Which traders contribute to price discovery most? Evidence from the KOSPI 200 options market

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Abstract

We examine which group of investors, individuals, institutions, or foreigners, has more information about the true price process in the KOSPI 200 options market. Using Hasbrouck (1995)'s information share and Gonzalo and Granger (1995)'s common factor weight approach, we document that foreigners are the most informative about the efficient price process. This result holds firmly even after controlling the effects of trading volume and the number of trades.

JEL classification: G14; G15

Keywords: price discovery, options market, informed investor, Vector Error Correction Model

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1 Introduction

In the market microstructure literature, which trade is informative and so helps to discover the efficient price has long been considered as an important research question. Barclay and Warner (1993), Hasbrouck (1995) are two pioneers in the area. Barclay and Warner (1993) propose the weighted price contribution (WPC) measure to test the stealth-trading hypothesis, which argues that the informed traders camouflage their information by dividing their trades into medium size. Following Barclay and Warner (1993), numerous papers the WPC measure to examine the stealth-trading hypothesis in many markets (Barclay and Hendershott (2003); Chae and Lee (2011); Chakravarty (2001); Kim and Ryu (2012)). Hasbrouck (1995) develops the vector autoregression (VAR) based methodology and utilize the measure of “information shares” to examine the relative importance of the trades in each market when a security is traded in many markets. On the other hand, Gonzalo and Granger (1995) proposes another measure, called the common factor weights, to measure the relative importance in price discovery in the same VAR-based model. The difference from the two approaches is that the information shares are from the variance decomposition of the permanent component, and the common factor weights are from the assumption that the permanent component is a linear combination of prices in different markets. A series of papers compares the two approaches, and discuss that they are closely related but have different meaning (Baillie, Booth, Tse and Zabotina (2002); De Jong (2002); Hasbrouck (2002), and others).

In this paper, we examine how much individual, institutional, and foreign investor group contributes the price discovery in the Korea Stock Price Index 200 (KOSPI200 index) options market. The KOSPI200 index options market provides a nice playground for the research in the market microstructure. It is one of the most liquid derivative markets in the world. More importantly, compared to the U.S. stock and derivatives markets, which have multiple market makers, every trade in the KOSPI200 options market goes through a single electronic call system. This feature allows us to reach a high-quality dataset with more accurate information of the trades in the market. In addition, the Korea Exchange provides the data marking clearly which investor group trades for each transaction.

In terms of the empirical approach, Anand and Chakravarty (2007), who investigate how price discovery occurs in the options market through trade size choice, is the closest paper to ours. We focus on various investor groups instead of trade size. Chakravarty (2001) argues that the disproportionally large price impact of medium-size trades in a stock market is from the trades by institutions, thus proposes that institutions are informed investors. Thanks to our dataset, we analyze more directly whether institutions or other investor groups are informed investors.

In this paper, we apply the VAR-based approach by Hasbrouck (1995) and Gonzalo and Granger (1995) to examine which group of investors is informative in the price discovery process. Although there are a number of papers about the informed investors in the Korean stock and derivatives market, most of them focus on the stealth-trading hypothesis and order-splitting behavior of informed traders, and none of them applies the VAR-based approach to investigate the price discovery process.

The main findings of this paper are summarized as follows. First, both in Hasbrouck (1995)'s information share and Gonzalo and Granger (1995)'s common factor weight approach, foreigners make the largest price discovery contribution with more than 50% share, and the contribution by individuals is comparable to that by institutions. Second, foreigners' information shares and common factor weights decrease with option trading volume, while individuals' and institutions' contribution to price discovery increase with option trading volume. Our main result of foreigners' information superiority holds firmly even after controlling the effects of trading volume and the number of trades.

Our empirical results suggest that foreigners are informed traders in the KOSPI200 options market, consistent with the findings in Ahn, Kang and Ryu (2008), Kang and Park (2008), and Kim and Ryu (2012). By contrast, institutions' low information share may imply that their focus of trades in the options market is hedging. Their trades do not have much information on the future price movements of the KSOPI200 index options.

The remainder of this paper is organized as follows. Section 2 reviews the related literature. Section 3 shows the data and empirical methodology. Section 4 shows the empirical evidence. Section 5 summarizes and concludes.

2 Data and Empirical Methodology

2.1 Data

We use the intraday transactions data of the KOSPI200 options market from the Korea Exchange (KRX). The sample period is from January 4, 2010 to June 30, 2014 (1,115 trading days). We restrict our analysis to normal continuous double auction trading hours (from 9:00 am to 3:05 pm). Following Chae and Lee (2011), Kim and Ryu (2012) and others, we exclude the transaction data on the maturity dates, since the motivation of the trade might be different on those days. We do not utilize the inter-day price movement, and use the intraday prices of individual option series as one price vector. Following Anand and Chakravarty (2007), we call this as "option-series-day".

The dataset used in our analysis has two useful features. First, we can identify the initiator of a trade by its order submission numbers. Each of the transaction has its buyer's and seller's time-ordered submission numbers. Since a larger number is assigned to the order placed later, we choose the one with the larger order submission number as the initiator without any algorithmic process such as the Lee and Ready (1991) algorithm. Second, we can see the participants' identity by their own identity numbers. This enables us to classify the investors into their types. We divide the investors into three groups: individuals, institutions, and foreigners.

When describing the moneyness of the options in this paper, we use with the criterion $m = S/K$ when the option is call ($m = K/S$ when the option is put). We define the moneyness category of an option as follows: DOTM (Deep Out-Of-The-Money) when $m \leq 93$, OTM (Out-Of-The-Money) when $0.93 < m \leq 0.97$, ATM (At-The-Money) when $0.97 < m \leq 1.03$, ITM (In-The-Money) when $1.03 < m \leq 1.07$, and DITM (Deep In-The-Money) when $m > 1.07$.

From the options issued on March 9, 2012, the option multiplier of the KOSPI200 options has been changed from 1 million Won to 5 million Won. The purpose of this event is to prevent speculative investments in the options market, and protect the individual investors. This event may change the market constituents, and their trading behavior. For example, if the uninformed, speculative, and lottery-type individual investors were ruled out after the increase of the option multiplier as the original intention of the event suggests, the individuals would contribute more to the price discovery process after the event than before, since the noisy individual traders decrease after the change.

Table 1 displays the summary statistics of our data. It shows the mean values of time-to-maturity, moneyness, trading volume (the number of contracted traded), and the number of transactions by investor subgroups. In terms of trading volume, foreigners consist of more than half, and trading volume of individuals is similar to that of institutions. Turning our point to number of trades, foreigners still have more than half of the percentage, while institutions constitute only about 9% of total number of transactions. This shows that institutions usually prefer large block trades, and individuals make relatively small trades.

2.2 Empirical Methodology

In this research, we employ the vector autoregression (VAR) technique by Hasbrouck (1995) and Gonzalo and Granger (1995). To be specific, Hasbrouck (1995)'s information share is the contribution of a group to the variance of the random walk process, thus focuses more on the variance. Gonzalo and Granger (1995)'s common factor weight is useful in constructing the efficient price assuming that the permanent component is a linear combination of each price. If we use the analogy by De Jong (2002), Hasbrouck (1995)'s information share is like a partial R^2 $(\beta_i^2 \sigma_{X_i}^2 / \sigma_y^2)$, and Gonzalo and Granger (1995)'s common factor weight is like a normalized coefficient $(\beta_i / (\beta' \mathbf{1}))$ in the regression model of $y = \beta' X + \epsilon$. In this paper, we employ both techniques in that they show different dimension of price discovery.

The baseline assumption in our analysis is that the prices of the three investor groups for an option-series-day act as those in three different markets, and they share a common random walk component, which we call the "efficient price process". We express the log price vector of the three investor groups as equation (1).

$$p_t = \begin{bmatrix} p_{ind,t} \\ p_{ins,t} \\ p_{for,t} \end{bmatrix} = \begin{bmatrix} V_t + e_{ind,t} \\ V_t + e_{ins,t} \\ V_t + e_{for,t} \end{bmatrix} \quad (1)$$

The efficient price process follows random walk as $V_{t+1} = V_t + u_{t+1}, u_{t+1} \sim N(0, \sigma_u^2)$ (2)

By construction, the three prices are cointegrated with order 2. Then, by the Granger representation theorem, the cointegrated prices can be expressed as a vector error correction model (VECM) as equation (3).

$$\Delta p_t = A_1 \Delta p_{t-1} + \cdots + A_N \Delta p_{t-N} + \gamma (z_{t-1} - \mu_z) + \epsilon_t, \text{ where } cov(\epsilon_t) = \Omega \text{ and } z_t = \begin{bmatrix} p_{ind,t} - p_{ins,t} \\ p_{ind,t} - p_{for,t} \end{bmatrix}. \quad (3)$$

In the vector moving average (VMA) representation of the model, the changes in the price vector can be expressed as follows.

$$\Delta p_t = B_0 \epsilon_t + B_1 \epsilon_{t-1} + \cdots, \text{where } B_0 = I_3. \quad (4)$$

The cumulative impulse-response matrix $B(1) = \lim_{k \to \infty} \sum_{i=1}^{k} B_i$ has three identical rows B. The total variance of the efficient price changes can be expressed by $\sigma_T^2 = B \Omega B'$. When Ω

happen to be diagonal such as $\Omega = \begin{bmatrix} \sigma_{ind}^2 & 0 & 0 \\ 0 & \sigma_{ins}^2 & 0 \\ 0 & 0 & \sigma_{for}^2 \end{bmatrix}$, the information share of a trader group i is $IS_i = \frac{B_i^2 \sigma_i^2}{\sigma_T^2}$. In general, the error covariance matrix Ω is not diagonal, and so we need to use the Cholesky decomposition to estimate the maximum and minimum information shares.

In Hasbrouck's representation, the price vector is given by the VECM form in equation (3). In Gonzalo and Granger (1995)'s method, the permanent component is alternatively defined as a linear combination of prices of each market, and the transitory component is the error-correction term z_t in equation (3), thus resulting in the following equation.

$$p_t = C_1(\beta' p_t) + C_2 z_t \quad (5)$$

The first term, $\beta' p_t$, is the permanent component, and the second term, z_t, is the error-correction transitory component. Then, the weight of the permanent component, β, should be an orthogonal vector of γ with the sum of the weight being 1, as $\beta = \gamma^{\perp}/(\gamma^{\perp'}\mathbf{1}_3)$. The vector β describes the relative weight of each price to the permanent component, and we call this as Gonzalo and Granger (1995)'s common factor weight.

In estimating the VECM in equation (3), we follow Hasbrouck (2003) and Anand and Chakravarty (2007). For a given option-series-day, we refine the transactions data into 1-second intervals, and choose the options with at least 3,000 trades in the refined second-by-second dataset in a day. We use 300 seconds (5 minutes) as the lag of the VAR system (N in equation (3)). To reduce the number of coefficients estimated in the system, we employ polynomial distributed lags over lags 1-10, 11-20, and 21-30, and moving averages over 31-60, 61-120, and 121-300. In the VMA representation in equation (4), we use 3,600 seconds (1 hour) as the maximum lag.[1]

[1] We thank Joel Hasbrouck to share his program codes and description publicly. Further details in the estimation procedure can be found in his homepage (http://people.stern.nyu.edu/jhasbrou/).

3 Empirical Evidence

3.1 Price discovery by investor types

Table 2 illustrates Hasbrouck (1995)'s information share results. Panel A reports the means and standard deviations of the maximum and the minimum of information shares from the full sample. Although the mean of the minimum and the maximum information share shows some differences, we can clearly see that the foreigners' information share is the highest with the mean maximum share of 73.3% and mean minimum share of 56.7%. Given the large number of observations (18468 option-series-day), foreigners' mean minimum share is statistically higher than those of individuals and institutions. Hence, the results indicate that foreigners contribute most to price discovery. Even though the institutions have the lowest share when we compare among the maximum shares and the minimum shares, the mean maximum share of the institutions is 19.2%, which is higher than the mean minimum share of the individuals (16.5%). Therefore, the relative importance of individuals and institutions is inconclusive.

Panel B and Panel C of Table 2 show the information share results by various option characteristics (multiplier, call/put, time to maturity, and moneyness). Panel B reports the mean maximum shares, and Panel C reports the mean minimum shares. Overall, the subsample results do not differ much from the full sample results, and there is no remarkable pattern among the subsamples. Foreigners constitute the most in price discovery process, and the mean maximum share of institutions is higher than the mean minimum share of individuals, except for DITM and DOTM options case. Focusing on the subsample results by the option multiplier change, there is little evidence that the policy change affects our results. Therefore, in terms of the information shares, the price discovery by each group of investors is unchanged after the option multiplier change event.

Table 3 summarizes the Gonzalo and Granger (1995)'s common factor weight results. Panel A presents the mean common factor weights from the full sample. The results in Panel A confirm the results in Table 2. Foreigners have the largest mean weight of 0.654, and institutions have the smallest weight with 0.153. The common factor weight of individuals is slightly larger than that of institutions with 0.193. Panel B reports the subsample results by option characteristics. In the OTM options and the shortest time-to-maturity options with maturities less than 5 days, institutions have larger weights. However, in most subsample cases, the patterns in the full sample remain unchanged.

To see how shocks to prices of different investor groups affect other prices, we present the impulse-response function of the estimated VAR in Figure 1. We pick a sample option-series-day, and show responses to unit shocks on prices of individuals, institutions, and foreigners in Panel A, B, and C, respectively.[2] In all of the three graphs, the responses to initial shock diminish to a stable level before 10 minutes. Considering that our maximum lag in the VAR system is 5 minutes, the speed of convergence is not too slow. The level of the permanent shock exactly repeats the results in Table 2. An initial shock to foreigners' price induces the biggest response of all prices. It ensures that the price movement by foreigners' price is the most important in future efficient price movement.

In sum, regardless of whether we examine the relative contribution to price discovery by Hasbrouck's information share or Gozalo and Granger's common factor weight, we find that the price discovery attributed by foreigners is more than a half portion. Although individuals exhibit a little higher contribution in most cases, we cannot say firmly that individuals have a higher contribution than institutions. Also, the option characteristics (multiplier, call/put, time to maturity, moneyness) do not affect our results, and no interesting patterns can be found among the subsamples.

We interpret our results as follows. First, the highest information share of foreigners can be

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[2] We get qualitatively the same results when we aggregate all the option-series-days and take averages. However, to be consistent with the original meaning of impulse-response analysis, we pick a sample option-series-day.

understood as the superiority of their information on the efficient price. Since the trades initiated by foreigners contain more information, they account for the highest portion of the variance of the efficient price movement. This implication is consistent with the market lore that foreign investors are informed investors in Korea (see Ahn, Kang and Ryu (2008); Kang and Park (2008).) Second, we interpret the low information share of institutions as their different trading motivation. Even though our results are not consistent with Chakravarty (2001), which document that institutions are the source of stealth-trading and are informed traders in NYSE stock market, it may not be the case in the KOSPI200 options market. Rather, if domestic institutions use options as a hedging tool, their trades may not necessarily have the information of the future price movement.

3.2 Price Discovery, Option Volume, and Number of Trades

The stealth trading hypothesis by Barclay and Warner (1993) has two alternative hypotheses. First, if most price movements are caused by public information, the investor group category is irrelevant in price discovery. Under that situation, price discovery is proportional to the number of trades (the public information hypothesis). Second, in conventional market wisdom, larger trades make larger price movements. If that is the case, price discovery is directly proportional to trading volume (the trading volume hypothesis).

In this subsection, we perform further analyses of the estimated information shares and common factor weights. Although our empirical evidence suggests that price discovery attributed by foreigners is the highest, one may argue that those results may merely come from their high trading volume or large number of trades. Especially, in our Table 1, the mean numbers of trades have almost the same pattern as the information shares and common factor weights in Table 2 and Table 3.

Before testing the alternative hypotheses, we see the pattern of information shares by option volume quartiles. In Panel A of Table 4, we report the mean information shares across option trading volume quartiles. We use the midpoint of minimum and maximum shares. We find that foreigners' information share decreases with option trading volume, while individuals' and institutions' information shares increase with option trading volume. The tendency is much clearer than the results in Table 2, with other option characteristics (multiplier, call-put, time to maturity, and moneyness).

We look for the possible linkage of the tendency to the alternative hypotheses in Panel B of Table 4. We report the mean values of trading volume and the number of trades by option quartiles. To measure the trading volume of each investor group for an option-series-day, we take the percentage of the trading volume of an investor group on the total trading volume. In the same way, we also report the number of trades by each group. The results show a clear tendency that foreigners' trading volume and the number of trades are decreasing in option trading volume, and those of individuals and institutions show the opposite pattern. Therefore, the results in Panel B of Table 4 lead us to the doubt that our results may be consistent with the trading volume hypothesis or the public information hypothesis.

To test the alternative hypotheses, we follow Barclay and Warner (1993) and Anand and Chakravarty (2007). We regress the midpoints of maximum and minimum information shares on three investor group dummy variables and trading volume (number of trades) to test the trading volume hypothesis (the public information hypothesis). If the trading volume hypothesis (the public information hypothesis) purely drives our results, the coefficient on trading volume (number of trades) should be one, and the dummy variables should be zero.

In Panel C of Table 4, we display the regression results of information shares on trading volume (number of trades) and investor group dummies.[3] First, the coefficient on trading volume (number of trades) is 0.637 (0.602). Those coefficients are statistically less than one.

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[3] We also try to control the other option characteristics, such as time to maturity, moneyness, and market volatility measured by VKOSPI index value. However, the coefficients are not significant or only marginally significant, and the inclusion of the control variables does not influence our main results.

These results rule out the trading volume hypothesis and the public information hypothesis. Second, all of the coefficients on investor group dummy variables are statistically positive. This confirms that the two alternative hypotheses are strongly rejected. Moreover, the loadings on the foreigners dummy are 0.247 and 0.290, respectively, and they are significantly greater than those on the individuals dummy or institutions dummy. Therefore, we conclude that foreigners have more information content on the efficient price after controlling for the effect of trading volume and the number of trades. Finally, the coefficients on individuals and institutions are indistinguishable, since their relative sizes change with the model specification.

Table 5 presents the analysis on common factor weights in a similar way to Table 4. Panel A of Table 5 shows the common factor weights by option volume quartiles. The results are qualitatively the same as those in Panel A of Table 4. Foreigners' common factor weight decreases with option trading volume, while that of individuals and institutions increase. Panel B of Table 4 reports the regression results of common factor weights on trading volume (number of trades) and investor group dummies. Similar to Panel C of Table 4, the coefficients of trading volume and the number of trades are statistically less than one, and the loadings on all dummies are significantly larger than zero. Again, the trading volume hypothesis and the public information hypothesis are rejected. The coefficients on the foreigners dummy are larger than those of individuals and institutions. This result indicates that foreigners have more information than the others. Unlike the information shares case, the loadings on institutions dummy is larger than those on individuals dummy in all the cases. However, combined with the information share results, it is hard to say that one of the two investor groups is superior to the other in the information content of its trades.

4 Conclusion

In this paper, we empirically investigate which group of investors is more informative in price discovery. Our KOSPI200 options transaction dataset enables us to identify the initiator and her identity in each trade. We employ the VAR-based approach by Hasbrouck (1995) and Gonzalo and Granger (1995) to see whose trades are helpful in describing the permanent component of the efficient price.

Our main findings are as follows. We find that foreigners account for the highest information shares and the largest common factor weights, which indicates that foreigners contribute most to price discovery in the KOSPI200 options market. There exist a tendency that the price discovery contribution of foreigners decreases with trading volume and the number of trades, but, even after controlling for the effects of trading volume and the number of trades,our results that foreigners have the most information of the true price of the KOSPI200 index options stand firmly.

Our empirical evidence implies that foreigners' trades contain superior information of the true price movement in the KOSPI200 market, supporting the conventional wisdom in the Korean market. Consistent with the findings in Chae and Lee (2011) and Kim and Ryu (2012), our results reject the trading volume hypothesis and the public information hypothesis. In contrast to Chakravarty (2001), the domestic institutions have a fairly low level of the price discovery contribution. In our interpretation, domestic institutions usually use the options as a hedging tool, thus their trades are not closely related to the efficient price movement.

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Table 1. Summary Statistics

This table reports the summary statistics of our sample. "Trading Volume" measures the mean number of contracts of a day for the unit of "option-series-day" in the corresponding category. "Number of Trades" displays the mean number of transactions in the "option-series-day" in the corresponding category.

		Time to maturity	moneyness	Trading volume	% Trading volume	Number of trades	% number of trades
Call	Individuals	17.32	96.89	106,883	0.23	10,318	0.35
	Institutions			119,136	0.26	2,693	0.09
	Foreigners			233,988	0.51	16,477	0.56
Put	Individuals	16.70	95.77	83,420	0.23	9,048	0.36
	Institutions			67,618	0.19	2,248	0.09
	Foreigners			208,865	0.58	14,183	0.56

Table 2. Hasbrouck (1995)'s information shares

This table displays Hasbrouck (1995)'s information shares. Panel A reports mean and standard deviation of the maximum and minimum information shares from the full sample. Panel B reports the mean of maximum information shares, displayed by various option characteristics. Panel C shows the mean of minimum information shares, classified by various option characteristics.

Panel A: Results from the full sample							
			Individuals	Institutions	Foreigners		
	Max Share	MEAN	0.285	0.192	0.733		N=18468
		STD	(0.164)	(0.165)	(0.197)		
	Min Share	MEAN	0.165	0.090	0.567		
		STD	(0.142)	(0.123)	(0.21)		
Panel B: Results by option characteristics - Maximum information share							
Multiplier	Call/Put	TTM	Moneyness	N	Individuals	Institutions	Foreigners
1				9840	0.285	0.189	0.721
5				8628	0.286	0.195	0.748
	Call			8666	0.290	0.213	0.713
	Put			9802	0.281	0.173	0.751
		T<5d		2051	0.311	0.250	0.702
		5d<T<30d		14720	0.290	0.190	0.732
		T>30d		1697	0.211	0.135	0.781
			ATM	8623	0.292	0.188	0.793
			ITM	81	0.122	0.095	0.852
			DITM	1	0.109	0.023	0.924
			OTM	6970	0.283	0.210	0.683
			DOTM	2793	0.274	0.162	0.672
Panel C: Results by option characteristics - Minimum information share							
1				9840	0.174	0.093	0.569
5				8628	0.154	0.086	0.563
	Call			8666	0.168	0.105	0.544
	Put			9802	0.162	0.076	0.587
		T<5d		2051	0.159	0.123	0.505
		5d<T<30d		14720	0.169	0.087	0.563
		T>30d		1697	0.137	0.075	0.676
			ATM	8623	0.129	0.064	0.579
			ITM	81	0.068	0.077	0.789
			DITM	1	0.057	0.019	0.868
			OTM	6970	0.191	0.114	0.542
			DOTM	2793	0.213	0.108	0.582

Table 3. Gonzalo and Granger (1995)'s common factor weights

This table shows the results of Gonzalo and Granger (1995)'s common factor weights for each investor group (Individuals, Institutions, and Foreigners). Panel A displays the results from the full sample, and Panel B reports the subsample results by options characteristics. In Panel B, we only report the mean common factor weights.

Panel A: Results from the full sample							
			Individuals	Institutions	Foreigners		
		Mean	0.193	0.153	0.654		N=18468
		Std	0.075	0.218	0.200		
Panel B: Results by option characteristics							
Multiplier	Call/Put	TTM	Moneyness	N	Individuals	Institutions	Foreigners
1				9840	0.196	0.155	0.650
5				8628	0.189	0.152	0.658
	Call			8666	0.192	0.175	0.634
	Put			9802	0.194	0.135	0.672
		T<5d		2051	0.181	0.191	0.628
		5d<T<30d		14720	0.195	0.156	0.650
		T>30d		1697	0.188	0.091	0.721
			ATM	8623	0.198	0.112	0.691
			ITM	81	0.135	-0.031	0.896
			DITM	1	0.138	0.113	0.749
			OTM	6970	0.185	0.198	0.617
			DOTM	2793	0.199	0.176	0.625

Table 4. Information shares by option trading volume

Panel A presents the mean and standard deviation of information shares by option trading volume quartiles. Panel B describes percentage trading volume and percentage number of trades of each investor group by option trading volume quartiles. Panel C shows the result of regressions of information shares on trading volume, number of trades, and investor group dummies. We measure the trading volume of each group as the ratio of the investor group's trading volume to total volume of the corresponding option-series-day. We use the same method to measure the number of trades.

Panel A: Information shares by option trading volume quartiles

Quartiles		Individuals	Institutions	Foreigners
1	MEAN	0.160	0.084	0.759
	STD	(0.148)	(0.111)	(0.183)
2	MEAN	0.219	0.126	0.668
	STD	(0.137)	(0.132)	(0.183)
3	MEAN	0.249	0.159	0.607
	STD	(0.141)	(0.146)	(0.182)
4	MEAN	0.272	0.194	0.565
	STD	(0.122)	(0.126)	(0.16)

Panel B: Trading volume and number of trades by option trading volume quartiles

Quartiles		Trading volume			Number of trades		
		Individuals	Institutions	Foreigners	Individuals	Institutions	Foreigners
1	MEAN	0.190	0.062	0.748	0.270	0.041	0.689
	STD	(0.062)	(0.063)	(0.099)	(0.088)	(0.028)	(0.096)
2	MEAN	0.212	0.123	0.665	0.309	0.065	0.625
	STD	(0.051)	(0.115)	(0.133)	(0.067)	(0.029)	(0.08)
3	MEAN	0.227	0.179	0.595	0.352	0.080	0.568
	STD	(0.059)	(0.121)	(0.14)	(0.092)	(0.033)	(0.102)
4	MEAN	0.235	0.241	0.524	0.391	0.100	0.509
	STD	(0.053)	(0.126)	(0.137)	(0.082)	(0.034)	(0.093)

Panel C: Testing alternative hypotheses

Model		Volume	Number of trades	Individuals	Institutions	Foreigners
1	estimate	0.637		0.087	0.045	0.247
	t-stat	(129.125)		(59.051)	(35.242)	(75.105)
2	estimate		0.602	0.026	0.098	0.290
	t-stat		(83.758)	(9.898)	(80.425)	(65.437)

Table 5. Common factor weights by option trading volume

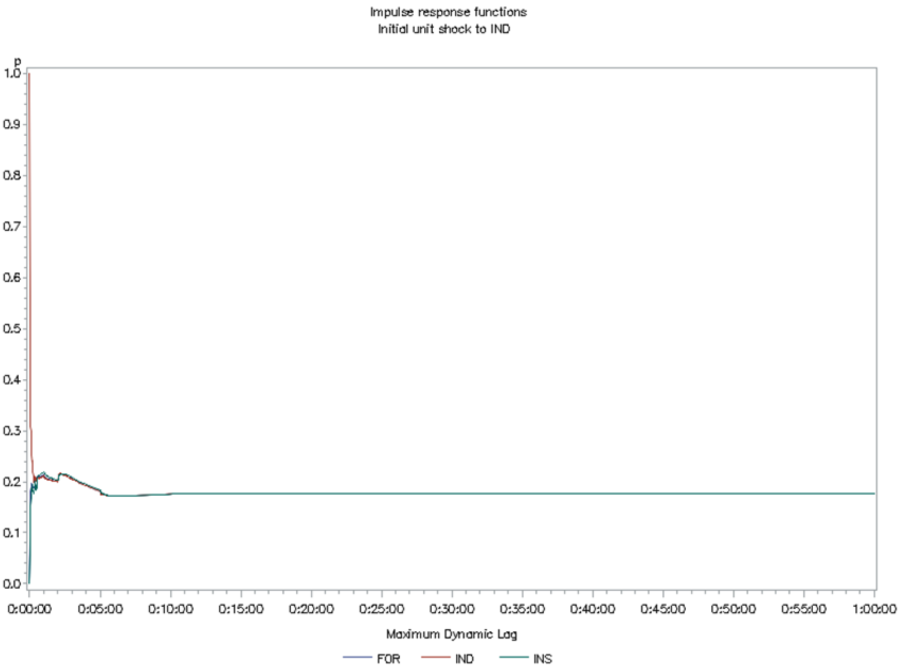
Panel A shows the mean and standard deviation of common factor weights by option trading volume quartiles. Panel B presents the result of regressions of common factor weights on trading volume, number of trades, and investor group dummies. We measure the trading volume of each group as the ratio of the investor group's trading volume to total volume of the corresponding option-series-day. We use the same method to measure the number of trades.

Panel A: Common factor weights by option trading volume quartiles						
Volume		Individuals	Institutions	Foreigners		
1	MEAN	0.177	0.066	0.756		
	STD	(0.103)	(0.33)	(0.296)		
2	MEAN	0.195	0.133	0.673		
	STD	(0.068)	(0.169)	(0.156)		
3	MEAN	0.197	0.190	0.613		
	STD	(0.065)	(0.155)	(0.131)		
4	MEAN	0.202	0.225	0.573		
	STD	(0.055)	(0.121)	(0.108)		
Panel B: Testing alternative hypotheses						
Model		Volume	Number of trades	Individuals	Institutions	Foreigners
1	estimate	0.634		0.056	0.058	0.253
	t-stat	(112.539)		(32.948)	(39.925)	(67.303)
2	estimate		0.466	0.039	0.120	0.375
	t-stat		(56.631)	(12.837)	(86.301)	(73.884)

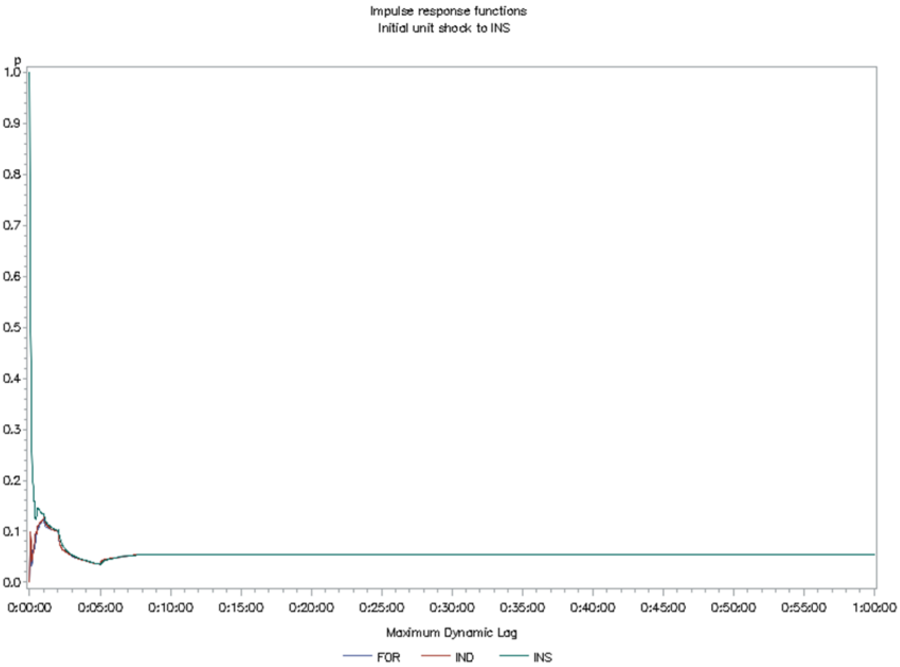
Figure 1. Impulse-response of an option-series-day

This figure displays the impulse-response function of a sample option-series-day, which is an option "KR4201FA2308" on October 4, 2011. The responses of each price up to an hour (3600 seconds) are reported. Panel A shows the responses to a unit shock on individuals' price. Panel B shows the responses to a unit shock on institutions' price. Panel C shows the responses to a unit shock on foreigners' price.

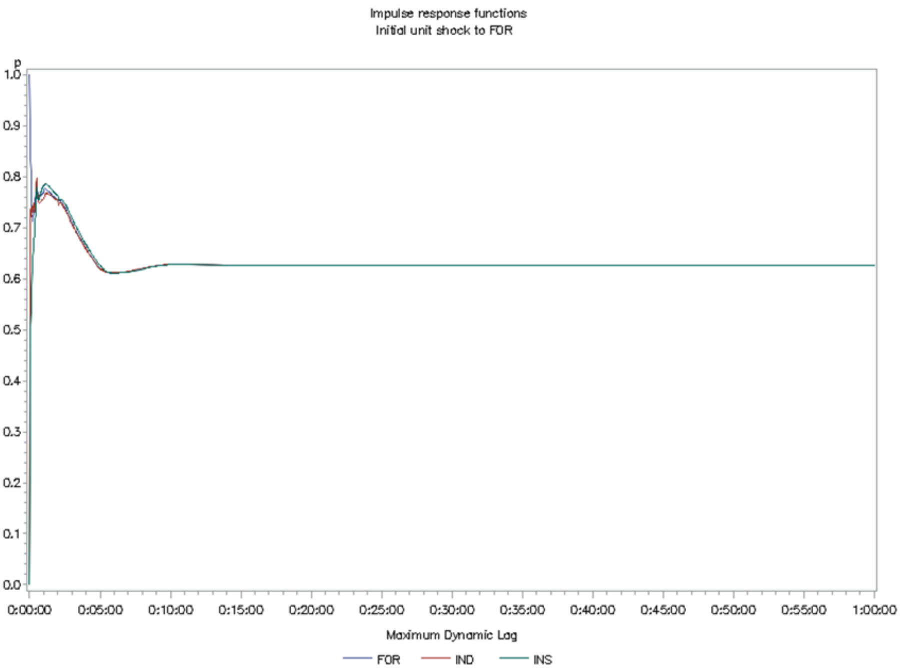
Panel A: Responses to initial individuals' price shock



Panel B: Responses to initial institutions' price shock



Panel C: Responses to initial foreigners' price shock


Impulse response functions
Initial unit shock to FOR
p
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:00:00
0:05:00
0:10:00
0:15:00
0:20:00
0:25:00
0:30:00
0:35:00
0:40:00
0:45:00
0:50:00
0:55:00
1:00:00
Maximum Dynamic Lag
FOR
IND
INS