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# Long memory and the relation between options and stock prices<sup>☆</sup>

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## ABSTRACT

This study investigates the long-memory property and the fractionally cointegration between absolute changes in observed stock prices and implied stock prices from option pricing model. We find a stylized fact that absolute price movements in stock and option markets are characterized by long memory and they present a fractionally cointegrated relation. The option prices appear to be valuable for the stock prices based on an appropriate econometric methodology, which captures the persistence of both price series. Our empirical results also support the presence of information effect in call option, but the volume effect is absent for all cases.

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## 1. Introduction

Investors regard options as an ideal vehicle for garnering high financial leverage and low trading costs (e.g., Black, 1975). If traders with information traded in the options market, options prices would contain some information that is not reflected in observed stock prices, and options are not redundant. Thus, a better understanding of relation between the option prices and stock prices could help improve option pricing and risk management.

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Past studies, however, related to this area find inconclusive evidence. On the one hand, some researchers find that implied stock price contains information that is not fully included in observed stock price (e.g., [Bhattacharya, 1987](#); [Anthony, 1988](#)). [Bhattacharya \(1987\)](#) documents that option price changes have some predictive power about the stock price changes. Moreover, [Easley et al. \(1998\)](#), [Schlag and Stoll \(2005\)](#), and [Pan and Poteshman \(2006\)](#) report that option volume contains information about stock price or volume. On the other hand, some studies provide evidence to the contrary (e.g., [Stephan and Whaley, 1990](#); [Chan et al., 2002](#)). [Stephan and Whaley \(1990\)](#) report that price changes in the stock market lead price changes in the option market as well as the trading volume. These, studies, however, do not consider the long-memory property of financial time series in their empirical analysis. Our primary objection is to address the topic of whether price movements in option market can predict the price movement in stock market, as the both price series are characterized by long memory.

Some increasing empirical literatures provide evidence that the economic and financial time series is characterized by long memory (e.g., [Ding et al., 1993](#); [Baillie et al., 1996](#); [Fleming and Kirby, 2011](#)). [Bollerslev and Jubinski \(1999\)](#) based on the evidence of long memory in volatility to investigate the extent to which volatility and volume share common order of fractional integration. [Fleming and Kirby \(2011\)](#) extent the topic of [Bollerslev and Jubinski \(1999\)](#) using more precise volatility estimates acquired using high-frequency returns. Their results indicate that volatility and volume both display long memory, and a strong relation between the innovations to volatility and volume.

We extend this argument to investigate the relation between absolute movement in observed and implied stock prices. Thus, the use of ordinary least squares in testing this relation cannot provide consistent estimates (e.g., [Robinson, 1994](#); [Bandi and Perron, 2006](#)). To address this problem, we adopt an econometric approach, namely the narrow-band spectral least squares formula (NBLS, hereafter) of [Bandi and Perron \(2006\)](#), which can captures the persistence of both price series based on long memory.<sup>1</sup>

In addition, we also examine whether the information effect and volume effects have impact on the prediction process. As reported by [Stephan and Whaley \(1990\)](#), when an option is regarded as a vehicle for reacting and profiting from their own new information, it is rational that they use high delta value options because high delta options have lower transaction costs. To recognize whether different predictive performances exist where the motivation for the trade differs, we stratify each option contract days in half according to the average daily delta value of the option. As for the volume effect, the measure of volume is an important feature of the financial market, which is directly corrected with the trading cost (see [Admati and Pfleiderer, 1988](#); [Chordia et al., 2001](#)). Similar to what we examine the information effect, we also investigate whether the trades with different volume indicate different prediction ability, the each option contract days is stratified in half according to the average daily volume of the option.

## 2. Methodology

### 2.1. Implied stock price estimates

To investigate the fractionally cointegration between the absolute changes in the observed and implied stock prices, we need to estimate the stock price implied by option price. Following [Stephan and Whaley \(1990\)](#) and [Chakravarty et al. \(2004\)](#), we transform option price into implied stock price using the option pricing model<sup>2</sup> as follows:

<sup>1</sup> As reported by [Bandi and Perron \(2006\)](#), if the predictive regression between regressor (implied volatility) and regressand (realized volatility) is a fractional cointegrating relation, then the classical regression cannot be used to test for option market efficiency because cointegration is associated with long-run comovements. They propose an adequate econometric approach, namely NBLS model, which capture the persistence of both volatility series and provide a consistent estimates of the long-run relation.

<sup>2</sup> Generally, one can use any option pricing model, following [Chakravarty et al. \(2004\)](#), we employ a binomial tree approach that explicitly estimate for the early exercise feature and multiple discrete dividends.

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