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The cross-sectional variation of volatility risk premia[☆]

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ABSTRACT

This paper analyzes the determinants of the cross-sectional variation of the average volatility risk premia for a representative set of portfolios sorted by volatility risk premium beta. The market volatility risk premium and, especially, the default premium are shown to be key risk factors in the cross-sectional variation of average volatility risk premium payoffs. The cross-sectional variation of risk premia seems to reflect a very different behavior of the underlying components of our sample portfolios with respect to credit or financial stress that generates a significant dispersion of the volatility swap pricing of these securities.

1. Introduction

Since the seminal paper of Bakshi and Kapadia (2003a), the market variance risk premium has been reported to be negative, on average, during alternative sample periods.[1] Given that the payoff of a variance swap contract is the difference between the realized variance and the variance swap rate, negative returns to long positions on variance swap contracts for all time horizons mean that investors are willing to accept negative returns for purchasing realized variance. Equivalently, investors who are sellers of variance and are providing insurance to the market require positive returns. This could be rational, as the correlation between volatility shocks and market returns is known to be strongly negative and investors want protection against stock market crashes. Along these lines, Bakshi and Madan (2006) and Chabi-Yo (2012) show theoretically that the skewness and kurtosis of the underlying market index are key determinants of the market variance risk premium. Bakshi and Madan (2006), Bollerslev, Gibson, and Zhou (2011), Bekaert and Hoerova (2013), and Bekaert, Hoerova, and Lo Duca (2013) argue that the market variance risk premium is an indicator of aggregate risk aversion.[2] Zhou

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[1] For additional empirical evidence of the negative variance risk premium on the market index, see Carr and Wu (2009) and the papers cited in their work.

[2] A related interpretation is due to Bollerslev, Tauchen, and Zhou (2009) and Drechsler and Yaron (2011), who interpret the market

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(2010) shows that the market variance risk premium significantly predicts short-run equity returns, bond returns, and credit spreads. Consequently, the author argues that risk premia in major markets co-move in the short run and that such co-movement seems to be related to the market variance risk premia. Finally, Campbell, Giglio, Polk, and Turley (2014), using an intertemporal capital asset pricing model (ICAPM) framework, argue that co-variation with aggregate volatility news has a negative premium. At this point, it is fair to argue that the behavior of the market variance risk premium and its implications for financial economics are understood.

However, surprisingly little is known about the variance risk premium at the individual level. Bakshi and Kapadia (2003b) show that the variance risk premium is also negative in individual equity options. But, as Driessen, Maenhout, and Vilkov (2009) find, the variance risk premium for stock indices is systematically larger, that is, more negative, than for individual securities. They argue that the variance risk premium can, in fact, be interpreted as the price of time-varying correlation risk. They show that the market variance risk is negative only to the extent that the price of the correlation risk is negative. In a related paper, Buraschi, Trojani, and Vedolin (2014) argue that the wedge between index and volatility risk premia is explained by investor disagreement. Hence, the greater the differences in beliefs among investors, the larger the market volatility risk relative to the volatility risk premium of individual options. Even these papers are particularly concerned with the behavior of the market variance risk premium, despite employing data at the individual level.

We argue that an analysis and understanding of the time series and cross-sectional behavior of the variance risk premium at the individual level is lacking in the previous literature. This paper partially covers this gap. Our main contribution is to analyze the cross-sectional variation of the volatility risk premium (*VRP*) at the portfolio level. We employ daily data from OptionMetrics for the Standard & Poor's (S&P) 100 Index options and for individual options on 181 stocks included at some point in the S&P 100 Index during the sample period from January 1996 to February 2011. We calculate the *VRP* for each stock at the 30-day horizon as the difference between the corresponding realized volatility and the model-free implied volatility described by Jiang and Tian (2005). Similarly, we estimate the market *VRP* using the S&P 100 Index as the underlying index. For each month, we construct 20 equally weighted portfolios ranking the individual *VRP* values according to their betas with respect to the market *VRP*. These volatility risk premium betas are estimated over the previous month with daily data. The main objective of the paper is to analyze the determinants of the cross-sectional variation of the *VRP* of our 20 *VRP* beta-sorted portfolios.

The betas of the *VRP* beta-sorted portfolios estimated with respect to the market *VRP* range from −0.95 to 3.89. The portfolio with the most negative beta has the highest average *VRP*, and the two portfolios with higher positive beta present the most negative average *VRP*. Therefore, we find both negative and positive average *VRP* values ranging from 0.103 to −0.035 on an annual basis while the average market *VRP* is negative, as in previous literature.

Regarding the cross-sectional variation of the *VRP*, we find that consumption risk under the recursive preferences of Epstein and Zin (1991) does not seem to explain the cross-sectional behavior of *VRP*. Factor asset pricing models seem to be more useful in explaining *VRP* at the cross section. The key factors explaining average *VRP* across our 20 portfolios are the market *VRP* and, in addition, the default premium. The risk premia associated with the default premium betas are positive and statistically significant, even if we explicitly recognize the potential misspecification of the models. Moreover, we cannot reject the overall specification of the two-factor model, and the cross-sectional R^2 is equal to 0.514, with an asymptotic standard error of 0.211. Finally, our findings are related to credit risk and financial market stress conditions. The cross-sectional variations of volatility risk premia reflects the different uses of volatility swaps to hedge default and the financial stress risks of the underlying components of our sample portfolios.

This paper is organized as follows. Section 2 briefly describes variance swaps and volatility swap contracts and presents the alternative asset pricing models that we employ in the study of the cross-sectional variation of average *VRP*. Section 3 contains a description of the data. Section 4 discusses the model-free implied volatility and the estimation of *VRP* at the portfolio level. Section 5 presents the basic characteristics of the 20 *VRP* beta-sorted portfolios and empirical results using unconditional *VRP* beta estimates. Section 6 reports the main empirical findings of the paper and discusses the econometric strategy. Section 7 relates our evidence to financial stress conditions. Section 8 concludes the paper.

2. Theoretical framework

In a variance swap, the buyer of this forward contract receives at expiration a payoff equal to the difference between the annualized variance of stock returns and the fixed swap rate. The swap rate is chosen such that the contract has zero present value, which implies that the variance swap rate represents the risk-neutral expected value of the realized return variance:

$$E_t^Q\left(RV_{t,t+1}^i\right) = SW_{t,t+1}^i, \tag{1}$$

where $E_t^Q(\cdot)$ is the time t conditional expectation operator under a given risk-neutral measure Q, $RV_{t,t+1}^i$ is the realized variance of asset (or portfolio) i between t and $t+1$, and $SW_{t,t+1}^i$ is the delivery price for the variance or the variance swap rate on the underlying asset i. The variance risk premium of asset i is defined as

$$VARP_{t,t+1}^i = E_t^P\left(RV_{t,t+1}^i\right) - E_t^Q\left(RV_{t,t+1}^i\right). \tag{2}$$

At expiration, a volatility swap pays the holder the difference between the annualized volatility and the volatility

(*footnote continued*)
variance risk premium as a proxy of macroeconomic risk (consumption uncertainty). They show that time-varying economic uncertainty and a preference for the early resolution of uncertainty are required to generate a negative market variance risk premium.