The Cross-Sectional Variation of Skew Risk Premia*

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Abstract

This paper estimates the variance risk premium (VRP) and the skew risk premium (SRP) for the individual stocks and indexes in the US financial markets, and then further analyzes the determinants of the cross-sectional variations of (i) the VRP and SRP for 40 indexes and stocks, (ii) the average VRP and SRP for a representative set of portfolios sorted by the VRP and SRP betas, and (iii) the future variance and skew risk premia. We find that (i) most of the stocks and indexes have negative and significant variance and skew risk premia; (ii) the default premium (DEF) is the key risk factor in the cross-sectional variation of average SRP payoffs; and (iii) there is a negative and statistically significant relation between the future SRP and the lottery demand factor (MAX).

Keywords: skew swap; skew risk premium; variance risk premium; cross-section.

JEL Classifications: G13, G12.

1. Introduction

In the last decade, the variance risk premium (VRP) in the US financial markets has generated strong interest among academic researchers. Carr and Wu (2009) originally use the difference between the realized variance (RV) and a synthetic variance swap rate to quantify the VRP and find that there exists a large and negative mean of the VRP on five stock indexes and 35 individual stocks by using a large options data set. Later on, Todorov (2010); Bollerslev and Todorov (2011); Bollerslev, Todorov, and Xu (2015) use the rare events to account for the large average VRP. Recently, González-Urteaga and Rubio (2016) have extended this research to discuss and explain the VRP at the portfolio level. Theoretically, Bollerslev, Tauchen, and Zhou (2009); Drechsler and Yaron (2011); Drechsler (2013) adopt the long-run risks model (first proposed by Bansal and Yaron (2004)) to successfully explain the large average VRP, and Buraschi, Trojani, and Vedolin (2014) use a two-tree Lucas (1978) economy with two heterogeneous investors to explain well the VRP.

Following Carr and Wu (2009), Kozhan, Neuberger, and Schneider (2013) newly define the skew risk premium based on Neuberger's (2012) realized skewness (RS). They use the difference between the RS and a synthetic skew swap rate to quantify the SRP and provide strong empirical evidence for the coexistence of both skew and variance risk premia in the equity index market (i.e., S&P 500 Index). Similar to Carr and Wu (2009), they also use the common factor models to explain the significant and negative skew risk premia (SRP).

This paper contributes to the existing literature. First, we extend the VRP discussed in Carr and Wu (2009); González-Urteaga and Rubio (2016) into the SRP. Second, we cross-sectionally study the SRP unlike Kozhan et al. (2013), who only estimate the SRP of the S&P 500 Index market. Specifically, we estimate the VRP and SRP for 5 common indexes and 35 stocks based on option quote availability and explain it by using classic factor models as same as the models Carr and Wu (2009) uses. Furthermore, we sort around 1000 stocks into 40 portfolios based on VRP and SRP beta and compare the explanatory performance of common factor models. Finally, we run Fama and MacBeth (1973) predictive regressions to test whether the firm-specific characteristics can explain the cross-section of the future VRP and SRP.

In our analysis of 40 indexes and stocks, first, we find results consistent with Carr and Wu (2009) that the sample averages of the VRP are significant and negative for all 5 indexes and most of the individual stocks. Second, in terms of the SRP of the S&P 500 Index, we also find the significant and negative SRP, which is consistent with Kozhan et al. (2013). Third, the means of SRP across 5 indexes and most of the individual stocks are significant and negative. Finally, we compare the value and correlations of the VRP and the SRP based on different definitions in order to find a relatively good proxy of the SRP.

In our portfolio level analysis, following González-Urteaga and Rubio (2016), we sort around 1000 stocks into 20 groups based on their VRP (SRP) betas. Furthermore, following Fama and French (2015), we use Gibbons, Ross, and Shanken (1989) tests to compare 11 common factor models and find that the default premium (DEF) is the key risk factor in the cross-sectional variation of average SRP payoffs. Especially, the combination of the market SRP and DEP works best to explain the cross-section of the SRP based on 20 SRP beta sorted portfolios.

In our firm level analysis, we find that the cross-section of the future VRP can be explained by the one-month lagged illiquidity (ILLIQ), idiosyncratic volatility (IVOL) and systematic volatility (SVOL). In addition, there are negative and statistically significant relations between the future SRP and the log market capitalization (SIZE) and between the future SRP and the maximum daily return (MAX), while, there is a positive and statistically significant relation between the cross-section of the future SRP and the IVOL. Furthermore, we find the lottery demand factor, MAX, is the strongest predictive factor among 11 firm-specific characteristics.

The remainder of our paper is organized as follows. Section 2 defines the skew swap and risk premia. Section 3 shows our data and methodology. Section 4 provides our empirical analysis, and Section 5 concludes.

2. Skew risk premia

2.1 Two g-function swaps

Following Neuberger (2012); Kozhan et al. (2013), we denote the stock price at time t as S_t, and then the log return of the stock from t to T can be defined as $r_{t,T} = \ln S_T - \ln S_t$. Now we consider a g^V-function swap whose underlying is

$$g^V_{t,T} = 2\left(e^{r_{t,T}} - 1 - r_{t,T}\right), \tag{1}$$

and a g^S-function swap whose underlying is

$$g^S_{t,T} = 6\left(2 + r_{t,T} - 2e^{r_{t,T}} + r_{t,T}e^{r_{t,T}}\right). \tag{2}$$

The fixed leg (i.e., the fair price) of the g^V-function swap is

$$G^V_{t,T} \equiv E^{\mathbb{Q}}_t\left[g^V_{t,T}\right] = 2E^{\mathbb{Q}}_t\left[\frac{S_T}{S_t} - 1 - \ln\frac{S_T}{S_t}\right], \tag{3}$$

and the fixed leg of the g^S-function swap is

$$\begin{aligned} G^S_{t,T} \equiv E^{\mathbb{Q}}_t\left[g^S_{t,T}\right] &= E^{\mathbb{Q}}_t\left[6\left(\frac{S_T}{S_t} + 1\right)\ln\frac{S_T}{S_t} - 12\left(\frac{S_T}{S_t} - 1\right)\right] \\ &= 6E^{\mathbb{Q}}_t\left[\frac{S_T}{S_t}\ln\frac{S_T}{S_t} - \left(\frac{S_T}{S_t} - 1\right)\right] - 6E^{\mathbb{Q}}_t\left[\frac{S_T}{S_t} - 1 - \ln\frac{S_T}{S_t}\right] \\ &= 3\left(G^E_{t,T} - G^V_{t,T}\right), \end{aligned} \tag{4}$$

where

$$G^E_{t,T} = 2E^{\mathbb{Q}}_t\left[\frac{S_T}{S_t}\ln\frac{S_T}{S_t} - \left(\frac{S_T}{S_t} - 1\right)\right]. \tag{5}$$

According to Appendix A.1, $G^E_{t,T}$ and $G^V_{t,T}$ can be replicated by European options,

$$G^E_{t,T} = \frac{2}{B_{t,T}S_t}\left(\int_{S_t}^{+\infty}\frac{1}{K}C_{t,T}(K)dK + \int_0^{S_t}\frac{1}{K}P_{t,T}(K)dK\right), \quad (6)$$

and

$$G^V_{t,T} = \frac{2}{B_{t,T}}\left(\int_{S_t}^{+\infty}\frac{1}{K^2}C_{t,T}(K)dK + \int_0^{S_t}\frac{1}{K^2}P_{t,T}(K)dK\right). \quad (7)$$

Letting N denote the number of call (put) options sorted in ascending order by strike prices, we denote the prices of the call (put) option with the strike price K_j as $C_{t,T}(K_j)$ ($P_{t,T}(K_j)$) for $j \in \{1, ..., N\}$. We there after define the strike differences for options as $\Delta K_j = \frac{K_{j+1}-K_{j-1}}{2}$ for $j \in \{2, ..., N-1\}$ and $\Delta K_1 = K_2 - K_1$ and $\Delta K_N = K_N - K_{N-1}$. We then approximate $G^E_{t,T}$ and $G^V_{t,T}$ as

$$G^E_{t,T} = \frac{2e^{r(T-t)}}{S_t}\left(\sum_j \frac{C_{t,T}(K_j)}{K_j}\Delta K_j + \sum_j \frac{P_{t,T}(K_j)}{K_j}\Delta K_j\right), \quad (8)$$

$$G^V_{t,T} = 2e^{r(T-t)}\left(\sum_j \frac{C_{t,T}(K_j)}{K_j^2}\Delta K_j + \sum_j \frac{P_{t,T}(K_j)}{K_j^2}\Delta K_j\right). \quad (9)$$

2.2 Skew swap and risk premia

We assume there are $T - t$ days in $[t, T]$ and the return from day i to day $i + 1$ is $r_{i,i+1} = \ln S_{i+1} - \ln S_i$. According to Neuberger (2012); Kozhan et al. (2013); Zhao, Zhang, and Chang (2013), two g functions have the aggregation property, i.e,

$$E_t\left[2\left(e^{r_{t,T}} - 1 - r_{t,T}\right)\right] = E_t\left[\sum_{i=t}^{T-1} 2\left(e^{r_{i,i+1}} - 1 - r_{i,i+1}\right)\right], \quad (10)$$

and

$$\begin{aligned} &E_t\left[6\left(2 + r_{t,T} - 2e^{r_{t,T}} + r_{t,T}e^{r_{t,T}}\right)\right] \\ =&E_t\left[\sum_{i=t}^{T-1}\left(6\left(2 + r_{i,i+1} - 2e^{r_{i,i+1}} + r_{i,i+1}e^{r_{i,i+1}}\right) + 3\Delta G^E_{i,i+1}\left(e^{r_{i,i+1}} - 1\right)\right)\right], \end{aligned} \quad (11)$$

where

$$\Delta G_{i,i+1}^{E} = G_{i+1,T}^{E} - G_{i,T}^{E}. \tag{12}$$

We thereafter define the realized variance (RV) during the period from t to T as

$$RV_{t,T} = \sum_{i=t}^{T-1} 2\left(e^{r_{i,i+1}} - 1 - r_{i,i+1}\right), \tag{13}$$

and the realized skew (RS) as

$$RS_{t,T} = \frac{RTM_{t,T}}{\left(G_{t,T}^{V}\right)^{3/2}}, \tag{14}$$

where the realized third moment (RTM) is

$$RTM_{t,T} = \sum_{i=t}^{T-1}\left[\underbrace{6\left(2 + r_{i,i+1} - 2e^{r_{i,i+1}} + r_{i,i+1}e^{r_{i,i+1}}\right)}_{RTM^{jump}} + \underbrace{3\Delta G_{i,i+1}^{E}\left(e^{r_{i,i+1}} - 1\right)}_{RTM^{corr}}\right]. \tag{15}$$

Based on Neuberger (2012); Kozhan et al. (2013), we decompose the RTM into two components: the jumps (RTM^{jump}) in stock returns and covariation between shocks to the price level and shocks to future variance (RTM^{corr}). In others words, the skewness in long-horizon returns comes from two sources: the skewness of short-horizon returns (mainly driven by jumps in the returns; see Amaya, Christoffersen, Jacobs, and Vasquez (2015)) and the correlation between the returns and volatility innovations.

Now, we can formally define the variance, the third moment swap and the skew swap.

Definition 1 (Variance Swap). *At time t, two parties enter a variance swap and agree to settle the realized variance at expiration date, T, with the price predetermined, i.e., the fixed leg of the variance swap. The payoff of a variance swap can be expressed as*

$$(RV_{t,T} - FV_{t,T}) \times NA, \tag{16}$$

where $RV_{t,T}$ is the realized variance from t to T calculated by using formula (13)*; $FV_{t,T}$ is the fixed leg of the variance swap predetermined at time t; and NA is the notional amount.*

Definition 2 (Third Moment Swap). *At time t, two parties enter a third moment swap and agree to settle the realized third moment at expiration date, T, with the price predetermined, i.e., the fixed leg of the third moment swap. The payoff of a third moment swap can be expressed as*

$$(RTM_{t,T} - FTM_{t,T}) \times (-NA) \,, \tag{17}$$

where $RTM_{t,T}$ is the realized third moment from t to T calculated by using formula (15)*; $FTM_{t,T}$ is the fixed leg of the third moment swap predetermined at time t; and NA is the notional amount.*

Definition 3 (Skew Swap). *At time t, two parties enter a skew swap and agree to settle the realized skew at expiration date, T, with the price predetermined, i.e., the fixed leg of the skew swap. The payoff of a skew swap can be expressed as*

$$(RS_{t,T} - FS_{t,T}) \times (-NA) \,, \tag{18}$$

where $RS_{t,T}$ is the realized skew from t to T calculated by using formula (14)*; $FS_{t,T}$ is the fixed leg of the skew swap predetermined at time t; and NA is the notional amount.*

Based on Definition 1, long a variance swap is to lock your floating variance during the period from t to T in the fixed leg so that the variance swap is a useful financial tool to hedge the upward movements in the variance of stock returns. It is very important to add a negative sign in front of the notional amount in payoffs of the third moment and skew swaps in Definitions 2 and 3. Investors do not like large variance, so they are willing to long variance swaps as hedging instruments; and the investors do not like the negative skewness of stock returns, so they seek some financial derivatives to hedge the negative skewness risks. In order to achieve this function, adding the negative sign in the payoff of the third moment and skew swaps satisfies investors' needs. If the realized skew (third moment) becomes more negative than the fixed leg, the investors in a long position in skew (third moment) swaps will get a premium as a compensation to make up the loss in the stock market.

Due to the no-arbitrage principle and the aggregation property, the fixed leg of the variance swap (FV), the fixed leg of the third moment swap (FTM) and the fixed leg of the skew swap (FS) can be solved as

$$FV_{t,T} \equiv E_t^{\mathbb{Q}}[RV_{t,T}] = E_t^{\mathbb{Q}}[g_{t,T}^V] = G_{t,T}^V, \tag{19}$$

$$FTM_{t,T} \equiv E_t^{\mathbb{Q}}\left[RTM_{t,T}\right] = E_t^{\mathbb{Q}}\left[RTM_{t,T}\right] = G_{t,T}^S = 3\left(G_{t,T}^E - G_{t,T}^V\right), \tag{20}$$

$$FS_{t,T} \equiv E_t^{\mathbb{Q}}\left[RS_{t,T}\right] = \frac{E_t^{\mathbb{Q}}\left[RTM_{t,T}\right]}{\left(G_{t,T}^V\right)^{3/2}} = \frac{3\left(G_{t,T}^E - G_{t,T}^V\right)}{\left(G_{t,T}^V\right)^{3/2}}. \tag{21}$$

Definition 4 (Risk Premia). *Following Carr and Wu (2009), the variance risk premium can be defined as the difference between the fixed leg of the variance swap and the realized variance, i.e., the payoff of the variance swap.*

$$VRP_{t,T} \equiv (RV_{t,T} - FV_{t,T}) \times 100 = \left(RV_{t,T} - G_{t,T}^V\right) \times 100. \tag{22}$$

Similarly, we define the third moment and skew risk premia as their payoffs.

$$TMRP_{t,T} \equiv (RTM_{t,T} - FTM_{t,T}) \times (-100) = \left[RTM_{t,T} - 3\left(G_{t,T}^E - G_{t,T}^V\right)\right] \times (-100), \tag{23}$$

$$SRP_{t,T} \equiv (RS_{t,T} - FS_{t,T}) \times (-1) = \frac{RTM_{t,T} - 3\left(G_{t,T}^E - G_{t,T}^V\right)}{\left(G_{t,T}^V\right)^{3/2}} \times (-1), \tag{24}$$

where 100 *is the NA for the variance and third moment risk premia and* 1 *is the NA for the skew swap.*

If the floating leg of the skew swap has less negative value than the fixed leg of the skew swap, then the investors who long the skew swap will have to pay a premium. This premium is an insurance fee to lock the skewness in at a fixed level. Based on this contract, if the fixed leg of the skew swap is positive and the floating leg is larger than the positive fixed leg, the investors still need to pay a premium as they lock the skewness in at a positive fixed level. If the floating leg skew becomes more negative compared with the fixed leg, the investors in long positions will get a premium. $TMRP_{t,T}$ and $SRP_{t,T}$ are good indicators to reflect the investors' attitude on the protection of negative skewness. As we demonstrate below, the $VRP_{t,T}$ and $TMRP_{t,T}$ are highly correlated; we prefer the $SRP_{t,T}$ over the $TMRP_{t,T}$ in this paper.

In addition, based on (15), the RTM has two components. In Qiao and Harris (2017), their skewness risk premium (i.e., $RTM^{jump}_{t,T} - FTM_{t,T}$), essentially is not a "premium" but a good proxy of the covariation between shocks to the prices level and shock to future variance (i.e., $RTM^{corr}_{t,T}$).

We also provide the alternative proxies of variance and skew risk premia (i.e., the excess return from investment in the fixed leg), based on Carr and Wu (2009); Kozhan et al. (2013).

$$xv_{t,T} \equiv \frac{RV_{t,T} - FV_{t,T}}{FV_{t,T}} = RV_{t,T}/G^{V}_{t,T} - 1, \tag{25}$$

$$xs_{t,T} \equiv \frac{RTM_{t,T} - FTM_{t,T}}{FTM_{t,T}} = \frac{RS_{t,T} - FS_{t,T}}{FS_{t,T}} = \frac{RTM_{t,T}}{3\left(G^{E}_{t,T} - G^{V}_{t,T}\right)} - 1. \tag{26}$$

The proxy, $xs_{t,T}$, has a disadvantage. Based on use of the third moment or skew swap contract and the meaning of the risk premia, $xs_{t,T}$ needs to be a good measure for the gain (loss) of long a swap if the realized third moment or skew is more (less) negative. However, it cannot achieve this property if the fixed leg is positive. In other words, if the fixed leg of the skew swap is positive and the floating leg is smaller than the positive fixed leg, essentially, the investor should get a positive premium. However, based on the definition of $xs_{t,T}$, the excess return from investment in the fixed leg is negative. This suggests that $xs_{t,T}$ is not a good proxy of the third moment or skew risk premium when the third moment or skew is positive. As we demonstrate below, $FTM_{t,T}$ and $FS_{t,T}$ can be positive for most stocks including the index on several days. In our empirical analysis, we therefore prefer the $SRP_{t,T}$ over the $xs_{t,T}$ in this paper.

3. Data and methodology

Option data from 04 January 1996 to 29 April 2016 are obtained from OptionMetrics Ivy DB. We filter out all entries with nonstandard settlements. We keep options whose underlying assets are stocks which are available in CRSP and the prices of stocks are larger than \$ 1. In order to calculate the fixed legs of swaps, we keep all out-of-the-money (OTM) options that mature within 60 days. Following Carr and Wu (2009); González-Urteaga and Rubio (2016), at each time t, we focus a fixed 30-day horizon maturity, interpolated when necessary using the two nearest maturities. Shorter or longer horizon maturity can be easily extended.

To do so, at each time t, we keep two maturities τ_1 and τ_2 which are nearest to maturity τ. Then the linear interpolation can be applied as

$$G^V_{t,t+\tau} = \frac{\tau_2 - \tau}{\tau_2 - \tau_1} G^V_{t,t+\tau_1} + \frac{\tau - \tau_1}{\tau_2 - \tau_1} G^V_{t,t+\tau_2}, \tag{27}$$

$$G^E_{t,t+\tau} = \frac{\tau_2 - \tau}{\tau_2 - \tau_1} G^E_{t,t+\tau_1} + \frac{\tau - \tau_1}{\tau_2 - \tau_1} G^E_{t,t+\tau_2}. \tag{28}$$

For the rolling windows from t to $t + \tau$, we need to calculate $G^E_{t+i,t+\tau}$ for $i \in \{1, 2, ..., \tau - 1\}$ and $G^E_{t+\tau,t+\tau} = 0$, which will be used to calculate the realized skew in (15). As the procedure diagram shows in Figure 1, for the time $t + i$, we simply use the linear interpolation to get $G^E_{t+i,t+\tau}$. For the time $t + j$ which are so close to the fixed maturity, $t + \tau$, we may only find one nearest maturity (i.e., τ_2). In this scenario, we use the fact that $G^E_{t+j,t+j} = 0$ to linearly interpolate the $G^E_{t+j,t+\tau}$, incorporating $G^E_{t+j,t+\tau_2}$. In other words, we set $\tau_1 = j$ and then $G^E_{t+j,t+\tau_1} = 0$.

[Insert Figure 1]

After this rolling procedure, for each time t, we have the stock prices $G^V_{t,t+\tau}$ and $G^E_{t+i,t+\tau}$ for $i \in \{0, 1, 2, ..., \tau\}$, so that we can calculate the realized variance, the scaled and unscaled realized skew, the fair prices of swaps, variance and skew risk premia and swaps returns a fixed 30-day horizon maturity in Equation (13)-(26). As $G^E_{t+i,t+\tau}$ is not always available, we keep same observations for calculating RS^{ret} and RS^{corr} in (15) in each 30-day period. Following González-Urteaga and Rubio (2016), we calculate the realized skew if no more than 14 $\Delta G^E_{i,i+1}$ and $r_{i,i+1}$ are missing from each 30-day period. Finally, we get all variables in daily frequency. The monthly data are obtained from the beginning of each month. From 04 January 1996 to 29 April 2016, there are 5116 trading days. We only keep stocks which have more than 1000 valid trading days with no-missing VRP and SRP. After applying this rule, we have 1065 stocks left.

We collect daily and monthly data on the MKT (the value-weighted stock market portfolio excess return), the SMB (small minus big) and HML (high minus low) Fama and French risk factors, and the momentum factor (UMD) from the Kenneth French Data Library. In addition, the default premium (DEF), which is the difference between Moody's yield on Baa corporate bonds and the ten-year government bond yield, are obtained from the Federal Reserve Bank of St. Louis. Accounting and balance sheet data are obtained from COMPUSTAT for calculating firm-specific characteristics.

4. Empirical analysis

4.1 5 indexes and 35 stocks

Following Carr and Wu (2009), we present the 5 most popular stock indexes and top 35 individual stocks based on quote availability (i.e., they have more than 4100 valid trading days) in Table 2.[1]

[1]A list of the 5 indexes and 35 stocks is provided in Appendix A.2.

[Insert Table 2]

From Table 2, we have several observations. (i) Consistent with Carr and Wu (2009), the sample averages of the VRP and xv are negative for all 5 indexes and most of the individual stocks. The serial dependence adjusted t-statistics according to Newey and West (1987) with 30 lags are very large in the first four indexes, i.e., SPX, RUT, OEX and DJX. NDX has a relatively small value of t-statistics. (ii) Similar to Kozhan et al. (2013), for SPX, there is significant and negative xs with a mean of -0.49. The average of the daily 30-day xv is -0.25, which is also close to the monthly average of xv in Kozhan et al. (2013) (i.e., -0.223). (iii) Besides that, we also find a significant and negative xs in RUT, OEX and DJX. Similarly, the average xs of NDX is negative but not significant. (iv) The means of SRP across 5 indexes and 35 stocks are more significant than the means of xs, TMRP and VRP. (v) For the first four indexes, their realized third moments are negative and most are caused by the correlation between the returns and volatility innovations (RTM^{corr}). The less negative correlation and jumps (RTM^{jumps}) generate a positive RTM and RS for individual returns. (vi) Even though, the means of TMRP, SRP and xs for some stocks are positive, the medians of all indexes and stocks are negative.

We present the correlations among five risk premium proxies in Table 3. From Column 1, we find VRP and xv are highly correlated. Therefore, as a good comparison of SRP, in this paper, we prefer to further study VRP rather than xv. The correlation between VRP and TMRP are very highly implied by Column 2. From Column 8, we find SPX has an extremely high correlation between xs and SRP. This is because the fixed leg of the third moment or skew swap is highly negative on most of trading days. The errors caused by the positive value of fixed legs for the SPX are very small. Its descriptive statistics and correlations are consistent with Kozhan et al. (2013).

[Insert Table 3]

Following Carr and Wu (2009), we examine whether the classic risk factors explain the VRP and SRP based on monthly regressions. The results of daily regressions are highly consistent with the monthly. To save space, we do not report the estimations results but they are available upon request. The monthly regressions are given as

$$VRP_{t,T} = \alpha + \beta_{MKT} MKT_t + \beta_{SMB} SMB_t + \beta_{HML} HML_t + \beta_{UMD} UMD_t + \beta_{DEF} DEF_t + \epsilon_t, \tag{29}$$

and

$$SRP_{t,T} = \alpha + \beta_{MKT} MKT_t + \beta_{SMB} SMB_t + \beta_{HML} HML_t + \beta_{UMD} UMD_t + \beta_{DEF} DEF_t + \epsilon_t, \tag{30}$$

for 40 indexes and stocks, where MKT is the value-weighted stock market portfolio excess return; SMB, HML and UMD are risk factors related to the firm size, boo-to-market value and the momentum; and DEF is the default premium.

We run (1) MKT, (2) $MKT+SMB+HML$, (3) $MKT+SMB+HML+UMD$, (4) DEF, (5) $MKT + DEF$, and (6) $MKT + SMB + HML + DEF$ models for VRP and SRP. We find that adding SMB, HML factors based on Fama and French (1993) and UMD momentum suggested by Carhart (1997) only slightly improves the explanatory power, so that we present only the results of model (1) in Table 4. The average R^2 of model (1) (which is essentially the capital asset pricing model (CAPM) model), in terms of explaining VRP is 7.5%, while in terms of explaining SRP, it is 1.8%. The market factor, MKT, works better for indexes than the individual stocks. For example, the R^2 of SPX is 22.1% for the VRP and 12.4% for the SRP. In addition, the t-statistics of MKT's coefficients are almost significant and negative in Panel A. Only the index level has significant and negative MKT coefficients in Panel B. The CAPM works better to explain the VRP than the SRP.

[Insert Table 4]

González-Urteaga and Rubio (2016) document that the DEF is a key factor in explaining the VRP at the portfolio level. We also present the results of model (5) as a comparison.[2] We find a result similar to Carr and Wu (2009) that the DEF only can slightly improves the explanatory power of the VRP at the 40-index-and-stock level. However, for the SRP, adding the DEF in Table 5, compared with Table 4, the average R^2 increases from 1.8% to 5.8%. This suggests that the DEF is a key factor in explaining the SRP at the 40-index-and-stock level.

[Insert Table 5]

4.2 Portfolio level analysis

Following González-Urteaga and Rubio (2016), we study 20 VRP beta sorted portfolios and 20 SRP beta sorted portfolios. First, we run the following ordinary least squares (OLS) regressions by using monthly data during the period from January 1996 to April 2016 to get the "VRP (SRP) betas" for each stock.

$$VRP^j_{t,T} = \alpha^j + \beta^j_{VRP} VRP^{SPX}_{t,T}, \tag{31}$$

and

$$SRP^j_{t,T} = \alpha^j + \beta^j_{SRP} SRP^{SPX}_{t,T}, \tag{32}$$

where $VRP^j_{t,T}$ is the VRP of stock j; $VRP^{SPX}_{t,T}$ is the VRP of SPX as the market VRP; $SRP^j_{t,T}$ is the SRP of stock j; and $SRP^{SPX}_{t,T}$ is the SRP of SPX as the market SRP.

We then sort all stocks into 40 portfolios based on their VRP and SRP betas from low to high. The descriptive statistics of the 40 portfolios are given in Table 6. The mean and standard deviation are given in both monthly and daily frequency. First, we find the average VRP and SRP in both are very close. The standard deviation of the monthly VRP and SRP is smaller than that of the daily VRP and SRP. For our longer period and large data sample, different to González-Urteaga and Rubio (2016), there is no monotonic decreasing pattern for the VRP across the 20 VRP beta sorted

[2] The empirical results of the above 6 models are available upon request.

portfolios. In addition, the average SRP is not sensitive to the SRP beta as the cross-sectional variation of the average SRP across the 20 SRP beta sorted portfolios is very small.

[Insert Table 6]

As González-Urteaga and Rubio (2016) mentioned that the DEF is a key factor in explaining the VRP at the portfolio level, following Fama and French (2015), we use Gilboa and Schmeidler (1989) (GRS) test to compare the (1) MKT, (2) $MKT + SMB + HML$, (3) $MKT + SMB + HML + UMD$, (4) DEF, (5) $MKT + DEF$ and (6) $MKT + SMB + HML + DEF$ models in terms of explaining the VRP (SRP) across the 20 VRP (SRP) beta sorted portfolios. The results are given in Table 7.

[Insert Table 7]

From Table 7, first, the GRS test easily rejects all models considered for all left-hand-side (LHS) portfolios and right-hand-side (RHS) factors. The GRS statistics are all large than 1, which says that all models are incomplete descriptions of the VRP and SRP. Second, comparing the relative performance of model (1), (2) and (3), we confirm that adding SMB, HML factors and the UMD momentum factor only slightly improves the explanatory power. Third, comparing them with model (4), (5) and (6), we find in Panel B that there is a huge improvement for the SRP, in terms of GRS statistics, $A|a_i|$ and $\frac{A|a_i|}{A|\bar{r}_i|}$. For example, the GRS statistic in model (1) is 56.9, while in model 5, it reduces to 1.50. This confirms that the DEF factor indeed is a very important factor in explaining the SRP. The improvement of adding DEF for the VRP is less than the SRP.

Following González-Urteaga and Rubio (2016), we also run the (7) $MKT + MKT^2$, (8) $V(S)RP^{SPX}$, (9) $V(S)RP^{SPX} + DEF$ and (10) $MKT + V(S)RP^{SPX} + DEF + HML$ models to test whether the market $V(S)RPM$ is an important factor to explain the $V(S)RP$ at the portfolio level. From Table 7, we find (i) there is not a very big improvement made by adding the market $V(S)RP^{V(S)RP}$ in both Panel A and B, which is consistent with González-Urteaga and Rubio (2016); (ii) a combination of SRP^{SPX} and DEF, i.e., model (9), works best in terms of explaining the SRP, based on GRS statistics and $A|a_i|$.

4.3 Firm level analysis

In this subsection, we answer the research question: Are the risk premia driven by firm-specific characteristics? In line with Bali, Cakici, and Whitelaw (2011); An, Ang, Bali, Cakici, et al. (2014) and others, we calculate the following firm-specific characteristics as our control variables: market beta (BETA), log market capitalization (SIZE), book-to-market ratio (BM), the cumulative return from month $t-12$ to month $t-2$. (MOM), illiquidity (ILLIQ), the return in the past month (REV), idiosyncratic volatility (IVOL) and systematic volatility (SVOL) over the current month t, systematic skewness (SSKEW) and idiosyncratic skewness (ISKEW) over the most recent 12 month and maximum daily return (MAX) over the current month t. The details of variable constructions are provided in section A.3 of the appendix. We obtain the daily and monthly stock return data from CRSP and accounting and balance sheet data from COMPUSTAT. The data period is from 04 January 1996 to 29 April 2016.

Monthly cross-sectional regressions are run for the following econometric specification and nested versions thereof:

$$\begin{aligned} VRP^i_{t+1} =& \alpha + \lambda_{BETA} BETA^i_t + \lambda_{SIZE} SIZE^i_t + \lambda_{BM} BM^i_t + \lambda_{MOM} MOM^i_t \\ &+ \lambda_{ILLIQ} ILLIQ^i_t + \lambda_{REV} REV^i_t + \lambda_{IVOL} IVOL^i_t + \lambda_{SVOL} SVOL^i_t \\ &+ \lambda_{SSKEW} SSKEW^i_t + \lambda_{ISKEW} ISKEW^i_t + \lambda_{MAX} MAX^i_t, \end{aligned} \quad (33)$$

and

$$\begin{aligned} SRP^i_{t+1} =& \alpha + \lambda_{BETA} BETA^i_t + \lambda_{SIZE} SIZE^i_t + \lambda_{BM} BM^i_t + \lambda_{MOM} MOM^i_t \\ &+ \lambda_{ILLIQ} ILLIQ^i_t + \lambda_{REV} REV^i_t + \lambda_{IVOL} IVOL^i_t + \lambda_{SVOL} SVOL^i_t \\ &+ \lambda_{SSKEW} SSKEW^i_t + \lambda_{ISKEW} ISKEW^i_t + \lambda_{MAX} MAX^i_t, \end{aligned} \tag{34}$$

where VRP^i_{t+1} is the VRP for stock i in month $t+1$ and SRP^i_{t+1} is the SRP for stock i in month $t+1$. The predictive cross-sectional regressions are run on one-month lagged values of BETA, SIZE, BM, MOM, ILLIQ, REV, IVOL, COSKEW and MAX.

Table 8 reports the time-series averages of the slope coefficients λ_j (j = BETA, SIZE, BM, MOM, ILLIQ, REV, IVOL, SVOL, SSKEW, ISKEW and MAX) over the period from 04 January 1996 to 29 April 2016. The Newey and West (1987) adjusted t-statistics are given in parentheses. In Panel A, the univariate regressions show that the cross-section of the future VRP has a significant and negative relation with ILLIQ and IVOL. However, the market price of SSKEW risk for the future VRP is significant and negative. The multivariate regressions reveal the same positive relation between SSKEW and the cross-section of the future VRP.

In Panel B, the univariate regressions show there is a negative and statistically significant relations between the future SRP and SIZE and between the future SRP and MAX, while there is a positive and statistically significant relation between the cross-section of the future SRP and IVOL. The t-statistics of the coefficients of SIZE and MAX are -5.73 and -4.36, and the t-statistics of the coefficients of IVOL is 2.73. The multivariate regressions deliver the same information except IVOL. This suggests that SIZE, MAX and IVOL are three important predictors for the cross-section of the future SRP.

[Insert Table 8]

In the period of financial crisis, there was high equity market volatility. As a robustness test, we therefore present the pre-crisis (that is from January 1996 to June

2007 based on Drechsler (2013)) Fama and MacBeth (1973) regression results in Table 9. Comparing Table 9 with Table 8, we get a consistent conclusion that SIZE, MAX and IVOL are three important predictors for the cross-section of the future SRP. The lottery demand factor, MAX, is the strongest predictive factor among 11 firm-specific characteristics, combining Table 8 and Table 9. The investor who holds lottery-like assets is willing to pay higher skew risk premia (i.e., more negative SRP), based on the negative and significant slope coefficients.

[Insert Table 9]

5. Conclusion

Kozhan et al. (2013) newly define the SRP but only estimate at the market index level. Our empirical evidence shows that the SRP at the individual or portfolio level has a different pattern than the market index level. This paper comprehensively estimates, discusses and tests the SRP at the 40-index-and-stock level, portfolio level and the individual level. We show that most of the stocks and indexes have negative and significant VRP and SRP and the averages of SRP in the statistics are more significant than the averages of the VRP. Further, we find the default premium (DEF) is the key risk factor in the cross-sectional variation of average SRP payoffs. Finally, by running predictive regressions, we find that MAX is an important predictor for the cross-section of the future SRP. The robustness tests further support our conclusion.

A. Appendix

A.1 Proof

According to Bakshi, Kapadia, and Madan (2003), for any twice differentiable function $f(S_T)$, we have

$$
\begin{aligned}
f(S_T) =& f(K_0) + f'(K_0)(S_T - K_0) + \int_{K_0}^{+\infty} f''(K) \max(S_T - K, 0) dK \\
& + \int_0^{K_0} f''(K) \max(K - S_T, 0) dK,
\end{aligned} \tag{35}
$$

where K_0 is a reference strike price that could take any value.

We set $f(S_T) = \frac{S_T}{S_t} \ln \frac{S_T}{S_t}$ and $K_0 = S_t$, then

$$
\begin{aligned}
\frac{S_T}{S_t} \ln \frac{S_T}{S_t} = \left(\frac{S_T}{S_t} - 1 \right) + \int_{S_t}^{+\infty} \frac{1}{S_t K} \max(S_T - K, 0) dK \\
+ \int_0^{S_t} \frac{1}{S_t K} \max(K - S_T, 0) dK.
\end{aligned} \tag{36}
$$

Thus, we get

$$
\begin{aligned}
G_{t,T}^{E} =& 2E_t^{\mathbb{Q}} \left[\frac{S_T}{S_t} \ln \frac{S_T}{S_t} - \left(\frac{S_T}{S_t} - 1 \right) \right] \\
=& \frac{2}{B_{t,T} S_t} \left(\int_{S_t}^{+\infty} \frac{1}{K} C_{t,T}(K) dK + \int_0^{S_t} \frac{1}{K} P_{t,T}(K) dK \right).
\end{aligned} \tag{37}
$$

Similarly, we set $f(S_T) = \ln \frac{S_T}{S_t}$ and $K_0 = S_t$, then

$$
\begin{aligned}
\ln \frac{S_T}{S_t} = \left(\frac{S_T}{S_t} - 1 \right) + \int_{S_t}^{+\infty} \frac{-1}{K^2} \max(S_T - K, 0) dK \\
+ \int_0^{S_t} \frac{-1}{K^2} \max(K - S_T, 0) dK,
\end{aligned} \tag{38}
$$

Then

$$
\begin{aligned}
G^V_{t,T} =& 2E^{\mathbb{Q}}_t\left[\frac{S_T}{S_t} - 1 - \ln\frac{S_T}{S_t}\right] \\
=& \frac{2}{B_{t,T}}\left(\int_{S_t}^{+\infty}\frac{1}{K^2}C_{t,T}(K)dK + \int_0^{S_t}\frac{1}{K^2}P_{t,T}(K)dK\right).
\end{aligned}
\tag{39}
$$

A.2 List of 5 Indexes and 35 Stocks

[Insert Table 1]

A.3 Firm-specific characteristics

- BETA: We run the market model at the daily frequency to obtain the monthly beta of an individual stock,

$$
r_{i,d} - r_{f,d} = \alpha_i + \beta_{1,i}MKT_{d-1} + \beta_{2,i}MKT_d + \beta_{3,i}MKT_{d+1} + \varepsilon_{i,d}, \tag{40}
$$

  where $r_{i,d}$ is the return on stock i on day d, MKT_d is the market excess return on day d, and $r_{f,d}$ is the risk-free rate on day d. The sum of the estimated slop coefficients, $\hat{\beta}_{1,i} + \hat{\beta}_{2,i} + \hat{\beta}_{3,i}$, is the energy market beta of stock i in month t.

- SIZE: Firm size is measured as the natural logarithm of the market value of equity at the end of the month for each stock.

- Book-to-Market Ratio (BM): We compute the book-to-market ratio in month t of a firm using the market value of its equity at the end of December of the previous year and the book value of common equity plus balance-sheet deferred taxes for the firms latest fiscal year ending in the prior calendar year, in line with Fama and French (1993); Davis, Fama, and French (2000).

- Momentum (MOM): Following Jegadeesh and Titman (1993), the momentum variable for each stock in month t is defined as the cumulative return from month

$t-12$ to month $t-2$.

- Illiquidity (ILLIQ): Following Amihud (2002), the illiquidity, for each stock in month t is defined as the annual average of the ratio of the absolute daily stock return to its dollar trading volume over month t,

$$ILLIQ_{i,t} = 1/D_{i,t} \sum_{d=1}^{D_{i,t}} |R_{i,d}|/VOLD_{i,d} \times 10^6, \tag{41}$$

where $R_{i,t}$ is the return on stock i in month t, and $VOLD_{i,t}$ is the monthly trading volume of stock i in dollars.

- Short-Term Reversal (REV): Following Jegadeesh (1990); Lehmann (1990), we define short-term reversal for each stock in month t as the return on the stock over the previous month from $t-1$ to t.

- Idiosyncratic Volatility (IVOL): Following Ang, Hodrick, Xing, and Zhang (2006), we run the market model at the daily frequency,

$$r_{i,d} - r_{f,d} = \alpha_i + \beta_{i,MKT} MKT_d + \beta_{i,SMB} SMB_d + \beta_{i,HML} HML_d + \varepsilon_{i,d}, \tag{42}$$

where $r_{i,d}$ is the return on stock i on day d, MKT_d is the market return on day d, and $r_{f,d}$ is the risk-free rate on day d. Idiosyncratic volatility of each stock in month t is defined as the standard deviation of daily residuals in month t, $IVOL_{i,t} = \sqrt{var(\varepsilon_{i,d})}$.

- Systematic Volatility (SVOL): According to Cao and Han (2013), systematic volatility is the square root of $\sqrt{RVOL^2 - IVOL^2}$, where the realized volatility (RVOL) of stock i in month t is defined as the standard deviation of daily returns over month t, $RVOL_{i,t} = sd(R_{i,d})$.

- Systematic Skewness (SSKEW): Systematic skewness (also known as co-skewness), defined as in Harvey and Siddique (2000), is calculated as the slope coefficient

(γ_i) on the squared market terms in the following regression.

$$r_{i,d} - r_{f,d} = \alpha_i + \beta_i MKT_d + \gamma_i MKT_d^2 + \varepsilon_{i,d}, \tag{43}$$

where $r_{i,d}$ is the return on stock i on day d, MKT_d is the market return on day d, and $r_{f,d}$ is the risk-free rate on day d. The above regression is performed using daily observations over the most recent 12 months (i.e., from $t - 11$ to t). The estimation procedure is repeated each month to obtain the SSKEW measure for each month.

- Idiosyncratic Skewness (ISKEW): Idiosyncratic skewness is defined as the skewness of the daily residual terms obtained from the same regression used to calculate the (monthly) SSKEW measure, i.e., $ISKEW_{i,t} = skewness(\varepsilon_{i,d})$.
- Maximum (MAX): MAX is the maximum daily return within a month, according to Bali et al. (2011).

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Table 1: List of 5 Indexes and 35 Stocks

No.	Ticker	Issuer
1	SPX	S&P 500 INDEX
2	RUT	RUSSELL 2000 INDEX
3	OEX	S&P 100 INDEX
4	DJX	DOW JONES INDUSTRIAL AVER
5	NDX	NASDAQ 100 INDEX
6	AAPL	APPLE COMPUTER INC
7	ADBE	ADOBE SYS INC
8	AMAT	APPLIED MATERIALS INC
9	AMGN	AMGEN INC
10	AMZN	AMAZON.COM INC
11	BA	BOEING CO
12	BBBY	BED BATH & BEYOND INC
13	BBY	BEST BUY INC
14	BHI	BAKER HUGHES INC
15	BIIB	BIOGEN IDEC INC
16	COF	CAPITAL ONE FINL CORP
17	EA	ELECTRONIC ARTS INC
18	FDX	FEDEX CORP
19	GILD	GILEAD SCIENCES INC
20	HAL	HALLIBURTON CO
21	HD	HOME DEPOT INC
22	IBM	INTERNATIONAL BUSINESS MACHS
23	INTC	INTEL CORP
24	INTU	INTUIT
25	JPM	JPMORGAN CHASE & CO
26	KLAC	KLA-TENCOR CORP
27	LLTC	LINEAR TECHNOLOGY CORP
28	MMM	3M CO
29	MO	ALTRIA GROUP INC
30	MRK	MERCK & CO INC NEW
31	MS	MORGAN STANLEY
32	MU	MICRON TECHNOLOGY INC
33	NEM	NEWMONT MINING CORP
34	NKE	NIKE INC
35	QCOM	QUALCOMM INC
36	SBUX	STARBUCKS CORP
37	TXN	TEXAS INSTRS INC
38	UNH	UNITEDHEALTH GROUP INC
39	XLNX	XILINX INC
40	YHOO	YAHOO INC

Table 2: The means of daily 30-day floating and fixed legs of variance, third moment and skew swaps, and their corresponding risk premia. Entries report the means of the daily 30-day floating and fixed legs of variance, third moment and skew swaps, and their corresponding risk premia. The *t*-statistics of the mean risk premia are adjusted for serial dependence according to the Newey-West method with a lag of 30 days. The data are from 04 January 1996 to 29 April 2016.

	(1)	(2)	(3)		(4)		(3)	(4)	(5)	(6)	(7)		(8)	(9)	(10)		(11)	
	RV	FV	VRP	t	xv	t	RTM^{jump}	RTM^{corr}	RTM	FTM	TMRP	t	RS	FS	SRP	t	xs	t
SPX	0.31	0.40	-0.09	-3.52	-0.25	-6.04	0.00	-0.03	-0.03	-0.06	-0.03	-5.14	-0.90	-1.88	-0.98	-8.91	-0.49	-8.11
RUT	0.44	0.55	-0.10	-3.80	-0.24	-6.39	0.00	-0.03	-0.03	-0.06	-0.03	-5.69	-0.60	-1.21	-0.61	-9.39	-0.56	-4.00
OEX	0.32	0.40	-0.08	-3.38	-0.23	-5.46	0.00	-0.03	-0.03	-0.04	-0.02	-3.72	-0.87	-1.62	-0.75	-7.33	-0.39	-5.16
DJX	0.29	0.37	-0.08	-3.43	-0.24	-5.99	0.00	-0.02	-0.02	-0.04	-0.02	-6.08	-0.77	-1.65	-0.88	-10.50	-0.48	-9.54
NDX	0.72	1.72	-0.99	-1.06	-0.11	-2.98	0.01	0.05	0.06	-2.57	-2.63	-1.04	-0.45	-1.25	-0.80	-3.21	-0.63	-1.84
AAPL	1.68	3.65	-1.97	-1.26	-0.11	-2.40	-0.04	0.04	0.00	-4.10	-4.11	-1.18	-0.04	-0.48	-0.45	-5.23	-0.82	-1.66
ADBE	1.81	1.92	-0.12	-1.23	-0.09	-2.11	0.01	0.01	0.03	-0.12	-0.15	-3.60	0.04	-0.52	-0.56	-11.10	-1.12	-3.56
AMAT	1.96	2.05	-0.09	-1.12	-0.09	-2.68	0.04	-0.01	0.03	-0.13	-0.16	-4.90	0.08	-0.54	-0.62	-15.60	-6.23	-1.23
AMGN	1.01	1.29	-0.28	-2.76	-0.11	-2.64	0.01	-0.01	0.00	-0.29	-0.30	-3.83	0.09	-0.97	-1.06	-12.20	0.11	0.10
AMZN	3.14	3.28	-0.14	-1.00	-0.02	-0.30	0.14	0.00	0.15	-0.58	-0.72	-5.95	0.22	-0.75	-0.97	-9.78	-1.29	-4.49
BA	0.81	0.92	-0.10	-2.52	-0.09	-2.30	0.00	0.00	0.00	-0.06	-0.07	-3.83	0.00	-0.81	-0.81	-12.20	1.64	0.83
BBBY	1.31	1.27	0.05	0.60	-0.03	-0.85	0.02	0.01	0.03	-0.08	-0.11	-5.92	0.10	-0.57	-0.67	-12.30	-0.75	-3.08
BBY	2.00	5.99	-3.99	-1.16	-0.06	-1.33	-0.02	-0.04	-0.06	-11.20	-11.10	-1.17	-0.07	-0.66	-0.59	-8.95	-0.62	-2.37
BHI	1.47	1.89	-0.42	-2.48	-0.08	-1.79	0.00	0.02	0.02	-0.28	-0.30	-1.35	0.05	-0.59	-0.64	-7.28	1.55	0.98
BIIB	2.24	2.29	-0.06	-0.42	0.04	0.43	-0.01	-0.02	-0.02	-0.20	-0.18	-4.31	-0.37	-0.53	-0.16	-0.42	-0.34	-0.33
COF	2.09	2.42	-0.33	-1.66	-0.09	-1.60	0.01	-0.02	-0.01	-0.85	-0.84	-3.56	-0.09	-0.99	-0.90	-5.95	-0.63	-1.78
EA	1.83	1.96	-0.13	-1.30	-0.11	-2.79	0.03	0.00	0.03	-0.12	-0.15	-9.89	0.10	-0.46	-0.56	-13.70	-0.30	-0.38
FDX	0.83	0.92	-0.10	-2.67	-0.09	-2.79	0.01	0.00	0.01	-0.10	-0.11	-5.63	0.04	-0.77	-0.81	-16.90	-1.00	-3.45
GILD	1.82	1.99	-0.17	-1.40	-0.07	-2.07	0.03	-0.05	-0.02	-0.39	-0.38	-2.45	-0.01	-0.73	-0.72	-11.90	-1.77	-3.49
HAL	1.70	1.68	0.02	0.16	0.01	0.18	-0.01	0.00	-0.01	-0.19	-0.17	-4.04	-0.07	-0.60	-0.52	-8.02	-0.37	-0.92
HD	0.90	0.98	-0.07	-1.48	-0.11	-2.78	0.00	0.00	0.00	-0.12	-0.11	-4.88	-0.04	-1.05	-1.01	-12.30	-0.64	-2.77
IBM	0.69	0.77	-0.08	-2.74	-0.13	-3.74	0.00	0.00	0.01	-0.07	-0.08	-8.24	0.00	-0.96	-0.96	-17.50	-0.92	-3.46
INTC	1.36	1.33	0.03	0.47	-0.01	-0.24	0.00	0.00	0.00	-0.12	-0.12	-8.02	0.03	-0.76	-0.79	-14.20	-0.90	-7.82
INTU	1.93	1.72	0.21	1.73	-0.01	-0.22	0.02	-0.01	0.00	-0.08	-0.08	-2.91	-0.02	-0.53	-0.52	-7.76	-0.78	-2.00
JPM	1.45	3.47	-2.01	-3.31	-0.11	-2.74	0.04	0.22	0.26	0.62	0.36	0.20	6.83	-5.24	-12.10	-1.13	-1.54	-3.25
KLAC	2.31	2.15	0.15	1.50	0.01	0.27	0.05	-0.02	0.02	-0.16	-0.18	-7.58	0.06	-0.57	-0.63	-14.10	-1.23	-9.75
LLTC	1.67	1.60	0.07	0.93	-0.08	-2.20	0.02	-0.01	0.01	-0.11	-0.12	-8.32	0.05	-0.58	-0.63	-18.90	-1.49	-6.46
MMM	0.49	0.59	-0.10	-3.73	-0.15	-4.51	0.00	0.00	0.00	-0.07	-0.08	-3.00	-0.03	-1.08	-1.05	-17.00	-1.79	-2.29
MO	0.62	1.72	-1.10	-2.56	-0.24	-5.75	0.01	-0.02	-0.01	5.08	5.09	1.97	0.24	-0.85	-1.10	-5.15	-0.91	-1.29
MRK	0.66	1.24	-0.58	-1.89	-0.02	-0.38	0.00	-0.01	-0.01	-1.11	-1.10	-1.92	-0.27	-1.05	-0.78	-3.46	-2.32	-2.41
MS	2.59	2.33	0.26	0.63	0.02	0.38	0.55	0.11	0.65	-0.72	-1.38	-1.60	0.04	-0.97	-1.01	-14.00	-1.01	-8.82
MU	2.93	3.35	-0.41	-2.90	-0.07	-2.18	0.04	-0.04	0.00	-0.44	-0.45	-5.86	-0.03	-0.46	-0.43	-9.24	-0.71	-1.26
NEM	1.50	1.86	-0.36	-2.06	-0.07	-2.01	0.02	0.03	0.05	-0.47	-0.51	-2.31	0.09	-0.35	-0.43	-6.32	-0.98	-0.91
NKE	0.88	0.96	-0.08	-1.64	-0.09	-2.17	0.01	0.00	0.01	-0.06	-0.07	-6.98	0.10	-0.70	-0.80	-12.90	-1.33	-11.90
QCOM	1.96	1.89	0.07	0.62	-0.01	-0.26	0.06	0.01	0.07	-0.20	-0.27	-6.52	0.04	-0.79	-0.83	-13.90	-0.84	-4.40
SBUX	1.25	1.25	0.00	-0.02	-0.04	-1.03	0.01	0.00	0.01	-0.10	-0.11	-5.58	0.06	-0.68	-0.75	-13.60	-0.48	-1.34
TXN	1.58	1.60	-0.02	-0.37	-0.05	-1.65	0.03	-0.02	0.01	-0.19	-0.20	-4.74	-0.01	-0.79	-0.78	-16.10	-1.21	-4.88
UNH	1.06	1.37	-0.32	-2.08	-0.06	-0.84	-0.01	-0.01	-0.02	0.09	0.11	1.47	0.51	-1.83	-2.34	-1.32	-0.67	-1.00
XLNX	2.06	2.06	0.00	0.05	-0.05	-1.46	0.01	-0.01	0.00	-0.21	-0.22	-7.77	-0.05	-0.71	-0.66	-10.00	-1.21	-4.56
YHOO	2.62	2.86	-0.23	-1.47	-0.10	-1.99	0.09	0.00	0.09	-0.32	-0.42	-5.76	0.15	-0.35	-0.50	-4.34	5.61	0.71

Table 3: Correlations among risk premia. Entries report the correlations among VRP, TMRP, SRP, xv and xs. The data are from 04 January 1996 to 29 April 2016.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	(VRP, xv)	(VRP, TMRP)	(VRP, SRP)	(VRP, xs)	(xv, TMRP)	(xv, SRP)	(xv, xs)	(xs, SRP)	(xs, TMRP)	(SRP, TMRP)
SPX	0.75	0.80	0.52	0.66	0.49	0.83	0.88	0.92	0.53	0.44
RUT	0.81	0.67	0.59	0.07	0.45	0.76	0.08	0.09	0.04	0.55
OEX	0.75	0.85	0.50	0.62	0.52	0.82	0.72	0.73	0.55	0.44
DJX	0.75	0.79	0.48	0.33	0.51	0.78	0.50	0.53	0.21	0.44
NDX	0.05	1.00	0.00	0.00	0.04	0.28	0.10	0.54	0.01	0.01
AAPL	0.15	1.00	0.09	0.02	0.08	0.62	0.17	0.24	0.00	0.05
ADBE	0.77	-0.26	-0.09	-0.01	-0.09	0.04	-0.02	0.28	0.03	0.49
AMAT	0.81	-0.32	-0.26	-0.11	-0.21	-0.26	-0.09	0.02	0.02	0.54
AMGN	0.55	0.80	0.12	0.00	0.16	-0.21	-0.02	0.05	0.03	0.36
AMZN	0.68	0.07	-0.26	-0.09	-0.08	-0.59	-0.21	0.33	0.06	0.24
BA	0.84	0.11	0.22	0.01	0.11	0.34	0.02	0.02	0.01	0.55
BBBY	0.81	-0.37	-0.17	0.02	-0.24	-0.14	0.02	0.06	0.01	0.56
BBY	0.11	1.00	0.04	0.00	0.09	0.43	0.05	0.12	0.00	0.03
BHI	0.65	0.36	0.07	0.02	0.07	-0.03	0.04	-0.03	0.00	0.52
BIIB	0.77	0.35	0.49	0.29	0.55	0.81	0.46	0.56	0.40	0.70
COF	0.53	0.66	0.06	0.06	0.13	0.30	0.15	0.04	0.02	0.05
EA	0.86	-0.07	-0.11	0.02	-0.14	-0.16	0.04	-0.02	0.02	0.60
FDX	0.72	0.50	0.16	0.00	0.11	0.07	-0.01	0.06	0.00	0.43
GILD	0.53	0.75	0.17	-0.06	0.09	0.19	-0.02	0.01	0.01	0.24
HAL	0.86	0.23	0.20	0.02	0.15	0.22	0.01	0.10	0.08	0.72
HD	0.87	0.47	0.54	0.17	0.30	0.52	0.15	0.18	0.11	0.48
IBM	0.77	0.11	0.01	0.02	-0.03	0.16	0.01	0.11	0.09	0.32
INTC	0.81	0.15	0.21	0.06	0.13	0.16	0.06	0.16	0.07	0.42
INTU	0.73	-0.09	0.05	0.06	-0.03	0.12	0.04	0.09	0.06	0.48
JPM	0.18	0.21	-0.01	-0.02	-0.04	-0.83	-0.06	0.01	0.08	0.01
KLAC	0.81	-0.03	0.04	-0.09	-0.02	-0.03	-0.10	0.10	0.06	0.40
LLTC	0.82	0.04	0.11	-0.03	-0.06	0.00	-0.05	0.06	0.02	0.36
MMM	0.55	0.77	0.16	0.00	0.05	0.25	0.00	-0.01	0.00	0.15
MO	0.19	-0.99	-0.22	0.00	-0.10	-0.09	0.02	0.04	0.00	0.20
MRK	0.19	0.99	0.10	0.00	0.09	0.74	0.05	0.04	0.00	0.06
MS	0.55	-0.71	-0.36	-0.07	-0.18	-0.18	-0.07	0.19	0.05	0.31
MU	0.76	0.60	0.13	0.00	0.18	0.09	0.00	0.04	0.01	0.43
NEM	0.50	0.88	0.21	0.00	0.16	0.10	-0.01	-0.02	0.00	0.30
NKE	0.79	-0.01	-0.16	-0.08	-0.09	-0.35	-0.09	0.10	0.03	0.47
QCOM	0.79	-0.55	-0.39	-0.09	-0.35	-0.10	-0.03	0.11	0.09	0.56
SBUX	0.83	0.26	0.21	0.04	0.13	0.19	0.07	0.01	0.01	0.49
TXN	0.67	0.43	0.11	-0.02	0.05	0.23	-0.01	0.01	-0.01	0.32
UNH	0.51	-0.73	0.00	0.01	-0.02	-0.39	0.03	0.00	0.00	0.01
XLNX	0.68	0.20	0.15	0.01	0.06	0.53	0.04	0.07	0.01	0.26
YHOO	0.83	-0.33	-0.55	0.01	-0.51	-0.66	0.00	0.02	0.01	0.74

Table 4: Explaining the VRP and SRP with model (1). Entries report the estimates of the model (1) in monthly frequency. The t-statistics of estimates are adjusted for serial dependence according to the Newey-West method with a lag of 6 months and R^2 reports the unadjusted R-squared. The data are from 04 January 1996 to 29 April 2016.

	Panel A: VRP					Panel B: SRP				
	MKT		Constant		R^2	MKT		Constant		R^2
SPX	-0.05	(-8.28)	-0.06	(-2.13)	0.221	-0.16	(-5.85)	-0.88	(-7.16)	0.124
RUT	-0.05	(-7.32)	-0.07	(-2.28)	0.182	-0.08	(-5.03)	-0.58	(-7.74)	0.095
OEX	-0.05	(-8.51)	-0.05	(-2.08)	0.231	-0.15	(-5.73)	-0.68	(-5.80)	0.120
DJX	-0.04	(-8.16)	-0.06	(-2.34)	0.232	-0.12	(-6.62)	-0.91	(-11.1)	0.166
NDX	-0.06	(-7.50)	0.01	(0.26)	0.189	-0.20	(-3.22)	-0.69	(-2.47)	0.041
AAPL	0.40	(2.03)	-1.22	(-1.34)	0.018	-0.03	(-1.08)	-0.41	(-3.20)	0.005
ADBE	-0.11	(-4.81)	0.03	(0.25)	0.089	0.00	(-0.035)	-0.58	(-8.46)	0.000
AMAT	-0.08	(-4.41)	-0.03	(-0.39)	0.075	0.00	(0.26)	-0.65	(-14.9)	0.000
AMGN	-0.02	(-0.87)	-0.24	(-2.22)	0.003	0.00	(0.093)	-1.14	(-8.48)	0.000
AMZN	-0.04	(-1.11)	0.11	(0.59)	0.006	-0.02	(-0.60)	-0.97	(-7.65)	0.002
BA	-0.06	(-5.19)	-0.05	(-0.97)	0.101	-0.01	(-0.67)	-0.76	(-10.8)	0.002
BBBY	-0.02	(-1.09)	0.17	(1.68)	0.005	-0.01	(-0.74)	-0.66	(-9.99)	0.002
BBY	0.03	(0.12)	-1.41	(-1.29)	0.000	-0.02	(-1.02)	-0.62	(-7.27)	0.005
BHI	-0.13	(-3.42)	-0.29	(-1.66)	0.047	0.05	(1.97)	-0.70	(-5.89)	0.016
BIIB	-0.05	(-1.60)	0.08	(0.53)	0.011	0.01	(0.078)	-0.29	(-0.91)	0.000
COF	-0.10	(-1.98)	-0.21	(-0.92)	0.017	-0.04	(-1.56)	-0.96	(-8.34)	0.011
EA	-0.09	(-4.20)	-0.03	(-0.31)	0.070	-0.01	(-0.97)	-0.57	(-10.9)	0.004
FDX	-0.04	(-5.02)	-0.06	(-1.72)	0.097	-0.02	(-1.40)	-0.81	(-16.0)	0.008
GILD	-0.06	(-2.65)	-0.07	(-0.67)	0.029	-0.02	(-1.23)	-0.70	(-11.5)	0.006
HAL	-0.12	(-4.27)	0.15	(1.13)	0.073	0.01	(0.96)	-0.50	(-7.55)	0.004
HD	-0.06	(-5.18)	-0.03	(-0.53)	0.102	-0.02	(-0.87)	-0.98	(-12.5)	0.003
IBM	-0.03	(-4.42)	-0.04	(-1.31)	0.075	0.00	(-0.028)	-1.00	(-16.8)	0.000
INTC	-0.08	(-5.19)	0.11	(1.58)	0.107	-0.01	(-0.74)	-0.80	(-12.0)	0.002
INTU	-0.13	(-4.63)	0.38	(2.89)	0.084	0.02	(1.04)	-0.55	(-7.75)	0.005
JPM	0.49	(3.76)	-2.37	(-3.89)	0.057	-0.06	(-1.50)	-0.66	(-3.83)	0.010
KLAC	-0.09	(-3.56)	0.32	(2.85)	0.050	0.00	(0.13)	-0.66	(-14.2)	0.000
LLTC	-0.06	(-2.87)	0.19	(2.17)	0.034	0.00	(0.57)	-0.63	(-17.5)	0.001
MMM	-0.03	(-4.53)	-0.05	(-1.87)	0.081	0.00	(0.078)	-0.98	(-17.3)	0.000
MO	0.13	(1.69)	-1.06	(-3.10)	0.012	-0.08	(-1.72)	-0.76	(-3.57)	0.012
MRK	0.07	(0.87)	-0.78	(-2.27)	0.003	0.00	(-0.053)	-0.56	(-1.33)	0.000
MS	-0.54	(-5.84)	0.55	(1.29)	0.125	-0.05	(-1.36)	-0.86	(-5.51)	0.008
MU	-0.18	(-6.10)	-0.21	(-1.54)	0.138	0.00	(0.11)	-0.34	(-3.74)	0.000
NEM	-0.17	(-5.09)	-0.08	(-0.52)	0.099	-0.02	(-1.30)	-0.45	(-5.52)	0.007
NKE	-0.04	(-3.27)	-0.01	(-0.22)	0.043	0.01	(0.32)	-0.84	(-11.1)	0.000
QCOM	-0.06	(-2.09)	0.12	(0.92)	0.018	-0.02	(-1.07)	-0.79	(-11.6)	0.005
SBUX	-0.04	(-2.42)	0.08	(1.09)	0.024	-0.02	(-1.87)	-0.66	(-11.6)	0.014
TXN	-0.04	(-2.69)	0.08	(1.17)	0.029	0.00	(-0.24)	-0.78	(-15.4)	0.000
UNH	-0.15	(-5.23)	-0.10	(-0.75)	0.103	-0.14	(-3.05)	-0.30	(-1.42)	0.037
XLNX	-0.11	(-4.89)	0.18	(1.76)	0.091	-0.01	(-0.31)	-0.66	(-8.63)	0.000
YHOO	-0.08	(-1.91)	-0.14	(-0.74)	0.016	0.06	(1.26)	-0.66	(-2.82)	0.007
AVG.					0.075					0.018

Table 5: Explaining the VRP and SRP with model (5). Entries report the estimates of the model (5) in monthly frequency. The t-statistics of estimates are adjusted for serial dependence according to the Newey-West method with a lag of 6 months and R^2 reports the unadjusted R-squared. The data are from 04 January 1996 to 29 April 2016.

	Panel A: VRP							Panel B: SRP						
	MKT		DEF		Constant		R^2	MKT		DEF		Constant		R^2
SPX	-0.05	(-8.18)	0.01	(0.31)	-0.08	(-0.93)	0.222	-0.15	(-5.66)	0.22	(1.47)	-1.46	(-3.56)	0.132
RUT	-0.05	(-7.09)	0.09	(2.27)	-0.29	(-2.86)	0.199	-0.08	(-4.94)	0.05	(0.50)	-0.70	(-2.81)	0.096
OEX	-0.05	(-8.45)	0.00	(-0.040)	-0.05	(-0.59)	0.231	-0.14	(-5.56)	0.19	(1.34)	-1.17	(-3.02)	0.127
DJX	-0.04	(-8.07)	0.02	(0.54)	-0.10	(-1.18)	0.233	-0.12	(-6.58)	0.00	(0.022)	-0.92	(-3.16)	0.166
NDX	-0.06	(-7.51)	-0.02	(-0.55)	0.07	(0.60)	0.190	-0.20	(-3.22)	-0.06	(-0.16)	-0.55	(-0.59)	0.041
AAPL	0.40	(2.02)	0.02	(0.013)	-1.26	(-0.41)	0.018	-0.04	(-1.26)	-0.28	(-1.77)	0.32	(0.73)	0.019
ADBE	-0.10	(-4.62)	0.17	(1.31)	-0.41	(-1.18)	0.096	0.00	(-0.20)	-0.12	(-1.38)	-0.28	(-1.21)	0.008
AMAT	-0.08	(-4.41)	-0.03	(-0.27)	0.04	(0.14)	0.075	0.00	(-0.25)	-0.25	(-4.79)	-0.02	(-0.13)	0.088
AMGN	-0.03	(-1.07)	-0.25	(-1.80)	0.39	(1.06)	0.017	0.00	(-0.14)	-0.37	(-2.21)	-0.19	(-0.42)	0.021
AMZN	-0.05	(-1.34)	-0.54	(-2.36)	1.52	(2.43)	0.030	-0.02	(-0.73)	-0.23	(-1.43)	-0.35	(-0.80)	0.011
BA	-0.06	(-5.12)	0.02	(0.38)	-0.11	(-0.65)	0.102	-0.02	(-1.16)	-0.38	(-4.53)	0.21	(0.95)	0.081
BBBY	-0.03	(-1.14)	-0.08	(-0.60)	0.36	(1.07)	0.007	-0.02	(-1.24)	-0.38	(-4.87)	0.32	(1.53)	0.094
BBY	0.06	(0.27)	1.88	(1.36)	-6.31	(-1.68)	0.008	-0.02	(-1.14)	-0.13	(-1.17)	-0.29	(-1.00)	0.011
BHI	-0.13	(-3.41)	-0.03	(-0.16)	-0.20	(-0.34)	0.047	0.05	(1.88)	-0.10	(-0.70)	-0.43	(-1.09)	0.018
BIIB	-0.06	(-1.81)	-0.38	(-2.01)	1.06	(2.07)	0.027	0.00	(-0.057)	-0.52	(-1.32)	1.04	(0.99)	0.007
COF	-0.08	(-1.74)	0.57	(2.01)	-1.68	(-2.19)	0.034	-0.04	(-1.76)	-0.24	(-1.67)	-0.33	(-0.84)	0.023
EA	-0.09	(-4.21)	-0.05	(-0.40)	0.09	(0.29)	0.070	-0.01	(-0.99)	-0.02	(-0.26)	-0.53	(-3.02)	0.004
FDX	-0.04	(-4.80)	0.10	(2.19)	-0.32	(-2.60)	0.115	-0.02	(-1.78)	-0.21	(-3.36)	-0.28	(-1.66)	0.054
GILD	-0.06	(-2.65)	-0.02	(-0.15)	-0.02	(-0.061)	0.029	-0.02	(-1.58)	-0.21	(-2.83)	-0.16	(-0.80)	0.039
HAL	-0.12	(-4.17)	0.10	(0.61)	-0.11	(-0.24)	0.074	0.01	(0.46)	-0.38	(-4.78)	0.47	(2.21)	0.093
HD	-0.06	(-5.31)	-0.10	(-1.53)	0.24	(1.30)	0.111	-0.02	(-1.35)	-0.46	(-4.95)	0.21	(0.82)	0.098
IBM	-0.03	(-4.75)	-0.11	(-2.72)	0.24	(2.19)	0.103	-0.01	(-0.69)	-0.42	(-6.03)	0.06	(0.34)	0.132
INTC	-0.08	(-5.18)	-0.03	(-0.30)	0.18	(0.75)	0.108	-0.02	(-1.14)	-0.27	(-3.31)	-0.10	(-0.43)	0.049
INTU	-0.14	(-4.87)	-0.37	(-2.28)	1.32	(3.05)	0.104	0.01	(0.73)	-0.31	(-3.58)	0.24	(1.04)	0.056
JPM	0.45	(3.49)	-2.19	(-2.93)	3.26	(1.62)	0.091	-0.07	(-1.77)	-0.54	(-2.53)	0.72	(1.26)	0.036
KLAC	-0.09	(-3.75)	-0.23	(-1.66)	0.90	(2.44)	0.061	0.00	(-0.39)	-0.24	(-4.31)	-0.04	(-0.29)	0.072
LLTC	-0.06	(-3.12)	-0.22	(-1.98)	0.75	(2.54)	0.049	0.00	(0.040)	-0.19	(-4.41)	-0.14	(-1.20)	0.077
MMM	-0.03	(-4.68)	-0.05	(-1.51)	0.08	(0.89)	0.090	-0.01	(-0.73)	-0.47	(-7.31)	0.22	(1.27)	0.186
MO	0.09	(1.27)	-1.76	(-4.27)	3.41	(3.10)	0.082	-0.07	(-1.59)	0.28	(1.05)	-1.47	(-2.08)	0.017
MRK	0.06	(0.74)	-0.46	(-1.07)	0.39	(0.34)	0.008	-0.02	(-0.19)	-0.60	(-1.14)	0.97	(0.69)	0.005
MS	-0.51	(-5.58)	1.49	(2.85)	-3.26	(-2.32)	0.154	-0.05	(-1.59)	-0.41	(-2.15)	0.20	(0.39)	0.027
MU	-0.18	(-6.14)	-0.25	(-1.36)	0.42	(0.88)	0.145	0.00	(0.060)	-0.22	(-1.71)	0.20	(0.61)	0.013
NEM	-0.16	(-4.86)	0.45	(2.41)	-1.24	(-2.46)	0.121	-0.02	(-1.31)	-0.01	(-0.13)	-0.42	(-1.54)	0.007
NKE	-0.04	(-3.22)	0.02	(0.30)	-0.06	(-0.35)	0.043	0.00	(-0.057)	-0.32	(-3.45)	-0.03	(-0.12)	0.048
QCOM	-0.06	(-2.16)	-0.13	(-0.79)	0.46	(1.03)	0.020	-0.02	(-1.45)	-0.27	(-3.27)	-0.10	(-0.44)	0.047
SBUX	-0.04	(-2.55)	-0.12	(-1.31)	0.39	(1.58)	0.031	-0.03	(-2.52)	-0.35	(-5.17)	0.23	(1.26)	0.114
TXN	-0.04	(-2.68)	-0.01	(-0.076)	0.09	(0.43)	0.029	-0.01	(-0.65)	-0.23	(-3.69)	-0.21	(-1.25)	0.054
UNH	-0.15	(-5.06)	0.23	(1.38)	-0.69	(-1.54)	0.110	-0.15	(-3.43)	-0.80	(-3.15)	1.76	(2.57)	0.076
XLNX	-0.11	(-5.01)	-0.17	(-1.29)	0.61	(1.75)	0.097	-0.01	(-0.71)	-0.33	(-3.61)	0.20	(0.79)	0.052
YHOO	-0.09	(-2.17)	-0.60	(-2.53)	1.43	(2.21)	0.044	0.06	(1.23)	-0.08	(-0.26)	-0.45	(-0.55)	0.007
AVG.							0.086							0.058

Table 6: VRP and SRP based on 20 beta-sorted portfolios: descriptive statistics. We run the OLS regressions 31 and 32 by using monthly data during the period from January 1996 to April 2016 to get the "VRP (SRP) betas" for each stock. We then sort all stocks into 40 portfolios based on VRP and SRP betas from low to high. The mean and standard deviation (sd) are given in both monthly and daily frequency.

Panel A: VRP of 20 Portfolios sorted by VRP Beta					Panel B: SRP of 20 Portfolios sorted by SRP Beta				
portfolios	Monthly		Daily		portfolios	Monthly		Daily	
	mean	sd	mean	sd		mean	sd	mean	sd
PVRP1	-1.03	2.85	-1.09	3.75	PSRP1	-1.71	11.44	-1.71	20.48
PVRP2	-0.26	1.27	-0.24	1.92	PSRP2	-0.50	0.96	-0.54	1.10
PVRP3	-0.32	1.44	-0.38	1.69	PSRP3	-0.60	0.70	-1.01	24.49
PVRP4	-0.22	0.92	-0.33	5.40	PSRP4	-0.45	0.50	-0.49	0.81
PVRP5	-0.25	0.83	-0.27	1.21	PSRP5	-0.54	0.33	-0.56	0.43
PVRP6	-0.20	0.67	-0.15	0.82	PSRP6	-0.54	0.32	-0.56	0.40
PVRP7	-0.18	0.81	-0.17	1.11	PSRP7	-0.55	0.36	-0.56	0.42
PVRP8	-0.10	0.73	-0.07	0.94	PSRP8	-0.57	0.35	-0.58	0.44
PVRP9	-0.12	0.69	-0.09	0.88	PSRP9	-0.55	0.37	-0.58	0.43
PVRP10	-0.34	0.92	-0.31	1.61	PSRP10	-0.55	0.34	-0.56	0.44
PVRP11	-0.12	0.95	-0.44	5.00	PSRP11	-0.48	0.44	-0.54	3.67
PVRP12	-0.22	0.93	-0.23	1.12	PSRP12	-0.53	0.34	-0.57	1.77
PVRP13	-0.13	1.47	-0.23	4.18	PSRP13	-0.58	0.47	-0.62	0.58
PVRP14	-0.09	1.15	-0.11	1.31	PSRP14	-0.55	0.41	-0.55	0.66
PVRP15	-0.37	2.33	-0.61	19.23	PSRP15	-0.61	0.40	-0.60	0.51
PVRP16	-0.29	2.89	-0.21	2.37	PSRP16	-0.65	0.39	-0.66	0.49
PVRP17	-0.24	1.56	-0.31	1.87	PSRP17	-0.63	0.49	-0.63	0.71
PVRP18	-0.32	1.96	-0.33	2.14	PSRP18	-0.63	0.71	-0.63	0.71
PVRP19	-0.02	2.57	-0.08	2.58	PSRP19	-0.77	1.31	-0.77	2.12
PVRP20	-1.66	9.08	-2.15	14.66	PSRP20	-3.03	17.87	-1.90	11.45

Table 7: GRS tests. The table shows the GRS statistic testing whether the expected values of all 20 intercept estimates are zero, with the corresponding p-value, the average absolute value of the intercepts, $A|a_i|$, $A|a_i|/A|\overline{r}_i|$, the average absolute value of the intercept a_i over the average absolute value of $\overline{r}_i$, which is the average risk premia on portfolio i minus the average of the portfolio risk premia, and the average of adjusted R^2, $A|adj.R^2|$. The data are from 04 January 1996 to 29 April 2016.

	model (1)	model (2)	model (3)	model (4)	model (5)	model (6)	model (7)	model (8)	model (9)	model (10)
Panel A: VRP										
GRS	5.69	5.62	5.70	1.48	1.32	1.22	4.87	6.83	1.37	1.23
p-value	0.00	0.00	0.00	0.09	0.17	0.24	0.00	0.00	0.14	0.23
$A\|a_i\|$	0.28	0.28	0.30	0.44	0.34	0.33	0.49	0.22	0.29	0.29
$A\|adj.R^2\|$	0.06	0.06	0.07	0.00	0.07	0.07	0.10	0.18	0.18	0.19
$\frac{A\|a_i\|}{A\|\overline{r}_i\|}$	1.34	1.33	1.41	2.10	1.61	1.58	2.35	1.06	1.39	1.40
Panel B: SRP										
GRS	56.90	56.50	57.70	1.54	1.50	1.49	37.40	47.00	1.00	1.06
p value	0.00	0.00	0.00	0.07	0.08	0.09	0.00	0.00	0.46	0.39
$A\|a_i\|$	0.75	0.74	0.75	0.11	0.16	0.18	0.71	0.76	0.27	0.30
$A\|adj.R^2\|$	0.01	0.01	0.02	0.14	0.16	0.16	0.02	0.02	0.17	0.18
$\frac{A\|a_i\|}{A\|\overline{r}_i\|}$	2.28	2.27	2.30	0.35	0.48	0.57	2.18	2.34	0.83	0.93

Table 8: Fama and MacBeth (1973) regressions based on firm-specific characteristics for the cross-section o the future VRP and SRP. This table reports the average intercept and time series averages of the slope coefficients from the monthly cross-sectional regressions of one-month ahead VRP and SRP on different firm-specific characteristics for the period from January 1996 to April 2016. We report the Newey and West (1987) t-statistics with 6 lags. *, ** and *** indicate significance at the 10, 5 and 1% level.

Panel A: VRP												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
BETA	0.014											-0.048
	(0.38)											(-0.63)
SIZE		0.035										-0.068
		(1.07)										(-1.60)
BM			-0.030									-0.071
			(-0.26)									(-0.45)
MOM				0.0025								0.00078
				(1.61)								(0.51)
REV					0.0028							0.0021
					(1.05)							(0.79)
ILLIQ						-82.0***						-32.9
						(-2.82)						(-1.31)
IVOL							-0.11***					-0.092
							(-2.73)					(-1.44)
SVOL								0.020				0.051
								(0.42)				(0.61)
SSKEW									2.44***			2.01**
									(2.73)			(2.30)
ISKEW										-0.011		0.0088
										(-0.50)		(0.19)
MAX											0.0023	0.0022
											(0.80)	(0.72)
Panel B: SRP												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
BETA	-0.0044											-0.019
	(-0.35)											(-0.71)
SIZE		-0.054***										-0.071***
		(-5.73)										(-4.30)
BM			-0.031									-0.015
			(-1.45)									(-0.50)
MOM				0.0010*								0.0014
				(1.79)								(1.38)
REV					0.00032							0.00086
					(0.34)							(0.70)
ILLIQ						5.48						-27.4*
						(0.55)						(-1.81)
IVOL							0.030***					-0.0043
							(2.73)					(-0.13)
SVOL								0.011				-0.023
								(0.35)				(-0.46)
SSKEW									-0.19			-0.018
									(-1.11)			(-0.072)
ISKEW										-0.0048		-0.013
										(-0.75)		(-1.31)
MAX											-0.0046***	-0.0052***
											(-4.36)	(-3.05)

Table 9: Subsample Fama and MacBeth (1973) regressions based on firm-specific characteristics for the cross-section o the future VRP and SRP. This table reports the average intercept and time series averages of the slope coefficients from the monthly cross-sectional regressions of one-month ahead VRP and SRP on different firm-specific characteristics for the period from January 1996 to June 2007. We report the Newey and West (1987) t-statistics with 6 lags. *, ** and *** indicate significance at the 10, 5 and 1% level.

Panel A: VRP												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
BETA	0.062											-0.079
	(1.34)											(-0.65)
SIZE		0.051										-0.011
		(0.99)										(-0.19)
BM			-0.066									0.035
			(-0.43)									(0.13)
MOM				0.0040								0.0010
				(1.57)								(0.41)
REV					0.0039							0.0077**
					(1.50)							(2.32)
ILLIQ						-58.5**						-17.0
						(-2.33)						(-0.83)
IVOL							-0.021					-0.015
							(-0.54)					(-0.20)
SVOL								0.083*				0.059
								(1.67)				(0.45)
SSKEW									1.55			1.86*
									(1.15)			(1.67)
ISKEW										0.053**		0.067
										(2.03)		(0.86)
MAX											0.0060	0.0061
											(1.57)	(1.48)

Panel B: SRP												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
BETA	-0.0097											-0.011
	(-1.49)											(-1.06)
SIZE		-0.014**										-0.013
		(-2.10)										(-1.02)
BM			0.00077									-0.023
			(0.030)									(-0.69)
MOM				0.00026								0.000070
				(0.89)								(0.19)
REV					-0.00057							-0.0010
					(-0.64)							(-0.66)
ILLIQ						3.45						0.25
						(1.08)						(0.038)
IVOL							0.020**					0.048***
							(2.58)					(3.75)
SVOL								-0.022				-0.033
								(-1.19)				(-1.27)
SSKEW									-0.21***			-0.21**
									(-3.48)			(-2.45)
ISKEW										-0.0064		-0.0058
										(-0.83)		(-0.55)
MAX											-0.0049***	-0.0057***
											(-5.92)	(-4.48)

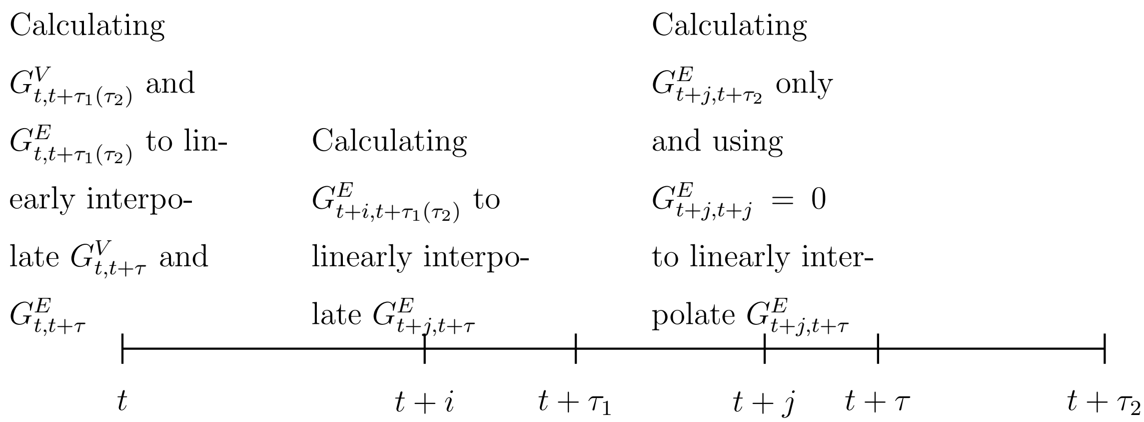

Figure 1: The daily calculation procedure.