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Volume, volatility and information linkages in the stock and option markets

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ABSTRACT

This paper examines the relationship between option trading activity and stock market volatility. Although the option market is uniquely suited for trading on volatility information, there is little analysis on how trading activity in this market is linked to stock price volatility. The bulk of the discussion tends to focus on whether trading activity in the stock market is informative about stock volatility. To analyze the information in option trading activity for stock market volatility, a sample of 15 stocks with the highest option trading volume is selected. For each stock, it is noted that the trading activities in the put and call option markets have significant explanatory power for stock market volatility. In addition, the results indicate that the call option trading activity has a stronger impact on stock volatility compared with that of the put options. Our results demonstrate that information and sentiment in the option market is useful for the estimation of stock market volatility. Also, the significance of the effects of option trading activity on stock price volatility is observed to be comparable to that of stock market trading activity. Furthermore, the persistence and asymmetric effects in the volatility of some stocks tend to disappear once option trading activity is taken into account.

1. Introduction

The information embodied in the trading activity of option and stock markets is an interesting subject studied by many researchers. Assuming markets are complete, option trading should not contain new information for market participants, as options derive their prices from the underlying stocks. However, if markets are incomplete, then this unidirectional relationship may not be true, because informed traders may prefer to trade options instead of the underlying stocks for several reasons: one, option trading involves lower transaction costs and higher financial leverage; and two, investors who have private information about stock price volatility can only make their bet on volatility in the option market (see Chan, Chung, & Fong, 2002). As such, the option trading process may not be redundant. Instead, it could play a significant role in price discovery and even contain information on stock market volatility.

The existing literature on whether the option market plays an important role in impounding information into stock prices presents rather mixed evidence. As noted by Amin and Lee (1997), a large proportion of long (or short) positions are initiated in the option market prior to earnings announcements on the underlying stock. Boluch and Chamberlain (1997) suggest that the option volume–stock price relationship is largely characterized by feedback, with option volume causing stock price changes. In contrast, Easley, O'Hara, and Srinivas (1998) provide evidence that stock price changes seem to lead option volumes, and there is "little or no evidence that put or call option volumes lead stock price changes". However, when they categorize option trades into positive-news and negative-news trades, they reject the hypothesis that option volumes contain no information about future stock price changes. More recently, Pan and Poteshman (2006) find strong evidence that equity option trading volume contains information about future stock price movements; stocks with relatively more new calls (puts) bought on them experience higher (lower) returns subsequently.

Compared with the research on the relationship between option trading activity and stock prices, there is little analysis on the information embodied in option transaction volume for stock market volatility, which undoubtedly is an important variable for risk management and portfolio allocation. This is quite surprising, considering the fact that the option market is uniquely suited for trading on volatility information. Cherian and Weng (1999) empirically investigate the presence of volatility information trading in the option market and its implications for option bid–ask implied volatility spreads as predicted in a recent article by Cherian and Jarrow (1998). Their major finding is consistent with the prediction that there will be a positive correlation between option volume and bid–ask implied volatility spreads, given the presence of

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directional and volatility information traders. A recent paper by Ni, Pan, and Poteshman (2007) demonstrates that option volume is informative about future stock market volatility, because the net volatility demand for options is positively related to the subsequent volatility of underlying stocks.

Indeed, the bulk of the discussion on the volume–volatility linkage tends to focus on how stock trading volume (instead of option volume) influences stock market volatility (see, for instance, Bollerslev & Jubinski, 1999; Chan & Fong, 2000; Fleming & Kirby, 2006; Fleming, Kirby, & Ostdiek, 2006; Hsu, 2000; Jones, Kaul, & Lipson, 1994; Karpoff, 1987; Lamoureux & Lastrapes, 1990; Naes & Skjeltorp, 2003; Roskelley, 2006; Shalen, 1993; Wang, 2004; Wu & Guo, 2004). In particular, Karpoff (1987) highlights many studies that document a positive relation between stock price variability and trading volume. Lamoureux and Lastrapes (1990) provide empirical evidence for the notion that autoregressive conditional heteroskedasticity in daily stock return data reflects time dependence in the process generating information flow to the market. Daily trading volume, used as a proxy for information arrival time, is shown to have a significant explanatory power regarding the variance of daily returns. Jones et al. (1994) further demonstrate that the stock price volatility and the number of transactions in the market are positively related. Various models are proposed to explain the stock volume–volatility relation, including the asymmetric information models by Admati and Pfleiderer (1988), the mixture-of-distribution models associated with Epps and Epps (1976), Tauchen and Pitts (1993) and Andersen (1996), and the differences-in-opinion models associated with Varian (1989) and Harris and Raviv (1993). However, these models are silent on the informational role of option volume on stock market volatility.

This paper fills the gap in the literature by focusing on the dynamic linkages between option trading volume and stock market volatility. In particular, the significance of option trading activity in explaining the volatilities of the underlying stocks is compared with that of stock market volume. Our approach implies the following two distinctive features. First, instead of the put/call volume ratio conventionally used in the literature, we measure the influence of option volume on stock market volatility by constructing the relative put (RPUT) and relative call (RCALL) ratios. The main advantages for this approach are: (1) we can determine the intensity of the option trading activity for a particular day relative to the past trading sessions, (2) the RPUT and RCALL ratios can be used to measure the degree of market sentiment, i.e., a high RPUT (RCALL) ratio may indicate that bearish (bullish) sentiment is comparatively strong, which allow us to address the question of whether *relative* peaks and valleys in call and put volumes reflect changes in information and sentiment that impact stock price volatility, and (3) since the relative put and call volume ratios are separately computed, it may be possible to distinguish the effects of bearish and bullish sentiments on stock market volatility (see Steenbarger, 2003, 2006).

Second, our approach also allows us to quantify the impact of option volume on the existence of persistence and asymmetry in stock market volatility.[1] Instead of the usual generalized autoregressive conditional heteroskedasticity (GARCH) model that is commonly used to analyze the stock volume–volatility relation, we adopt Nelson's (1991) exponential GARCH (EGARCH) approach in this study. The EGARCH(1,1) model places no restrictions on all the parameters, which makes the estimation process more tractable. The persistence of volatility shocks can also be meaningfully interpreted, as the model resembles the structure of a linear autoregressive model in logarithms. The EGARCH model also permits a certain degree of oscillatory behavior in the conditional variance as the persistence coefficient can be either positive or negative, and, unlike the symmetric GARCH model, asymmetric effects in volatility are incorporated in the EGARCH model.

We find evidence that the RPUT and RCALL ratios are positively correlated with stock market volatility, thereby supporting our argument that the option trading process is not redundant and contains valuable information on stock market volatility. The results show that the impact of the trading activity of the call option market on stock volatility is relatively stronger than that of the put option market, and the significance of option trading activity in explaining the volatilities of the underlying stocks is comparable to that of the stock trading activity. The persistence and asymmetric effects in the volatility of some stocks tend to disappear once option trading activity is taken into account. These finding lend additional support to our argument that option and stock markets are quite integrated, and has important implication for practitioners in the market and future research in this area.

The rest of the paper is organized as follows. Section 2 describes the methodology used for this study, and Section 3 analyzes the data sets and the estimation results. The last section concludes.

2. Analytical framework

It is well documented that the volatility of financial time series exhibits time-varying conditional heteroskedasticity, which is commonly modeled using the GARCH approach of Bollerslev (1986). Various hypotheses have been proposed to explain the stylized fact of GARCH effects in volatility, and one promising explanation suggests that daily stock returns are generated by a mixture of distributions (Andersen, 1996). According to the mixture-of-distribution hypothesis, the rate at which information arrives in the market can be viewed as a process generated by the stochastic mixing variable. If the daily number of information arrivals is positively correlated across days, then the model predicts serial correlation in the squared daily returns. The amount of information arrivals can be approximated by the daily trading activity in the stock market, and many researchers incorporate the effects of stock volume when they estimate the volatility of stock markets (see Bohl & Henke, 2003; Brailsford, 1996; Gallagher & Kiely, 2005; Lamoureux & Lastrapes, 1990). According to Lamoureux and Lastrapes (1990), under the assumption that trading volume is the mixing variable, volume is weakly exogenous in the sense of Engle, Hendry, and Richard (1983). Many of these papers typically use the GARCH model, which does not admit asymmetric effects in volatility and require non-negative constraints to be imposed on the parameters.

To circumvent the problems associated with the symmetric GARCH approach, we adopt Nelson's (1991) EGARCH model. In order to specify the EGARCH model, we begin by modeling the conditional mean equation for daily stock returns:

$$r_t = \mu(r_{t-1}) + \varepsilon_t \tag{1}$$

$$\varepsilon_t|\Phi_{t-1} \sim N(0, h_t) \tag{2}$$

where r_t represents the rate of return, $\mu(r_{t-1})$ is the conditional mean function (which can be an autoregressive-moving average (ARMA) model), ε_t is the random disturbance term that is normally distributed conditional on past information Φ_{t-1}, and h_t represents the conditional variance of stock market returns.

We then specify and estimate the following three conditional variance equations. The first one is set for stock market volatility without any trading activity:

$$\log h_t = \omega + \beta_1 \left| \frac{\varepsilon_{t-1}}{h_{t-1}} - \sqrt{\frac{2}{\pi}} \right| + \gamma \frac{\varepsilon_{t-1}}{h_{t-1}} + \beta_2 \log h_{t-1}. \tag{3}$$

Eq. (3) serves as the baseline model, as it does not involve any inclusion of the trading volumes of the option and stock markets. The parameter γ measures the magnitude of asymmetry in volatility.

[1] Volatility persistence and asymmetry have been highlighted as empirical regularities by many researchers (see Bollerslev, Chou, and Kroner (1992) for an extensive review of the literature on volatility persistence and asymmetry), and several papers have suggested that the driving forces behind these phenomena are the existence of serially correlated information arrivals and heterogeneous expectations.