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Impacts of implied volatility on stock price realized jumps

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ABSTRACT

This paper investigates the impact of *ex ante* implied volatility on stock price realized jumps. In particular, it examines how the different behaviors of informed and noise traders affect stock price jumps. We find that *ex ante* implied volatility interacts with the level of information quality for a stock when leading realized jumps, and that the direction of the relation changes across the states of the business cycle. We also document an asymmetric impact from *ex ante* implied volatility on price jumps across stocks with different degrees of information-based trading activity.

1. Introduction

A number of studies have recently shown that stock price jumps have significant implications for return properties, risk management, and portfolio allocation. Zhang et al. (2009) find that realized jumps in stock prices and their parameters are key determinants of the spreads for equity credit default swaps. Tauchen and Zhou (2011) document that market jumps are a significant factor predicting the risk on credit spreads. Jiang and Yao (2013) evaluate risk-based explanations of cross-sectional stock return predictability, including some driven by patterns of stock price realized jumps. However, relatively little work has focused on the causes of jumps in individual stock prices, and this paper fills a gap by modeling stock price jumps according to levels of implied volatility and information-based trading activity.[1]

The motivation for relating implied volatility to stock price jumps follows Bollerslev et al. (2009), who document that the premium between the implied and realized variations in stock market returns is able to explain a fraction of the aggregate market returns. The findings of Bollerslev et al. (2009) suggest the presence of time-varying economic uncertainty, which results from different volatility concepts on fundamental risk factors. In this framework, the lead-lag relation between implied volatility and the realized variation of returns would serve as a natural proxy for the underlying dynamics of uncertainty. In the spirit of Hong and Stein (1999) and Easley et al. (2010), this paper follows the conjecture that there are informed traders and noise traders in the market: informed traders react precisely to news about the level of uncertainty, while noise traders misreact more easily to the cash flow information in firm-specific variables. Jiang and Yao (2013) argue

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[1] Jiang and Yao (2013) argue that there are strong institutional and legal reasons to believe that lumpy information arrival is now more of a norm than an exception with recent regulations on corporate information disclosure. Their observation suggests that it is becoming more important for academics to understand the dynamics of stock price jumps.

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that when misreaction of traders exists and information about uncertainty is later released to the market in a conspicuous way (such as earnings announcements or profit warnings), investors may respond dramatically, causing stock price jumps. These analyses suggest a lead-lag pattern that would reflect the time-varying economic uncertainty, where the *ex ante* level of implied volatility is generated by informed traders, and realized jumps may occur after the unexpected information is revealed to noise traders.

This study is motivated by the above argument and the ongoing line of research to investigate the impact of *ex ante* implied volatility on stock price realized jumps under different levels of information-based trading activity. Since option trading is primarily done by sophisticated traders, following Bollerslev et al. (2009), this study uses the one-month-ahead implied volatility as a proxy of informed traders' perceptions regarding a given stock's current level of uncertainty. We focus on realized jumps rather than the variation of stock returns because large, discontinuous price movements are more infrequent and better reflect large surprises to the investors' information set. Jiang and Yao (2013) argue that the correction of mispricing can take the form of either diffusion or a jump, depending on whether the information to which investors initially misreacted was gradually released to the market or arrived in a single dump. In addition, more recent works modeling the realized jumps from intraday data by Barndorff-Nielsen and Shephard (2004),Huang and Tauchen (2005), and Tauchen and Zhou (2011) show that the jump component can be separated from the return variation, leading to a measurement more fitting to proxy sudden changes in trading behavior. This paper also adopts a new variable of information-based trading activity based on intraday price series, introduced by Hwang and Qian (2010). Detailed descriptions of all variables in the empirical application are discussed in the next section.

The results of this paper add to the existing literature in several ways. First, to the author's best knowledge, this research is the first to document an empirical relation between stock price jumps and firm-specific characteristics such as stock returns, firm size, book-to-market (B/M) ratio, earnings per share, and implied volatility. Second, this paper shows that the form of the relation between *ex ante* implied volatility and price jumps changes with the state of the business cycle and the magnitude of information-based trading activity. In particular, the impact of *ex ante* implied volatility on price jumps is much stronger and more significant during times of expansion, and the direction of the relation between these two variables reverses across periods with high or low activity of information-based trading. Third, this research finds that during times of recession, a significant impact of *ex ante* implied volatility on price jumps is only observed for stocks with low participation from information-based traders. This suggests that a stock with more information asymmetry is more strongly influenced by the misreactions of noise traders and experiences more stock price jumps.

The paper proceeds as follows. The next section describes the data and methodology. Section 3 presents the empirical results, and Section 4 concludes the research.

2. Data and methodology

The full sample is the intersection of all U.S. firms listed on NYSE, Amex, and Nasdaq from 2001 to 2011 and the firms with implied volatility histories in the Option Metrix database. Stocks with prices below $5 are excluded, so that the empirical findings are not driven by low-priced and illiquid stocks. Price series and firm characteristics are extracted from CRSP and COMPUSTAT. The measures of information-based trading activity are generated using intraday trading prices and volumes extracted from the TAQ database. Analyst forecasts are extracted from I/B/E/S.

This paper follows Barndorff-Nielsen and Shephard (2004), Huang and Tauchen (2005), Zhang et al. (2009), and Tauchen and Zhou (2011) in constructing a measurement of realized jumps based on intraday trading data. The literature suggests that the realized variance from high-frequency data provides a more accurate measure of short-term volatility than variances taken from low-frequency data (Andersen et al., 2001; Barndorff-Nielsen and Shephard, 2002; Meddahi, 2002). Christensen et al. (2014) show that measures of jump variation based on daily data spuriously attribute a burst of volatility to the jump component. Based on the theoretical stochastic process of stock prices, and the intuition that jumps in a financial market are large and rare, Barndorff-Nielsen and Shephard (2004) propose the following processes for realized variance (RV_t) and realized bipower variation (BV_t) on day t.

$$RV_t = \Sigma_{i=1}^{M} (r_{t,i})^2 \rightarrow \int_{t-1}^{t} \sigma^2 ds + \Sigma_{i=1}^{M} (J_{t,i})^2, \tag{1}$$

$$BV_t = \frac{\pi}{2} \Sigma_{i=1}^{M} |r_{t,i}| \cdot |r_{t,i-1}| \rightarrow \int_{t-1}^{t} \sigma^2 ds, \tag{2}$$

Where $r_{t,i} \equiv log(s_{t,i}/s_{t,i-1})$ is the ith intraday return on day t, and $s_{t,i}$ is the intraday stock price. M is the sampling frequency, and σ^2 and $J_{t,i}$ are the diffusion and jump components of the stock price process, respectively. The difference between RV_t and BV_t should be positive if there is a jump, and zero otherwise. This project adopts a ratio statistic (RJ_t) to determine if a jump occurs, based on Huang and Tauchen (2005) and Andersen et al. (2007).

$$RJ_t = \frac{RV_t - BV_t}{BV_t}. \tag{3}$$