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The information content of net buying pressure: Evidence from the KOSPI 200 index option market

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Abstract

This study investigates whether net buying pressure contains information, using the intraday data of the KOSPI 200 index option market. We document that the net buying pressure of call (put) options raises the implied volatilities of calls (puts), while the net buying pressure of put (call) options lowers the implied volatilities of calls (puts). Moreover, investors appear to buy call (put) options if the underlying asset price is expected to rise (fall). These relationships between net buying pressure and implied volatility can be accounted for by the direction learning hypothesis, which states that traders with information about the future movements of stock prices trade in the option market before trading in the stock market.

JEL classification: G13; G14

Key words: Learning hypothesis; Net buying pressure; KOSPI 200 option market; Implied volatility

1. Introduction

This paper examines whether price changes in an option market result mainly from informed trading, rather than from noise trading, by looking at the effect of buying pressure on the implied volatilities of options. Studies of informed trading initially focused on the stock market. The study of the effect of informed trading on stock prices goes back to Bagehot (1971), who suggests that market makers adjust the bid and ask prices to

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compensate for possible losses caused by informed trading. Copeland and Galai (1983) and Glosten and Milgrom (1985) show more formally that the bid-ask spread can be affected by informed trading. Grossman and Stiglitz (1980) show that informed trading must be profitable to reward agents for spending resources on information acquisition. Kyle (1985) develops a model showing that private information is gradually reflected in the price through trading in the market. Admati and Pfleiderer (1988) present a model that shows interactions among informed traders, discretionary liquidity traders, and indiscretionary liquidity traders; Foster and Viswanathan (1990) extend this model to consider the erosion of the information advantage of insiders over time.

As derivative markets grow fast, the literature on informed trading has expanded into the study of the preferred habitat of informed investors. As options have higher financial leverage and low transaction costs, and as they provide wider trading opportunities (e.g., speculation on volatility and no short-selling restriction), researchers suggest that informed investors exploit their private information in an option market before in its underlying asset market; thus, the information is disseminated from the option market to the underlying asset market (Black, 1975; Easley, O'Hara, and Srinivas, 1988).

However, the empirical research has been inconclusive. For example, Amin and Lee (1997), Easely, O'Hara, and Srinivas (1998), Chakravarty, Gluen, and Mayhew (2004), Stoll and Schlag (2005), Cao, Chen, and Griffin (2005), Pan and Poteshman (2006), and Kang, Lee, and Lee (2006) provide evidence that information flows from option markets to cash markets, while Bhattacharya (1987), Stoll and Whaley (1990), Booth, So, and Tse (1999), Chiang and Fung (2001), and Chan, Chung, and Fung (2002) see no evidence of this. This paper revisits the issue because we have access to a new dataset that promises new insights. This paper analyzes the KOSPI 200 index option market, which is substantially different from the S&P500 index market. The KOSPI 200 index option market is an electronic call market without any designated market makers, and trades in the market are dominated by individual investors rather than institutional investors. In addition, call options are traded more than put options.

This paper investigates the effect of informed trades in the KOSPI 200 index option market by examining the impact of net buying pressure on implied volatility. We provide three hypotheses regarding the information content of net buying pressure (the limit of arbitrage hypothesis, the direction learning hypothesis, and the volatility learning hypothesis) and test which hypothesis best accounts for the KOSPI 200 index option market. Using daily data, Bollen and Whaley (2004) provide empirical evidence that the net buying pressure for S&P500 options (especially, put options) drives the shape of the corresponding implied volatility smile and that liquidity suppliers can charge a premium over the options' true values due to limits to arbitrage (the limit of arbitrage hypothesis). They further document that selling OTM puts is profitable, even after delta-hedging positions. They interpret those empirical results as evidence against the learning hypothesis that the net buying pressure contains information regarding the volatility of options' underlying asset return. That is, they suggest that the net buying pressure of options affects the implied volatilities of options, but that it is not related to the information on the underlying asset's volatility.

Applying the Bollen and Whaley methodology to intraday observations of option demand and implied volatility, we find that the market for KOSPI 200 options is driven by direction traders and that net buying pressure in this market contains the information regarding the future movements of stock prices. We document that the net buying pressure of call (put) options raises the implied volatility of calls (puts), while the net buying pressure of put (call) options lowers the implied volatility of calls (puts). Moreover, investors appear to buy call (put) options if the underlying asset price is expected to rise (fall). Every investor group (individual, institution, and foreigner) also appears to be a directional trader, though there is a slight difference regarding the degree of directional trading among investor groups. In addition, we document that the informed trading results in temporary violations of put-call parity, and that exploitation of the violation can produce profit. We argue that these relationships between the net buying pressure and implied volatility, as well as the temporary violations of put-call parity, can be accounted for by the direction learning hypothesis, which states that traders with information about the future movements of stock prices trade in the option market before trading in the stock market.

The remainder of this article is organized as follows. Section 2 introduces the three hypotheses and shows what effects of net buying pressure can be expected under each hypothesis based on Bollen and Whaley's empirical tests. Section 3 presents the data used in the paper. Section 4 explains the empirical methodology and provides empirical results, and Section 5 contains the concluding remarks.

2. Net buying pressure hypotheses

Bollen and Whaley (2004) examine how implied volatilities across moneyness are linked to the net buying pressure on options and attribute the volatility smile phenomenon to net buying pressure. They suggest two alternative hypotheses, the limit of arbitrage and the learning hypotheses, to account for the relationship between implied volatilities and net buying pressure and provide empirical evidence supporting the limit of arbitrage hypothesis. This paper extends their hypotheses to examine informed trading effects in an option market.

The limit of arbitrage hypothesis assumes that the supply curve of an option has a positive slope. The upward sloping supply curve is possible due to the limits of arbitrage. Market makers will not stand ready to sell an unlimited number of contracts in an option series, even if there are profitable arbitrage opportunities in the market, as market makers are risk-averse and there is a possibility that mark-to-market losses may force liquidation of their positions before convergence (Shleifer and Vishny, 1997; Liu and Longstaff, 2004). If each option contract has an upward sloping supply curve, each implied volatility at time t is determined depending on the demand for each option contract; thus, the implied volatility function across moneyness at time t is determined accordingly.

In contrast, the learning hypothesis assumes that the slope of the supply curve of each option is flat. Option prices change only when new information hits the market, thus shifting the supply curve. There are at least two types of news that can move option prices.[1] The first concerns changes in the volatility of the future underlying asset prices, and the second considers the direction of the future underlying asset price movements. Bollen and Whaley implicitly assume that option traders are volatility traders and focus only on volatility shocks. In this case, under the learning hypothesis, if a volatility shock occurs and an order imbalance signals the shock to investors, then the order imbalance will

[1]News about jumps or regime shifts, which are not covered in this paper, can also move option prices. We appreciate the referee for pointing this out.

change the expectations of investors concerning future volatility; thus, the implied volatility will change accordingly. Therefore, we may observe a positive relationship between net buying pressure and implied volatility. We will call Bollen and Whaley's learning hypothesis *the volatility-learning hypothesis* in this paper.

There is a possibility that option traders are directional traders, as in Easley, O'Hara and Srinivas (1998). Since buying a call (put) option can be regarded as taking a leveraged long (short) position in the underlying asset, traders with information about the future underlying asset price movements can enjoy higher returns by taking a position in options than by taking a position in the underlying asset. Thus, option trading will be sought by directional traders as well as volatility traders. In the directional trader case, the learning hypothesis, under which the slope of the supply curve of each option is flat, indicates that the order imbalance will change the expectations of investors regarding the future price movements of the underlying asset, and the option prices will change accordingly. We will call this version of the learning hypothesis *the direction-learning hypothesis*.

To differentiate the limit of arbitrage hypothesis from the volatility-learning hypothesis, Bollen and Whaley suggest two empirical tests. First, they include the lagged changes in implied volatility in a regression that examines the relationship between changes in implied volatility and option demand. Under the limit of arbitrage hypothesis, changes in the implied volatility would be reversed since investors taking a risk by supplying liquidity want to rebalance their portfolio. On the other hand, the volatility-learning hypothesis predicts no serial correlations because information is already reflected in the price and the implied volatility by investors' trading activities. Second, they examine the impact of the net buying pressures of ATM options on changes in the implied volatilities of other option series. Under the limit of arbitrage hypothesis, the option series' own demand will affect its implied volatility, implying that the implied volatilities of different option series do not have to move together. Thus, the net buying pressure of ATM options does not necessarily affect the implied volatilities of OTM or ITM options. However, under the volatility-learning hypothesis, the net buying pressure of ATM options will drive the changes in the implied volatilities of all options in the same direction since ATM options have the highest vega, making them most informative with regards to the future volatility of the stock market.

Bollen and Whaley's empirical tests can also differentiate the direction-learning hypothesis from the other hypotheses. First, the direction-learning hypothesis implies a negative coefficient on the lagged change in implied volatility. If new information about the future underlying asset price movements arrives in the option market before it arrives in the underlying asset market, the implied volatility calculated with the underlying asset price will move. Fig. 1 shows the dynamics of the option price, index price, and implied volatility under the direction-learning hypothesis. Given a positive (negative) shock known to informed traders at time t and given that informed traders trade in the option market to exploit the information, positive (negative) net buying pressure on calls and negative (positive) net buying pressure on puts will be observed. These net buying pressures will result in higher (lower) prices and implied volatilities of calls and lower (higher) prices and implied volatilities of puts at time t. As the information is disseminated to the stock market at time $t+1$, the index price will rise at time $t+1$; thus, the implied volatilities of calls will go down (up), and the implied volatilities of puts will go up (down). Therefore, the direction-learning hypothesis implies a negative serial correlation of changes in implied volatility, and the prediction of the direction-learning hypothesis on the coefficient of the

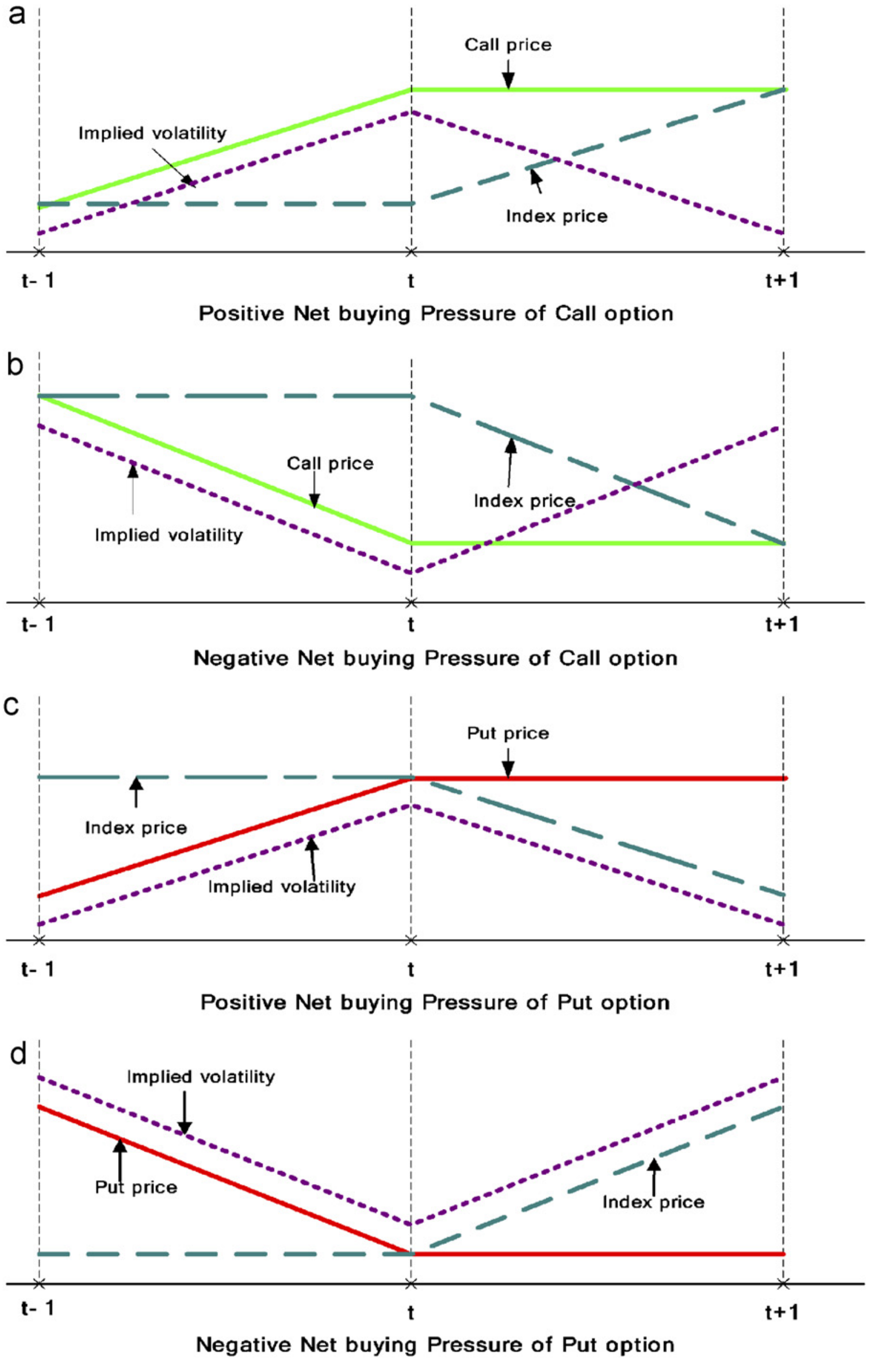

Fig. 1. Dynamics of prices and implied volatility under the directional learning hypothesis. The figures depict the movements of the call price, put price, index price, and implied volatility, when we observe net buying pressure driven by the information about the future index price movement at time *t*. (a) and (b) are dynamics of prices and implied volatility when we observe net buying pressure of call options, and (c) and (d) are those when we observe net buying pressure of put options.

lagged implied volatility in Bollen and Whaley's regression is identical to the one under the limit of arbitrage hypothesis. Second, the direction-learning hypothesis predicts the signs of the coefficients on the net buying pressure of calls and puts differently from the other two alternative hypotheses. Under the direction-learning hypothesis, the implied volatility of a call (put) option will be a positive (negative) function of the net buying pressure of call options, and a negative (positive) function of the net buying pressure of put options if the net buying pressure of options has information content regarding the future price movements of the underlying asset.

Although Bollen and Whaley's evidence is consistent with the limit of arbitrage hypothesis, there are other studies supporting the volatility-learning hypothesis or the direction-learning hypothesis. For example, Dubinsky and Johannes (2005) show that the implied volatility of call options increases before earnings announcements and decreases after earnings announcements. Ni, Pan, and Poteshman (2006) find that the demand for individual equity options contains information regarding the future realized volatility of underlying stocks. Many authors document that price movements of options can predict the future price movements of their underlying assets (Stoll and Whaley, 1990; Amin and Lee, 1997; Easley, et al., 1998; Chan, Chung, and Fung, 2002; Chakravarty, Gulen, and Mayhew, 2004; Stoll and Schlag, 2005; Pan and Poteshman, 2006).

3. Data

3.1. Data specification

This paper analyzes the KOSPI 200 index and index options.[2] The KOSPI 200 index options are the most actively traded index options in the world. As can be seen in Table 1, the trading volume of the KOSPI 200 index options is larger than the sum of the trading volume of S&P100 index options and S&P500 index options in 2002. The KOSPI 200 index is a capitalization-weighted index of 200 blue-chip stocks representing the Korean stock market and industry groups. The base date of the KOSPI 200 index is January 3, 1990, with a base index of 100. The KOSPI 200 index has been calculated since June 15, 1994. The KOSPI 200 index options are European options and are cash settled. Their contract months are the three consecutive following months plus one nearest the quarterly cycle, as with the S&P 500 index options. The last trading day of the KOSPI 200 index option is the second Thursday of the contract month.

Our data set from the Korea Stock Exchange (KSE) consists of all the trades, quotes, information about trader types, and volume records with a time stamp recorded to the nearest second in the KOSPI 200 index options market from June 1, 1998 to February 28, 2002 during the competitive bidding times.[3] The KOSPI 200 option market is a pure order-driven electronic call market without any designated market makers. Thus, all of the quotes are posted by traders through limit orders in this market, and all of the orders, including market orders, are fed into the Automated Trading System in KSE which

[2] Although there are options on a number of individual stocks in the Korean option market, these individual options are rarely traded. Thus, this paper focuses only on index options.

[3] Until 2001, trading hours of the KOSPI 200 Index options were from 9:00 to 15:05 and competitive biddings were performed between 9:30 to 14:30. However, since 2002, trading hours range from 8:00 to 15:15 and competitive bidding time is now between 9:00 and 15:00.

Table 1
Trading volume comparisons among the KOSPI 200 index options, OEX and SPX

This table presents the trading volume of the KOSPI 200 index options, the S&P 100 index options and S&P 500 index options in terms of the number of contracts, total premiums, and total notional amount in dollars from January, 2002 to December, 2002. The statistics of the KOSPI 200 index options are from the website of KSE (http://krx.co.kr) and those of the S&P 100 and S&P 500 options are from the website of CBOE (http://www.cboe.com/data). When calculating the dollar amount of the total premiums of the KOSPI 200 index options, we use the average exchange rate for the period of year 2002, which is obtained from Korea Exchange Bank (http://www.keb.co.kr/IBS).

Products	Types	The number of contracts	The total premiums	The total notional amount ($)
KOSPI 200 Index options	Calls	1,053,998,304	70,508,552,828,000	57,173,423,525
	Puts	835,825,482	54,719,202,549,000	44,370,278,736
	Totals	1,889,823,786	125,227,755,377,000	101,543,702,262
OEX(S&P 100)	Calls	6,534,139	3,811,289,634	3,811,289,634
	Puts	6,996,020	290,196,485	290,196,485
	Totals	13,530,159	4,101,486,119	4,101,486,119
SPX(S&P 500)	Calls	12,680,856	31,390,488,229	31,390,488,229
	Puts	17,258,742	52,053,575,234	52,053,575,234
	Totals	29,939,598	83,444,063,463	83,444,063,463

matches the best buy orders with the best sell orders continuously and automatically. These trading features provide a clean data set. Moreover, since quote and trade information is recorded in a correct sequence, we can easily find the closest bid/ask prices prior to a transaction. When the system receives an order, it also records which type of investor made the order: individual, categorized institutional, or foreign investor.

When option deltas are calculated, the Black-Scholes formula is used, in which the proxy for the standard deviation is estimated as the historical volatility of the return of the KOSPI 200 index over the most recent sixty trading days. In order to estimate the implied volatilities of options using the Black-Scholes model, linearly interpolated interest rates using one-month, two-month, three-month, six-month, and one-year Korean Government bond yields are used. These data are obtained from the Korea Securities Dealers Association. In addition, dividend yields of the KOSPI 200 Index are obtained from the KSE website.[4]

Table 2-A illustrates how each of the five moneyness categories is defined. This categorization is identical to that in Bollen and Whaley. Table 2-B shows the summary statistics of the implied volatilities of each moneyness category in the sample period. Both the implied volatility functions estimated from call options and from put options monotonically decrease to the 4th category, and then increase slightly in the 5th category. One thing notable here is that the implied volatilities for DITM options are much higher than those for DOTM options, contradictory to the findings in the US option markets (Bollen and Whaley, 2004; Bates, 1996). This is, however, consistent with the market microstructure effect shown in Hentschel, 2003. Since the bid-ask spreads of the DITM

[4]www.kse.or.kr. The dividend yields of the KOSPI 200 index are calculated as the total dividend from the KOSPI 200 index constituents over the total market value of the KOSPI 200 index constituents. KSE updates this dividend yield monthly.

Table 2
Summary statistics of implied and realized volatilities of KOSPI 200 index options

This table provides the definition of each moneyness category used by Bollen and Whaley (2004) and reports the descriptive statistics for implied volatility across the five moneyness categories. Bollen and Whaley measure moneyness of an option using the option's delta, which can be interpreted as the likelihood of being in the money at expiration. In calculating implied volatilities and deltas, the closing prices of KOSPI 200 index are used. The sample period is from June 1, 1998 to February 28, 2002. During the sample period, the realized volatility was 48.58%.

(A) Terminology of Bollen and Whaley

Call Category		Delta range	Put Category		Delta range
1	DITM	$0.875 < \Delta_C \leqslant 0.98$	1	DOTM	$-0.125 < \Delta_P \leqslant -0.02$
2	ITM	$0.625 < \Delta_C \leqslant 0.875$	2	OTM	$-0.375 < \Delta_P \leqslant -0.125$
3	ATM	$0.375 < \Delta_C \leqslant 0.625$	3	ATM	$-0.625 < \Delta_P \leqslant -0.375$
4	OTM	$0.125 < \Delta_C \leqslant 0.375$	4	ITM	$-0.875 < \Delta_P \leqslant -0.625$
5	DOTM	$0.02 < \Delta_C \leqslant 0.125$	5	DITM	$-0.98 < \Delta_P \leqslant -0.875$

(B) Summary Statistics of Implied Volatilities

Category	Average implied volatility					Average difference between implied and realized volatility				
	1	2	3	4	5	1	2	3	4	5
Call	0.693	0.450	0.446	0.459	0.486	0.158	0.025	0.020	0.032	0.044
Put	0.533	0.472	0.466	0.482	0.681	0.095	0.046	0.040	0.053	0.148

DITM stands for deep in-the-money, ITM is in-the-money, ATM is at-the-money, OTM is out-of -the-money, and DOTM is deep out-of-the-money.

options are much wider than for those of the DOTM options in the KOSPI 200 index option market (Cho, Hwang, Kang, and Lee, 2005), the implied volatilities for the DITM options can be biased toward higher values due to arbitrage trades. Table 2-B also shows that the historical volatilities of the KOSPI 200 index are lower than the implied volatilities of the KOSPI 200 options, regardless of moneyness.

3.2. Net buying pressure and investor types

Since net buying pressure indicates the difference between the number of buyer-initiated trades and the number of seller-initiated trades, it is necessary to identify whether a particular trade is buyer-initiated or seller-initiated. Given that all orders in the KSE are fed into its automated trading system, which continuously matches buy orders with sell orders, all of the trades take place either at the ask or the bid price. Thus, a trade is identified as a purchase (sale) if the transaction price is the ask (bid) price. This identification method is also used by Schlag and Stoll (2005) in the German DAX Index market operated by the automated Eurex system. The net buying pressure is computed as the difference between the number of purchase contracts and the number of sale contracts multiplied by the absolute value of the option's delta.

The trading volume and net buying for each investor group are reported in Table 3. Individual investors initiated 66.8% of the total option trades, while institutional investors and foreign investors initiated 25.7% and 7.5% of the total option trades, respectively.

Table 3
The number of KOSPI 200 index options traded across investor types

This table presents the number of contracts traded in the KOSPI 200 options market and the net buying across investor types. The delta values are calculated by using the closing prices of KOSPI 200 index, the yield to maturity of the Korea Treasury bond matching the option's time to maturity, and the historical volatility over the most recent sixty trading days. The sample period is from June 1, 1998 to February 28, 2002. All trades are allocated into three investor groups: individual, institutional and foreign investors. In Panel B, the net buying of contracts across investor types is defined as the number of contracts traded above the prevailing bid/ask midpoint less the number of contracts traded below the prevailing midpoint times the absolute value of the option's delta.

Delta value categorization	Individual investors				Institutional investors				Foreign investors			
	Call		Put		Call		Put		Call		Put	
	No. of contract	Prop. of total	No. of contract	Prop. of total	No. of contract	Prop. of total	No. of contract	Prop. of total	No. of contract	Prop. of total	No. of contract	Prop. of total
Panel A: Number of contracts traded												
1	1113600	0.001	147720000	0.116	1198200	0.001	41545000	0.033	577880	0.000	16247000	0.013
2	10683000	0.008	202630000	0.159	7017700	0.006	69868000	0.055	2370900	0.002	20618000	0.016
3	58344000	0.046	31238000	0.025	31909000	0.025	15821000	0.012	9267200	0.007	5674100	0.004
4	260890000	0.205	5345000	0.004	108280000	0.085	3557400	0.003	25108000	0.020	1276300	0.001
5	130560000	0.103	772190	0.001	47159000	0.037	656080	0.001	12924000	0.010	366910	0.000
Totals		0.363		0.305		0.154		0.103		0.040		0.035
Panel B: Net buying of contracts												
1	50297		217330		−18073		394370		−42053		−3024	
2	−45515		1166600		273970		1719400		216320		36536	
3	−69946		734820		−347460		104390		−175580		120243	
4	−153330		218270		−1713900		28476		−325070		86626	
5	−54114		−78297		428200		135850		62339		80226	
Totals	−272608		2258723		−2233663		2382486		−264044		180121	

Thus, individual investors are dominant trade-initiators in the KOSPI 200 option market. In addition, this table shows that the trading volume of calls is greater than that of puts. This differs from the US option markets, in which puts are traded more than calls. Bollen and Whaley attribute the dominant role of the net buying pressures of puts in the S&P500 index option market to the prevalence of puts in the market; and if their hypothesis is true, we would expect that the net buying pressures of call options would be more important in the KOSPI 200 option market.

Panel B of Table 3 illustrates the net buying pressure in call and put options across investor groups. This table shows that investors generally have net selling positions in call options and net buying positions in put options, regardless of the investor type. One notable exception is that individual and institutional investors are net sellers (buyers) of DOTM calls (puts), while foreign investors are net buyers (sellers) of DOTM calls (puts). This general tendency of the negative net buying position in call options and the positive net buying position in put options can be accounted for most easily by the limit of arbitrage hypothesis in the sense that the average implied volatility of put options is

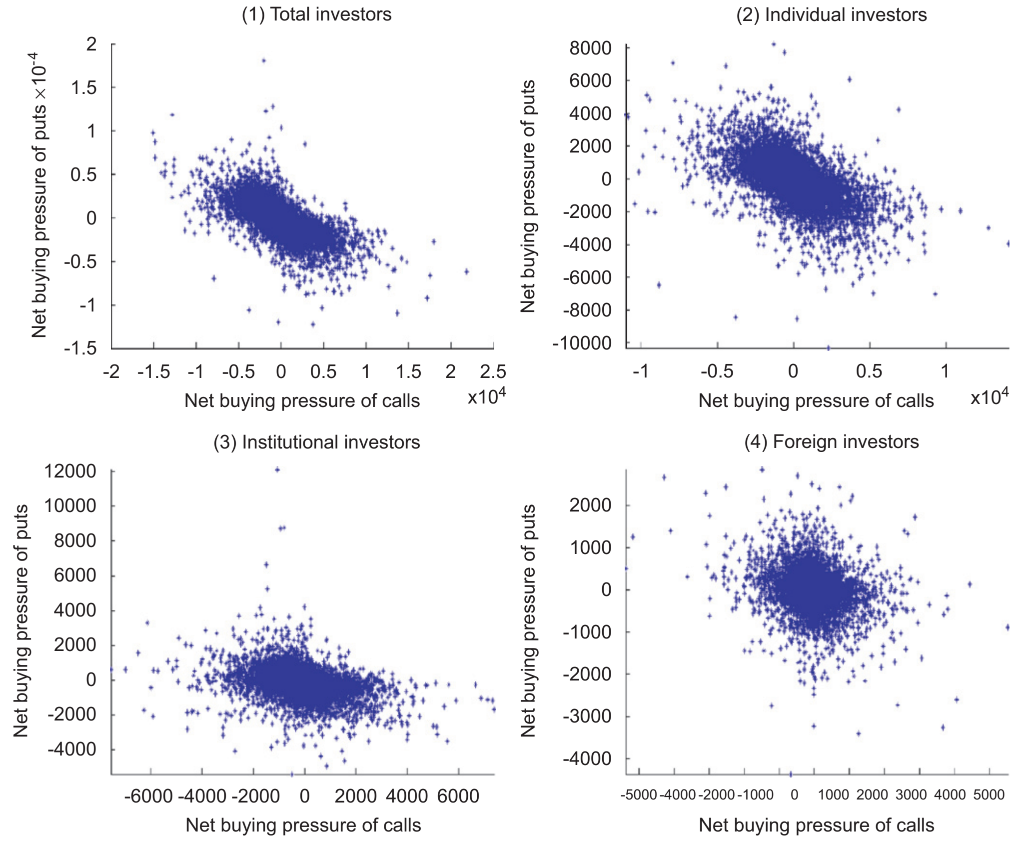

Fig. 2. Relation between the Net Buying Pressure of Calls and Net Buying Pressure of Puts. The figures depict scatter diagrams showing the relation between net buying pressure of calls and net buying pressure of puts. Each point denotes a pair of net buying pressures of calls and puts over a 5-min interval. Horizontal and vertical axes are net buying pressure of calls and net buying pressure of puts, respectively.

generally higher than that of call options, as shown in Panel B of Table 2. However, it does not imply that Part B of Table 3 is inconsistent with the other hypotheses.

Fig. 2 shows scatter diagrams of the pairs of the net buying pressures of calls and puts. Each point in these scatter diagrams denotes a pair of the net buying pressures of calls and puts over a five-minute interval. Here, we can see that the net buying pressure of calls is generally negatively correlated to the net buying pressure of puts, regardless of the investor type. The correlation between the net buying pressures of calls and puts is −0.675 for all investors, −0.595 for individual investors, −0.342 for institutional investors, and −0.225 for foreign investors. This is consistent with the direction learning hypothesis.

4. Empirical analysis

This section empirically examines the three hypotheses in terms of the relationship between net buying pressure and implied volatility and provides evidence for the direction learning hypothesis. The regression methods from Bollen and Whaley's study are utilized here with 5-min intraday option data, instead of the daily option data used in Bollen and Whaley's study, in order to focus more on the information effect of the net buying pressure on the implied volatility.

This study also investigates how different the impact of the net buying pressure of an investor group on the implied volatilities might be. For example, institutional investors' demand for put options to hedge their portfolios, which is emphasized in Bollen and Whaley, may affect implied volatilities differently.

4.1. Regression specifications

To assess the impact of the net buying pressure on the implied volatilities, the change in the average implied volatility of options is regressed in a particular moneyness category on contemporaneous measures of the index return, index trading volume, net buying pressure, and a lagged change in the average implied volatility. The contemporaneous return of the index and its trading volume in the regression are included as control variables for leverage and information flow effects. Index returns are expected to be negatively correlated with changes in implied volatility due to the leverage effect (Black, 1976; Christie, 1982) or the positive feedback effect (French, Schwert, and Stambaugh, 1987; Campbell and Hentschel, 1992). Trading volume is expected to be correlated with volatility since both variables represent information flow in the market.

The lagged change in the average implied volatility is included to differentiate the alternative hypotheses discussed in Section 2. Under the limit of arbitrage hypothesis, the temporary nature of the impact of the net buying pressure implies a negative coefficient on the lagged change in implied volatility. The direction-learning hypothesis also implies a negative coefficient on the lagged change in implied volatility because option prices lead their underlying asset price under the direction-learning hypothesis. In contrast, under the volatility-learning hypothesis, the coefficient of the lagged change in implied volatility will be insignificant. Under the volatility-learning hypothesis, the lagged change in implied volatility should be uncorrelated with the current change in implied volatility since new information regarding market volatility drives changes in the implied volatility, and shocks in market volatility are unpredictable or serially uncorrelated.

Regressions are run for the cases of ATM calls, ATM puts, OTM calls, and OTM puts. In summary, these regressions are specified as follows:

$$\Delta ATM\_\sigma_t = \alpha_0 + \alpha_1 RS_t + \alpha_2 VS_t + \alpha_3 ATM\_D_{1,t} + \alpha_4 ATM\_D_{2,t} + \alpha_5 \Delta\sigma_{t-1} + \varepsilon_t, \tag{1}$$

$$\Delta OTM\_\sigma_t = \alpha_0 + \alpha_1 RS_t + \alpha_2 VS_t + \alpha_3 OTM\_D_{1,t} + \alpha_4 ATM\_D_{2,t} + \alpha_5 \Delta\sigma_{t-1} + \varepsilon_t, \tag{2}$$

where ΔATM_σ_t is the change in the average implied volatility of ATM calls (or puts) and ΔOTM_σ_t is the change in the average implied volatility of OTM calls (or puts) at a five-minute time interval t. RS_t is the index return during the time interval t, and VS_t is the summed trading volume of the KOSPI 200 index over the time-t interval expressed in trillions of Korean won. ATM_D_t and OTM_D_t denote the summed net buying pressures of ATM calls or puts and OTM calls or puts, respectively, during the time interval t.

To investigate the effects of the net buying pressure of different investor types on changes in implied volatility, regressions (1) and (2) are run for each investor group—domestic individual investors, domestic institutional investors, and foreign investors—as well as for the entire investor group. For instance, if individual investors' net buying pressure effect on ATM calls is desired, then $ATM\_D_{1,t}$ is replaced by individual investors' ATM call net buying pressure and $ATM\_D_{2,t}$ is replaced by individual investors' ATM put net buying pressure in Eq. (1).

It is possible to differentiate the three alternative hypotheses by comparing the size and the sign of the coefficients of net buying pressures, $\alpha 3$'s and $\alpha 4$'s, in Eq. (1) and (2). In Eq. (1), under the volatility-learning hypothesis, the impacts of the net buying pressure of ATM calls and puts on the changes in the volatility of ATM calls or puts are expected to be positive and indistinguishable from each other, as both ATM calls and puts have the same vega and, hence, are equally sensitive to changes in expectations of future volatility. If the limit of arbitrage hypothesis is correct, these two coefficients will be positive, but need not be equal since ATM calls and puts are traded with no relation to the expectations of changes in volatility. Under the direction-learning hypothesis, in the regressions of the changes in ATM call (put) volatility, the coefficient of the net buying pressure of ATM calls will be positive (negative), and the coefficient of the net buying pressure of ATM puts will be negative (positive).

Eq. (2) can also be used to distinguish the three hypotheses. Under the volatility-learning hypothesis, ATM options' net buying pressure should have more impact on the changes in the implied volatility of OTM options than it does on the OTM options' own net buying pressure because ATM options have higher vegas compared to OTM options; thus, investors will react more rapidly in the ATM option market than in the other option markets. In addition, the volatility-learning hypothesis predicts that the coefficient of the net buying pressure of every option should be positive. The limit of arbitrage hypothesis predicts that the coefficients of the net buying pressure of OTM call (put) options will be positive and larger in the regressions of the changes in the implied volatility of the OTM call (put) options compared to those of the net buying pressure of ATM options. The direction-learning hypothesis predicts that the coefficients of the net buying pressure of call (put) options will be positive and the coefficients of the net buying pressure of put (call) options will be negative, regardless of moneyness, in the regressions of the changes in the implied volatility of OTM call (put) options.

4.2. Regression results

Table 4 reports the intraday regression results of Eqs. (1) and (2). The estimation results for changes in the implied volatility of ATM calls and puts are reported in Panel A and Panel B, while those of OTM calls and puts are reported in Panels C and D, respectively.

All of the coefficients of index return, α_1's in the regressions of changes in the implied volatility of ATM and OTM call options in Panels A and C are negative and statistically significant at the 5% significance level. This is consistent with the leverage or positive feedback hypothesis, but those coefficients for the regressions of ATM and OTM put options in Panel B and Panel D are all positive and statistically significant, which contradicts the leverage hypothesis. However, the direction-learning hypothesis can account for these signs of α_1's. Fig. 1 shows that $\Delta\sigma_t$ should be negatively related with RS_t for calls and positively correlated with RS_t for puts under the direction learning hypothesis. When information is first reflected in the option market and then disseminated to the stock market, the changes in implied volatilities are reversed. This is precisely what we observe in Table 4, which also shows that $\Delta\sigma_t$ is negatively correlated with $\Delta\sigma_{t-1}$ ($\alpha5<0$), which is consistent with the direction learning hypothesis.

Table 4 shows that the coefficients of the trading volume, α_2s, are negative and statistically significant at the 5% significance level for all of the regressions. These coefficients show that the price of an option tends to decrease if stocks are more actively traded. The main test of the information effect of net buying pressure in Table 4 is revealed in the coefficients of the net buying pressure, α_3s and α_4s. The coefficients of the option series' own net buying pressure (that is, ATM calls for ATM calls, ATM puts for ATM puts, OTM calls for OTM calls, and OTM puts for OTM puts), α_3s, are always positive and are statistically significant at the 5% significance level except for the foreign investor group. The coefficients of the net buying pressure of ATM calls for OTM calls and ATM puts for OTM puts, α_4's, are positive and often significant in Panel C and D of the table. On the other hand, the coefficients of the net buying pressure of the other option series (that is, ATM puts for ATM and OTM calls, and ATM calls for ATM and OTM puts), α_4s, are negative and are often statistically significant at the 5% significance level in Panel A and B of the table. The limit of the arbitrage hypothesis or the volatility-learning hypothesis cannot account for these results, but the direction-learning hypothesis is consistent with these results. If investors acquire new information that stock prices will go up (down), they will place buy orders in call (put) options or place sell orders in put (call) options, which results in net buying pressure on call (put) options or net selling pressure on put (call) options. The information of the news is spread through the net buying pressure of call (put) options or the net selling pressure of put (call) options before it arrives at the stock market, causing the price or the implied volatility of the call (put) options to increase. Combined with the evidence documented by Kang, Lee, and Lee, 2006 in which the KOSPI 200 options return is found to lead the KOSPI 200 stock index return by up to 10 min, the direction-learning hypothesis can account for the positive α_3s and the negative α_4s.

4.3. Additional tests

Though all the regression results thus far appear consistent with the direction-learning hypothesis, there is a possibility that the results are driven by noise trading in the index

Table 4
Intraday regression results for the impact of the net buying pressure on the changes of implied volatility

This table presents the coefficients from the regression:

$$\Delta\sigma_t = \alpha_0 + \alpha_1 RS_t + \alpha_2 VS_t + \alpha_3 D_{1,t} + \alpha_4 D_{2,t} + \alpha_5 \Delta\sigma_{t-1} + \varepsilon_t,$$

where $\Delta\sigma_t$ is the change in the option's implied volatility in moneyness category over 5-min interval t, RS_t is the return of KOSPI 200 Index over 5-min interval t, VS_t is the summed trading volume of the index over 5-min interval t expressed by trillions of Korean won, and $D_{1,t}$ and $D_{2,t}$ are summed net buying pressures over 5-min interval t divided by one million. Panel A contains the results for the change in the implied volatility of ATM call options, Panel B contains the results for the change in the implied volatility of ATM put options, Panel C contains the results for the change in the implied volatility of OTM call options, and Panel D contains the results for the change in the implied volatility of OTM put options. An asterisk * is attached when the coefficient is significant at the 5% significance level. The sample period is from June 1,1998 to February 28, 2002.

D_1	D_2	Parameter estimates						
		Adj. R^2	α_0	α_1	α_2	α_3	α_4	α_5
Panel A: Changes in ATM call volatility as a function of D_1 and D_2								
TNBP_ATMC	TNBP_ATMP	0.092	0.000	−0.773*	−0.326*	0.166*	−0.255*	−0.261*
INBP_ATMC	INBP_ATMP	0.092	−0.000	−0.762*	−0.333*	0.284*	−0.229*	−0.261*
SNBP_ATMC	SNBP_ATMP	0.092	−0.000	−0.760*	−0.255*	0.333*	−0.401*	−0.261*
FNBP_ATMC	FNBP_ATMP	0.090	−0.000	−0.740*	−0.264	−0.184*	−0.773	−0.261*
Panel B: Changes in ATM put volatility as a function of D_1 and D_2								
TNBP_ATMP	TNBP_ATMC	0.110	0.000	0.374*	−0.858*	0.551*	−0.183*	−0.319*
INBP_ATMP	INBP_ATMC	0.109	0.000	0.353*	−0.880*	0.594*	−0.183*	−0.319*
SNBP_ATMP	SNBP_ATMC	0.110	0.000	0.358*	−0.859*	0.923*	−0.395*	−0.319*
FNBP_ATMP	FNBP_ATMC	0.107	0.000	0.327*	−0.919*	0.796*	−0.247	−0.319*
Panel C: Changes in OTM call volatility as a function of D_1 and D_2								
TNBP_OTMC	TNBP_ATMC	0.087	0.000*	−0.750*	−0.667*	0.140*	0.045*	−0.198*
TNBP_OTMC	TNBP_ATMP	0.087	0.000*	−0.754*	−0.677*	0.141*	−0.107*	−0.198*
INBP_OTMC	INBP_ATMC	0.087	0.000*	−0.747*	−0.640*	0.188*	0.058*	−0.198*

Table 4 (*continued*)

D_1	D_2	Parameter estimates						
		Adj. R^2	α_0	α_1	α_2	α_3	α_4	α_5
INBP_OTMC	INBP_ATMP	0.087	0.000*	−0.748*	−0.681*	0.192*	−0.109*	−0.198*
SNBP_OTMC	SNBP_ATMC	0.086	0.000*	−0.740*	−0.692*	0.260*	0.109*	−0.197*
SNBP_OTMC	SNBP_ATMP	0.086	0.000*	−0.740*	−0.648*	0.269*	−0.175*	−0.197*
FNBP_OTMC	FNBP_ATMC	0.085	0.000*	−0.723*	−0.659*	−0.161*	−0.020	−0.198*
FNBP_OTMC	FNBP_ATMP	0.085	0.000*	−0.724*	−0.659*	−0.161*	−0.030	−0.198*
Panel D: Changes in OTM put volatility as a function of D_1 and D_2								
TNBP_OTMP	TNBP_ATMC	0.061	0.000*	0.382*	−0.790*	0.201*	−0.052*	−0.215*
TNBP_OTMP	TNBP_ATMP	0.061	0.000*	0.380*	−0.782*	0.209*	0.084*	−0.215*
INBP_OTMP	INBP_ATMC	0.060	0.000*	0.377*	−0.784*	0.256*	−0.059*	−0.215*
INBP_OTMP	INBP_ATMP	0.060	0.000*	0.376*	−0.745*	0.261*	0.102*	−0.215*
SNBP_OTMP	SNBP_ATMC	0.060	0.000*	0.373*	−0.804*	0.419*	−0.132*	−0.215*
SNBP_OTMP	SNBP_ATMP	0.060	0.000*	0.368*	−0.843*	0.442*	0.078*	−0.215*
FNBP_OTMP	FNBP_ATMC	0.058	0.000*	0.356*	−0.831*	−0.143*	−0.035	−0.215*
FNBP_OTMP	FNBP_ATMP	0.059	0.000*	0.356*	−0.836*	−0.128*	0.128*	−0.215*

Note: TNBP_ATMC stands for total investor's net buying pressure on at-the-money call options, INBP_ATMC for individual investor's net buying pressure on at-the-money call options, SNBP_ATMC for institutional investor's net buying pressure on at-the-money call options, and FNBP_ATMC for foreign investor's net buying pressure on at-the-money call options. In the same way, TNBP_ATMP, TNBP_OTMC, TNBP_OTMP stand for total investor's net buying pressure on at-the-money put options, out-of-the money call options, and out-of-the-money put options, respectively.

option market.[5] If investors think that the index will rise, they will buy calls and sell puts, which increases the price and implied volatility of calls and reduces those of puts. If the index does not rise on average, calls will drop back down in value and puts will rise back up in value. This will generate a negative serial correlation in implied volatility ($\alpha 5<0$) as well as all the signs of coefficients shown in the regressions in Table 4.

To distinguish the direction-learning hypothesis from the noise trader hypothesis above, two additional tests are performed in this section. First, whether or not the future KOSPI 200 index returns can be predicted from the current net buying pressure of an index option is examined. If the proposed direction-learning hypothesis is true so that informed traders trade in the index option market first and information content of the trades is then disseminated in the underlying asset market, the net buying pressure of the index option market should have some prediction power for future index returns. Alternatively, under the noise trader hypothesis or the limits of arbitrage hypothesis, the net buying pressure of the index option market will not have any prediction power for future index returns. Second, the violations of the put-call parity relationship (hereafter PCP) are examined. The direction-learning hypothesis predicts that PCPs can be temporarily violated since the prices and implied volatilities of call and put options move in opposition directions as a result of informed trading. Thus, under the direction-learning hypothesis, it is reasonable to expect that PCP violations will increase when there are information shocks. Moreover, it is predicted under the direction-learning hypothesis that investors can turn profits (before transactions costs) in the underlying asset market by appropriately using the net buying pressure of index options as a trading signal. On the other hand, the net buying pressure of an index option cannot generate a trading profit under the noise trader or limits of arbitrage hypotheses.

To examine the prediction power of the net buying pressure of the KOSPI 200 index options over the future index returns, the following regression is run:

$$NBP_t = \alpha_0 + \sum_{i=-2}^{2} \alpha_{i+3} r_{t+i} + \alpha_6 NBP_{t-1} + \varepsilon_t, \tag{3}$$

where NBP_t is the net buying pressure over a 5-min interval t and r_t is the return of the KOSPI 200 index over the five minute interval t. α_4 and α_5 should be close to zero under the noise trader hypothesis or the limit of arbitrage hypothesis, while under the direction-learning hypothesis α_4 or α_5 should differ from 0, with their signs determined by the characteristics of the option series.

Table 5 shows the estimation results of Eq. (3).[6] As can be seen in this table, the net buying pressure of call options and put options leads the KOSPI 200 stock return. All the coefficients of r_{t+1} are statistically significant at the 5% significance level except for the cases of ITM and OTM put options in the foreign investor group, regardless of which option series is examined. Moreover, all the coefficients of r_{t+1} in the regressions of the net buying pressure of call options are positive, while all the coefficients of r_{t+1} in the regressions of the net buying pressure of put options are negative. These signs of the coefficients are consistent with the direction-learning hypothesis. When the net

[5]We appreciate the anonymous referee who pointed out this possibility and suggested the PCP test below.

[6]In a previous version of the paper, we reported the results only for the observations with extreme net buying pressure. The qualitative results for those extreme observations are virtually identical to those reported here.

Table 5
Relation between net buying pressure and the KOSPI 200 index returns

This table presents the relation between net buying pressure on options and returns of the KOSPI 200 index, which is estimated by:

$$NBP_t = \alpha_0 + \sum_{i=-2}^{2} \alpha_{i+3} r_{t+i} + \alpha_6 NBP_{t-1} + \varepsilon_t,$$

where NBP_t is the net buying pressure over the five minute interval t, and r_t is the return of the KOSPI 200 index over the 5-min interval t. An asterisk * is attached when the coefficient is significant at the 5% significance level. The sample period is from June 1, 1998 to February 28, 2002.

Category	Investor type	Parameter estimates						
		α_0	α_1	α_2	α_3	α_4	α_5	α_6
Panel A. Relations between call option's net buying pressure and returns of the KOSPI 200 index								
ITM	Total	0.01	−0.43	−1.38	0.94	5.51*	−1.97	−0.11
	Individual	0.00	−0.61	−0.73	0.75	2.72*	−0.88	−0.21
	Institutional	0.01	0.44	−0.38	0.53	1.58*	−0.42	0.07
	Foreigner	0.00	−0.22	−0.18	−0.27	1.25*	−0.61*	0.12
ATM	Total	0.01	−0.08	−0.34	1.07	6.32*	−1.64	0.12
	Individual	0.00	−0.21	−0.24	0.59	3.31*	−0.91*	0.09
	Institutional	0.00	0.28	0.32	0.25	2.98*	−0.36	−0.19
	Foreigner	0.00	0.05	−0.23	0.25	0.22*	−0.18	0.27
OTM	Total	0.00	−0.19	−0.47	2.66	7.79*	−2.05	−0.05
	Individual	0.00	−0.31	−0.56	2.04	5.93*	−0.93*	−0.04
	Institutional	0.00*	0.09	0.19	0.32	1.57*	−0.89	0.00
	Foreigner	0.00	0.17	−0.09	0.45	0.32*	−0.07*	0.14*
Panel B. Relations between put option's net buying pressure and returns of the KOSPI 200 index								
ITM	Total	−0.01	0.68	0.71	−0.64	−3.19*	1.07	0.12*
	Individual	0.00	0.25	0.54	−0.56	−1.69*	0.83*	−0.11*
	Institutional	0.00	0.16	0.08	−0.08	−1.35*	0.25	0.05*
	Foreigner	0.00	0.29	0.21	−0.17	−0.18	0.11	0.24*
ATM	Total	0.00	0.05	0.15	−0.61	−4.13*	0.87	0.7
	Individual	0.00	0.21	0.2	−0.26	−2.55*	0.46	0.16*
	Institutional	0.00	−0.07	−0.01	−0.39	−1.42*	0.37	0.56
	Foreigner	0.00	−0.05	−0.01	−0.09	−0.37*	0.10	0.09*
OTM	Total	−0.01	0.11	0.14	−1.05	−5.33*	1.19*	−0.02
	Individual	0.00	0.14	0.23	−0.82	−3.09*	0.85*	−0.01
	Institutional	0.00	−0.02	−0.03	−0.18	−2.86*	0.23	−0.05
	Foreigner	0.00	−0.07	−0.02	−0.16	−0.29	0.13	0.15*

buying pressure of call (put) options is observed, the stock return goes up (down) over the next five minute interval. Thus, the index option market leads its underlying market, as in Easley et al., 1998; Chakravarty, Gluen, and Mayhew, 2004; Schlag and Stoll, 2005; and Pan and Poteshman, 2006. In addition, every investor group can be regarded as a directional option trader. It may be presumed before the analysis in Table 5 that institutional or foreign investors are more likely to be volatility traders and that individual investors are more likely to be directional traders. However, this is not the case. All of the coefficients are of the same sign, and the absolute values of the coefficients have the expected order, considering the trade size of each group in the KOSPI 200 index option market.

Next, the violations of PCP are examined. There are two types of PCP violations:

$$\begin{aligned} &\text{Type } 1: \quad c_t^{bid} + Xe^{-r\tau} - p_t^{ask} - (I_t - D) > 0, \\ &\text{Type } 2: \quad p_t^{bid} - Xe^{-r\tau} - c_t^{ask} + (I_t - D) > 0, \end{aligned} \tag{4}$$

where c_t^{bid}, c_t^{ask}, p_t^{bid}, and p_t^{ask} are the bid and ask prices of calls and puts at time t, respectively; X is the exercise price of the call and put options; τ is the maturity of the call

Table 6
Put-call parity violations

Panel A presents the percentage of the following put-call parity violations:

$$\textit{Type 1 violation}: \quad c^{bid} + Xe^{-r\tau} - p^{ask} - (I - D) > 0.$$

$$\textit{Type 2 violation}: \quad p^{bid} + (I - D) - c^{ask} - Xe^{-r\tau} > 0,$$

where c^{bid}, c^{ask}, p^{bid}, and p^{ask} are calls and puts bid and ask prices, respectively, X is the strike price of call and put options, τ is the maturity of these call and put options, I is the index price at time t, D is the present value of the dividends paid over τ. When the net buying pressure of a call is positive (negative) and the net buying pressure of a put is negative (positive), we call the information embedded in the net buying pressure 'positive (negative)'. In each case, we report the percentage of each type of put-call parity violation. Panel B presents the trading profit of exploiting the violations of put-call parity. An index is bought (sold) when type 1 (2) violations occur and the position is reversed after 5, 10, or 15 min. An asterisk * is attached when the average profit or put-call parity violation is significant at the 5% significance level. The sample period is from June 1,1998 to February 28, 2002.

Information type	Violation type	Time period (min)	Delta categorization				
			DITM	ITM	ATM	OTM	DOTM
Panel A. Percentage of put-call parity violations							
POSITIVE	TYPE1	0	23.269	26.167	22.710	22.230	26.544
		5	22.354	25.031	21.712	21.409	25.400
		10	11.896	14.421	11.171	10.969	14.844
	TYPE2	0	1.632	3.795	2.876	1.768	0.589
		5	1.464	3.531	2.613	1.553	0.471
		10	1.342	3.292	2.436	1.404	0.454
NEGATIVE	TYPE1	0	9.637	7.470	8.904	10.207	8.154
		5	9.430	7.294	8.739	10.007	7.958
		10	9.271	7.164	8.614	9.880	7.783
	TYPE2	0	17.236	34.018	38.868	25.108	7.743
		5	13.499	27.962	31.840	19.836	4.208
		10	6.279	15.385	18.948	7.651	2.525
Panel B. Trading performance exploiting the violations of put-call parity							
POSITIVE	TYPE1	5	0.074*	0.070*	0.074*	0.070*	0.036*
		10	0.085*	0.066*	0.061*	0.060*	0.031
		15	0.086*	0.064*	0.047*	0.052*	0.031
	TYPE2	5	−0.024	−0.047	−0.036*	−0.036*	−0.035
		10	−0.042	−0.046	−0.023	−0.043	−0.035
		15	−0.029	−0.048	−0.011	−0.033	−0.040
NEGATIVE	TYPE1	5	−0.047	−0.062	−0.071	−0.065*	−0.047
		10	−0.030	−0.046	−0.062	−0.060	−0.044
		15	−0.013	−0.030	−0.055	−0.061	−0.052
	TYPE2	5	0.053*	0.079*	0.094*	0.058*	0.060
		10	0.045*	0.074*	0.098*	0.051*	0.110
		15	0.004	0.063*	0.090*	0.043*	0.052

and put options; r is the risk-free interest rate at time t; I is the index price at time t; and D is the present value of the dividend paid over τ. Under the direction-learning hypothesis, it can be expected that the Type 1 (Type 2) violation will be more prevalent when there is positive net buying pressure of a call (put) or negative net buying pressure of a put (call). Panel A in Table 6 reports the results. When the net buying pressure of a call is positive (negative) and the net buying pressure of a put is negative (positive), the information embedded in the net buying pressure is termed 'positive (negative)'. This Panel shows the percentages of PCP violations among all possible put-call matches with the same exercise price for the period of $[t, t+5\,\text{min})$, $[t+5\,\text{min}, t+10\,\text{min})$, and $[t+10\,\text{min}, t+15\,\text{min})$ when the net buying pressures over $[t, t+5\,\text{min})$ are given. As can be seen in this panel, Type 1 (Type 2) PCP violations are much more prevalent than Type 2 (Type 1) PCP violations when information is positive (negative). In addition, the percentage of the Type 1 (Type 2) violation drops significantly after 5 min when positive information occurs, as shown in the panel. This is consistent with the direction learning hypothesis and shows that the index option market leads the stock market at least by 5 min.

However, results shown in Panel A do not rule out the noise trader hypothesis. To distinguish one from the other, the performances of index trades using the net buying pressure as a trade signal are examined. An index is bought (sold) when Type 1 (Type 2) PCP violations occur. Panel B shows the performance of the trading strategy when the position is reversed after 5 min, 10 min, and 15 min. As the index should move following the option market movements under the direction learning hypothesis, the strategy should be profitable. On the other hand, the strategy will not make any money under the noise trader hypothesis. The results in Panel B of Table 6 are consistent with the direction learning hypothesis: when the index is bought (sold) after positive (negative) information is signaled, statistically significant profit can be made. Since the profits from the strategy do not differ much regardless of whether the position is reversed after 5 min, 10 min, or 15 min, it is clear that information is reflected in the option market first, but that the information is disseminated to the stock market 5 min later.

5. Conclusion

The KOSPI 200 index option market is substantially different from the S&P500 index market. The KOSPI 200 index option market is an electronic call market without any designated market makers, and trades in the market are dominated by individual investors rather than institutional investors. In addition, call options are more heavily traded than put options. This paper examines how net buying pressure of options affects the implied volatility of options in this market by applying the Bollen and Whaley methodology to intraday observations in this market. It highlights how information regarding the value of the underlying asset is incorporated into option prices.

The empirical evidence in this study shows that the net buying pressure of a call (put) option affects the implied volatility of call (put) options positively, while it affects the implied volatility of put (call) options negatively. To account for the empirical results, we argue that option traders are directional traders rather than volatility traders or noise traders in the KOSPI 200 index option market, and supporting evidence is provided for this argument. Option traders in the KOSPI 200 option market buy call options when stock prices are expected to rise, and buy put options when stock prices are expected to decline. Thus, positive net buying pressure on call options increases call prices and decreases put prices, while positive net buying pressure on put options increases put prices and decreases call prices. In addition, we document that a prediction can be made that index returns will increase (decrease) for the next 5-min interval as well as for the current 5-min interval when positive (negative) net buying pressure on call options is observed. On the other hand, when positive (negative) net buying pressure on put options is observed, it is possible to predict that stock returns will decrease (increase) for the next 5-min interval as well as for the current 5-min interval. We show that informed trading or net buying pressure of options results in temporary violations of the put-call parity and that any information disparity between the KOSPI 200 option market and its underlying asset market is resolved five minutes after informed trading in the option market.

Given the general belief that it is hard for investors to possess private information regarding the future movements of a stock index or of the economy, these empirical findings may result in uneasiness for some. However, noting that the option market for individual stocks is not yet developed for Korean stocks and that a handful of stocks dominate the KOSPI 200 index, directional traders in the KOSPI 200 index option market may be the ones with private information concerning the future movements of those individual stocks rather than such information regarding the Korean economy.

In conclusion, this paper documents that option traders in the KOSPI 200 options market are directional traders rather than volatility traders and that they trade in the options market to exploit their private information with regard to the future movements of the underlying stock price before they trade in the stock market. Thus, net buying pressure in the KOSPI 200 option market contains information regarding the future movements of the Korean stock market.

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