Does Information Drive Trading in Option Strategies?

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Abstract

We study trading in option strategies such as straddles, strangles, vertical and horizontal spreads using a unique sample of all trades in individual options and option strategies on the FTSE-100 index. In our sample, trades in option strategies represent around 37% of the total number of trades and over 75% of the total trading volume. We test whether the option strategy order flow contains information about either future returns or future volatility or both. We find evidence that the order flow in options-only volatility strategies—strategies with vega exposure—contains information about future realized volatility. We do not find evidence that the order flow in directional strategies—strategies with delta exposure—contains information about future returns. In contrast, we find that the directional order flow is strongly positively correlated with lagged returns. We measure the gains and losses over five-day periods for each trade and find that volatility strategies generate a mean gain of £1.5 per contract whereas directional strategies generate a mean loss of £0.9 per contract. The corresponding five-day raw returns are approximately 1.5% and -2.0%. Overall, our evidence suggests that option strategies are used both by traders who possess non-public information about future volatility and by uninformed speculators who appear to follow unprofitable trend chasing strategies.

Keywords: Option Strategies; Option Spreads; Option Combinations; Information; Trading.
JEL codes: G00; G13; G14.

1 Introduction

Option strategies play a central role in the practice and pedagogy of derivatives. Bear, bull, butterfly, calendar, and ratio spreads along with straddles and strangles are some of the option strategies that are described in detail in popular derivatives books including Bookstaber (1991), Cox and Rubinstein (1985), Hull (2003), Kolb (2002), McMillan (2002, 2004), McDonald (2003), and Natenberg (1994). A trader who wishes to speculate on the future direction or volatility of an asset may want to trade in an option strategy. For example, a trader who expects future volatility of an asset to be lower than the current implied volatility may want to sell straddles or strangles or buy butterfly spreads. Trading in such strategies may therefore help move option prices so that implied volatility is aligned with the market's assessment of future volatility. Yet, there are very few studies of trading in option strategies. How much trading occurs in different option strategies? What is the information content of trading in option strategies? Is trading in option strategies driven by information? We address these questions using a comprehensive sample of trades in option strategies in the FTSE-100 index options market.

In our sample, around 37 percent of all option trades are trades in option strategies with the remaining 63 percent being trades in individual options. Traders in the market we study can trade 44 distinct strategies ranging from common ones such as straddles or bull spreads to more exotic ones such as iron butterflies, jelly rolls, or condors, but much of the trading is concentrated in a few popular strategies. More than 50 percent of all strategy trades are in either strangles, straddles, bull and bear spreads, or covered calls and puts whereas strategies such as iron butterflies, jelly rolls, condors, ladders, or strips together account for less than 1% of all trades. Trading in strategies is more active in volatile periods consistent with the idea that one of the rationales for trading in option strategies is to speculate on the future volatility of the index.

We examine the information content of the order flow in option strategies. A daily order flow measure is constructed by taking the difference between the total number of contracts of buyer-initiated trades and the total number of contracts of seller initiated trades on a given day. We construct separate daily order flow measures for directional strategies, which include all option strategies with large delta and small vega exposure, and volatility strategies, which include all option strategies with small delta and large vega exposure. We report evidence that the order flow in the volatility strategies predicts the next day realized volatility consistent with traders in volatility strategies having some non-public information about volatility. We find no corresponding evidence for directional strategies and the next day's index return. We also do not find any evidence that the order flow in outright put or call options help predict the next day's realized volatility or index return.

We also examine the short-term gains and losses on different types of strategies by marking to market each strategy trade using the end of day options and futures prices at approximately five days after each trade. On average, volatility strategies generate a gain of £1.5 and directional strategies generate a loss of £0.9 per contract and trade. The mean net premium is £101 for volatility strategies and £43 for directional strategies implying five-day unadjusted returns of approximately 1.5% and -2%. This evidence is consistent with the order flow in volatility strategies being informative about future volatility and the order flow in directional strategies being uninformative about future returns.

One interpretation of our findings for the directional strategies is that such trades primarily come from uninformed speculators. We show that the directional order flow is strongly positively correlated with lagged index returns suggesting that the traders using directional strategies behave as trend chasers. Our results therefore suggest that both information and noise drive trading in option strategies.

A few key institutional features of Liffe's electronic trading platform (Liffe Connect) allow us to identify and classify trades in option strategies. Trade records include a flag for strategies and a price and time stamp for each leg of a strategy. The exchange defines a strategy as a simultaneous trade in one or more options and futures contracts originating from a single trading account. The trading platform includes a special execution facility that permits only a fixed set of option strategies known as *recognized option strategies* to be traded in this fashion. We use this information to develop an algorithm that maps virtually all strategy trade records into one of the recognized strategies.

We believe our sample provides an accurate picture of the trading in the recognized strategies that takes place on Liffe's Connect system. Trading one of the recognized strategies outside the exchange's special strategy trade facility, i.e., trading each leg as a regular option trade, would, unnecessarily, expose the trader to execution risk and a higher trading fee. Furthermore, there is no difference in anonymity that could affect a trader's decision, as all trades on the Connect system are completely anonymous. Given these considerations we believe most traders would choose, whenever possible, the special trading facility and hence their strategy trades would appear in our sample. On the other hand, the exchange rule requiring that all legs of a strategy trade originate from a single trade account ensures that our sample of strategies is not inflated by regular option trades masquerading as strategy trades.

Our sample is unique regarding the level of detail for strategy trades, but it shares some of the limitations of other available option datasets. While each strategy trade must originate from a single trade account, we cannot link different strategy trades originating from the same trade account, nor do we observe any pre-existing position associated with a given trade account. Our sample only contains information on trading that takes place on Liffe's Connect system and so does not capture any over-the-counter trading in options on the FTSE-100.

In a series of papers Chaput and Ederington (2003, 2005a,b) provide the first empirical results on trading in option strategies. Their sample includes all large option strategy trades in Eurodollar interest rate options on the Chicago Mercantile Exchange. Chaput and Ederington (2003) report findings on the relative popularity of different strategies that are broadly consistent with our findings for the FTSE-100 market. A key difference between our sample and their sample is that our sample includes both a transaction price and a time stamp for each leg of a strategy and complete information about concurrent option and futures quotes. This information is critical since it allows us to sign the strategy trades and to measure the index returns and volatility before and after each strategy trade.

Other studies in which option strategies play a key role include Ronn and Ronn (1989) and Hemler and Miller (1997) who study arbitrage conditions for a box spread strategy, which involves a trade in four options and is equivalent to riskless lending. Culumovic and Welch (1995) examine the profitability of a call spread strategy. Coval and Shumway (2001) and Santa-Clara and Saretto (2005) study the risk-return tradeoffs on different options strategies including straddles and strangles. The option strategies in the above studies are constructed from the observed quotes for individual options. They do not, however, represent actual trades in the strategies. Our sample allows us to study the timing and information content of actual option strategies.

Ni, Pan, and Poteshman (2005) report evidence consistent with trading on volatility information in equity options. Specifically, they find that non-market maker demand for volatility predicts future realized volatility for the underlying stocks for periods of up to one week. We also study possible trading on volatility information in the options market and use disaggregated information on options trading to isolate such effects. A key difference between the studies is the nature of the samples. Their sample contains trades in individual options; our sample contains trades in option strategies. Our sample does not contain information about whether a given trade opens or closes a position nor does it contain information about non-market maker versus market maker trading. Instead, our sample identifies trading activity across a range of option strategies with different sensitivities to directional or volatility information.

2 Trading of Option Strategies on Liffe and Our Sample

2.1 Trading of Option Strategies on Liffe

Trading of option strategies on the London International Financial Futures Exchange (Liffe) takes place in a special strategy trade facility that operates in tandem with the main market mechanism. The main market mechanism is an electronic limit order book with trading rules that are very close to those of other markets with electronic limit order books. Our discussion therefore focuses on the special strategy trade facility.

The need for a special trading facility for option strategies arises for at least two reasons. First, all option strategies involve multiple legs which means that there is execution risk if the legs are traded separately. Second, traders may be willing to trade strategies that include option legs for which the individual options are very thinly traded or not traded at all.

A typical trade in the special strategy trading facility starts by a trader sending a *request for quote*. For example, a trader may request a quote for a long strangle with specific strike prices, expiration date, and size. Another market participant may respond to this request by posting quotes that meet the request. These quotes are specific to the quote request in the sense that they are not executable by a concurrent market order in the main mechanism. Execution risk is reduced in this case in that the trader requesting the quote either accepts or rejects the quote posted; a situation in which only one leg or part of one leg of the strangle was executed cannot arise. Individual option quotes in the main mechanism 'participate' in the bidding for strategy order flow in the sense that the strategy trade facility automatically checks for a subset of strategies whether the requesting trader would obtain a better price by trading with the quotes 'implied' by the existing quotes rather than by trading with the quotes posted by the responding market participant.

Once the requesting trader accepts a quote for a strategy, the strategy trade is completed and reported after an exchange official has verified that the agreed upon price for each leg is appropriate. The verification is particularly relevant when the strategy includes option legs that lack quotes in the individual option market. In such situations, the verification involves checking that the price of the 'quote-less' leg is within some maximum distance from a theoretical price generated by a pricing model maintained by the exchange. The maximum time lag arising from the verification process is five minutes. We therefore use a five minute lag implying that the relevant individual option quotes for a strategy trade reported at 11:15 are the quotes in force at 11:10.

All option strategy trades must, for each side, comprise a single order, which results in the same client or account trading all legs of the trade.[1] Exchange member firms are not allowed to combine different customer orders into one strategy trade. For example, a member firm may not take two separate customer buy orders for the same number of puts and calls and bundle them into a single

[1]Exceptions are strategy trades that are fulfilled through implied quotes from the outright market. For such trades the passive side may be represented by more than one trade account.

strategy buy order for a strangle.

There is a fixed set of what is known as *recognized option strategies* which determines the types of strategies that may be traded in the special strategy trade facility. During our sample period, there were a total of 44 recognized option strategies: 28 strategy trades involving options only and 16 strategies involving both options and futures. All strategies that involve options and futures are designed to have a net position with a delta that is approximately zero. A zero delta is achieved by buying or selling the appropriate number of futures contracts.

2.2 Our Sample

Our sample consists of quotes and trades for the FTSE-100 European-style index options and futures. The sample period is August 2001 to December 2004.[2] The sample was obtained from the market date services of Liffe and Euronext.liffe. We obtained data on Libor interest rates and dividend yields for the FTSE-100 index from Datastream.

Table 1 reports statistics on the weekly trading activity broken down into the following three categories: option strategy trades and regular and block trades of individual options. Summary statistics for option strategies are reported in the top six rows followed by the corresponding statistics for regular trades and block trades of individual options. The first column reports statistics for the overall sample with sub-sample figures in the second and third columns.

There are, on average, 1,132 strategy trades a week, compared to 1,888 regular trades, and 13 block trades of individual options implying that 37% of all option trades are strategy trades. But since option strategy trades tend to be relatively large, their share of the overall trading volume is approximately twice as large. On average, an option strategy trade consists of 176 contracts, compared to 20 contracts per regular option trade.[3] Block trades are much larger with an average size of 2,868 contracts per block trade, but they are also relatively infrequent. The weekly aggregate premium traded is at £195.0 million substantially higher for option strategy trades than for regular

[2] In January 2002, Liffe became a part of Euronext to form a market called Euronext.liffe. Euronext was formed by the merger of the Amsterdam, Brussels, and Paris stock and derivatives exchanges in September 2000. The merger did not change the trading platform for the FTSE-100 options and futures. In fact, all derivatives trading on the different Euronext satellite markets transferred to the Liffe Connect system in 2003.

[3] We omit the futures leg in this calculation.

trades (£23.2 million). On average, approximately 75% of the weekly aggregate premium traded is generated by option strategy trades.

Table 1 also reports trading activity statistics for the first and second half of the sample. Trading is more active in the second half of the sample with the average weekly number of trades approximately 50% higher than for the first half of the sample. During the second half of the sample, strategy trades represent a smaller, but still significant, fraction of both the number of trades (35% versus 41%) and the aggregate premium (72% versus 79%).

Figure 1 plots the monthly number of strategy trades and the level and range of index movements. The bars represent number of strategy trades, with the corresponding y-axis on the left-hand-side. The average monthly index level is represented by the black solid line and the right y-axis. The monthly range of the index is displayed by the vertical black lines. For example, the effect of September 11th, 2001 is evident from the September 2001 range of more than 1,200 index points in the plot. While there does not seem to be an obvious relationship between the FTSE-100 index level and the number of strategy trades, the plot suggests that there is some relationship between the range of the index and the trading volume, especially in sample months prior to July 2003. In our empirical analysis, we execute robustness checks of our results by splitting the sample into two periods of equal length. Note that during the first period, from August 2001 to April 2003, the index level was mostly falling and the range of the index was large and varying from month to month. During the second period, the index level was moderately increasing, while the range of the index was smaller and decreasing throughout most of the sample. These two subsamples thus provide a different market environment.

Figure 2 plots the monthly number of strategy trades and the average at-the-money implied volatility. The average monthly implied volatility is calculated from short-term at-the-money call and put options and is represented by a solid black line in the plot. While some of the most active months coincide with high implied volatilities for the early part of the sample, there is no strong relationship between the the number of strategy trades and the implied volatility for the whole sample period.

2.2.1 Identification of Strategy Trades

We identify the option strategy trades by combining the information in the trade records with the knowledge of the recognized option strategies. The trade records separately identify any recognized option strategy that involves only options and any option strategy that involves options and futures. In addition to the identifier each distinct option and futures leg of a strategy trade has a unique (common) time stamp and a separate transaction price.

One piece of information that is available to market participants but that we do not observe is the alphanumerical code that uniquely identifies each recognized option strategy. We reverse engineer the missing codes using the available information. First, as mentioned above, strategy trades involving only options can be separated from strategies involving both options and futures. Second, each strategy has a specific sequence in which the trade information for each leg must be reported. We use this information to create an algorithm that maps virtually all strategy trade records into a unique option strategy.[4]

For example, both a combo (sell call, buy put at lower strike) and a strangle (buy call, buy put at lower strike) involve a call option and a lower-strike put option in the same maturity category, and without further information, it may be difficult to decide whether a combo or a strangle was traded. But the reporting rules specify that the combo must be entered starting with the call leg, followed by the put leg, while the strangle must be entered in the reverse order.

Table A1 in the Appendix provides a short description of the different recognized option strategies. Each description is for a long position. For example, a long combo consist of a sold call option and a bought put option with a strike price that is less than the strike price of the call option.

Table 2 describes recognized option strategies that consist only of options. The first column lists the strategy name, the second column describes the overall number of observations during our sample period, the third column shows the total number of trades of the given strategy as a percentage of all strategy trades, and the fourth column shows the relative frequency with respect

[4]One exception is a strip and a ladder, which we cannot tell apart because the options involved and the sequence of reporting coincide. Strips and ladders are only a very small fraction ($<1\%$) of our sample.

to options-only trades. The fifth column groups strategy trades that can be constructed from both calls and puts into one single category.

Table 2 shows that the most common options-only strategy was a strangle with 14,142 observations or 13.7% of overall trading volume. Call and put (bull or bear) spreads were the second most active strategy, with more than 8,000 observations for both call and put bull/bear spreads. Straddles were actively traded with 4,600 observations. Calendar spreads, both with the same strike price and different strike prices, were the next active category, representing 22.6% of the sample of options-only strategies. Two-to-one ratio spreads comprise 3.8% of all options-only strategy trades. Combos, iron condors, and guts, which are strategy trades that seek to exploit large moves in the stock price, have around 1,000 trades each during our sample period. The butterfly spread is inactively traded at only 1.3% of all options-only strategies. A synthetic underlying is rarely traded, as are condors and iron butterflies. Box trades, which are not exposed to index movements, represent 0.8% of the sample. Several recognized strategies have not been traded during our sample period including a call spread combined with a put and a straddle combined with a sold call option. It is interesting to note that both strategies seeking exposure to volatility—such as straddles and strangles—and strategies that are directional with limited exposure to volatility—such as bull/bear spreads and combos—are very actively traded.

Table 3 describes option strategies that consist of one or more option legs and a futures leg to give zero-delta exposure. The two most common delta-neutral trades were trades in which the delta of a single call or put were neutralized with an appropriate short or long position in the futures contracts. There were 10,252 put volatility trades and 9,768 call volatility trades. The next highest frequency was observed for bull and bear spreads that were made delta-neutral with an offsetting futures position. We observed approximately 10,000 such trades. Combos, conversion or reversals, and calendar and ratio spread all have more than 2,000 total observations. There are 835 trades of delta-neutral straddles. The remaining permissible delta-neutral strategy trades—put and call ladders against the underlying, put and call spreads against another option and the underlying—were very infrequently traded.

2.2.2 Signing of Trades

We use a Lee-Ready like algorithm (Lee and Ready (1991)) to determine whether a strategy trade was buyer- or seller-initiated. Since we only observe strategy trades, but not quotes, we construct strategy quotes that are implied by the quotes of the individual legs from outright markets. We then apply our algorithm to the implied bid and ask quotes for a strategy trade. Below we provide an example that illustrates our methodology.

A sample observation states that at 9:37:19 a strategy trade involving five call options with a strike price of 5525 and August expiry and five call options with the same strike but September expiry was traded at prices of £12.5 (August expiry) and £90.5 (September expiry), respectively. This is a call calendar spread and we use the individual bid and ask quotes for the 5525 strike calls of 10 and 14 (August) and 87 and 96 (September) to calculate an implied bid and ask quote of 73 (=87-14) and 86 (=96-10). Since the observed price is 78 (=90.5-12.5), which is smaller than the implied mid-quote of 79.5, we label the trade as a seller-initiated trade.

Sometimes strategy trades are established that involve deep in-the-money and deep out-of-the-money options for which contemporaneous quotes from the outright market are not available. For these cases, we cannot calculate implied bid and ask prices for the strategies using our methodology. We chose not to generate quotes from an ad-hoc Black-Scholes model for these options, but rather to drop them in the subsequent analysis. Also, option strategies that did not have more than 500 trades during the sample period after the above requirement are removed from the final sample.

Table 4 shows summary statistics for the final sample of 65,166 trades in 18 different option strategies that meet both the requirement of concurrent option quotes and a minimum of 500 trades. The first two columns show the total number of trades per strategy in absolute terms and as a fraction of the total sample. The remaining columns split each strategy trade in buyer and seller initiated trades and report the number of observations, the fraction that was buyer or seller initiated, and the total premium and volume. The fractions of buyer- and seller-initiated trades often do not add up to 100%; the difference reflects the fraction of trades that was executed at the midpoint. When option strategies require different sizes in the individual legs, we have reported the lower number. For all delta-neutral trades, we have reported the volume of the option legs.

Within each strategy category, prices and volume do not differ much between buyer-and seller-initiated trades, but there is a considerable cross-sectional difference in the size of the strategies. Delta-neutral strategies, i.e., strategies that involve the futures contract, are much larger in size than options-only strategies. For example, call and put volatility trades have a size of approximately 350 contracts, while call and put spreads involve approximately 35 contracts. However, the difference in prices is not as significant. This suggests that call and put volatility trades are implemented with cheaper out-of-the-money options.

Options-only strategies that are designed to benefit from increases in volatility tend to be more seller-initiated: 62% of all strangles, 66% of all straddles, and 62% of all guts are classified as seller-initiated.

2.2.3 Examples of Strategy Trades

The first example is a guts strategy. Figure 3 shows the profit diagram and the evolution of the index for one guts strategy trade in our sample. The plot on the left shows the profit diagram. The guts strategy consists of a bought call option with a strike of 5325 and a bought put option with a strike of 5475. The plot shows the profits as a function on the index value at the expiration date for each leg of the strategy and for the strategy itself. Figure 3 shows that the guts is an expensive strategy, since it requires the payment of two premia.

The plot on the right shows the evolution of the FTSE-100 index starting four days before the purchase and ending at the expiration date for the options in the strategy. The guts strategy was bought on 12/6/2001, when the FTSE-100 traded at approximately 5,380. It is evident from the solid line of the profit diagram that the guts would only be profitable after considerable index movements of about 175 index points in either direction during the remaining 15 days to expiration.[5] The buyer of the guts established the position after a considerable increase in the index in the previous four days; he may have speculated on a price reversal. The index fell to about 5,100 points at expiration, making his strategy profitable.

[5]Hence, it takes "guts" to enter into such a volatility bet.

Figure 4 shows the profit diagram and the evolution of the index for a bought combo strategy trade in our sample. The combo strategy consists of a sold call option with a strike of 5125 and a bought put option with a lower strike of 4625. The left plot shows the profits at the expiration date as a function on the index value for each leg of the strategy and for the strategy itself. The strategy was established on May 8, 2002 at an index level of approximately 5200. The profit diagram shows that at an index level of 5200 the sold call option was in the money while the bought put option was deep out of the money. Therefore, the long combo strategy would yield a stable, small profit for a moderate decrease in the index level (the premium of the received short call less the premium for the bought put) and a higher profit for sharp decreases in the index level below the strike price of the put option. The right plot shows that the index steadily decreased until the expiration date of the option on June 21, 2002. At expiration, the index level was approximately 4,600, and the combo strategy paid the premium difference plus the payoff of the put leg of 25 index points.

Figure 5 shows the profit diagram and the evolution of the index for a sold put volatility trade in our sample. A short put volatility trade consists of a certain number of sold put options and sold index futures. The number of index futures that are sold is designed to make the trade delta-neutral at the time of initiation. The position was established on December 6th, 2004 at an index level of approximately 4710, and required 7 sold futures for 10 sold put options to make the trade delta-neutral. The profit diagram on the left assumes that the position was not continuously rebalanced to remain delta-neutral by buying or selling an appropriate number of futures contracts. Hence, the profit of the strategy varies substantially with changes in the index. The sold put volatility trade pays off if the index level does not change much during the 11 days until expiration of the option. Losses to the position occur whenever the index moves above approximately 4850 or below 4650. The slope of the profit diagram is steeper for index increases. The right plot shows the index evolution around the option trade, and up to the date of expiration. The index did not move much during the remainder of the option's life. The index level at expiration was approximately 4700, and the position yielded a small profit.

2.3 Characteristics of the Strategy Trades

Table 5 shows first, second, and third quartiles for characteristics of all strategy trades included in our final sample. The first 6 columns report first quartile, median, and third quartile days to expiration, separated by buyer- and seller-initiated trades. The next block reports data for moneyness (defined as the highest strike price of the strategy divided by the index level), and the final 6 columns show the distance between the different strike prices of the strategy (whenever applicable). The differences between buyer- and seller-initiated strategies are small for both the moneyness and strike distance classifications of all strategies. For days to maturity, the differences are also small with the exception of put and call calendar spreads, where the buyer-initiated strategies have a substantially longer time to maturity.

The median days to expiration for most strategies is between 30 and 60 days. The exception are conversions or reversals which seem to be entered into on a very short-term basis with a median maturity of three days. The spread between first and third quartile days to expiration varies substantially across different strategies, ranging from about thirty days for strangles to more than a hundred days for call spreads vs. the underlying. The inter-quartile differences in moneyness within a given strategy are significant. For example, the first and third quartile moneyness for a straddle is 0.99 and 1.01, respectively, while the first and third quartile of a put being part of a volatility strategy is 0.91 and 0.99. More generally, strategies that use put options tend to have a moneyness smaller than one, while strategies using call options tend to have a moneyness larger than one, suggesting that traders like to use out-of-the money options when constructing strategies. The strike price differentials for many of the strategies are relatively small, considering that the smallest differential that can be used in the FTSE100 market is 50 index points. The exceptions are strangles, with a median strike price differential of 550 index points, and collars (combo vs underlying), with a strike price differential of 600 to 700 index points.

3 Empirical Results

If trading in option strategies contains information about either future returns or volatility or both, we would expect trading volume in option strategies to be higher in more volatile periods. Volatility tends to cluster and both trading on directional and volatility information is more profitable in volatile markets. As a preliminary step towards determining whether trading in option strategies contains information about future volatility, we regress daily trading volume on concurrent and lagged realized volatility and return. The regression results are reported in Table 6.

The first column of Table 6 contains the results for a regression with the daily total number of contracts traded in all option strategies as the dependent variable. The next three columns report the results for regressions in which the dependent variable is the daily number of contracts traded in directional strategies and volatility strategies using either options only or options and futures. In all regressions the estimated coefficients on both concurrent and lagged volatility are positive consistent with more active trading in more volatile periods. The effect is economically strong. A 100 basis point increase in realized volatility is associated with an increase in trading volume of 8,000 contracts or approximately a 20% increase in the daily trading volume.[6] The coefficients on the concurrent and lagged returns are negative in two of the specifications. None of the estimated coefficients are significantly different from zero.

The positive correlation between trading volume and realized volatility suggests that trading volume in option strategies may contain information. To determine whether this is the case we need to examine signed order flow and futures returns and volatility.

3.1 The Information Content of Strategy Trades

Different options strategies allow traders to speculate on the future direction or volatility of an asset. By combining options in an appropriate strategy, traders can eliminate exposure to volatility (vega) and benefit from directional (delta) movements, independent of the volatility of the underlying. Similarly, option strategies are useful for traders who wish to speculate—or have information—on

[6]According to Table 1 the average weekly trading volume is approximately 200,000 contracts (1132.2 trades multiplied by 175.9 contracts per trade).

the future volatility of an asset but who do not have a view on the direction of the value of the asset. Trading profiles with exposure to volatility and no exposure to direction are particularly easy to implement using strategies.

Table 7 illustrates this point. The table reports the bi-variate distribution of the net-greeks for strategies. Each panel shows the distribution across six delta categories and six categories of either gamma, vega, or theta. For example, the category in the top row and second column of Panel A with the entry '1.2 (6.6)' is for a delta between -1.0 and -0.1 and gamma between -0.1 and -0.05. The first figure (1.2) is the percentage of strategy trades with a delta and gamma that falls within those bounds. The figure in parentheses (6.6) is the percentage of individual option trades that have a delta and gamma that fall within those bounds. For all strategies the greeks are calculated from the trade initiator's perspective, for example, a buyer-initiated straddle in our sample will have a positive vega and a seller-initiated straddle will have a negative vega. We use the individual options to create a benchmark. We chose to randomly assign the individual options to be either buyer- or seller-initiated and calculated the greeks accordingly. The last column of each panel in Table 7 reports the marginal distribution across delta and the last rows of each panel reports the marginal distributions across gamma, vega, and theta.

The marginal distribution for delta shows that by trading in option strategies traders are indeed able to obtain more positions with less exposure to the direction of the market. For example, for the individual options about 10% of the sample of options have a delta between -0.05 and 0.05 whereas 53.8% of the option strategies do. But for the approximately delta-neutral strategies there is an increase in more extreme values for gamma, vega, and theta. Among all strategies with deltas that are 0.05 or less in absolute value 16.9% have a vega that is less than -2.5 compared to 0.1% for individual options. Similar shifts occur for gamma and theta. Traders seem to make use of the special greek profiles strategy trades offer.[7]

We start our empirical analysis by examining whether the trade-initiators of directional strategy

[7] Note that the marginal distributions for gamma, vega, and theta also show a shift towards greeks that are closer to zero. For example, over 40% of the option strategies have vegas between -2.5 and 2.5 compared to 31.3% for individual options. However, by combining multiple options that are either bought or sold it is quite natural for the greeks to be less extreme on average.

trades have some information on the future return of the index, and whether the initiators of volatility strategy trades have information on the future volatility of the index.

Traders with positive information or a positive view about the future return of the index but with no information or view on the future volatility would want to initiate positions that are long delta. Traders with positive information or a positive view about the future volatility but no information or view about the future returns would want to initiate positions that are long vega. Building on this intuition we create measures of the net buying of delta and the net buying of vega and use these measures to test whether they contain information about future returns or volatility.

We view all strategy trades from the perspective of the trade initiator so that, for example, a buyer-initiated trade in a call spread represents a long delta position whereas a seller-initiated trade in a call spread represents a short delta position. We construct a measure of net buying of delta, which we refer to as the directional order flow, by subtracting the number of contracts traded that are short delta from the number of contracts that are long delta. We use only strategy trades that primarily have delta exposure and little or no vega exposure in the calculation of the directional order flow (call spreads, put spreads, and combos).

We create a similar measure for net buying of vega by subtracting the daily number of contracts that are short vega from the daily number of contracts traded that are long vega. We refer to the measure as the volatility order flow. Strategies that use futures to make the strategy delta-neutral are treated separately since such strategies need to be continuously rebalanced to remain delta-neutral. We do not observe to what extent the required rebalancing takes place and therefore we do not know to what extent such strategies ultimately have both delta and vega exposure.

We define the one-day realized volatility as the range of the index on day t divided by the closing value of the index on day $t-1$. The realized volatility is measured in basis points. We define the one-day return as the closing price on day t, divided by the prior day's closing price, less one.

To the determine whether the strategy trades contain information about future volatility we regress the realized volatility on the three different lagged order flow measures defined above, the lagged realized volatility, and the lagged futures and options volume. To determine whether the strategy trades contain information about future returns we regress the one-day returns on the three different lagged order flow measures, the lagged returns, and the lagged futures and options volume. If the strategy trades contain information we would expect a positive coefficient on the lagged order flow.

Table 8 contains the results of the predictive regressions. The first four columns report results for the realized volatility. All regressions include quarterly fixed effects. If some market participants have information on the future volatility of the underlying, we would expect that a higher demand for volatility (i.e., an increase in the order flow for volatility strategies) has a positive coefficient in the regression. The estimated coefficient is positive for the options-only strategy order flow. A one standard deviation higher net demand for volatility from options-only strategies leads to a higher realized volatility of $99.45 \times 0.87 = 88$ basis points. The coefficient on the options and futures order flow is also positive but not significantly different from zero. We conclude that there is some evidence for predictive power of volatility strategy traders. The estimated coefficient on the net demand for long directional exposure is negative and statistically significant. It is difficult to interpret this coefficient economically, as we do not know whether the underlying directional strategy trade had a positive or negative vega. The fourth and the fifth columns report the results of regressing the realized volatility on lagged order flow in outright call and put options. The estimated coefficient on the call order flow is negative although it is not significantly different from zero. The estimated coefficient on the put order flow is 57.6 with a t-statistic of 1.75. So there is some evidence that higher lagged put volume predicts higher realized volatility.

The estimated coefficients on lagged trading volume in the FTSE-100 index are positive and significant consistent with the results for equities in Lamoureux and Lastrapes (1990). Lagged trading volume in option strategies and outright options, however, do not help predict future realized volatility.

Columns five to eight of Table 8 contain results for the index return predictive regressions, where we use a specification similar to the one employed in the volatility regressions. Applying the same logic as for the volatility regressions we would expect a positive coefficient on the net demand for delta, if the directional order flow contains information. We do not find any predictive power of lagged directional order flow on returns; the estimated coefficients are small and we cannot reject that they are all equal to zero. The coefficient on past returns is 0.06, suggesting that there is little autocorrelation of the daily return series. Overall the return regressions have adjusted R-squares that are very close to zero, indicating that the right hand side variables do not predict returns.

In Table 9 we report results for three alternative specifications of the regressions of realized volatility on lagged order flow and control variables. The first column reports results for the options-only order flow weighted by the signed delta and the vega of each strategy trade. The coefficient on the delta-weighted order flow is insignificantly different from zero consistent with the results above. The coefficient on the vega-weighted order flow is positive (20.55) and is significantly different from zero. The economic magnitude of the effect implied by this point estimate is in line with the one reported above. The standard deviation of the vega-weighted order flow is 4.66, which implies that a one standard deviation change in the vega-weighted order flow is associated with a higher realized volatility of $20.55 \times 4.66 = 95.8$ basis points.

Columns two and three of Table 9 report the results for order flow measures that only include option strategies that use longer time to expiration options or that exclude smaller trade sizes. The coefficients on the order flow measures are somewhat greater than the coefficient estimate reported in Table 8 suggesting that strategy trades in longer time to expiration options and in greater trade sizes contain more information about the future volatility. The standard deviation of the longer time to expiration order flow is 0.83, which implies that a one standard deviation change in the order flow is associated with a higher realized volatility of $120.54 \times 0.83 = 100$ basis points. While we cannot determine with certainty whether any strategy trade is used to open or close a position, it may be reasonable to assume that the likelihood that a trade opens a position is greater the longer the time to expiration is. Under that assumption the greater impact of longer time to expiration trades provides further evidence on the information content of strategy trades.

3.2 Profitability of Strategy Trades

Table 1 shows that the trading in option strategies represents a substantial fraction of the overall trading volume in FTSE-100 index options, and the results presented in the previous section suggest that the volatility order flow contains information. If the volatility order flow contains information, we would also expect strategies with vega exposure to be profitable on average.

As we discussed in section 2 we do not know whether a given strategy trade observed in our sample opened a new position or closed an existing position. So we cannot directly measure the realized profits. But we can still get a sense of the profitability of the strategy trades by looking at the profits of each strategy over different assumed holding periods. For example, consider a seller-initiated trade in a straddle on date t at a price of p_t. If the trade represents the opening of a new position and the trade initiator has negative information about the future volatility we would expect the price of the same straddle to be lower in the future, i.e., $p_{t+\tau} < p_t$ for some $\tau > 0$. Suppose instead that the trade represented a closing of an existing position. In this case, we have no reason to expect either a higher or lower price for this straddle in the future.

Building on the above intuition we measure the profits on each strategy trade by taking, for buyer-initiated trades, the difference between the value of the strategy calculated from to the option closing prices five days after the trade and the actual transaction price. For seller-initiated trades we take the difference between the transaction price for the strategy and the value of the strategy calculated from the closing option prices five days after the trade. The choice of a five day horizon is, of course, arbitrary.

Table 10 shows the results of the five-day profit calculations. Overall, the mean gain per strategy trade is £0.87, or, relative to the mean net premium, approximately a weekly return of 1%. The positive return stems from trades that are seller-initiated (gain per contract £3.64), buyer-initiated trades made a loss of £2.11. The next two sections of the table split the trades into directional trades and volatility trades. Directional trades lose, on average, money over the one-week horizon. The mean loss is £0.89, which is statistically and economically significant. Relative to the average premium of £43.43, the mean loss corresponds to a percentage loss of 2% per week. The table suggests that these losses stem mostly from buyer-initiated trades. Volatility trades are on average profitable, with a mean gain of £1.48. When split into buyer-initiated and seller-initiated trades, we again see that the gains seem to come from seller-initiated trades.

To determine whether or not the profitability results for seller-initiated strategies can be attributed to sample-period specific effects we split the sample period in half. Figure 1 shows that the first half of our sample is characterized by a falling index and higher volatility, while the second half of our sample is characterized by an increasing index and falling volatility. One may therefore worry that the established profits on strategies selling volatility mainly stem from the second sample period, where traders just happened to be on the right side. We calculate profits for the first and second half of our sample. The bottom six rows of the table show that seller-initiated trades are profitable in both periods.

Overall, the results show that volatility strategy trades are, on average, profitable, and their profitability is mainly driven by seller-initiated trades. This evidence is consistent with the predictive power of lagged order flow of the previous section.

3.3 Drivers of Initiation of Strategy Trades

It is common, especially in practitioner oriented books, to discuss how traders may use market conditions, i.e., past information, to generate trading signals for option strategies. Given that directional trades are on average not profitable, we explore the possibility that they are generated by systematic patterns in the past history of the index and volatility. We start by examining the movements in the index level around trades in three option strategies that are directional.

Figure 6 plots the change in the index around the time of three different types of strategy trades that are all sensitive to the direction of the market. The top sub-plot shows the change in the index for buyer- and seller-initiated trades in call (bull) spreads. The index change for buyer-initiated trades is shown with a solid line and the index change for the seller-initiated trade is shown with a dashed line. The middle plot shows the corresponding index changes for put (bear) spreads and the bottom plot shows the index changes for combos.

For all three strategy trades the greatest systematic movements appear to occur before the trades are initiated. For call spreads the market has moved up before trades and for put spreads the market has moved down. Interestingly, this is true both for buyer- and seller-initiated trades. Perhaps this reflects different traders having different beliefs about whether the market will continue to move up or down. It suggest that the trading in these strategies is partly triggered by market movements. For the combo the interesting movements occur right before the trades. Before buyer-initiated trades (solid line) the market moves down and before seller-initiated trades the market moves up. Given that the long combo is a bearish bet and and the short combo is a bullish bet this suggest that traders expect the trend to continue (trend chasing).[8]

Figure 7 shows a close-up of the top two sub-plots of Figure 6. The time interval is 90 minutes before and after the trade. The close-up shows that buyer-initiated call spreads (long bull spreads) are initiated following index increases consistent with the plot for the longer time window. For the seller-initiated trades, however, there is a reversal to the index increase that is evident in Figure 6. Within 20 minutes before a seller-initiated trade there is a downtick in the index and after the trade the index continues to move down slightly. A weaker, but qualitatively similar effect is observed for the seller-initiated trades in put spreads.

In order to more systematically investigate the relationship between past information and strategy trade initiation we regress both the directional and volatility order flow on past prices and volatility. Table 11 reports the results from a regression of the strategy and outright order flow on concurrent and lagged realized volatility and concurrent and lagged returns. The first column shows the results for directional order flow, and the second and third columns show the results for volatility order flow. The last two columns show the results for the outright order flow in put and call options. The results confirm the evidence from the plot for the individual directional strategies: Concurrent and past returns are strong predictors for bought delta, even after aggregating the different directional strategies and controlling for volatility and quarterly fixed effects. The higher the concurrent and past return, the more delta-strategies are bought; initiators of direc-

[8]Of course, for the combo it is important to note that we do not know if the trade initiator has a long position that closely corresponds to the FTSE-100. In that case the combo would be used to create a collar.

tional strategies display a behavior consistent with trend chasing. Interestingly, the coefficient on concurrent realized volatility is negative, which suggests that market participants initiate long delta strategy trades when the market is relatively calm. The majority of the directional strategies in our sample are call and put spreads, which have limited upside potential. The results above suggest that traders initiate such trades in relatively calm markets trying to profit from short-term index continuations.

Unlike the case for directional order flow there is no evidence that traders buy volatility through strategy trades when past realized volatility is particularly high - the coefficients on concurrent and past realized volatility are low and statistically indistinguishable from zero. For volatility trades, there is some evidence that long volatility trades are initiated whenever the concurrent return is negative. The order flow in outright puts and calls does not depend on lagged returns or lagged realized volatility.

4 Conclusion

We study trading in option strategies using a unique sample that covers all trading in individual options and option strategies involving on the FTSE-100 index. Trading in option strategies is very active in our sample with approximately 37% of the number of option trades and around 75% of the number of contracts traded is accounted for by different option strategy trades. The most actively traded strategies include strangles, straddles, bull and bear spreads, calendar spreads, and covered calls and puts whereas other strategies such as butterfly spreads are traded relatively infrequently. Strategies that are approximately delta-neutral but have exposure to volatility are popular and among these strategies traders tend to initiate more trades with negative exposure to volatility. Thus, option strategies are used to obtain positions with exposures that are not feasible using individual options alone.

Our evidence suggests that the option strategy trades that are long or short vega (volatility trades) and involve only options, but have little delta exposure, contain information about future volatility. A one standard deviation change in the net buying of vega is, on average, associated with an approximately 88 basis points higher realized volatility on the following day. We do not find a corresponding effect for options strategies that have vega, but little delta exposure, that involve options and futures. It is possible that such strategies are more often used for hedging purposes and therefore the order flow in such strategies does not contain volatility information. Option strategy trades that are long or short delta (directional trades), but have little vega exposure, do not contain information about future returns. Consistent with the above findings we report evidence that directional strategies are, on average, unprofitable.

Any evidence of information in the strategy trades raises questions about the efficiency of the market. If traders who initiate trades in option strategies have some non-public information, one would expect the market to infer the information from trades in strategies without delay. Information about strategy trades becomes public information with a very short time lag. However, information about whether trades are buyer- or seller-initiated is not readily available so market participants would have to infer that using the prevailing or lagged quotes in the individual options. Whether or not information processing can explain the delay is an interesting question.

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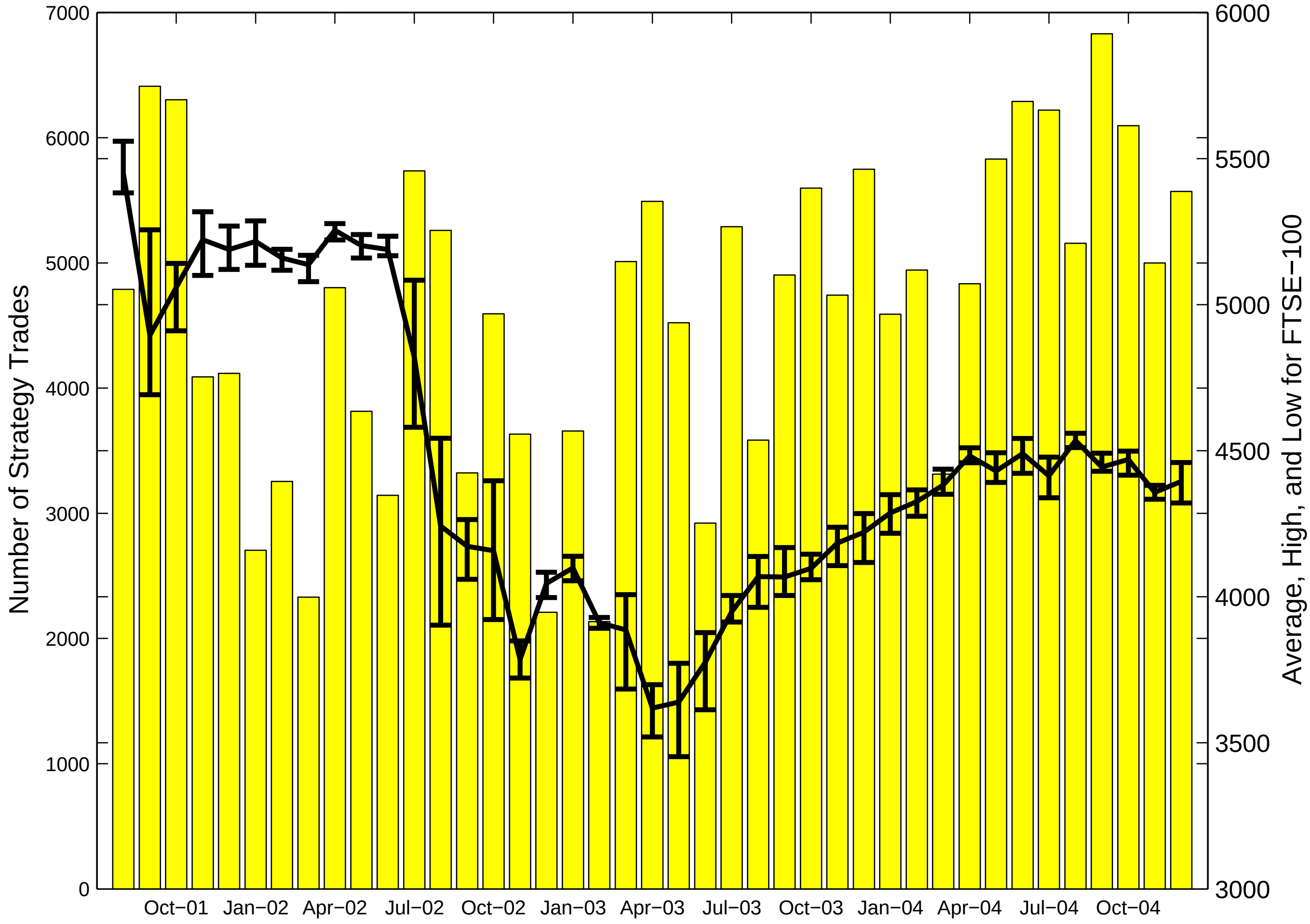

Figure 1: The plot shows the average monthly number of FTSE-100 index option trades that were part of a strategy trade as well as the average monthly FTSE-100 index level. Also shown is the range of the monthly index variations. The number of strategy trades are displayed as bars, with the corresponding y-axis on the left-hand-side. The average monthly index level is represented by the black solid line and the right y-axis. The monthly range of the index is displayed by the vertical black lines. The sample period is from August 2001 to December 2004.

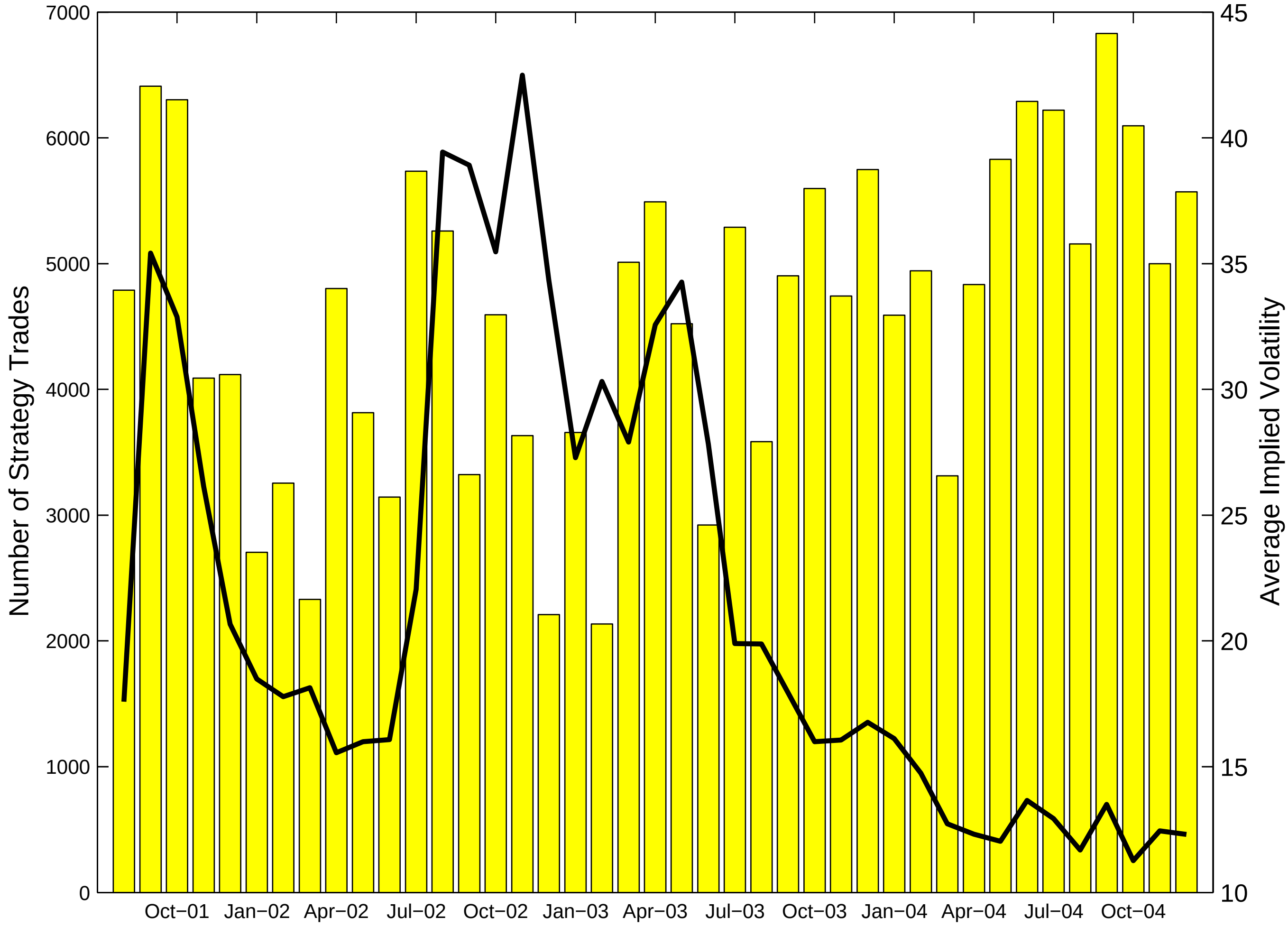

Figure 2: The plot shows the average monthly number of FTSE-100 index option trades that were part of a strategy trade as well as the average monthly at-the-money implied volatility for the shortest term-to-maturity FTSE-100 European-style index options. The number of strategy trades are displayed as bars, with the corresponding y-axis on the left-hand-side. The average monthly at-the-money implied volatility is represented by the black solid line and the right y-axis. The sample period is from August 2001 to December 2004.

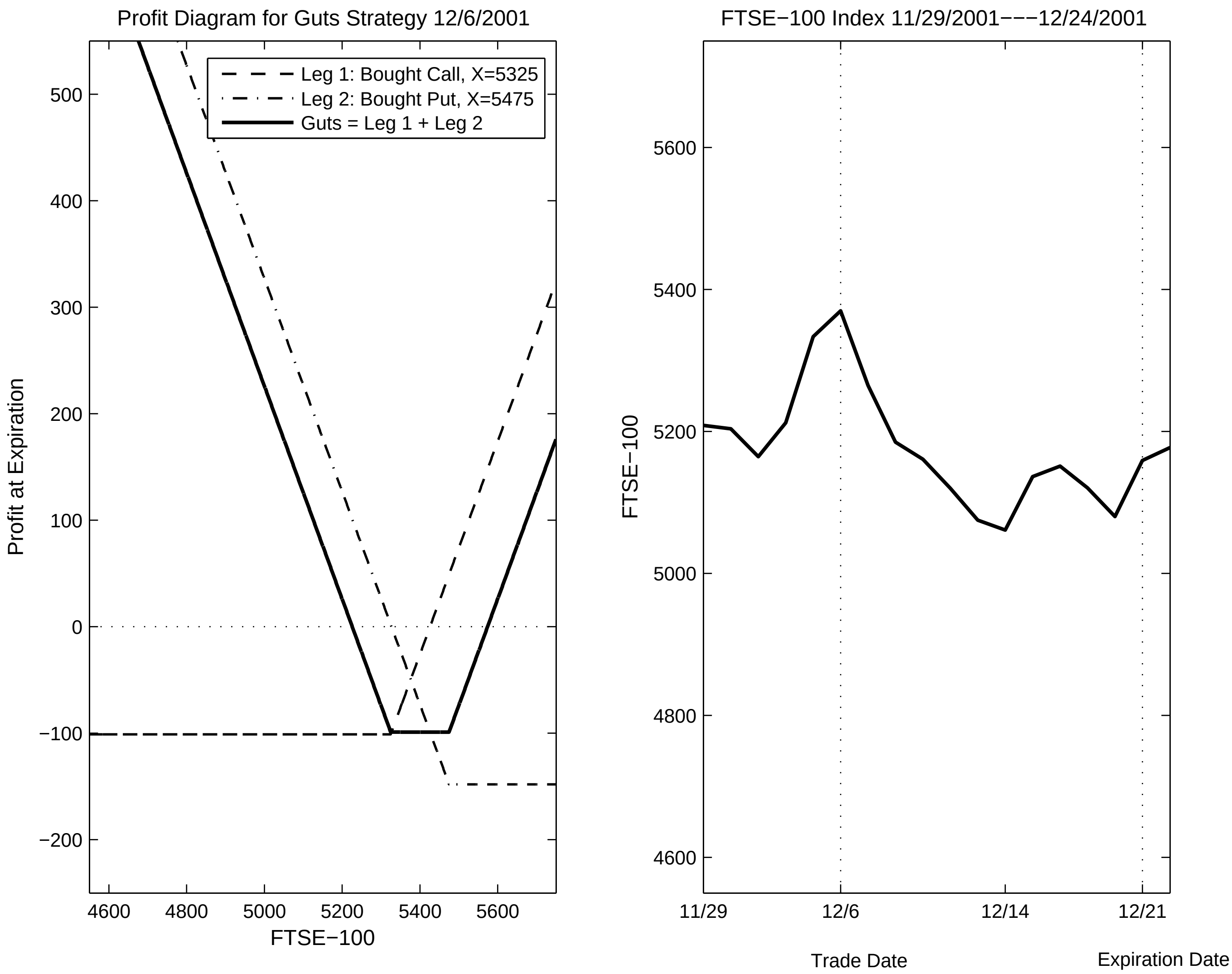

Figure 3: The plot on the left shows the profit diagram for one guts strategy in our sample. The strategy was bought on 12/6/2001. The plot shows the profits as a function on the index value at the expiration date for each leg of the strategy and for the strategy itself. The plot on the right shows the evolution of the FTSE-100 from five trading days before the trade date to the expiration date.

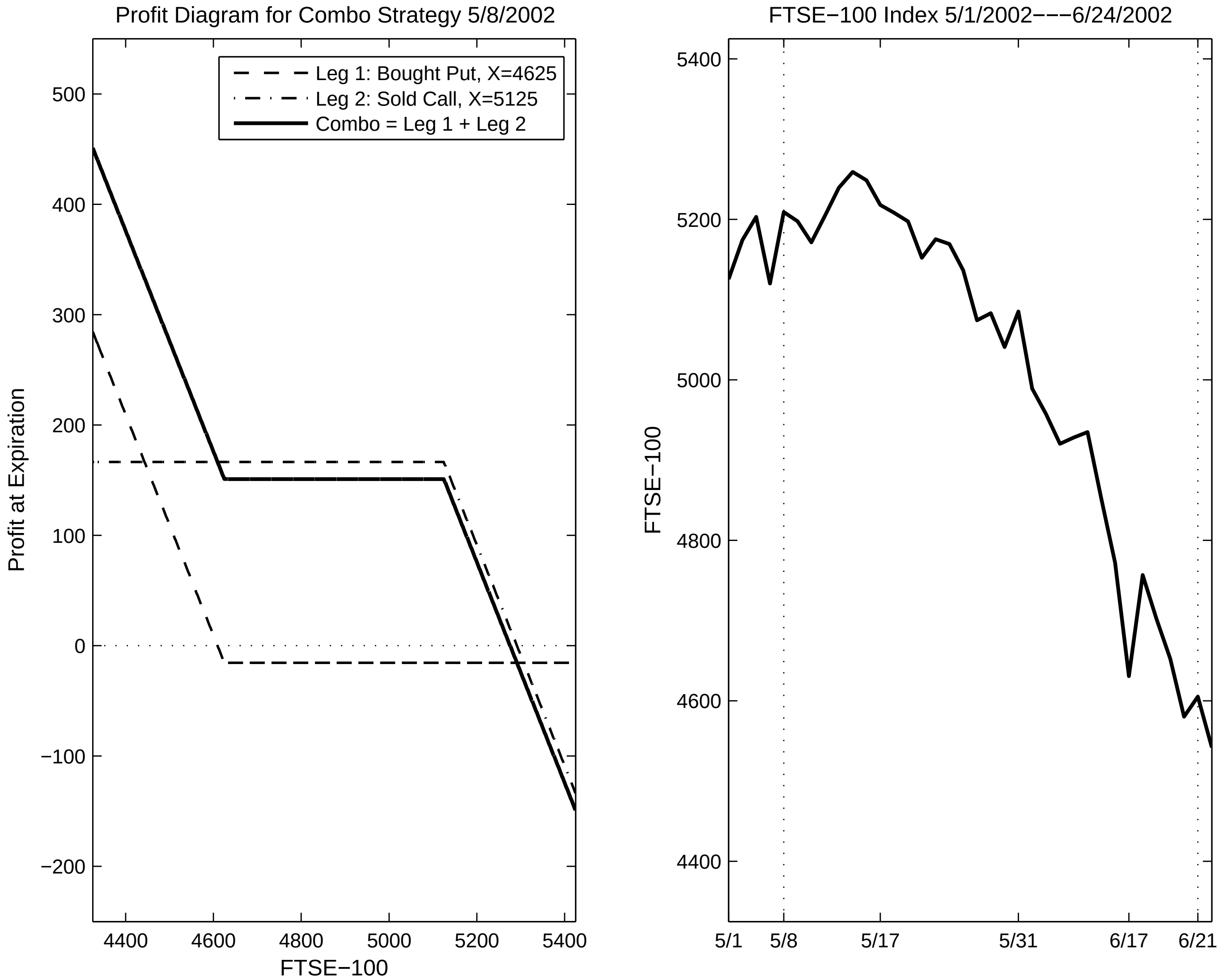

Figure 4: The plot on the left shows the profit diagram for one combo strategy in our sample. The strategy was bought on 5/8/2002. The plot shows the profits as a function on the index value at the expiration date for each leg of the strategy and for the strategy itself. The plot on the right shows the evolution of the FTSE-100 from five trading days before the trade date to the expiration date.

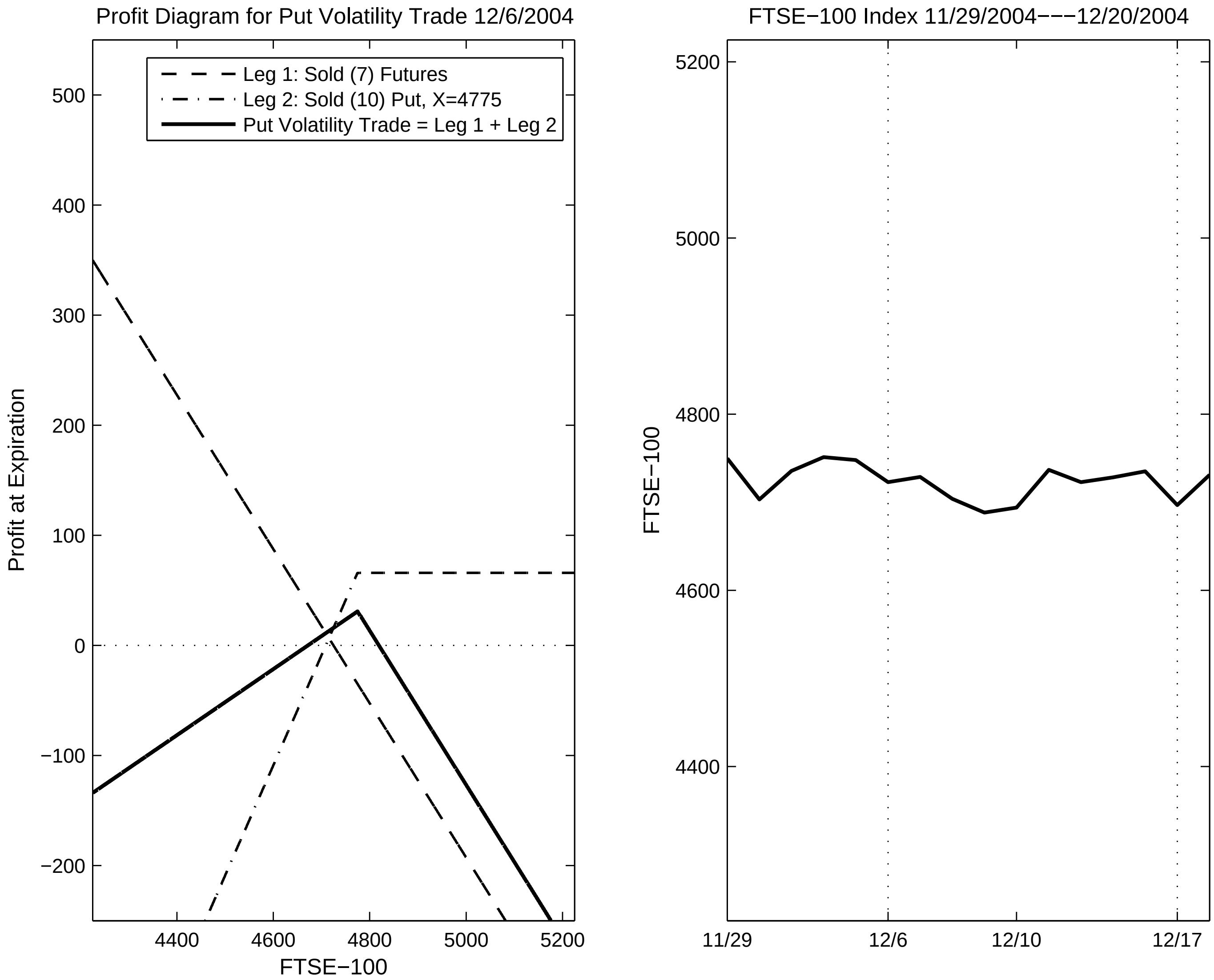

Figure 5: The plot on the left shows the profit diagram for one put volatility trade in our sample. The strategy was sold on 12/6/2004. The plot shows the profits as a function of the index value at the expiration date for each leg of the strategy and for the strategy itself. The profits are shown per put option contract sold. In total, 10 puts are sold and 7 futures contracts are sold, making the strategy approximately delta neutral at the time of the trade. The plot on the right shows the evolution of the FTSE-100 from five trading days before the trade date to the expiration date.

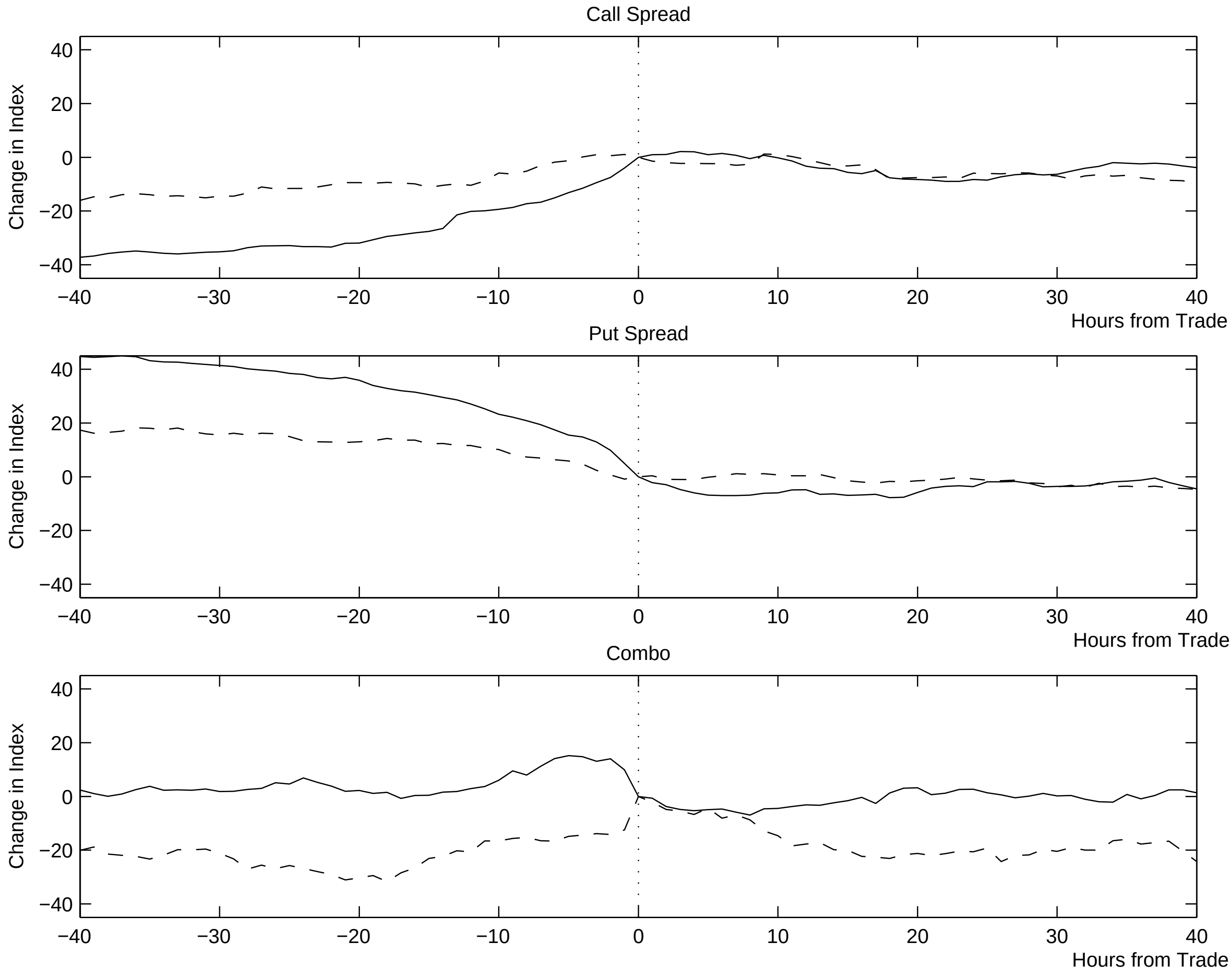

Figure 6: The figure plots the change in index values from 40 hours before a trade to 40 hours after a trade, where the change is defined as the index value at time t minus the index value at the time of the trade. The upper plot shows the average index movements for call spreads, the middle plot shows the average index movements for put spreads, and the lower plot shows the average index movements for a combo strategy trade. In each sub-plot the changes around buyer-initiated trades are plotted with a solid line and changes around seller-initiated trades are plotted with a dashed line.

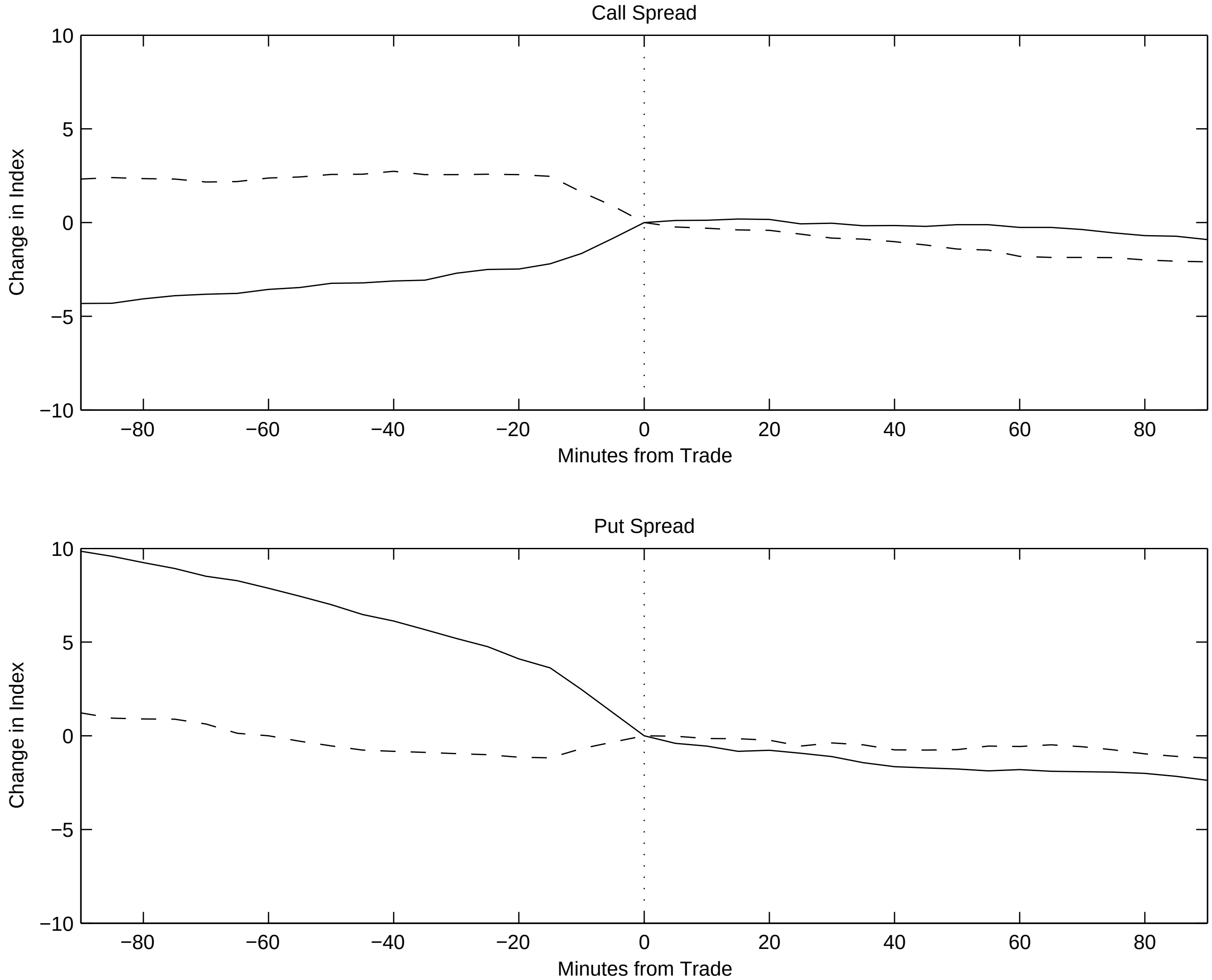

Figure 7: The top sub-plot shows the change in the index value for buyer-initiated and seller-initiated trades from 90 minutes before to 90 minutes after a trade in a call (bull) spread (top sub-plot) and put (bear) spread (bottom sub-plot). The change is defined as the index value at time t minus the index value at the time of the trade. The adjustment is done separately for buyer- and seller-initiated trades. In each sub-plot the changes around buyer-initiated trades are plotted with a solid line and changes around seller-initiated trades are plotted with a dashed line.

Table 1: **Descriptive Statistics—Weekly Trading Activity**

	Full Sample	Sub-Samples	
	Aug 2001 -Dec 2004	Aug 2001 -Apr 2003	May 2003 -Dec 2004
	Option Strategies		
Number of Trades	1132.2	1005.2	1256.3
	(443.2)	(419.4)	(432.5)
Number of Contracts	175.9	180.2	171.6
per Trade	(44.2)	(43.0)	(45.2)
Aggregate Premium	195.0	211.2	179.3
£Millions	(101.0)	(115.8)	(81.8)
	Individual Options - Regular Trades		
Number of Trades	1887.9	1411.4	2354.0
	(998.9)	(746.3)	(997.8)
Number of Contracts	19.6	19.0	20.2
per Trade	(4.2)	(4.2)	(4.1)
Aggregate Premium	23.2	20.0	26.3
£Millions	(14.7)	(16.1)	(12.4)
	Individual Options - Block Trades		
Number of Trades	12.5	7.7	16.2
	(9.7)	(5.4)	(10.6)
Number of Contracts	2868.1	3025.4	2747.9
per Trade	(1336.4)	(1816.3)	(787.9)
Aggregate Premium	40.4	35.8	43.9
£Millions	(56.4)	(52.4)	(59.3)

The table reports the means and the standard deviations of the weekly number of trades, number of contracts per trade, and aggregate premium traded for option strategies, individual options using the regular trading facility and individual options using the block trade facility. Standard deviations are reported in parentheses. The first six rows report the figures for all option strategies, the middle six rows report the corresponding figures for all individual options, and the bottom six rows report the figures for all individual options traded as block trades. The first column reports the means and standard deviations for the full sample period from August 2001 to December 2004, and columns 2 and 3 report the means and standard deviations for 2 sub-samples. The number of contracts per trade includes only the options legs of an option strategy excluding any leg that involves index futures contracts.

Table 2: **Descriptive Statistics—Options-Only Strategies**

		Percent of		
	Num. of	All	All Options	Sub-total
Strategy	Obs.	Trades	-Only Trades	by category
Strangle	14,142	13.7	23.0	23.0
Put Spread	8,257	8.0	13.4	
Call Spread	8,414	8.1	13.7	27.1
Straddle	4,624	4.5	7.5	7.5
Put Calendar Spread	3,616	3.5	5.9	
Call Calendar Spread	3,675	3.6	6.0	11.8
Put Diagonal Calendar Spread	2,924	2.8	4.8	
Call Diagonal Calendar Spread	3,748	3.6	6.1	10.8
2×1 Ratio Put Spread	1,279	1.2	2.1	
2×1 Ratio Call Spread	1,032	1.0	1.7	3.8
Combo	1,117	1.1	1.8	1.8
Iron Condor	1,087	1.1	1.8	1.8
Guts	983	1.0	1.6	1.6
Put Butterfly	334	0.3	0.5	
Call Butterfly	473	0.5	0.8	1.3
Synthetic Underlying	392	0.4	0.6	0.6
Condor	249	0.2	0.4	0.4
Iron Butterfly	228	0.2	0.4	0.4
Box Trade	491	0.5	0.8	0.8
Put Ladder OR Put Strip	145	0.1	0.2	
Call Ladder OR Call Strip	74	0.1	0.1	0.4
Straddle Calendar spread	48	0.0	0.1	0.1
Jelly Roll	41	0.0	0.1	0.1
Straddle Diag Calendar Spread	2	0.0	0.0	0.0
Buy a Call Spread vs. a Put	0	0.0	0.0	
Buy a Put Spread vs. a Call	0	0.0	0.0	0.0
Straddle Strip	0	0.0	0.0	0.0
Straddle vs. a Call	0	0.0	0.0	
Straddle vs. a Put	0	0.0	0.0	0.0
Total	57,375	55.6	100.0	100.0

The table lists all strategies involving combinations of options only (i.e., no position in the futures contract). Column two shows the number of trades for each strategy over the sample period August 2001 to December 2004. Column three shows the number of trades as a fraction of all strategy trades, and column four displays the number of trades as a fraction of all options-only strategies. The last column groups calls and puts of a similar strategy together, e.g., calendar spreads represent 11.8% of all strategies traded.

Table 3: **Descriptive Statistics—Strategies Using Options and Futures**

		Percent of		
Strategy	Num. of Obs.	All Trades	All Delta-neutral Trades	Sub-total by category
Put volatility trade	10,252	9.9	24.6	
Call volatility trade	9,768	9.5	23.4	48.0
Put Spread vs. Underlying	5,523	5.3	13.2	
Call Spread vs. Underlying	4,613	4.5	11.1	24.3
Combo vs. Underlying	4,546	4.4	10.9	10.9
Conversion or Reversal	4,162	4.0	9.1	9.1
Put Calendar Spread vs. Underlying	1,969	1.9	4.7	
Call Calendar Spread vs. Underlying	2,016	2.0	4.8	9.5
2×1 Ratio Put Spread vs. Underlying	1,258	1.2	3.0	
2×1 Ratio Call Spread vs. Underlying	829	0.8	2.0	5.0
Straddle vs. Underlying	835	0.8	2.0	2.0
Put Ladder vs. Underlying	38	0.0	0.1	
Call Ladder vs. Underlying	34	0.0	0.1	0.2
Put Spread vs. Call vs. Underlying	42	0.0	0.1	
Call Spread vs. Put vs. Underlying	17	0.0	0.0	0.1
Total	45,902	44.4	100.0	100.0

The table lists all delta-neutral strategies involving combinations of options and the futures and the number of trades for each strategy over the sample period August 2001 to December 2004. Column three shows the number of trades as a fraction of all strategy trades, and column four displays the number of trades as a fraction of all delta-neutral strategies. The last column groups calls and puts of a similar strategy together, e.g., put and call volatility trades represent 48% of all delta-neutral strategies traded.

Table 4: **Characteristics of Strategy Trades: Buyer- vs. Seller-Initiated Trades, Premia, and Trade Sizes**

			Seller Initiated				Buyer Initiated			
Strategy	Total	Percent	Nobs	%	Premium	Size	Nobs	%	Premium	Size
Strangle	10,862	16.7	6,766	62	66.9	26.3	3,513	32	61.3	24.2
Put Volatility Trade	8,891	13.6	4,560	51	92.9	371.3	4,306	48	91.0	373.3
Call Volatility Trade	8,436	12.9	4,077	48	100.7	323.8	4,325	51	94.2	342.2
Put Spread	6,624	10.2	2,558	39	50.2	43.8	3,560	54	49.0	50.2
Call Spread	6,411	9.8	2,442	38	59.3	27.8	3,638	57	59.3	27.3
Straddle	4,239	6.5	2,779	66	212.3	24.8	1,256	30	242.9	25.2
Put Diagonal Calendar Spread	2,126	3.3	1,019	48	8.9	36.1	1,025	48	11.9	39.7
Call Diagonal Calendar Spread	3,110	4.8	1,634	53	(4.4)	19.7	1,355	44	3.1	28.5
Put Calendar Spread	2,539	3.9	1,204	47	50.1	62.5	1,225	48	52.7	72.9
Call Calendar Spread	2,977	4.6	1,520	51	55.8	34.5	1,322	44	53.5	46.8
Put Spread vs. Underlying	1,478	2.3	681	46	57.7	414.9	795	54	48.5	448.5
Call Spread vs. Underlying	1,171	1.8	538	46	88.7	374.5	628	54	83.8	348.1
Conversion/Reversal	1,471	2.3	665	45	(0.6)	152.5	668	45	6.4	141.2
Combo vs. Buying Underlying	1,234	1.9	598	48	15.3	423.3	632	51	21.4	439.1
2×1 Ratio Put Spread	1,011	1.6	553	55	(3.5)	70.3	419	41	(3.4)	72.3
2×1 Ratio Call Spread	808	1.2	427	53	(20.4)	32.5	333	41	(25.0)	28.6
Combo	963	1.5	488	51	(12.2)	31.6	450	47	(18.0)	51.6
Guts	815	1.3	509	62	264.8	6.4	280	34	281.3	6.7
Total	65,166	100.0	33,018				29,730			

The table lists all strategies included in our detailed empirical analysis. The first two columns report the total number and relative frequency of each type of strategy. The next eight columns report the number and frequency of trades that are classified as buyer- and seller-initiated trades, and the average premium and trade size for buyer- and seller-initiated trades. We classify the trades based on the bid and ask quotes implied by the quotes for the individual option legs using the Lee and Ready (1991) method. The frequencies reported omit trades that occur at the mid-quote.

Table 5: **Characteristics of Strategy Trades: Days to Expiration, Moneyness, and Distance between Strike Prices**

	Days to Expiration			Moneyness K_1/S			Distance $K_1 - K_2$ $(K1 > K_2)$		
Strategy	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
Strangle	35 29	53 49	66 66	1.04 1.03	1.06 1.06	1.08 1.08	450 350	550 550	750 800
Put Volatility Trade	28 28	57 60	120 126	0.91 0.90	0.95 0.95	0.99 0.99	- -	- -	- -
Call Volatility Trade	25 23	51 52	109 116	1.01 1.00	1.03 1.02	1.06 1.06	- -	- -	- -
Put Spread	14 15	28 30	56 59	0.94 0.94	0.98 0.97	1.00 1.00	100 100	200 200	300 300
Call Spread	17 16	39 35	79 71	1.02 1.03	1.05 1.06	1.09 1.09	100 100	150 150	200 200
Straddle	16 22	35 36	63 66	0.99 0.99	1.00 1.00	1.01 1.01	- -	- -	- -
Put Diagonal Calendar Spread	42 36	60 53	91 81	0.96 0.97	1.00 1.01	1.02 1.03	100 100	150 100	250 200
Call Diagonal Calendar Spread	36 35	46 42	76 66	1.00 0.99	1.02 1.01	1.05 1.04	100 100	100 100	200 150
Put Calendar Spread	44 32	74 39	105 88	0.96 0.97	0.99 0.99	1.01 1.01	- -	- -	- -
Call Calendar Spread	39 31	72 38	109 67	0.99 0.98	1.01 1.00	1.03 1.02	- -	- -	- -
Put Spread vs. Underlying	16 15	36 38	97 105	0.93 0.94	0.97 0.98	1.00 1.00	100 100	200 200	400 400
Call Spread vs. Underlying	15 16	45 53	133 127	1.03 1.03	1.07 1.07	1.11 1.11	100 100	200 200	400 400
Conversion/Reversal	1 1	3 3	23 16	1.00 1.00	1.00 1.00	1.00 1.00	- -	- -	- -
Combo vs. Buying Underlying	35 29	85 64	165 137	1.04 1.04	1.07 1.06	1.11 1.10	400 400	700 600	1000 900
2x1 Ratio Put Spread	15 15	39 37	87 79	0.94 0.94	0.98 0.97	1.00 0.99	100 100	200 200	300 300
2x1 Ratio Call Spread	15 16	30 31	59 72	1.02 1.02	1.04 1.04	1.07 1.07	100 100	150 150	200 200
Combo	27 24	38 37	61 50	1.00 0.99	1.02 1.01	1.05 1.04	50 50	150 50	463 300
Guts	7 24	23 29	30 36	1.01 1.01	1.02 1.02	1.03 1.02	88 50	150 100	250 200

The table lists, for buyer-initiated and seller-initiated trades, the first, second, and third quartiles for characteristics of all strategies included in our detailed empirical analysis. The first six columns report first quartile (buyer- and seller-initiated), median (buyer- and seller-initiated), and third quartile (buyer- and seller-initiated) for the number of days to expiration by strategy. For calendar strategies the leg with the largest number of days to maturity is used. The next six columns report the corresponding quartiles for the strategies' moneyness defined as the ratio of the maximum strike price over the current index value. The last six columns report the quartiles for the difference between the strike prices (largest minus smallest), when applicable.

Table 6: **Determinants of Trading Volume in Option Strategies**

			Volatility	
	All	Directional	Options Only	Options& Futures
Realized volatility	0.08	0.02	0.01	0.05
	(2.67)	(6.67)	(2.00)	(2.50)
Lagged realized volatility	0.12	0.01	0.01	0.10
	(4.00)	(3.33)	(2.50)	(5.00)
Return	-0.35	-0.01	0.02	-0.34
	(-1.52)	(-0.47)	(0.49)	(-1.59)
Lagged return	3.30	-2.40	0.58	10.70
	(0.15)	(-0.81)	(0.17)	(0.51)
Adjusted R^2	17.26	11.21	19.60	14.40
Quarterly dummies	Yes	Yes	Yes	Yes

The table reports the results for regressions of the trading volume in option strategies on the concurrent and lagged daily realized volatility and the concurrent and lagged return of the FTSE-100 index. The first column reports the results for a regression with trading volume of all types of option strategies as the dependent variable. The next columns report the corresponding results for regression in which the dependent variable is the trading volume in directional strategies or volatility strategies using either option only or options and futures. The trading volume is measured in number of contracts traded. Both volatility and return are measured in basis points.

Table 7: **Distribution of 'Greeks' for Strategies vs. Individual Options**

	Panel A: Gamma × 100						
	$(-\infty, -0.1]$	$(-0.1, -0.05]$	$(-0.05, 0]$	$(0, 0.05]$	$(0.05, 0.1]$	$(0.1, +\infty]$	Total
$-1.0 < \Delta \leq -0.1$	4.8 (11.8)	1.2 (6.6)	2.7 (2.7)	2.6 (4.3)	1.4 (6.1)	3.3 (7.8)	16.0 (39.3)
$-0.1 < \Delta \leq -0.05$	2.4 (0.3)	0.6 (1.2)	0.9 (0.7)	1.5 (2.2)	0.6 (0.6)	1.6 (0.2)	7.5 (5.2)
$-0.05 < \Delta \leq 0$	4.8 (0.0)	3.4 (0.3)	9.0 (2.2)	4.9 (2.4)	3.3 (0.1)	3.8 (0.0)	29.2 (5.1)
$0 < \Delta \leq 0.05$	4.6 (0.0)	3.7 (0.1)	5.9 (2.3)	4.0 (2.3)	3.0 (0.4)	3.5 (0.0)	24.6 (5.2)
$0.05 < \Delta \leq 0.1$	1.8 (0.2)	0.9 (0.7)	1.3 (2.3)	0.8 (0.8)	0.5 (1.2)	1.1 (0.3)	6.5 (5.4)
$0.1 < \Delta \leq 1.0$	4.0 (7.7)	1.6 (6.1)	2.9 (4.2)	3.3 (2.6)	1.3 (6.7)	3.2 (11.8)	16.3 (39.2)
Total	22.3 (20.1)	11.4 (15.0)	22.7 (14.5)	17.0 (14.6)	10.0 (15.2)	16.5 (20.2)	

	Panel B: Vega						
	$(-\infty, -5]$	$(-5, -2.5]$	$(-2.5, 0]$	$(0, 2.5]$	$(2.5, 5]$	$(5, +\infty]$	Total
$-1.0 < \Delta \leq -0.1$	3.1 (10.8)	2.4 (6.3)	3.6 (4.0)	3.1 (3.2)	1.9 (6.2)	1.8 (8.8)	16.0 (39.3)
$-0.1 < \Delta \leq -0.05$	1.8 (0.1)	0.7 (0.7)	1.3 (1.5)	1.8 (1.9)	0.8 (1.0)	1.0 (0.2)	7.5 (5.2)
$-0.05 < \Delta \leq 0$	6.0 (0.0)	3.0 (0.0)	8.0 (2.6)	4.5 (2.4)	3.2 (0.1)	4.4 (0.0)	29.2 (5.1)
$0 < \Delta \leq 0.05$	4.9 (0.0)	3.4 (0.1)	5.0 (2.4)	3.8 (2.7)	2.9 (0.0)	4.6 (0.0)	24.6 (5.2)
$0.05 < \Delta \leq 0.1$	1.1 (0.2)	1.2 (1.0)	1.5 (1.9)	1.4 (1.5)	0.5 (0.7)	0.8 (0.1)	6.5 (5.4)
$0.1 < \Delta \leq 1.0$	2.5 (8.7)	3.1 (6.1)	3.1 (3.3)	4.2 (4.0)	1.9 (6.4)	1.5 (10.8)	16.3 (39.2)
Total	19.6 (19.8)	13.8 (14.2)	22.4 (15.6)	18.9 (15.7)	11.2 (14.4)	14.1 (19.8)	

	Panel C: Theta						
	$(-\infty, -1]$	$(-1, -0.5]$	$(-0.5, 0]$	$(0, 0.5]$	$(0.5, 1]$	$(1, +\infty]$	Total
$-1.0 < \Delta \leq -0.1$	2.6 (8.9)	1.3 (6.8)	2.4 (2.2)	3.4 (3.7)	1.6 (7.3)	4.7 (10.4)	16.0 (39.3)
$-0.1 < \Delta \leq -0.05$	1.2 (0.6)	0.9 (1.2)	1.3 (1.3)	1.2 (1.6)	0.8 (0.5)	2.2 (0.2)	7.5 (5.2)
$-0.05 < \Delta \leq 0$	3.9 (0.2)	3.6 (0.4)	8.0 (1.9)	4.5 (2.4)	3.7 (0.1)	5.6 (0.1)	29.2 (5.1)
$0 < \Delta \leq 0.05$	4.1 (0.1)	3.0 (0.1)	4.3 (2.6)	4.5 (1.9)	3.8 (0.4)	4.8 (0.2)	24.6 (5.2)
$0.05 < \Delta \leq 0.1$	1.1 (0.3)	0.5 (0.4)	1.1 (1.6)	1.1 (1.3)	1.1 (1.2)	1.7 (0.6)	6.5 (5.4)
$0.1 < \Delta \leq 1.0$	3.6 (10.6)	1.5 (7.3)	4.5 (3.7)	2.6 (2.1)	1.2 (6.8)	3.0 (8.7)	16.3 (39.2)
Total	16.5 (20.5)	10.8 (16.3)	21.5 (13.2)	17.2 (13)	12.1 (16.3)	21.8 (20.2)	

The table reports the empirical distribution of greeks for all strategies and all individual options that are part of a strategy in our sample. Each panel reports two bi-variate distribution of greeks across 36 categories, e.g., Panel A reports the distribution of delta and gamma. For each category the table reports the percentage of strategy trades, viewed from the trade initiator's perspective, that fall into that category. The figure in parenthesis is the corresponding percentage for all *individual options* in our sample. The individual options' greeks are also viewed from the initiator's perspective but since this is a benchmark that we create we randomly assign the options to be buyer- or seller-initiated.

Table 8: **The Information Content of the Strategy and Outright Order Flow**

	Realized Volatility				Return			
Order Flow	Directional	Volatility options only	Volatility options & futures	Outright	Directional	Volatility options only	Volatility options & futures	Outright
Explanatory Variables								
Lagged order flow	-153.99	99.45	10.44		0.11	-0.04	-0.01	
	(-2.22)	(2.21)	(1.04)		(1.39)	(-0.76)	(-1.30)	
Lagged call option				-24.74				-0.02
order flow				(-0.63)				(-0.47)
Lagged put option				57.58				0.01
order flow				(1.75)				(0.40)
Lagged realized volatility	0.27	0.27	0.27	0.29				
	(6.53)	(6.76)	(6.55)	(7.17)				
Lagged index return					-0.06	-0.06	-0.06	-0.05
					(-1.79)	(-1.76)	(-1.68)	(-1.53)
Lagged futures volume	318.84	372.79	427.58	411.23	0.30	0.28	0.24	0.27
	(2.14)	(2.56)	(2.74)	(3.00)	(2.05)	(1.96)	(1.59)	(2.07)
Lagged option strategy	31.49	32.87	113.25	-16.80	-0.10	-0.11	-0.20	-0.05
volume	(0.34)	(0.36)	(1.08)	(-0.23)	(-1.02)	(-1.13)	(-1.70)	(-0.65)
Lagged outright option	140.20	114.18	96.26	82.71	-0.09	-0.07	-0.06	-0.09
volume	(1.46)	(1.22)	(0.97)	(0.88)	(-0.83)	(-0.68)	(-0.55)	(-0.89)
Adjusted R-square	55.65	55.64	55.63	55.89	0.00	0.00	0.00	0.00
Quarterly dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The table reports the parameter estimates for regressions of the realized volatility (columns 1 to 4) and the index return (columns 5 to 8) on lagged information. T-statistics are reported in parentheses. The dependent variable in the first four regressions is the one day realized volatility measured as the range of the index on day t divided by the closing value of the index on day $t-1$. The realized volatility used is measured in basis points. The dependent variable for the regressions of columns 5 to 8 is the one-day FTSE-100 index return. The order flow for directional strategy trades is defined as the difference between the number of long delta strategies and short delta strategies on day $t-1$, measured in number of contracts traded. The order flow for volatility strategy trades is defined as the difference between the number of long vega strategies and short vega strategies on day $t-1$, measured in number of contracts traded. The order flow in the outright options is defined as the difference between the number of contracts bought and sold on day $t-1$. All three volume variables are defined as the logarithm of the number of contracts traded on day $t-1$.

Table 9: **Alternative Specifications for Options-Only Strategies**

	Realized Volatility		
Order Flow	Delta/Vega Weighted Order Flow	Expiration 1 Month or more	Trade Size 10 contracts or more
Explanatory Variables			
Lagged order flow with ≥ 1 month to expiration		120.54	
		(2.53)	
Lagged order flow with trade size of 10 contracts or more			105.52
			(2.32)
Lagged delta-weighted order flow	0.13		
	(0.21)		
Lagged vega-weighted order flow	20.55		
	(2.32)		
Lagged realized volatility	0.27	0.27	0.29
	(6.68)	(6.70)	(6.95)
Lagged futures volume	377.76	349.95	275.62
	(2.59)	(2.41)	(1.81)
Lagged option strategy volume	25.09	28.44	38.27
	(0.28)	(0.32)	(0.39)
Lagged outright option volume	127.61	113.85	153.80
	(1.36)	(1.22)	(1.52)
Adjusted R-square	55.61	54.67	55.13
Quarterly dummies	Yes	Yes	Yes

The table reports the parameter estimates for regressions of the realized volatility on lagged information. T-statistics are reported in parentheses. The dependent variable is the one day realized volatility measured as the range of the index on day t divided by the closing value of the index on day $t-1$ expressed in basis points. The order flow with 1 month or more to expiration or 10 or more contracts of trade size are computed as the difference between bought and sold volatility strategies excluding all strategies with either less than one month or a trade size less than 10 contracts. The delta- and vega-weighted order flows are measured as the daily sums of trade sizes multiplied by the delta or vega of each options-only strategy trade. All three volume variables are defined as the logarithm of the number of contracts traded on day $t-1$.

Table 10: **The Profitability of Option Strategies**

		Gain/Loss per contract and trade (£)			Net Premia	
	N	Mean	T-stat.	Median	Mean	Q3-Q1
All Trades	46,718	0.87	(4.58)	0.00	84.73	100.34
Buyer-initiated	22,471	-2.11	(-8.14)	-2.48	78.98	88.50
Seller-initiated	24,247	3.64	(13.17)	2.50	90.05	110.08
Directional Trades	13,303	-0.89	(-4.09)	-0.50	43.43	53.00
Buyer-initiated	7,682	-1.34	(-4.72)	-1.50	44.84	55.50
Seller-initiated	5,621	-0.28	(-0.83)	1.00	41.51	52.00
Volatility Trades	33,297	1.48	(5.91)	0.50	100.82	120.11
Buyer-initiated	14,745	-2.53	(-6.99)	-3.00	96.42	109.56
Seller-initiated	18,552	4.67	(13.56)	2.93	104.32	127.11
		August 2001 — April 2003				
Directional Trades	6,138	-0.89	(-2.04)	-0.50	51.75	71.00
Buyer-initiated	3,422	-1.33	(-2.24)	-2.00	53.83	74.50
Seller-initiated	2,716	-0.35	(-0.54)	2.00	49.14	60.00
Volatility Trades	13,946	1.69	(3.37)	0.50	138.31	160.65
Buyer-initiated	6,187	-0.28	(-0.38)	-4.00	136.00	162.09
Seller-initiated	7,754	3.26	(4.73)	4.00	140.16	159.86
		May 2003 — December 2004				
Directional Trades	7,165	-0.89	(-5.87)	-0.50	36.30	45.00
Buyer-initiated	4,260	-1.35	(-7.15)	-1.50	37.62	45.00
Seller-initiated	2,905	-0.22	(-0.87)	0.50	34.36	45.00
Volatility Trades	19,351	1.34	(5.64)	0.43	73.81	86.68
Buyer-initiated	8,558	-4.16	(-12.40)	-2.50	67.80	70.64
Seller-initiated	10,793	5.69	(17.52)	2.50	78.56	100.86

The table reports the mean and median five-day gains or losses on strategy trades. The first column reports the number of observations in each category. The second and third columns show the mean five-day gain or loss in pounds per contract and trade with the corresponding t-statistic in parenthesis. The fourth column reports the median gain or loss per contract and trade in pounds. The last two columns report the mean and the interquartile range for the net premium per trade measured in pounds. The top three rows show the gains or losses and premia for all trades, and for all buyer- and seller-initiated trades. The next six rows contain the corresponding figures for directional and volatility trades. The last twelve rows show the gains or losses and premia for directional and volatility trades for the first and second halves of the sample overall and split between buyer- and seller-initiated trades.

Table 11: **Determinants of Strategy and Outright Option Order Flow**

	Strategy Trades			Outright Trades	
Order Flow	Directional	Volatility options only	Volatility options & futures	Put Options	Call Options
Explanatory Variable					
Realized Volatility	-0.01	0.00	-0.00	-0.00	-0.01
	(-2.79)	(1.34)	(-0.14)	(-0.95)	(-1.25)
Lagged Realized Volatility	0.00	-0.01	0.01	-0.01	-0.00
	(1.20)	(-1.59)	(0.98)	(-1.81)	(-0.60)
Return	3.86	-4.31	-34.48	8.96	5.87
	(2.27)	(-1.67)	(-2.89)	(2.31)	(1.70)
Lagged Return	3.87	-0.32	15.51	4.17	-5.02
	(2.36)	(-0.13)	(1.34)	(1.10)	(-1.50)
Adjusted R^2	3.37	2.60	3.10	1.43	1.76
Quarterly dummies	Yes	Yes	Yes	Yes	Yes

The table reports the parameter estimates from regressions of strategy and outright order flow on concurrent and lagged realized volatility and concurrent and lagged returns. T-statistics are in parentheses below the corresponding parameter estimates. The following five order flow measures are used: order imbalance from directional strategy trades, order imbalance from volatility trades using option only, order imbalance from volatility trades using options and futures, and order imbalance from trades in outright put and call options. For all five order flow measures, the order imbalance is defined as the difference between the number of contracts bought and sold on a given day.

Appendix A

Table A1: **Description of the Options-only Strategies**

Strategy	Description
Strangle	Buy put, buy call at higher strike
Put Spread (Bear spread)	Buy put, sell any call (same month) at higher strike
Call Spread (Bull spread)	Buy call, sell any put (same month) at lower strike
Straddle	Buy put, buy call at the same strike
Put Calendar Spread	Sell near month put, buy far month put (same strikes)
Call Calendar Spread	Sell near month call, buy far month call (same strikes)
Put Diagonal Calendar Spread	Sell near month put, buy far month put at different strike
Call Diagonal Calendar Spread	Sell near month call, buy far month call at different strike
2×1 Ratio Put Spread	Sell put, buy two puts at lower strike
2×1 Ratio Call Spread	Sell call, buy two calls at higher strike
Combo (Risk reversal)	Sell call, buy put at lower strike
Iron Condor	Sell put, buy put at higher strike, buy call at even higher strike, sell call at even higher strike
Guts	Buy call, buy put at higher strike
Put Butterfly	Buy put, sell two puts at higher strike, buy put at an even higher strike
Call Butterfly	Buy call, sell two calls at higher strike, buy call at an even higher strike
Box Trade	Buy call and sell put at the same strike, buy put and sell call at higher strike
Synthetic Underlying	Buy a call, sell a put at the same strike
Condor	Buy put (call), sell put (call) at two higher strikes, buy put (call) at even higher strike
Iron Butterfly	Buy a straddle, sell a strangle
All delta-neutral strategies e.g., Put Spread vs. Underlying	All strategies involving options and futures are constructed by combining one of the above strategies and a long or short position in the index futures to obtain a total position that is delta-neutral or close to delta-neutral.