depending on the formation period in question revealing an inversion in the relation for longer formation windows. The relation between realized kurtosis and returns is negative but with low statistical significance.

Keywords: Realized volatility, Realized Skewness, Realized Kurtosis, Cross-section of stock returns.

Sumário

Eu usei dados diários de todas as empresas cotadas na bolsa espanhola de janeiro 1990 a dezembro 2021 para calcular medidas de volatilidade, assimetria e curtose para 3 períodos de formação e estudar as suas propriedades transversais. O estudo da volatilidade revelou uma relação inversa com resultados futuros, visto que comprar ações no quintil de volatilidade mais baixo e vender ações no quintil mais alto gera um rácio de Sharpe de 0.72 para o período de formação completo, 0.77 para o período de formação intermédio e de 0.62 para o período de formação recente com estatísticas T de 4.02, 4.28 e 3.40 respectivamente. A relação entre o coeficiente de assimetria e retornos futuros é dependente do período de formação utilizado, com uma inversão com o aumento da duração dos quintis. A relação entre o coeficiente de curtose e resultados futuros é negativa mas com pouca significância estatística.

Keywords: Volatilidade, Assimetria, Curtose, Retornos de ações cruzados.

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1. Introduction

In this thesis I intend to analyse if and how accurately higher moments predict future returns. Merton (1980) first stated that volatility may be measured with increasing precision as the sampling frequency increases. This realization was later implemented in the assessment of time-varying volatility in the realized volatility literature, which constructs daily measures of realized volatility computed from intraday squared returns. Extending the now well-established notion of realized volatility. Being this said, I computed the realized volatility for the prediction formation periods that will be used ahead based on daily log returns using the standard deviation. The same premise was used to compute the realized skewness and realized kurtosis based on daily log returns for the different formation periods.

In this thesis I apply strategies and methodology taught during my Master's in Finance, increasing my understand on the matter of the relation between realized higher moments and future stock returns.

The empirical strategy used in this study consists of a sample of all the Spanish listed stocks' daily returns which were used to compute the realized moments: volatility, skewness and kurtosis. The sample comprises a total of 1047155 daily observations or 58033 monthly observations. The formation periods used were based on the intermediate momentum approach of *Novy-Marx(2012)* who found greater profitability for an intermediate formation period (12 to 7 months prior to portfolio formation) compared to the full period (12 to 2 months prior to portfolio formation) and recent period (6 to 2 months prior to portfolio formation) across momentum strategies trading international equity indices, commodities, and currencies.

The time-variation of the first and last cross-sectional quintiles are observed in figures 1 to 3 and show the dispersion of the realized volatility increase over the sample for the full and recent formation periods, which is not in line with the discoveries from *Amaya, Christoffersen, Jacobs, & Vasquez (2015)* who studied higher moments for all listed stocks in the Trade and Quote (TAQ) database between 1993 and 2013. *Amaya et al.(2015)* also observe an increasing dispersion in realized skewness and kurtosis over time which align with the performance of the realized higher moments computed in this work.

Then, to assess the relation between the realized higher moments and future stock returns, for each month, those moments were sorted into percentiles with 20 percent increments for each formation period. Next, five portfolios were built by allocating stocks based on the formation

period quintiles and their corresponding stock returns of the current month are averaged and allocated accordingly. The strategy distinguishes between winners and losers in terms of performance, with portfolio 1 corresponding to the lowest end of higher moments and portfolio 5 the highest ending.

At the start of the sample, each portfolio incorporates on average 24 stocks and grows to an average of 37 stocks in 2021. This increase is inconsistent with other studies who found a decreasing number of companies in the market as a result of 2002 market meltdown the 2008 global crisis and the 2019 Covid pandemic. The trading strategy applied follows the long-short portfolio strategy applied by Jegadeesh (1990) and Jegadeesh & Titman (1993) consisting of a zero-cost portfolio with a long position on stocks on the highest quintile and a short position on stocks on the first quintile which is referred in this thesis as high-low or 5-1 strategy. For this analysis, all portfolios are equally weighted.

Table 1 shows the performance of all the portfolios for all the formation periods, as well as the high-low strategy. Analysing the realized volatility, for the full formation period, the high-low had a Sharpe-ratio of -0.72 with a t-stat of -3.97. For the intermediate formation period yields a Sharpe-ratio of -0.77 and recent formation period has a Sharpe-ratio of -0.62, both statistically significant to a 1% level. This indicates the existence of a strong and significant negative relation between realized volatility and future stock returns, especially for the full and intermediate formation periods which goes against the findings of *Amaya et al. (2015)* and *Wang Faff and Zhu (2022)*.

For the realized skewness, the high-low strategy for the full formation period had a Sharpe-ratio of -0.10 which is not statistically significant. The intermediate formation period had a positive Sharpe-ratio of 0.12, also not significant. Never the less, for the recent formation period, the strategy had a Sharpe-ratio of 0.26 and as the other strategies sorted by realized skewness is not statistically significant. These results fail to support the findings of *Amaya et al (2015)* and *Boyer et al.(2010)* who find a negative relation between realized skewness and stock returns, While *Xing, Zhang, and Zhao (2010)* and *Rehman and Vilkov (2010)* report a positive relation supporting the results in this thesis.

For the realized kurtosis, the strategy for the full formation period had a Sharpe-ratio of -0.25 but this value is not statistically significant. For the intermediate and recent formation periods, the strategies had Sharpe-ratios of -0.26 and -0.12 respectively, both only statistically

significant to a 10% level. *Wang Faff and Zhu (2022)* and *Amaya et al.(2015)* fail to find any significant relation between realized volatility and stock return.

Therefore, for all realized moments, realized volatility is the one with the most robust findings. This is further supported with the double sorted portfolios' analysis where the relation is consistent and strong.

Despite these findings, this paper fails to replicate any external observable benchmark as the AQR Spanish market factor. Taking this into consideration, all the analysis has to be taken with a grain of salt due possible unreliability of the results. Despite this previous statement, with the data obtained from Eikon DataStream, I found a strong negative relation between realized volatility and future stock returns.

This study is organized as follows: chapter 2 states the relevant literature review about the topic of higher moments. Chapter 3 computes the realized higher moments for the relevant formation periods. Furthermore, in this chapter I also analyse the characteristics of the higher moments of the Spanish market and analyses the characteristics of the market itself. In chapter 4, I compute the cross-section returns of the portfolios sorted by realized volatility, realized skewness and realized kurtosis for each of the formation periods in analysis and tests the significance of the relation between the realized moments and future stock returns using 3 predictive regression analysis. Chapter 5 analyses portfolios double sorted by 2 realized higher moments and the trends that come from them. Chapter 6 shows the cross-sectional portfolios their performance each decade of the analysis. Chapter 7 presents the conclusions of taken in this thesis.

2. Literature Review

The results in this thesis are constructed based on immersive previous literature. In terms of the study of realized volatility, *Schwert(1989)* determined variables affecting volatility over time using monthly data. *Andersen, Bollerslev, Diebold, & Ebens (2001)* were amongst the first to study realized volatility for individual stocks and verified a negative relation between volatility and returns. *Fleming, Kirby, & Ostdiek (2003)* used realized volatility and correlation from intraday data in portfolio allocation by assessing its impact in an investment decisions framework. Previous work of *Andersen &Benzoni(2009)* center on realized volatility with reliable estimates observed for returns when sampled at high frequency. *Paye (2012)* tested

what drives market volatility along the possibility to improve volatility forecasts by using daily returns to construct monthly and quarterly realized volatility.

In terms of the analysis of realized skewness and its predictive power of future stock returns and its importance as a determinant of equilibrium asset returns, *Kraus and Litzenberger(1976)*, showing the coskewness as a determinant of cross-section stock returns using a theoretical model. *Brunnermeier et al.(2007)* demonstrated that as investors have higher demands for assets with higher skewness, the more skewed assets hold lower average returns. *Mitton and Vorkink(2007)* show that idiosyncratic skewness can impact equilibrium prices and that undiversified investors tend to hold more stocks with higher average skewness than diversified investors. *Barberis and Huang(2008)* find and demonstrate that assets with greater skewness should have lower returns when investors make decisions according to cumulative prospect theory. This negative relation between realized skewness and stock returns is corroborated by empirical evidence *Boyer et al.(2010); Bali et al.(2011); Conrad et al.(2013); Zhang(2006)* found by measuring the cross-sectional skewness. These findings are also substantiated by the conclusions of *Amaya et al.(2015)*.

Amaya et al.(2015), *Choi and Lee(2017)* and *Bollerslev et al. (2020)* exam the predictive power of the realized higher moments. *Choi and Lee (2017)* investigate the predictive power of the realized higher moments around the analyst' earnings forecast and recommendation releases. *Wang Faff and Zhu (2022)* expand the investigations of *Amaya et al.(2015)* by analysing the predictive power of the realized measures around the earnings announcement.

This thesis is closely related with the work of *Amaya et al.(2015)*. In that paper, the authors also explore the predictive power of realized higher moments for future returns. Being this said, while *Amaya et al.(2015)* studies this in the US market while I study the Spanish market. Moreover, this thesis further extends the study by analysing 3 different formation periods, recent, intermediate and full periods while the author analyses weekly realized higher moments using intraday data.

3. Data Methodology

In this chapter, we first, describe the data that was extracted and the characteristics of the market before starting to compute the realized measures. We then explain how we computed the

realized higher moments and elaborate on their respective characteristics and limiting properties.

3.1 Data

To build the portfolios, first I started by analysing the Spanish economy and all its listed stocks. The analysis period is from January 1, 1990, to December 30, 2021, as the European Fama and French factors only start in July 1990 and this way, all portfolios can be completely analysed in the models. The choice for Spain came from it being a developed market with substantial similarities with the Portuguese market.

Before start computing the moments, the data was clean in order to avoid any bias. First, any stocks with errors were removed, as well as companies dead before 1991. Finally, any stocks that died inside the sample had the returns after the death disregarded in order to not affect any computations. Based on the remaining companies, we calculate the daily log return of each stock. Based on the daily return data, I excluded all bank holidays throughout our period.

For the computations, the data was extracted from DataStream using WSCOPEES for the Series “**RI**” (Return Index) in order to have into consideration all the information about the returns to have an unbiased analysis as the “**RI**” includes both the dividends and the reinvestment of dividends for shareholders. Then the Fama and French 3-factors and 5-factors from the Kenneth R. French data library for the future regressions. For precisions, for this work I used the European Fama and French factors as the market in analysis is European. In total, 455 stocks were used in this analysis. Each month, the number of used stocks used ranges from 115 and 200.

3.2 Computing the realized higher moments

To compute the moment-based portfolios, first I started by computing the daily log return for each of the stocks. To compute the daily return, I used the following formula:

$$r_{t,i} = p_{t,i} - p_{(t-1),i}$$

We use the natural logarithm of the price performance of time t over the price performance of t-1 for all the days in our sample for 32 years of data.

Then, in order to check if the findings of *Amaya et al.(2015)* hold for different formation periods, I decided to analyze the predictive power of the higher moments using the previous year of data. This constitutes the full formation period for this paper. Furthermore, I divided this period into 2, with the recent period formed by the most recent 6 months and the intermediate by the 6 months prior.

defined the lagging period for each strategy, with a recent past performance based on the past 6 months and the intermediate past performance based on the previous 12 months excluding the most recent 6 months. A last one was also defined with the formation period of the last 12 months.

To compute the volatility, I used the formula of *Andersen & Bollersle(1998)* with n representing the number of days of the formation period used:

$$Vol_{t,i} = \sqrt{\frac{\sum(r_{t,i} - \bar{r})^2}{n - 1}}$$

In terms of the asymmetry of the return distributions, I computed a measure of realized skewness based on daily returns where n represents the number of days of the formation period for each month and s the sample standard deviation:

$$Skew_{t,i} = \frac{\sum(r_{t,i} - \bar{r})^3}{(N - 1)s^3}$$

The interpretation of the skewness is as follows: negative values indicate that the stock return's distribution will display a left tail that is fatter than the right tail, indicating frequent small gains and few extreme losses and vice versa.

In order to analyze the extremes of the of the distribution, I calculated a measure for realized excess kurtosis defined by:

$$Kurt_{t,i} = \frac{\sum(r_{t,i} - \bar{r})^4}{(N - 1)s^4} - 3$$

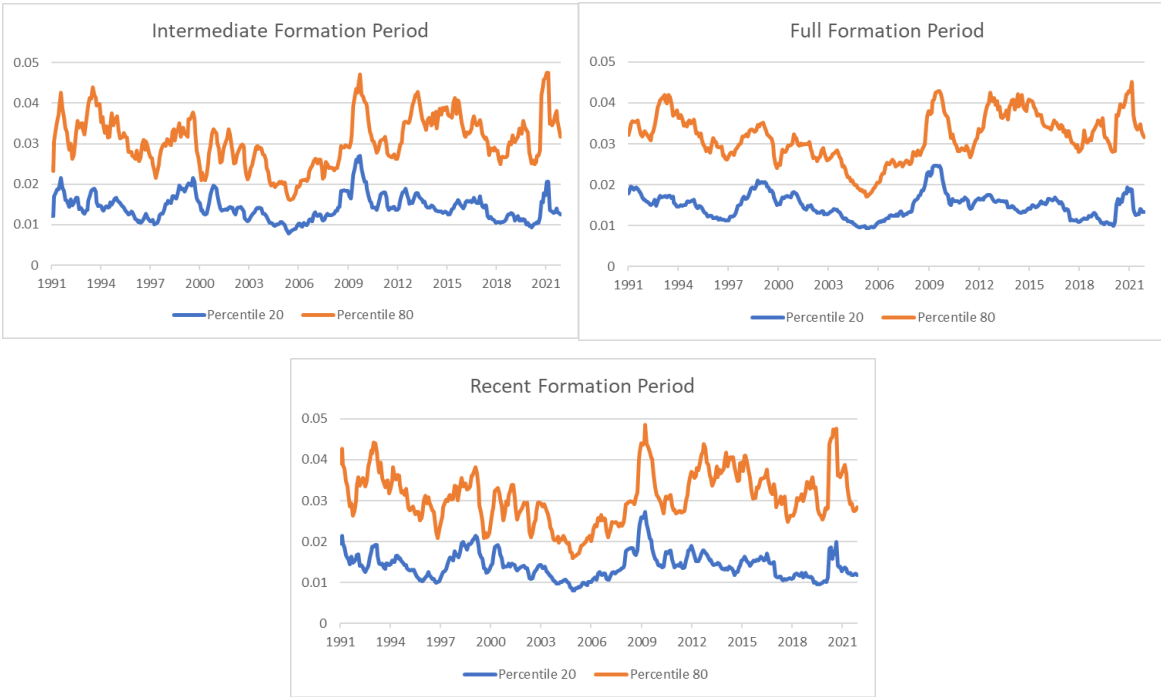
3.3 Realized higher moments and distributions

All those moments were computed for all the sample, from January 1991 to December 2021. In total, 56970 moments were computed for each investment formation period and the first and last quintiles can be seen in figures 1, 2 and 3.

During that period, the sample in analysis had an annualized excess return of -0.59% and realized volatility of 17.11% comprising a Sharpe ratio of -0.03. Both the annualized returns and Sharpe ratio are not statistically significant. Being this said, comparing the performance of the sample with the market factor of the AQR of “Betting Against Beta Equity Factors Monthly”, we can see some differences. The AQR factor for Spain for the same period had an annualized average return of 7%, a Sharpe ratio of 0.32, both statistically significant to a 10% level and a realized volatility of 22.06%. Taking a look at the European equity factor of AQR of the same paper, one can realize that the annualized average return of the European market was 10.25% with a Sharpe ratio of 0.89.

Realized volatility is depicted on figure 1. As it is expected, the full formation period presents less pronounced spikes over time, as the sample size is larger than the intermediate and recent formation periods. The effects of the 2008 crisis and the Covid-19 pandemic can also be seen in figure 1.

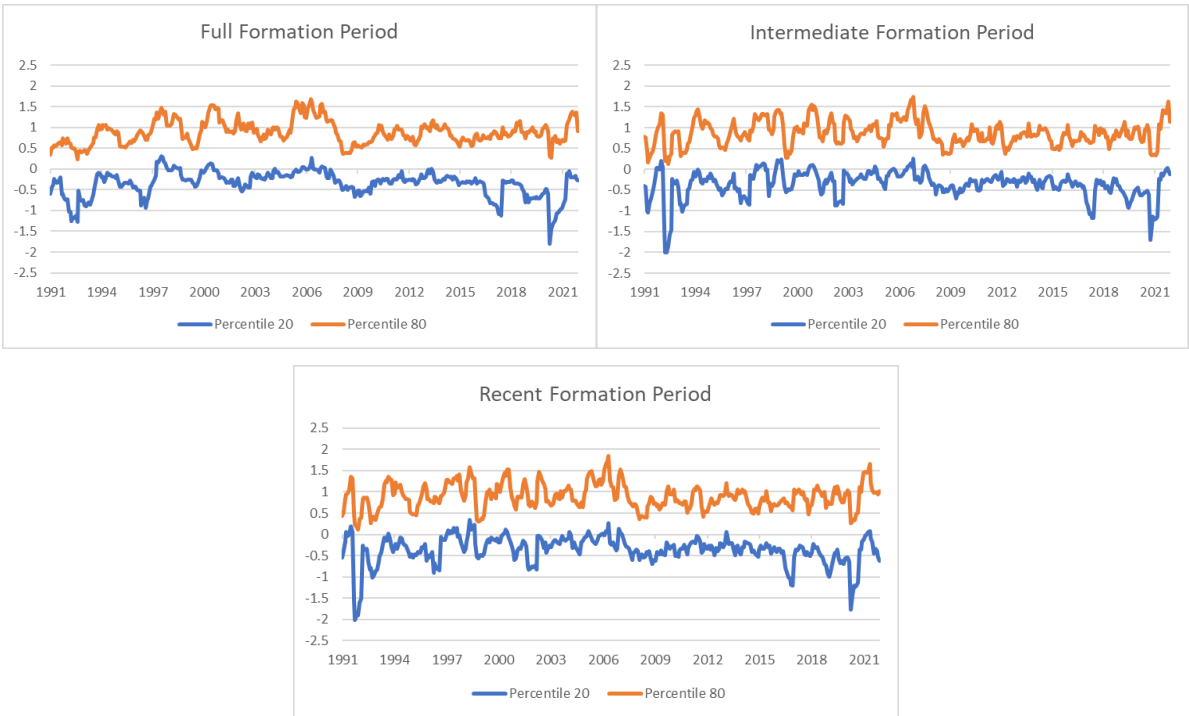
Figure 1 Cross-sectional percentiles of realized Volatility. The graphs display the cross-sections quintiles of realized volatility for the Spanish market during the period January 1991 to December 2021. The full formation period corresponds to the last 12 months prior to the portfolio formation, the intermediate formation period corresponds to the 12th to 7th months prior to portfolio formation and recent formation period corresponds to the 6 months prior to portfolio formation.



We can also realize that after the 2008 crisis, the dispersion between the first and last quintile increased. Analyzing the dispersion between quintiles, we can see an increase on for the full formation period form a 1.43 percentage points in 1991 to 1.83 percentage points in 2021. For the intermediate formation period it also grew form 1.2 percentage points in 1991 to 1.92 percentage points in 2022. For the recent formation period, the dispersion decrease form 1.96%

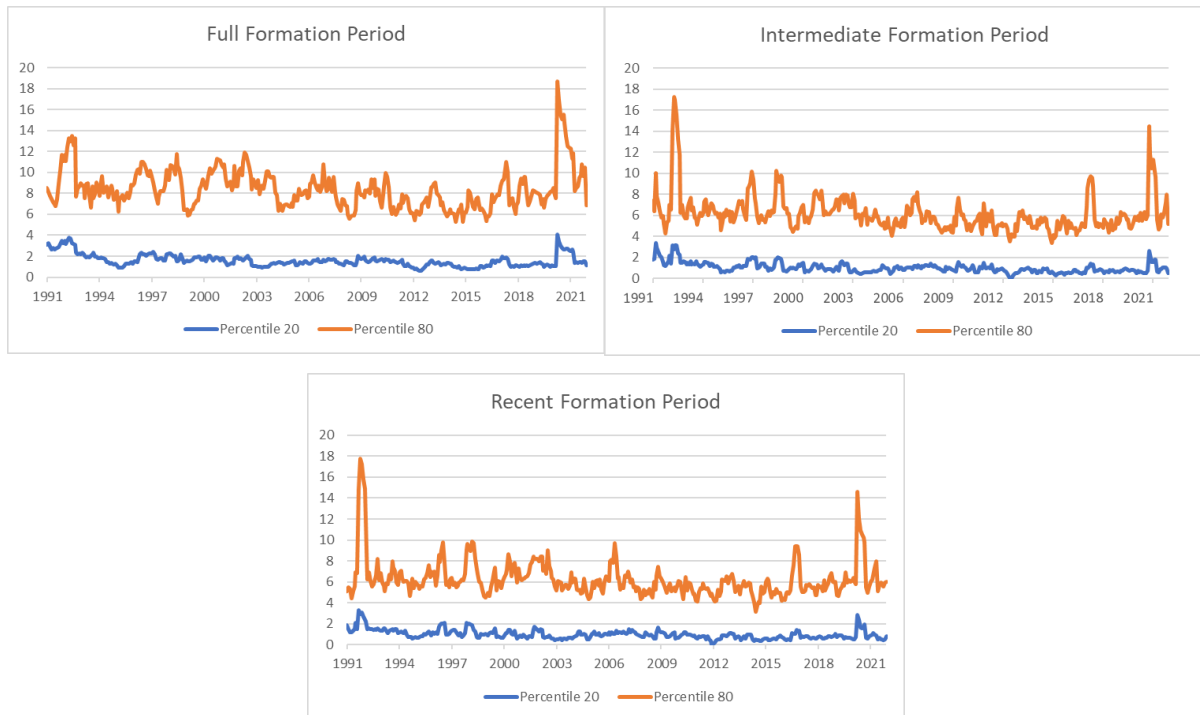
in the beginning of the sample to 1.66 percentage points at the end of the analysis. In terms of the median realized volatility, for the full formation period, it increases 0.43 percentage points during the analysis, for the intermediate formation period it decreases 0,14 percentage points and for the recent formation period it increases 0,95 percentage points. The first and last quintiles of the realized Skewness is depicted on figures 2. As was the case for realized volatility, the full formation period for realized skewness shows lower peaks as sample size is larger than the other formation periods.

Figure 2 Cross-sectional percentiles of realized skewness. The graphs display the cross-sections quintiles of realized skewness for the Spanish market during the period January 1991 to December 2021. The full formation period corresponds to the last 12 months prior to the portfolio formation, the intermediate formation period corresponds to the 12th to 7th months prior to portfolio formation and recent formation period corresponds to the 6 months prior to portfolio formation.



There was a decrease in the dispersion between quintiles for the full formation period during the analysis, with a difference of 0.94 in 1991 and 1.19 in 2021. For the intermediate formation period the difference grew from 1.18 in 1991 to 1.26 in 2021 and for the recent formation period it grew from 0.98 in 1991 to 1.63 in 2021. In terms of the realized skewness median, for the full formation period, it decreases by 0.40 during the 31 years in analysis, for the intermediate formation period it decreased by 0.13 and for the recent formation period it decreases by 0.19 in that period.

Figure 3 Cross-sectional percentiles of realized excess kurtosis. The graphs display the cross-sections quintiles of realized excess kurtosis for the Spanish market during the period January 1991 to December 2021. The full formation period corresponds to the last 12 months prior to the portfolio formation, the intermediate formation period corresponds to the 12th to 7th months prior to portfolio formation and recent formation period corresponds to the 6 months prior to portfolio formation.



In figure 3 is depicted the first and last quintiles for the realized kurtosis. During the period in analysis, 2 peaks can be identified, the first during the Exchange Rate Mechanism crisis of 1992 and 1993 and the other during the Covid-19 pandemic. For the full formation period, the distance between quintiles had a slight increase, going from 5.41 in 1991 to 5.72 in 2021. For the intermediate formation period, the distance decreased throughout the years, being 5.53 in 1991 and 4.66 in 2021. Finally, for the recent formation period, the difference grew from 3.18 in 1991 to 5.22 in 2021.

4. Realized Moments and the Cross-Section of Stock Returns

To construct the portfolios, first I started by dividing each stock into quintiles based on the higher moments computed in the previous section for each predicting formation period for each month t . After having each stock assigned into percentiles for each month t . Moreover, for each portfolio, a cross-section regression analysis was conducted using both the CAPM and Fama and French 3 factor model (FF3M) to determine if the results are still captured by the 3 models. Additionally, a regression using the Fama and French 5 factors (FF5M) was done to verify if the same conclusions can be taken. The results are present in table 1. All the portfolios in this

chapter are equal-weighted and the analysis period is from January 1991 to December 2021 in order to have access to the Fama and French European 3 and 5 factors.

4.1 Sorting Stock Return on Realized Volatility

Every month the stocks were divided into quintiles based on their realized volatility during the respective formation period. The first 4 columns of table 1 reports the results for each quintile, as well as the T-statistics of those results. For the 31 years of data, a high-low strategy was built, with a long position on the fifth quintile and a short position on the first quintile.

For the full formation period shown in panel A of table 1, the strategy ended up with an annualized Sharpe-Ratio of -0.72 and an annualized average return of -16.64%. Both the returns and the Sharpe-Ratio are statistically significant to a 1% level with T-statistics of 4.02. The CAPM and FF3M alphas are larger with larger t-statistics. The alphas of these 2 regressions are -19.98 and -20.77 with t-statistics of -5.13 and 5.47. The FF5M also captured this strong negative relation with an alpha of -16.61 and T-statistics of -3.75.

The intermediate formation period shown in panel B held a lower return maintaining the negative relation between realized volatility and returns, yielding an annualized Sharpe-Ratio of -0.77 and an annualized average return of -14.65%, which is statistically significant for a 1% level. As in the case of the full formation period, the CAPM and FF3M regression alphas are larger and more significant than the annualized return. Nevertheless, as in the previous case, the FF5M captures a similar performance as the average return, the high-low strategy yielding an alpha of -14.87% with a T-statistics of -3.92.

Finally, the recent formation period reveals a similar relation between realized volatility and future stock returns. Being this said, for this formation period, the high-low strategy generates an annualized average return of -15.24%, with a T-statistics of -3.43. The Sharpe-ratio of this strategy is -0.62 with a T-statistics of 3.40. As in the case of the whole and intermediate formation period, the CAPM and FF3M regression alphas are higher and more significant than the annualized return. The FF5M reveals similar and significant alpha compared with the annualized average return with a value of -15.11 and a T-statistics of -3.18.

Analyzing the results above, a negative and significant relation between realized volatility and future stock performance can be found. These findings align with *Ang, Hodrick, Xing, &*

Zhang(2006) and Andersen, Bollerslev, Diebold, & Ebens (2001) who found a negative relation between realized volatility and returns, and are not consistent with Amaya *et al.*(2015) with the last not having statistically significant results and alphas.

4.2 Sorting Stock Return on Realized Skewness

The fifth to eighth columns of table 1 shows the results, CAPM alpha, FF3M alpha, FF5M alpha and their p-values of the portfolios based on the skewness quintiles for the respective time formation period, as well as a portfolio high-low portfolio, with a long position on the fifth quintile and a short. As stated in the beginning of this chapter, all portfolios are equal-weighted.

Panel A illustrates a declining trend between lagging skewness and average returns. The long-short portfolio holds an annualized average return of -1,44% and a Sharpe-Ratio of -0.10. Despite the value of the Sharpe-ratio and average return obtained, neither of them is statistically significant, with T-statistics of -0.53. The CAPM and FF3M alphas are smaller and both of them are not statistically significant. The alphas of these 2 regressions are -0,92 and -1.13 respectively. Unlike the case of the realized volatility, the FF5M presents an alpha larger than both the regression alphas and the average return and is statistically significant for a 10% level. These findings would be consistent with previous literature. Conrad, Dittmar, & Ghysels (2013) as well as Boyer, Mitton, & Vorkink (2010) found the same negative relation between realized skewness and returns, as well as Amaya *et al.*(2015).

Panel B, on the other hand, inverts the relation between realized skewness and returns, having now a positive one. The long-short portfolio yields a return of 1.17% with a Sharpe-Ratio of 0.08. As in panel A, neither the returns, nor the Sharpe-Ratio. The CAPM and FF3M regression alphas are considerably smaller than the returns with the last one being negative besides not being statistically significant. The FF5M alpha, unlike the previous case, has a similar value to the FF3M, showing that the model does not capture well the positive relation between realized skewness and future returns for the intermediate formation period.

Panel C depicts the same positive relation as in panel B. Comparing with the intermediate formation period, the high-low strategy yields a higher annualized average return and Sharpe-ratio. Despite being higher, none of them is statistically significant. All the regressions' alphas have lower values comparing to the average returns and are also not statistically significant.

Table 1: Realized moments and the cross-section of stock returns. The table reports the returns of quintiles portfolios formed from realized moments and the respective *t*-statistics (in italics) and high-low strategy for the period of January 1991 to December 2021 us using stocks in the Spanish market. Panel A displays the results for the full formation period (12 prior to portfolio formation), panel B displays for the intermediate formation period (12 to 7 months prior to portfolio formation) and panel C displays the returns for the recent formation period (6 months prior to portfolio formation). Alpha is the intercept from time-series regressions of the returns of the portfolio using the CAPM and Fama and French 3 and 5 factor models (FF3M and FF5M). All the portfolios in this table are qual-weighted.

Realized Higher Moments and the cross-section of stock returns													
		Volatility				Skewness				Kurtosis			
		Returns	Alpha, CAPM	Alpha, FF3M	Alpha, FF5M	Returns	Alpha, CAPM	Alpha, FF3M	Alpha, FF5M	Returns	Alpha, CAPM	Alpha, FF3M	Alpha, FF5M
Panel A: Full Formation Period													
1	8.11	6.05	5.74	6.63	4.10	-0.45	-1.25	3.18	2.30	-2.44	-3.09	0.47	
	<i>4.73</i>	<i>4.15</i>	<i>4.02</i>	<i>3.69</i>	<i>1.18</i>	<i>0.44</i>	<i>0.65</i>	<i>1.13</i>	<i>0.69</i>	<i>-0.93</i>	<i>-1.20</i>	<i>0.13</i>	
2	5.97	2.18	1.45	4.45	1.61	-2.46	-3.44	-0.33	3.59	-1.59	-2.56	1.84	
	<i>2.23</i>	<i>1.05</i>	<i>0.72</i>	<i>1.58</i>	<i>0.41</i>	<i>0.24</i>	<i>0.32</i>	<i>-0.10</i>	<i>1.01</i>	<i>-0.58</i>	<i>-0.97</i>	<i>0.49</i>	
3	3.61	-1.48	-2.70	1.41	7.01	2.33	1.53	4.16	-0.29	-4.80	-5.93	-2.02	
	<i>1.05</i>	<i>-0.57</i>	<i>-1.11</i>	<i>0.39</i>	<i>1.94</i>	<i>0.22</i>	<i>0.60</i>	<i>1.41</i>	<i>-0.09</i>	<i>-1.78</i>	<i>-2.31</i>	<i>-0.57</i>	
4	-0.40	-6.42	-8.02	-2.24	5.59	1.22	0.38	2.36	4.86	0.54	-0.58	3.41	
	<i>1.98</i>	<i>0.69</i>	<i>0.31</i>	<i>0.24</i>	<i>1.19</i>	<i>0.45</i>	<i>0.67</i>	<i>0.24</i>	<i>0.70</i>	<i>0.19</i>	<i>0.25</i>	<i>0.89</i>	
5	-8.53	-13.94	-15.04	-9.98	2.66	-1.37	-2.37	-0.64	-2.04	-5.74	-6.84	-3.74	
	<i>-1.76</i>	<i>-3.28</i>	<i>-3.63</i>	<i>-1.95</i>	<i>0.84</i>	<i>0.30</i>	<i>0.35</i>	<i>-0.25</i>	<i>-0.56</i>	<i>-1.76</i>	<i>-2.16</i>	<i>-0.97</i>	
5-1	-16.64	-19.98	-20.77	-16.61	-1.44	-0.92	-1.13	-3.82	-4.35	-3.30	-3.74	-4.21	
	<i>-4.02</i>	<i>-5.13</i>	<i>-5.47</i>	<i>-3.75</i>	<i>-0.53</i>	<i>0.73</i>	<i>0.68</i>	<i>-1.84</i>	<i>-1.39</i>	<i>0.29</i>	<i>0.22</i>	<i>-1.24</i>	
Panel B: Intermediate Formation Period													
1	8.32	5.84	5.41	7.87	-0.85	-4.40	-5.20	-1.67	3.60	-1.53	-2.34	1.32	
	<i>4.12</i>	<i>3.43</i>	<i>3.25</i>	<i>3.70</i>	<i>-0.29</i>	<i>-1.78</i>	<i>-2.16</i>	<i>0.54</i>	<i>1.02</i>	<i>-0.56</i>	<i>-0.89</i>	<i>0.36</i>	
2	5.92	1.99	1.32	4.38	2.08	-2.77	-3.67	-0.09	2.85	-2.26	-3.15	1.78	
	<i>2.09</i>	<i>0.89</i>	<i>0.60</i>	<i>1.46</i>	<i>0.61</i>	<i>-1.06</i>	<i>-1.44</i>	<i>-0.02</i>	<i>0.80</i>	<i>-0.83</i>	<i>-1.18</i>	<i>0.48</i>	
3	1.96	-3.35	-4.56	0.38	5.14	-0.09	-1.17	3.69	1.29	-3.47	-4.69	-0.69	
	<i>0.52</i>	<i>1.15</i>	<i>-1.65</i>	<i>0.10</i>	<i>1.41</i>	<i>-0.03</i>	<i>-0.44</i>	<i>0.97</i>	<i>0.37</i>	<i>-1.23</i>	<i>-1.76</i>	<i>-0.19</i>	
4	0.77	-4.98	-6.64	-0.31	2.25	-2.84	-3.87	0.06	2.82	-1.44	-2.70	1.11	
	<i>0.18</i>	<i>-1.47</i>	<i>-2.11</i>	<i>-0.07</i>	<i>0.61</i>	<i>-0.98</i>	<i>-1.38</i>	<i>0.02</i>	<i>0.84</i>	<i>-0.52</i>	<i>-1.04</i>	<i>0.32</i>	
5	-7.17	-12.37	-13.45	-7.00	1.04	-2.97	-4.24	-0.76	-0.86	-4.44	-5.36	-2.33	
	<i>-1.62</i>	<i>-3.26</i>	<i>-3.64</i>	<i>-1.50</i>	<i>0.30</i>	<i>-1.00</i>	<i>-1.52</i>	<i>-0.21</i>	<i>-0.27</i>	<i>-1.58</i>	<i>-1.96</i>	<i>-0.69</i>	
5-1	-14.65	-17.30	-17.86	-14.87	1.71	1.26	0.81	0.91	-4.15	-2.53	-2.59	-3.65	
	<i>-4.28</i>	<i>-5.34</i>	<i>-5.64</i>	<i>-3.92</i>	<i>0.65</i>	<i>0.63</i>	<i>0.76</i>	<i>0.33</i>	<i>-1.42</i>	<i>0.38</i>	<i>0.36</i>	<i>-1.20</i>	
Panel C: Recent Formation Period													
1	8.16	6.35	6.06	6.70	0.27	-3.92	-4.54	-1.24	2.40	-2.35	-3.05	0.89	
	<i>5.45</i>	<i>5.00</i>	<i>4.86</i>	<i>4.20</i>	<i>0.08</i>	<i>0.07</i>	<i>0.09</i>	<i>0.36</i>	<i>0.72</i>	<i>-0.91</i>	<i>-1.21</i>	<i>0.25</i>	
2	6.34	2.64	1.97	4.70	5.24	1.20	-0.01	4.10	2.67	-2.14	-2.98	0.71	
	<i>2.43</i>	<i>1.30</i>	<i>1.01</i>	<i>1.71</i>	<i>1.61</i>	<i>0.33</i>	<i>1.00</i>	<i>1.19</i>	<i>0.80</i>	<i>-0.82</i>	<i>-1.18</i>	<i>0.20</i>	
3	3.10	-1.87	-3.14	1.08	5.51	1.01	0.46	5.06	2.65	-1.98	-3.20	0.36	
	<i>0.90</i>	<i>-0.70</i>	<i>-1.27</i>	<i>0.30</i>	<i>1.66</i>	<i>0.35</i>	<i>0.86</i>	<i>1.44</i>	<i>0.78</i>	<i>-0.73</i>	<i>-1.26</i>	<i>0.10</i>	
4	-0.93	-6.92	-8.45	-3.58	6.83	2.20	1.30	4.76	1.13	-3.20	-4.35	-0.83	
	<i>-0.22</i>	<i>-2.07</i>	<i>2.69</i>	<i>-0.80</i>	<i>1.88</i>	<i>0.23</i>	<i>0.66</i>	<i>1.25</i>	<i>0.34</i>	<i>-1.18</i>	<i>-1.69</i>	<i>-0.23</i>	
5	-7.08	-12.76	-14.07	-8.41	4.04	-0.48	-1.42	1.96	0.37	-3.47	-4.63	-0.95	
	<i>-1.38</i>	<i>-2.84</i>	<i>-3.22</i>	<i>-1.55</i>	<i>1.21</i>	<i>0.43</i>	<i>0.58</i>	<i>0.55</i>	<i>0.10</i>	<i>-1.07</i>	<i>-1.49</i>	<i>-0.25</i>	
5-1	-15.24	-19.11	-20.12	-15.11	3.76	3.44	3.13	3.20	-2.02	-1.12	-1.58	-1.84	
	<i>-3.43</i>	<i>-4.63</i>	<i>-4.99</i>	<i>-3.18</i>	<i>1.47</i>	<i>0.18</i>	<i>0.22</i>	<i>1.15</i>	<i>-0.67</i>	<i>0.71</i>	<i>0.59</i>	<i>-0.56</i>	

Panels B and C seem to contradict the findings of *Conrad, Dittmar, & Ghysels (2013)*, *Boyer, Mitton, & Vorkink (2010)* and *Amaya et al.(2015)*. Even though the significance of the results obtained is low, the evidences seem to suggest that unlike the case of the US market analysed by *Amaya et al.(2015)*, the Spanish market demonstrates a positive relation between realized volatility and future stock returns, especially for the recent formation horizon.

4.3 Sorting Stock Return on Realized Excess Kurtosis

The last 4 columns of table 1 show the same performance metrics as the two topics above for portfolios based on the kurtosis quintiles for the respective time formation period. As before, the analysis period is from January 1991 to December 2021. As before, all portfolios in this analysis are equal-weighted.

As with the previous moments, Panel A shows the metrics for the full formation period. For the whole sample, the high-low strategy yields an annualized average return of -4.35% and a Sharpe-ratio of -0.25, though, none of them is statistically significant. The regressions' alphas also suggest the negative relation between realized kurtosis and future stock performance. All of the alphas are negative but lower than the average returns and are not statistically significant.

Looking at panel B, there is a similar trend as in panel A with decreasing returns as realized kurtosis increases. The long-short portfolio yields a -4.15% average annualized return and as in panel A, it is not statistically significant and a Sharpe-ratio of -0.26. Watching the CAPM and FF3M alphas, they are lower and less significant. The FF5M alpha has a value closer to the average return, however it is less significant.

Panel C shows the average stock returns for quintiles based on realized kurtosis during the recent formation period as well as the CAPM, FF3M and FF5M alphas and respective T-statistics. It also shows the returns and alphas for the long-short strategy. As in the previous cases, stock returns decrease with realized kurtosis as demonstrated by the high-low strategy having an annualized average return of -2.02% and Sharpe-ratio of -0.12, and none is statistically significant. For the recent formation period, the regression alphas are also negative, yet they are lower and less significant.

For all formation periods, it seems to be a negative trend as all the long-short strategies have negative annualized average return. The same can be said for their regression alphas. Being this

said, none of those values have statistical significance. This is not consistent with Amaya *et al.*(2015) who found a positive relation between realized kurtosis and returns, despite that relation not being statistically significant.

Summarizing what was discussed in this chapter and the findings obtained, for all the formation periods, the evidences suggest a strong inverse relation between realized volatility and future stock returns. For the case of realized skewness, the results suggest a positive relation with stock returns. Despite the existence of this positive relation, there is a lack of evidences of it having strong predictive power as the results have low statistical significance.

5. Portfolios double sorted

On this chapter, for each month t , the stocks were double sorted following the criteria set on each subchapter. As in chapter 4, all portfolios are equal-weighted. For this chapter, the data used is still the Spanish market stock return from January 1991 to December 2021.

For this chapter, the quintiles for the realized measures used for the cross-section analysis in chapter 4 were used to construct double sorted portfolios with the obtained annualized average returns depicted in tables 2, 3 and 4.

5.1. Portfolios double sorted by Realized Volatility and Realized Skewness.

Table 2 shows the annualized average return for the double sorted portfolios by realized volatility and realized skewness.

Panel A of table 2 presents the annualized returns for the double sorted portfolios for the full formation period. As can be seen, the portfolios with the highest performance are in the first realized volatility quintile confirming the negative relation between realized volatility and future stock returns. This performance is particularly high for stocks with higher realized skewness. As in chapter 4, realized skewness does not seem to have a high predictive power for stock returns despite showing a negative relation with stock return when realized volatility is also low.

Panel B of table 2 covers the annualized average returns portfolios double sorted by realized volatility and realized skewness for the intermediate formation period. As in the case of panel A of table 2, the first quintile of realized volatility had the highest performance confirming the negative relation between realized volatility and stock performance. Unlike panel A of table 2,

panel B reveals a stronger negative relation between realized skewness and stock performance when the realized volatility is high and a positive relation when realized volatility is high.

Table 2. Annualized average returns for portfolios double sorted on Realized Volatility (column) and Realized Skewness. Panel A covers the full formation period corresponding to the previous year prior to portfolio formation. Panel B covers the intermediate formation period, matching the period from 12 to 7 months prior to portfolio formation. Panel C corresponds the recent formation period corresponding to the 6 months prior to portfolio formation. The data analysed in this table covers the Spanish market during period from January 1991 to December 2021. The portfolios are equal-weighted.

Panel A: Full Formation Period

Annualized Average return		Realized Volatility				
		1	2	3	4	5
Realized skewness	1	6.71%	5.79%	4.63%	5.87%	2.30%
	2	10.41%	3.82%	7.77%	-2.58%	-24.11%
	3	9.07%	1.85%	6.95%	1.81%	8.81%
	4	12.69%	5.66%	-0.84%	2.08%	3.49%
	5	9.74%	9.54%	2.41%	-5.37%	-3.14%

Panel B: Intermediate Formation Period

Annualized Average return		Realized Volatility				
		1	2	3	4	5
Realized skewness	1	8.95%	8.67%	4.26%	6.26%	-0.02%
	2	10.90%	1.22%	4.71%	2.09%	-8.10%
	3	9.88%	4.70%	1.20%	10.22%	-1.74%
	4	9.77%	2.55%	5.28%	6.62%	-5.55%
	5	12.19%	5.21%	7.22%	-8.48%	-10.23%

Panel C: Recent formation Period

Annualized Average return		Realized Volatility				
		1	2	3	4	5
Realized skewness	1	9.64%	3.31%	0.67%	0.57%	-10.16%
	2	8.84%	6.25%	5.16%	0.91%	-6.27%
	3	14.05%	6.68%	-0.63%	-2.45%	-0.94%
	4	6.79%	6.61%	1.99%	3.38%	15.16%
	5	9.10%	8.13%	6.67%	-7.94%	6.56%

Panel C of table 2 also reveals the trend for higher stock returns for stocks with lower realized volatility for the recent formation period, especially for stocks with lower realized skewness. In terms of realized skewness there is a positive relation between realized skewness and stock returns for stocks with higher realized volatility.

The negative relation between realized volatility and stock performance found when double sorted is consistent with the findings of chapter 4 and the previous work of *Ang, Hodrick, Xing, & Zhang(2006)* and *Andersen, Bollerslev, Diebold, & Ebens (2001)* who found a negative

relation between realized volatility and returns, and are not consistent with Amaya *et al.*(2015). The positive relation found in panel C is consistent with the findings in chapter 4.2 and fail to support the discoveries of Conrad, Dittmar, & Ghysels (2013), Boyer, Mitton, & Vorkink (2010) and Amaya *et al.*(2015).

5.2. Portfolios double sorted by Realized Skewness and Realized Kurtosis.

Table 3 reports annualized average returns of the 25 portfolios double sorted by realized skewness and realized kurtosis for the Spanish market from January 1991 to December 2021.

Table 3. Annualized average returns for portfolios double sorted on Realized Skewness (column) and Realized Kurtosis (rows). Panel A covers the full formation period corresponding to the previous year prior to portfolio formation. Panel B covers the intermediate formation period, matching the period from 12 to 7 months prior to portfolio formation. Panel C corresponds to the recent formation period corresponding to the 6 months prior to portfolio formation. The data analysed in this table covers the Spanish market during the period from January 1991 to December 2021. The portfolios are equal-weighted.

Panel A: Full Formation Period

Annualized Average return		Realized skewness				
		1	2	3	4	5
Realized Kurtosis	1	9.24%	4.27%	7.36%	4.30%	7.83%
	2	1.28%	2.30%	4.29%	3.00%	6.28%
	3	0.50%	-2.47%	-0.85%	1.27%	0.08%
	4	6.30%	4.69%	11.98%	6.39%	6.33%
	5	7.94%	-0.85%	8.25%	9.29%	-3.97%

Panel B: Intermediate Formation Period

Annualized Average return		Realized skewness				
		1	2	3	4	5
Realized Kurtosis	1	11.03%	6.28%	3.96%	-3.08%	6.32%
	2	5.89%	-1.89%	0.43%	4.55%	9.69%
	3	4.00%	3.23%	4.19%	5.61%	0.63%
	4	4.71%	2.03%	15.69%	9.00%	-0.87%
	5	6.75%	2.29%	2.36%	3.06%	-2.27%

Panel C: Recent formation Period

Annualized Average return		Realized skewness				
		1	2	3	4	5
Realized Kurtosis	1	-0.20%	6.82%	5.76%	12.73%	2.29%
	2	-1.08%	2.87%	5.07%	3.79%	5.82%
	3	9.58%	2.18%	4.97%	0.39%	3.25%
	4	-0.17%	4.73%	3.33%	3.91%	1.38%
	5	-1.37%	3.64%	3.67%	11.69%	10.17%

Panel A reports this analysis for the full formation period. As is visible in table 3, there is no clear trend when double sorting portfolios by realized skewness and kurtosis. This is consistent with the findings in chapter 4, further proving the lack of significance of the relation between

realized skewness and kurtosis and future stock returns. The most profitable portfolio during the analysis period for the full formation period was when sorted for the third quintile for realized skewness and fourth quintile for realized kurtosis.

Panel B as the previous panel, does not reveal any substantial trend in terms of a relation between the realized skewness and future stock returns. Being this said, unlike panel A, there is a trend for a negative relation between realized kurtosis and future stock return, consistent with the data from the panel B of table 1. These findings do not support the findings of Amaya *et al.*(2015) who find a negative relation between realized skewness and stock returns and a lack of relation between realized kurtosis and stock performance. The maximum return of the double sorted portfolios for the intermediate formation period comes from the third quintile for realized skewness and the fourth quintile for realized kurtosis.

Panel C reports the double sorted portfolios for the recent formation period. As was the case for the portfolios double sorted by realized volatility and skewness, panel C reports a positive relation between realized skewness and future stock performance.

This positive relation does not support of Conrad, Dittmar, & Ghysels (2013), Boyer, Mitton, & Vorkink (2010) and Amaya *et al.*(2015). As in chapter 4, realized kurtosis does not exhibit any trend in respects to stock returns. In terms of realized kurtosis, the results when double sorted with realized skewness reveal he same lack of a significative relation with stock performance. The same lack of a significative predictive power of this measure is found on Amaya *et al.*(2015).

5.3. Portfolios double sorted by Realized Volatility and Realized Kurtosis.

This section analyses the annualized average returns of the portfolios double sorted by realized volatility and realized kurtosis for the Spanish market during the period of January 1991 to December 2021.

As in chapters 5.1 and 5.2, panel A of table 4 reports the annualized average returns for portfolios double sorted by the full formation period quintiles. In case of this chapter, the measures sorted were realized volatility and realized kurtosis. This panel confirms predictive power of the realized volatility from chapters 4.1 and 5.1. As was the case of the previous chapter, here is no significative relation between realized kurtosis and stock returns.

Table 4. Annualized average returns for portfolios double sorted on Realized Volatility (column) and Realized Kurtosis (rows). Panel A covers the full formation period corresponding to the previous year prior to portfolio formation. Panel B covers the intermediate formation period, matching the period from 12 to 7 months prior to portfolio formation. Panel C corresponds the recent formation period corresponding to the 6 months prior to portfolio formation. The data analysed in this table covers the Spanish market the period from January 1991 to December 2021. The portfolios are equal-weighted.

Panel A: Full Formation Period

Annualized Average return		Realized Volatility				
		1	2	3	4	5
Realized Kurtosis	1	7.58%	7.15%	4.57%	-4.26%	-13.01%
	2	7.29%	3.81%	4.39%	-0.24%	-0.91%
	3	7.50%	3.17%	-0.57%	-5.49%	-5.71%
	4	7.36%	6.49%	5.18%	4.77%	0.21%
	5	8.98%	7.94%	3.95%	2.08%	-15.92%

Panel B: Intermediate Formation Period

Annualized Average return		Realized Volatility				
		1	2	3	4	5
Realized Kurtosis	1	9.11%	7.38%	-0.56%	-0.01%	-3.51%
	2	9.14%	4.80%	7.32%	2.23%	-15.55%
	3	8.93%	3.22%	3.69%	-1.88%	-8.59%
	4	7.95%	7.18%	-2.71%	-0.59%	1.02%
	5	5.43%	4.66%	0.03%	3.19%	-9.24%

Panel C: Recent formation Period

Annualized Average return		Realized Volatility				
		1	2	3	4	5
Realized Kurtosis	1	10.13%	5.65%	4.36%	-3.22%	-16.90%
	2	9.45%	6.48%	1.10%	-8.05%	2.38%
	3	6.49%	3.62%	1.37%	1.58%	-2.47%
	4	4.06%	6.55%	2.75%	-3.38%	-3.42%
	5	7.82%	6.08%	5.71%	7.22%	-11.97%

Panel B of table 4 reveals the same inverse relation between realized volatility and future stock returns, in this case, for the intermediate formation period when double sorted with realized kurtosis. Panel B of table 4 also suggests a subtle negative relation between realized kurtosis consistent with the data from panel B of table 1. As in previous cases, panel B confirms the findings of chapters 4.1 and 4.3 relatively with the intermediate formation period. Nonetheless, portfolios with low realized volatility and kurtosis yield the higher annualized average returns.

Panel C of table 4 still reveals the decreasing trend for stock returns as realized volatility increases, independent of the realized kurtosis quintile analysed, this time for the recent formation period. Unlike panel B of table 4, panel C of table 4 reveal a non-substantial increasing trend in terms of realized kurtosis and stock return. Nevertheless, the negative relation between realized volatility and stock returns is stronger when realized kurtosis is on

the highest or the lowest quintile. These findings are consistent with the analysis of chapter 4.1 and 4.3, as well with panel C of table 1.

Table 4 is consistent with the findings of *Ang, Hodrick, Xing, & Zhang(2006)*, *Andersen, Bollerslev, Diebold, & Ebens (2001)* who as previously stated found strong negative relation between realized volatility and fail to support *Amaya et al.(2015)*. The negative relation for realized kurtosis found in panel B is also not consistent with *Amaya et al.(2015)* who found a non-significant positive relation between realized kurtosis and stock return which is consistent with panel C of the same table.

Taking into consideration the findings in this chapter, double sorting the portfolios give us a deeper understand of the effects of the realized measurements and how they interact to have stronger or weaker predictive power. Example of this panel A of table 2 who gives us the trend that for full formation period, stocks with high realized skewness and with low realized volatility yield higher returns.

6. Realized Moments and the Cross-Section of Stock Returns

This chapter separates the portfolios analyzed in chapter 4 by decades. The first subsample comprises the period from January 1991 to December 2000. The second subsample encompasses the period from January 2001 to December 2010. Finally, the last subsample corresponds to the period from January 2011 to December 2021. The main goal of this chapter is to understand if the results obtained in chapter 4 are consistent throughout the analysis period or if it is due to abnormalities in specific periods.

As in chapter 4, there were run 3 predictive regressions using the Fama and French European factors. The 3 models used were the CAPM, the Fama and French 3 Factor Model (FF3M) and the Fama and French 5 Factor Model (FF5M) with the objective to confirm the predictive power of the 3 strategies.

In panel A of table 5 is depicted the annualized average returns, the Sharpe-Ratio and the regression alphas foe each portfolio as well as the respective T-Statistics of each value. For the full formation period, the high minus low strategy for the portfolio sorted by realized volatility yields an annualized average return of -10.72% and a Sharpe Ratio of -0.46. Being this said, neither the return nor the Sharpe-Ratio is statistically significant. The alphas are also large and not statistically significant.

Table 5: Realized moments and the cross-section of stock returns. The table reports the returns of quintiles portfolios formed from realized moments and the respective *t*-statistics (in italics) and high-low strategy for the period of January 1991 to December 2021 us using stocks in the Spanish market. Panel A reports the performance and regression alphas for cross-section portfolios for the period of January 1991 to December 2000. Panel B reports the performance and regression alphas for cross-section portfolios for the period of January 2001 to December 2010. Panel C reports the performance and regression alphas for cross-section portfolios for the period of January 2011 to December 2021. The full formation period corresponds to the year prior to formation of the portfolio. The intermediate formation period corresponds to the 12 to 7 months prior to portfolio formation. The recent formation period corresponds to the 6 months prior to portfolio formation. The factors used to run the regressions were extracted from the Fama and French Data Library. All the portfolios depicted in this table are equal weighted.

Realized Higher Moments and the cross-section of stock returns per decade															
	Volatility					Skewness					Kurtosis				
	Returns	Sharpe-Ratio	Alpha, CAPM	Alpha, FF3M	Alpha, FF5M	Returns	Sharpe-Ratio	Alpha, CAPM	Alpha, FF3M	Alpha, FF5M	Returns	Sharpe-Ratio	Alpha, CAPM	Alpha, FF3M	Alpha, FF5M
Panel A: From January 1991 to December 2000															
Full Formation Period	-10.72	-0.46	-12.28	-9.93	-8.19	3.12	0.21	3.51	1.95	-4.31	-0.71	-0.03	1.10	2.96	-6.64
	<i>-1.44</i>	<i>-1.44</i>	<i>-1.64</i>	<i>-1.34</i>	<i>-0.99</i>	<i>0.65</i>	<i>0.65</i>	<i>0.47</i>	<i>0.68</i>	<i>-1.10</i>	<i>-0.11</i>	<i>-0.11</i>	<i>0.87</i>	<i>0.66</i>	<i>-0.90</i>
Intermediate Formation Period	-9.59	-0.57	-10.65	-8.80	-8.36	4.42	0.25	4.50	5.22	3.93	-1.98	-0.10	0.18	1.28	-5.44
	<i>-1.79</i>	<i>-1.78</i>	<i>-1.97</i>	<i>-1.65</i>	<i>-1.26</i>	<i>0.80</i>	<i>0.80</i>	<i>0.42</i>	<i>0.36</i>	<i>0.71</i>	<i>-0.31</i>	<i>-0.31</i>	<i>0.98</i>	<i>0.84</i>	<i>-0.84</i>
Recent Formation Period	-9.32	-0.38	-11.95	-10.29	-5.96	6.79	0.44	6.67	5.66	3.58	-2.31	-0.12	-0.83	0.11	-8.81
	<i>-1.19</i>	<i>-1.19</i>	<i>-1.53</i>	<i>-1.32</i>	<i>-0.69</i>	<i>1.39</i>	<i>1.39</i>	<i>0.18</i>	<i>0.26</i>	<i>0.66</i>	<i>-0.37</i>	<i>-0.37</i>	<i>0.90</i>	<i>0.99</i>	<i>-1.27</i>
Panel B: From January 2001 to December 2010															
Full Formation Period	-14.93	-0.71	-17.36	-17.45	-17.97	-4.84	-0.37	-4.79	-7.30	-5.17	-7.10	-0.50	-5.60	-7.88	-4.80
	<i>-2.25</i>	<i>-2.22</i>	<i>-3.01</i>	<i>-2.96</i>	<i>-2.46</i>	<i>-1.17</i>	<i>-1.17</i>	<i>0.25</i>	<i>0.09</i>	<i>-1.50</i>	<i>-1.59</i>	<i>-1.58</i>	<i>0.16</i>	<i>0.05</i>	<i>-0.98</i>
Intermediate Formation Period	-15.85	-0.84	-18.02	-17.28	-18.78	-0.03	0.00	-0.03	-1.65	-1.90	-5.68	-0.43	-4.154	-4.00	-3.87
	<i>-2.64</i>	<i>-2.60</i>	<i>-3.43</i>	<i>-3.34</i>	<i>-2.89</i>	<i>-0.01</i>	<i>-0.01</i>	<i>0.99</i>	<i>0.68</i>	<i>-0.45</i>	<i>-1.37</i>	<i>-1.37</i>	<i>0.25</i>	<i>0.29</i>	<i>-0.85</i>
Recent Formation Period	-12.15	-0.54	-14.66	-16.63	-17.11	0.44	0.03	0.47	-1.71	1.22	-4.02	-0.29	-2.74	-4.38	-0.88
	<i>-1.72</i>	<i>-1.71</i>	<i>-2.36</i>	<i>-2.61</i>	<i>-2.20</i>	<i>0.10</i>	<i>0.10</i>	<i>0.91</i>	<i>0.70</i>	<i>0.26</i>	<i>-0.91</i>	<i>-0.91</i>	<i>0.50</i>	<i>0.28</i>	<i>-0.18</i>
Panel C: From January 2011 to December 2021															
Full Formation Period	-23.57	-0.97	-28.79	-26.19	-21.43	-2.50	-0.15	-0.94	-0.95	-3.26	-5.14	-0.31	-6.30	-6.36	-1.96
	<i>-3.20</i>	<i>-3.14</i>	<i>-4.24</i>	<i>-4.03</i>	<i>-2.73</i>	<i>-0.50</i>	<i>-0.50</i>	<i>0.85</i>	<i>0.85</i>	<i>-0.88</i>	<i>-1.04</i>	<i>-1.03</i>	<i>0.21</i>	<i>0.20</i>	<i>-0.37</i>
Intermediate Formation Period	-18.16	-0.87	-21.79	-18.90	-15.36	0.82	0.06	-0.87	1.41	1.29	-4.74	-0.32	-4.03	-4.30	-4.46
	<i>-2.87</i>	<i>-2.83</i>	<i>-3.61</i>	<i>-3.25</i>	<i>-2.24</i>	<i>0.19</i>	<i>0.19</i>	<i>0.84</i>	<i>0.74</i>	<i>0.27</i>	<i>-1.05</i>	<i>-1.04</i>	<i>0.38</i>	<i>0.36</i>	<i>-0.93</i>
Recent Formation Period	-23.44	-0.88	-29.71	-26.98	-19.79	4.03	0.29	2.85	4.01	3.15	0.05	0.00	-0.83	-1.11	2.52
	<i>-2.91</i>	<i>-2.86</i>	<i>-4.08</i>	<i>-3.83</i>	<i>-2.30</i>	<i>0.96</i>	<i>0.96</i>	<i>0.50</i>	<i>0.35</i>	<i>0.69</i>	<i>0.01</i>	<i>0.01</i>	<i>0.86</i>	<i>0.82</i>	<i>0.49</i>

For the intermediate formation period the high minus low strategy yields an annualized average return of 9.59% and a Sharpe-Ratio of 0.57. Both are statistically significant to a 10% level. The CAPM are also large and statistically significant to a 10% level. Despite still being large, the FF5M is not statistically significant. For the recent formation period this strategy yields a return of 9.32% and a Sharpe-Ratio of 0.38. As was the case for the intermediate formation period, both are not significant and the CAPM and FF3M alphas are also large and not significant. The FF5M have a lower alpha which also is not significant.

Panel B reports the performance of the strategies for the period from January 2001 to December 2010. During this period, the high minus low strategy for the portfolios sorted by realized volatility for the full formation period the strategy ended up with an annualized Sharpe-Ratio of -0.71 and an annualized average return of -14.93%. Both the returns and the Sharpe-Ratio are statistically significant to a 1% level with T-statistics of -2.22 and 2.25 respectively. The CAPM and FF3M alphas are larger with larger t-statistics. The alphas of these 2 regressions are -17.36 and -17.45 with t-statistics of -3.01 and -2.96 respectively. The FF5M also captured this strong negative relation with an alpha of -17.97 and T-statistics of -2.46.

For the intermediate formation period the strategy keeps capturing the strong negative relation between realized volatility and future stock returns as suggested in chapter 4. During this period, the annualized average return of the strategy is 15.85% and the respective Sharpe-Ratio is -0.84, both statistically significant to a 1% level. The regression alphas are also large and significant. The recent formation period during the time interval of panel B had lower returns compared to the other formation periods with average returns of -12.15% and Sharpe-Ratio of -0.54. Being this said, the regression alphas are also large and significant.

For the interval from January 2011 to December 2021 depicted in panel C of table 5, the performance of the portfolios of the high minus low strategy for portfolios sorted by realized volatility jumps compared to the previous period. For the full formation period, the annualized average return is -23.57% and the Sharpe-Ratio is -0.97, both of them statistically significant to a 1% level. The alphas are also large and significant. For the intermediate formation period, the annualized return is -18.16% and the Sharpe-Ratio is -0.84 and as the previous case, they are statistically significant to a 1% level. The alphas for this formation period are also large and significant. Finally, for the recent formation period, the annualized average return is -23.44% and the Sharpe-Ratio is -0.88 and as before they are statistically significant. The regression alphas are also large and statistically significant.

In terms of the analysis of the performance for the portfolios sorted by realized skewness over the 3 decades in study, examining panel A of table 5 for the full formation period the high minus low strategy sorted by realized skewness, the strategy yields an annualized average return of 3.12% and a Sharpe-Ratio of 0.21. As in the case of realized volatility, neither the annualized return nor the Sharpe-ratio of this strategy during this period is statistically significant. The regression alphas are low and not significant. For the intermediate formation period the annualized return is 4.42% and the Shape-Ratio is 0.25. The regression alphas are close to the annualized return and as are not statistically significant as well. For the recent formation period, the high minus low strategy for the portfolio sorted by realized volatility has an annualized average return of 6.67% and a Sharpe-Ratio of 0.44. The regression alphas are lower than the annualized return and, like the return and Sharpe-Ratio are not significant.

Analyzing panel B, during the years of 2001 to 2010, high minus low strategy for portfolios sorted by realized skewness for the full formation period has a return of -4.84% and a Sharpe-Ratio of -0.37. The alphas of the regressions also are negative and non-significant. For the intermediate formation period, the annualized average return is -0.03 and the Sharpe-Ratio is 0.00 and are not significant. The alphas of the regressions are low and not significant. For the recent formation period, the alphas of the regressions are low and not significant as well as the returns and Sharpe-Ratio.

During the years described in panel C of table 5, the cross section returns for portfolios sorted by realized skewness for the full formation period are -2.5% and the Sharpe-Ratio is -0.15. All the alphas are also low and not significant. For the intermediate formation period, the returns, Sharpe-Ratio and alphas are low and not significant. Finally, for the recent formation period, despite having larger returns and alphas, those values are not statistically significant.

Table 5 shows that the negative relation between realized volatility and future returns captured in chapter 4.1 is present throughout the whole sample. Being this said, despite being present during the whole period, the predictive power of relation increases as time passes. Table 5 also shows that as time passes, the significance of the relation increases.

Analyzing the performance of the strategies of portfolios sorted by realized skewness, during the first 10 years of the sample, the measure has positive relation with future returns independently of the formation period, despite it being greater for the recent one. During the next 10 years, there is an inversion on the relation for the full formation period while others had little returns. For the last 11 years of the sample the full formation period keeps showing an

inverse relation between realized skewness and future returns. The recent formation period still shows a positive relation between realized skewness and future stock returns. ~

This evolution further justifies the low predictive power of the realized skewness during the sample, specifically for the full and intermediate formation periods while the recent has a consistent relation with stock returns.

Evaluating the relation between realized kurtosis and future stock returns stated on table 5, we can see that the measure has the largest predictive power during period from January 2001 to December 2010 for formation periods with annualized average returns of -7.10% for the full formation period, -5.68% for the intermediate formation period and -4.02% for the recent formation period. With all of this said, the relation between realized kurtosis and future stock returns is not statistically significant for any subsample and any formation period.

7. Conclusion

In this paper I applied strategies taught during my Master's, while increasing my literature about the topic of realized higher moments and their predictive power of future stock returns.

The aim of this study is to understand the relations between realized volatility, skewness and kurtosis and future returns. For this, multiple formation periods were tested based on the focused on the Spanish market as a developed and mature economy to study the previously stated relation.

Daily data was the foundation for the computation of the higher moments which were divided into quintiles for the respective formation period. In order to test the significance of the relationships, we two models were used for the analysis, the CAPM and Fama and French 3 factor model. Also, a zero-cost high-low strategy were analyzed in this study.

Results indicate a significant negative relation between realized volatility and stock returns. Buying stocks on the lowest quintile and selling stocks on the highest over the period of January 1991 and December 2021 in the Spanish market results in consistent performance, with Sharpe-ratios of 0.35 for the full formation period and 0.78 for the intermediate and recent formation periods. These results are also captured by the CAPM and FF3M models with higher statistically significant alphas.

Realized skewness did not hold a significant relation with future stock performance for the full and intermediate formation periods. On the other hand, for the recent formation period, the

relation is significant with a Sharpe-ratio of 0.74 with large and significant alphas for the models. Finally, realized kurtosis also had a negative relation with future stock returns. Though, this relation is less significant compared with the other moments.

Analyzing the portfolios double sorted by the realized moments confirm the negative relation with stock returns. Independently of being paired with realized volatility or realized kurtosis, the relation is evident and confirms the results of chapter 4.

The relation between realized volatility and future stock returns, despite being inverse throughout the whole sample, the low minus high strategy had increasing results and Sharpe-ratios and the years pass, implying that the predictive power of the measure increases in the more recent years.

The findings in this thesis had different results comparing with previous literature, specifically in the relation between realized skewness and stock returns. The positive relation found, despite the low significance do not support the research of *Conrad, Dittmar, & Ghysels (2013)*, *Boyer, Mitton, & Vorkink (2010)* and *Amaya et al.(2015)*.

Despite these findings, this work failed to replicate any proven portfolios or benchmarks, suggesting that the sample used for this study may not be reliable. Being this said, regardless of this situation, this work finds a significant negative relation between realized volatility and future stock returns for the Spanish market from January 1991 to December 2021.

A possible follow-up of this work could be trying to replicate these results using a more reliable sample where a reliable portfolio or benchmark could be replicated.

References

- Amaya, D., Christoffersen, P., Jacobs, K., & Vasquez, A. (2015). Does realized skewness predict the cross-section of equity returns? *Journal of Financial Economics*, 118(1), 135–167. <https://doi.org/https://doi.org/10.1016/j.jfineco.2015.02.009>
- Andersen, T. G., & Benzoni, L. (2009). Realized Volatility. In: Mikosch T., Kreiß JP., Davis R., Andersen T. (Eds) *Handbook of Financial Time Series*. Springer, Berlin, Heidelberg, 555–575.
- Andersen, T. G., & Bollerslev, T. (1998). Answering the Skeptics: Yes, Standard Volatility Models do Provide Accurate Forecasts. *International Economic Review*, 39(4), 885–905. <https://doi.org/10.2307/2527343>
- Andersen, T. G., Bollerslev, T., Diebold, F. X., & Ebens, H. (2001). The distribution of realized stock return volatility. *Journal of Financial Economics*, 61(1), 43–76. [https://doi.org/https://doi.org/10.1016/S0304-405X\(01\)00055-1](https://doi.org/https://doi.org/10.1016/S0304-405X(01)00055-1)
- Ang, A., Hodrick, R. J., Xing, Y., & Zhang, X. (2006). The Cross-Section of Volatility. *Journal of Finance*, 61, 259–299.
- Boyer, B., Mitton, T., & Vorkink, K. (2010). Expected Idiosyncratic Skewness. *The Review of Financial Studies*, 23(1), 169–202. <https://doi.org/10.1093/rfs/hhp041>
- Conrad, J., Dittmar, R. F., & Ghysels, E. (2013). Ex Ante Skewness and Expected Stock Returns. *The Journal of Finance*, 68(1), 85–124. <https://doi.org/https://doi.org/10.1111/j.1540-6261.2012.01795.x>
- Fleming, J., Kirby, C., & Ostdiek, B. (2003). The economic value of volatility timing using “realized” volatility. *Journal of Financial Economics*, 67(3), 473–509. [https://doi.org/https://doi.org/10.1016/S0304-405X\(02\)00259-3](https://doi.org/https://doi.org/10.1016/S0304-405X(02)00259-3)
- Jegadeesh, N. (1990). Evidence of Predictable Behavior of Security Returns. *The Journal of Finance*, 45(3), 881–898. <https://doi.org/10.2307/2328797>
- Jegadeesh, N., & Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *The Journal of Finance*, 48(1), 65–91. <https://doi.org/10.2307/2328882>

Merton, R. C. (1980). On estimating the expected return on the market: An exploratory investigation. *Journal of Financial Economics*, 8(4), 323–361. [https://doi.org/https://doi.org/10.1016/0304-405X\(80\)90007-0](https://doi.org/https://doi.org/10.1016/0304-405X(80)90007-0)

Novy-Marx, R. (2012). Is momentum really momentum?. *Journal of Financial Economics*, 103(3), 429-453, <https://doi.org/10.1016/j.jfineco.2011.05.003>.

Paye, B. S. (2012). ‘Déjà vol’: Predictive regressions for aggregate stock market volatility using macroeconomic variables. *Journal of Financial Economics*, 106(3), 527–546. <https://doi.org/https://doi.org/10.1016/j.jfineco.2012.06.005>

Rapach, D., Strauss, J., & Zhou, G. (2009). Out-of-Sample Equity Premium Prediction: Combination Forecasts and Links to the Real Economy. *Review of Financial Studies*, 23, 821–862. <https://doi.org/10.2139/ssrn.1257858>

Schwert, G. W. (1989). Why Does Stock Market Volatility Change Over Time? *The Journal of Finance*, 44(5), 1115–1153.

Wang, Q., Faff, R., & Zhu, M. (2022). Realized moments and the cross-sectional stock returns around earnings announcements. *International Review of Economics & Finance*, 79, 408-427.