Implied Volatility Spreads and Expected Market Returns

Online Appendix

To save space, we present some of our findings in the Online Appendix. In Section I, we investigate the intertemporal relation between various skewness measures and expected market returns. In Section II, we orthogonalize the implied volatility spread measures with respect to the implied variance, realized variance, physical skewness and risk-neutral skewness measures. In Section III, we orthogonalize the implied volatility spread measures with respect to the implied variance and nonparametric value-at-risk measures to tease out the risk component of volatility spreads. In Section IV, we control for the non-normality of empirical return distributions by estimating the predictive regressions using a skewed fat-tailed density function in a maximum likelihood framework. In Section V, we address the issue of small-sample bias by utilizing the randomization and bootstrapping methods under the null hypothesis of no predictability. We also perform an alternative small-sample bias analysis by exploiting information about the autocorrelation structure of the volatility spread measures. In Section VI, rather than compounding market returns for different time periods, we use several lags of the volatility spread measures as independent variables. In Section VII, we use logarithmic excess market returns as dependent variables and control for squared volatility spreads to account for outliers and nonlinearities. In Section VIII, we include additional macroeconomic controls in our specifications.

I Skewness and Market Returns

Among academics and practitioners, there is wide interest in examining the link between higher order conditional moments and stock returns. Conditional skewness is one of these higher order moments which attracted the most attention. Financial economists have theorized a negative relation between expected returns and co-skewness (or systematic skewness). Investors prefer higher skewness, therefore they are willing to accept lower returns for holding assets that increase the skewness of their portfolios (see, e.g., Kraus and Litzenberger (1976), Barberis and Huang (2008), and Kumar (2009)). In light of these studies, implied volatility spreads used in this paper, which can also be interpreted as the slope of the volatility smile, may proxy for the conditional skewness of the aggregate market, and hence forecast expected market returns. We should note that when left-tail risk or negative skewness risk increases, we should expect the volatility spread measures to be higher. OTM put options give relatively more weight on the tail support than ATM options, so shifts in skewness and tail risk should affect the implied volatility of OTM put options more. Hence, an increase in volatility spreads should be accompanied by an increase in expected returns. In other words, we are supposed to find a positive slope coefficient on the volatility spreads if the spreads proxy for the conditional skewness of the aggregate market. However, our results suggest a negative relation between volatility spreads and expected market returns. Nevertheless, we aim to provide comprehensive analysis using the physical and risk-neutral measures of skewness in predictive regressions to rule out any potential concerns about a skewness-based explanation of our results.

I.1 Intertemporal Relation between Physical Skewness and Market Returns

Bakshi, Kapadia and Madan (2003) theoretically and empirically show that the slope of the volatility smile is related to skewness. Thus, it is possible that the relation between volatility spreads and excess market returns is driven by an intertemporal link between conditional skewness and aggregate returns rather than the trading activities of informed investors. To see whether the link between volatility spreads and expected market returns is due to an intertemporal relation between conditional skewness and expected market returns, we construct alternative measures of skewness that are more direct than the slope of the volatility smirk. Measuring conditional skewness is not an easy task. First, past skewness is not an accurate predictor of future skewness because skewness is not persistent over time. Second, skewness is associated with small probability events that are difficult to capture within a short period of time. Thus, a long history of returns is necessary to obtain accurate skewness estimates and this brings severe data constraints and survivorship bias to empirical studies. Inspired by Kumar (2009) and Goetzmann and Kumar (2009), we construct four distinct measures of physical skewness and test their predictive power for future market returns. Specifically, PSKEW1M is equal to the skewness of the daily index returns over the past month. Similarly, PSKEW3M, PSKEW6M and PSKEW12M are equal to the skewness of the daily S&P 500 returns over the past three months, six months and twelve months, respectively. Also, following Neuberger (2012), we compute the realized third moment from high-frequency returns. In his study, Neuberger (2012) refers to daily returns as high-frequency returns in order to calculate quarterly and annual skewness estimates that are unbiased. Because the predictability documented in our paper only extends to a one-week horizon due to its informational nature, we would need intraday option returns which are not available to construct daily and weekly skewness measures. Nevertheless, we use intraday index returns to calculate skewness measures for windows ranging from one day to one month as the skewness of the five-minute returns during the corresponding period. This measure of physical skewness is also denoted realized skewness, or REALSKEW.

Table I presents descriptive statistics for these physical skewness measures. The correlation coefficients between various volatility spread and physical skewness measures are all negative. Table II presents results from the time-series regressions of the future market returns on physical skewness measures, implied variance and macroeconomic control variables:

$$R_{t+1} = \alpha + \beta PSKEW_t + \gamma VIXSQ_t + \theta X_t + \varepsilon_{t+1}. \tag{1}$$

The dependent variable in the first set of regressions is one-day ahead excess market returns. None of the four physical skewness measures that are constructed from daily returns have significant coefficients and the t-statistics range between -0.67 and -1.84. The t-statistic for the coefficient of REALSKEW is equal to 1.62 and also insignificant. This result remains intact for longer horizons over which expected market returns are measured. In all of the specifications, all five measures of physical skewness have insignificant coefficients. This finding is consistent with the conjecture that physical skewness does not drive the negative relation between volatility spreads and aggregate stock returns. The coefficient on VIXSQ is significantly positive in all of the specifications for all return measurement horizons. These coefficients range between 6.80 and 7.77 for one-day ahead return regressions and between 4.43 and 4.73 for one-month ahead return regressions. The lowest t-statistic associated with the implied variance coefficients in Table II is 2.53, whereas the highest t-statistic is 3.22.

I.2 Intertemporal Relation between Risk-Neutral Skewness and Market Returns

In this section, we use risk-neutral skewness measures to test whether a link between risk-neutral skewness and expected market returns exists. One may expect risk-neutral skewness measures derived from option prices to be more accurate proxies of expected skewness as option data already incorporate the market's expectations about future skewness. Bakshi, Kapadia and Madan (2003) show that any payoff to a security can be constructed and priced using a set of option prices with different strike prices on that security.[1] The risk-neutral density moments can be reflected in terms of the payoffs of the quadratic, cubic and quartic contracts. In particular, the τ-maturity price of a security that pays the quadratic, cubic and quartic returns on the base security can be expressed as

$$V(t,\tau) = \int_{S(t)}^{\infty} \frac{2(1-\ln[\frac{K}{S(t)}])}{K^2} C(t,\tau;K)dK + \int_{0}^{S(t)} \frac{2(1+\ln[\frac{S(t)}{K}])}{K^2} P(t,\tau;K)dK \tag{2}$$

$$W(t,\tau) = \int_{S(t)}^{\infty} \frac{6\ln[\frac{K}{S(t)}] - 3(\ln[\frac{K}{S(t)}])^2}{K^2} C(t,\tau;K)dK + \int_{0}^{S(t)} \frac{6\ln[\frac{S(t)}{K}] + 3(\ln[\frac{S(t)}{K}])^2}{K^2} P(t,\tau;K)dK \tag{3}$$

$$X(t,\tau) = \int_{S(t)}^{\infty} \frac{12(\ln[\frac{K}{S(t)}])^2 - 4(\ln[\frac{K}{S(t)}])^3}{K^2} C(t,\tau;K)dK + \int_{0}^{S(t)} \frac{12(\ln[\frac{S(t)}{K}])^2 + 4(\ln[\frac{S(t)}{K}])^3}{K^2} P(t,\tau;K)dK \tag{4}$$

where $V(t,\tau)$, $W(t,\tau)$ and $X(t,\tau)$ are the quadratic, cubic and quartic contracts, respectively, and $C(t,\tau;K)$ and $P(t,\tau;K)$ are the prices of call and put options written on the underlying stock with strike price K and expiration τ periods from time t. As can be seen, the procedure involves using a weighted sum of out-of-the-money options across varying strike prices to construct the prices of payoffs related to the second, third and fourth moments of returns. Given the prices of these contracts, risk-neutral moments can be calculated as

$$\sigma_Q^2 = e^{r\tau}V(t,\tau) - \mu(t,\tau)^2 \tag{5}$$

$$SKEW_Q = \frac{e^{r\tau}W(t,\tau) - 3e^{r\tau}\mu(t,\tau)V(t,\tau) + 2\mu(t,\tau)^3}{[e^{r\tau}V(t,\tau) - \mu(t,\tau)^2]^{3/2}} \tag{6}$$

$$KURT_Q = \frac{e^{r\tau}X(t,\tau) - 4e^{r\tau}\mu(t,\tau)W(t,\tau) + 6e^{r\tau}\mu(t,\tau)^2V(t,\tau) - 3\mu(t,\tau)^4}{[e^{r\tau}V(t,\tau) - \mu(t,\tau)^2]^2} \tag{7}$$

where $\mu(t,\tau) = e^{r\tau}[1 - e^{-r\tau} - \frac{1}{2}V(t,\tau) - \frac{1}{6}W(t,\tau) - \frac{1}{24}X(t,\tau)]$ and r is the risk-free rate. We compute these integrals and risk-neutral moments separately for each option maturity (τ) on a given trading day t. Based on the risk-neutral skewness estimates for each maturity, we calculate four different

[1] Some studies investigate the role of these risk-neutral moments in asset pricing models (see, e.g., Rehman and Vilkov (2010), Chabi-Yo (2008, 2012) and Diavatopoulos, Doran, Fodor and Peterson (2012)).

measures of risk-neutral skewness. RSKEWVOL and RSKEWOPEN weight each maturity-specific risk-neutral skewness estimate by the total volume and total open interest of all the options, respectively. RSKEWEQ equally weights each risk-neutral skewness estimate for each maturity. RSKEWMO is the risk-neutral skewness measure that is derived from options whose maturity is closest to thirty days on a given trading day. The descriptive statistics associated with each risk-neutral skewness measure are presented in Table I. The correlation coefficients between various volatility spread and risk-neutral skewness measures are all negative.

Table III presents parameter estimates obtained from the time-series regressions of the excess market returns on the risk-neutral skewness measures, implied variance and macroeconomic control variables:

$$R_{t+1} = \alpha + \beta RSKEW_t + \gamma VIXSQ_t + \theta X_t + \varepsilon_{t+1}. \quad (8)$$

For daily returns, none of the risk-neutral skewness measures have significant coefficients and the t-statistics range between 0.03 and 0.30. This result remains intact for longer horizons over which expected market returns are measured and in all of the specifications, all four measures of risk-neutral skewness have insignificant coefficients.[2] For example, for the one-month horizon, the t-statistics associated with the coefficients of RSKEW measures range from 0.49 to 0.70. The significantly positive coefficients for the implied variance remain intact for all of the specifications and return windows. Overall, these results do not provide any support for the hypothesis that the link between volatility spreads and expected market returns is driven by skewness. In fact, the empirical findings are in the opposite direction.

II Orthogonolization

Although the paper tests whether our main result is driven by a potential correlation between implied volatility spreads and conditional variance and skewness, we provide more evidence that this is not the case by orthogonalizing the implied volatility spread measures with respect to implied variance, realized variance, physical skewness and risk-neutral skewness in this section.

First, we regress the volatility spread measures on contemporaneous PSKEW6M and RSKEWOPEN:

$$VS_t = \lambda_0 + \lambda_1 PSKEW_t + \lambda_2 RSKEW_t + \varepsilon_t. \quad (9)$$

[2] For this analysis, we also use another alternative control for the conditional variance, RVAR defined as the risk-neutral variance measure derived using equation (5). The risk-neutral variance is calculated differently for each specification using the same procedure as in the calculation of the particular risk-neutral skewness measure used in the specification. In unreported tests, we find that risk-neutral skewness still has no predictive power in the presence of risk-neutral variance in the regressions. Also, the coefficient of RVAR is significantly positive in all specifications for all return measurement horizons. The t-statistics associated with the coefficients of risk-neutral variances range from 1.96 to 3.04.

Next, we take the error terms from these regressions and include them as explanatory variables along with implied variance, realized variance and macroeconomic controls to explain one-period ahead market returns. The results are presented in Table IV. The residuals associated with all four volatility spread measures have significantly negative coefficients for the daily and weekly frequencies. The t-statistics vary between -3.38 and -4.51 for the one-day horizon and between -2.77 and -3.61 for the one-week horizon.

We repeat the orthogonalization procedure in eq. (9) by including implied variance and realized variance as additional orthogonalizing variables:[3]

$$VS_t = \lambda_0 + \lambda_1 PSKEW_t + \lambda_2 RSKEW_t + \lambda_3 VIXSQ_t + \lambda_4 REALVAR_t + \varepsilon_t. \quad (10)$$

Then, we include the residuals that come from these regressions along with the macroeconomic controls to forecast one-period ahead excess market returns. The results are presented in Table V. The negative intertemporal relation between the residual volatility spreads and excess aggregate returns documented earlier remains intact. The t-statistics for the coefficients of the orthogonalized volatility spread measures vary between -3.25 and -4.65 for the one-day horizon and between -2.26 and -3.29 for the one-week horizon. These findings indicate that the short-term predictive power of implied volatility spreads for aggregate returns cannot be explained by either conditional variance or conditional skewness.

III Volatility Spreads and Aggregate Risk

Implied volatility spreads reflect both a risk component and a demand component. In this section, we decompose our volatility spread measures by regressing them on aggregate risk metrics. We interpret the fitted values of these regressions as the component of volatility spreads that can be explained by aggregate risk and the residual values of these regressions as the component of volatility spreads that cannot be explained by aggregate risk. The two measures of aggregate risk that we use are implied variance of the market, or VIXSQ, and the nonparametric value-at-risk, or VaR, defined as the negative of the minimum daily return of the S&P 500 index over the last month. The nonparametric value-at-risk is a measure of the left-tail risk of the aggregate equity return distribution and is potentially linked with volatility spreads since the spreads may also be correlated with this type of downside risk. Our results are robust to alternative measurement windows for the nonparametric value-at-risk.

Specifically, we run the following first-stage regression:

[3] The results remain qualitatively the same when we use the variance risk premium as an additional orthogonalizing variable.

$$VS_t = \lambda_0 + \lambda_1 VIXSQ_t + \lambda_2 VaR_t + \varepsilon_t. \tag{11}$$

Next, we take the fitted and residual terms from these regressions and include them as explanatory variables along with macroeconomic controls to explain one-period ahead returns. The results are presented in Table VI. The residuals associated with all four volatility spread measures have significantly negative coefficients for the daily and weekly frequencies. The t-statistics vary between -3.19 and -4.05 for the one-day horizon and between -1.86 and -2.47 for the one-week horizon. These results suggest that the negative relation between volatility spreads and expected market returns is not driven by the risk component of volatility spreads. The results also suggest that the risk component has a significantly positive intertemporal relation with market returns since the coefficients of the fitted terms are significantly positive in all specifications.

IV Accounting for Non-Normalities in the Empirical Return Distribution

There is substantial empirical evidence showing that the distribution of stock returns has properties that deviate from the normal distribution. The fat tails and negative skewness suggest that extreme returns happen much more frequently than would be predicted by the normal distribution, and the negative returns of a given magnitude have higher probabilities than positive returns of the same magnitude. This also suggests that the normality assumption in estimating the intertemporal relation between volatility spreads and expected returns based on the OLS regressions can produce parameters that are inappropriate measures of the relation between volatility spreads and expected market returns. To account for skewness and excess kurtosis in the data, we use the skewed t distribution of Hansen (1994):

$$f(z_t;\mu,\sigma,v,\lambda) = \begin{cases} bc\left(1+\frac{1}{v-2}\left(\frac{bz_t+a}{1-\lambda}\right)^2\right)^{-\frac{v+1}{2}} & \text{if } z_t < -\frac{a}{b} \\ bc\left(1+\frac{1}{v-2}\left(\frac{bz_t+a}{1+\lambda}\right)^2\right)^{-\frac{v+1}{2}} & \text{if } z_t \geqslant -\frac{a}{b} \end{cases} \tag{12}$$

where $z_t = \frac{R_t-\mu}{\sigma}$ is the standardized market return, the constants a, b, and c are given by

$$a = 4\lambda c\left(\frac{v-2}{v-1}\right),\ b^2 = 1+3\lambda^2-a^2,\ c = \frac{\Gamma\left(\frac{v+1}{2}\right)}{\sqrt{\pi(v-2)}\Gamma\left(\frac{v}{2}\right)} \tag{13}$$

Hansen (1994) shows that this density is defined for $2 < v < \infty$ and $-1 < \lambda < 1$. This density has a single mode at $-a/b$, which is of opposite sign with the parameter λ. Thus, if $\lambda > 0$, the mode of the density is to the left of zero and the variable is skewed to the right, and vice versa when $\lambda < 0$. Furthermore, if $\lambda = 0$, Hansen's distribution reduces to the standardized t distribution. If $\lambda = 0$ and

$v = \infty$, it reduces to a normal density.

We estimate the following specification:[4]

$$R_{t+1} = \alpha + \beta VS_t + \gamma VIXSQ_t + \theta X_t + \varepsilon_{t+1}. \tag{14}$$

Table VII presents the maximum likelihood parameter estimates along with the corresponding t-statistics in parentheses. When the volatility spread measures are included in the estimation along with VIXSQ and macroeconomic controls, we find that all volatility spread measures have significantly negative coefficients at the daily and weekly frequencies. For the one-day horizon, the lowest (highest) volatility spread coefficient (in absolute magnitude) is associated with HVVS (OWVS) and is equal to -0.0119 (-0.0292). Without any exception, all volatility spread coefficients are significant at the 0.5% level or better. For the one-week horizon, the lowest (highest) volatility spread coefficient (in absolute magnitude) is again associated with HVVS (OWVS) and is equal to -0.0444 (-0.1090). All the volatility spread coefficients are highly significant.

In all specifications, VIXSQ has a significantly positive coefficient confirming the positive intertemporal relation between conditional volatility and expected market returns. The detrended riskless rate and the dividend yield are positively related to excess market returns for various horizons. Another notable point in Table VI is that the tail-thickness parameter (v) is significantly greater than 2 up to the two-week horizon and the null hypothesis of $1/v = 0$ is strongly rejected. Moreover, the skewness parameter (λ) is negative and highly significant, indicating negative skewness and fat tails in the empirical distribution of daily returns. To summarize, after taking the non-normality of market returns and relatively infrequent events into account, the negative and significant link between volatility spreads and future market returns remains intact.

V Small Sample Biases

As argued by Stambaugh (1999), there exists a small sample bias in predictive regressions of the sort used in this paper, because the regression disturbances are correlated with the regressors' innovations, hence the expectation of the regression disturbance conditional on the future values of regressors no longer equals zero. The small sample bias indicated by Stambaugh (1999) is a function of the bias of

[4]The intercept (α) and slope coefficients (γ, β, θ) as well as the standard deviation, skewness, and tail-thickness parameters of the Skewed t density (σ, λ, v) are estimated simultaneously by maximizing the conditional log-likelihood function of R_{t+1} :

$$LogL = n \ln b + n \ln \Gamma\left(\frac{v+1}{2}\right) - \frac{n}{2}\ln \pi - n \ln \Gamma(v-2) - n \ln \Gamma\left(\frac{v}{2}\right) - n \ln \sigma - \left(\frac{v+1}{2}\right)\sum_{t=1}^{n} \ln\left(1 + \frac{d_t^2}{(v-2)}\right)$$

where $d_t = \frac{bz_t + a}{(1-\lambda s)}$ and s is a sign dummy taking the value of 1 if $bz_t + a < 0$ and s=-1 otherwise.

the autoregressive coefficients of the independent variables, the correlation between the error terms, and the sample size. The sign of the bias depends on the sign of the correlation between the error terms. If the regression disturbance is positively (negatively) correlated with the regressor's innovation, there is a negative (positive) bias.

Therefore, we consider the randomization technique of Nelson and Kim (1993) to correct for the small sample bias. We run each one of the predictive regressions, record the residuals, and estimate a first-order autoregression for the independent variables (in this case volatility spread measures, volatility proxies and macro-economic variables). The residuals of the first-order autoregression are randomized to create pseudo-independent variables and returns that have similar time-series properties as the actual series but have been generated under the null of no predictability. It should be noted that the pseudo stock return is generated as the unconditional mean plus the randomized error term and in each simulation, residuals from the predictive regression and the autoregressions for the independent variables are randomized simultaneously, hence the correlation that drives the Stambaugh bias is preserved. We repeat this randomization procedure 1000 times for each regression and create the empirical distribution of the coefficient estimates. Subsequently, the small sample bias adjusted coefficient estimates and p-values are estimated. Small sample bias adjusted p-values are computed as the percentage of times the simulated t-statistics are higher than the sample t-statistics. Both t-statistics are computed using the Newey-West (1987) correction for heteroscedasticity and autocorrelation. For example, p-value of 0.995 (0.005) shows that the coefficient is negative (positive) and significant at the 1% level.

As shown in Table VIII, the parameters associated with volatility spreads are not affected by small sample bias. The magnitude and statistical significance of the coefficient estimates on the volatility spreads are similar to those reported in Table 3 of the manuscript, indicating the existence of information flow from options to stock markets up to a weekly horizon. However, for some of the specifications, the economic and statistical significance of the implied variance coefficients and the slopes on control variables are slightly affected by the small sample bias correction.

We also perform an alternative small sample bias analysis based on Lewellen (2004). Most studies underestimate the forecasting power of predictive variables because they ignore the knowledge about these variables' sample autocorrelation. Specifically, the predictive variables have to be stationary and the autocorrelation coefficients of these variables are limited by one. Incorporating this information can raise the power of empirical tests. Lewellen (2004) develops a test to exploit such information in a univariate context and he states that his test is useful only when the predictive variable's sample autocorrelation is close to one. Our volatility spread measures are not highly persistent and the sample autocorrelation of these measures is at most 0.65 (0.26) at the daily (monthly) frequency. Nevertheless, we follow the methodology developed in Lewellen (2004) and test the univariate predictive power of the volatility spread measures for the value-weighted excess market returns. The results are presented in Table IX and show that after correcting for small sample biases following Lewellen (2004), the predictive power of our volatility spread measures turn out to be similar to those reported in Table VIII (i.e., small sample bias correction based on Nelson and Kim (1993)).

VI Distributed Lags

In this section, as an alternative test for the predictive ability of volatility spreads for expected excess market returns, we regress daily future excess S&P 500 returns on implied variance, macroeconomic controls and multiple daily lags of the volatility spread measures:

$$R_{t+1} = \alpha + \sum_{i=1}^{n} \beta_i VS_{t+1-i} + \gamma VIXSQ_t + \theta X_t + \varepsilon_{t+1}. \tag{15}$$

In other words, rather than compounding market returns for different time periods and regressing them on one-period lagged volatility spreads, we regress daily expected market returns on several daily lags of the volatility spread measures. For the one-week horizon, n equals 5, i.e., we use five daily lags of the volatility spread measures in our specification. The corresponding lags are 10 and 21 for the two-week and one-month horizons, respectively. Our focus is on the significance of the sum of the slope coefficients for the lagged volatility spread measures.

The results are presented in Table X. To conserve space, we do not report individual β's and instead opt to report the sum of these slope coefficients for different horizons. These sums are denoted by SUMVS. The p-values, reported under SUMVS in brackets, are the p-values for the F-statistics that are obtained from the tests of the equality of the sum of the slope coefficients to zero. For the one-week horizon, the p-values for SUMVS indicate statistical significance at conventional levels lending support to our earlier findings that provide evidence for a negative intertemporal relation between volatility spreads and excess returns on the market. The sum of the slope coefficients loses their significance after the one-week horizon with the exception of HOVS which has a significantly negative coefficient at the two-week horizon.

VII Outliers and Nonlinearities

It is possible that the return predictability that we document is driven by some outlier observations. To address this issue, we change the dependent variable in our baseline regression and replace the excess value-weighted returns with their logarithms. The results are presented in Table XI. For the daily return regressions, the coefficients of the volatility spread measures vary between -0.0144 and -0.0331 with t-statistics between -3.23 and -4.04. For the weekly return regressions, the coefficients of the volatility spread measures vary between -0.0378 and -0.942 with t-statistics between -1.80 and -2.38. All volatility spread measures except HVVS have a significantly negative relation with expected market returns at conventional levels up to a weekly forecasting horizon. The intertemporal relation between volatility spreads and market returns does not extend to longer return horizons. To summarize, the results for the logarithmic excess returns are very similar to those for the raw excess returns.

Next, we also take into account the possibility that there may be nonlinearities in the relation between volatility spreads and expected market returns. To address this possibility, we include an additional term in our baseline specification:

$$R_{t+1} = \alpha + \beta VS_t + \delta VSSQ_t + \gamma VIXSQ_t + \theta X_t + \varepsilon_{t+1}. \tag{16}$$

where $VSSQ$ is equal to the square of the particular volatility spread measure used in the specification. The results are presented in Table XII. For the daily regressions, the coefficients of the volatility spread measures vary between -0.0231 and -0.1086 with t-statistics between -1.97 and -2.35. For the weekly regressions, HOVS and OWVS have significantly negative relations with one-week ahead market returns with t-statistics of -2.20 and -2.03, respectively. Again, the coefficients of the volatility spread measures are insignificant at the biweekly and monthly return horizons. None of the squared volatility spread measures can predict excess market returns. Compared to Table 3 of the manuscript, the effect of controlling for squared volatility spreads seems to be increasing the coefficients of the volatility spreads in an absolute sense, but somewhat reducing their significance. However, the intertemporal relation between volatility spreads and market returns stays intact after this robustness test.

VIII Additional Macroeconomic Controls

We control for several macroeconomic variables in our empirical treatment due to the fact variables such as default premium, term premium, detrended riskless rate and dividend price ratio have been shown to predict market returns and these variables are available at daily frequency. Although we would want to control for other stock market characteristics and macroeconomic controls, most candidate variables are available only at monthly or even longer frequencies and, as such, they cannot be used in predictive regressions of higher-frequency market returns. Nonetheless, we turn to Goyal and Welch (2008) and identify two more control variables that are available at the daily frequency. The first variable is DFR which is the change in the default return spread calculated as the change in the difference between the yields of AAA-rated corporate bonds and 10-year Treasury bonds. The second variable is LTY which is the long-term yield defined as the change in the yield of the 10-year Treasury bonds. We include these variables among the macroeconomic controls X_t in the baseline regression and re-estimate our specifications. The results are presented in Table XIII. We find that the volatility spread measures retain their significance at the daily and weekly horizons. For the daily horizon, all volatility spread measures have significant coefficients with t-statistics that vary between -3.21 and -4.08. For the weekly horizon, the t-statistics vary between -1.86 and -2.42. Neither the default return spread nor the long-term yield can forecast market returns at any horizon.

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Table I. Descriptive Statistics for Skewness Measures

This table presents descriptive statistics for various physical skewness and risk-neutral skewness measures. Panel A presents the summary statistics for skewness measures. Panel B presents the correlation matrix between the volatility spreads and the skewness measures. HOVS (HVVS) is the implied volatility difference between the OTM put option and the ATM call option that have the highest open interest (volume) in a given trading day. VWVS (OWVS) is equal to the difference between the volume-weighted (open interest-weighted) average of the volatility spreads for all OTM put options and the volume-weighted (open interest-weighted) average of the volatility spreads for all ATM call options. PSKEW1M is the physical skewness measure calculated as the skewness of the daily index returns over the past month. PSKEW3M is the physical skewness measure calculated as the skewness of the daily index returns over the past three months. PSKEW6M is the physical skewness measure calculated as the skewness of the daily index returns over the past six months. PSKEW12M is the physical skewness measure calculated as the skewness of the daily index returns over the past twelve months. REALSKEW is the realized skewness calculated based on intraday return data following Neuberger (2012). The risk-neutral skewness measures are calculated using the method of Bakshi, Kapadia and Madan (2003). RSKEWVOL (RSKEWOPEN) is calculated by weighting each maturity-specific risk-neutral skewness estimate by the total volumes (total open interests) of all the options used to calculate each maturity-specific risk-neutral skewness estimate in a given trading day. RSKEWEQ is calculated by equal-weighting the risk-neutral skewness estimates for each maturity. RSKEWMO the risk-neutral skewness estimate that is derived from options whose maturity is closest to thirty days.

Panel A. Summary Statistics for Skewness Measures

	PSKEW 1M	PSKEW 3M	PSKEW 6M	PSKEW 12M	REAL SKEW	RSKEW VOL	RSKEW OPEN	RSKEW EQ	RSKEW MO
Mean	-0.014	-0.080	-0.120	-0.131	0.026	-3.195	-3.171	-3.033	-3.130
Median	-0.006	-0.072	-0.066	-0.060	-0.004	-2.513	-2.485	-2.462	-2.497
StDev	0.554	0.460	0.443	0.353	0.728	2.603	2.713	2.236	2.536
Min	-3.131	-2.834	-2.115	-1.271	-4.302	-33.570	-35.967	-33.570	-36.938
P25	-0.365	-0.283	-0.306	-0.430	-0.352	-3.501	-3.455	-3.351	-3.444
P75	0.318	0.186	0.155	0.103	0.362	-1.852	-1.835	-1.848	-1.823
Max	1.786	1.014	0.783	0.551	5.088	0.144	0.221	-0.418	0.150
Skew	-0.308	-1.017	-1.053	-0.346	0.517	-3.995	-4.597	-4.073	-4.374
Kurt	4.506	6.390	4.856	2.394	9.059	26.867	35.149	30.804	34.637

Panel B. Correlations for Volatility Spreads and Skewness Measures

	HOVS	HVVS	OWVS	VWVS	PSKEW 1M	PSKEW 3M	PSKEW 6M	PSKEW 12M	REAL SKEW	RSKEW VOL	RSKEW OPEN	RSKEW EQ	RSKEW MO
HOVS	1.000												
HVVS	0.304	1.000											
OWVS	0.636	0.495	1.000										
VWVS	0.440	0.759	0.785	1.000									
PSKEW1M	-0.011	-0.077	-0.100	-0.108	1.000								
PSKEW3M	-0.070	-0.143	-0.171	-0.203	0.533	1.000							
PSKEW6M	-0.061	-0.159	-0.194	-0.231	0.406	0.815	1.000						
PSKEW12M	-0.112	-0.147	-0.169	-0.212	0.277	0.570	0.782	1.000					
REALSKEW	-0.003	-0.017	-0.001	-0.009	0.030	0.031	0.008	-0.022	1.000				
RSKEWVOL	-0.054	-0.111	-0.190	-0.152	0.078	0.173	0.164	0.151	-0.001	1.000			
RSKEWOPEN	-0.066	-0.100	-0.197	-0.142	0.067	0.158	0.147	0.126	0.000	0.984	1.000		
RSKEWEQ	-0.039	-0.102	-0.176	-0.141	0.067	0.162	0.153	0.146	-0.003	0.973	0.960	1.000	
RSKEWMO	-0.013	-0.100	-0.131	-0.128	0.035	0.141	0.144	0.161	-0.001	0.844	0.811	0.849	1.000

Table II. Physical Skewness and Market Returns

This table presents results from the time-series predictive regressions of excess returns of the S&P 500 index on the physical skewness measures, implied variance and macroeconomic variables. The physical skewness measures are defined in Table I whereas implied variance and macroeconomic variables are defined in Table 1. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead excess value-weighted market returns, where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the intercepts and slope coefficients. The second row presents Newey-West adjusted t-statistics using optimal lag length.

	Constant	PSKEW 1M	PSKEW 3M	PSKEW 6M	PSKEW 12M	REAL SKEW	VIXSQ	RET	DEF	TERM	RREL	DP
1-day	-0.0043	-0.0003					7.2484	-0.0239	-5.0638	-0.0565	0.1031	0.1952
	(-3.26)	(-0.67)					(2.71)	(-1.26)	(-1.57)	(-0.13)	(1.85)	(3.01)
	-0.0043		-0.0010				7.6310	-0.0238	-5.2159	-0.0725	0.1020	0.1809
	(-3.20)		(-1.72)				(2.84)	(-1.27)	(-1.61)	(-0.17)	(1.84)	(2.77)
	-0.0044			-0.0010			7.7712	-0.0237	-5.1781	-0.0571	0.1069	0.1860
	(-3.35)			(-1.84)			(2.91)	(-1.26)	(-1.61)	(-0.14)	(1.92)	(2.88)
	-0.0043				-0.0006		7.1813	-0.0245	-5.0696	-0.0609	0.0994	0.1903
	(-3.24)				(-1.01)		(2.70)	(-1.31)	(-1.57)	(-0.14)	(1.78)	(2.89)
	-0.0043					0.0006	6.8029	-0.0398	-5.0779	0.0010	0.0942	0.1941
	(-3.19)					(1.62)	(2.53)	(-1.94)	(-1.57)	(0.00)	(1.68)	(3.00)
1-week	-0.0182	0.0004					5.1118	-0.0342	-2.0146	2.1405	0.4748	0.8840
	(-3.05)	(0.24)					(2.66)	(-0.77)	(-0.33)	(2.17)	(1.78)	(2.88)
	-0.0178		-0.0034				5.5368	-0.0314	-2.7519	2.1255	0.4817	0.8184
	(-3.07)		(-1.73)				(2.92)	(-0.71)	(-0.44)	(2.16)	(1.82)	(2.68)
	-0.0183			-0.0040			5.6923	-0.0311	-2.7519	2.1613	0.4994	0.8285
	(-3.22)			(-1.83)			(3.00)	(-0.70)	(-0.44)	(2.20)	(1.85)	(2.79)
	-0.0178				-0.0021		5.1684	-0.0333	-2.3274	2.1487	0.4701	0.8427
	(-3.01)				(-0.74)		(2.73)	(-0.76)	(-0.38)	(2.19)	(1.73)	(2.70)
	-0.0177					0.0022	4.8724	-0.0420	-2.8074	2.2183	0.4418	0.8669
	(-2.93)					(1.59)	(2.56)	(-0.94)	(-0.45)	(2.22)	(1.61)	(2.78)
2-week	-0.0351	0.0003					5.3958	0.0449	5.2633	2.7924	1.3274	1.6635
	(-3.28)	(0.11)					(3.00)	(0.68))	(0.92)	(2.25)	(2.54)	(3.13)
	-0.0342		-0.0078				5.7518	0.0495	4.2357	2.7914	1.3200	1.5240
	(-3.48)		(-1.08)				(3.22)	(0.80)	(0.71)	(2.27)	(2.59)	(3.10)
	-0.0350			-0.0083			5.8435	0.0478	4.2409	2.8200	1.3405	1.5439
	(-3.55)			(-1.44)			(3.18)	(0.78)	(0.73)	(2.33)	(2.59)	(3.17)
	-0.0344				-0.0048		5.4114	0.0456	4.8253	2.7936	1.3018	1.5770
	(-3.31)				(-0.99)		(3.06)	(0.74)	(0.84)	(2.28)	(2.48)	(3.01)
	-0.0349					0.0025	5.2069	0.0442	4.9746	2.7197	1.2739	1.6721
	(-3.21)					(1.32)	(2.89)	(0.70)	(0.86)	(2.17)	(2.32)	(3.08)
1-month	-0.0597)	-0.0063					4.5944	0.0458	9.9619	2.8288	3.0119	2.7902
	(-2.89)	(-0.93)					(2.77)	(0.48)	(1.10)	(1.79)	(3.34)	(2.68)
	-0.0595		-0.0136				4.7323	0.0274	7.7335	2.7652	2.9431	2.7014
	(-3.17)		(-1.39)				(3.12)	(0.28)	(0.89)	(1.77)	(3.39)	(2.79)
	-0.0596			-0.0138			4.6861	0.0242	7.3886	3.0234	3.0526	2.6877
	(-3.21)			(-1.52)			(3.17)	(0.24)	(0.85)	(1.99)	(3.36)	(2.81)
	-0.0593				-0.0073		4.4346	0.0266	7.9889	2.9495	2.9750	2.7670
	(-2.86)				(-0.71)		(2.82)	(0.26)	(0.90)	(1.93)	(3.18)	(2.60)
	-0.0616					0.0036	4.4340	0.0333	8.2347	2.9345	2.9730	2.9551
	(-2.85)					(0.53)	(2.64)	(0.32)	(0.91)	(1.93)	(3.14)	(2.75)

Table III. Risk-Neutral Skewness and Market Returns

This table presents results from the time-series predictive regressions of excess returns of the S&P 500 index on the risk-neutral measures of skewness, implied variance and macroeconomic variables. The risk-neutral skewness measures are defined in Table I whereas implied variance and macroeconomic variables are defined in Table 1. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead excess value-weighted market returns, where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the intercepts and slope coefficients. The second row presents Newey-West adjusted t-statistics using optimal lag length.

	Constant	RSKEW VOL	RSKEW OPEN	RSKEW EQ	RSKEW MO	VIXSQ	RET	DEF	TERM	RREL	DP
1-day	-0.0043	0.0000				7.0761	-0.0245	-4.9977	-0.0600	0.1043	0.2008
	(-3.19)	(0.30)				(2.60)	(-1.30)	(-1.55)	(-0.14)	(1.84)	(3.12)
	-0.0044		0.0000			7.1326	-0.0245	-4.9948	-0.0609	0.1028	0.2006
	(-3.21)		(0.14)			(2.62)	(-1.30)	(-1.55)	(-0.14)	(1.83)	(3.12)
	-0.0044			0.0000		7.1660	-0.0245	-4.9936	-0.0614	0.1020	0.2006
	(-3.21)			(0.03)		(2.63)	(-1.31)	(-1.55)	(-0.15)	(1.81)	(3.12)
	-0.0044				0.0000	7.1667	-0.0245	-4.9932	-0.0615	0.1020	0.2006
	(-3.24)				(0.03)	(2.65)	(-1.31)	(-1.55)	(-0.15)	(1.80)	(3.12)
1-week	-0.0200	0.0001				6.2671	-0.0964	-6.2384	1.8795	0.7154	0.9520
	(-3.28)	(0.23)				(2.91)	(-2.12)	(-1.07)	(1.49)	(2.28)	(3.18)
	-0.0201		0.0001			6.2846	-0.0965	-6.2318)	1.8811	0.7124	0.9514
	(-3.32)		(0.22)			(2.94)	(-2.12)	(-1.07)	(1.49)	(2.28)	(3.18)
	-0.0203			0.0000		6.3491	-0.0969	-6.2338	1.8860	0.7027	0.9505
	(-3.31)			(-0.02)		(2.93)	(-2.13)	(-1.07)	(1.49)	(2.24)	(3.17)
	-0.0205				-0.0001	6.4070	-0.0975	-6.2503	1.8941	0.6936	0.9500
	(-3.39)				(-0.22)	(3.00)	(-2.15)	(-1.07)	(1.50)	(2.23)	(3.18)
2-week	-0.0363	0.0003				5.6994	0.0251	1.8256	1.8454	1.5012	1.7822
	(-3.68)	(0.53)				(3.09)	(0.42)	(0.27)	(1.54)	(2.68)	(3.61)
	-0.0362		0.0004			5.6771	0.0252	1.8554	1.8344	1.5038	1.7789
	(-3.68)		(0.66)			(3.11)	(0.43)	(0.27)	(1.53)	(2.69)	(3.61)
	-0.0365			0.0003		5.7277	0.0248	1.8042	1.8604	1.4937	1.7790
	(-3.65)			(0.41)		(3.07)	(0.42)	(0.27)	(1.56)	(2.65)	(3.60)
	-0.0383				-0.0001	5.9619	0.0215	1.6692	1.8954	1.4223	1.7734
	(-3.90)				(-0.27)	(3.25)	(0.36)	(0.25)	(1.60)	(2.55)	(3.60)
1-month	-0.0676	0.0009				5.0143	0.0832	11.2466	4.4137	3.2363	3.3585
	(-3.42)	(0.70)				(2.69)	(0.76)	(1.01)	(2.92)	(3.69)	(3.54)
	-0.0688		0.0006			5.0740	0.0812	11.2143	4.3740	3.1886	3.3534
	(-3.40)		(0.49)			(2.71)	(0.75)	(1.01)	(2.91)	(3.67)	(3.54)
	-0.0684			0.0007		5.0417	0.0822	11.2291	4.3875	3.1988	3.3606
	(-3.44)			(0.62)		(2.70)	(0.76)	(1.01)	(2.92)	(3.71)	(3.54)
	-0.0679				0.0009	5.0572	0.0850	11.4852	4.4117	3.2498	3.3625
	(-3.43)				(0.60)	(2.74)	(0.77)	(1.03)	(2.89)	(3.64)	(3.52)

Table IV. Orthogonalization with respect to PSKEW and RSKEW

This table presents parameter estimates from the time-series predictive regressions of the excess returns of the S&P 500 index on the residual volatility spreads, implied variance, realized variance and macroeconomic variables. The residual volatility spreads are the error terms obtained from the first-stage regressions of volatility spread measures on PSKEW6M and RSKEWOPEN. Volatility spread measures, implied variance, realized variance and macroeconomic variables are defined in Table 1 whereas PSKEW6M and RSKEWOPEN are defined in Table I. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead excess value-weighted market returns, where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the intercepts and slope coefficients. The second row presents Newey-West adjusted t-statistics using optimal lag length.

	Constant	Resid HOVS	Resid HVVS	Resid OWVS	Resid VWVS	VIXSQ	REAL VAR	RET	DEF	TERM	RREL	DP
1-day	-0.0044	-0.0150				6.2040	2.9141	-0.0273	-4.9031	-0.0553	0.1101	0.1980
	(-3.33)	(-3.38)				(1.88)	(1.01)	(-1.44)	(-1.54)	(-0.13)	(1.91)	(3.08)
	-0.0044		-0.0162			6.1548	2.8068	-0.0275	-4.7821	-0.0394	0.1017	0.1951
	(-3.25)		(-3.55)			(1.88)	(0.99)	(-1.47)	(-1.52)	(-0.09)	(1.77)	(3.01)
	-0.0042			-0.0389		6.9008	2.8731	-0.0285)	-4.6503	-0.0300	0.1116	0.1769
	(-3.17)			(-4.51)		(2.17)	(1.01)	(-1.54)	(-1.49)	(-0.07)	(1.92)	(2.75)
	-0.0045				-0.0345	7.2475	2.5773	-0.0285	-4.7557	-0.0098	0.1090	0.1913
	(-3.34)				(-4.29)	(2.21)	(0.90)	(-1.53)	(-1.53)	(-0.02)	(1.87)	(2.95)
1-week	-0.0218	-0.0646				19.3983	-25.1275	-0.1672	-2.6126	1.2934	0.9145	0.9586
	(-3.54)	(-3.19)				(5.38)	(-4.97)	(-3.61)	(-0.43)	(1.31)	(3.45)	(3.18)
	-0.0217		-0.0539			19.1602	-24.9299	-0.1622	-2.2389	1.4291	0.9029	0.9576
	(-3.49)		(-2.77)			(5.32)	(-4.80)	(-3.54)	(-0.38)	(1.43)	(3.39)	(3.17)
	-0.0212			-0.1475		20.1574	-25.6613	-0.1683	-1.2775	1.2318	0.9142	0.8895
	(-3.47)			(-3.61)		(5.87)	(-5.16)	(-3.59)	(-0.21)	(1.27)	(3.49)	(2.97)
	-0.0219				-0.1171	20.1068	-25.4285	-0.1626	-2.0701	1.3184	0.8905	0.9280
	(-3.54)				(-3.58)	(5.69)	(-4.97)	(-3.47)	(-0.34)	(1.34)	(3.38)	(3.08)
2-week	-0.0316	-0.0326				16.7166	-23.9816	-0.0933	2.7260	1.3111	1.5366	1.4377
	(-3.52)	(-0.89)				(6.61)	(-6.98)	(-1.70)	(0.40)	(1.33)	(3.44)	(3.14)
	-0.0304		-0.0805			16.8334	-24.1069	-0.1001	4.1618	1.4999	1.5359	1.3628
	(-3.47)		(-2.43)			(6.93)	(-7.14)	(-1.81)	(0.65)	(1.54)	(3.50)	(3.02)
	-0.0302			-0.1527		17.2744	-24.5697	-0.1022	4.5016	1.1922	1.5427	1.3239
	(-3.41)			(-2.04)		(7.26)	(-7.30)	(-1.85)	(0.64)	(1.23)	(3.53)	(2.94)
	-0.0308				-0.1236	17.1120	-24.1860	-0.0957	3.7731	1.2944	1.5261	1.3563
	(-3.46)				(-1.88)	(7.08)	(-7.21)	(-1.71)	(0.57)	(1.34)	(3.52)	(3.00)
1-month	-0.0404	0.0446				11.9169	-20.1423	-0.0459	16.6956	1.8552	2.5845	2.1005
	(-2.24	(0.54)				(6.57)	(-5.90)	(-0.48)	(1.63)	(1.54)	(3.52)	(2.39)
	-0.0401		0.0173			12.0568	-20.2822	-0.0486	16.3595	1.9156	2.5766	2.0695
	(-2.19		(0.25)			(6.43)	(-5.85)	(-0.51)	(1.61)	(1.63)	(3.50)	(2.26)
	-0.0380			-0.0909		12.5356	-20.6818	-0.0496	17.8691	2.0837	2.6800	1.8717
	(-2.01			(-0.58)		(6.86)	(-5.83)	(-0.53)	(1.74)	(1.73)	(3.83)	(1.98)
	-0.0399				-0.0633	12.3938	-20.5508	-0.0469	16.7448	1.9933	2.6380	2.0057
	(-2.17)				(-0.46)	(6.85)	(-5.93)	(-0.50)	(1.66)	(1.69)	(3.72)	(2.21)

Table V. Orthogonalization with respect to PSKEW, RSKEW, VIXSQ and REALVAR

This table presents parameter estimates from the time-series predictive regressions of excess returns of the S&P 500 index on the residual volatility spreads and macroeconomic variables. The residual volatility spreads are the error terms obtained from the first-stage regression of volatility spread measures on implied variance, realized variance, PSKEW6M and RSKEWOPEN. Volatility spread measures, implied variance, realized variance and macroeconomic variables are defined in Table 1 whereas PSKEW6M and RSKEWOPEN are defined in Table I. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead excess value-weighted market returns, where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the intercepts and slope coefficients. The second row presents Newey-West adjusted t-statistics using optimal lag length.

	Constant	Resid HOVS	Resid HVVS	Resid OWVS	Resid VWVS	RET	DEF	TERM	RREL	DP
1-day	-0.0020	-0.0147				-0.0364	-4.2234	-0.0917	0.0378	0.1350
	(-2.01)	(-3.25)				(-1.96)	(-1.27)	(-0.21)	(0.75)	(2.35)
	-0.0020		-0.0163			-0.0364	-4.1042	-0.0757	0.0308	0.1333
	(-1.97)		(-3.62)			(-1.97)	(-1.26)	(-0.17)	(0.61)	(2.30)
	-0.0017			-0.0396		-0.0374	-3.9717	-0.0669	0.0400	0.1148
	(-1.67)			(-4.65)		(-2.05)	(-1.22)	(-0.15)	(0.78)	(2.00)
	-0.0019				-0.0350	-0.0375	-4.0761	-0.0467	0.0363	0.1287
	(-1.89)				(-4.43)	(-2.04)	(-1.26)	(-0.11)	(0.71)	(2.22)
1-week	-0.0096	-0.0594				-0.1447	-4.5010	1.6463	0.4021	0.6569
	(-1.95)	(-2.59)				(-3.19)	(-0.73)	(1.33)	(1.31)	(2.33)
	-0.0095		-0.0498			-0.1405	-4.1303	1.7671	0.3930	0.6559
	(-1.94)		(-2.26)			(-3.12)	(-0.69)	(1.39)	(1.29)	(2.31)
	-0.0085			-0.1421		-0.1452	-3.2346	1.5888	0.4050	0.5946
	(-1.74)			(-3.29)		(-3.19)	(-0.52)	(1.31)	(1.33)	(2.11)
	-0.0091				-0.1143	-0.1407	-3.9493	1.6663	0.3797	0.6280
	(-1.84)				(-3.18)	(-3.07)	(-0.65)	(1.34)	(1.25)	(2.22)
2-week	-0.0177	-0.0220				-0.0419	4.6088	1.6165	0.8111	1.2177
	(-2.07)	(-0.47)				(-0.72)	(0.61)	(1.28)	(1.51)	(2.47)
	-0.0167		-0.0784			-0.0487	5.9969	1.7817	0.8231	1.1524
	(-1.98)		(-1.73)			(-0.83)	(0.82)	(1.40)	(1.54)	(2.38)
	-0.0162			-0.1389		-0.0490	6.1655	1.5044	0.8276	1.1268
	(-1.97)			(-1.51)		(-0.84)	(0.79)	(1.24)	(1.55)	(2.38)
	-0.0165				-0.1182	-0.0446	5.5909	1.5873	0.8071	1.1446
	(-1.97)				(-1.44)	(-0.76)	(0.74)	(1.28)	(1.53)	(2.38)
1-month	-0.0345	0.0365				-0.0243	13.1125	3.5974	1.6761	2.3504
	(-2.05)	(0.34)				(-0.27)	(1.11)	(2.24)	(1.69)	(2.42)
	-0.0344		0.0236			-0.0264	12.8017	3.6390	1.6644	2.3417
	(-2.01)		(0.29)			(-0.29)	(1.10)	(2.26)	(1.66)	(2.37)
	-0.0312			-0.0887		-0.0266	14.1806	3.8038	1.7649	2.1543
	(-1.81)			(-0.45)		(-0.29)	(1.19)	(2.31)	(1.79)	(2.17)
	-0.0332				-0.0595	-0.0253	13.1431	3.7053	1.7128	2.2704
	(-1.94)				(-0.34)	(-0.28)	(1.13)	(2.32)	(1.74)	(2.31)

Table VI. Volatility Spreads and Aggregate Risk

This table presents parameter estimates from the time-series predictive regressions of the excess returns of the S&P 500 index on the predicted volatility spreads, residual volatility spreads, implied variance, realized variance and macroeconomic variables. The fitted volatility spreads are the predicted terms obtained from the first-stage regressions of volatility spread measures on implied variance and nonparametric value-at-risk. The residual volatility spreads are the error terms obtained from the first-stage regressions of volatility spread measures on implied variance and nonparametric value-at-risk. Volatility spread measures, implied variance and macroeconomic variables are defined in Table 1. Non-parametric value-at-risk is equal to the lowest daily index return over the preceding month. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead excess value-weighted market returns, where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the intercepts and slope coefficients. The second row presents Newey-West adjusted t-statistics using optimal lag length.

		Constant	VS fitted	VS resid	RET	DEF	TERM	RREL	DP
1-day	HOVS	-0.0172	0.1686	-0.0152	-0.0207	-4.7478	-0.0516	0.1222	0.2078
		(-3.16)	(2.79)	(-3.49)	(-1.12)	(-1.49)	(-0.12)	(2.18)	(3.26)
	HVVS	-0.0149	0.1427	-0.0142	-0.0345	-4.6487	-0.0871	0.0783	0.1779
		(-2.80)	(2.44)	(-3.19)	(-1.85)	(-1.46)	(-0.20)	(1.49)	(2.88)
	OWVS	-0.0282	0.2684	-0.0331	-0.0303	-4.5988	-0.0592	0.1141	0.1837
		(-2.92)	(2.73)	(-4.05)	(-1.64)	(-1.46)	(-0.14)	(2.05)	(2.90)
	VWVS	-0.0184	0.1740	-0.0281	-0.0322	-4.6938	-0.0515	0.1010	0.1909
		(-2.97)	(2.66)	(-3.71)	(-1.73)	(-1.49)	(-0.12)	(1.84)	(3.01)
1-week	HOVS	-0.0714	0.6866	-0.0528	-0.0948	-5.0219	1.7844	0.7499	0.9511
		(-3.46)	(2.99)	(-2.47)	(-2.11)	(-0.86)	(1.46)	(2.47)	(3.29)
	HVVS	-0.0695	0.6596	-0.0392	-0.1249	-5.8354	1.8029	0.6213	0.8670
		(-3.17)	(2.80)	(-1.86)	(-2.74)	(-1.01)	(1.46)	(1.93)	(2.83)
	OWVS	-0.1260	1.1869	-0.0970	-0.1111	-5.1686	1.7114	0.7278	0.9051
		(-3.40)	(3.15)	(-2.41)	(-2.42)	(-0.89)	(1.42)	(2.27)	(3.00)
	VWVS	-0.0832	0.7805	-0.0709	-0.1130	-5.8361	1.7643	0.6790	0.9099
		(-3.38)	(3.03)	(-2.05)	(-2.45)	(-1.01)	(1.44)	(2.12)	(2.98)
2-week	HOVS	-0.1448	1.4213	-0.0143	0.0325	2.6897	1.9760	1.5216	1.7784
		(-4.10)	(3.55)	(-0.33)	(0.57)	(0.40)	(1.76)	(2.72)	(3.74)
	HVVS	-0.0968	0.8786	-0.0621	-0.0238	3.6767	1.7055	1.1164	1.4631
		(-2.45)	(2.06)	(-1.57)	(-0.38)	(0.51)	(1.35)	(1.99)	(2.84)
	OWVS	-0.2120	1.9777	-0.0637	0.0030	2.6439	1.6635	1.3317	1.6510
		(-3.28)	(2.99)	(-0.81)	(0.05)	(0.37)	(1.39)	(2.36)	(3.36)
	VWVS	-0.1320	1.2140	-0.0675	-0.0031	2.6279	1.6450	1.2578	1.6030
		(-3.14)	(2.73)	(-0.94)	(-0.05)	(0.37)	(1.35)	(2.24)	(3.18)
1-month	HOVS	-0.2267	2.1355	0.1204	0.0547	13.8517	4.1438	2.9470	3.3021
		(-3.27)	(2.81)	(1.23)	(0.54)	(1.29)	(2.71)	(3.56)	(3.65)
	HVVS	-0.2857	2.7472	0.1109	0.0800	7.7006	3.7274	2.6729	3.3108
		(-3.13)	(2.75)	(1.45)	(0.74)	(0.69)	(2.49)	(3.07)	(3.53)
	OWVS	-0.4588	4.2765	0.1091	0.0852	7.6420	3.8846	2.8937	3.5310
		(-3.22)	(2.98)	(0.62)	(0.79)	(0.68)	(2.51)	(3.47)	(3.61)
	VWVS	-0.3119	2.9290	0.0972	0.0834	8.3360	3.9104	2.8791	3.3580
		(-3.24)	(2.90)	(0.61)	(0.77)	(0.76)	(2.63)	(3.39)	(3.62)

Table VII. Accounting for Non-Normalities in the Empirical Return Distribution

This table presents results from the time-series predictive regressions of excess returns of the S&P 500 index on volatility spreads, implied variance and macroeconomic variables. Volatility spread measures, implied variance and macroeconomic variables are defined in Table 1. The parameters of the skewed t density function of Hansen (1994) are estimated using the maximum likelihood methodology. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead excess value-weighted market returns, where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the intercepts, slope coefficients and parameter estimates for the Skewed t density. σ, λ, and υ represent the standard deviation, skewness, and tail-thickness parameters, respectively. The second row presents the t-statistics obtained from the maximum likelihood estimation.

		Constant	VS	VIXSQ	RET	DEF	TERM	RREL	DP	σ	λ	υ
1-day	HOVS	-0.0014	-0.0129	11.7310	-0.0360	-2.6963	0.1345	0.1038	0.2230	0.0115	-0.0984	4.1619
		(-1.12)	(-3.26)	(7.51)	(-2.42)	(-1.05)	(0.41)	(1.95)	(4.02)	(32.11)	(-3.71)	(11.03)
	HVVS	-0.0012	-0.0119	11.0776	-0.0355	-2.7119	0.1543	0.0884	0.2169	0.0115	-0.1004	4.1988
		(-0.94)	(-3.01)	(7.06)	(-2.38)	(-1.04)	(0.46)	(1.66)	(3.90)	(32.65)	(-3.78)	(11.01)
	OWVS	0.0006	-0.0292	11.5895	-0.0363	-2.5779	0.1712	0.1072	0.2068	0.0115	-0.1004	4.1658
		(0.47)	(-4.31)	(7.42)	(-2.44)	(-1.01)	(0.51)	(2.02)	(3.72)	(32.10)	(-3.78)	(11.02)
	VWVS	0.0001	-0.0261	12.0297	-0.0364	-2.5777	0.1881	0.0988	0.2188	0.0115	-0.1060	(4.1661
		(0.08)	(-4.12)	(7.61)	(-2.44)	(-1.00)	(0.57)	(1.86)	(3.94)	(32.02)	(-3.99)	(11.01)
1-week	HOVS	-0.0004	-0.0634	12.8879	-0.0524	-10.3765	0.6450	0.7897	0.9295	0.0243	-0.2985	4.7652
		(-0.08)	(-3.23)	(9.11)	(-1.72)	(-1.73)	(0.95)	(3.04)	(3.54)	(16.07)	(-5.19)	(4.54)
	HVVS	-0.0016	-0.0444	12.1586	-0.0588	-10.733	0.6678	0.7813	0.9067	0.0242	-0.2854	5.0674
		(-0.27)	(-2.30)	(8.50)	(-1.89)	(-1.74)	(0.85)	(2.96)	(3.44)	(17.89)	(-4.95)	(4.53)
	OWVS	0.0071	-0.1090	12.7106	-0.0572	-8.9734	0.6034	0.7929	0.8318	0.0241	-0.3071	5.1682
		(1.08)	(-3.44)	(9.05)	(-1.83)	(-1.51)	(0.88)	(3.07)	(3.17)	(18.01)	(-5.28)	(4.50)
	VWVS	0.0020	-0.0780	12.6183	-0.0531	-10.5016	0.7157	0.7550	0.8777	0.0241	-0.2903	5.1298
		(0.32)	(-2.56)	(8.75)	(-1.70)	(-1.74)	(1.04)	(2.91)	(3.31)	(18.06)	(-4.98)	(4.50)
2-week	HOVS	-0.0079	-0.0328	8.6318	-0.0034	3.3481	0.9947	1.2962	1.3520	0.0307	-0.2822	6.8855
		(-0.62)	(-0.90)	(5.79)	(-0.06)	(0.38)	(0.94)	(2.32)	(2.52)	(14.10)	(-3.24)	(2.22)
	HVVS	-0.0059	-0.0561	8.3479	-0.0088	4.3672	1.0347	1.2310	1.3389	0.0306	-0.2737	6.7346
		(-0.49)	(-1.47)	(5.64)	(-0.17)	(0.49)	(1.00)	(2.21)	(2.56)	(13.66)	(-3.12)	(2.21)
	OWVS	-0.0067	-0.0468	8.4304	-0.0027	4.0470	1.0153	1.2864	1.3527	0.0306	-0.2721	7.1236
		(-0.46)	(-0.71)	(5.66)	(-0.05)	(0.46)	(0.96)	(2.30)	(2.46)	(14.51)	(-3.09)	(2.18)
	VWVS	-0.0077	-0.0421	8.3609	-0.0007	3.7700	1.0032	1.2675	1.3625	0.0306	-0.2680	7.0344
		(-0.59)	(-0.72)	(5.59)	(-0.01)	(0.43)	(0.97)	(2.27)	(2.55)	(14.26)	(-3.02)	(2.17)
1-month	HOVS	-0.0230	0.1159	5.1793	0.0633	14.0603	3.8571	2.5619	2.9964	0.0413	-0.4050	61.8922
		(-0.74)	(1.52)	(2.98)	(0.78)	(1.17)	(2.09)	(1.75)	(2.72)	(15.95)	(-2.60)	(0.18)
	HVVS	-0.0279	0.0653	5.4971	0.0551	13.2515	3.9672	2.5732	2.9432	0.0413	-0.3408	57.4306
		(-0.86)	(0.82)	(3.13)	(0.70)	(1.12)	(2.13)	(1.80)	(2.66)	(15.31)	(-2.03)	(0.18)
	OWVS	-0.0313	0.0779	5.4434	0.0585	12.0308	3.9148	2.5826	3.0600	0.0414	-0.3413	47.1204
		(-0.85)	(0.64)	(3.10)	(0.75)	(1.02)	(2.05)	(1.81)	(2.62)	(15.07)	(-2.04)	(0.22)
	VWVS	-0.0259	0.0550	5.4810	0.0528	12.9722	4.0033	2.5978	2.9225	0.0414	-0.3464	59.0715
		(-0.77)	(0.52)	(3.11)	(0.69)	(1.11)	(2.12)	(1.82)	(2.61)	(15.29)	(-2.06)	(0.18)

Table VIII. Small Sample Bias Correction

This table presents results from the time-series predictive regressions of the excess returns of the S&P 500 index on volatility spreads, implied variance and macroeconomic variables. Volatility spread measures, implied variance, and macroeconomic variables are defined in Table 1. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead excess market returns. The regressions employ the randomization method of Nelson and Kim (1993) to correct for small sample biases identified in Stambaugh (1999). For each regression, the first row gives the small sample bias corrected intercepts and slope coefficients. The second row presents the small sample bias corrected p-values. A p-value of 0.995 (0.005) shows that the coefficient is negative (positive) and statistically significant at the 1% level.

	Constant	HOVS	HVVS	OWVS	VWVS	VIXSQ	RET	DEF	TERM	RREL	DP
1-day	-0.0025	-0.0149				7.9227	-0.0228	-4.6459	-0.0770	0.1180	0.1419
	[0.98]	[1.00]				[0.00]	[0.88]	[0.92]	[0.56]	[0.06]	[0.00]
	-0.0023		-0.0146			7.5875	-0.0228	-4.8381	-0.0418	0.1116	0.1354
	[0.97]		[1.00]			[0.00]	[0.88]	[0.96]	[0.55]	[0.05]	[0.02]
	-0.0003			-0.0336		7.9600	-0.0261	-4.7771	-0.0606	0.1191	0.1249
	[0.64]			[1.00]		[0.00]	[0.91]	[0.95]	[0.54]	[0.05]	[0.01]
	-0.0013				-0.0282	8.1314	-0.0258	-4.8831	-0.0454	0.1219	0.1409
	[0.85]				[1.00]	[0.00]	[0.93]	[0.95]	[0.58]	[0.03]	[0.01]
1-week	0.0306	-0.0577				7.9965	-0.1116	-6.4690	2.1791	1.0252	-2.1974
	[0.95]	[0.98]				[0.00]	[0.99]	[0.79]	[0.04]	[0.01]	[0.02]
	0.0218		-0.0382			6.3285	-0.1102	-5.8366	1.7963	0.7187	-1.3248
	[0.96]		[0.96]			[0.00]	[0.99]	[0.80]	[0.02]	[0.03]	[0.05]
	0.0125			-0.0948		6.3281	-0.1009	-4.9777	1.7701	0.7747	-0.5200
	[0.73]			[1.00]		[0.00]	[0.99]	[0.75]	[0.03]	[0.02]	[0.02]
	0.0208				-0.0571	6.5459	-0.0926	-7.3841	2.0656	0.7994	-1.1520
	[0.88]				[0.97]	[0.00]	[1.00]	[0.82]	[0.02]	[0.03]	[0.03]
2-week	0.0102	-0.0140				5.6522	0.0237	1.3300	1.9991	1.4687	-1.0581
	[0.98]	[0.64]				[0.00]	[0.36]	[0.39]	[0.08]	[0.01]	[0.04]
	0.0393		-0.0763			4.4673	0.0308	4.2641	1.7829	1.4679	-2.6433
	[0.91]		[0.92]			[0.01]	[0.40]	[0.39]	[0.06]	[0.00]	[0.06]
	0.0266			-0.0182		4.5078	0.0249	0.2112	1.3286	0.5126	-2.3385
	[0.97]			[0.83]		[0.00]	[0.37]	[0.38]	[0.12]	[0.02]	[0.01]
	0.0355				-0.0320	5.0211	0.0339	0.0805	0.6520	0.4939	-2.1632
	[0.93]				[0.88]	[0.00]	[0.40]	[0.36]	[0.10]	[0.04]	[0.05]
1-month	0.0579	0.0035				5.8597	0.0698	13.8847	5.6832	5.3198	-4.4964
	[0.90]	[0.38]				[0.00]	[0.43]	[0.14]	[0.17]	[0.01]	[0.01]
	0.0304		0.0738			6.7293	0.0309	8.0964	3.1419	2.4750	-3.6850
	[0.91]		[0.20]			[0.00]	[0.37]	[0.19]	[0.24]	[0.03]	[0.02]
	-0.0287			0.1380		4.9889	0.1178	9.6364	3.9882	2.6816	-0.1442
	[0.94]			[0.17]		[0.00]	[0.48]	[0.15]	[0.22]	[0.03]	[0.08]
	-0.0075				0.0860	3.7956	0.0901	9.4740	4.2859	3.0311	-1.0076
	[0.92]				[0.19]	[0.01]	[0.46]	[0.15]	[0.20]	[0.02]	[0.04]

Table IX. Alternative Small Sample Bias Correction

This table presents parameter estimates from the time-series predictive regressions of excess returns of the S&P 500 index on the volatility spreads. Volatility spread measures are defined in Table 1. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead value-weighted excess market returns where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the small sample bias corrected intercepts and slope coefficients following Lewellen (2004). The second row presents the small sample bias corrected t-statistics.

	Constant	HOVS	HVVS	OWVS	VWVS
1-day	0.0013	-0.0119			
	(3.02)	(-2.65)			
	-0.0023		-0.0161		
	(-5.27)		(-3.46)		
	0.0049			-0.0276	
	(6.37)			(-3.52)	
	-0.0031				-0.0283
	(-4.48)				(-3.79)
1-week	-0.0241	-0.0698			
	(-12.07)	(-3.28)			
	-0.0148		-0.0496		
	(-7.06)		(-2.24)		
	-0.0205			-0.1119	
	(-5.64)			(-3.01)	
	-0.0160				-0.0762
	(-4.89)				(-2.18)
2-week	-0.1051	-0.1114			
	(-29.08)	(-2.88)			
	-0.0498		-0.1132		
	(-13.05)		(-2.91)		
	-0.1083			-0.1749	
	(-16.13)			(-2.53)	
	-0.0609				-0.1310
	(-10.29)				(-2.08)
1-month	-0.1031	0.0518			
	(-13.47)	(0.60)			
	-0.0433		0.1002		
	(-5.27)		(1.16)		
	-0.1765			0.0294	
	(-12.77)			(0.21)	
	-0.0808				0.1276
	(-6.39)				(0.93)

Table X. Distributed Lags

This table presents results from the time-series predictive regressions of excesss returns of the S&P 500 index on the lagged values of volatility spreads, implied variance and macroeconomic variables. For the 1-week horizon, we include five daily lags of each volatility spread measure in the regressions. The corresponding lags are 10 and 21 for the 2-week and 1-month horizons, respectively. SUMVS is equal to the sum of the coefficients of the lagged volatility spreads. Volatility spread measures, implied variance and macroeconomic variables are defined in Table 1. In each regression, the dependent variable is the 1-day ahead excess market returns, where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the intercepts and slope coefficients. The second row presents Newey-West adjusted t-statistics using optimal lag length except for the SUMVS column where the second row presents p-values associated with the F-test for the equality of the sum of the coefficients of the lagged volatility spread measures to zero.

		Constant	SUMVS	VIXSQ	RET	DEF	TERM	RREL	DP
1-week	HOVS	-0.0030	-0.0204	8.2682	-0.0254	-4.6925	-0.0773	0.1270	0.2077
		(-2.14)	[0.01]	(3.16)	(-1.36)	(-1.47)	(-0.18)	(2.27)	(3.26)
	HVVS	-0.0039	-0.0072	7.4966	-0.0272	-4.8533	-0.0648	0.1068	0.2023
		(-2.55)	[0.04]	(2.82)	(-1.46)	(-1.54)	(-0.15)	(1.91)	(3.14)
	OWVS	-0.0022	-0.0233	7.8673	-0.0287	-4.4831	-0.0515	0.1174	0.1936
		(-1.22)	[0.01]	(3.01)	(-1.57)	(-1.45)	(-0.12)	(2.07)	(3.01)
	VWVS	-0.0027	-0.0208	8.0120	-0.0293	-4.6535	-0.0457	0.1134	0.2023
		(-1.64)	[0.10]	(3.00)	(-1.58)	(-1.50)	(-0.11)	(2.00)	(3.12)
2-week	HOVS	-0.0024	-0.0267	8.4400	-0.0264	-4.4501	-0.0667	0.1343	0.2014
		(-1.71)	[0.02]	(3.22)	(-1.41)	(-1.39)	(-0.16)	(2.37)	(3.14)
	HVVS	-0.0036	-0.0100	7.6064	-0.0272	-4.7100	-0.0479	0.1096	0.1992
		(-2.31)	[0.32]	(2.82)	(-1.46)	(-1.49)	(-0.11)	(1.95)	(3.08)
	OWVS	-0.0021	-0.0239	7.9113	-0.0293	-4.3483	-0.0418	0.1182	0.1900
		(-1.16)	[0.06]	(3.01)	(-1.59)	(-1.38)	(-0.10)	(2.08)	(2.96)
	VWVS	-0.0028	-0.0192	8.0302	-0.0307	-4.6919	-0.0460	0.1125	0.1981
		(-1.66)	[0.44]	(2.98)	(-1.65)	(-1.50)	(-0.11)	(1.97)	(3.05)
1-month	HOVS	-0.0029	-0.0208	8.3711	-0.0245	-4.8056	-0.0993	0.1300	0.2023
		(-1.86)	[0.10]	(3.24)	(-1.30)	(-1.50)	(-0.23)	(2.32)	(3.15)
	HVVS	-0.0039	-0.0070	7.6032	-0.0247	-4.7216	-0.0091	0.1108	0.1988
		(-2.30)	[0.55]	(2.82)	(-1.33)	(-1.49)	(-0.02)	(1.97)	(3.08)
	OWVS	-0.0021	-0.0233	7.7937	-0.0284	-4.7676	-0.0459	0.1175	0.1899
		(-1.04)	[0.52]	(2.99)	(-1.54)	(-1.51)	(-0.11)	(2.07)	(2.97)
	VWVS	-0.0030	-0.0164	7.8720	-0.0295	-4.8456	-0.0207	0.1119	0.1966
		(-1.60)	[0.88]	(2.92)	(-1.57)	(-1.53)	(-0.05)	(1.96)	(3.04)

Table XI. Logarithmic Returns

This table presents parameter estimates from the time-series predictive regressions of logarithmic excess returns of the S&P 500 index on volatility spreads, implied variance and macroeconomic variables. Volatility spread measures, implied variance and macroeconomic variables are defined in Table 1. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead logarithmic excess value-weighted market returns, where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the intercepts and slope coefficients. The second row presents Newey-West adjusted t-statistics using optimal lag length.

	Constant	HOVVS	HVVS	OWVS	VWVS	VIXSQ	RET	DEF	TERM	RREL	DP
1-day	-0.0034	-0.0149				7.5529	-0.0250	-4.8991	-0.0658	0.1185	0.2051
	(-2.53)	(-3.44)				(2.86)	(-1.34)	(-1.54)	(-0.16)	(2.11)	(3.22)
	-0.0033		-0.0144			7.2550	-0.0252	-4.7969	-0.0507	0.1087	0.2037
	(-2.47)		(-3.23)			(2.71)	(-1.36)	(-1.53)	(-0.12)	(1.94)	(3.16)
	-0.0012			-0.0331		7.6176	-0.0261	-4.6620	-0.0398	0.1219	0.1901
	(-0.82)			(-4.04)		(2.91)	(-1.41)	(-1.49)	(-0.09)	(2.14)	(2.97)
	-0.0021				-0.0282	7.8072	-0.0262	-4.7692	-0.0255	0.1148	0.2024
	(-1.47)				(-3.72)	(2.91)	(-1.41)	(-1.52)	(-0.06)	(2.02)	(3.13)
1-week	-0.0161	-0.0518				6.1534	-0.1027	-5.5205	1.8364	0.7440	0.9472
	(-2.83)	(-2.38)				(3.03)	(-2.29)	(-0.96)	(1.48)	(2.36)	(3.21)
	-0.0170		-0.0378			5.9311	-0.0986	-5.2768	1.9382	0.7362	0.9498
	(-2.91)		(-1.80)			(2.90)	(-2.19)	(-0.93)	(1.51)	(2.36)	(3.19)
	-0.0109			-0.0942		6.1564	-0.1007	-4.7143	1.8094	0.7496	0.9150
	(-1.73)			(-2.33)		(3.05)	(-2.20)	(-0.81)	(1.45)	(2.37)	(3.09)
	-0.0141				-0.0693	6.2176	-0.0976	-5.2748	1.8728	0.7262	0.9379
	(-2.31)				(-1.99)	(3.01)	(-2.13)	(-0.92)	(1.47)	(2.31)	(3.14)
2-week	-0.0368	-0.0087				5.6339	0.0240	1.5661	1.8639	1.4494	1.7617
	(-3.93)	(-0.20)				(3.21)	(0.40)	(0.24)	(1.61)	(2.56)	(3.61)
	-0.0316		-0.0584			5.6444	0.0182	2.8224	1.9333	1.4715	1.7128
	(-3.26)		(-1.51)			(3.23)	(0.30)	(0.42)	(1.65)	(2.61)	(3.52)
	-0.0312			-0.0620		5.6928	0.0217	2.4071	1.7874	1.4663	1.7266
	(-2.93)			(-0.81)		(3.30)	(0.36)	(0.35)	(1.56)	(2.60)	(3.60)
	-0.0309				-0.0690	5.7506	0.0227	2.3341	1.8056	1.4614	1.7261
	(-2.91)				(-0.99)	(3.31)	(0.38)	(0.34)	(1.57)	(2.61)	(3.54)
1-month	-0.0805	0.1168				4.6102	0.0773	11.2824	3.9919	3.0524	3.4448
	(-3.58)	(1.20)				(2.56)	(0.73)	(1.07)	(2.65)	(3.69)	(3.67)
	-0.0806		0.1097			4.6626	0.0688	10.0608	4.1253	2.9878	3.4263
	(-3.84)		(1.51)			(2.53)	(0.65)	(0.93)	(2.81)	(3.52)	(3.68)
	-0.0831			0.1087		4.6921	0.0720	8.5511	4.0014	2.9446	3.5153
	(-2.79)			(0.61)		(2.74)	(0.67)	(0.78)	(2.57)	(3.58)	(3.54)
	-0.0795				0.1017	4.7156	0.0689	9.7314	4.1051	2.9918	3.3708
	(-3.34)				(0.65)	(2.62)	(0.65)	(0.91)	(2.77)	(3.60)	(3.61)

Table XII. Controlling for Squared Volatility Spreads

This table presents parameter estimates from the time-series predictive regressions of excess returns of the S&P 500 index on volatility spreads, squared volatility spreads, implied variance and macroeconomic variables. Volatility spread measures, implied variance and macroeconomic variables are defined in Table 1. VSSQ is equal to the square of the volatility spread measure used in the specification. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead excess value-weighted market returns, where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the intercepts and slope coefficients. The second row presents Newey-West adjusted t-statistics using optimal lag length.

	Constant	HOVVS	HVVS	OWVS	VWVS	VSSQ	VIXSQ	RET	DEF	TERM	RREL	DP
1-day	-0.0031	-0.0231				0.0402	8.0165	-0.0254	-4.8045	-0.0741	0.1207	0.2090
	(-2.29)	(-1.97)				(0.74)	(3.03)	(-1.36)	(-1.51)	(-0.18)	(2.16)	(3.28)
	-0.0024		-0.0366			0.1021	7.4559	-0.0260	-4.9752	-0.0512	0.1057	0.2110
	(-1.59)		(-1.99)			(1.22)	(2.78)	(-1.41)	(-1.55)	(-0.12)	(1.89)	(3.28)
	0.0023			-0.1086		0.3734	7.5955	-0.0252	-4.8071	-0.0345	0.1186	0.1968
	(0.92)			(-2.35)		(1.64)	(2.92)	(-1.38)	(-1.53)	(-0.08)	(2.11)	(3.07)
	0.0005				-0.0886	0.3143	7.6423	-0.0258	-4.9408	-0.0183	0.1072	0.2085
	(0.25)				(-2.31)	(1.64)	(2.83)	(-1.41)	(-1.57)	(-0.04)	(1.90)	(3.23)
1-week	-0.0162	-0.0477				-0.0911	6.7854	-0.1027	-5.0986	1.7941	0.7781	0.9670
	(-2.83)	(-2.20)				(-1.30)	(3.33)	(-2.29)	(-0.89)	(1.49)	(2.48)	(3.25)
	-0.0166		-0.0564			0.0773	6.4803	-0.0992	-5.5785	1.8472	0.7472	0.9689
	(-2.54)		(-0.91)			(0.36)	(3.16)	(-2.20)	(-0.97)	(1.49)	(2.41)	(3.24)
	-0.0116			-0.0876		-0.0549	6.7511	-0.1008	-4.5930	1.7612	0.7732	0.9352
	(-1.77)			(-2.03)		(-0.73)	(3.35)	(-2.21)	(-0.80)	(1.46)	(2.46)	(3.13)
	-0.0148				-0.0634	-0.0294	6.7721	-0.0978	-5.3021	1.8165	0.7434	0.9550
	(-2.26)				(-1.31)	(-0.28)	(3.28)	(-2.13)	(-0.93)	(1.48)	(2.39)	(3.18)
2-week	-0.0396	0.0560				-0.3439	6.0048	0.0245	1.6342	1.8129	1.4391	1.7769
	(-3.40)	(0.49)				(-0.65)	(3.33)	(0.42)	(0.24)	(1.59)	(2.58)	(3.60)
	-0.0257		-0.1782			0.5112	5.7335	0.0089	2.3779	1.9847	1.4735	1.7089
	(-2.50)		(-1.63)			(1.24)	(3.30)	(0.15)	(0.34)	(1.68)	(2.67)	(3.53)
	-0.0206			-0.2954		1.1659	5.8134	0.0195	2.9682	1.8193	1.4482)	1.7563
	(-1.32)			(-1.11)		(0.92)	(3.30)	(0.33)	(0.42)	(1.55)	(2.59)	(3.67)
	-0.0184				-0.3434	1.4058	5.7278	0.0195	2.5127	1.8824	1.4179)	1.7384
	(-1.42)				(-1.76)	(1.53)	(3.30)	(0.33)	(0.36)	(1.60)	(2.57)	(3.58)
1-month	-0.0816	0.0641				0.5641	4.5370	0.0741	11.3975	4.1299	3.0034	3.5228
	(-3.85)	(0.60)				(1.70)	(2.63)	(0.71)	(1.06)	(2.78)	(3.61)	(3.87)
	-0.0593		-0.3964			2.3683	4.5062	0.0739	11.9584	4.5966	3.0835	3.5512
	(-2.51)		(-1.80)			(2.64)	(2.65)	(0.72)	(1.09)	(3.12)	(3.63)	(3.70)
	-0.0737			-0.0404		0.7315	4.7300	0.0717	11.5798	4.3456	3.0399	3.4428
	(-2.46)			(-0.18)		(1.83)	(2.82)	(0.69)	(1.00)	(2.75)	(3.61)	(3.62)
	-0.0679				-0.1541	0.9816	4.8402	0.0763	11.8685	4.4489	3.0812	3.5218
	(-2.75)				(-0.60)	(1.69)	(2.81)	(0.74)	(1.07)	(2.98)	(3.68)	(3.68)

Table XIII. Additional Macroeconomic Controls

This table presents parameter estimates from the time-series predictive regressions of excess returns of the S&P 500 index on volatility spreads, implied variance and macroeconomic variables. Volatility spread measures, implied variance and macroeconomic variables except DFR and LTY are defined in Table 1. DFR is the change in the default return spread calculated as the change in the difference between the yields of AAA-rated corporate bonds and 10-year Treasury bonds. LTY is the long-term yield defined as the change in the yield of 10-year Treasury bonds. In each regression, the dependent variable is the 1-day, 1-week, 2-week or 1-month ahead excess value-weighted market returns, where the returns start accruing from the opening of the next trading day. For each regression, the first row gives the intercepts and slope coefficients. The second row presents Newey-West adjusted t-statistics using optimal lag lengths.

	Constant	HOVVS	HVVS	OWVS	VWVS	VIXSQ	RET	DEF	TERM	RREL	DP	DFR	LTY
1-day	-0.0034	-0.0151				7.8844	-0.0183	-4.5877	0.2830	0.1234	0.2048	1.1248	-1.6284
	(-2.51)	(-3.48)				(2.97)	(-0.97)	(-1.22)	(0.67)	(2.18)	(3.21)	(0.39)	(-1.26)
	-0.0033		-0.0144			7.5976	-0.0191	-4.7005	0.2846	0.1135	0.2037	0.7559	-1.6670
	(-2.47)		(-3.21)			(2.82)	(-1.01)	(-1.25)	(0.67)	(2.00)	(3.16)	(0.26)	(-1.27)
	-0.0012			-0.0331		7.9380	-0.0196	-4.2680	0.2909	0.1264	0.1897	1.2221	-1.4960
	(-0.81)			(-4.03)		(3.02)	(-1.05)	(-1.14)	(0.68)	(2.19)	(2.96)	(0.42)	(-1.15)
	-0.0021				-0.0283	8.1538	-0.0201	-4.6751	0.3101	0.1197	0.2024	0.7514	-1.6695
	(-1.47)				(-3.72)	(3.03)	(-1.07)	(-1.25)	(0.72)	(2.08)	(3.13)	(0.26)	(-1.28)
1-week	-0.0173	-0.0528				7.0989	-0.1195	-10.4377	1.8737	0.7985	0.9924	-9.2071	-3.5176
	(-2.93)	(-2.42)				(3.43)	(-2.53)	(-1.44)	(1.33)	(2.60)	(3.30)	(-1.57)	(-1.34)
	-0.0182		-0.0391			6.9042	-0.1164	-10.1884	1.9189	0.7893	0.9969	-9.4484	-3.2804
	(-3.02)		(-1.86)			(3.34)	(-2.45)	(-1.43)	(1.32)	(2.60)	(3.30)	(-1.60)	(-1.25)
	-0.0122			-0.0938		7.0777	-0.1166	-9.3443	1.8245	0.7995	0.9586	-8.6886	-3.2176
	(-1.84)			(-2.30)		(3.45)	(-2.42)	(-1.29)	(1.30)	(2.59)	(3.18)	(-1.49)	(-1.24)
	-0.0152				-0.0709	7.1764	-0.1148	-10.1814	1.8840	0.7794	0.9835	-9.2988	-3.4052
	(-2.41)				(-2.05)	(3.43)	(-2.38)	(-1.41)	(1.31)	(2.55)	(3.24)	(-1.59)	(-1.30)
2-week	-0.0357	-0.0123				5.6406	0.0365	2.3613	2.2660	1.4698	1.7398	3.8732	-1.2600
	(-3.70)	(-0.28)				(3.09)	(0.60)	(0.33)	(1.86)	(2.52)	(3.49)	(0.55)	(-0.45)
	-0.0314		-0.0553			5.6997	0.0276	3.2063	2.2863	1.4914	1.7032	2.7003	-1.2640
	(-3.21)		(-1.37)			(3.11)	(0.44)	(0.45)	(1.86)	(2.58)	(3.43)	(0.38)	(-0.46)
	-0.0305			-0.0615		5.6963	0.0342	3.1850	2.1768	1.4831	1.7076	3.7677	-1.1482
	(-2.83)			(-0.80)		(3.17)	(0.55)	(0.42)	(1.81)	(2.56)	(3.49)	(0.55)	(-0.41)
	-0.0306				-0.0654	5.7674	0.0339	2.9049	2.1925	1.4806	1.7117	3.2875	-1.2509
	(-2.85)				(-0.94)	(3.18)	(0.54)	(0.40)	(1.81)	(2.57)	(3.44)	(0.48)	(-0.45)
1-month	-0.0806	0.1175				4.8116	0.0821	11.9935	4.0163	3.0604	3.4535	0.3910	0.2316
	(-3.55)	(1.17)				(2.43)	(0.75)	(1.00)	(2.23)	(3.68)	(3.63)	(0.04)	(0.05)
	-0.0804		0.1076			4.8547	0.(0740	10.7478	4.1870	3.0029	3.4295	0.4560	0.0707
	(-3.75)		(1.46)			(2.45)	(0.69)	(0.89)	(2.32)	(3.51)	(3.63)	(0.05)	(0.01)
	-0.0831			0.1076		4.9102	0.0783	9.4635	3.9890	2.9449	3.5233	0.7968	0.5422
	(-2.79)			(0.59)		(2.60)	(0.71)	(0.79)	(2.14)	(3.47)	(3.55)	(0.08)	(0.11)
	-0.0795				0.0993	4.9541	0.0749	10.6129	4.0783	2.9919	3.3837	0.6175	0.5713
	(-3.30)				(0.62)	(2.53)	(0.69)	(0.89)	(2.24)	(3.53)	(3.57)	(0.07)	(0.11)