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Volatility-of-volatility and tail risk hedging returns ☆

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ABSTRACT

This paper reports that the volatility-of-volatility implied by VIX options has predictability for tail risk hedging returns. Specifically, an increase in the volatility-of-volatility as measured by the VVIX index raises current prices of tail risk hedging options, such as S&P 500 puts and VIX calls, and lowers their subsequent returns over the next three to four weeks. The results are robust to jump risk, skewness, kurtosis, option liquidity, variance risk premium, and limit of arbitrage. The predictability can be explained by either risk premiums for a time-varying crash risk factor or uncertainty premiums for a time-varying uncertain belief in volatility.

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1. Introduction

The recent financial crisis has provoked an interest in tail risk hedging strategies that are structured to generate positive payoffs in bad states of the world in which asset values plunge, market

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volatility soars, funding/market liquidity drops, and institutional investors are forced to deleverage their risk exposures because of higher margin and haircut rates. For example, equity portfolio risk can be hedged by buying stock index put options or volatility derivatives such as the VIX futures and options. Despite the growing interest in tail risk hedges, little is known about their expected returns. The financial media expresses skepticism about the efficacy of tail risk hedges because the increased demand following the 2007–2009 financial crisis has made them too expensive.[1] Against this backdrop, the objective of this paper is to propose a new measure of marketwide tail risk and examine its relation to expected returns on two popular forms of tail risk hedges: the out-of-the-money (OTM) S&P 500 (SPX) puts and the OTM VIX calls.

The market's perception of tail risk can be incorporated into the stock index dynamics through two stochastic channels: a jump process and a persistent volatility process with a leverage effect, which is a negative correlation between changes of prices and volatility. Most of the existing studies, such as Bollerslev and Todorov (2011) and Du and Kapadia (2012), identify tail risk through the lens of a jump process because it offers an easy-to-understand framework to conceptualize tail risk. However, the precision of the jump-based tail risk measures heavily relies on the existence and accuracy of deep OTM SPX puts. In fact, it is highly difficult to obtain precise estimates of jump-based tail risk due to the limited availability and poor liquidity of deep OTM SPX puts. This measurement-error issue becomes even worse during a crisis when a tail risk indicator would be most useful, because the pre-crisis OTM SPX puts often turn into in-the-money.

Unlike the jump-based tail risk literature, this paper takes the perspective that tail risk information may be impounded into volatility-of-volatility because even a small change in the variable has a critical influence on the tails of return distributions. Motivated by this insight, I suggest using the volatility-of-volatility implied by the VIX options as a tail risk indicator, in particular, the Chicago Board Options Exchange (CBOE) VVIX index. Calculated by applying the VIX methodology to a cross-section of the VIX options, the VVIX index represents a risk-neutral expectation of volatility of the 30-day forward VIX index.

A nice property of the VVIX index is that it is less prone to measurement errors than the extant tail risk measures for two reasons. First, the VIX options market has, on a per-contract basis, a larger trading volume, a lower bid–ask spread, and a lower (Amihud, 2002) illiquidity measure than the SPX options market. In short, the VIX options market has greater market liquidity than the SPX options market. Second, the VVIX index is the second moment of VIX return distributions, so its computation is more weighted toward slight and moderate OTM options than deep OTM ones. As such, the absence of deep OTM options is less of a concern for the computation of the VVIX index, while some tail risk measures, such as the (Bollerslev and Todorov, 2011) fear index, hinge on the existence of deep OTM puts.

A central hypothesis tested in this paper is the negative relation between tail risk and expected returns on tail risk hedging options. That is, a higher level of tail risk increases the current prices of tail risk hedges, lowering their subsequent returns over the next period. Consistent with the hypothesis, the VVIX index is predictive of tail risk hedging returns with a negative sign over the next three to four weeks, implying that the tail risk hedging options become more expensive when the VVIX index is high. A one standard deviation increase in the current VVIX index is associated with a 1.63% to 2.19% decrease in the next day's SPX put returns and a 0.68% to 0.87% decrease in the next day's VIX call returns. The results are robust to a wide range of control variables, including other jump and tail risk measures; skewness and kurtosis measures; option (il)liquidity measures; variance risk premiums; and limits of arbitrage.

As the VVIX index compounds both information on volatility-of-volatility risk and its associated risk premium, the true source of the predictability of the VVIX index is unclear. To uncover the true source I introduce an approach to separating the VVIX index into a physical measure of volatility-of-volatility (*RVVIX*) and a volatility-of-volatility risk premium (*VVRP*). *RVVIX* is obtained by computing the realized variance of the five-minute front-month VIX future returns over the past one month. *VVRP* is then defined as the difference between the squared VVIX index and the *RVVIX* measure. By running predictive regressions of tail risk hedging returns against *RVVIX* and *VVRP*, I find that they both significantly contribute to the forecasting power of the VVIX index, although the former is more statistically significant than the latter.

[1] For example, Barclays' exchange-traded note on the first two front-month VIX futures lost more than one half of its value in the first half of 2012.