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On the predictive ability of conditional market skewness

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ON THE PREDICTIVE ABILITY OF CONDITIONAL MARKET SKEWNESS[1]

ABSTRACT

This study analyzes the capacity of conditional market skewness to predict future market returns over a recent period of time, which contains the last two major market crises: the financial crisis of 2008 and the COVID-19 pandemic in 2020. The results show that conditional market skewness performs well in terms of predicting future S&P 500, Nasdaq Composite and EUR/USD returns, even after controlling for business cycle fluctuations. However, contrary to what is expected, it is found that during this period containing two major financial crises, the relationship between conditional market asymmetry and future returns is positive. The rationale behind this finding is that during periods with major crises, when large drops in asset prices that sharply reduce market asymmetry occur, many investors find prices attractive, increasing buying pressure and thus reducing market returns in the next period.

Keywords: market return predictions, conditional skewness, sample skewness, conditional variance, sample variance.

JEL Classification: G11, G12, G14, G17

RESUMEN

En este trabajo se analiza la capacidad predictiva de la asimetría del mercado sobre los rendimientos futuros del mismo durante un periodo de tiempo renciente, que contiene dos grandes crisis: la crisis financiera de 2008 y la crisis provocada por la pandemia COVID-19 en 2020. Los resultados muestran que la asimetría condicional del mercado se comporta bien en términos de predicción de las rentabiliades futuras de los índices S&P 500 y Nasdaq Composite, así del tipo de cambio EUR/USD, incluso después de controlar por las fluctuaciones debidas al ciclo económico. Sin embargo, al contrario de lo que se esperaría, la relación entre la asimetría condicional del mercado y los rendimientos futuros del mismo es positiva. Esto se debe a que durante periodos de grandes crisis, cuando se producen grandes caídas en los precios de los activos que reducen drásticamente la asimetría del mercado, muchos inversores encuentran los precios atractivos, aumentando la presión de compra y por lo tanto reduciendo la rentabilidad del mercado en el siguiente periodo.

Palabras clave: precidcciones de la rentabilidad del mercado, asimetría condicional, asimetría muestral, varianza condicional, varianza muestral.

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1. INTRODUCTION

The tree-moment-based CAPM (Kraus and Litzenberger, 1976; Simaan, 1993; Harvey and Siddique, 2000) incorporates skewness into asset valuation. However, although there are several empirical studies confirming the capacity of individual skewness to predict future individual stock returns (Boyer et al, 2010; Conrad et al., 2013; Amaya et al., 2015), no conclusive evidence has been found in the literature regarding the capacity of market skewness to predict future market returns (Chang et al., 2011; Jondeau et al., 2019).

Jondeau et al. (2019) found evidence supporting the capacity of average skewness in individual stock returns to predict subsequent market returns. However, market skewness was found to be a weak predictor of subsequent market returns. According to these authors, the capacity of skewness to predict future market returns can be explained as follows. Investors seem to prefer stocks with positive skewness (Scott and Horvath, 1980); therefore, stocks with positive skewness tend to be overpriced and to have negative expected returns in the next period. Thus, a negative relationship should be found between average skewness and future market returns, i.e., the higher the average skewness in a given month, the lower the market return in the following month should be.

In this study, the role of market skewness as a predictor of future market returns is investigated. However, in contrast to Jondeau et al. (2019), who estimate market skewness as the sample skewness of market excess returns, in this paper, market skewness is estimated by means of a GARCH-type model considering conditional variance and skewness. As explained in Section 2, sample skewness exhibits a much more parsimonious evolution trend than conditional skewness, implying that conditional skewness responds much more quickly to changes in market excess returns. Furthermore, we use a recent period of time containing the last two major market crises: the financial crisis of 2008 and the COVID-19 pandemic in 2020.

The results show that conditional market skewness performs well in terms of predicting future S&P 500, Nasdaq Composite and EUR/USD returns, even after controlling for business cycle fluctuations. However, contrary to what is expected, a positive relationship is found between conditional market skewness and future market returns. The rationale behind this finding is that during periods of crisis, such as the financial crisis of 2008 and the COVID-19 crisis of 2020, when there is a large fall in the price of

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an asset, which increases asymmetry (in terms of absolute value, although the value of the coefficient of skewness becomes more negative), many investors find prices attractive, increasing buying pressure and thus reducing market returns in the next month.

The remainder of this paper is organized as follows. The next section presents a summary of the data series employed, as well as the estimation process for conditional and sample skewness. Section 3 presents the results of the designed regression models for predicting future market returns. Finally, Section 4 concludes with a summary and discussion.

2. DATA AND CONDITIONAL AND SAMPLE SKEWNESS

The examined sample is composed of monthly prices from the S&P 500 and Nasdaq Composite indices, as well as the EUR/USD exchange rate, during the period ranging from January 1990 to October 2020 (370 monthly observations). The conditional and sample skewness are estimated using a rolling window of 200 months so that the out-of-sample period contains the last 170 observations (from September 2006 to October 2020). Some descriptive statistics for the three excess return series over the risk-free rate, proxied by one-month Treasury bill rates[2], for the whole period and for the out-of-sample period are contained in Table 1. The three series exhibit negative skewness and excess kurtosis. Figure 1 shows the time series evolution of the monthly excess returns for the whole sample period.

Two measures of market skewness are obtained as predictors for one-month-ahead market excess returns. The first measure is the sample skewness, which is estimated with a rolling window of the 200 previous monthly returns. Together with the sample skewness, the sample variance of the market excess returns is estimated.

Let $R_{m,t}$ and $R_{f,t}$ be the market return and the risk-free rate in month t. Thus, the market excess return in month t is $r_{m,t} = R_{m,t} - R_{f,t\text{-}1}$. The sample variance and skewness in month t can be computed as:

$$h_{s,t} = \frac{1}{200}\sum_{i=t-1}^{t-200}\left(r_{m,i} - \bar{r}_{m,t}\right)^2, sk_{s,t} = \frac{1}{200}\sum_{i=t-1}^{t-200}\left(\frac{r_{m,i}-\bar{r}_{m,i}}{\sigma_{m,t}}\right)^3$$

where $\bar{r}_{m,t}$ and $\sigma_{m,t}$ are the average excess market return and volatility in month t, which are calculated as the sample average and the sample

[2] Treasury bill rates have been obtained from the Federal Reserve Bank of St. Louis web page.

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standard deviation of the previous 200 monthly excess returns, respectively.

In this way, 170 monthly estimations of sample variance and skewness are obtained for each month from September 2006 to October 2020.

In addition to these sample measures of market variance and skewness, conditional estimations of both moments are obtained based on the GARCHS model proposed by Leon et al. (2005)[3]:

$$r_{m,t} = \varepsilon_t;\ \varepsilon_t|I_{t-1} \sim GT\left(0, h_{c,t}\right);\ \eta_t = \varepsilon_t h_{c,t}^{1/2}$$
$$h_{c,t} = \beta_0 + \beta_1 \varepsilon_{t-1}^2 + \beta_2 h_{c,t-1}$$
$$sk_{c,t} = \gamma_0 + \gamma_1 \eta_{t-1}^2 + \gamma_2 sk_{c,t-1}$$

where $I_{t\text{-}1}$ is an information set covering the period until t -1, *GT* is the distribution proposed by Gallant and Tauchen (1989), which is based on a Gram-Charlier series expansion of the normal density function truncated at the fourth moment, $h_{c,t} = var(r_{m,t}|I_{t-1})$ and $sk_{c,t} = skewness(\eta_t|I_{t-1})$.

For each month t from September 2006 to October 2020, this GARCHS model is estimated by maximum likelihood with a rolling window containing the 200 previous monthly excess returns[4]. Based on this rolling window, we can obtain one-month-ahead estimations of the conditional variance and skewness ($h_{c,t}$ and $sk_{c,t}$, respectively). The results of the estimations output by the GARCHS model for the first rolling window (January 1990 to August 2006) for the three financial series of excess returns are shown in Table 2. Although some of the parameters in the skewness equation are not significant, the autoregressive parameter (γ_2) is always significant, implying a significant presence of conditional skewness and suggesting that days with high skewness are followed by additional days with high skewness (γ_2 is positive). Table 3 contains the means and the standard deviations of the estimated parameters for the 170 rolling windows.

Figure 2 shows the time series evolution of the 170 variance and skewness rolling window estimations from September 2006 to October 2020. It is worth noting that the sample variance and skewness exhibit much more parsimonious evolutions than the corresponding conditional moments, implying that the conditional moments respond much more quickly to changes in the monthly excess returns[5]. It is also interesting to observe the two peaks shown in the conditional variance plots (corresponding to the 2008 financial crisis and the 2020 COVID-19 pandemic), especially for

[3] Here, we use a reduced version of the original GARCHSK model proposed by Leon et al. (2005) with constant kurtosis; we call this the GARCHS model.
[4] See Leon et al. (2005) for details about the log-likelihood function.
[5] Kim and White (2004) and Bonato (2011) show that the standard skewness and kurtosis measures may not properly describe the behavior of market returns.

the cases of the S&P 500 and Nasdaq Composite indices. These two peaks are not adequately captured by the sample variance. Furthermore, it is quite striking to observe the exaggerated response shown by the conditional skewness to the first crisis in terms of the two market indices, while the response to the second crisis is much more moderated. The graphs of the sample skewness also show some peaks, but unlike what happens in the conditional case, the sample skewness recovers to the original values slowly.

3. REGRESSION MODELS FOR PREDICTING FUTURE MARKET RETURNS

In this section, we investigate the abilities of conditional and sample variance and skewness to predict one-month-ahead market returns. This is done in a regression context, as in Jondeau et al. (2019):

$$r_{m,t} = a + b \cdot h_{c,t} + c \cdot sk_{c,t} + d \cdot h_{s,t} + e \cdot sk_{s,t} + \varepsilon_t$$

where, as defined above, $r_{m,t}$ is the market excess return over the risk-free rate in month t, $h_{c,t}$ and $sk_{c,t}$ are one-month-ahead estimations of the conditional variance and skewness in month t (estimated with the GARCHS model and with a rolling window from t – 1 to t – 200 market excess returns), and $h_{s,t}$ and $sk_{s,t}$ are one-month-ahead estimations of the variance and skewness in month t, which are estimated as the sample variance and skewness with a rolling window from t – 1 to t – 200 market excess returns. In all regressions below, the p-values are estimated based on Newey-West heteroskedasticity and autocorrelation-consistent standard errors.

Table 4 shows the results of the regressions of the three series of excess returns on the conditional and sample variances and skewness estimated using a rolling window containing the 200 previous observations, as well as on the first lag of the excess return. The results show that conditional market skewness is highly significant in all cases (at a 1% significance level). Moreover, conditional market skewness shows a positive relationship with the market excess return. The conditional and sample variances are weakly significant in the cases of the S&P 500 and Nasdaq composite indices. However, as found in previous studies, sample market skewness is not significant (Jondeau et al., 2019) except in the case of the EUR/USD exchange rate. The adjusted R^2 coefficient from this regression model ranges from 4.6% to 7.6%.

However, it is necessary to control for business cycle fluctuations because it could be the case that the ability of conditional market skewness to predict one-month-ahead excess market returns is due to its relationships with other variables related to the business cycle (Goyal and Santa Clara, 2003 and Jondeau et al., 2019). In the cases of the S&P 500 and Nasdaq Composite excess returns, these control variables are the relative three-month Treasury bill rate (*RREL*), calculated as the current Treasury bill rate minus its 12-month backward-moving average; the term spread (*TERM*), calculated as the 10-year Treasury bond yield minus the 3-year Treasury bond yield; the default spread (*DEF*), calculated as the yield of Moody's Baa corporate bond minus the 10-year Treasury bond yield; and the dividend-price ratio (*DP*), calculated as the log of the ratio of the dividends over the last 12 months to the current market index. In the case involving the EUR/USD excess returns, the control variables are *RREL*, *TERM*, *DEF*, the US 10-year/Germany 10-year government bond spread (10*YGB*) and the US/Germany inflation spread (*INF*)[6].

The results of the regression estimates obtained while including these control variables are shown in Table 5. Although the conditional and sample variances and sample skewness, as well as some control variables (mostly in the case of the S&P 500 excess returns), are significant in some cases, it is quite striking to observe how conditional skewness is still significant in all cases (at 5% in the case of the S&P 500 and at 1% in the Nasdaq Composite and EUR/USD cases) after including the control variables described above in the regression model. Furthermore, contrary to what is expected, a positive relationship is found between conditional skewness and future market returns. As stated in the introduction, the rationale behind this finding is that during periods of major crises, when there is a large drop in the price of an asset (which makes asymmetry large and negative), many investors find prices attractive, increasing buying pressure and thus reducing market returns in the next month.

4. CONCLUSIONS

In this paper, we investigate the relationship between conditional market skewness and future market excess returns. Contrary to previous studies, where no relationship was found between future market excess returns and sample market skewness, in this study, market skewness is estimated by means of a GARCH-type model for conditional variance and skewness, and it was found that conditional market skewness performs well in terms of predicting future market excess returns. The superiority of conditional skewness over sample skewness is derived from the fact that conditional skewness responds much more quickly to changes in market excess returns. Furthermore, it is found that during periods of major crises, the relationship between

[6] Rossi (2013).

future market excess returns and conditional market skewness is positive. This fact has important implications in terms of asset allocation, which will be the subject of future research.

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ANNEX

Figure 1

Time Evolution of Excess Returns

This figure shows the time series evolution of the three series of monthly excess returns over the risk-free rate, during the period ranging from January 1990 to October 2020.

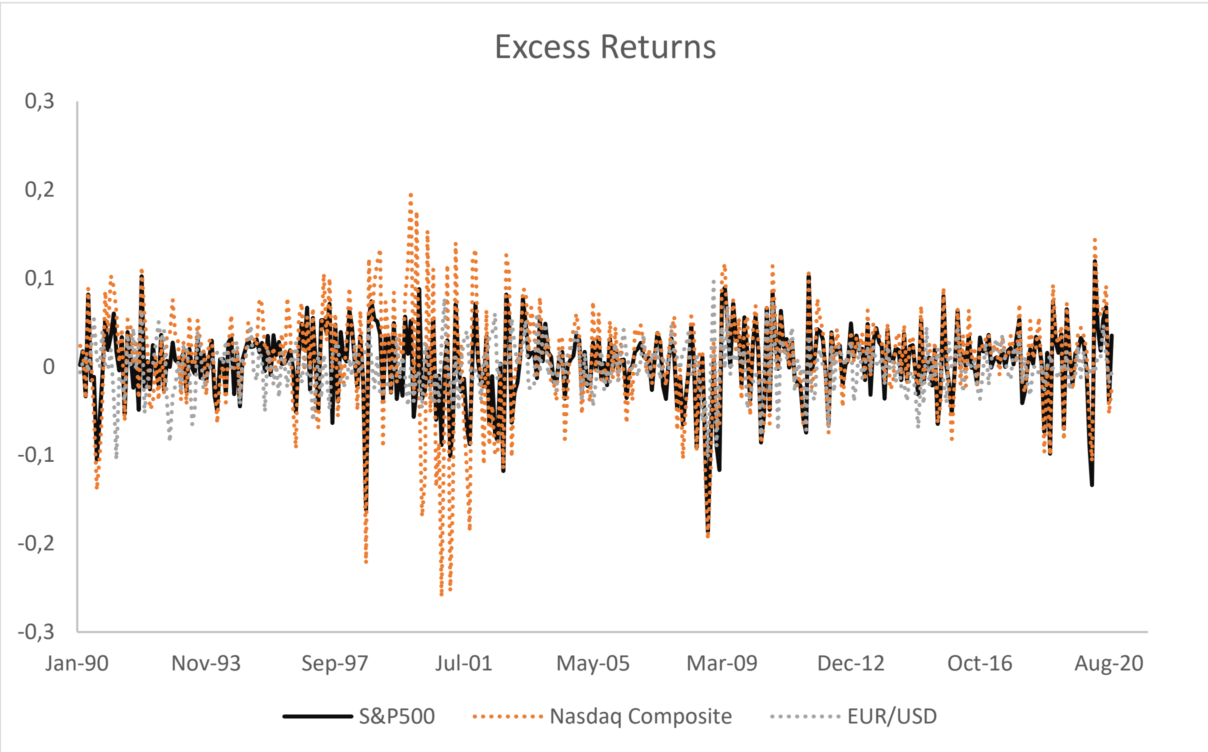

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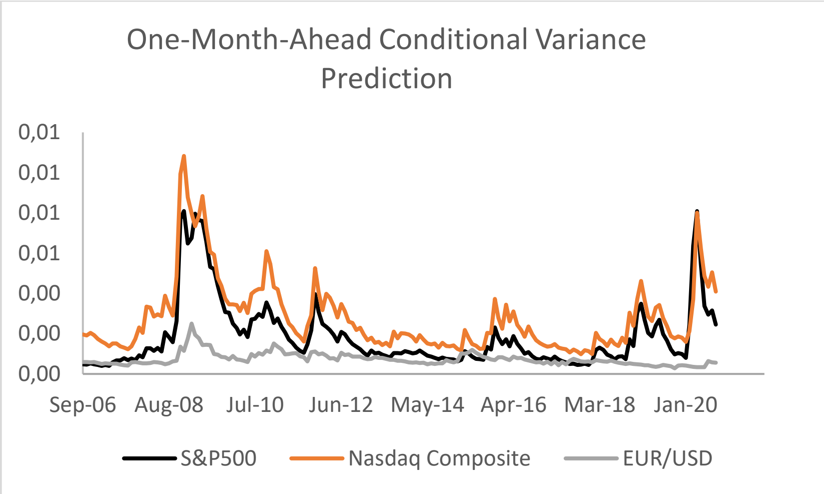
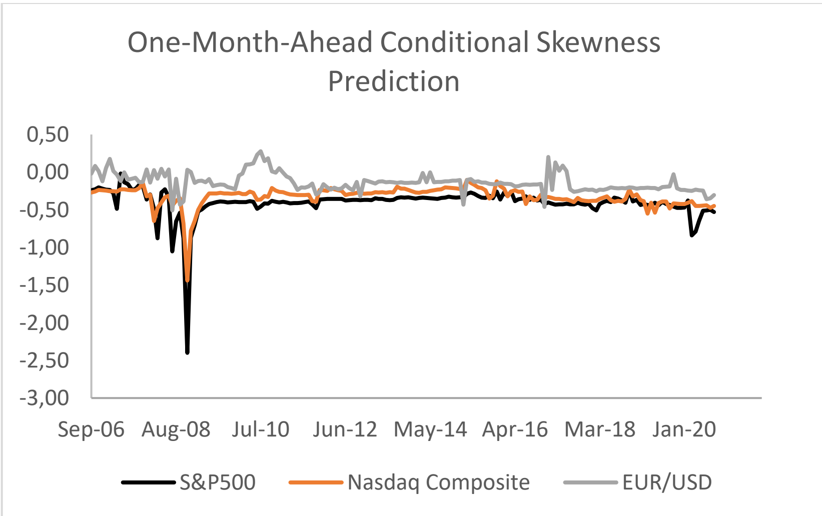
Figure 2

One-Month-Ahead Variance and Skewness Predictions

This figure shows one-month-ahead predictions of variance and skewness for each month from September 2006 to October 2020 based on a rolling window containing the 200 previous monthly excess returns. The conditional estimations of variance and skewness are based on the GARCHS model described in Section 2, whereas the sample estimations of variance and skewness are the sample variance and skewness calculated over the previous 200 monthly observations.





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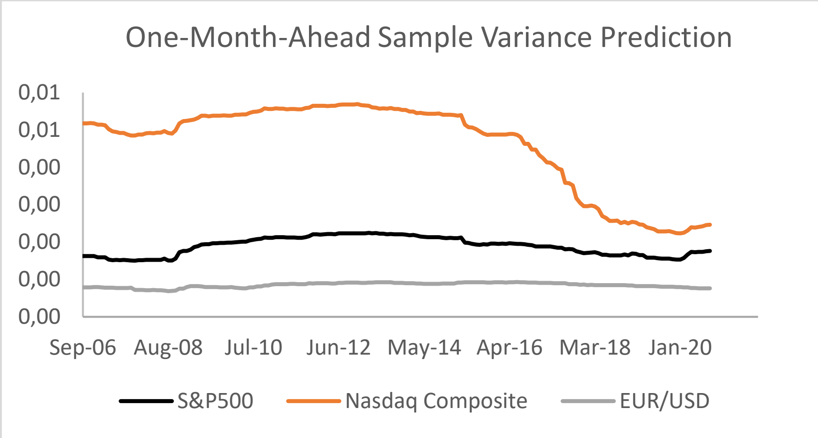

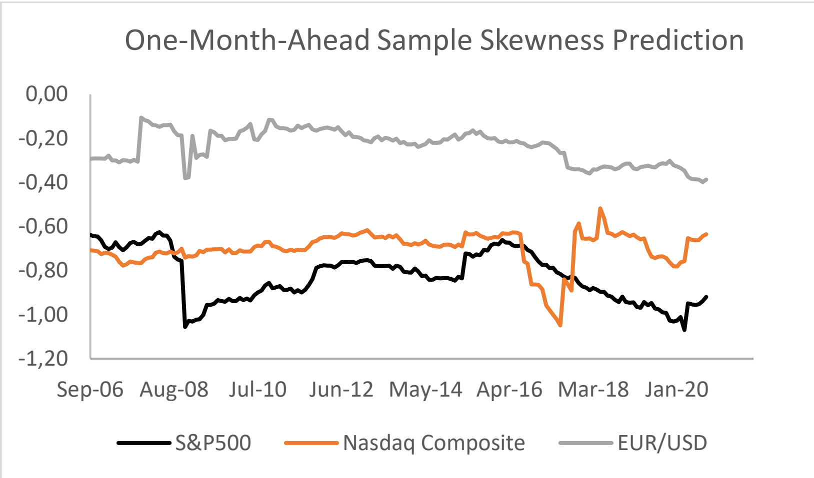

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Table 1

Descriptive Statistics of the Excess Returns

	S&P500		Nasdaq Composite		EUR/USD	
	Jan 1990 – Oct 2020	**Sep 2006 – Oct 2020**	**Jan1990 – Oct 2020**	**Sep 2006 – Oct 2020**	**Jan 1990 – Oct 2020**	**Sep 2006 – Oct 2020**
Mean	0.0042	0.0050	0.0088	0.00945	-0.0001	-0.0006
Median	0.0085	0.0108	0.0177	0.0187	0.0005	-0.0003
Maximum	0.1193	0.1193	0.1986	0.1436	0.0962	0.0962
Minimum	-0.1862	-0.1862	-0.2601	-0.1952	-0.1047	-0.1023
Std. Dev.	0.0423	0.0447	0.0631	0.0511	0.0282	0.0286
Skewness	-0.7850	-0.9195	-0.7394	-0.6918	-0.3395	-0.3895
Kurtosis	4.7177	5.0366	5.0525	4.1850	4.2674	4.8737
Jarque-Bera	83.2485	53.3347	98.3935	23.5070	31.7875	29.1665
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Sum	1.5513	0.8477	3.2674	1.6088	-0.0369	-0.0949
Sum Sq. Dev.	0.6597	0.3374	1.4668	0.4421	0.2935	0.1378
Observations	369	170	369	170	369	170

This table shows the main descriptive statistics of the series of S&P 500, Nasdaq Composite and EUR/USD excess returns over the whole sample period (January 1990 – 2020) and for the out-of-sample period (September 2006 – October 2020).

Table 2

Parameters Estimated by the GARCHS Model

	Estimated Value		
Parameter	**S&P500**	**Nasdaq Composite**	**EUR/USD**
$\beta 0$	0.0000 (0.6016)	0.0001 (0.1201)	0.0000 (0.3295)
$\beta 1$	0.1192*** (0.0019)	0.1289*** (0.0016)	0.0218 (0.2451)
$\beta 2$	0.8660*** (0.0000)	0.8346*** (0.0000)	0.9419** (0.0386)
$\gamma 0$	-0.1057 (0.9929)	-0.0793 (0.9261)	-0.0004 (0.5113)
$\gamma 1$	0.0221 (0.1007)	0.0223* (0.0987)	-0.0068 (0.6847)
$\gamma 2$	0.5457** (0.0227)	0.6899*** (0.0000)	1.0262*** (0.0000)
Log-likelihood	-553.7219	-453.9852	-614.6644
SIC	-569.6168	-469.8801	-630.5593

This table shows the estimated parameters (with their p-values in parentheses) output by the GARCHS model for the S&P 500, Nasdaq

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Composite and EUR/USD excess returns from January 1990 to August 2020 (200 monthly observations). SIC stands for the Schwarz information criterion, defined as ln(log-likelihood) – q/2ln(T), where q is the number of estimated parameters and T is the number of observations. The estimated values are reported, where * denotes significance at the 10% level, ** denotes significance at the 5% level, and *** denotes significance at the 1% level.

Table 3

Parameters Estimated by the GARCHS Model with Rolling Windows

	S&P500		Nasdaq Composite		EUR/USD	
Parameter	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
$\beta 0$	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000
$\beta 1$	0.1678	0.0360	0.1875	0.0317	0.0792	0.0288
$\beta 2$	0.7817	0.0663	0.7406	0.0567	0.8225	0.0581
$\gamma 0$	-0.2018	0.1783	-0.1465	0.1409	-0.0534	0.0802
$\gamma 1$	0.0062	0.0126	0.0117	0.0132	-0.0052	0.0075
$\gamma 2$	0.4644	0.4617	0.5468	0.3773	0.6094	0.5891

This table shows the means and the standard deviations of the parameters estimated by the GARCHS model with rolling windows containing the 200 previous monthly returns from September 2006 to October 2020 (170 monthly estimations) for the three financial series considered: the S&P 500, Nasdaq Composite and EUR/USD excess returns.

Table 4

Predictive Regressions for the Excess Market Returns

Variable	**Estimated coefficient (p-value)**		
	S&P500	**Nasdaq Composite**	**EUR/USD**
Constant (a)	-0.0404 (0.2450)	0.0624 (0.1005)	-0.0538 (0.2763)
rm,t-1	-0.0013 (0.9880)	-0.0762 (0.2666)	-0.0302 (0.7054)
hc,t	5.4513* (0.0808)	6.4925** (0.0125)	10.8773 (0.2360)
skc,t	0.05013*** (0.0028)	0.1525*** (0.0012)	0.0595*** (0.0017)
hs,t	27.3028** (0.0229)	-7.9694* (0.0513)	34.4994 (0.4907)
sks,t	-0.0055 (0.8809)	-0.0220 (0.5469)	-0.1029*** (0.0082)
Adj. R2	6.1332%	4.6044%	7.6159%
F-stat. (p-value)	3.1954*** (0.0088)	2.6218** (0.0261)	3.7699*** (0.0029)

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This table shows the estimated parameters of the one-month-ahead regressions of the S&P 500, Nasdaq Composite and EUR/USD excess returns on the conditional and sample estimations of the variance and skewness, as well as on the first lag of the market excess return. The sample period is September 2006 to October 2020 (169 monthly observations). The p-values shown in parentheses are calculated based on Newey-West heteroskedasticity and autocorrelation-consistent standard errors. The estimated values are reported, where * denotes significance at the 10% level, ** denotes significance at the 5% level, and *** denotes significance at the 1% level.

Table 5

Predictive Regressions for the Excess Market Returns with Control Variables

Variable	**Estimated coefficient (p-value)**		
	S&P500	**Nasdaq Composite**	**EUR/USD**
Constant (a)	0.2174** (0.0432)	0.1421** (0.0271)	-0.1408*** (0.0085)
rm,t-1	-0.0449 (0.5701)	-0.0726 (0.2904)	-0.0696 (0.2804)
hc,t	12.0307** (0.0196)	6.1500 (0.1174)	9.2064 (0.5624)
skc,t	0.0350** (0.0212)	0.1501*** (0.0009)	0.0550*** (0.0006)
hs,t	123.2420*** (0.0000)	-3.3784 (0.4894)	136.3219** (0.0174)
sks,t	0.0402 (0.3321)	-0.0336 (0.2938)	-0.1247*** (0.0066)
RRELt-1	-0.0154* (0.0990)	0.0048 (0.5649)	-0.0067 (0.2860)
TERMt-1	-0.0118*** (0.0019)	-0.0037 (0.3115)	-0.0023 (0.4887)
DEFt-1	-0.0488*** (0.0014)	0.0035 (0.7099)	-0.0033 (0.5458)
DPt-1	0.1803*** (0.0053)	0.0235* (0.0604)	-
10YGBt-1	-	-	0.0071* (0.0619)
INFt-1	-	-	0.0145** (0.0196)
Adj. R2	16.87%	4.7238%	13.2893%
F-stat. (p-value)	4.7868*** (0.0000)	1.9255* (0.0519)	3.5725*** (0.0003)

This table shows the estimated parameters of the one-month-ahead regressions of the S&P 500, Nasdaq Composite and EUR/USD excess returns on their first lags, the conditional and sample estimations of their variance and skewness, and the control variables: the relative three-month Treasury bill rate (RREL), the term spread (TERM), the default spread (DEF), the dividend-price ratio (DP), the US 10 year/German 10 year government bond spread (10YGB) and the US/Germany inflation spread (INF). The period ranges from September 2006 to October 2020 (169 monthly observations). The p-values shown in parentheses are calculated based on Newey-West heteroskedasticity and autocorrelation-consistent standard errors. The estimated values are reported, where * denotes significance at the 10% level, ** denotes significance at the 5% level, and *** denotes significance at the 1% level.

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