Does market volatility have predictive power for momentum returns? Evidence for the United Kingdom and Japan

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The dissertation is written under the supervision of Professor Dr. Pedro Monteiro e Silva Barroso.

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Abstract [EN]

Recent studies for the United States indicate that market volatility predicts momentum returns. The objective of this paper is to analyze if this happens in two different countries, the United Kingdom and Japan. Using a simple time series regression not only with variables regarding market volatility and market state but also macroeconomic variables, the return dispersion, sentiment index, default risk, and expected future volatility it turns out that indeed, in the case of the UK, market volatility has predictive power for the momentum payoff after controlling for all other variables except one, the VSTOXX. This measure of expected volatility can subsume the power of market volatility but only in the positive market state. Regarding Japan, the volatility of the market only has predictive power when it is used in combination with macroeconomic variables. This situation maintains with the rest of the variables except for the default risk proxies that in a down market take away the predictive power of market volatility. The conclusions that were obtained from the study of each country differ.

Keywords: market volatility, momentum payoff, predictability, United Kingdom, Japan, expected future volatility and default risk.

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Resumo [PT]

Estudos recentes para os Estados Unidos indicam que a volatilidade do mercado ajuda a prever o lucro da estratégia momentum. O presente estudo tem como objetivo analisar se o mesmo acontece em dois outros países, o Japão e o Reino Unido. Utilizando uma simples regressão linear, que não apenas contém variáveis relacionadas com a volatilidade e com o estado de mercado, mas também variáveis macroeconómicas, dispersão do retorno, índice de sentimento, risco de falência das empresas e volatilidade futura esperada, concluiu-se que de facto isso acontece no Reino Unido. A volatilidade do mercado pode ser usada para prever o lucro do momentum quando é controlado o efeito de outras variáveis exceto uma, a VSTOXX. A volatilidade esperada futura absorve o poder da volatilidade do mercado, mas apenas num estado de mercado considerado positivo. No que diz respeito ao Japão, a volatilidade do mercado apenas tem poder de previsão quando são introduzidas variáveis macroeconómicas. Esta situação mantém-se quando são inseridas as restantes variáveis com a exceção da variável referente ao risco de falência das empresas, que em mercados em estado considerado negativo consegue retirar o poder da volatilidade do mercado em prever o rendimento da estratégia. As conclusões obtidas para os dois países diferem.

Palavras-chave: volatilidade do mercado, lucro do momentum, prever, Reino Unido, Japão, volatilidade esperada futura e risco de falência.

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Introduction

The past return-based investment strategies, more explicitly, the momentum strategy tested by Jegadeesh and Titman (1993) has been one of the most used by financial investors and the most analyzed by the academic body as it is said by Grinblatt, Titman, and Wermers (1995).

Following the idea of Wang and Xu (2015) and in view of the analysis of Figure 1 and 2 in the Appendix, market volatility and momentum payoff are correlated. When there is an increase in market volatility during the 2008/2009 economic crisis and the 2020/2021 crisis, the momentum payoff tended to decrease in subsequent periods suggesting that market volatility predicts the strategy's profit.

Given this situation, in this thesis, I will examine whether market volatility helps predict the momentum strategy's profit in a market where it is profitable and, in a market, where it isn't. As many works of literature have already referred to the East Asia countries, in this case Japan, the strategy does not have any significant premium (e.g., Griffin et al. 2003; Fama and French, 2012; Asness et al. 2013) and sometimes even has negative average returns (Chou et al. 2007). There are several explanations for this to happen, from the low individualism of Japanese society (Chui et al. 2010) to the different market dynamics (Hanauer, 2014). I also include the UK, with a more individualistic mentality, in the study to analyze a case where momentum works (Lui et al. 1999).

In this study, I'm replicating a previous paper entitled "Market volatility and momentum" by Wang and Xu (2015) made for the US in two different markets. In the original paper, they conclude, that in the US, the market volatility has predictive power in momentum. To arrive to that conclusion, Wang and Xu build on previous work such as the paper "Market States and Momentum (2004)" by Cooper, Gutierrez, and Hammed (CGH) and the paper "Momentum, Business cycle and time-varying expected returns (2002)" by Chordia and Shivakumar (CS).

CS investigates

"The relative importance of common factors and firm-specific information as sources of momentum profit." (Chordia and Shivakumar 2002, p.1), i.e., whether macroeconomic variables help explain the momentum payoff. CGH (2004) analyze whether the separation of the market state is up or down (the market is up (down) when the lagged three-year market return is non-negative (negative)) and if it has relevance for the profitability of the momentum strategy. Their conclusion was that, in fact, momentum is dependent on the market state.

From the results of the previously mentioned papers and following the same methodology of Wang and Xu (2015), the data was divided into volatility levels, in high or low; and in different market states, up or down; to see if market volatility would help predict the momentum's profit. After observing the tables, I verified that in both cases the profit of the strategy does not depend on the market state, since in the positive market states there is not always a higher profit but, rather, it depends on the level of volatility. However, in relation to the UK, it can be confirmed that volatility has predictive power of the momentum payoff. The same, no longer happens with Japan. For confirmation, and in accordance with Wang and Xu (2015), the macroeconomic variables of CS (2002) were added. With these new variables, it was found that in relation to the United Kingdom there were no changes in the predictive power of volatility. The same was not verified for Japan, in this case, volatility began to have predictive power of the momentum profit.

In addition to the analyzed variables related to market volatility and market state, other ones were inserted, such as the return dispersion (Stivers and Sun, 2012), expected future volatility, sentiment index (Fisher and Statman, 2003), and default risk to see if they have some predictive power of the momentum payoff and if when these are inserted the predictive power of volatility has a significant change. The main conclusion was that only VSTOXX, in the UK, and Default Risk in down markets in Japan subsume the predictive power of volatility.

The structure of this work is as it follows: in section 1 the methodology and data used are presented; in sections 2 and 3 the main results for market volatility are discussed to observe if it helps predict the profit of the strategy; in section 4 is analyzed potential explanations; and in section 5 is the conclusion.

1. Methodology

The purpose of this paper is to analyze whether market volatility has predictive power in the momentum payoff and whether this impact changes when adding certain variables. To analyze this premise, I used the paper of Wang and Xu (2015).

It was decided to choose two completely different countries, the UK and Japan. Since the United Kingdom is a European country, with a Western and more individualistic mentality, the strategy momentum, has been proven to work. On the other hand, Japan has a less individualistic Eastern mentality where it is recognized that such a strategy fails (Griffin et al 2003; Asness et al.2013; Fama and French, 2012). The timeline of this study is between January 1987 and September 2021 since the only data available starts in 1987.

The variables that were used follow the idea of Wang and Xu (2015), however, the database that they used is different to the database that I used to calculate the same variables.

To answer this question, we run the following predictive regression:

$$\gamma_{i,t} = a_i + \beta x_{i,t-1} + \varepsilon_{i,t}$$

Variable dependent:

The dependent variables were taken from the AQR library website which may not match the Fama and French (1996) strategy since the original makes an independent sort, and AQR makes the dependent sort first by size and then by momentum. The reason why they use conditional sort is to guarantee a balanced number of securities in all portfolios.

1. $Mom_{i,t}$ is the momentum payoff in month t and country i . Consists on the average return on the two high returns portfolios minus the average return of the two low return portfolios on the period t. The prior portfolios are formed on previous returns and not in contemporary returns. The momentum portfolios are value-weighted, and the return is calculated over the prior 12 months, skipping the most recent month, due to the short-term reversal effect (Fama 1965).

$$Mom_{i,t} = \frac{1}{2}\left(Small\ high_{i,t} + Big\ high_{i,t}\right) - \frac{1}{2}\left(Small\ low_{i,t} + Big\ low_{i,t}\right)$$

For the robustness test, six portfolios formed monthly on size and momentum were used. The portfolios are the intersections of two portfolios constructed on size (total market value of equity) , the breakpoint is the 80th percentile by country, and three portfolios constructed on past returns. For this dependent variable the timeline used was between July 1988 and September 2021, since there was only available data for this period.

2. $MomFF_{i.t}$ is the mean return on the three small portfolios minus the mean return on the three big portfolios. These portfolios are also value-weighted.

$$MomFF_{i,t} = \frac{1}{3}\left(Small\ value_{i,t} + Small\ neutral_{i,t} + Small\ growth_{i,t}\right) - \frac{1}{3}\left(Big\ value_{i,t} + Big\ neutral_{i,t} + Big\ growth_{i,t}\right)$$

Independent variables:

- **$MKS_{t-36:t,i}$** consists of the market state that is defined as the past three-year market return of the equities in the market of each country, that is, the sum of market returns in the past thirty six months divided by twelve months, to annualize. Once I went to get this variable from the AQR library, I had to make some changes. It was necessary to add the risk-free rate and to convert to the currency of each country in the month t through the Exchange rate that was withdrawn from Yahoo Finance.
- **$VOL_{t-12:t,i}$** is the lagged twelve-month market volatility, that is, the average market volatility of the past twelve months. To calculate the market volatility, the standard deviation of the daily market return was used. The volatility is in percentage.

To check for robustness the variables are lagged just for six months but, the calculations remain the same. For MKS it is the sum of market returns in the past six months divided by twelve months to annualize and, for VOL it is the average market volatility in the past six months.

[Insert Figure 3 and 4]

In figure 3 and 4 represented in the appendix, the market volatility and market state were graphically represented for both time windows and for each country. In Panel A, in both countries, the highest volatility that ever existed was during the financial crisis of 2008 and in the 2020/2021 crisis. More specifically, in Japan was in October 2008, and in the United Kingdom was in March

2020. As it is represented in the other panels, there are more negative months when the market state is defined by the past six-month return. This situation is corroborated by the article of Wang and Xu (2015) and that is why it was decided to use the past six-month return to check for robustness and to divide in the up or down market state.

Following Wang and Xu (2015), to make a more detailed analysis of the volatility depending on the market state it was decided to create two more variables.

- **$VOL(+)_{t-12:t,i}$** which is equal to volatility if the market state is positive and 0 if it happens otherwise.
- **$VOL(-)_{t-12:t,i}$** which is equal to volatility if the market state is negative and 0 if it happens otherwise.

In the other variables, in the macroeconomics of CS that Wang and Xu (2015) also used, there are differences between countries. For that reason, we will separate the explanation of these variables into two sections, one for each country.

I. The first section, macroeconomic variables for the United Kingdom:
   - **$DIV_{t-1,i}$**: constitutes the dividend yield of the FSTE All-Share Index, which is a market index weighted by capitalization, comprising about 604 constituents.
   - **$DEF_{t-1,i}$:** is the difference between the yield of the S&P UK AAA Corporate bond index and S&P UK BBB Corporate bond index.
   - **$TERM_{t-1,i}$** (term spread): is the difference between the average yield of Government bonds with more or equal to ten years for maturity and the yield of Government bonds with two years for maturity.
   - **$YLD_{t-1,i}$:** is the yield of a three-month treasury yield.

II. The second section, macroeconomic variables for Japan:
   - **$DIV_{t-1,i}$**: constitutes the dividend yield of the FTSE Japan Index. This index is a market capitalization index representing the performance of large and mid-cap Japanese companies that are constituents of the FTSE All-world index.

- **<u>DEF</u>**: no indices that reflected the yield of rated BAA or AAA bonds were discovered so this variable was not included.
- $\mathbf{TERM_{t-1,i}}$ and $\mathbf{YLD_{t-1,i}}$ are calculated in the same way as those of the United Kingdom.

The variables related to volatility and market state were recovered from the AQR Library, while macroeconomic variables were retrieved from Refinitiv Eikon.

As in Wang and Xu (2015), in the second part of the paper, it is tested potential explanations for the results obtained in the first part using cross-section return dispersion; sentiment index; expected future volatility; and variations related to default risk. Regarding to cross-section return, the same methodology of Stivers and Sun (2010) was applied retrieving the portfolios from Kenneth R. French data library, the expected future volatility is retrieved from Yahoo Finance and both the sentiment index and the variables to construct the default risk were taken from Refinitiv Eikon DataStream. The explanation of these new variables is presented in detail in the second part.

2. Predictive Power of market volatility

In agreement with Wang and Xu (2015), the purpose of this section is to find if there is indeed a predictive power of market volatility, controlling for a variety of market states, in the momentum payoff not only in the countries that many academic papers have proven that this strategy works but also in the countries that do not work. For that reason, it was decided to test for United Kingdom and Japan. In order to do that, the sample was sorted in four ways depending on market volatility and market state. Just as in Wang and Xu (2015), it was followed the idea of CGH (2004) a month is in a positive (negative) market state if the lagged three-year return is positive (negative) also, a month is of high (low) volatility if the lagged twelve-month market volatility is greater (lower) than the lagged 36-month market volatility.

Analysis of Panel A – United Kingdom

Regarding the first country, in the Table 1 Panel A , the sample has 353 months that are in a positive market state and 64 that are in a negative market state. Additionally, there are 188 (229) months in a High (Low) market volatility. Lastly, if the sample is divided into the four subsamples there is 146 (207) in a positive state and high (low) volatility and 42 (22) in a negative state, and a high (low) volatility.

Observing Table 2 Panel A, it can be noticed that the profit of the momentum strategy for the full timeline of the investigation was on average 0.994 basis points.

In Table 2 Panel A it is demonstrated that the profit of the implemented strategy is higher in more recent periods, this is in accordance with recent studies. When the sample is divided into two equal parts, we were able to recognize that between May of 2004 and September of 2021 the payoff was considerably higher with a value of 1.001% even though, during the timeline the two biggest economic and social crises occurred in the world, reasons that were neither determining nor preventing this premise from changing.

When analyzing the volatility and market state subgroups, it is observed that there is no unequivocal agreement neither with CGH (2004) nor with Wang and Xu (2015), since the negative market state does not always have less payoff than the positive market state. As can be seen in the Table 2 Panel A, in the period from January 1987 to April 2004 in the positive market state with high volatility the profit is 0.197% and in the same period and volatility in the negative market state there is a profit of 0.612%. However, with acquired values, it is agreed that high volatility always has less payoff than low volatility and that is more important in negative markets. The difference between low and high in the negative market state is 1.986% (1.777% – (- 0.209)%) and the same difference in the positive market state reaches the value of 0.875% (1.451%- 0.576%) as we can see in values of the variable low-high.

Analysis of Panel B – Japan

In this case as it can be seen in Table 1 Panel B, there are 277 months in a positive market state including 101 (176) high (low) volatility and 140 months in a negative market state of which 56 (84) are in a high (low) volatility market.

Analyzing the data in Table 2 Panel B, for the period in question, it is recognized that the profit obtained was 0.079 basis points.

Again, it turns out that profit is higher in periods of lower volatility than in periods with higher volatility, however, there is an exception that runs between January 1987 and April 2004. During this, the timeline in the negative market state and in low volatility is obtained by a negative payoff of -0.082% and in high volatility the payoff was positive with a value of 0.030%.

Another aspect that the data in the Table 2 Panel B allow us to measure is that high volatility generally has negative payoffs, being the lowest value of -1.597% that happens in the most recent period. In the same timeline, profitability is lower having a value of 0.028%.

Doing a comparative analysis of both countries allows us to find that the profit of the strategy, in general, is always higher in the United Kingdom since with the examination of the data it was found that in Japan the payoff focuses mostly on negative values. Another point worth comparing is in fact the profit in the most recent period. As mentioned in the UK's individual analysis, it is proven that in the timeline between May 2004 and September 2021 the profit should be higher, which is not the case in Japan. Such situation can happen since it is proven that the strategy, momentum, does not have the expected results so that it can be considered valuable in that country.

Table 1- Number of observations for each market state and volatility
The monthly momentum payoff is retrieved from the AQR Library that consists of the difference between the average return of the two high return portfolios and the two low return portfolios. The momentum factor is value weighted. A month is in a positive (negative) market state if the lagged three-year return is positive (negative). A month is of high (low) volatility if the lagged 12-month market volatility is greater (lower) than the lagged 36-month market volatility. The values stated are the number of observations for each subsample.

Panel A- United Kingdom

MOM	Positive market state		Negative market state	
	High	Low	High	Low
Jan 87 - Sept 21				
417	146	207	42	22
Jan 87 - Apr 04				
208	65	115	19	9
May 04 -Sept 21				
209	81	92	23	13

Panel B -Japan

MOM	Positive market state		Negative market state	
	High	Low	High	Low
Jan 87 - Sept 21				
417	101	176	56	84
Jan 87 - Apr 04				
208	30	84	40	54
May 04 -Sept 21				
209	71	92	16	30

Table 2- Momentum payoff, market state, and volatility
The monthly momentum payoff is retrieved from the AQR Library that consists of the difference between the average return of the two high return portfolios and the two low return portfolios. The momentum factor is value weighted. A month is in a positive (negative) market state if the lagged three-year return is positive (negative). A month is of high (low) volatility if the lagged 12-month market volatility is greater (lower) than the lagged 36-month market volatility. Low-High volatility is a dummy that equals to 1 if the volatility is low and 0 otherwise. The values stated are the average of the momentum payoff for each of these four sub-samples presented in percentage and the robust t-statistics that are shown in parenthesis.

Panel A- United Kingdom

MOM	Positive market state			Negative market state		
	High	Low	Low-High	High	Low	Low-High
Jan 87 - Sept 21						
0.994	0.576	1.451	0.875	-0.209	1.777	1.985
(4.55)	(1.43)	(6.75)	(2.06)	(-0.17)	(2.97)	(1.13)
Jan 87 - Apr 04						
0.988	0.197	1.462	1.265	0.612	1.434	0.822
(3.18)	(0.30)	(4.42)	(1.90)	(0.42)	(1.39)	(-0.36)
May 04 -Sept 21						
1.001	0.880	1.436	0.556	-0.887	2.014	2.900
(3.25)	(1.80)	(5.68)	(1.05)	(-0.46)	(2.69)	(-1.11)

Panel B -Japan

MOM	Positive market state			Negative market state		
	High	Low	Low-High	High	Low	Low-High
Jan 87 - Sept 21						
0.079	-0.445	0.519	0.934	-0.434	0.126	0.560
(0.36)	(-1.04)	(1.67)	(1.84)	(-0.48)	(0.33)	(0.65)
Jan 87 - Apr 04						
0.129	-0.358	0.483	0.842	0.030	-0.082	-0.113
(0.35)	(-0.37)	(0.84)	(0.75)	(0.03)	(-0.16)	(-0.10)
May 04 - Sept 21						
0.028	-0.482	0.550	1.032	-1.597	0.500	2.096
(0.11)	(-1.05)	(1.97)	(2.01)	(-0.95)	(1.02)	(1.52)

3. Market state and macroeconomic variables

Following the paper of Wang and Xu (2015), in this section, predictive regressions are presented. In Panel A only variables regarding the market state and market volatility are used, but to check for robustness, different time windows are applied to calculate these variables. The First Pair MKS consists in the lagged three-year market return in annual terms and VOL, is the lagged twelve-month market volatility presented in percentage but in the Second and Third Pair, the variables are lagged just for six months.

Regarding Panel B it is included the macroeconomic variables mentioned by CS, which also are used by Wang and Xu (2015), to see if they have any power to decrease the significance of the market volatility and market state. Also, in this Panel, distinct dependent variables are used. In the First Pair, the dependent variable consists of the regular momentum construction, this is the same that it is used in the other tables. In the Second Pair, the dependent variable is size-balanced momentum profit.

Analysis of Table 3 – United Kingdom

In Table 3 in the First Pair when performing the regression only with the MKS and VOL we find that the variable VOL has a negative sign with a statistical significance. The standard deviation of VOL is 0.34, then one standard deviation increase in VOL is associated with a decrease in momentum payoff of 0.00799. However, the market state has a coefficient with a positive value, nevertheless, this is not significant.

In the second regression of Table 3, already with the variables MKS, VOL (+), and VOL (-), the MKS coefficient now has a negative value, but still has no statistical significance. Concerning the variables VOL (+) and VOL (-) both have negative coefficients and statistical significance of 10% and 1% respectively, yet the VOL (-) has a greater impact on momentum profit since the coefficient is higher, as well as the robust t-statistics that has a value of -3.29.

In Table 3 in the second pair, the analysis of MKS and VOL maintains. When calculating the market volatility over the past six months it led to a decrease in the t-statistics of VOL (+). Yet, for VOL (-) the significance was amplified.

In the third pair, the VOL (+) becomes significantly stronger than the VOL (-).

Regarding to Panel B in Table 3, when macroeconomic variables were implemented and when the dependent variable is the regular momentum construction, the statistical significance remains the same as Panel A, VOL, VOL (+), and VOL (-) are the only variables with significance and none of the new variables have a significant impact on momentum. Still, when the dependent variable is size-balanced momentum profit, in the first regression, VOL is the only one with significant power of only 10%. In the second regression VOL (-), DIV and YLD are significant at 1%.

It can be seen that what happened in Panel A also happens in Panel B, in the sense that market volatility has predictive power in the momentum, with VOL (-) still having a greater impact.

Analysis of Table 4 – Japan

When looking at the data relating to Table 4 Panel A concerning the first pair, it turns out that none of the variables have significant power, and the MKS in the second regression has a small t-statistics value of 0.03.

In the second pair of Table 4 Panel A, it was found that volatility becomes significant maintaining a negative value in the coefficient. When VOL (+) and VOL (-) are inserted, only the last one has significant power. However, in the third pair, volatility is no longer significant in the first regression, but there is still significance in the variable VOL(-) in the second regression.

This leads us to say that volatility does not always have predictive power in Japan.

Analyzing the values that are referred in Panel B Table 4 when the business cycle's variables are implemented and when the dependent variable is the regular momentum construction the volatility and the YLD are significant at 1% having both negative coefficients. In the second regression, YLD maintains its significance and now VOL (+) and VOL (-) also have, being stronger in VOL (-). Nevertheless, when the dependent variable is size-balanced momentum profit no variable is significant as shown by the negative value of adjusted R- squared that it is -0.0020 in the first regression, and -0.0015 in the second. One of the reasons this can be verified is due to the decrease in the timeframe.

When a comparative analysis of the data is made, it can be realized that, although in most cases the variables related to volatility do not have predictive power in the momentum in Japan, when this exists there is always greater evidence in VOL (-), that is, in negative markets, which is also the case in the other country under study. In the UK with robust testing, it is revealed that market volatility always has significance independently of how to calculate the momentum which does not happen in Japan.

Table 3 – Predictive power of market volatility for United Kingdom

We are applying multiple variables as market volatility, market state, and macroeconomic variables to predict momentum payoff. The regression consists of $\gamma_{i,t} = \alpha_i + \beta x_{i,t-1} + \varepsilon_{i,t}$. MKS consists of the lagged three-year market return in annual terms. Vol is the lagged twelve-month market volatility presented in percentage. Vol + (-) is equal to Vol if the MKS is positive (negative) and equal to 0 otherwise. DIV is the dividend yield of the FTSE All-Share. DEF is the difference between the yield of the S&P UK AAA corporation bond index and the yield of the S&P UK BBB corporation bond index. TERM is the difference between the average yield of Government bonds with more or equal to ten years for maturity and the yield of Government bonds with two years to maturity. YLD is the yield of a three-month treasury bill. To check for robustness, it is used a different time window for the calculations of the market state and the market volatility and alternative measure of momentum payoff "Size-balanced momentum profit". For each of these regressions, it is reported coefficients, robust t-statistics in parentheses, and adjusted R-squares. For simplicity, the intercept is omitted from these tables.

Panel A. Market state and volatility

MKS	Vol	Vol+	Vol-	Adj-R^2
I. Market state and market volatility				
0.0231	-0.0235			0.0372
(0.66)	(-2.96)			
-0.0153		-0.0184	-0.0281	0.0398
(-0.35)		(-2.11)	(-3.29)	
II. Market volatility calculated over the past six months				
0.0298	-0.0208			0.0401
(0.90)	(-3.16)			
-0.0033		-0.0153	-0.0239	0.0417
(-0.08)		(-1.95)	(-3.41)	
III. Both state and volatility calculated over the past six months				
-0.0183	-0.0272			0.0393
(-1.61)	(-4.31)			
-0,0070		-0.0306	-0.0244	0.0390
(-0.42)		(-4.18)	(-3.49)	

Panel B. Market state, market volatility, and business cycles

MKS	Vol	Vol+	Vol-	DIV	DEF	TERM	YLD	Adj-R^2
I. Regular momentum construction								
0.0063	-0.0349			-0.0099	0.0046	-0.0015	-0.0021	0.0402
(0.14)	(-2.42)			(-1.46)	(0.74)	(-0.20)	(-0.62)	
		-0.0299	-0.0356	-0.0076	0.0044	-0.0072	-0.0010	0.0427
		(-1.99)	(-2.67)	(-1.09)	(0.72)	(-0.03)	(-0.30)	
II. Size-balanced momentum profit								
-0.0322	0.0186			-0.0057	-0.0043	-0.0014	-0.0029	0.0205
(-1.00)	(1.86)			(-1.21)	(-1.02)	(-0.28)	(-1.27)	
		0.0077	0.0231	-0.0106	-0.0043	-0.0039	-0.0052	0.0520
		(0.76)	(2.52)	(-2.22)	(-1.04)	(-0.80)	(-2.20)	

Table 4 – Predictive power of market volatility for Japan

We are applying multiple variables as market volatility, market state, and macroeconomic variables to regress momentum payoff. The regression consists of $\gamma_{i,t} = \alpha_i + \beta x_{i,t-1} + \varepsilon_{i,t}$. MKS consists of the lagged three-year market return in annual terms. Vol is the lagged twelve-month market volatility presented in percentage. Vol + (-) is equal to Vol if the MKS is positive (negative) and equal to 0 otherwise. DIV is the dividend yield of FTSE Japan. . TERM is the difference between the average yield of Government bonds with more or equal to ten years for maturity and the yield of Government bonds with two years to maturity. YLD is the yield of a three-month government bond. To check for robustness, it is used a different time window for the calculations of the market state and the market volatility and alternative measure of momentum payoff "Size-balanced momentum profit". For each of these regressions, it is reported coefficients, robust t-statistics in parentheses, and adjusted R-squares. For simplicity, the intercept is omitted from these tables.

Panel A. Market state and volatility

MKS	Vol	Vol+	Vol-	Adj-R^2
I. Market state and market volatility				
0.0092	-0.0116			0.0070
(0.41)	(-1.60)			
0.0008		-0.0105	-0.0125	0.0049
(0.03)		(-1.38)	(-1.65)	
II. Market volatility calculated over the past six months				
0.0088	-0.0120			0.0109
(0.42)	(-2.03)			
-0.0059		-0.0103	-0.0137	0.0098
(-0.20)		(-1.63)	(-2.16)	
III. Both state and volatility calculated over the past six months				
0.0110	-0.0103			0.0158
(1.41)	(-1.81)			
0.0009		-0.0067	-0.0123	0.0160
(0.08)		(-1.01)	(-2.05)	

Panel B. Market state, market volatility, and business cycles

MKS	Vol	Vol+	Vol-	DIV	TERM	YLD	Adj-R^2
I. Regular momentum construction							
-0.0023	-0.0162			-0.0081	0.0038	-0.0010	0.0334
(-0.09)	(-2.06)			(-1.62)	(0.59)	(-2.35)	
		-0.0181	-0.0163	-0.0086	0.0032	-0.0011	0.0340
		(-2.09)	(-2.30)	(-1.73)	(0.52)	(-2.38)	
II. Size-balanced momentum profit							
-0.0076	0.0029			0.0020	-0.0023	-0.0001	-0.0020
(-0.56)	(0.70)			(0.75)	(-0.67)	(-0.54)	
		0.0022	0.0037	0.0019	-0.0022	-0.0001	-0.0015
		(0.47)	(0.98)	(0.74)	(-0.68)	(-0.59)	

4. Potential explanations

In this section, I decided to do the same strategies as Wang and Xu did in their 2015 article "Market volatility and momentum". We are going to study if return dispersion, expected future market volatility, sentiment index, and default risk have some predictive power of momentum payoff and if when these variables are inserted the predictive power of volatility has a significant change.

4.1 Return dispersion

Stivers and Sun's (2010) work shows that there is a relationship between Return Dispersion and momentum and that it remains unchanged when it is controlled by macroeconomic variables.

Following their study, I test whether this relationship is observed for these two countries under study.

Cross-section return dispersion (RD) is built from monthly data of twenty-five portfolios formed on size and book-to-market equity ratios. These portfolios consist of five portfolios formed by size and five portfolios formed by book-to-market equity ratios.

O RD is the cross-sectional standard deviation of the monthly disaggregate returns :

$$RD_{\tau} = \sqrt{\frac{\sum_{i=1}^{n}(R_{i,t} - R_{u,t})^2}{n-1}}$$

In which n corresponds to the number of disaggregate portfolios, $R_{i,t}$ is equivalent to the return of the same portfolio i at time t, and $R_{u,t}$ is the equal-weight portfolio return of the disaggregate portfolios of the same period t. According to Stivers and Sun (2010), we are going to use the three-month moving average of the RD

> "Because we feel that three months is a reasonable compromise that is responsive to changing market conditions but also removes some of the noise in month-to-month variation."(Stivers and Sun, 2010, p.995).

For the United Kingdom, it is used the twenty-five portfolios from Europe and, for Japan is used the twenty-five Japanese Portfolios that are taken from the data library of Ken French. The reason why it is applied the twenty-five portfolios from Europe it is because there are not readily available five-by-five size and book-to-market portfolios for the UK .

Stivers and Sun (2010) use monthly data from 100 portfolios, but they report that structuring with twenty-five portfolios has an analogous performance that suggests that although the same conclusions have not been obtained, it is not due to this difference.

Analysis of Table 5 Panel A- United Kingdom

Testing the correlation between RD_{1-3} and the momentum payoff it was found that the value is residual and negative of -0.0874. However, between RD_{1-3} and volatility (VOL) the value is quite high of 0.6360 having a t-stats of 0.00.

When regression is performed only with the variable RD_{1-3} despite having a negative sign in the coefficient, which is in line with the results presented by Stivers and Sun, it has no statistical significance.

One might think that this is because not only UK-related portfolio is necessarily used, so it has been decided to test for Europe's momentum payoff as the dependent variable. When running the regression, the same result was obtained. RD_{1-3} continues to have a negative coefficient and statistical insignificance.

However, when inserting the variables MKS and VOL, RD_{1-3} becomes positive with statistical significance at 1% which is maintained in the remaining regressions and there has always been an increase in robust t-statistics. Another important aspect is the statistical significance also to 1% of the variables related to volatility. The volatility in a negative market state is more prevalent being the difference between the robust t-statistics of VOL(-) and VOL(+) of -0.8.

Analysis of Table 6 Panel A- Japan

When examining the correlation of this new variable with the dependent variable and with volatility, it is found that, it has a negative correlation of -0.1131 with momentum payoff and, with VOL presenting a positive value of 0.4209 with a t-stats of 0.00.

The variable RD_{1-3} is never statistically significant in any of the four regressions that are performed. Volatility is only significant when macroeconomic variables are inserted, among them only YLD is significant at 1% in the third and fourth regression and DIV at 10% in the fourth regression.

Regards, to VOL (+) and VOL (-) both have statistical significance nevertheless, the volatility in a negative market state is higher at 1%.

4.2 Expected future market volatility

Analysis of <u>Table 5 Panel B - United Kingdom</u>

Since there is no volatility index only for the UK, VSTOXX will be used, which is a volatility index in Europe. This index measures the implied 30-day volatility of the Euro Stoxx 50.

In the first regression in Table 5 Panel B, the VSTOXX has a negative coefficient of -0.001 and this is significant at 1%. The standard deviation of VSTOXX is 8.89, meaning that one standard deviation increase in VSTOXX is associated with a decrease in momentum payoff of 0.0089. However, in the next regressions, it becomes insignificant maintaining the negative coefficient.

A relevant aspect that is present in the fourth regression is, the fact that the variable VOL (+) becomes insignificant when we include VSTOXX which was not the case in Table 3 Panel B, which leads to the conclusion that VSTOXX removes predictive power from volatility in the positive market state.

To test whether the present result is not derived from not having used an index for that country it was decided to carry out a table with the dependent variable momentum payoff of Europe.

In the first regression, VSTOXX has a negative coefficient of -0.0009 and significance at 1%. In the second regression, its significance decreases to only 10%. However, VOL_EURO has no significance.

When the variables MKS_EURO, VOL_EURO(+), and VOL_EURO(-) are implemented VSTOXX is not statistically significant.

From these results, it is concluded that in fact, the expected future market volatility decreases the predictive power of the volatility, more specific, it decreases the volatility when the market state is positive.

- Other's variables related to volatility

Motivated by previous result in the literature (Barroso and Santa-Clara, 2015; Barroso and Wang, 2021), it was decided to test if, with the volatility of the strategy itself and the volatility of the return of the FTSE All-Share index, a conclusion similar to the expected future market volatility was reached. The VOL_MOM is the standard deviation of daily momentum payoff and VOL_FTSE is the standard deviation of the FTSE All-share return.

VOL_MOM has a correlation with VOL in the value of 0.6065. In Table 7 Panel A VOL_MOM is always statistically significant at 1% when it is used alone and when the market state and market volatility was added. Though, none of the other variables are statistically significant, which gives us the understanding that momentum volatility takes the predictive power out of market volatility, as it is the case with VSTOXX as already mentioned in the previous point.

In relation to Table 7 Panel B, VOL_FTSE has a correlation of 0.3318 between VOL but never has statistical significance in any of the regressions. However, VOL, VOL (+), and VOL (-) have statistical significance having even greater power when VOL_FTSE is included. In this case, this new variable even increases the predictive power of market volatility.

Table 7 - Other's variables related to volatility for United Kingdom.

The regression consists of $\gamma_{i,t} = \alpha_i + \beta x_{i,t-1} + \varepsilon_{i,t}$. Applied VOL_MOM and VOL_FTSE to find out if the predictive power of market volatility on momentum payoff can be absorbed. The VOL_MOM is the standard deviation of daily momentum payoff and VOL_FTSE is the standard deviation of the FTSE All-share return. All the other variables are the same as in Table 2. The values shown are the coefficients of the variables, the robust t-statistics that are presented in parentheses, and adjusted R-squares.

Panel A. Volatility of the momentum

MKS	VOL	VOL(+)	VOL (-)	VOL_MOM	Adj-R^2
				-0.0213	0.0459
				(-4.58)	
0.0227	-0.0098			-0.0164	0.0524
(0.65)	(-1.04)			(-2.69)	
-0.0181		-0.0040	-0.0144	-0.0167	0.0557
(-0.41)		(-0.40)	(-1.46)	(-2.75)	

Panel B. Volatility of the FTSE All-Share

MKS	VOL	VOL(+)	VOL(-)	VOL_FTSE	Adj-R^2
				0.0021	-0.0017
				(-0.53)	
0.0257	-0.0251			0.0033	0.0362
(0.73)	(-3.06)			(0.77)	
-0.0113		-0.0198	-0.0291	-0.0006	0.0382
(-0.25)		(-2.19)	(-3.34)	(-0.59)	

Analysis of <u>Table 6 Panel B – Japan</u>

In Japan, we use the VXJ index that is about the volatility of the Japanese stock market at the time t+1 based on the Nikkei225 index.

In the first regression of Table 6 Panel B, when it was elaborated only with the index, there is no statistical significance. The same happens in other regressions, it always has no significance, however, the coefficient signal changes being negative in the first and fourth regression and positive in the second and third regression.

For the other VOL variable, it only has statistical significance at 1% in the third regression when we add the variables of the business cycle, the variables DIV and YLD also have significance, the first at 10% and the second at 1%, these continue in the fourth regression.

The variables VOL (+) and VOL (-) have statistical significance at 1% and volatility in negative markets is the most prevalent, with a coefficient of -0.0161 with a robust t-statistics of -2.28.

4.3 Sentiment Index

In the paper of Wang and Xu (2015), they used the Baker-Wurgler sentiment index, however, this index is not available neither for Japan nor for the United Kingdom. Given this situation and based on evidence from previous studies (Fisher and Statman, 2003; Schmeling, 2009), where they used Consumer Confident Index (CCI) as a sentiment index, I decided to do the same. CCI is an economic indicator made by The Conference Board, which assigns how optimistic or pessimistic consumers are about the expected financial situation.

Fisher and Statman (2003) found that consumer confidence " has some ability to predict stock market " and that

> " There is a negative relationship between the level of consumer confidence in one month and stock returns in the following month although that relationship is statistically significant " (Fisher and Statman 2003, p.11).

Analysis of <u>Table 5 Panel C - United Kingdom</u>

When analyzing CCI it was found that this has a negative correlation in the value of -0.4407 with volatility having a t-stats of 0.00 and a positive correlation predictive of 0.0128 with momentum payoff, which makes sense since the increase in the CCI means an optimistic increase on the part of people which leads to lower volatility and sometimes can even lead to an increase in investment.

At Table 5 Panel C, it can be noticed that when the regression is done only with CCI it has a very small positive coefficient of 0.0003 but has statistical significance at 5% with a robust t-statistics of 1.97.

However, when inserting MKS and VOL, CCI has no significance, which remains in the next regressions having a negative coefficient when inserting macroeconomic variables.

Only the variables related to volatility, as VOL, VOL(+), and VOL (-), are statistically significant, all of which are significant at 1%. As has already been seen in the other tables, volatility in a negative market state is always the one that has a higher robust t-statistics value having a greater impact on momentum payoff.

Analysis of <u>Table 6 Panel C – Japan</u>

The correlation between momentum payoff and CCI is 0.0623 and, the correlation between VOL and CCI is -0.5023 having a t-stats of 0.00. These values are much higher than the ones found for the UK.

As it can be seen in Table 6 Panel C, the CCI variable has no predictive power in the momentum payoff since none of the regressions are significant. The coefficient always has very low values and being only positive in the first regression and negative in the others. VOL, on the other hand, only has significance when variables related to business cycles are inserted, including DIV and YLD, which are always significant one at 10% and the other at 1% respectively.

In relation to VOL (+) and VOL (-) both have significance at 1% and VOL (-) is more predominant, with a coefficient of -0.0207 with a robust t-statistics of -2.46.

Table 5- Potential explanations: return dispersion, expected future market volatility, and investor sentiment for United Kingdom

The regression consists of $\gamma_{i,t} = \alpha_i + \beta x_{i,t-1} + \varepsilon_{i,t}$. These variables are applied to find out if the predictive power of market volatility on momentum payoff can be absorbed or it can change. The data that is used to compute the return dispersion is retrieved from the data library of Ken French that consists of the 25 size and book-to-market portfolios for Europe. RD_{1-3} is the three-month moving average of the cross-sectional standard deviation of the 25 portfolios return. VSTOXX is the expected future market volatility for the European stock market. For the sentiment index, we use the Consumer Confidence Index. All the other variables are the same presented in Table 3. The values shown are the coefficients of the variables, the robust t-statistics that are presented in parentheses, and adjusted R-squares.

Panel A. Return Dispersion

DIV	DEF	TERM	YLD	MKS	Vol	Vol+	Vol-	RD_{1-3}	Adj-R^2
								-0.0031	-0.0019
								(-0.53)	
				0.0441	-0.0353			0.0200	0.0532
				(1.20)	(-3.79)			(2.66)	
-0.0146	0.0047	-0.0029	-0.0039	0.0189	-0.0495			0.0012	0.0660
(-2.12)	(0.77)	(-0.41)	(-1.18)	(0.41)	(-3.28)			(2.94)	
-0.0123	0.0048	-0.0017	-0.0028			-0.0444	-0.0525	0.0011	0.0700
(-1.73)	(0.79)	(-0.24)	(-0.81)			(-2.85)	(-3.65)	(3.02)	

Panel B. Expected future market volatility

DIV	DEF	TERM	YLD	MKS	Vol	Vol+	Vol-	VSTOXX	Adj-R^2
								-0.0010	0.0277
								(-2.95)	
				0.0172	-0.0244			-0.003	0.0402
				(0.72)	(-2.11)			(-0.63)	
-0.0097	0.0048	-0.0013	-0.0017	-0.0058	-0.0309			-0.003	0.0374
(-1.38)	(0.74)	(-0.17)	(-0.45)	(-0.11)	(-1.92)			(-0.68)	
-0.0072	0.0042	0.0003	-0.0006			-0.0262	-0.0316	-0.003	0.0393
(-1.00)	(0.66)	(0.004)	(-0.15)			(-1.59)	(-2.03)	(-0.53)	

Panel C. Investor Sentiment

DIV	DEF	TERM	YLD	MKS	Vol	Vol+	Vol-	CCI	Adj-R^2
								0.0003	0.0068
								(1.97)	
				0.0256	-0.0214			0.0001	0.0354
				(0.72)	(-2.37)			(0.50)	
-0.0129	0.0025	-0.0008	-0.0018	-0.0097	-0.0371			-0.0003	0.0393
(-1.69)	(0.37)	(-0.11)	(-0.52)	(-0.19)	(-2.53)			(-0.86)	
-0.0098	0.0029	0.0002	-0.0009			-0.0318	-0.0361	-0.0002	0.0403
(-1.21)	(0.44)	(0.02)	(-0.28)			(-2.06)	(-2.68)	(-0.54)	

Table 6- Potential explanations: return dispersion, expected future market volatility, and investor sentiment for Japan

The regression consists of $\gamma_{i,t} = \alpha_i + \beta x_{i,t-1} + \varepsilon_{i,t}$. These variables are applied to find out if the predictive power of market volatility on momentum payoff can be absorbed or it can change. The data that is used to compute the return dispersion is retrieved from the data library of Ken French that consists of the 25 size and book-to-market portfolios for Japan market. $RD_{1\text{-}3}$ is the three-month moving average of the cross-sectional standard deviation of the 25 portfolios return. VXJ is the expected future market volatility for the Japanese stock market. For the sentiment index, we use the Consumer Confidence Index. All the other variables are the same as presented in Table 4. The values shown are the coefficients of the variables, the robust t-statistics that are presented in parentheses, and adjusted R-squares.

Panel A. Return Dispersion

DIV	TERM	YLD	MKS	Vol	Vol+	Vol-	$RD_{1\text{-}3}$	Adj-R^2
							-0.0093	-0.0012
							(-0.74)	
			0.0123	-0.0140			0.0035	0.0075
			(0.54)	(-1.80)			(0.24)	
-0.0080	0.0038	-0.0010	-0.0020	-0.0163			0.0025	0.0304
(-1.60)	(0.59)	(-2.35)	(-0.08)	(-1.92)			(0.04)	
-0.0086	0.0032	-0.0010			-0.0179	-0.0161	-0.0028	0.0310
(-1.72)	(0.50)	(-2.37)			(-1.98)	(-2.01)	(-0.05)	

Panel B. Expected future market volatility

DIV	TERM	YLD	MKS	Vol	Vol+	Vol-	VXJ	Adj-R^2
							-0.0046	-0.0025
							(-0.12)	
			0.0090	-0.0116			-0.0035	0.0043
			(0.40)	(-1.60)			(-0.00)	
-0.0091	0.0036	-0.0010	-0.0055	-0.0163			-0.0003	0.0314
(-1.72)	(0.58)	(-2.30)	(-0.21)	(-2.08)			(-0.58)	
-0.0097	0.0032	-0.0010			-0.0185	-0.0161	-0.0003	0.0323
(-1.85)	(0.51)	(-2.34)			(-2.13)	(-2.28)	(-0.66)	

Panel C. Investor Sentiment

DIV	TERM	YLD	MKS	Vol	Vol+	Vol-	CCI	Adj-R^2
							0.0005	-0.0002
							(0.95)	
			0.0129	-0.0126			-0.0003	0.0049
			(0.51)	(-1.66)			(-0.43)	
-0.0089	0.0043	-0.0011	0.0085	-0.0200			-0.0008	0.0338
(-1.77)	(0.68)	(-2.44)	(0.31)	(-2.31)			(-1.07)	
-0.0096	0.0032	-0.0011			-0.0219	-0.0207	-0.0007	0.0338
(-1.90)	(0.52)	(-2.44)			(-2.30)	(-2.46)	(-0.97)	

Does market volatility have predictive power for momentum returns?

4.4 Default Risk

From the previous tables, it was concluded that volatility in the negative market state has always more predictive power than volatility in the positive market state. This conclusion is in line with the result obtained from the paper of Wang and Xu (2015). Given this, I decided to do the same strategy from the previously mentioned paper, analyzing if the default risk has predictive power in the momentum payoff.

To calculate default risk, Altman's z-score method is going to be used. I decided to use the Altman's z-score method due to the fact that can be analyze by everyone, even by individuals who are not directly connected to the financial area. Altman's Z-score is based on five financial ratios that are account profitability, leverage, liquidity, solvency, and activity. These ratios were constructed by merging accounting stock for all firms in the two countries with the respective market data.

The Avg variable consists of the average of all z-scores of the companies at the time t. To test in positive and negative market states, it was created the variable AVG + (-) which will be equal to AVG if the lagged three-year market return is positive (negative) and 0 if not.

Analysis of United Kingdom

Following Agarwal and Taffler (2008) to the United Kingdom I decided to use a discriminant modeling approach:

$$Z = 3.20 + 12.18X_1 + 2.50X_2 - 10.68X_3 + 0.029X_4$$

In which:

- $X_1 = \frac{\text{EBIT}}{\text{Current Liabilities}}$
- $X_2 = \frac{\text{Current Assets}}{\text{Total Liabilities}}$
- $X_3 = \frac{\text{Current Liabilities}}{\text{Total assets}}$

- $X_4 = \frac{\text{quick assets} - \text{current liabilities}}{\text{sales} - \text{ebit} - \text{depreciation}/365}$

Description of the variables :

- EBIT- it is the earnings before interest and taxes.
- Current Liabilities – are the firm's debt or obligations that are due within a year.
- Current Assets- are all assets that the firm is expected to be sold or to be used as a result of the operations of the firm within a year.
- Total Liabilities– represents all short and long-term obligations estimated to be fulfilled by the firm.
- Total Assets- represents to the total amount of assets retained by a firm.
- Quick Assets- consist of cash and equivalents, marketable securities, and accounts receivable. (Quick assets = Current assets – Inventories)
- Depreciation- is the decrease in the monetary value of a real asset over time due to use.

I decided to use this model as it has been proven that it "dominates other naïve predictive approaches" (Agarwal and Taffler, 2007, p.1). In this model when Z>0 the company is not at risk of default but when Z<0 the risk of default is present.

For reasons of lack of data, we use the companies that are in the FTSE 100. This index represents 100 corporations that are in the London exchange market with the uppermost market capitalization. The data collected starts in May 1990 and ends in October 2021. On average, in this period, 158 months are in the risk zone and, 219 are not.

As it can be seen in Table 8 Panel A, the correlation between volatility and average, regardless of market state, is always positive and the correlation between VOL (-) and AVG (-) is 0.1487 higher than the correlation between VOL (+) and AVG (+) which is 0.1137.

The Variable AVG never has statistical significance and always presents a robust t-statistics very low. Although, AVG in the negative market state has no significance, it is the variable that has a higher value of robust t-statistics of -1.31. Despite this, it cannot be said that it has predictive power in the momentum payoff.

Does market volatility have predictive power for momentum returns?

When testing the predictive power of the variables in up and down markets, very similar results were achieved. In Table 9 Panel A section I, up market, when the regression is done only with the variables MKS, VOL and business cycle, the variables DIV and VOL both have statistical significance at 1%. When AVG is included, the same occurs. The only difference is that in DIV the robust t-statistics increases to a value of -2.86, and with the VOL this value decreases to -2.61, however, AVG still has no statistical significance.

In Table 9 Panel A section II, in a down market, neither in the first nor in the second regression there is a variable with statistical significance. This may be a consequence of existing very few months in negative market states and having a smaller timeline.

Analysis of Japan

In relation to Japan, Altman's original Z-score method was used for companies present in the Nikkei 223 stock average index. In this case, the timeline is the same as the last tables beginning in January 1987 and ending in September 2021.

The original z-score formula consists of:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5$$

In which:

- $\mathrm{X}_1 = \frac{\text{Working Capital}}{\text{Total Assets}}$
- $\mathrm{X}_2 = \frac{\text{Retained } Earnings}{\text{Total Assets}}$
- $\mathrm{X}_3 = \frac{\text{EBIT}}{\text{Total assets}}$
- $\mathrm{X}_4 = \frac{\text{Market } value\ of\ equity}{\text{total Liabilities}}$
- $X_5 = \frac{Sales}{Total\ Assets}$

Description of the variables :

- Total Assets, EBIT and Total Liabilities are the same as previously mentioned.
- Working Capital- is the difference between current assets and current liabilities.
- Retained Earnings- consist of the profits that are not distributed to shareholders as dividends and instead are used to reinvest in the business.
- Market Value of Equity- is calculated by multiplying the total number of shares outstanding by the market price of a firm's stock

In this model there are three distinct zones, the 1st occurs when $Z > 2.99$ which is considered the safe zone; the 2nd is when $1.81 < Z < 2.99$ is considered the Gray Zone and the 3rd is when $Z < 1.81$ which is the Distress Zone, the most problematic zone. In our data, there are 194 months in the safe zone, 417 in the gray zone, and 0 in the "Distress Zone".

As it can be observed in Table 8 Panel B, the correlation between AVG and VOL is negative with a very small value of -0.0524. However, the correlation between AVG (+) and VOL (+) and between AVG (-) and VOL (-) is already positive and quite high, being the last one, the highest with a value of 0.9722.

When elaborating the regressions to analyze if the average has predictive power, it was detected that none of these regressions has statistical significance as it can be perceived through the negative values of adjusted R-squared of -0.0012 in the first regression and -0.0030 in the second one.

In Table 9 Panel B the regressions are divided into up and down markets. In section I, up market, in the two regressions, the only variable that is statistically significant is the YLD at 1%. In section II, down market, volatility has statistical significance at 10%. However, when the variable AVG is included, although this is not significant, volatility loses its significance having only a robust t- statistics of -1.70.

Table 8- Z-score probabilities of bankruptcy

Panel A-United Kingdom.

The regression consists of $\gamma_{i,t} = \alpha_i + \beta x_{i,t-1} + \varepsilon_{i,t}$. We employ the alternation model of the z-score of Altman for the United Kingdom economy to calculate the probability of defaults of the companies. The regressor Avg is the average of the z-score probability across all companies at time t presented in the FTSE 100. Avg + (-) is equal to Avg if the lagged three-year market return is positive (negative) and 0 if not. The values shown are the coefficients of the variables, the robust t-statistics that are presented in parentheses, and adjusted R-squares.

Corr(Avg,Vol) = 0.1288			
Corr(Avg+,Vol+) = 0.1137			
Corr(Avg-,Vol-) = 0.2624			
Avg	Avg+	Avg-	Adj-R^2
-0.0097 (-0.35)			-0.0023
	-0.0051 (-0.18)	-0.0029 (-1.31)	-0.0006

Panel B- Japan

The regression consists of $\gamma_{i,t} = \alpha_i + \beta x_{i,t-1} + \varepsilon_{i,t}$. We employ the model of the z-score of Altman for the Japanese economy to calculate the probability of defaults of the companies. The regressor Avg is the average of the z-score probability across all companies at time t presented in the Nikkei 223 stock average. Avg + (-) is equal to Avg if the lagged three-year market return is positive (negative) and 0 if not. The values shown are the coefficients of the variables, the robust t-statistics that are presented in parentheses, and adjusted R-squares.

Corr(Avg,Vol) = -0.0524			
Corr(Avg+,Vol+) = 0.8272			
Corr(Avg-,Vol-) = 0.9722			
Avg	Avg+	Avg-	Adj-R^2
0.0017 (0.72)			-0.0012
	0.0013 (0.51)	0.0003 (0.09)	-0.0030

Table 9 – Predictive power of Z-score probabilities in UP and DOWN markets

In this table, we regress momentum profit on the market state (MKS), market volatility (VOL), economics variables (DIV, DEF, TERM, and YLD), and default probability measure (Avg) The regressors are all the same in the prior tables such as Table 3 and Table 4. We define a market to be in UP (Down) if the lagged six-month market return is Positive (Negative). The values shown are the coefficients of the variables, the robust t-statistics that are presented in parentheses, and adjusted R-squares.

Panel A- United Kingdom

DIV	DEF	TERM	YLD	MKS	Vol	Avg	Adj-R^2
Section I. UP market							
-0.0221	-0.0054	-0.0059	-0.0061	0.0467	-0.0437		0.1231
(-2.55)	(0.76)	(-0.01)	(-1.55)	(0.86)	(-2.86)		
-0.0234	0.0046	0.0008	-0.0050	0.0574	-0.0406	0.0007	0.1232
(-2.86)	(0.64)	(0.09)	(-1.24)	(1.04)	(-2.61)	(1.01)	
Section II. DOWN market							
-0.0028	-0.0020	-0.0024	0.0016	-0.0486	-0.0167		-0.0340
(-0.20)	(-0.15)	(-0.17)	(0.25)	(-0.55)	(-0.36)		
-0.0071	-0.0036	-0.0050	0.0028	-0.0301	-0.0072	0.0027	-0.0290
(-0.50)	(-0.26)	(-0.35)	(0.43)	(-0.33)	(-0.15)	(1.17)	

Panel B- Japan

DIV	TERM	YLD	MKS	Vol	Avg	Adj-R^2
Section I. UP market						
-0.0105	0.0110	-0.0011	-0.0106	-0.0181		0.0712
(-1.54)	(1.34)	(-2.61)	(-0.31)	(-1.58)		
-0.0106	0.0108	-0.0011	-0.0104	-0.0179	-0.0002	0.0656
(-1.44)	(1.21)	(-2.60)	(-0.30)	(-1.55)	(-0.05)	
Section II. DOWN market						
-0.0073	-0.0068	-0.0055	-0.0054	-0.0212		0.0045
(-0.98)	(-0.66)	(-0.64)	(-0.13)	(-1.87)		
-0.0081	-0.0089	-0.0063	0.0030	-0.01999	-0.0042	-0.0006
(-1.06)	(-0.79)	(-0.72)	(0.07)	(-1.70)	(-0.50)	

5. Conclusion

The paper "Market volatility and momentum" by Kevin Q. Wang and Jianguo Xu (2015) discovered that market volatility has predictive power in the momentum payoff for the United States, taking that into account I decided to replicate their study to see if the same happens in other countries.

The construction of this paper aimed to verify whether market volatility helps predict the profit of the momentum strategy in a country where this strategy works and a country where it does not, United Kingdom and Japan. At the same time, it is intended to ascertain whether this predictive power is robust to controlling for macroeconomic variables. Another aspect to examine is whether the variables return dispersion, expected future volatility, sentiment index and default risk also help to predict momentum profit and if changes in the predictive power of market volatility can occur.

Regarding the analysis carried out for both countries it was concluded that there are common aspects, namely, the period with higher volatility has less profit than periods with low volatility; the market state never has statistical significance, and volatility in negative market states always has more impact than volatility in positive market states.

Alongside the common conclusions, there are also differences. In the UK the most recent period is the one that has the highest profit, which is not the case in Japan. Market volatility in the UK always has a negative significant impact; in Japan, this only happens when you change the time window to six months or when you enter the macroeconomic variables.

Regarding the analysis of the variables return dispersion, expected future volatility, index sentiment, and default risk, it was observed that the discrepancies are not so notorious. The return dispersion does not take away the predictive power of volatility-related variables in any of the countries, however, in the UK, the variable is significant and in Japan, it is not. Regarding to the expected future volatility variable the opposite happens, it has no statistical significance in neither countries. Nevertheless, Vstoxx in the UK takes away the power of volatility in positive market states. In the index sentiment variable, it is confirmed in both countries that it has no significance nor removes the predictive power from volatility. To conclude the default risk proxies in down markets remove the predictive power of market volatility but only in Japan.

An interesting conclusion, that it was obtained from the other variables related to volatility in United Kingdom is that the volatility of momentum, apparently, also subsumes the effect of market volatility. This confirms the conditional variable "realized volatility of momentum" proposed in Barroso and Santa-Clara (2015).

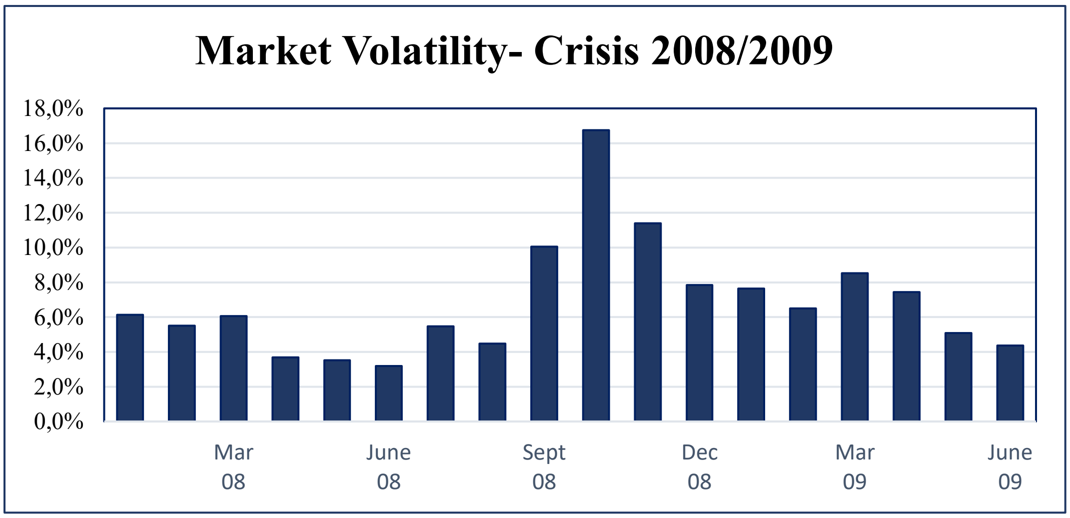
To finalize this paper, I decided to suggest some extensions for future study. One of the suggestions is expanding for other countries since few things can be concluded using only these two. Another one is using alternative forms of momentum, as industry momentum or 52-week-high (Barroso and Wang, 2021).

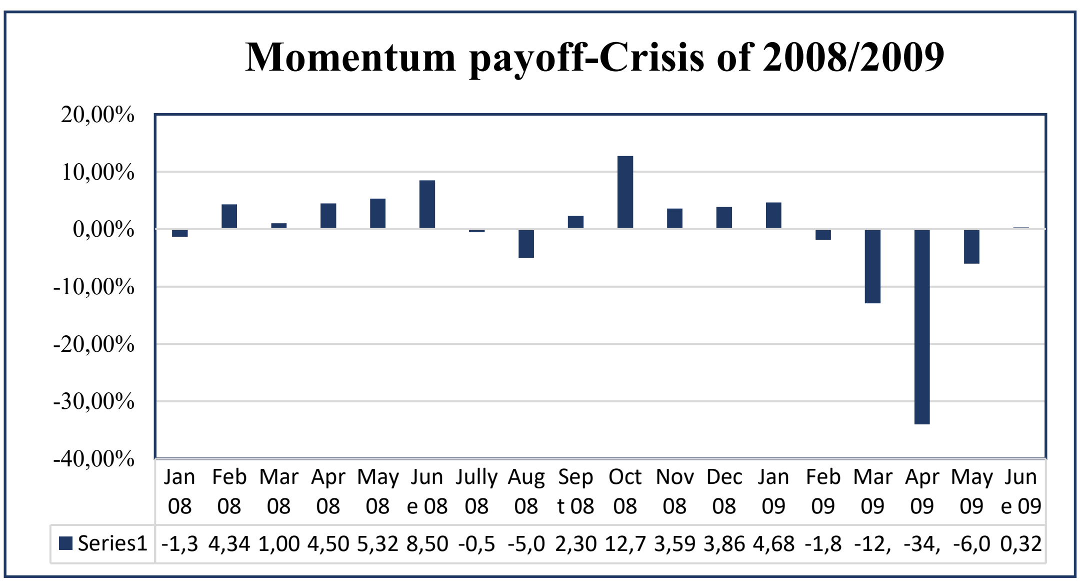
Appendix

Figure 1 – Market volatility and momentum payoff in the periods of financial crisis for United Kingdom.

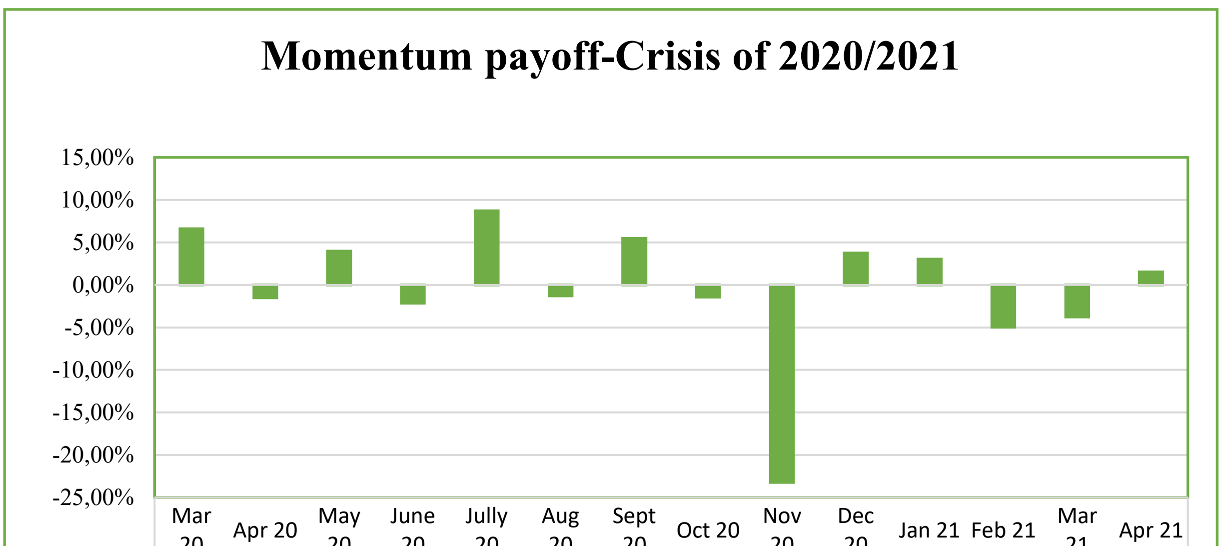
The monthly market volatility annualized is the standard deviation of daily market return multiplied by the square root of twelve and the monthly momentum payoff is retrieved from the AQR Library that consists of the difference between the average return of the two high return portfolios and the two low return portfolios. The momentum factor is value weighted. Panel A represents the market volatility and the momentum payoff for 2008/2009 and in Panel B for 2021/2021.

Panel A)





Panel B)

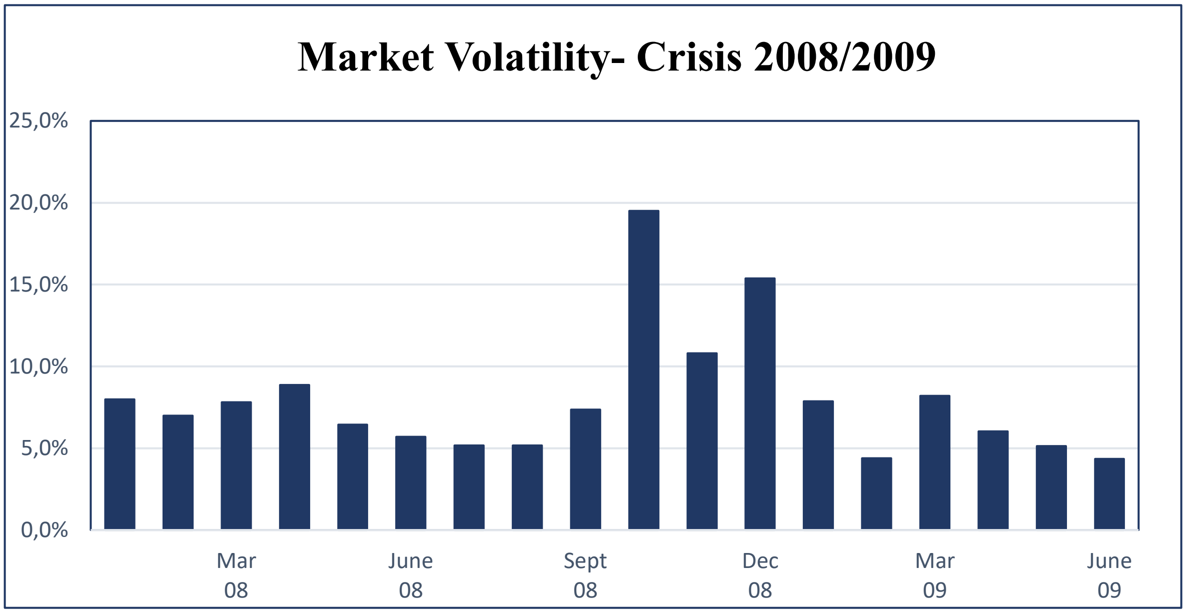


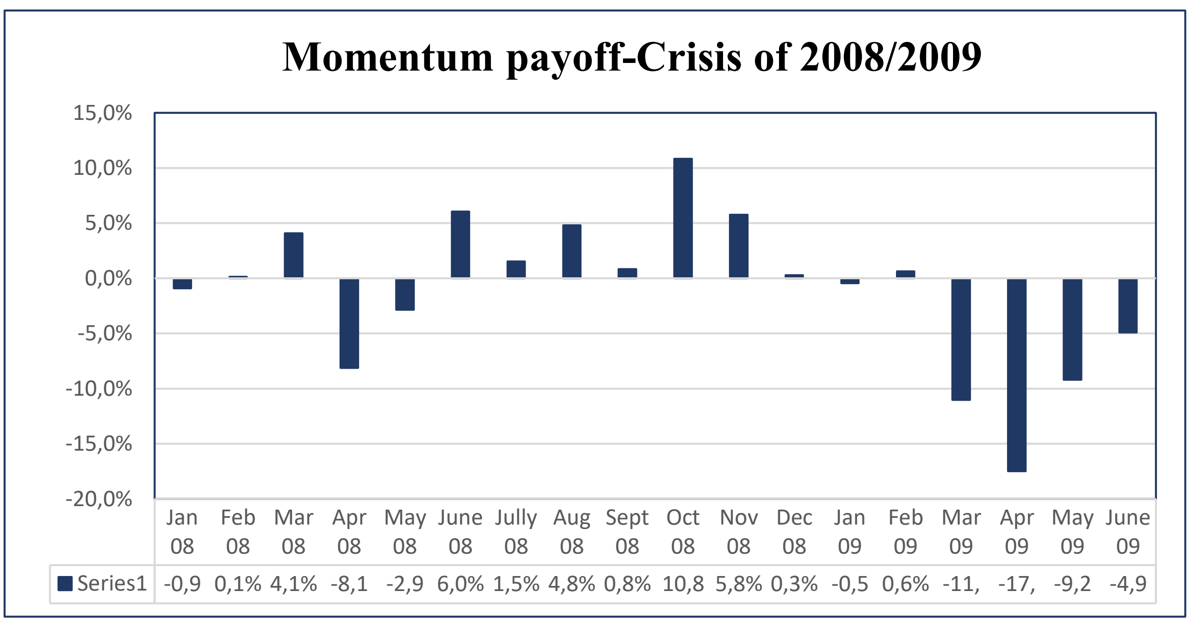
	Mar 20	Apr 20	May 20	June 20	Jully 20	Aug 20	Sept 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21
Series1	6,62%	-1,52%	3,97%	-2,17%	8,72%	-1,28%	5,47%	-1,43%	-23,23	3,75%	3,02%	-4,99%	-3,77%	1,53%

Figure 2 – Market volatility and momentum payoff in the periods of financial crisis for Japan.

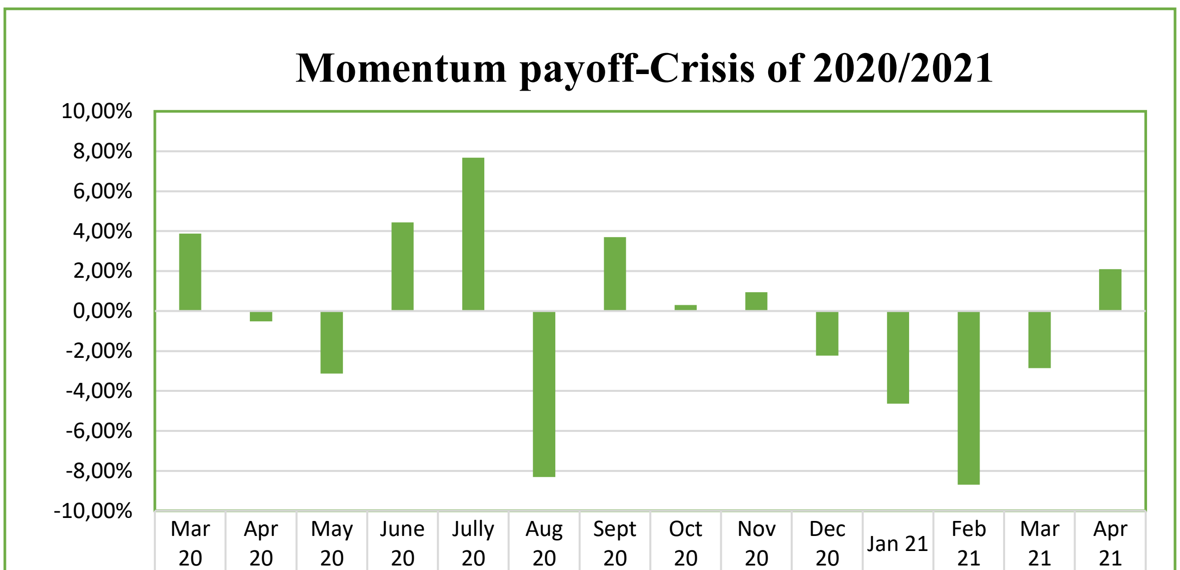
The monthly market volatility annualized is the standard deviation of daily market return multiplied by the square root of twelve and the monthly momentum payoff is retrieved from the AQR Library that consists of the difference between the average return of the two high return portfolios and the two low return portfolios. The momentum factor is value weighted. Panel A represents the market volatility and the momentum payoff for 2008/2009 and in Panel B for 2021/2021.

Panel A)





Panel B)

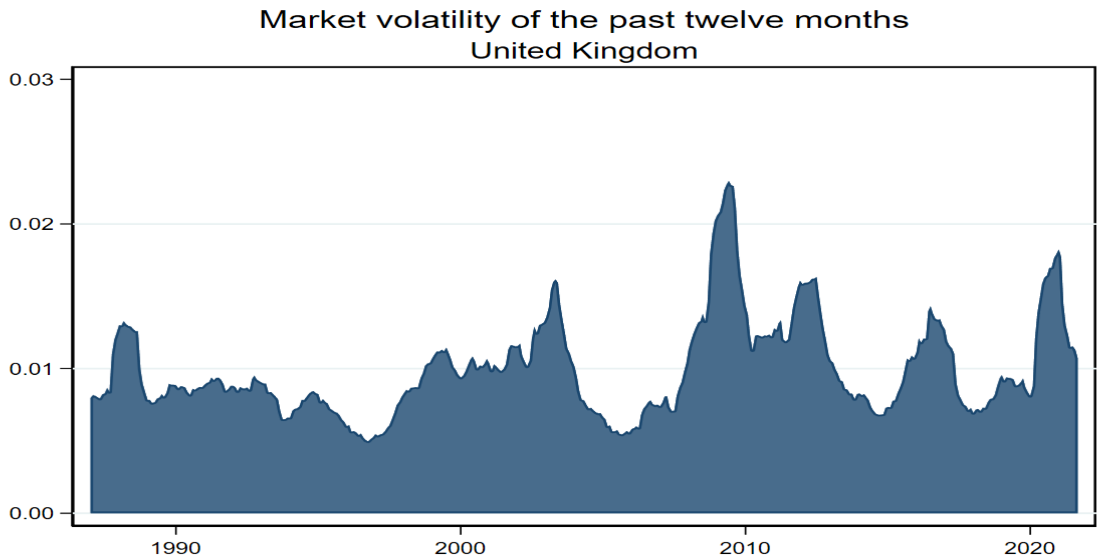


	Mar 20	Apr 20	May 20	June 20	Jully 20	Aug 20	Sept 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21
Series1	3,88%	-0,52%	-3,13%	4,45%	7,67%	-8,31%	3,70%	0,30%	0,94%	-2,24%	-4,64%	-8,70%	-2,86%	2,10%

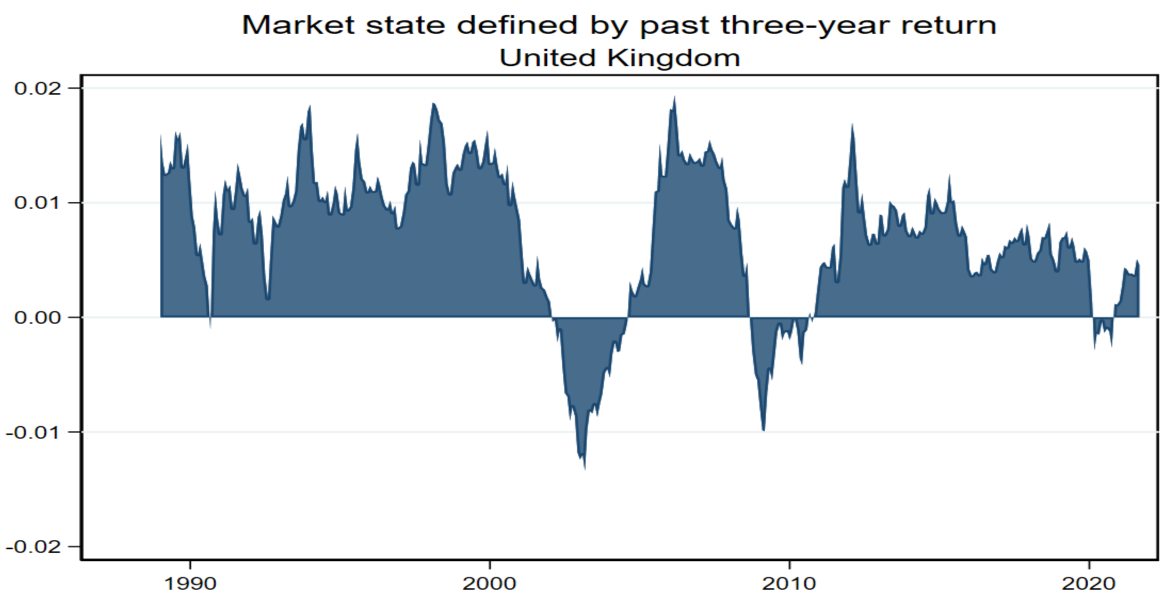
Figure 3 – United Kingdom

It is represented the market state and market volatility. In Panel A, market volatility is the standard deviation of daily market return in the last twelve months. In Panel B, market state is the lagged three-year market return, and it is calculated using the monthly average. In Panel C is the market state lagged six-month market return.

Panel a)



Panel b)



Panel c)

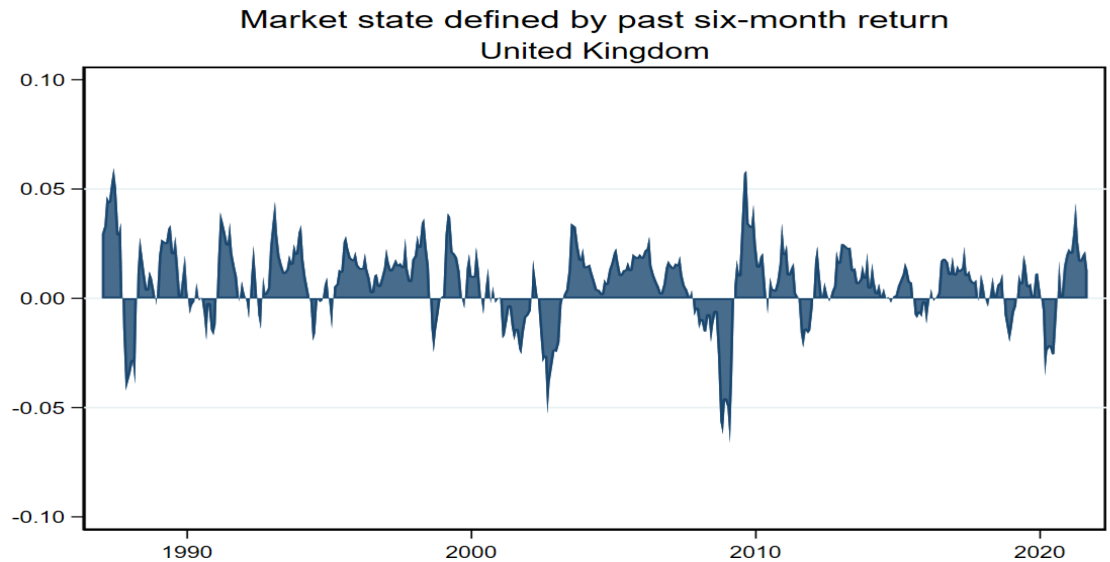
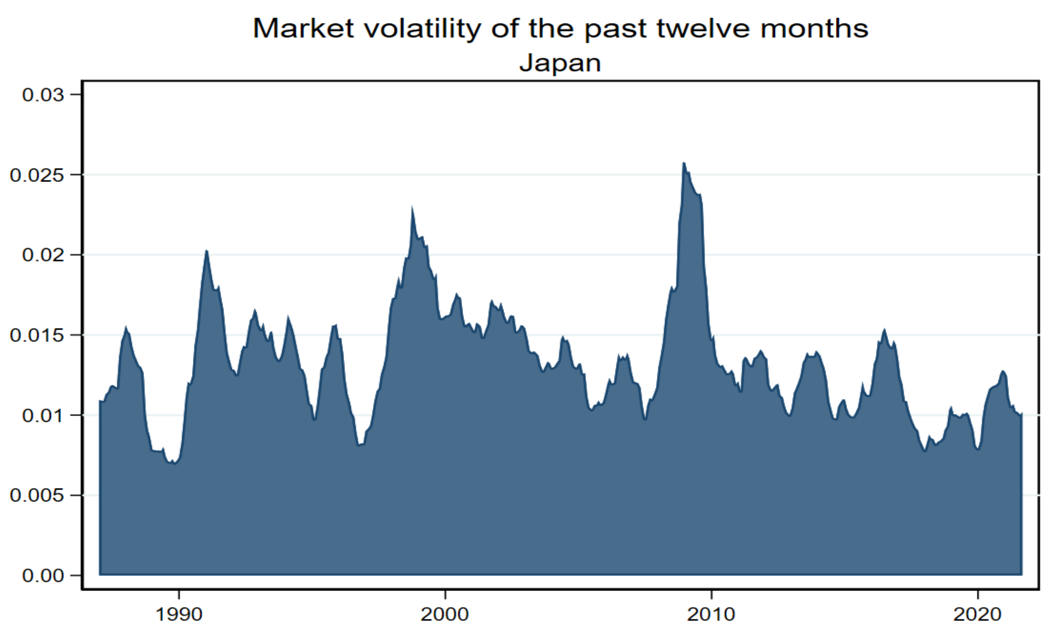


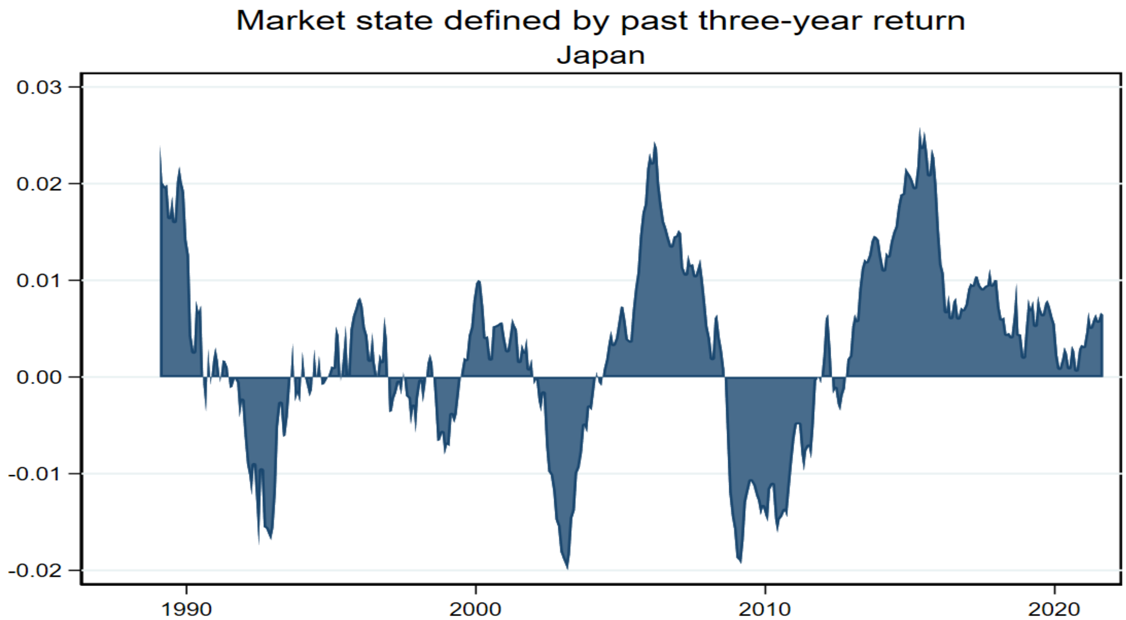
Figure 4 – Japan

It is represented the market state and market volatility. In Panel A, market volatility is the standard deviation of daily market return in the last twelve months. In Panel B, market state is the lagged three-year market return, and it is calculated using the monthly average. In Panel C is the market state lagged six-month market return.

Panel a)



Panel b)



Panel c)

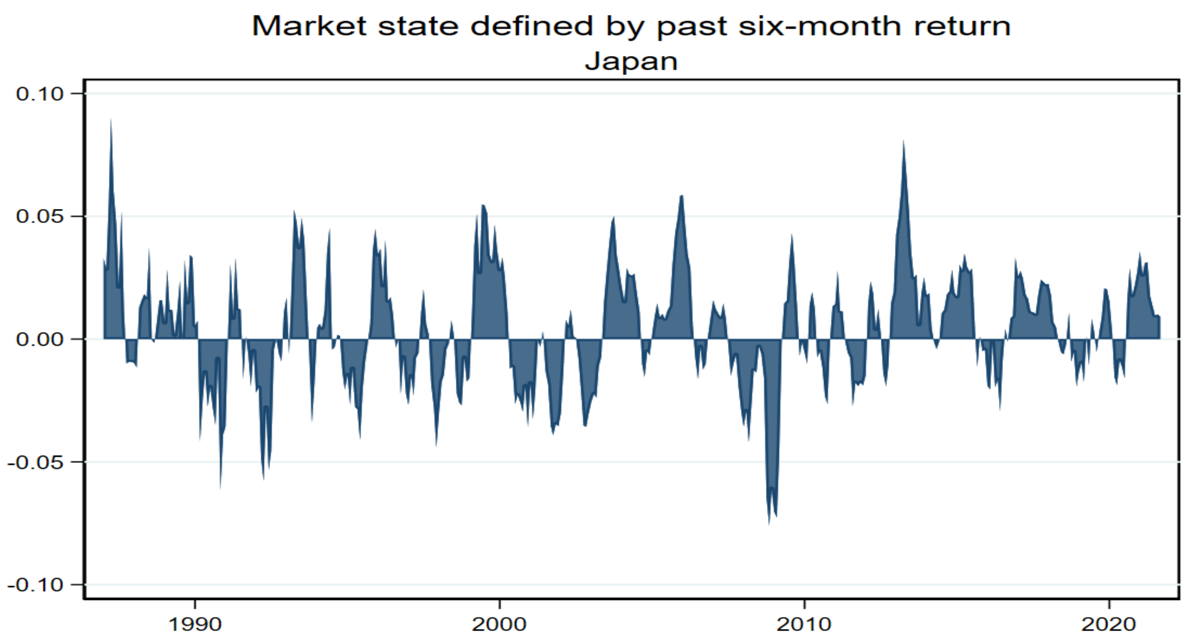


Table 10- Potential explanations: return dispersion, expected future market volatility for European market

The regression consists of $\gamma_{i,t} = \alpha_i + \beta x_{i,t-1} + \varepsilon_{i,t}$. MKS_Euro consists of the lagged three-year market return in annual terms. Vol_Euro is the lagged twelve-month market volatility presented in percentage. Vol_Euro + (-) is equal to Vol_Euro if the MKS_Euro is positive (negative) and equal to 0 otherwise. These variables are applied to find out if the predictive power of market volatility on momentum payoff can be absorbed or it can change. The return dispersion is retrieved from the data library of Ken French that consists of the 25 size and book-to-market portfolios for Europe. $RD_{1\text{-}3}$ is the three-month moving average of the cross-sectional standard deviation of the 25 portfolios return. VSTOXX is the expected future market volatility for the European stock market. The values shown are the coefficients of the variables, the robust t-statistics that are presented in parentheses, and adjusted R-squares.

Panel A. Return Dispersion

MKS_Euro	VOL_EURO	VOL_EURO(+)	VOL_EURO (-)	$RD_{1\text{-}3}$	Adj-R^2
				-0.0045	-0.0006
				(-0.88)	
0.0276	-0.0114			0.0049	0.0160
(1.20)	(-2.14)			(0.81)	
0.0089		-0.0083	-0.0139	0.0060	0.0172
(0.32)		(-1.41)	(-2.43)	(0.99)	

Panel B. Expected future market volatility

MKS_Euro	VOL_EURO	VOL_EURO(+)	VOL_EURO (-)	VSTOXX	Adj-R^2
				-0.0009	0.0261
				(-2.88)	
0.0063	-0.0081			-0.0006	0.0256
(0.22)	(-1.24)			(-1.68)	
-0.0108		-0.0052	-0.0097	-0.0006	0.0242
(-0.30)		(-0.70)	(-1.42)	(-1.59)	

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