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Trading activity and bid–ask spreads of individual equity options

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ABSTRACT

We empirically examine the impact of trading activities on the liquidity of individual equity options measured by the proportional bid–ask spread. There are three main findings. First, the option return volatility, defined as the option price elasticity times the stock return volatility, has a much higher power in explaining the spread variations than the commonly considered liquidity determinants such as the stock return volatility and option trading volume. Second, after controlling for all the liquidity determinants, we find a maturity-substitution effect due to expiration cycles. When medium-term options (60–90 days maturity) are not available, traders use short-term options as substitutes whose higher volume leads to a smaller bid–ask spread or better liquidity. Third, we also find a moneyness-substitution effect induced by the stock return volatility. When the stock return volatility goes up, trading shifts from in-the-money options to out-of-the-money options, causing the latter's spread to narrow.

1. Introduction

The literature on option liquidity is sparse. Among the few papers that study liquidity for various derivatives markets,[1] only Mayhew et al. (1999), Kalodera and Schlag (2004) and Cao and Wei (2010) empirically examine liquidity for individual equity options. Mayhew et al. (1999) link the options order flow to the characteristics of the underlying stock and find that options are more liquid for stocks with a higher price, greater volatility and higher trading volume. Kalodera and Schlag (2004) perform a similar analysis on German stocks and options and find that a higher stock trading volume positively impacts options' liquidity measured by volume and trading frequency. In a recent study, Cao and Wei (2010) examine liquidity commonality and other features of the overall equity option market.

The literature on the properties of equity-option liquidity per se is even thinner. George and Longstaff (1993), Chong et al. (2003) and Cao and Wei (2010) are three studies loosely related to the topic. George and Longstaff (1993) examine the bid–ask spread of the S&P 100 index options across exercise prices and maturities and find that the cross-sectional differences in liquidity are linked to market-making costs and trading frequency. They also find that call and put options tend to be substitutes – calls are traded more frequently when the bid–ask spread for puts is higher, and vice versa. Their study is largely cross-section in that they only examine data for 1989. Chong et al. (2003) find a negative relation between maturity and the bid–ask spread for at-the-money, OTC currency options. Cao and Wei (2010) mostly focus on the liquidity covariation among stock options. The literature is completely lacking on the time-series properties of liquidity for individual equity options.[2]

Our paper takes the first step toward filling this gap in the literature. We ask and attempt to answer the following two related questions: (1) What are the important liquidity determinants for stock options? (2) Is the time-series behavior of option liquidity affected by trading activities other than the identified liquidity determinants? The trading activities we focus on are related to option expiration cycles and the level of stock return volatility. Using the proportional bid–ask spread (PBA) to gauge liquidity for actively traded options retrieved from OptionMetrics from January 1996 to June 2007, we obtain several interesting findings.

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[1] These include Vijh (1990), Cho and Engle (1999), Mayhew et al. (1999), Brenner et al. (2001), Kalodera and Schlag (2004), Tang and Yan (2008), Deuskar et al. (2009) and Cao and Wei (2010).

[2] In contrast, the literature on stock market liquidity is rich. In this journal alone, several papers on this topic have been published recently (e.g. Chan et al., 2008; Frino et al., 2008; Rakowski and Beardsley, 2008; Mantecon and Poon, 2009; Wang, 2010).

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Regarding the first question, we find that time to maturity, moneyness, stock return volatility, option return volatility, option trading volume and option price all affect the level of PBA. Contrary to common beliefs, stock return volatility and option volume, though both negatively related to PBA, have the least impact compared with other determinants. Options with a shorter maturity, being out of the money and with lower prices tend to have a larger PBA. The above determinants together explain about 55% of the time-series variations in PBA. The most striking finding is the strong explanatory power of the option return volatility, denned as the option price elasticity times the stock return volatility, which alone explains over 45% of the PBA variations. In other words, option return volatility is by far the most significant determinant of option liquidity. That the option's bid–ask spread is inherently linked to its return volatility is consistent with the theoretical models (Stoll, 1978a; Ho and Stoll, 1981) and empirical evidence (Benston and Hagerman, 1974; Branch and Freed, 1977) for stocks.

Regarding the second question, supplementing the call-put substitution effect for index options (George and Longstaff, 1993), we uncover two substitution effects for equity options. The first, the maturity-substitution effect, establishes an intricate link between option liquidity and the expiration cycle. By convention, the expiration months follow a quarterly cycle and there must be options available for the current and the next months. This convention causes the third expiry month to not always situate right after the second expiry month. There can be a 1- or 2-month gap, and the width of this gap varies for the same stock depending on where the stock is with respect to its own expiration cycle. We show that this maturity gap causes traders to substitute the short-term options (i.e., options maturing in the current month or the next) for the distant maturity options. This maturity-substitution has a direct bearing on the liquidity of short-term options: the PBA of short-term options decreases when the trading volume is shifted from the distant maturity options to the short-term options. This substitution effect remains significant even after controlling for all the identified liquidity determinants. The average impact on PBA is about 20 basis points, a relatively modest impact in light of the average PBA of 8.6% in our sample.

The second substitution effect, called "moneyness-substitution effect," has to do with moneyness and stock return volatility. When the stock return volatility increases, trading is shifted from in-the-money options to out-of-the-money options, especially for short-term options. This shift in volume directly affects the relative liquidity of in-the-money and out-of-the-money options. Specifically, when the stock return volatility goes up, the PBA of out-of-the-money options decreases relative to in-the-money options. This moneyness-substitution effect is the strongest for the current month options. Here, when the stock return volatility goes up by 5% (e.g., from 30% to 35%), the PBA of out-of-the-money options goes down by about 40 basis points relative to that of in-the-money options.

Our study contributes to the literature in three aspects. First, we offer insights into the determination and time-series properties of liquidity for individual equity options, an area that is currently void in the literature. The finding that the option return volatility is the single most important determinant of proportional bid–ask spread will have direct implications for all future studies on option liquidity.

Second, the discovery of the two substitution effects sheds light on the unique feature of option liquidity. To the best of our knowledge, George and Longstaff (1993) is the only study documenting a substitution effect among options. Their focus is on the substitution between calls and puts while we uncover two additional types of substitution along the dimensions of moneyness and maturity. Besides, George and Longstaff (1993) only examine S&P 100 index options while we examine a cross-section of individual equity options. The economic significance of the two substitution effects is by no means large compared with the absolute level of the spread itself. However, our findings are best judged on contributing to the overall understanding of option liquidity, not on profitable trading strategies.

The third aspect in which we contribute to the literature is the implication for the breakdown of bid–ask spreads. The literature on spread decomposition for stocks is voluminous (examples include Stoll, 1978a,b; Ho and Stoll, 1981; Glosten and Milgrom, 1985; Glosten and Harris, 1988). The three commonly considered components/factors are order processing cost, inventory cost and adverse selection cost. No consensus has emerged as to the relative importance of the three components. Similar research for options does not yet exist. Our finding that more than 45% of the spread variations can be explained by the option return volatility alone speaks to the importance of inventory risk in the formation of option spreads. On a day-to-day basis, the option return volatility measures the inventory risk faced by market makers. The high explanatory power of this return volatility means that a large portion of the spread is due to inventory risk.

The rest of the paper is organized as follows. In Section 2, we describe the data and explain the option expiration cycles. Section 3 studies the option liquidity determinants and trading patterns around expiration cycles. Section 4 relates the proportional bid–ask spread to maturity- and moneyness-substitutions. In Section 5, we present some alternative tests and briefly discuss the robustness checks. Section 6 concludes the paper.

2. Data and option expiration cycles

2.1. Data

The data source is Ivy DB's OptionMetrics, which covers all exchange-traded options on US stocks. The dataset starts on January 1, 1996 and the cut-off date for this study is June 30, 2007, covering a period of eleven and half years. Among other things, the database provides the day-end best bid and ask quotes, open interest, volume, delta and implied volatility (the last two items are calculated via a binomial tree with a constant interest rate). For the underlying stocks, the dataset provides the daily high/low/close prices and trading volume. To ensure that we have enough option observations for the purpose of studying the expiration cycle effects, we restrict our sample to the top 100 stocks ranked by option volume. Specifically, for each calendar year, we rank the stocks by their total option volume and select the top 100 stocks. This procedure results in 287 distinct tickers. The option data are further screened in the following manner:

- To minimize the impact of tick size on bid–ask spreads, we delete observations where the bid is lower than \$0.125 or \$1/8. This screening criterion is conservative in that after 2001 the tick size was reduced from \$1/16 and \$1/8 (for option prices below and above \$3) to \$0.05 and \$0.10, respectively. Therefore, \$0.125 represents the largest possible tick size in the entire dataset.
- To avoid potential recording errors, we delete observations whose trading volume is larger than five times the sum of today's and yesterday's open interests; observations with an option volume larger than the stock volume is also deleted.[3]

[3] OptionMetrics reports bid and ask quotes associated with both non-zero and zero trading volumes. In this study we retain the zero-volume quotes since our focus is on the behavior of bid–ask spreads. For certain analyses (e.g., when trading volume is a dependent variable in the regression), we delete the zero-volume observations. The zero-volume observations account for about 30% of the screened dataset.