Who Has Skills in Trading Options?*

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Abstract

This paper uses account-level transaction data in Korea's index options and futures to examine option trading skills by different types of investors. We first investigate how common option trading strategies are used. We find that (i) retail investors, both domestic and foreign, are more likely to use simple option strategies, while institutional investors are more likely to use complicated strategies; (ii) volatility trading is used more often than the other classic options strategies; (iii) a small number of accounts, both institutional and retail, generate large volumes of trades using sophisticated and well hedged positions. Then we examine the association between trading strategies and account performance. Our results show that (i) foreign investors are similar to domestic investors; (ii) for both retail and institutional investors, those using volatility strategies outperform their peers and mainly gain from selling volatilities, although subject to large downside risk; (iii) retail investors who use simple one-directional strategies underperform, but institutions are able to gain from such strategies, possibly due to informational advantages. Our findings suggest that skilled options traders use volatility and complicated strategies, but country domicile is less important.

Keywords: *Options, Institutional investors, Retail investors, Trading skills, Volatility*

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This paper uses account-level transaction data in Korea's index options and futures to examine option trading skills by different types of investors. We first investigate how common option trading strategies are used. We find that (i) retail investors, both domestic and foreign, are more likely to use simple option strategies, while institutional investors are more likely to use complicated strategies; (ii) volatility trading is used more often than the other classic options strategies; (iii) a small number of accounts, both institutional and retail, generate large volumes of trades using sophisticated and well hedged positions. Then we examine the association between trading strategies and account performance. Our results show that (i) foreign investors are similar to domestic investors; (ii) for both retail and institutional investors, those using volatility strategies outperform their peers and mainly gain from selling volatilities, although subject to large downside risk; (iii) retail investors who use simple one-directional strategies underperform, but institutions are able to gain from such strategies, possibly due to informational advantages. Our findings suggest that skilled options traders use volatility and complicated strategies, but country domicile is less important.

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1. Introduction

How do investors use options? Who is skilled at trading options? And which option trading strategies are profitable? These questions are important for researchers, investors and policy makers who want to gain a better understanding of the activity in derivatives markets. We answer them in this study by examining Korea's index options and futures markets, where both institutional and retail investors from around the globe trade actively.

Options expand the trading opportunity set. Although trading volumes in options markets have been growing for decades, actual trading patterns and the motivations of different types of investors for trading options are not clearly identified. There is very little evidence compared to what we know about equity trading, largely due to data limitations and the complexity of options trading. Unlike a simple long or short position in stocks to gain directional risk exposure, options can be used to hedge underlying price changes or volatility risk, and to speculate or trade on information about future price movements or future volatility of the underlying security. Finance textbooks (e.g. Hull, 2018) describe many possible options trading strategies. However, with limited evidence in the literature, we know little about how options are used in reality by different investors. Most publicly available option datasets only provide aggregate daily volume and open interest, not separated by investor accounts. Therefore, it is impossible to study options trading skills using these data.

This study provides detailed descriptions of the derivatives usage of institutions and retail investors at the account level. We use a complete dataset of intraday transactions with account ID, for both options and futures on the same underlying, the Korea Composite Stock Price Index or KOSPI 200, which is the representative stock market index of South Korea, similar to the S&P 500 index in the United States. During our sample period between January 2010 and June 2014, the average daily options premium of KOSPI 200 options reaches the

equivalent of 1 billion USD, comparable to the whole index options market in the U.S. at the same time. Our investigation also benefits from detailed account information separating institutional and retail investors, as well as domestic and foreign investors.

Our analyses reveal several interesting patterns. First of all, we find a significant difference in strategy complexity between retail and institutional investors. About two thirds of retail investors trade only options but not futures during the whole sample period. The pattern reverses for institutional investors, as only one third of them trade options exclusively. The result holds for both domestic and foreign investors. Moreover, simple one-directional strategies, which constitute of concentrated bets of long or short positions in only call or put options that are not combined with futures, are the most common among both domestic and foreign retail investors, accounting for about 50% of the account-days for this class of investors. Institutional investors, on the contrary, are more likely to use a variety of complicated strategies involving multiple option positions in their portfolios together with futures. Nonetheless, 21.3% of domestic institutional positions and 11% of foreign institutional positions are also concentrated simple option positions. In general, we find that simple strategies are widely used.

Second, we show that investors' usage of options for volatility trading is significantly larger than previous literature suggests. At least 16.5% of all account-days with non-zero end-of-day positions in options are classified as volatility strategies, including straddles, strangles, butterflies, and combinations of the aforementioned. On average, their positions account for 14.5% of the end-of-day total market open interest. These numbers represent lower bounds, as we are not able to identify all instances of volatility trading in the sample. Overall, we find significant evidence of the important role of options as instruments for trading on or hedging underlying volatility. While this result differs from the conclusion of Lakonishok et al. (2007), it is in line with the conventional wisdom that options trading is often motivated by volatilities.

All investor classes in our sample trade on volatilities. Although most of the retail accounts use simple strategies, some retail investors are able to use more sophisticated strategies. In fact, volatility trading is more popular among retail investors than institutional investors, as over 16% of retail positions are identified as volatility positions and this ratio is only 11.1% for domestic institutions and 4.03% for foreign institutions. The other common options trading strategies in finance textbooks, however, are not commonly used. Covered calls and protective puts together account for only 1% of total account-days, and option spreads appear 3.68% of the time.

Third, a small fraction of accounts generates large trading volumes and holds a significant amount of open interest in our data. This is mainly due to institutional investors' use of combinations of options and futures and complicated options-only strategies. Surprisingly, some retail investors also use such complicated strategies. We estimate that retail investors have such positions in 2%-21% of their account-day observations, representing 11.1% to 54.5% of market open interest on average. These retail investors obviously trade more than their peers and they trade more like institutional investors. From these complicated positions, we extract the ones that are well hedged and call them Greek-neutral strategies. In this way, we attempt to mark the accounts that act as arbitrageurs and/or market makers in our data.

After documenting detailed options market activities at the account-day level, we then examine options trading performance of different types of accounts. To do so, we categorize each account by its dominant position type into simple strategy trader, volatility trader, or Greek-neutral trader. If an account frequently changes trading strategies or uses strategies that we are unable to identify, the account becomes unclassified and serves as the benchmark case in our performance analysis. We also look at the four account classes of domestic retail, foreign retail, domestic institution, and foreign institution. Moreover, we interact trading strategy

dummies and investor classes to examine the conditional effect in our multivariate regression analysis of account profitability.

Our method for calculating account profitability is the following. For each account and each trading day, we first use the transactions records to calculate cumulative daily profit and loss (P&L) in dollar terms. End-of-day positions are marked to market based on the last daily quote midpoint on non-expiration dates. If a position is held until maturity, P&L is calculated using the final settlement price based on the underlying index value. Next, to measure profitability per dollar invested, we scale daily P&L values by the capital requirement at the end of the previous day. Such capital requirement arises from the fact that investors pay the full option prices to open long positions and deposit margins to open short positions in the options market. When the value of the margin account falls short of predetermined thresholds (maintenance margin), the exchange will issue margin calls to investors requesting top up in the margin account. This feature of capital requirement sets options trading different from stock trading because options sellers do not receive the sales proceeds and usually put down a sizable margin instead. In other words, selling options is analogous to short selling borrowed stocks. The scaled P&L is therefore a rate of return to each dollar of capital invested in KOSPI derivatives. Compared to the simple option return calculated based on price changes, our scaled P&L is a more practical and implementable measure of profitability or skills because it takes into account the unique feature of margins in derivatives trading. We calculate end-of-day capital requirements using the margin requirements of the Korea Exchange (KRX). Because the margin settlement is daily, we exclude intraday trades and intraday profits from our calculations. Hence, we separate only the profits derived from end-of-day position holdings and scale them by the lag of end-of-day capital requirement. Finally, to have one single profitability measure for each account, we take the mean and median of daily scaled P&L of the same account during the whole sample period.

In our profitability analysis, we first examine the effects of investor class and trading strategies separately. We find that, not surprisingly, institutional investors outperform retail investors on average. These results are largely consistent with the literature on underperformance of retail investors as in e.g., Odean (1999) and Barber and Odean (2000). Foreign investors seem to outperform domestic investors in terms of total account dollar profits, consistent with some literature on outperformance of foreign investors as in e.g., Grinblatt and Keloharju (2000). However, after we scale dollar profits by capital requirements, the performance of foreign and local investors appears more similar. When we look at trading strategies, we find that simple strategy traders underperform compared to the other types of traders. The worst performance comes from the group with most retail traders, the simple strategy traders. Volatility traders, on the other hand, strongly outperform the other traders.

Next, we examine the conditional effects of investor classes and trading strategies by interacting them. The results can be summarized as follows. First, the effects from investor classes are all greatly reduced, while the effects from option strategies remain similar in magnitude. Second, while retail investors still have the worst performance, those using volatility and sophisticated strategies perform much better than their peers, and the performance gap between retail and institutional investors is narrowest for these two types of strategies. Third, institutional simple strategy traders perform better than their retail peers. While retail investors lose from directional simple strategies, some institutions are able to gain from them, possibly due to informational advantages. In summary, we find that the bottom option investors underperform mainly because of their use of unsophisticated options trading strategies, while the top option investors outperform by mastering skills in trading volatilities and using sophisticated strategies.

Furthermore, when we examine the relation between account profitability and exposure to options Greeks, we find that long vega exposure is negatively related to account profitability,

while short vega exposure is significantly positively related to performance. These results support our conclusion that volatility trading strategies (strategies with high vega exposure) contribute to higher profitability, and we show that volatility traders mainly gain from selling vega, but not from buying vega. While selling vega is a popular strategy among practitioners, there is still debate about the source of such profitability in academia. There are two possible reasons why short vega positions are profitable. One reason is the risk premium for stochastic volatilities embedded in derivatives contracts (Carr and Wu (2009), Bollerslev, Tauchen, and Zhou (2009)). Investors selling vega are more likely to be sophisticated in understanding a risk premium associated with the second moment of the return dynamic. The other possible reason is mispricing of volatilities (Goyal and Saretto (2009)), where the volatility implied by options is higher than the actual volatility, and options are priced higher in reality than in classic models such as Black and Scholes (1973) and Merton (1973). Although selling vega can be profitable, we show evidence that the profits of all volatility traders are significantly more negatively skewed compared to the profits of other investors, suggesting that volatility traders are exposed to extreme downside risk. Similar to selling insurance, short vega strategies profit most of the time from collecting premiums, but once in a while incur a large loss.

As an additional robustness check, we conduct an out-of-sample test to see whether the performance of different types of investors is persistent. Our results show that it is. All volatility traders have positive excess profitability on average, while retail simple strategy traders have negative excess profitability on average, both in-sample and out-of-sample.

Our contributions to the finance literature are mainly twofold. We are the first to document detailed account-level activity in the options and futures markets. The only study from the US market that provides stylized facts about the options trading activity of several types of investors is by Lakonishok et al. (2007). However, their account-level analysis is significantly restricted by data availability and quality. The holdings data they analyse come

from a small sample of retail investors only, and do not have detailed characteristics of each option contract. Given the complexity of options strategies, it is challenging to identify trading motivations and actual strategies in such data.[1] While Lakonishok et al. infer that volatility trading accounts for less than 3% of options market activity, we show that it is more common with a lower bound estimate of 16.5% at the account-day level using a complete set of account-level transactions data. The most common strategies identified by Lakonishok et al., covered calls and protective puts, on the contrary, account for less than 1% of observations in our data. While our results are derived from the Korean market, we do find similar patterns on foreign investors in our sample. It is also possible that the development of global derivatives markets in the last two decades has changed the trading pattern fundamentally since the end of Lakonishok et al.'s sample.

By comparing the trading strategies and profitability of different classes of investors, we also contribute to the literature on the characteristics of institutional versus retail traders. Institutions are generally regarded as sophisticated informed investors, while retail traders are believed to be uninformed noisy traders who commit systematic mistakes. Several studies show that individual traders in the Taiwanese stock and futures markets incur losses (e.g., Barber et al. (2009), Kuo, Lin, Zhao (2015, 2018)). On the other hand, some recent papers suggest that retail equity traders may be informed, as their aggregate trading can predict future stock returns (Kaniel, Saar and Titman (2008), Kelley and Tetlock (2013), Barrot, Kaniel and Sraer (2016), Boehmer, Jones and Zhang (2017)). We show that a subset of retail investors are skilled in

[1] Several other studies examine options trading in international markets (see Bauer, Cosemans and Eichholtz (2009), Chaput and Ederington (2002), Fahlenbrach and Sandas (2010), Flint, Lepone and Yang (2014)). Those studies are undermined by various data issues, either having only a small sample of options, or lacking account-level transactions and positions data, or not being able to compare institutional and retail investors. In contrast, our study uses a comprehensive dataset of account-level transactions and positions in Korean index options and futures, which allows us to study in detail the option trading strategies of different types of investors.

using volatility trading strategies or well hedged complicated positions, which contribute to their persistent superior performance. Evidence of such ability of retail derivatives investors is novel to the literature. Related to our findings, Bauer, Cosemans, and Eichholtz (2009) also find a small subgroup of retail option traders outperform their peers. However, they provide little insight on the source of such outperformance, while we find volatility and well-hedged strategies are the key performance contributors. On the other hand, retail traders lose pervasively from directional bets while institutions profit from them, indicating that the playfield is less level there. Because such simple directional bets are often used by speculators and informed traders, it is clear that institutional investors are better skilled at acquiring advanced information.

The rest of the paper proceeds as follows. Section 2 provides details about the KOSPI 200 derivatives markets and summary statistics of our data. Section 3 describes the various strategies used by option position holders. Section 4 analyses the profitability of the different types of investors and strategies. Section 5 concludes the paper.

2. Description of the KOSPI 200 derivatives markets and the data

We use detailed data of all account-level transactions executed in Korea's main derivatives markets, the KOSPI 200 index options and futures markets, in the period from 1 January 2010 to 30 June 2014. The options and futures contracts are based on the underlying KOSPI 200 index, which consists of the 200 largest companies listed on the Korea Exchange (KRX), thus representing Korea’s overall stock market, similarly to the S&P 500 index in the US. The KOSPI 200 options and futures attract both domestic and foreign investors globally, and have become some of the world's most actively traded and liquid derivatives instruments.

The KOSPI 200 options and futures markets are order-driven and do not need to rely on designated market makers for the provision of liquidity. Orders submitted by investors are collected in a central electronic limit order book (CLOB) and are executed according to price and time priority rules. The daily continuous trading session opens at 9:00 and closes at 15:05.[2] There is a pre-opening batch auction from 8:00 to 9:00 and a post-market batch auction from 15:05 to 15:15, when all submitted orders are first accumulated in the CLOB and then executed at a single market price at the end of the sessions. The contract size for futures is KRW 500,000. For options, it is KRW 100,000 for contracts that mature in or before June 2012, and changes to KRW 500,000 for contracts that mature after June 2012, to match the futures contracts multiplier. For each contract, the minimum tick size is 0.05 points.

Our data consists of trades with a millisecond time stamp and detailed information about both counterparties to each transaction, including account numbers, bid and ask order submission times, country codes, and investor types. Any contracts that start being traded in 2009 are excluded from the sample, since our transactions data starts from 2010. Table 1 reports aggregate summary statistics. Panel A describes the options data, and Panel B describes the futures data. We report statistics for the number of transactions, trading volume (number of contracts traded), volume-weighted options premium or futures trade price, and $volume in billions of KRW (equal to options premium or futures trade price multiplied by trading volume and contract size). First, we calculate total number of transactions, trading volume, $volume, and volume-weighted average premium or trade price for each day. Then, we calculate the

[2] There are some exceptions to the normal trading hours. On the first trading day of the calendar year, the opening of the continuous trading session is delayed by one hour, to 10:00. In addition, each year in November, on the day of the Korean national College Scholastic Ability Test (CSAT) for college entrance, the opening and closing of the continuous trading session are delayed by one hour, from 10:00 to 16:05.

mean, standard deviation, minimum, median, maximum, and total sum of these variables across all days in the sample.

[Table 1 about here]

During our sample period, the total trading volume in KOSPI 200 derivatives is approximately 8.6 billion option contracts and 217.5 million futures contracts traded. These correspond to options and futures dollar volumes of KRW 1,323,552 billion and KRW 27,928,474 billion, respectively, or approximately USD 1,173 billion and USD 24,756 billion. Such numbers are comparable to the total trading volumes observed in the US derivatives markets and testify to the high liquidity of the Korean markets.

The sub-panels in Table 1 contain summary statistics for different sub-samples. As expected, most trading activity takes place during normal trading hours, which refer to the daily continuous trading session from 9:00 to 15:05. Trading volume in call options is slightly higher than that in put options. Moneyness of a call (put) option is defined by the ratio of the underlying spot price (strike price) to the strike price (underlying spot price). An option is out of the money (OTM) / at the money (ATM) / in the money (ITM) if its moneyness is less than 0.95 / between 0.95 and 1.05 / greater than 1.05. ATM options are most actively traded, followed by OTM options, while ITM options attract little trading volume. Contracts that are closer to maturity are more actively traded.

Table 2 reports the total number of investor accounts that trade at least once during our sample period. It also reports the number of accounts that trade options at least once in the data, and these are further separated into accounts that trade only options and accounts that trade both options and futures. Table 2 also reports the number of accounts by investor class. We use the country codes to separate accounts into domestic (Korean) and foreign accounts, and we use the investor type codes to separate them into retail investors and institutions (which include

financial investment companies, banks, pension funds, insurance companies, trusts, state and local government institutions, and other institutions). Based on these categories, we assign a unique class to each account: Domestic Institution, Foreign Institution, Domestic Retail, or Foreign Retail.

[Table 2 about here]

In total, there are 187,323 trading accounts in our data, of which 161,010 are option traders. Most accounts are domestic retail investors, of which two thirds trade only options, and the remaining one third trade both options and futures. On the other hand, only one third of institutional accounts trade options exclusively, while the majority of them trade both options and futures. Although most of the accounts in the data are domestic investors, Table 3 shows that foreign institutions generate a large portion of options trading volume. The table provides summary statistics of the options trading activity of the different account classes. We use the bid and ask markers in the data to mark which transaction counterparty is the buyer and which is the seller. We compare the bid and ask order submission times and mark the investor who submitted their order first as the liquidity provider and the investor whose order matched the first one as the trade initiator (or aggressor). Panel A contains summary statistics by trade initiator class, and Panel B by liquidity provider class. There are some transactions where the two orders cross at the same time, hence the trade initiator and liquidity provider cannot be identified. Those observations are not included in the results in Table 3. The table shows that, on an average day, foreign institutions initiate the largest number of transactions and generate the greatest trading volume of all investor classes. On the other hand, domestic institutions and domestic retail investors tend to act as liquidity providers. Foreign retail investors execute only a small portion of all trades.

[Table 3 about here]

3. Strategies of option position holders

In order to study the different trading strategies that option investors use, we first separate accounts into day traders and position holders. Accounts that only trade intraday and never hold a position in options at the end of the trading day are categorized as day traders. For the remaining accounts, we use the transactions data to construct the end-of-day positions held by each account in each different contract. For each account, day and contract, the end-of-day position is equal to the previous day's position plus any purchased lots minus any sold lots. Then, we can study the combinations of different contracts that each account-day holds and extract the corresponding strategies.

Table 4 reports account-day results for option position holders' strategies, grouped into five main categories. Combinations of options and futures include covered calls, protective puts, and any other combinations. Simple strategies refer to one-directional exposure from holding only one type of option contracts. These include positions in long calls only, or short calls only, or long puts only, or short puts only. They may be thought of as naked options in the sense that they are not accompanied by any position in futures contracts. Volatility trading strategies include straddles, strangles, and butterflies. These are strategies used by investors who want to trade on information about underlying volatility or to hedge volatility risk. Spreads include strategies that use options to create synthetic stocks, bull spreads, bear spreads, and calendar spreads. Finally, the category of other strategies consists of any combinations of option contracts which do not fall into the above categories. For each strategy category, we report the number of account-days that hold a position corresponding to the strategy, as a percentage of all account-days with a non-zero end-of-day position in options. We also report the average percentage of open interest: for each strategy, first we calculate the end-of-day number of options held by all investors who use that strategy, as a percentage of the total number of options held in the market by all investors (overall open interest), and then we take

the time-series average. The open interest percentages sum to a total of 200% since each option contract is held simultaneously by two counterparties – each long position has a corresponding short position. The table contains results for all account-days aggregated, as well as for each investor class separately.

[Table 4 about here]

The results in Table 4 show that options are used for volatility trading more widely than Lakonishok et al. (2007) suggest. 16.5% of all account-days hold options as part of a volatility trading strategy. On average, positions in these strategies account for 14.5% of the overall market end-of-day open interest. It must be noted that these numbers represent a lower bound for volatility trading, as we are not able to identify all volatility trading strategies in the data, and it is likely that some of them are part of the category of other strategies. We discuss this in more detail in Section 3.3. Examining the usage of volatility trading strategies by the different investor classes reveals that they are popular with all investors. 11% of domestic institution account-days and 4% of foreign institution account-days hold positions as part of volatility trading strategies, although on average their positions account for a small percentage of open interest. About 17% of both domestic and foreign retail account-days hold volatility trading positions. The positions of domestic retail volatility traders account for about 11% of total open interest on an average day. These numbers show that volatility trading is a significant determinant of options trading.

A surprisingly large percentage of account-days hold positions in simple strategies. We define simple strategies as concentrated bets of long or short positions in only call or put options (positions in long calls only, or short calls only, or long puts only, or short puts only). Such options positions provide one-directional exposure to the underlying and are not combined with any positions in futures. Hence, they do not hedge any market exposure from futures contracts.

This leads us to believe that it is possible that options are widely used for one-directional speculative trading. This result is in line with Lakonishok et al. (2007) who also conclude that hedging directional price changes of the underlying security by non-market-makers drives only a small part of option market activity. They base this conclusion on the holdings of a small sample of retail accounts. Indeed, when we examine the break-down of our results by investor class, we can see that about 50% of retail account-days hold positions in simple strategies, which accounts for about 13% of total end-of-day open interest on average. Although this type of strategy is also used by 21% of domestic institution account-days and 11% of foreign institution account-days, they each account for less than 1% of open interest on average. Simple strategies are further examined in Section 3.2.

Combinations of options and futures account for 88.7% of total option market open interest on average and are predominantly used by institutions. We examine these strategies in more depth in Section 3.1.

Spreads do not seem to be widely used by option position holders. Only 3.7% of account-days hold spreads, and their positions account for less than 6% of open interest on average. For this reason, we do not examine these account-days further.

The remaining category of other option strategies accounts for an average of 76.3% of open interest. The large holdings in options-and-futures combinations and other strategies point to a possible use of such strategies by accounts who act as market makers. We explore this possibility further in Section 3.4.

3.1. Combinations of options and futures

This section focuses on the strategies that option traders create in combination with futures. We extract these by checking the type of options and futures exposure that an account-

day has: long calls, short calls, long puts, short puts, long futures, or short futures. Well-known combinations include covered calls and protective puts. Long covered calls consist of long calls and short futures, while short covered calls consist of short calls and long futures. Long protective puts are created with long puts and long futures, while short protective puts are created with short puts and short futures. Table 5 breaks down the category of options-and-futures combinations into these four strategies, as well as a remaining category of any other combinations. We can think of futures positions as exposure to the underlying, and options could be used to hedge that exposure. However, we can see that hedging strategies such as covered calls and protective puts are rarely used. So at least when it comes to combinations with futures, options do not seem to be used often for hedging. On the other hand, the category of other combinations constitutes 60% of foreign institutions account-days, 22% of domestic institutions account-days, and about 5% of retail account-days. In total, their positions account for an average of 87.5% of overall market open interest. In Section 3.4, we further explore the possibility that this category of other options-and-futures combinations includes Greek-neutral positions of accounts that act as market makers.

[Table 5 about here]

3.2. Simple strategies

In this section, we take a closer look at simple option trading strategies. We include here account-days which hold positions in either long calls only, or short calls only, or long puts only, or short puts only. These are one-directional exposures which are not combined with any positions in futures contracts. In that sense, they can be thought of as naked options. Although these options could also be used to hedge investors' equity portfolios, we do not have the necessary data to conclude anything about this possibility. ETF trading volumes in Korea are very low during our sample period, so it is unlikely that these option positions hedge ETFs.

We cannot be certain that they are not used for hedging stock portfolios. However, it seems unlikely that index options are used for hedging individual stocks, as this would imply that the investor is holding all 200 stocks that constitute the KOSPI 200 index. Otherwise, if an investor holds only a few stocks, it would make more sense for him to hedge with single stock options rather than index options. Therefore, we argue that these simple strategy positions are more likely to be speculative strategies rather than hedges of the underlying index. This assumption is supported by the findings of Lakonishok et al. (2007) and Bauer, Cosemans, Eichholtz (2009).

Table 6 shows that 30% of account-days hold simple positions in long calls only and 21% of account-days hold simple positions in long puts only. These long exposures also represent the largest percentages of total market open interest at the end of the day, compared to the short exposures. Simple short call and short put exposures are much less common. These results are driven by the retail investors in the sample. Our results differ somewhat from the analyses of Lakonishok et al. (2007) about one-directional holdings. They find that, in aggregate, long call and short call positions are most common, while we find that long call and long put exposures are most common.

[Table 6 about here]

The results in Table 6 may be taken as evidence that retail traders often use options to engage in one-directional speculative trading on future price changes of the underlying index. It seems that some institutions also engage in this type of trading, but much less than retail investors do.

3.3. Volatility trading

Now we turn to the volatility trading strategies. Table 7 presents details about the different strategies that option position holders use to trade on underlying volatility. First, we

extract long and short straddles and strangles created by taking a position in two different option contracts only. Long (short) straddles are created by combining long (short) calls and long (short) puts with the same strike price and maturity date. Long (short) strangles are created with long (short) calls and long (short) puts with the same maturity date but different strike prices. Next, we would like to extract account-days that use more than two different option contracts to create combinations of straddles and strangles. Regardless of how many different option contracts an account-day uses, we check the types of exposures they have. If they hold long calls and long puts only, we can be sure that they are using a combination of long straddles and/or long strangles. If they hold short calls and short puts only, then they are using a combination of short straddles and/or short strangles. In Table 7 we report these strategies as "long combinations" and "short combinations". Finally, we extract butterflies created with three different option contracts. A call (put) butterfly spread is a strategy that combines three call (put) contracts with different strike prices, such that the option contract with the middle strike price has twice the number of lots invested in it, compared to the number of lots invested in the other two option contracts. For example, a long call butterfly can be created by buying one lot in a call option contract with the lowest strike price, selling two lots in a call option contract with the middle strike price, and buying one lot in a call option contract with the highest strike price. We must note that we are only able to identify butterfly spreads created using three different option contracts, but we are unable to extract any combinations of butterflies created using six, nine, or more different option contracts, because we cannot be sure that they are not other strategies. Similarly, some combinations of long and short straddles and strangles may be left in the category of other strategies, because we cannot say for sure what type of strategy is used by an account that holds a large number of different option contracts. Therefore, the numbers presented in Table 7 are lower bounds, and the usage of options for volatility trading may in fact be larger.

[Table 7 about here]

Table 7 shows that at least 16.5% of all account-days engage in volatility trading, and their positions represent on average 14.5% of the total market open interest at the end of the day. Strangles are much more commonly used than straddles and butterflies. We also observe that about half of volatility trading strategies consist of combinations of straddles and/or strangles (using more than two different option contracts). Interestingly, more retail account-days hold positions as part of volatility trading strategies, compared to the institutional account-days. An exception to this is the 7% of domestic institutions that use combinations of short straddles and/or strangles. Butterflies, on the other hand, do not seem to be a popular strategy among any of the investor classes.

To be sure that we have accurately identified volatility trading strategies, we calculate the exposure of each account's end-of-day position to the Greeks. We focus on delta which measures the exposure of an option position to changes in the underlying price, and vega which measures the option position's sensitivity to changes in the underlying volatility. Hence, we should expect that volatility traders have low delta exposure and high vega exposure. We scale end-of-day delta and vega exposure by the number of lots held by the account on that day. As expected, all the identified strategies in Table 7 have a low average scaled delta, and a high average scaled vega in absolute terms. The long volatility strategies have an average scaled delta of 0.01 and an average scaled vega of 0.11, while the short volatility strategies have an average scaled delta of -0.02 and an average scaled vega of -0.16.

Overall, we find evidence that investors' usage of options for volatility trading is significantly larger than previously identified in the literature. This points to an important use of options as instruments for trading on or hedging underlying volatility, and not solely for speculating on or hedging underlying price changes.

3.4. Greek-neutral strategies

The KOSPI 200 options market is order-driven and does not rely on designated market makers for the provision of liquidity. Nevertheless, we would expect that some accounts act as market makers and profit by providing liquidity to other traders in the market. In this section, we attempt to identify account-days whose behavior resembles that of market makers. This will be helpful in the following analyses of the profitability of different options trading strategies. We start by collecting account-days which have remained without an assigned strategy. These include the account-days holding combinations of options and futures other than covered calls and protective puts (reported as "other combinations" in the last row of Table 5). They also include account-days holding only options, whose strategies do not include simple strategies, volatility trading, or spreads (reported as "other strategies" in the last row of Table 4). From these, we exclude any positions which may be used to achieve a calendar exposure (combinations of options with different maturities). We are left with complex strategies using more than two different option contracts, with more than two different exposures out of the four possible ones: long calls, short calls, long puts, and short puts. Hence, we identify a set of account-days which we refer to as possible market makers, reported in the first row of Table 8. They represent 22% of all account-days with non-zero positions in options, and on average 164% of total open interest. These numbers seem quite high, and as mentioned in the previous section, we can expect that some of these account-days are volatility traders. In order to separate the market makers from the volatility traders, we impose artificial cut-offs on the Greeks exposure of these account-days. Unlike volatility traders, market makers are expected to have a low end-of-day position exposure to both delta and vega. We calculate the 50^{th} and the bottom 25^{th} percentiles of absolute scaled delta exposure and absolute scaled vega exposure of this sub-sample of possible market makers. Those account-days that are in both the bottom delta percentile and the bottom vega percentile are categorized as Greek-neutral traders. Table

8 reports the results for both cases when we use 50% and 25% as the cut-off. Using the 25% cut-off seems to be too low, as we are left with account-days which hold on average only 38% of the overall market open interest. Hence, for any further analyses, we choose to use the 50% cut-off. It leaves us with about 7% of account-days identified as Greek-neutral traders. Their positions account for 77% of total open interest on average. We want to be sure that there is a significant difference between the Greeks exposure of this group of market makers and the rest of the accounts in the broader category "possible market makers" (which likely includes volatility traders). So, we calculate average absolute delta and vega by first averaging the absolute Greeks across accounts and then averaging across days. The bottom 50% market makers have an average absolute delta of 0.01 and an average absolute vega of 0.01, while the rest of the "possible market makers" have an average absolute delta of 0.14 and an average absolute vega of 0.09.

[Table 8 about here]

Although our strategy for identifying market makers is not perfect, we believe that we are able to identify a large portion of account-days which are likely to act as market makers. These are account-days that hold complex combinations of multiple different contracts, which do not correspond to any other trading strategy, and have low delta and vega exposure. We can see from the table that the identified Greek-neutral traders include account-days from all four investor classes.

4. Profitability of option traders

After discovering the most commonly used option strategies, we would like to know which of them are most profitable and which types of investors outperform the rest. In order to examine the relation between account profitability and type of strategy used, we need to label

each account as day trader, simple strategy trader, volatility trader, Greek-neutral trader, or other. We have already defined day traders as accounts who never hold a position at the end of the trading day. However, accounts which are position holders may hold different strategies on different days throughout the sample period. For this reason, we need to identify the dominant strategy of each account. If at least 50% of an account's end-of-day (non-zero) positions in options are positions in simple strategies, then we define that account as a simple strategy trader. Similarly, we mark an account as a volatility trader (Greek-neutral trader) if he holds positions that correspond to a volatility trading (Greek-neutral) strategy at least 50% of all days when he holds any options position. The remaining category labelled as "Others" consists of accounts that use several different strategies without having a dominant one, and accounts whose trading pattern does not fall into any of the above categories. Table 9 reports the number of accounts for each strategy and each investor class, as well as the percentage all accounts in the group.

[Table 9 about here]

About 8% of all accounts are day traders who never hold end-of-day positions in options. Roughly 21% of domestic institutions, 11.5% of foreign institutions, 8% of domestic retail investors, and 9% of foreign retail investors are day traders.

Around 64% of all accounts are classified as simple strategy traders. This closely matches Table 4 which showed that 55.7% of all account-days hold positions in simple strategies. By investor class, a small fraction of institutions are simple strategy traders (18.5% of domestic institutions and 24% of foreign institutions), but a large portion of retail investors predominantly use such one-directional trading strategies (66% of domestic retail and 55% of foreign retail accounts).

Approximately 6.5% of all accounts are volatility traders. Approximately 4.5% of domestic institutions, 2% of foreign institutions, 6.5% of domestic retail investors, and 8% of foreign retail investors are volatility traders. In comparison, we saw in Table 4 that 16.5% of account-days hold positions that are part of volatility trading strategies.

Finally, 3% of accounts are identified as Greek-neutral traders who likely act as market makers. By investor class, they are about 9% of domestic institutions, 15% of foreign institutions, 3% of domestic retail investors, and 6% of foreign retail investors. The rest of the accounts are in the category "Others".

Next, we proceed to analyze account profitability. We start by calculating each account's total dollar profits over the sample period. For each investor account, we use the transactions records to calculate the total cumulative profit and loss ($P&L) over the whole sample period. Hence, we measure the dollar amount generated by all trades that the account has executed from January 2010 to June 2014. If there are any positions that are not closed before the end of our sample period, we mark them to market based on the closing value of the underlying index on the last trading day in our sample (30 June 2014). We use the contract size (multiplier) to calculate profits in Korean won (KRW).

Table 10 shows the total account dollar profits (in KRW) averaged across accounts in each investor type category. The first part of the table shows results by investor class. Foreign institutions appear to be significantly more profitable compared to other investor classes which all lose money on average. The second part of the table shows the average dollar profits for each trading strategy. On average, simple strategy traders generate losses, while all other strategies are profitable, with Greek-neutral traders gaining the largest total account dollar profits.

[Table 10 about here]

Profitability measured in dollar terms does not reflect investor trading skills well because it can be contaminated by account size and capital constraints. In order to remove the effect of capital constraints on profitability, we use the following method to calculate profitability per dollar invested. For each account and each trading day, we first use the transactions records to calculate cumulative daily profit and loss (P&L) in dollar terms as before. End-of-day positions are marked to market based on the last daily quote midpoint on non-expiration dates. If a position is held until maturity, P&L is calculated using the final settlement price based on the underlying index value. Next, to measure profitability per dollar invested, we scale daily P&L values by the capital requirement at the end of the previous day. Such capital requirement arises from the fact that investors pay the full option prices to open long positions and deposit margins to open short positions in the options market. When the value of the margin account falls short of predetermined thresholds (maintenance margin), the exchange will issue margin calls to investors requesting top up in the margin account. This feature of capital requirement sets options trading different from stock trading because options sellers do not receive the sales proceeds and usually put down a sizable margin instead. In other words, selling options is analogous to short selling borrowed stocks. The scaled P&L is therefore a rate of return to each dollar of capital invested in KOSPI derivatives. Compared to the simple option return calculated based on price changes, our scaled P&L is a more practical and implementable measure of profitability or skills because it takes into account the unique feature of margins in derivatives trading. We calculate end-of-day capital requirements using the margin requirements of the Korea Exchange (KRX). Because the margin settlement is daily, we exclude intraday trades and intraday profits from our calculations. Hence, we separate only the profits derived from end-of-day position holdings and scale them by the lag of end-of-day capital requirement. Day traders are also excluded in subsequent analyses. Finally, to have one

single profitability measure for each account, we take the mean and median of daily scaled P&L of the same account during the whole sample period.

Figure 1 shows the scaled profitability of the daily positions of different investor accounts. We would like to understand which class of investors and which option trading strategies outperform others on average. The figures show the daily mean and median scaled P&L of each account, averaged across accounts in each investor type category. Panel A shows results by investor class. Institutions clearly outperform retail investors, whether we look at mean or median profitability. On average, institutions have positive profitability, while retail investors have zero or negative profitability. Foreign and domestic investors seem to perform similarly. Panel B shows results by account strategy. Volatility traders are the most profitable on average. Greek-neutral traders also perform well on average. On the other hand, simple strategy traders are unprofitable. Panel C shows results by account strategy for each investor class category separately. We can see that both domestic and foreign institutions who are volatility traders are highly profitable. Foreign institutions that use simple strategies also generate high profits on average, perhaps due to having an informational advantage. Retail traders, on the other hand, lose from simple strategies. However, there is a subset of retail investors who are skilled and use sophisticated volatility and Greek-neutral strategies to generate positive profits.

[Figure 1 about here]

Next, we test these patterns in multivariate regression analyses. Table 11 presents regression analyses of the relation between investor types and profitability, measured in the same way as in Figure 1. We perform three account-level regressions using mean daily scaled P&L as the dependent variable, and another three regressions using median daily scaled P&L. All regressions have control variables for account activity and trading frequency. We calculate

each account's total trading volume generated over the whole sample period, the number of trading days in the sample when the account was active (the number of days when he traded options or futures at least once), and the number of trading days when he held a position at the end of the day. We take the logarithms of these variables and use them as controls in the regression analyses. Table 11 contains the estimated regression coefficients and below them the corresponding t-statistics in parentheses.

[Table 11 about here]

The independent variables in the first regression are three dummy variables for the three investor classes: foreign retail, domestic institution, and foreign institution. Since all the remaining accounts are domestic retail, the intercept represents that class of investors. We can see that, on average, retail accounts incur losses, while institutions generate positive profits. Foreign investors tend to be similar to domestic investors. The second regression uses as independent variables three dummies for the three types of option traders we identified: simple strategy traders, volatility traders, and Greek-neutral traders. Volatility traders outperform all other strategies – whether we look at the mean or median daily scaled P&L regressions, the coefficients on the volatility trader dummy are all positive and significant. Simple strategy traders show negative performance, although only the coefficients in the median daily scaled P&L regressions are statistically significant. The coefficients on the Greek-neutral trader dummy are all positive but insignificant. The third regression includes the interaction effects between the account classes and strategy dummies. The coefficients on the strategy dummies remain the same as in the second regression, while the investor class dummies become insignificant and most of the interaction coefficients are insignificant. This suggests that the effects of skills and strategy choice are more important for profitability than investor class and country domicile. The only exception are the positive and significant coefficients on the interaction dummies for domestic and foreign institutions which are simple strategy traders in

the median daily scaled P&L regression. They show that some institutions are able to profit from simple strategies. Perhaps they are the ones who possess superior information that allows them to engage in directional speculative trading successfully.

Another way to test which type of strategies are more profitable is to examine the relation between account profitability and exposure to the Greeks. We calculate each account's end-of-day delta and vega exposure, scaled by the number of lots held by the account on that day. Then, we take the time-series average of the account's long delta exposure, absolute short delta exposure, long vega exposure, and absolute short vega exposure. Long delta (or positive delta) positions, such as long calls or short puts, represent directional bets on an increase in the underlying price. Short delta (or negative delta) positions, such as short calls or long puts, represent directional bets on a decrease in the underlying price. Long vega (or positive vega) positions, such as long straddles or long strangles, represent bets on an increase in underlying volatility, and therefore profit when the underlying price experiences large moves in either direction. Short vega (or negative vega) positions, such as short straddles or short strangles, represent neutral strategies where the trader believes that the underlying price will not move significantly in either direction. The maximum profit from strategies that sell vega is equal to the premium collected from writing the options. We take the absolute values of short delta and short vega exposures in order to use them in regressions.

Table 12 presents the results of regressing account mean and median daily scaled P&L (calculated in the same way as in Table 11) on average long delta and vega exposure and average absolute short delta and vega exposure, as well as the three investor class dummies used in the previous regressions in Table 11, and interaction effects between investor class and Greeks exposure. Since day traders do not hold any overnight positions and therefore do not have any end-of-day Greeks exposure, we exclude them from this analysis. The number of observations is slightly reduced because we have missing values for some accounts' exposure

to the Greeks (there are instances when it is not possible to estimate end-of-day delta and vega). The regression coefficients on average long vega exposure are negative, while the coefficients on average absolute short vega exposure are positive and strongly significant. These results support our earlier conclusion that volatility trading strategies (strategies with high vega exposure) contribute to higher profitability, but we can see that only positions that are short vega outperform. Therefore, volatility traders gain from selling vega, but not from buying vega. The coefficients on the interaction variables, which are not statistically significant, suggest that institutions and foreign retail investors are not better than domestic retail investors in selling vega.

[Table 12 about here]

If selling volatility provides superior performance, why are short volatility strategies not used by more investors? Even though we find that volatility trading is more widespread than previously thought, it still accounts for only a portion of total option market activity. Our next analysis aims to explain the reason. Short vega strategies, such as short straddles or short strangles, consist of writing options and represent the investor's belief that the underlying price will not move significantly in either direction over the life of the options. These strategies have a limited profit potential, equal to the premiums collected from writing the options, while the potential losses can be unlimited. Similarly to insurance sellers, vega sellers profit most of the time from collecting premiums, but once in a while incur a large loss. Table 13 shows empirical evidence of this profit pattern. The table presents regression analyses of the relation between investor types and skewness of daily scaled profitability. For each account, we measure daily scaled P&L in the same way as in our previous analyses, and then we calculate the skewness over the sample time period. We perform three regression analyses where the independent variables are the same as in Table 11. The results in Table 13 show that the profits of all volatility traders are significantly more negatively skewed compared to the profits of other

investors. Negative skewness describes a distribution with a longer left tail, meaning that most of the time volatility traders are profitable, but they are exposed to large downside risk.

[Table 13 about here]

As an additional robustness check, we conduct an out-of-sample test to see whether the performance of different types of investors is persistent. To do that, we split our sample into two equal subperiods. The first half of the sample, used for in-sample analysis, covers the period from 1 January 2010 to 31 Mar 2012. The second half of the sample, used for out-of-sample analysis, covers the remaining period from 1 Apr 2012 until 30 June 2014. Using trading data only from the first half of the sample, we assign to each account a strategy dummy: simple strategy trader, volatility trader, or Greek-neutral trader. We create the dummies following the same principle as in previous analyses: for example, if an account uses a volatility trading strategy at least 50% of the time in-sample (50% of the days when he holds a position in-sample), then he is marked as a volatility trader. Then, we keep the same account classification for the second half of the sample. We only keep accounts that execute transactions in both subperiods, which significantly reduces our sample. For each account, we calculate mean daily scaled profits generated in the two subperiods (calculated in the same way as in Table 11). We calculate excess profitability, equal to P&L minus market average P&L. In Table 14, we report the in-sample and out-of-sample average excess profitability for each investor type. We can see that there is performance persistence out-of-sample – the average profitability of most investor types is very similar in the two sample subperiods. All volatility traders have positive excess profitability on average, while retail simple strategy traders have negative excess profitability on average, both in-sample and out-of-sample. Many of the t-statistics are not significant due to the small number of observations in most categories, but they are strongly significant for the large categories of Domestic Retail simple strategy traders and volatility traders.

[Table 14 about here]

5. Conclusion

In this paper, we analyse a detailed account-level dataset of intraday transactions in KOSPI 200 index options and futures. We examine commonly used option trading strategies and their profitability when executed by different classes of investors. Our motivation for studying this comes from the fact that little is known about the real-world trading activities of different types of option investors, what purposes options are used for, and whether certain option strategies result in superior profits.

Our results reveal that retail investors are more likely to use simple strategies that provide one-directional exposure to the underlying, while institutional investors are more likely to use complicated strategies. A small number of accounts, both institutional and retail, generate large volumes of trades using sophisticated and well hedged positions. In addition, volatility trading is used more often than the other classic options strategies. In terms of account profitability, retail investors underperform in general, but those using volatility and sophisticated strategies outperform their peers, while those using simple strategies further underperform. Institutional investors outperform in general. Unlike retail traders, institutions that use simple strategies are able to gain from them, possibly due to informational advantages. Institutions which engage in volatility trading strategies are highly profitable. Additional analyses show that volatility traders gain from selling vega, but not from buying vega. Short volatility positions often profit from the premiums collected from writing options but are exposed to large downside risk. Overall, our findings suggest that skilled options traders use volatility and complicated strategies, but country domicile is less important as we find that foreign investors are similar to domestic investors.

Our study contributes to the literature by providing a series of facts about option markets and option investors' activities. We reveal the most common motivations for trading options, the main strategies that different types of investors use, and their profitability. The results are relevant for researchers and policy makers who want to gain a better understanding of derivatives markets, as well as for investors who can draw implications about their own derivatives usage.

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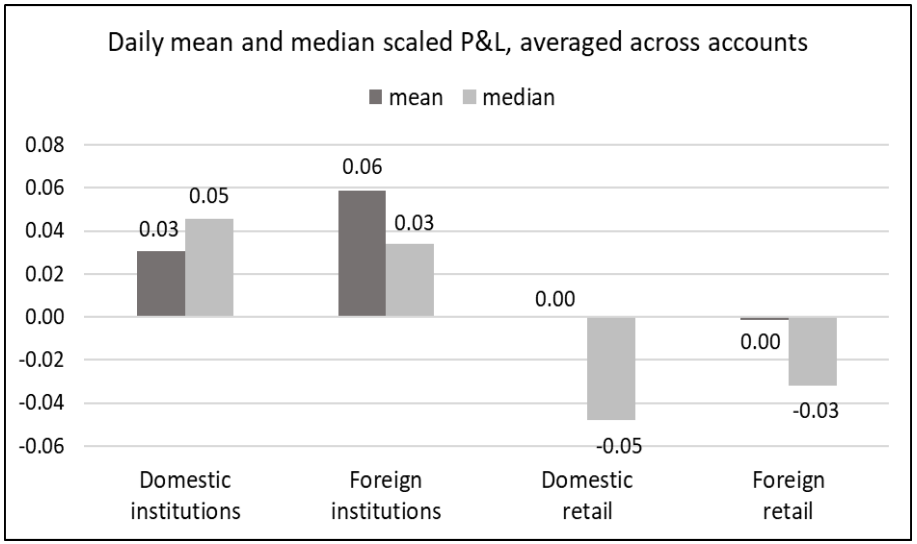
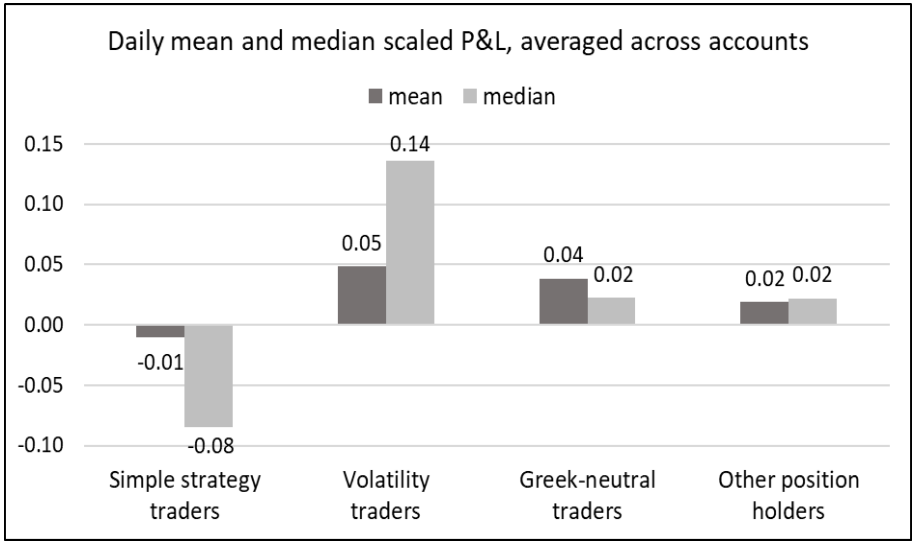
Figure 1
Scaled profitability of the daily positions of different investor accounts

Figure 1 shows the daily mean and median scaled P&L of each account, averaged across accounts in each investor type category. The total number of investor accounts in the sample is 161,010. We use the following method to calculate profitability per dollar invested. For each account and each trading day, we first use the transactions records to calculate cumulative daily profit and loss (P&L) in dollar terms. End-of-day positions are marked to market based on the last daily quote midpoint on non-expiration dates. If a position is held until maturity, P&L is calculated using the final settlement price based on the underlying index value. Then, we scale daily P&L values by the capital requirement at the end of the previous day. We calculate end-of-day capital requirements using the margin requirements of the Korea Exchange (KRX). Investors pay the full option prices to open long positions and deposit margins to open short positions in the options market. When the value of the margin account falls short of predetermined thresholds (maintenance margin), the exchange will issue margin calls to investors requesting top up in the margin account. Because the margin settlement is daily, we exclude intraday trades and intraday profits from our calculations. Hence, we separate only the profits derived from end-of-day position holdings and scale them by the lag of end-of-day capital requirement. Day traders are also excluded in this analysis. Finally, to have one single profitability measure for each account, we take the mean and median of daily scaled P&L of the same account during the whole sample period. Panel A shows results by investor class. Each account in our data is assigned a class: domestic institution, foreign institution, domestic retail, or foreign retail. Panel B shows results by account strategy. We extract the dominant strategy of each account and mark it as a simple strategy trader, volatility trader, Greek-neutral trader, or other position holder. Panel C shows results by account strategy for each investor class category separately. The sample time period is from 1 January 2010 to 30 June 2014.

Panel A: Results by investor class

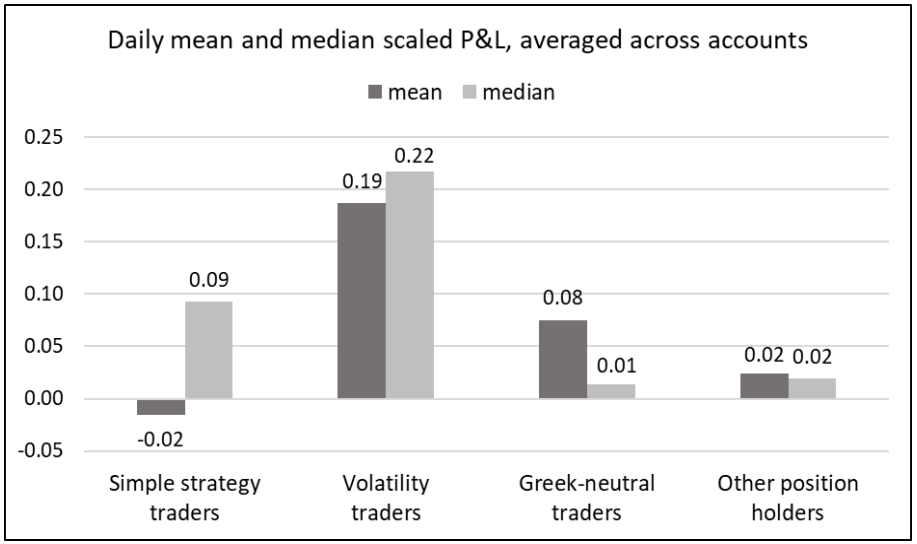


Panel B: Results by account strategy

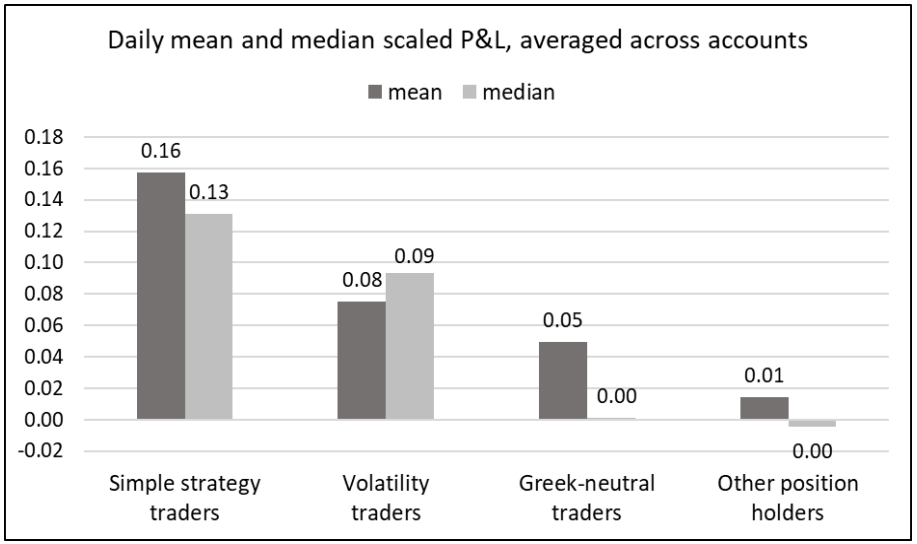


Panel C: Results by account strategy for each investor class category

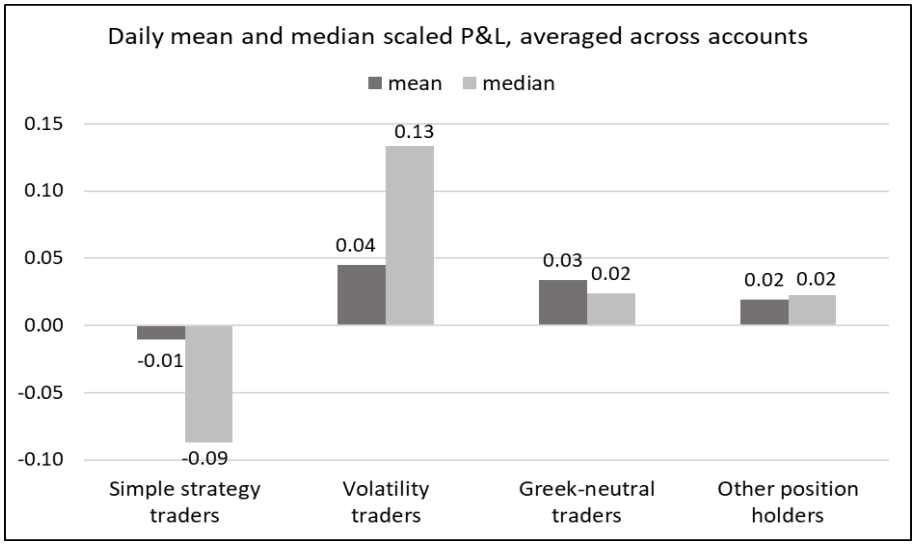
C.1. Domestic Institutions



C.2. Foreign Institutions



C.3. Domestic Retail



C.4. Foreign Retail

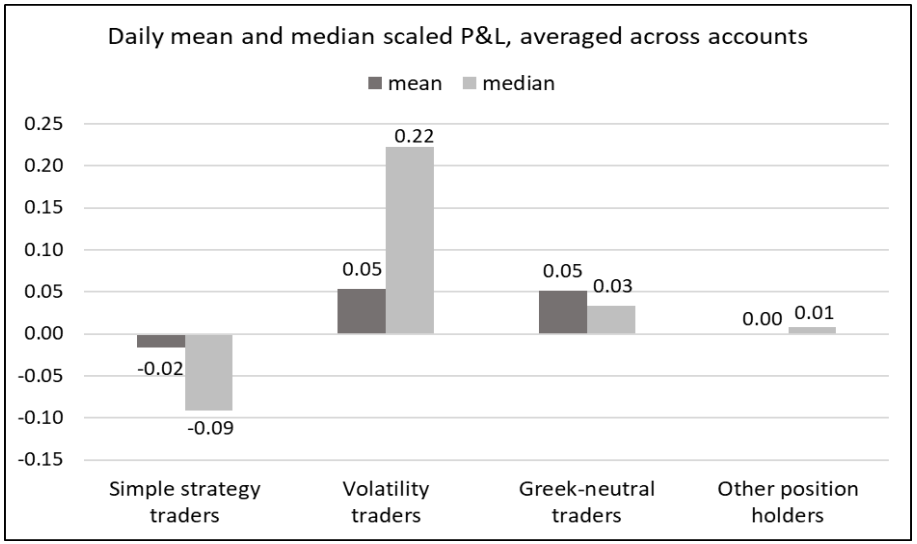


Table 1
Aggregate summary statistics for the options and futures data

This table reports aggregate summary statistics for our data. Panel A describes the options data; Panel B describes the futures data. All contracts are based on the underlying KOSPI 200 index. The sample time period is from 1 January 2010 to 30 June 2014. Contracts that start being traded in 2009 are excluded from the sample. We report statistics for the number of transactions, trading volume (number of contracts traded), volume-weighted options premium or futures trade price, and $volume in billions of KRW (equal to options premium or futures trade price multiplied by trading volume and contract size). First, we calculate total number of transactions, trading volume, $volume, and volume-weighted average premium or trade price for each day. Then, we calculate the mean, standard deviation, minimum, median, maximum, and total sum of these variables across all days in the sample. The contract size for futures is KRW 500,000. For options, it is KRW 100,000 for contracts that mature in or before June 2012, and changes to KRW 500,000 for contracts that mature after June 2012. The sub-panels contain summary statistics for different sub-samples. Normal trading hours refer to the daily continuous trading session from 9:00 to 15:05. Moneyness of a call (put) option is defined by the ratio of the underlying spot price (strike price) to the strike price (underlying spot price). An option is out of the money (OTM) / at the money (ATM) / in the money (ITM) if its moneyness is less than 0.95 / between 0.95 and 1.05 / greater than 1.05.

Panel A: Options data

A-1: Aggregate summary statistics for the options data

	Number of transactions	Trading volume	Premium	$volume (billions of KRW)
daily mean	905,026	7,783,991	1.14	1,197
std	505,100	7,664,950	0.47	597
min	984	4,342	0.51	1.61
median	804,878	5,054,738	1.05	1,100
max	3,360,618	42,188,606	4.33	6,277
total over the sample period	1,000,958,323	8,609,093,878		1,323,552

	Number of transactions daily mean	Trading volume daily mean	Premium daily mean	$volume (billions of KRW) total over the sample period
A-2: Summary statistics by option moneyness				
OTM	183,092	2,251,366	0.45	180,810
ATM	716,845	5,519,158	1.72	1,121,400
ITM	5,108	13,516	18.5	21,305
A-3: Summary statistics by option contract type				
Call	454,010	4,059,280	1.05	645,780
Put	451,016	3,724,711	1.30	677,770
A-4: Summary statistics by trading hours				
Normal trading hours	897,867	7,717,283	1.15	1,312,900
Outside normal trading hours	7,158	66,708	0.92	10,657
A-5: Summary statistics by time to maturity				
0-40 days to maturity	918,363	8,001,045	1.07	1,293,400
41-70 days to maturity	18,749	66,504	2.39	21,880
>70 days to maturity	2,488	10,665	4.89	8,244

Panel B: Futures data

B-1: Aggregate summary statistics for the futures data

	Number of transactions	Trading volume	Trade price	$volume (billions of KRW)
daily mean	110,926	215,543	254.8	27,679
std	61,169	122,784	15.5	15,509
min	1	1	203.1	0.10
median	110,697	211,869	256.4	27,242
max	387,316	759,318	295.4	92,362
total over the sample period	111,923,887	217,482,925		27,928,474

	Number of transactions daily mean	Trading volume daily mean	Trade price daily mean	$volume (billions of KRW) total over the sample period
B-2: Summary statistics by trading hours				
Normal trading hours	98,202	197,063	254.9	25,512,000
Outside normal trading hours	13,808	20,170	257.0	2,416,200
B-3: Summary statistics by time to maturity				
0-40 days to maturity	131,170	256,526	256.5	12,606,000
41-70 days to maturity	122,692	241,014	259.8	9,225,200
>70 days to maturity	25,004	47,197	255.5	6,097,000

Table 2
Description of investor accounts

This table reports the total number of investor accounts that trade at least once during our sample period. It also reports the number of accounts that trade options at least once in the data, and these are further separated into accounts that trade only options and accounts that trade both options and futures. We also report the number of accounts by investor class. We use the country codes in our data to separate accounts into domestic (Korean) and foreign accounts, and we use the investor type codes to separate them into retail investors and institutions (which include financial investment companies, banks, pension funds, insurance companies, trusts, state and local government institutions, and other institutions). Based on these categories, we assign a unique class to each account: Domestic Institution, Foreign Institution, Domestic Retail, or Foreign Retail. The sample time period is from 1 January 2010 to 30 June 2014.

	Number of accounts	Number of accounts that trade options	Number of accounts that trade only options	Number of accounts that trade options and futures
Total	187,323	161,010	108,122	52,888
Domestic Institutions	13,795	5,904	1,862	4,042
Foreign Institutions	1,556	667	183	484
Domestic Retail	171,274	153,835	105,682	48,153
Foreign Retail	698	604	395	209

Table 3
Summary statistics of the options trading activity of different investor classes

This table provides summary statistics of the options trading activity of the different account classes. We use the bid and ask markers in the data to mark which transaction counterparty is the buyer and which is the seller. We compare the bid and ask order submission times and mark the investor who submitted their order first as the liquidity provider and the investor whose order matched the first one as the trade initiator (or aggressor). Transactions for which the two orders cross at the same time are excluded from the results in this table, since the trade initiator and liquidity provider cannot be identified in those cases. Panel A contains summary statistics by trade initiator class, and Panel B by liquidity provider class. The sample time period is from 1 January 2010 to 30 June 2014.

	Number of transactions daily mean	**Trading volume** daily mean	**Premium** daily mean	**$volume (billions of KRW)** total over the sample period
Panel A: By trade initiator class				
Domestic Institutions	121,167	1,957,857	0.73	179,806
Foreign Institutions	505,523	3,957,154	1.31	849,309
Domestic Retail	276,995	1,854,944	1.07	292,682
Foreign Retail	1,221	13,904	0.93	1,564
Panel B: By liquidity provider class				
Domestic Institutions	197,588	2,813,749	0.74	275,061
Foreign Institutions	253,420	2,002,524	1.39	479,232
Domestic Retail	451,779	2,948,881	1.27	565,484
Foreign Retail	2,116	18,655	1.36	3,583

Table 4
Strategies of position holders

This table reports account-day results for option position holders' strategies. We define position holders as accounts that hold a position in options at the end of the trading day at least once in the sample. We use transactions data to construct the end-of-day positions held by each account in each different contract. For each account, day and contract, the end-of-day position is equal to the previous day's position plus any purchased lots minus any sold lots. Then, we study the combinations of different contracts that each account-day holds and extract the corresponding strategies. We group strategies into five main categories. Combinations of options and futures include covered calls, protective puts, and any other combinations. Simple strategies refer to one-directional exposure from holding only one type of option contracts. These include positions in long calls only, or short calls only, or long puts only, or short puts only. They may be thought of as naked options in the sense that they are not accompanied by any position in futures contracts. Volatility trading strategies include straddles, strangles, and butterflies. Spreads include bull spreads, bear spreads, synthetic stocks, and calendar spreads. The remaining category of other strategies consists of any combinations of option contracts which do not fall into the above categories. For each strategy category, we report the number of account-days that hold a position corresponding to the strategy, as a percentage of all account-days with a non-zero end-of-day position in options. We also report the average percentage of open interest: for each strategy, first we calculate the end-of-day number of options held by all investors who use that strategy, as a percentage of the total number of options held in the market by all investors (overall open interest), and then we take the time-series average. The open interest percentages sum to a total of 200% since each option contract is held simultaneously by two counterparties – each long position has a corresponding short position. The table contains results for all account-days aggregated, as well as for each investor class separately. The sample time period is from 1 January 2010 to 30 June 2014.

	All		**Domestic Institutions**		**Foreign Institutions**		**Domestic Retail**		**Foreign Retail**	
Number of account-days with a non-zero position in options	19,135,324		409,754		129,926		18,521,112		74,532	
	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest
Options and futures	6.24%	88.7%	25.4%	22.0%	63.0%	56.3%	5.42%	10.3%	7.27%	0.04%
Simple strategies	55.7%	14.6%	21.3%	0.72%	11.0%	0.95%	56.8%	12.9%	47.6%	0.06%
Volatility trading	16.5%	14.5%	11.1%	2.93%	4.03%	0.70%	16.7%	10.8%	17.7%	0.04%
Spreads	3.68%	5.91%	11.9%	2.74%	2.20%	0.21%	3.50%	2.95%	4.73%	0.02%
Other strategies	17.9%	76.3%	30.3%	17.6%	19.8%	13.3%	17.6%	45.0%	22.7%	0.36%

Table 5
Strategies of position holders: Combinations of options and futures

This table focuses on the strategies that option position holders create in combination with futures. We extract these by checking the type of options and futures exposure that an account-day has: long calls, short calls, long puts, short puts, long futures, or short futures. Long covered calls consist of long calls and short futures, while short covered calls consist of short calls and long futures. Long protective puts are created with long puts and long futures, while short protective puts are created with short puts and short futures. The table breaks down the category of options-and-futures combinations into these four strategies, as well as a remaining category of any other combinations. For each sub-category, we report the number of account-days that hold a position corresponding to the strategy, as a percentage of all account-days with a non-zero end-of-day position in options. We also report the average percentage of open interest: for each strategy, first we calculate the end-of-day number of options held by all investors who use that strategy, as a percentage of the total number of options held in the market by all investors (overall open interest), and then we take the time-series average. The total open interest in the market sums to 200% since each option contract is held simultaneously by two counterparties – each long position has a corresponding short position. The table contains results for all account-days aggregated, as well as for each investor class separately. The sample time period is from 1 January 2010 to 30 June 2014.

	All		**Domestic Institutions**		**Foreign Institutions**		**Domestic Retail**		**Foreign Retail**	
Number of account-days with a non-zero position in options	19,135,324		409,754		129,926		18,521,112		74,532	
	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest
Options and futures	6.24%	88.7%	25.4%	22.0%	63.0%	56.3%	5.42%	10.3%	7.27%	0.04%
● long covered calls	0.21%	0.20%	0.32%	0.02%	0.85%	0.10%	0.21%	0.08%	0.28%	0.00%
● short covered calls	0.28%	0.43%	1.71%	0.13%	0.21%	0.00%	0.25%	0.30%	0.42%	0.00%
● long protective puts	0.24%	0.31%	0.45%	0.04%	2.46%	0.19%	0.22%	0.08%	0.73%	0.00%
● short protective puts	0.25%	0.28%	0.99%	0.05%	0.47%	0.02%	0.23%	0.21%	0.47%	0.00%
● other combinations	5.26%	87.5%	21.9%	21.7%	59.0%	56.0%	4.51%	9.66%	5.38%	0.04%

Table 6
Strategies of position holders: Simple strategies

This table takes a closer look at simple option trading strategies. We include here account-days which hold a position in only one type of option contracts: either long calls only, or short calls only, or long puts only, or short puts only. These are one-directional exposures which may be thought of as naked options in the sense that they are not accompanied by any position in futures contracts. For each sub-category, we report the number of account-days that hold a position corresponding to the strategy, as a percentage of all account-days with a non-zero end-of-day position in options. We also report the average percentage of open interest: for each strategy, first we calculate the end-of-day number of options held by all investors who use that strategy, as a percentage of the total number of options held in the market by all investors (overall open interest), and then we take the time-series average. The total open interest in the market sums to 200% since each option contract is held simultaneously by two counterparties – each long position has a corresponding short position. The table contains results for all account-days aggregated, as well as for each investor class separately. The sample time period is from 1 January 2010 to 30 June 2014.

	All		**Domestic Institutions**		**Foreign Institutions**		**Domestic Retail**		**Foreign Retail**	
Number of account-days with a non-zero position in options	19,135,324		409,754		129,926		18,521,112		74,532	
	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest
Simple strategies	55.7%	14.6%	21.3%	0.72%	11.0%	0.95%	56.8%	12.9%	47.6%	0.06%
● long call	30.2%	7.52%	4.12%	0.12%	2.04%	0.14%	31.0%	7.23%	22.3%	0.02%
● short call	2.04%	0.99%	8.09%	0.38%	0.57%	0.06%	1.92%	0.55%	2.44%	0.00%
● long put	21.3%	5.28%	5.42%	0.14%	8.04%	0.75%	21.8%	4.37%	19.6%	0.03%
● short put	2.17%	0.83%	3.68%	0.07%	0.36%	0.00%	2.14%	0.75%	3.36%	0.00%

Table 7
Strategies of position holders: Volatility trading

This table presents details about the different strategies that option position holders use to trade on underlying volatility. First, we extract long and short straddles and strangles created by taking a position in two different option contracts only. Long (short) straddles are created by combining long (short) calls and long (short) puts with the same strike price and maturity date. Long (short) strangles are created with long (short) calls and long (short) puts with the same maturity date but different strike prices. Next, we would like to extract account-days that use more than two different option contracts to create combinations of straddles and strangles. Regardless of how many different option contracts an account-day uses, we check the types of exposures they have. If they hold long calls and long puts only, we can be sure that they are using a combination of long straddles and/or long strangles. If they hold short calls and short puts only, then they are using a combination of short straddles and/or short strangles. In the table below, we report these strategies as "long combinations" and "short combinations". Finally, we extract butterflies created with three different option contracts. A call (put) butterfly spread is a strategy that combines three call (put) contracts with different strike prices, such that the option contract with the middle strike price has twice the number of lots invested in it, compared to the number of lots invested in the other two option contracts. For example, a long call butterfly can be created by buying one lot in a call option contract with the lowest strike price, selling two lots in a call option contract with the middle strike price, and buying one lot in a call option contract with the highest strike price. We must note that we are only able to identify butterfly spreads created using three different option contracts, but we are unable to extract any combinations of butterflies created using six, nine, or more different option contracts, because we cannot be sure that they are not other strategies. Similarly, some combinations of long and short straddles and strangles may be left in the category of other strategies, because we cannot say for sure what type of strategy is used by an account that holds a large number of different option contracts. Therefore, the numbers presented in this table are lower bounds, and the usage of options for volatility trading may in fact be larger.

For each sub-category, we report the number of account-days that hold a position corresponding to the strategy, as a percentage of all account-days with a non-zero end-of-day position in options. We also report the average percentage of open interest: for each strategy, first we calculate the end-of-day number of options held by all investors who use that strategy, as a percentage of the total number of options held in the market by all investors (overall open interest), and then we take the time-series average. The total open interest in the market sums to 200% since each option contract is held simultaneously by two counterparties – each long position has a corresponding short position. The table contains results for all account-days aggregated, as well as for each investor class separately. The sample time period is from 1 January 2010 to 30 June 2014.

	All		Domestic Institutions		Foreign Institutions		Domestic Retail		Foreign Retail	
Number of account-days with a non-zero position in options	19,135,324		409,754		129,926		18,521,112		74,532	
	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest
Volatility trading	16.5%	14.5%	11.1%	2.93%	4.03%	0.70%	16.7%	10.8%	17.7%	0.04%
● long straddle	0.18%	0.03%	0.04%	0.00%	0.04%	0.00%	0.18%	0.03%	0.22%	0.00%
● short straddle	0.20%	0.05%	0.50%	0.00%	0.19%	0.01%	0.19%	0.03%	0.29%	0.00%
● long strangle	4.67%	1.04%	0.70%	0.02%	0.46%	0.03%	4.79%	0.98%	3.70%	0.00%
● short strangle	2.56%	2.10%	1.93%	0.24%	0.23%	0.01%	2.59%	1.85%	3.94%	0.01%
● long combinations	3.44%	2.12%	0.98%	0.68%	1.29%	0.17%	3.52%	1.28%	2.59%	0.01%
● short combinations	5.37%	9.11%	6.87%	1.98%	1.74%	0.49%	5.36%	6.63%	6.89%	0.02%
● long call butterfly	0.01%	0.01%	0.03%	0.00%	0.02%	0.00%	0.01%	0.00%	0.01%	0.00%
● short call butterfly	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
● long put butterfly	0.02%	0.02%	0.09%	0.01%	0.05%	0.00%	0.02%	0.01%	0.01%	0.00%
● short put butterfly	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 8
Strategies of position holders: Greek-neutral strategies

In this table, we attempt to identify account-days who use Greek-neutral strategies and whose behavior resembles that of market makers. These are account-days that hold complex combinations of multiple different contracts, which do not correspond to any other trading strategy, and are well hedged against delta and vega risks. We start by collecting account-days which have remained without an assigned strategy. These include the account-days holding combinations of options and futures other than covered calls and protective puts (reported as "other combinations" in the last row of Table 5). They also include account-days holding only options, whose strategies do not fall into the categories of simple strategies, volatility trading, or spreads (reported as "other strategies" in the last row of Table 4). From these, we exclude any positions which may be used to achieve a calendar exposure (combinations of options with different maturities). We are left with complex strategies using more than two different option contracts, with more than two different exposures out of the four possible ones: long calls, short calls, long puts, and short puts. Hence, we identify a set of account-days which we refer to as possible market makers, reported in the first row of the table. In order to separate the market makers from any volatility traders, we impose artificial cut-offs on the Greeks exposure of these account-days. We calculate the 50th and the bottom 25th percentiles of absolute scaled delta exposure and absolute scaled vega exposure of this sub-sample of possible market makers. Those account-days that are in both the bottom delta percentile and the bottom vega percentile are categorized as Greek-neutral. The table below reports the results for both cases when we use 50% and 25% as the cut-off. For each sub-sample, we report the number of account-days as a percentage of all account-days with a non-zero end-of-day position in options. We also report the average percentage of open interest: first we calculate the end-of-day number of options held by all investors in the sub-sample, as a percentage of the total number of options held in the market by all investors (overall open interest), and then we take the time-series average. The total open interest in the market sums to 200% since each option contract is held simultaneously by two counterparties – each long position has a corresponding short position. The table contains results for all account-days aggregated, as well as for each investor class separately. The sample time period is from 1 January 2010 to 30 June 2014.

	All		**Domestic Institutions**		**Foreign Institutions**		**Domestic Retail**		**Foreign Retail**	
Number of account-days with a non-zero position in options	19,135,324		409,754		129,926		18,521,112		74,532	
	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest	% of above account-days	average % of open interest
Possible market makers	22.2%	163.6%	52.0%	39.4%	78.7%	69.4%	21.2%	54.5%	27.1%	0.39%
● greeks in bottom 50%	7.08%	77.2%	20.5%	20.7%	23.3%	27.8%	6.66%	28.6%	10.2%	0.28%
● greeks in bottom 25%	2.29%	38.0%	10.3%	14.4%	9.85%	12.6%	2.06%	11.1%	3.01%	0.18%

Table 9
Dominant strategy by account

In this table, we extract the dominant strategy of each account and report the number of accounts for each strategy and each investor class, as well as the percentage of all accounts in the group. The total number of accounts that trade options in the sample is 161,010. We label each account as a day trader, simple strategy trader, volatility trader, Greek-neutral trader, or other. Day traders are defined as accounts that never hold a position at the end of the trading day. The rest of the accounts, which are position holders, may hold different strategies on different days throughout the sample period. For this reason, we want to extract their dominant strategy which they use most of the time. For example, if at least 50% of an account's end-of-day positions are positions in simple strategies, we classify him as a simple strategy trader. Similarly, we mark an account as a volatility trader (Greek-neutral trader) if he holds positions that correspond to a volatility trading (Greek-neutral) strategy at least 50% of all days when he holds any options position. The remaining category "Others" consists of accounts that switch between different strategies without having a dominant one, and accounts whose trading pattern does not fall into any of the above categories. The table contains results for all accounts aggregated, as well as for each investor class separately. The sample time period is from 1 January 2010 to 30 June 2014.

	All	**Domestic Institutions**	**Foreign Institutions**	**Domestic Retail**	**Foreign Retail**
	Number of accounts (% of all accounts)	Number of accounts (% of all Domestic Institutions)	Number of accounts (% of all Foreign Institutions)	Number of accounts (% of all Domestic Retail)	Number of accounts (% of all Foreign Retail)
Day traders	13,587	1,252	77	12,204	54
	8.4%	21.2%	11.5%	7.9%	8.9%
Simple strategy traders	103,541	1,091	159	101,958	333
	64.3%	18.5%	23.8%	66.3%	55.1%
Volatility traders	10,396	267	15	10,067	47
	6.5%	4.5%	2.2%	6.5%	7.8%
Greek-neutral traders	4,873	548	101	4,188	36
	3.0%	9.3%	15.1%	2.7%	6.0%
Others	28,613	2,746	315	25,418	134
	17.8%	46.5%	47.2%	16.5%	22.2%

Table 10
Total account dollar profits

This table shows average values of total account dollar profits for each investor class and strategy. The total number of investor accounts in the sample is 161,010. For each account, we use the transactions records to calculate the total cumulative profit and loss ($P&L) over the whole sample period. Hence, we measure the total dollar amount generated by all trades that the account has executed from 1 January 2010 to 30 June 2014. If there are any positions that are not closed before the end of our sample period, we mark them to market based on the closing value of the underlying index on the last trading day in our sample. We use the contract size (multiplier) to calculate profits in Korean won (KRW). The table presents total account $P&L averaged across accounts in each investor type category. The first part of the table divides accounts by investor class, and the second part of the table divides accounts by trading strategy.

	Total account $P&L (in KRW) averaged across accounts
Domestic institutions	-27,379,127
Foreign institutions	4,062,048,070
Domestic retail	-21,251,697
Foreign retail	-31,706,574
Day traders	31,981,778
Simple strategy traders	-22,978,205
Volatility traders	5,924,063
Greek-neutral traders	104,501,494
Others	22,128,464

Table 11
Scaled profitability of the daily positions of different investor accounts: Regression analysis

This table presents multivariate regression analyses of the relation between account profitability and investor types. The total number of investor accounts in the sample is 161,010. We use the following method to calculate profitability per dollar invested. For each account and each trading day, we first use the transactions records to calculate cumulative daily profit and loss (P&L) in dollar terms. End-of-day positions are marked to market based on the last daily quote midpoint on non-expiration dates. If a position is held until maturity, P&L is calculated using the final settlement price based on the underlying index value. Then, we scale daily P&L values by the capital requirement at the end of the previous day. Such capital requirement arises from the fact that investors pay the full option prices to open long positions and deposit margins to open short positions in the options market. When the value of the margin account falls short of predetermined thresholds (maintenance margin), the exchange will issue margin calls to investors requesting top up in the margin account. The scaled P&L is therefore a rate of return to each dollar of capital invested in KOSPI derivatives. We calculate end-of-day capital requirements using the margin requirements of the Korea Exchange (KRX). Because the margin settlement is daily, we exclude intraday trades and intraday profits from our calculations. Hence, we separate only the profits derived from end-of-day position holdings and scale them by the lag of end-of-day capital requirement. Day traders are also excluded in this analysis. Finally, to have one single profitability measure for each account, we take the mean and median of daily scaled P&L of the same account during the whole sample period.

We perform three account-level regressions using mean daily scaled P&L as the dependent variable, and another three regressions using median daily scaled P&L. All regressions have control variables for account activity and trading frequency. We calculate each account's total trading volume generated over the whole sample period, the number of trading days in the sample when the account was active (the number of days when he traded options or futures at least once), and the number of trading days when he held a position at the end of the day. We take the logarithms of these variables and use them as controls in the regression analyses. The independent variables in the first regression are three dummy variables for the three investor classes: foreign retail, domestic institution, and foreign institution. Since all the remaining accounts are domestic retail, the intercept represents that class of investors. The second regression uses as independent variables three dummies for the three types of option traders we identified: simple strategy traders, volatility traders, and Greek-neutral traders. The third regression adds interaction effects between the strategy dummies and the investor class dummies. The table contains the estimated regression coefficients and below them the corresponding t-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The sample time period is from 1 January 2010 to 30 June 2014.

Dependent variable:	Mean daily scaled P&L			Median daily scaled P&L		
	1	2	3	1	2	3
Intercept	-0.085***	-0.079***	-0.079***	-0.112***	-0.037***	-0.038***
	(-6.15)	(-4.62)	(-4.55)	(-15.81)	(-4.23)	(-4.26)
Foreign retail	-0.004		-0.018	0.016		-0.012
	(-0.06)		(-0.13)	(0.48)		(-0.18)
Domestic institution	0.032		0.013	0.102***		0.009
	(1.36)		(0.42)	(8.63)		(0.60)
Foreign institution	0.051		-0.010	0.093***		-0.017
	(0.81)		(-0.12)	(2.86)		(-0.38)
Simple strategy trader		-0.011	-0.010		-0.095***	-0.096***
		(-1.06)	(-0.95)		(-17.99)	(-17.47)
Volatility trader		0.04**	0.038**		0.12***	0.118***
		(2.31)	(2.09)		(13.50)	(12.92)
Greek-neutral trader		0.023	0.017		0.008	0.007
		(0.97)	(0.66)		(0.68)	(0.57)
Simple strategy trader * Foreign retail			0.013			0.010
			(0.08)			(0.13)
Simple strategy trader * Domestic institution			-0.004			0.185***
			(-0.07)			(6.35)
Simple strategy trader * Foreign institution			0.190			0.26***
			(1.26)			(3.40)
Volatility trader * Foreign retail			0.019			0.096
			(0.07)			(0.73)
Volatility trader * Domestic institution			0.142			0.09*
			(1.39)			(1.73)
Volatility trader * Foreign institution			0.054			0.002
			(0.13)			(0.01)
Greek-neutral trader * Foreign retail			0.034			0.019
			(0.12)			(0.13)
Greek-neutral trader * Domestic institution			0.050			0.008
			(0.67)			(0.22)
Greek-neutral trader * Foreign institution			0.035			0.022
			(0.20)			(0.24)
log (Total account trading volume)	-0.004*	-0.004	-0.004*	-0.009***	-0.008***	-0.008***
	(-1.70)	(-1.49)	(-1.70)	(-7.46)	(-6.05)	(-6.48)
log (Account active trading days)	0.013**	0.013**	0.014**	0.024***	0.022***	0.024***
	(2.31)	(2.19)	(2.37)	(8.03)	(7.50)	(8.03)
log (Account days with positions)	0.016***	0.016***	0.015***	0.011***	0.005**	0.005**
	(4.19)	(4.00)	(3.89)	(5.29)	(2.55)	(2.26)
N observations	145,210	145,210	145,210	145,210	145,210	145,210
Adjusted R^2	0.0006	0.0007	0.0007	0.0028	0.0088	0.0093

Table 12
Relation between account scaled profitability and Greeks exposure

This table shows the relation between account scaled profitability and exposure to the Greeks. We calculate each account's end-of-day delta and vega exposure, scaled by the number of lots held by the account on that day. Then, we take the time-series average of the account's long delta exposure, absolute short delta exposure, long vega exposure, and absolute short vega exposure. Since day traders do not hold any overnight positions and therefore do not have any end-of-day Greeks exposure, we exclude them from this analysis. The number of observations is slightly reduced because we have missing values for some accounts' exposure to the Greeks (there are instances when it is not possible to estimate end-of-day delta and vega). We perform two account-level regression analyses. The dependent variables in the first and second regressions are the account mean daily scaled P&L and median daily scaled P&L, respectively (calculated in the same way as in Table 11). The independent variables are average long delta and vega exposure, average absolute short delta and vega exposure, the three investor class dummies, and interaction effects between the Greeks exposure variables and the investor class dummies. The table contains the estimated regression coefficients and below them the corresponding t-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The sample time period is from 1 January 2010 to 30 June 2014.

Dependent variable:	Mean daily scaled P&L	Median daily scaled P&L
Intercept	0.015*	-0.055***
	(1.80)	(-13.47)
Average long delta exposure	0.203***	-0.04**
	(5.88)	(-2.26)
Average absolute short delta exposure	-0.115***	0.013
	(-3.14)	(0.72)
Average long vega exposure	-0.005***	-0.002***
	(-5.21)	(-5.40)
Average absolute short vega exposure	0.002***	0.009***
	(3.62)	(27.35)
Foreign retail	-0.003	0.028
	(-0.03)	(0.46)
Domestic institution	-0.004	0.076***
	(-0.10)	(3.71)
Foreign institution	0.066	0.107**
	(0.65)	(2.05)
Average long delta exposure * Foreign retail	-0.215	-0.083
	(-0.38)	(-0.28)
Average absolute short delta exposure * Foreign retail	0.189	0.087
	(0.35)	(0.31)
Average long vega exposure * Foreign retail	0.000	-0.002
	(0.03)	(-0.33)
Average absolute short vega exposure * Foreign retail	0.000	-0.001
	(0.03)	(-0.11)
Average long delta exposure * Domestic institution	-0.166	0.052
	(-1.26)	(0.77)
Average absolute short delta exposure * Domestic institution	0.126	-0.066
	(0.96)	(-0.98)
Average long vega exposure * Domestic institution	0.001	-0.003
	(0.19)	(-1.26)
Average absolute short vega exposure * Domestic institution	0.004	0.002
	(0.98)	(1.16)
Average long delta exposure * Foreign institution	0.249	0.449**
	(0.56)	(1.98)
Average absolute short delta exposure * Foreign institution	-0.361	-0.419*
	(-0.79)	(-1.79)
Average long vega exposure * Foreign institution	0.001	-0.004
	(0.14)	(-0.71)
Average absolute short vega exposure * Foreign institution	0.001	-0.001
	(0.09)	(-0.13)
N observations	144,535	144,535
Adjusted R^2	0.0005	0.0068

Table 13
Skewness of daily scaled profitability

This table presents regression analyses of the relation between account types and skewness of daily scaled profitability. The total number of investor accounts in the sample is 161,010. For each account, we measure daily scaled P&L in the same way as in Table 11, and then we calculate the skewness over the sample period. The sample time period is from 1 January 2010 to 30 June 2014. We perform three regression analyses where the independent variables are the same as in Table 11. The results report the estimated regression coefficients and below them the corresponding t-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable:	Skewness of daily scaled P&L		
	1	2	3
Intercept	1.166***	-0.358***	-0.471***
	(105.96)	(-15.44)	(-19.17)
Foreign retail	-0.422**		-0.262
	(-2.43)		(-0.77)
Domestic institution	-0.786***		0.929***
	(-12.55)		(11.71)
Foreign institution	0.697***		2.393***
	(4.09)		(10.75)
Simple strategy trader		2.161***	2.289***
		(81.86)	(82.85)
Volatility trader		-0.184***	-0.064
		(-4.02)	(-1.37)
Greek-neutral trader		0.544***	0.528***
		(9.03)	(8.17)
Simple strategy trader * Foreign retail			0.049
			(0.12)
Simple strategy trader * Domestic institution			-2.656***
			(-16.94)
Simple strategy trader * Foreign institution			-1.926***
			(-4.78)
Volatility trader * Foreign retail			-0.182
			(-0.27)
Volatility trader * Domestic institution			-1.061***
			(-3.86)
Volatility trader * Foreign institution			-3.867***
			(-3.55)
Greek-neutral trader * Foreign retail			0.943
			(1.30)
Greek-neutral trader * Domestic institution			-0.109
			(-0.56)
Greek-neutral trader * Foreign institution			-0.812*
			(-1.82)
N observations	135,748	135,748	135,748
Adjusted R^2	0.001	0.063	0.066

Table 14
Out-of-sample performance persistence analysis

This table reports the in-sample and out-of-sample profitability of the different types of investors. We start by dividing our sample into two equal subperiods. The first half of the sample, used for in-sample analysis, covers the period from 1 January 2010 to 31 Mar 2012. The second half of the sample, used for out-of-sample analysis, covers the remaining period from 1 Apr 2012 until 30 June 2014. Using trading data only from the first half of the sample, we assign to each account a strategy dummy: simple strategy trader, volatility trader, or Greek-neutral trader. We create the dummies following the same principle as in previous analyses: for example, if an account uses a volatility trading strategy at least 50% of the time in-sample (50% of the days when he holds a position in-sample), then he is marked as a volatility trader. Then, we keep the same account classification for the second half of the sample. We only keep accounts that have transactions in both subperiods, which significantly reduces the sample. For each account, we calculate mean daily scaled P&L (calculated in the same way as in Table 11) in the two subperiods (in-sample P&L and out-of-sample P&L). We calculate excess profitability, equal to P&L minus market average P&L. Finally, we report summary statistics for the calculated profitability measures. For each investor type, the table contains the number of accounts, in-sample and out-of-sample average excess profitability, and the corresponding t-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Investor type		N observations	In-sample mean excess profitability	Out-of-sample mean excess profitability
Simple strategy traders	Domestic institution	195	-0.154***	-0.034
			(-2.93)	(-0.80)
	Foreign institution	32	0.015	-0.237
			(0.12)	(-1.50)
	Domestic retail	23,187	-0.008***	-0.014***
			(-2.91)	(-5.86)
	Foreign retail	75	-0.007	-0.045
			(-0.13)	(-1.12)
Volatility traders	Domestic institution	40	0.06	0.197***
			(0.74)	(4.04)
	Foreign institution	3	0.079	0.031
			(1.54)	(0.48)
	Domestic retail	3,239	0.062***	0.066***
			(9.05)	(5.53)
	Foreign retail	13	0.154	0.087
			(1.47)	(1.44)
Greek-neutral traders	Domestic institution	82	0.031	0.086***
			(0.94)	(2.92)
	Foreign institution	29	-0.033***	0.002
			(-2.91)	(0.06)
	Domestic retail	1,024	0.005	0.005
			(1.28)	(0.40)
	Foreign retail	10	0.042	0.036
			(0.97)	(0.98)
Other position holders	Domestic institution	780	-0.004	0.001
			(-0.34)	(0.10)
	Foreign institution	127	-0.004	0.014
			(-0.34)	(0.74)
	Domestic retail	8,463	0.001	0.012***
			(0.36)	(2.92)
	Foreign retail	39	-0.033*	-0.016
			(-1.96)	(-1.34)