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Volatility risk premium decomposition of LIFFE equity options

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ABSTRACT

This study extends Bakshi and Kapadia's (2003b) framework to a multi-factor model to verify the common macro-factors attributed to the price of volatility risk in U.K. equity options. The results point out the presence of a negative risk premium and indicate that both idiosyncratic volatility and macro-factor volatilities arising from shocks to an index of industrial production and unanticipated inflation are priced in the individual LIFFE equity options. The evidence suggests that option investors are willing to pay for hedging against the shocks to those macro-factors and idiosyncratic risk.

1. Introduction

A substantial literature has devoted to the issue of negative volatility risk premia in option prices. Bakshi and Kapadia (2003a) show that the excess return of a delta-neutral portfolio is negatively correlated with time-varying volatility, and point out the existence of negative volatility risk premia in the S&P 500 index option market. Bakshi and Kapadia (2003b) discover the existence of a negative market volatility risk premium in U.S. individual stock option prices. Other related work includes, for example, Lamoureux and Lastrapes (1993), Jackwerth and Rubinstein (1996), Coval and Shumway (2001), Bakshi and Kapadia (2003a, 2003b), Sarwar (2002), Low and Zhang (2005), Doran and Ronn (2008), and Lin and Chen (2009).

In this paper, we adopt Bakshi and Kapadia's (2003b) framework and further extend it to a multi-factor model to investigate the common macro-factors attributed to the volatility risk premia in U.K. individual stock option prices. Enhanced understanding of factor decomposition of individual stock volatility premia has implications for asset pricing. Schwert (1989) exploits the relationship between economic variables and market volatility. The results point out a positive linkage between market volatility and macro-factors volatilities such as inflation, industrial production. Shiller (1994) shows that the inclusion of macro-factor determinants to derivatives can help manage swap risks. Errunza and Hogan (1998) find that volatilities of monetary and macroeconomic factors have significant influence on stock market volatility in European markets. In this paper, we try to verify the common macro-factors attributed to the market price of volatility risk in U.K. equity options. We apply four macroeconomic

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variables, originally proposed by Chen, Roll, and Ross (1986) in their arbitrage pricing theory model,[3] to our study: an index of industrial production, changes in default risk premia, twists in the yield curve, and unanticipated inflation.

Conventional theory holds that financial markets reward risk (volatility) with return. Do stock options with relatively high idiosyncratic volatilities in fact generate a relatively high magnitude of negative volatility risk premia? Idiosyncratic volatility has been increasing for individual stocks (Malkiel & Xu, 2006; Xu & Malkiel, 2003), although this may have reversed recently (Zhang, 2010) or it may be due to stock characteristics (Brandt, Brav, Graham, & Kumar, 2010). The research on using idiosyncratic volatility as a risk factor in asset pricing has not yet concluded. Bakshi and Kapadia (2003b) show that idiosyncratic volatility does not appear to be priced in U.S. individual stock option prices. In contrast, Goyal and Sata-Clara (2003) find idiosyncratic risk is priced in U.S. stocks by showing a significant correlation between average stock variance and the market return. Ang, Hodrick, Xing, and Zhang (2006) relate idiosyncratic risk to subsequent low stock returns. Angelidis and Tessaromatis (2009) examine the relationship between idiosyncratic risk and future stock market returns in the low variance regime.

To ascertain whether idiosyncratic volatility is related to the underlying factors that explain pricing in volatility risk, an important test of the independent explanatory influence of the idiosyncratic volatility on pricing is used to examine how it fares in direct competition with identified macro-factors. Specifically, to test the pricing influence on idiosyncratic volatility, this study adds one-month historical volatility, which is substituted for idiosyncratic volatility, to the set of identified macro-factors of stock return volatility. Evidence given by this study indicates that investors may be able to exploit a significantly negative risk premium for idiosyncratic volatility among U.K. stock options, robust to a broad set of macro-factor specifications and controls.

The study begins by calculating delta-hedged profits and losses (P&Ls) from 29 most liquidity individual equity options traded on London International Financial Futures and Options Exchange (LIFFE).[4] To mitigate the possible effect of model misspecification on the delta estimate, this study follows Lin and Chen (2009) to use the moment-adjusted option pricing model, which was originally proposed by Corrado and Su (1996) and modified by Brown and Robinson (2002), to relax the assumption of lognormality and incorporate skewness and kurtosis into the underlying distribution. For the purpose of comparison, the ad hoc Black–Scholes–Merton option pricing formula is also employed.

Individual equity option markets usually suffer from the low liquidity problem.[5] Sufficient liquidity guarantees the efficiency of option markets and thus the results for such markets may be reliable by negligent pricing errors. The extant literature such as Chakravarty, Gulen, and Mayhew (2004), Chordia, Roll, and Subrahmanyam (2008), and Tzang, Hung, Wang, and Shyu (2011) addresses the importance of liquidity in option markets. Table 1 shows the trading volume and open interests of U.K. individual equity options used in this paper, as indicative of an illiquidity issue arising for such markets relative to the FTSE 100 index option.[6] For the open interest of individual stock options, the standard deviations are about twice of the mean. On the other hand, the standard deviation is less than twice of the mean for the open interest of FTSE 100 Index option. The variation of open interest is larger for individual stock options. To mitigate the noise from option prices by illiquidity, this study follows Longstaff (1995) to incorporate the open interest as one measure of option demand that substitutes for option liquidity in our empirical tests. On the one hand, our findings show that the open interest successes to have a statistically significant effect on delta-hedged P&Ls in the sample period. On the other hand, the original macro-factor variables and idiosyncratic volatility have about the same significance as they did without liquidity constraint (not tabulated).

Summarizing, our results point out the presence of a negative risk premium and indicate that both idiosyncratic volatility and macro-factor volatilities arising from shocks to an index of industrial production and unanticipated inflation are priced in the individual LIFFE equity options.

The rest of the paper is organized as follows. Section 2 presents our theory. Section 3 discusses the data and the methodology. Section 4 analyzes empirical results. Section 5 concludes.

2. Multi-factor model

Bakshi and Kapadia (2003b) propose a non-parametric method of constructing delta-hedged P&Ls and examine to what extent their magnitude and sign are related to time-varying volatilities. Through the testable implication they prove the existence of negative volatility risk premia in the U.S. individual equity option prices. This study extends Bakshi and Kapadia's (2003b) single-factor theoretical framework to multifactor dimensions. This approach starts with a fixed number of unspecified factors that drive the dynamics of the variance of firm i. Denote the stock price and variance of firm i as $S_i(t)$ and $v_i(t)$, respectively. Let $S_i(t)$ follow a geometric Brownian motion under the physical probability measure. Our model can be specified as

$$\frac{dS_i(t)}{S_i(t)} = \mu_i(S_i, v_i)\, dt + \sqrt{v_i(t)}d\omega_i(t). \tag{1}$$

[3] Chen et al. (1986) link macroeconomic variables to stock returns and find that macro factors are priced.

[4] Data selection criteria and filtering schemes are discussed in Section 3.

[5] The authors fully acknowledge one anonymous reviewer for valuable opinions on option liquidity issues that have helped to improve the exposition of this article in significant ways.

[6] The daily volume of a specific option contract is simply a measure of the number of times that contract was traded on a particular day. The higher this daily volume, the more liquid this option contract becomes as compared to options with a lower daily volume. However, because each day brings a new daily volume, it is not the most accurate measure of option liquidity. Another measure of option liquidity is the open interest of the option. The open interest of an option contract is the number of outstanding options of that type which currently have not been closed out or exercised. The higher the open interest, the more liquid the option contract is thought to be.