Option Market Activity*

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ABSTRACT

This paper uses a unique option dataset to provide detailed descriptive statistics on the purchased and written open interest and open buy and sell volume of several classes of investors. We also show that volatility trading through straddles and strangles accounts for a small fraction of option trading volume and present evidence that a large percentage of call writing is part of covered call positions. Finally, we find that during the stock market bubble of the late 1990s and early 2000 the least sophisticated investors in the dataset substantially increased their purchases of calls on growth but not value stocks.

The seminal work of Black and Scholes (1973) and Merton (1973) generated an explosion of research into methods for computing theoretical option prices and hedge ratios. By contrast, more than three decades after the beginning of listed option trading much less is known about the trading of this important class of securities. This paper uses a unique option dataset to investigate activity in the equity option market. There are three main goals. The first is to describe some major stylized facts about the option trading of different types of investors. The second is to investigate the extent to which the documented facts can be explained by different types of option trading strategies. The third is to examine changes in option market activity during the stock market bubble of the late 1990s and early 2000.

The dataset contains detailed daily open interest and volume information for each equity option series listed at the Chicago Board Options Exchange (CBOE) from 1990 through 2001. The data are broken down by different types of investors: firm proprietary traders, public customers of full-service brokers, public customers of discount brokers, and other public customers. The open interest data provide both purchased and written positions for each investor type. The volume data are classified according to whether an investor type is buying or selling and also according to whether the investor type establishes brand new option positions or closes existing ones. Most other datasets, by contrast, provide only aggregate daily open interest and volume for each option series.[1]

Since so little is known about option trading, we begin by providing detailed descriptive statistics. We determine the average daily purchased and written put and call open interest for the different types of investors and for various categories of stocks such as large capitalization stocks and value and growth stocks. We also compute for the different investor types and categories of stocks average daily volume of purchases and sales of both calls and puts that open new positions. We establish that written option positions are more common than purchased positions: for both calls and puts, non-market maker investors in aggregate have more written than purchased open interest. This result is due to the full service customers, whose positions comprise the bulk of non-market maker aggregate open interest. The purchased open interests of firm proprietary traders, discount customers, and other public customers

somewhat exceed their written open interests. We also show that non-market maker investors have about four times more purchased call than purchased put open interest. This predominance of purchased call relative to purchased put open interest holds for all four investor groups. In addition, as one might predict from the previous two results, we find that overall purchased put open interest is smaller than written put open interest, and smaller still relative to both purchased and written call open interest. This holds for both discount and full-service customers; only for firm proprietary traders does purchased put open interest exceed written put open interest. When aggregated across our entire data period from 1990-2001, there are only small differences in open interest and trading volume across options with underlying growth and value stocks. We complete our description of option market activity by performing Tobit regressions of purchased and written call and put volume on past returns, book-to-market ratio, volatility, and dividend payment of underlying stocks. We find that greater option market activity is generally associated with higher past returns, lower book-to-market ratios, and higher volatilities.

There are a number of motivations for trading options that may lie behind the descriptive statistics. Possible motivations include using options to bet on or hedge changes in the volatility of underlying stocks and to bet on or hedge directional price changes of underlying stocks. A special case of the latter is the role options may play in allowing investors to circumvent the costs of and restrictions on the short sales of stocks.

We perform analyses that allow us to place upper bounds on the frequencies with which investors employ straddles and strangles, which are leading strategies used to speculate on or hedge volatility. We find that these volatility trading strategies account for at most a small fraction of option activity. This result is somewhat surprising in light of the prominence that option textbooks give to such strategies (see, e.g., MacDonald 2003, Section 3.4, "Speculating on Volatility").

Providing evidence that volatility trading is not a significant determinant of option activity is important, because it points toward speculating on and hedging the direction of underlying stock price movements as the main drivers of option market activity. We use another dataset which allows us to examine entire accounts from a sample of investors at a discount brokerage house to provide evidence

that a large fraction of the call writing that we observe is part of covered-call strategies. Apart from call writing, however, directional hedging appears to account for a relatively small fraction of option trading: after written calls the most common positions are purchased calls and written puts, and the known paucity of short stock positions (see, e.g., Dechow et al. 2001, Lamont and Stein 2004) implies that these option positions are only rarely undertaken as hedges against rising underlying stock prices unless option investors who purchase calls or write puts have a much greater propensity than other investors to short stocks. Purchased puts that can be either bets on declines in stock prices or used to hedge the downside risk of long stock positions account for a small fraction of option activity. In addition, the supplementary data set indicates that a majority of put purchases are naked positions which strongly suggests that they are based on speculation that underlying stock prices will go down.

Like the volatility trading results, several of these findings are also surprising. Perhaps the most unexpected is the low frequency of purchased puts and the relative popularity of written puts. Derivatives textbooks written for MBA and undergraduate courses[2] typically include a chapter discussing elementary option strategies, and these chapters almost invariably discuss protective puts as an important option market strategy. For example, in McDonald (2003, Chapter 3) the protective put is the first strategy discussed. One might also expect put purchases to be common because it is more costly and difficult to go short than long in the stock market, and purchased puts provide a way of avoiding these costs and difficulties. Yet, among purchased and written puts and calls, purchased puts are the least common.

The relative popularity of written puts is also somewhat surprising. Of the derivatives textbooks we examined, only Ritchken (1996; p. 121) mentions naked put writing as a common strategy, and only Stoll and Whaley (1993; pp. 282-283) mentions the strategy of writing puts while holding the underlying stock. Further, in Stoll and Whaley (1993) this is the very last of the 50 option strategies discussed.

Finally, the finding that, apart from covered calls, little option volume can be attributed to hedging is itself of interest, because it implies that a large fraction of option activity appears to be motivated by views about the direction of future stock price movements. Of course, this option activity

can be due either to correct beliefs about future stock price movements or to cognitive biases or other "behavioral" factors.

We also establish a number of key facts about option market activity during the stock market bubble of the late 1990s and early 2000. First, discount customers' call buying, put writing, and net positive exposure to the underlying stocks achieved through the option market increased dramatically during the bubble period. These changes were concentrated in options on growth stocks rather than value stocks. Second, in contrast to the discount customers, there were no increases in call purchases or put sales to open new positions by firm proprietary traders or customers of full-service brokers, and only limited changes in their purchased call and written put open interests. Finally, the purchase of puts to open new positions did not increase for any of the investor classes during the bubble. Purchased and written put open interest, however, did increase somewhat for both firm proprietary traders and customers of full service brokers.

We argue below that discount customers are probably the least sophisticated of the three groups of option investors. Consequently, our results from the bubble period suggest that the least sophisticated investors were speculating that the price of growth stocks would continue to rise and their speculation may have contributed to the bubble. More sophisticated investors, by contrast, at most had a mild bet that the prices of the growth stocks would continue to go up. The fact that the open buy put volume did not increase for any of the investor groups during the bubble is consistent with there having been little appetite for betting against the bubble, even though it would have been easy to do so by purchasing puts.[3] Hence, our results provide a different perspective on the bubble than Ofek and Richardson (2003) who argue that the existence of short sales constraints contributed to the development of the bubble and that the loosening of those constraints played a role in deflating it.

The remainder of the paper is organized as follows. Section 1 discusses the data. The second section defines our measures of option market activity and presents descriptive statistics for the entire data period. Section 3 explores factors that drive the observed option market activity. The fourth section examines changes in option market activity during the bubble period, and Section 5 concludes.

1. Data

The main data for this paper were obtained from the CBOE. The data cover option open interest and trading volume broken down by different types of investors from the beginning of 1990 through the end of 2001. The open interest data provide a daily record of closing written and purchased open interest for all CBOE listed options. When a CBOE listed option is also listed on other exchanges, the open interest data are inclusive of all exchanges at which it trades. Options that trade only at exchanges other than the CBOE, however, are not included in the dataset. The trading volume data consist of daily information for all trades that actually occur at the CBOE. It is broken down into four categories: volume from buy orders that open new long positions (open buy volume), volume from sell orders that open new short positions (open sell volume), volume from buy orders that close existing short positions (close buy volume), and volume from sell orders that close existing long positions (close sell volume).

The Option Clearing Corporation (OCC) assigns one of three origin codes to each option transaction: *F* for firm proprietary traders, *C* for public customers, and *M* for market makers. An example of a firm proprietary trader would be an employee of Goldman Sachs trading for the bank's own account. An analyst at the CBOE further subdivided the public customer data into orders that originated from discount customers, full-service customers, or other public customers. Clients of E-Trade are an example of discount customers, and clients of Merrill Lynch are an example of full-service customers. The other public customers category consists of all OCC public customer transactions that are not designated by the CBOE analyst as originating from discount or full-service customers.[4] In the empirical work below, we focus on option activity in individual equity options due to the firm proprietary trader, discount customer, and full-service customer categories.

We maintain that among these three groups of option investors, the firm proprietary traders have the highest level of sophistication, the full-service customers have an intermediate level of sophistication, and the discount customers have the lowest level of sophistication. Evidence that the firm proprietary option traders have the highest level of sophistication is provided in Poteshman and Serbin (2003) which

demonstrates that firm proprietary traders never engage in irrational early exercise of stock options while the full-service and discount customers do so with some regularity. One reason to believe that full-service option traders are on average more sophisticated than discount option traders is that most hedge funds trade through full-service brokerage houses. In addition, Pan and Poteshman (2005) find that full-service option traders have a greater propensity than discount option traders to open new purchased call (put) positions before stock price increases (decreases). Further evidence that full-service option customers are more sophisticated than discount option customers is provided in Mahani and Poteshman (2005) which shows that discount customers have a greater propensity for entering option positions that load up on growth stocks relative to value stocks in the days leading up to earnings announcements despite the fact that at earnings announcements value stocks outperform growth stocks by a wide margin. (LaPorta et al. 1997)

We obtain return, price, and number of shares outstanding data for the stocks that underlie the options from the Center for Research in Security Prices (CRSP). We use data from CRSP as well as COMPUSTAT to classify underlying firms into value and growth categories based upon their book-to-market (BM) equity ratios. In order to ensure that we are not using BM values before the data were actually available to investors, we assume a four month reporting lag for accounting data. Book value of equity is obtained from COMPUSTAT annual data item number 60. Market value of equity is computed by multiplying the CRSP share price and the number of shares outstanding. When calculating BM, the most recently available market value of equity is used.

2. Descriptive Statistics

This section presents summary statistics about average daily purchased and written put and call open interest and trading volume for different types of investors and various categories of stocks such as large capitalization stocks and value and growth stocks.

2.1 Measuring option market activity

We define a quantity that measures on a trade date the open interest on an underlying stock (delta-adjusted, so that we can compare option positions to stock positions) by one of the investor types as a percentage of the shares of the underlying stock outstanding. We denote this quantity $OpenInterestPercentageShares_{s,t}^{k,i}$, where *s* is an underlying stock, *t* is a trade date, *k* is a kind of open interest, and *i* is an investor type. The open interest kind *k* is either purchased call, purchased put, written call, or written put. The investor type *i* is either firm proprietary traders, discount customers, full-service customers, other public customers, or all non-market makers. Let $N_{s,t}^{k}$ be the number of different call (if *k* denotes a purchased or written call) or put (if *k* denotes a purchased or written put) contracts listed on stock *s* on trade date *t*, $\Delta_{s,j,t}^{k}$ be the delta of the *j*th call or put on underlying stock *s* on trade date *t*, and $N_{s,t}^{Shares}$ be the number of shares of stock *s* outstanding on trade date *t*. In addition, let $OpenInterest_{s,j,t}^{k,i}$ be the number of contracts of open interest of kind *k* for investor type *i* on the *j*th call or put on underlying stock *s* on trade date *t*. We then define $OpenInterestPercentageShares_{s,t}^{k,i}$ by

$$OpenInterestPercentageShares_{s,t}^{k,i} \equiv \left(\frac{\sum_{j=1}^{N_{s,t}^{k}} 100 \times OpenInterest_{s,j,t}^{k,i} \times \left| \Delta_{s,j,t}^{k} \right|}{N_{s,t}^{Shares}} \right) \times 100. \qquad (1)$$

In this expression, the factor of 100 and the delta in the numerator convert the open interest into an equivalent number of shares of the underlying stock.[5] The final factor of 100 converts the quantity into a percentage.

We measure option volume in a similar way. For example, let $OptionVol_{s,j,t}^{k,i}$ be the option volume of kind *k* by investor type *i* on the *j*th call or put on underlying stock *s* on trade date *t*. Now *k* is either open buy call volume, open buy put volume, open sell call volume, or open sell put volume. We then define $OptionVolPercentageShares_{s,t}^{k,i}$ by

$$OptionVolPercentageShares_{s,t}^{k,i} \equiv \left(\frac{\sum_{j=1}^{N_{s,t}^{k}} 100 \times OptionVol_{s,j,t}^{k,i} \times \left| \Delta_{s,j,t}^{k} \right|}{N_{s,t}^{Shares}} \right) \times 100. \quad (2)$$

To illustrate the computation of these measures, suppose that on June 1, 1998, XYZ has 23,000,000 shares outstanding and that firm proprietary traders have 120 contracts of purchased open interest in XYZ calls that expire in June 1998 with a strike price of $130 and 35 contracts of purchased open interest in XYZ calls that expire in July 1998 with a strike price of $125. Suppose further that on June 1, 1998 the Black-Scholes deltas of the June 1998 strike $130 call and the July 1998 strike $125 call are, respectively, 0.55 and 0.60. Then for firm proprietary traders, the purchased call open interest as a percentage of shares outstanding on XYZ for June 1, 1998 is 0.0378%. This percentage is computed as

$$OpenInterestPercentageShares_{XYZ,June\,1,1998}^{Purchased\ Call,\ Firm\ Prop.} = \left(\frac{100 \times 120 \times |0.55| + 100 \times 35 \times |0.60|}{23,000,000} \right) \times 100 \quad (3)$$
$$= 0.0378\%.$$

Finally, it should be noted that (holding other things fixed) stock price changes will not substantially impact our measures, but stock price changes would have an important impact on variables defined to gauge option market activity in dollar terms.

2.2 Levels of option open interest

We begin by examining option open interest and trading volume by different types of investors for options on various categories of underlying stocks. Table 1 presents average daily purchased and written put and call open interest as a percentage of shares of underlying stock outstanding over the 1990-2001 period. It also presents the net open interest which is the delta-adjusted net option position in the underlying stock and is computed as purchased call plus written put minus purchased put minus written call open interest. These averages are computed for four groups of underlying stocks: all those in the database, large stocks, large growth stocks, and large value stocks. Large stocks are defined as those in the top 500 by market capitalization in the CRSP universe as of the end of the previous calendar quarter.

Large growth and large value stocks are defined at the end of each quarter as, respectively, the lowest and highest BM quartile of the 500 largest stocks by market capitalization. We show the results for large stocks because these account for the bulk of the market capitalization and most of the option activity. The results for smaller companies are similar. In order to prevent the statistics from being too heavily influenced by smaller companies with fewer options or by periods of unusually high option activity, we use the following procedure to compute averages. First, for each trade date we use equation (1) to compute the delta-adjusted open interest for each underlying stock. Next for each calendar month we compute a market capitalization weighted average of the delta-adjusted open interest for each underlying stock on each trade date. Finally, we calculate a simple average over the months. Most averages reported in the paper are computed in this way.[6]

We note first that option market activity represents a reasonably large fraction of activity in the underlying asset. For example, for large underlying stocks the average open interest aggregated across types of open interest and all non-market maker investors is about 0.62% of the shares outstanding. Although this may initially seem like a small quantity, the contracts are actively traded, and the annual option market turnover corresponds to contracts on about 7% of the underlying shares.[7] Since the turnover in the market for the underlying shares is on the order of 60% a year, the option trading is appreciable when compared to the direct trading in the underlying stock.

We next examine the composition of the open interest. For concreteness, in the discussion we focus on the results for all firms, but the findings do not differ much across the categories. Panel E of Table 1 reports that over the 1990-2001 period for all non-market makers call purchased and written open interest are 0.232% and 0.282%, respectively, while aggregate put purchased and written open interest are 0.055% and 0.072%, respectively.[8] Combining the call and put positions, written open interest is 0.354%, approximately 23% greater than the purchased open interest of 0.287%. This predominance of written over purchased open interest is due primarily to the full service customers, whose positions comprise the bulk of the aggregate open interest. For them, written call open interest of 0.198% exceeds purchased call open interest of 0.132% by 50%, and written put open interest of 0.048% exceeds purchased put open

interest of 0.031% by slightly more than 50%. Combining puts and calls, written open interest of 0.246% is more than 50% greater than purchased open interest of 0.163%. In contrast, the purchased open interests of firm proprietary traders exceed their written open interests, and the purchased call open interest of discount customers exceeds their written call open interest. The final column of Panel E indicates that the large written call open interest results in non-market maker net delta-adjusted option positions that are negative.[9] In interpreting these numbers, it should be kept in mind that to some extent market makers manage risk by setting prices to balance the purchased and written demands of non-market maker investors.[10] Consequently, when considering the difference between purchased and written open interest, it should be understood that the observed difference is that which survives market maker efforts to balance the demand for purchased and written positions.

We next observe that calls dominate puts: non-market maker investors have more than four times as much purchased call open interest as purchased put open interest, and slightly less than four times as much written call open interest as written put open interest.[11] On an average trade date, full-service customers have purchased call open interest that controls 0.132% of the underlying shares while they have purchased put open interest that controls only 0.031% of the underlying shares. Discount customers have an even stronger relative preference for bought call positions. Their purchased call open interest controls 0.033% of the underlying shares while their bought put open interest controls only 0.004% of the underlying shares. Although the ratios differ, this predominance of call relative to put open interest also holds for written positions, and for all investor groups.

Third, and as one might predict from the first and second findings, overall purchased put open interest is smaller than written put open interest, and smaller still relative to both purchased and written call open interest. This holds for both discount and full-service customers; only for the firm proprietary trader category does purchased put open interest exceed written put open interest. The overall ordering of positions, from most to least common, is: (i) written call; (ii) purchased call; (iii) written put; and finally (iv) purchased put.

The low frequency of purchased puts is surprising, because it is more costly and difficult to go short than long in the stock market. For example, retail customers receive low interest rates on the proceeds from their short sales, and short stock positions can only be established on an uptick. In addition, it is sometimes difficult to borrow stocks to short, and this was especially true during the stock market bubble. At the same time, the difference between the cost and difficulty of taking short and long positions in the option market by buying puts or calls is not as large.[12] Since we have seen that for a typical firm open interest in the option market is quite small in comparison to the number of shares of stock outstanding, one might hypothesize that the difficulty of establishing short positions directly in stocks would result in a greater open interest in purchased puts relative to the other options positions since purchased puts can be used as an alternative to taking short stock positions. Table 1 shows that this is not the case.

It is worth pointing out that the relatively low frequency of purchased puts is unlikely to be due to market maker unwillingness to sell puts. Panel E of Table 1 shows that aggregate non-market maker written put open interest exceeds non-market maker purchased put open interest. This of course implies that market makers, on average, had a net purchased position in puts, and so presumably would have been willing to write additional puts had customers demanded them. The aggregate non-market maker call open interests in Table 1 imply that market makers on average also had net purchased positions in calls.

Table 1 also reveals that over our entire time period of 1990-2001 there are no major differences in open interest for value and growth stocks. The similarity across value and growth stocks holds for the non-market makers in aggregate and also for each of the four specific investor types. For example, for the full-service customers, the average daily written call open interest as a percentage of shares outstanding is 0.215% and 0.192%, respectively, for large growth and large value underlying stocks. It is interesting to note, however, that the largest percentage difference is observed for the written put open interest of full-service customers on growth and value stocks. In this case, the average daily written put open interest for growth and value stocks are, respectively, 0.046% and 0.067% which corresponds to full-service customers selling relatively more puts on stocks that might be perceived as undervalued.

We will see below that even though the open interest is similar across different types of underlying stocks over the entire sample period, during the stock market bubble of the late 1990s and early 2000 for some investors there were large differences in option market activity on growth and value stocks.

Table 2 disaggregates average open interest on all underlying stocks for non-market makers by moneyness (defined as the strike price divided by the closing underlying stock price) and time-to-expiration. The moneyness categories are $K/S < 0.9$, $0.9 \le K/S \le 1.1$, and $K/S < 1.1$. The middle moneyness category is not defined more narrowly in order to make it likely that at least one strike price per underlying stock will fall in this category on each trade date. (For example, if a stock price closes at \$22 and the stock has options with strike prices of \$20 and \$25, the corresponding moneyness values are 0.91 and 1.14.) The time-to-expiration categories are defined as $\tau \le 6$ weeks, 6 weeks < $\tau \le 18$ weeks, and $\tau > 18$ weeks. Options with about a week (or less) to expiration tend to be illiquid, so the shortest time-to-expiration category extends out to 6 weeks so that it is likely that it contains at least one liquid expiration date. The results in Table 2 show that delta-equivalent open interest is generally concentrated in near-the-money options, and also that there is some tendency for open interest to be higher for the shorter time-to-expiration categories. For example, the total (across moneyness categories) open interest of 0.032% + 0.061% + 0.002% = 0.095% in the short-term written calls exceeds the total open interest of 0.091% in the medium-term written calls, which in turn exceeds the total open interest of 0.089% in the long-term written calls. Purchased long-term calls are the one exception to the generalization that open interest declines as the time-to-expiration increases—for them total open interest of 0.0920% exceeds total open interest of 0.069% for medium-term purchased calls. Long-term calls, both purchased and written, are also the exception to the generalization that open interest is concentrated in near-the-money options, as the (delta-equivalent) open interest of in-the-money options exceeds that of near-the-money options. The larger deltas of in-the-money calls clearly contribute to this result.

2.3 Levels of option volume

Panels A-C of Table 3 report the average daily open volume as a percentage of shares outstanding over the 1990-2001 period for the three main investor classes and four groups of underlying stocks.[13] The first four columns list, respectively, average open buy call volume, open buy put volume, open sell call volume, and open sell put volume. The first two columns represent options bought to establish brand new purchased positions (and not to close out existing written positions), while the last two columns represent options sold to establish new written positions (and not to close out existing purchased positions.) The final net column is the open buy call plus open sell put minus open buy put minus open sell call volume. The first thing to note about Table 3 is that across all participants and groups of underlying stocks there is more opening volume on the buy side than the sell side for both calls and puts.[14] For both the full-service customers and for puts traded by discount customers this finding is somewhat unexpected, since for these categories Table 1 indicates that on average there is more written than purchased open interest. These findings imply that on average the full-service customers hold purchased call positions open for substantially less time than written call positions.

Panels D-F of Table 3 report the average number of trade days the various investor classes hold purchased and written call and put positions. Panel F of Table 3 shows that on average the full-service customers hold their written option positions substantially longer than their purchased option positions. For example, they hold their written call positions on large stocks an average of 47 days and their purchased call positions on large stocks an average of only 26 days. Panel E shows that discount customers also hold their written positions longer than their bought positions, while Panel D indicates that firm proprietary traders hold their purchased and written positions for roughly the same amount of time. Strikingly, full-service and discount customers hold their purchased puts for the shortest average length of time. These findings are consistent with the hypothesis that the full-service and discount customers use their purchased option positions more heavily for short-term speculation, whereas their written option positions are used more for hedging or as part of longer-term investment strategies. For the full-service customers the signs on the net volume statistics are mostly positive unlike in Table 1 where they are

mostly negative for net open interest. This difference can be attributed to the fact that these investors hold their written calls much longer than their purchased calls. Once again, no major differences are seen across growth and value stocks in the statistics reported in Table 3. However, differences will emerge when we focus on subperiods, especially the bubble period.

Table 4 disaggregates average open volume for non-market makers on all underlying stocks by the same moneyness and time-to-expiration categories used in Table 2. The results in Table 4 show that open volume is even more concentrated than open interest in near-the-money options. It appears that investors have a strong tendency to open option positions close to at-the-money and that their option holdings become somewhat less concentrated near-the-money as the underlying stock prices subsequently move away from the strike prices. The volume results in Table 4 also reveal that open volume is more concentrated than open interest in short-term options.

2.4 Determinants of option market activity

We next turn to an investigation of the cross-sectional determinants of option market trading. The dependent variables that we consider are purchased call, purchased put, written call, and written put open volume. As above, these variables are computed by aggregating the delta-equivalent option volume on each underlying stock on each trade date and normalizing the volume so that the variables represent the equivalent percentage of shares of the underlying stock traded in the option market. Since these variables cannot be less than zero (i.e., are truncated at zero), we perform Tobit regressions. In particular, for each calendar month we run a Tobit panel regression where the unit of observation is a moneyness/time-to-expiration category for an underlying stock and a trade date. There are nine moneyness/time-to-expiration categories defined by short, medium, and long time-to-expiration and low, medium, and high moneyness. The time-to-expiration categories are less than or equal to six weeks, greater than six and less than or equal to 18 weeks, and greater than 18 weeks. The moneyness categories are strike price divided by closing stock price less than 0.9, greater than or equal to 0.9 and less than or equal to 1.1, and greater than 1.1.

The first set of explanatory variables are the returns to underlying stocks over various horizons: the same day return (*Rsameday*), the return from trade dates –5 through –1 (*Rweek*), from trade dates –21 through –6 (*Rmonth*), from trade dates –252 through –22 (*Ryear*), and from trade dates –504 through –253 (*R2years*). The book-to-market ratio (*BM*), the volatility of the underlying stock (*Volatility*), the dividend yield of the underlying stocks (*DY*), and a number of dummy variables also serve as explanatory variables. In particular, we include dummy variables for a trade date being one of the five trade dates leading up to an ex-dividend date for an underlying stock (*DExDiv*), and for the low moneyness (*DMoneyLow*), high moneyness, (*DMoneyHigh*), medium time-to-expiration (*DMatMed*), and long time-to-expiration (*DMatLong*) categories. Finally, we include an interaction of the dividend yield with the ex-dividend date dummy variable as well as interactions of the past return variables with the moneyness and time-to-expiration dummy variables.

Panel A of Table 5 presents the results of averaging the coefficient estimates from the monthly Tobit regressions over the period 1990-2001 along with auto-correlation adjusted *t*-statistics computed according to the method of Chopra, Lakonishok, and Ritter (1992). The coefficient estimates are multiplied by 10,000. For brevity, we present results only for all non-market makers. The results are similar for each of the customer classes that comprise non-market makers, in that the coefficient estimates on the various variables are generally of the same signs for the different groups of customers.[15] The first thing to note is that more calls and puts are purchased to open new positions and more calls are written to open new positions after high returns on the underlying stock over all past horizons from one week to two years. For both purchased and written calls the coefficients on the more recent returns are larger, and decline monotonically as the lag increases. More puts are written to open new positions when returns have been higher from more than one month through two years in the past but not when returns have been higher over the past month. The negative coefficient estimates on the BM variable indicate that there are more option positions of all types opened on growth relative to value stocks. Except for purchased puts, higher volatility also is associated with the opening of more new option positions. Both option buying and writing are positively related to the dividend yield.

The negative (positive) coefficients on the ex-dividend date dummy variable for purchased (written) calls and puts indicate that fewer (more) purchased (written) option positions are opened leading up to dividend dates. There is not much evidence, however, that this change in option trading activity is related to dividend capture strategies, because using options as hedges in dividend capture strategies involves writing calls and purchasing puts (to hedge the purchase of stock that entitles the owner to the dividend), and the signs of coefficients are not entirely consistent with noticeably larger activities of these two option transactions. The estimated coefficients on the interaction term *DExDiv*×*DY* are negative, though not always significant, for all four transaction types. These estimates indicate less activity in high-dividend stocks shortly before ex-dividend dates, again providing no evidence that the greater activity in higher-yielding stocks is related to dividend capture strategies.

As the averages in Table 4 would lead one to expect, the coefficient estimates on the dummy variables for the low and high moneyness categories are negative for all four transaction types. The time-to-expiration dummies have mixed effects. The preponderance of the terms that interact the moneyness and maturity dummy variables with past returns are negative. This finding is unsurprising, because it indicates that the past return impact on option volume that is further from the money or of longer maturity is less than that for near-the-money short maturity options. Since there is generally less volume away from the money and at longer times-to-expiration, one would expect less volume impact for these moneyness/time-to-expiration categories.

Turning to the closing volume results in Panel B, the coefficient estimates show that the recent returns *Rweek* and *Rmonth* have opposite effects on closing volume for calls and puts. Purchased and written call closing volume is positively related to *Rweek* and *Rmonth*, while purchased put closing volume is negatively related to these return variables. Written put closing volume is negatively related to *Rweek*, and insignificantly positively related to *Rmonth*. Closing volume for all four option types is positively related to the return variables for longer lags, *Ryear* and *R2year*. With the exception of the negative coefficient estimates on *Rweek* and *Rmonth* for closing purchased put volume the signs of these coefficient estimates agree with those for opening volume in Panel A. This is unsurprising, because there

cannot be closing volume unless there has first been opening volume. The signs of the coefficient estimates on Ln(1+*BM*) and *Volatility* are, respectively, negative and positive, also similar to the results in Panel A, and the signs of the coefficient estimates on most of the interaction terms agree with those in Panel A.

Differences from Panel A appear in the coefficient estimates on the ex-dividend dummy *DExDiv*. Purchased call and put closing volume is positively related to the ex-dividend day dummy, in contrast to the negative coefficient estimates for opening volume in Panel A. Written call and put closing is negatively (though insignificantly) related to *DExDiv*, again different from the positive coefficient estimates in Panel A. However, the coefficients on the dividend yield *DY* and the interaction term *DExDiv*×*DY* in Panel B are of the same signs as those in Panel A.

3. Option Trading Strategies

The previous section documented some properties of option open interest and trading volume. There are a number of (possibly overlapping) motivations for option trading that could account for the observed option market activity. These include using options to speculate on or hedge against changes in underlying stock price volatility and to speculate on or hedge against directional moves in the prices of underlying stocks.[16] A special case of using options to speculate on or hedge against directional moves in underlying stock prices is the role that they may play in allowing investors to circumvent the costs of and restrictions on stock short sales. This section discusses the extent to which the evidence on option market activity either rejects, or is consistent with, several possible motivations for option activity. We first present evidence that straddles and strangles which are often considered the leading strategies for speculating on or hedging against changes in stock price volatility account for at most a small fraction of option activity. Ruling out volatility trading using straddles and strangles as an important determinant of option activity leaves us in a better position to interpret the previous findings about activity in calls and puts. Accordingly, after our analysis of volatility trading, we consider the extent to which the evidence presented in Section 2 is consistent with other motivations for option activity.

3.1 Volatility trading using straddles and strangles

Derivatives textbooks emphasize the fact that options provide a mechanism for investors to trade on information about stock price volatility, and they present straddles and strangles as the leading volatility trading strategies.[17] In the CBOE data simultaneous purchases or sales of calls and puts with the same strike and time to expiration could be due either to investors trading straddles, or to different investors within the same group separately trading calls and puts. Similarly, simultaneous purchases or sales of calls and puts where the puts have a lower strike price but the same time to expiration could be due either to investors trading strangles or to different investors within the same group separately trading the options. Consequently, although the CBOE data do not allow us to estimate the frequency of straddles and strangles, they do allow us to place upper bounds on the prevalence of these strategies.[18]

Consider the open volume of a particular customer class (e.g., customers of discount brokers) on underlying *s* on date *t*, e.g. EMC on 23 April 1996. Let U_{st}^{T} be an upper bound on the open volume on date *t* due to trades of a given type (such as at-the-money straddles) in options on underlying *s* with expiration date *T*, so that $\sum_{T} U_{st}^{T}$ is the aggregate (across times to expiration *T*) upper bound on the open volume due to trades of a given type. The construction of the upper bounds $\sum_{T} U_{st}^{T}$ differs for straddles and strangles, and is described below. For each underlying *s* and trade date *t* we construct the ratio

$$R_{st} = \frac{\sum_{T} U_{st}^{T}}{O_{st}}, \tag{4}$$

where O_{st} is the total open volume (both open buy and open sell, both calls and puts) aggregated across all strikes and expiration dates that are available for trading for underlying *s* on date *t*. Thus, the ratio R_{st} is an upper bound on the proportion of the day *t* open trading volume in options on underlying *s* that could possibly be due to a given type of opening trades. The results presented below consist of averages of these ratios across *s* and *t*.

The trade types we consider are at-the-money (ATM) straddles, straddles that are either at or near-the-money (ANTM), and strangles. We begin with ATM straddles. Let $[p_{st}^{\text{low}}, p_{st}^{\text{high}}]$ denote the high-low range for underlying stock *s* on date *t*, and let $X_{\ell t}^{T}$ denote the ℓth strike at expiration *T*. For the purposes of this analysis, an at-the-money straddle is defined to be a straddle where the strike $X_{\ell t}^{T}$ falls within the day's high-low range, i.e. $X_{\ell t}^{T} \in [p_{st}^{\text{low}}, p_{st}^{\text{high}}]$. Exploiting the fact that open volume can only be due to a straddle if there is matching put and call volume at the same strike for the same expiration date *T*, an upper bound on the buy (sell) straddle volume at strike $X_{\ell t}^{T}$ and expiration *T* is twice the minimum of the open buy (sell) call volume and the open buy (sell) put volume at $X_{\ell t}^{T}$. The possible ATM straddle buy or sell volume is then obtained by summing over the strikes that fall within the day's high-low range. Thus, for buy (sell) ATM straddle volume, the upper bound U_{st}^{T} is defined by

$$U_{st}^{T} = \sum_{\substack{\ell \text{ s.t.} \\ X_{\ell t}^{T} \in [p_{st}^{\text{low}},\ p_{st}^{\text{high}}]}} 2 \times \min\left[\text{open buy (sell) call vol. at } X_{\ell t}^{T}, \text{open buy (sell) put vol. at } X_{\ell t}^{T}\right]. \qquad (5)$$

On many days for many underlying stocks no strike price falls within the day's high-low range, implying that the measures of at-the-money straddle volume will be zero by construction. Thus, we broaden the measure of straddle activity to consider at-or-near-the-money (ANTM) straddles. An ANTM straddle is defined to be a straddle for which the strike falls within 100α percent of the day's high-low range for the underlying stock price, that is in equation (5) the sum is over ℓ such that $X_{\ell t}^{T} \in [(1-\alpha)p_{st}^{\text{low}}, (1+\alpha)p_{st}^{\text{high}}]$. In the results reported below we use $\alpha = 0.05$ and $\alpha = 0.10$, that is we use strikes that fall within either five or 10 percent of the day's high-low range for the underlying stock price.

Turning to strangles, let p_{st} denote the closing price of underlying *s* on date *t*. A bought (written) narrow strangle is defined to be a bought (written) call at the smallest strike price greater than or equal to p_{st} together with a bought (written) put at the largest strike price less than or equal to p_{st} and not equal to

the strike price of the call, while a bought (written) narrow or broad strangle is defined to be a bought (written) call at either of the two smallest strike prices greater than or equal to the day's closing price p_{st} and a bought (written) put at either of the two largest strike prices less than or equal to p_{st} and not equal to the lesser of the call strike prices. Let A_{st}^T be the set of call strike prices that satisfy these conditions on date t for underlying s and expiration T, and let B_{st}^T denote the set of put strike prices that satisfy these conditions. For narrow strangles the sets A_{st}^T and B_{st}^T will each have only one element, while for narrow or broad strangles they will each have two elements. Using these definitions, for narrow or narrow and broad strangles the upper bound on volume is defined by

$$U_{st}^T = 2 \times \min\left[\text{open buy (sell) call vol. at } X_{\ell t}^T \in A_{st}^T, \text{open buy (sell) put vol. at } X_{\ell t}^T \in B_{st}^T\right]. \quad (6)$$

Table 6 reports averages of the upper bounds on the proportions of option open volume that could possibly be due to various straddles and strangles for the three customer groups. For each trade date and each underlying stock we use equation (4) together with either of equations (5) or (6), respectively, to compute the upper bound on the proportion of straddle or strangle volume. Then for each calendar month we compute an equally-weighted average of the upper bounds for each underlying stock on each trade date. Finally, we calculate a simple average over the months. Hence, the averages reported in the table are average upper bounds on the proportion of option trading volume that could possibly be due to the various straddles and strangles.

Each column reports results for a particular kind of option trade (e.g., ATM bought straddles). The three panels show the average proportions for the three groups of customers, and the rows within the panels report the results for all underlying stocks and also disaggregate the results according to whether the underlying stock is small, medium, or large-capitalization. Large-capitalization firms are defined as above, medium-capitalization firms are the next largest 500 firms, and small-capitalization firms are comprised of the remaining companies.

The first two columns headed "ATM bought" and "ATM written" show the average proportions of open volume that could possibly be due to at-the-money bought and written straddles, respectively, where as above a straddle executed on a particular day is considered to be at-the-money if the strike is within the day's high-low range for the underlying stock. For example, for the firm proprietary traders in the row labeled "All", the numbers 0.65% and 0.34% in the first and second columns indicate that at most 0.65% of open volume (both bought and written) was due to ATM bought straddles, and on average at most 0.34% of open volume was due to ATM written straddles. The sum of these two numbers, 0.99%, is the average proportion of open volume that could possibly be due to either bought or written ATM straddles.

The average upper bounds in these two columns, and elsewhere in the table, are uniformly increasing across small, medium, and large-capitalization stocks. The pattern of increasing upper bounds across small, medium, and large-capitalization stocks is at least partly, and perhaps entirely, due to the fact that buy (sell) open call and put volume in the same strike and time to expiration is counted as possible bought (written) straddle volume even though the calls and puts might have been traded by different investors in the same investor class. This misidentification of trading by different investors as straddle volume is likely to be more common when there is more trading volume in options on an underlying stock. Because option volume is positively correlated with the market capitalization of the underlying stock, this misidentification will be least common for the small-capitalization stocks and most common for the large-capitalization stocks. This correlation between misidentification of straddles (and strangles) and market value is the reason that in this table we report equal-weighted averages rather than the market capitalization weighted averages reported elsewhere in the paper. Because the equal-weighted averages give less weight to the stocks where misidentifications are most likely, the equal-weighted averages are better measures of the frequency of straddle activity. For the same reason, the average proportions for the small and medium capitalization stocks likely provide a better measure of the prevalence of straddles, although even these proportions provide upward-biased estimates of the true prevalence. The misidentification of trading by different investors as straddle and strangle volume is also

likely to be more common for full service customers, as these customers account for the bulk of the total option trading volume.

The most striking feature of these average upper bounds on ATM straddle volume is that they are small, with all of the averages being less than one percent. The average upper bounds are low partly because in some cases there are no strikes within the day's high-low range for the underlying stock. The third through sixth columns address this issue by reporting the average proportions for at-or-near-the-money straddles defined by $X_{\ell t}^{T} \in [(1-\alpha)p_{st}^{\text{low}}, (1+\alpha)p_{st}^{\text{high}}]$, where the third and fourth columns use $\alpha =$ 0.05 and the fifth and sixth columns use $\alpha = 0.10$. As must be the case, open volume that could be due to at-or-near-the-money straddles is more frequent than open volume that could be due to at-the-money straddles, and open volume that could be due to at-or-near-the-money straddles defined by $\alpha = 0.10$ is more common than open volume that could be due to at-or-near-the-money straddles defined by $\alpha = 0.05$. But even with the broader definition of an at-or-near-the-money straddle, the largest average upper bounds are the 2.88% and 2.75% upper bounds on the proportions of full service customer open volume in large-capitalization stocks due to bought and written at-or-near-the-money straddles defined by $\alpha =$ 0.10. The corresponding average upper bounds for the discount customers and firm proprietary traders are smaller, and for all three customer classes the upper bounds for medium and small-capitalization stocks are considerably smaller.

The four right-most columns show the average upper bounds on the proportions of open buy volume that could possibly be due to narrow or narrow and broad strangles. These averages are similar to those for straddles, both in terms of the overall levels and the patterns across the different market-capitalization categories. For example, the largest percentage in these four columns is the 2.44% average upper bound on the proportion of open volume that could be due to narrow or broad strangles on large capitalization stocks written by customers of full-service brokers, and most of the averages are much smaller than 2.44%. These results make it clear that strangles also account for at most a small fraction of option trading volume.

Overall, the results in Tables 6 provide compelling evidence that volatility trading via straddles and strangles accounts for at most only a small proportion of option trading. Similar unreported analyses show that butterfly spreads also can account for at most a small fraction of option activity. In light of the prominence given to such strategies in option textbooks, this is somewhat surprising. An important caveat is that most option positions provide some exposure to volatility, so documenting that volatility trading through straddles, strangles, and butterflies cannot account for a large fraction of option activity does not rule out the hypothesis that investors use other option strategies to trade on volatility. Nonetheless, straddles, strangles, and butterfly spreads are widely viewed as the most natural ways to trade upon beliefs about volatility, and it seems unlikely that investors are making widespread use of other strategies primarily to trade on beliefs about volatility if they are not using straddles, strangles, and butterfly spreads.

3.2 Speculating on and hedging changes in stock prices

If investors are not trading options in order to bet on or hedge against changes in stock price volatility, then they are likely either speculating on or hedging directional changes in stock prices. In terms of open interest, bought calls are the second most important option position, and in terms of open volume, bought calls are the most important. In light of the low prevalence of short sales of common stock (see, e.g., Dechow et al. 2001, Lamont and Stein 2004), it is unlikely that a large fraction of call purchases are motivated by a desire to hedge short stock positions.[19] It seems particularly unlikely that the heavy call buying by discount customers is intended to hedge short stock positions, as Barber and Odean (2005) report that only 0.29% of the stock positions held by customers of a large discount brokerage (which is a major component of the discount broker category in the CBOE data) are short. The plausible alternative hypothesis is that the call purchases are motivated primarily by speculation that underlying stock prices will increase. Given the relatively high level of activity in bought calls, it appears that a significant fraction of option trading is speculative in nature.

The motivation for put buying could be either to hedge long stock positions using protective puts or to use the option market to create short exposure to the underlying stock. Absent data on investors'

stock positions, we cannot assess the relative importance of these two motivations. Nonetheless, the low prevalence of put buying implies that the factors that motivate put buying are less important in determining the overall level of option activity than are the factors that motivate put writing and call buying and writing.

Call writing is the most important category of option trade, based on open interest, and the second most important, based on open volume. Given our finding above that volatility trading using straddles and strangles is a small component of option activity, it is likely that most call writing (i) is motivated by a desire to create a synthetic short position in the underlying stock, or (ii) consists of covered calls. The results in Tables 1-5 do not allow us to estimate how much call writing results from each of these motives. It is worth noting, however, that call writing is not a natural way to profit from beliefs that the stock price will decline, because the profit is limited to the option premium while the potential loss is unbounded. Below we present evidence from a different data set indicating that investors who write calls tend to own the underlying common stock, i.e. they are writing covered calls. Covered-call writing is consistent with hedging motivations, though the protection provided is limited to the option premium.

Relative to buying puts, there is a lot of activity in selling puts. Although written puts can hedge short positions in the underlying stock, the low prevalence of stock short sales makes it seem unlikely that such hedging accounts for an important share of the observed put writing.[20] Written puts do provide positive exposure to stock price changes, though the fact that the possible profit is limited to the option premium might make one think that put writing is not the most natural way to profit from beliefs about stock price increases. However, the literature oriented toward retail investors (e.g., Kadavy 2003, Groenke 2004) and some literature oriented toward institutional investors (Angel, Gastineau, and Weber 1999) reveals that some investors use put writing as a means to acquire the underlying stocks at favorable prices.[21] In light of this, and because it cannot easily be interpreted as due to hedging, it appears that much put writing is speculative in nature.

3.3 Additional evidence on option strategies

The primary data set used in this paper does not include information on the stock positions of the option investors. We address this limitation by using a data set from a large discount brokerage firm that was first studied in Odean (1998) and that is described there and in Barber and Odean (2000). The Odean data contains monthly account summaries of 78,000 households from the period from January 1991 to November 1996. The account holdings are predominantly common stocks, followed by mutual funds and a broad range of other securities such as government bonds, corporate bonds, foreign securities, and derivatives, including options on common stocks. Of the month-end position statements, 1.3% show individual equity options.

In these data, option positions are identified through a nine character CUSIP.[22] In the standard rule for assigning option CUSIPs, the first six characters identify the underlying stock. When the seventh character is a '9', the security is an individual equity option. The eighth character is a letter that identifies the option class (i.e., put or call) and the expiration month. The standard rule is that 'A' through 'L' correspond to calls that expire, respectively, in January through December and 'M' through 'X' correspond to puts that expire, respectively, in January through December. The ninth character is a letter that maps to the strike price. The main CBOE volume data used in this paper come with explicit identification of option classes, expiration months, and strike prices, and the Odean discount brokerage house is among the brokerage houses included in the CBOE discount category. A comparison of the CBOE data and the Odean option data indicates that the first six characters of the CUSIP correctly map to the underlying stocks but that the standard option class, expiration, and strike price mapping rules for the eighth and ninth characters often are not followed. By comparing the CBOE and Odean data we have confirmed that the standard mapping provides valid information about the class of the Odean options, and we limit our investigation to analyses where we only need to determine the class of an option, i.e., whether it is a put or a call. We proceed under the assumption that the standard mapping correctly identifies option classes, but when interpreting our results keep in mind that the standard rule sometimes misclassifies a call as a put or vice versa.

For the month-end position summaries that include equity options, Table 7 shows the proportions of the options that consist of purchased and written calls and puts, as well as the proportions of the options positions of various kinds. For this table, an option position is defined to consist of all of the options on a single underlying that appear in a month-end account summary. For example, if a month-end account summary includes options on Microsoft and Dell, all of the Microsoft options comprise one option position and all of the Dell options comprise another. The second and third columns of results decompose the overall percentages in the first column of results into the parts that are due to option positions for which the accounts hold the underlying stock and option positions for which the accounts do not contain the underlying stock, so the percentages in the second and third columns sum to those reported in the first column.

This sample from the large discount broker confirms the basic finding from the CBOE data that for customers of discount brokers option writing dominates option buying. In the "All positions" column, the percentages of written calls and written puts sum to 31.9% + 24.3% = 56.2%, while the percentages of bought calls and bought puts sum to 25.7% + 18.1% = 43.8%. As above, the low prevalence of bought puts is of particular interest.

These additional data also shed light on several questions that could not be answered using the CBOE data. In the top part of the table, we see that 3.8% of the option positions consist of bought puts when the household holds the underlying stock, and 14.3% of positions consist of bought puts when the account does not contain the underlying stock. Lower down, 2.8% of the option positions consist of bought puts exclusively when the account also contains the underlying stock, and 12.6% of positions consist of bought puts exclusively when the household does not own the underlying stock. Taken at face value, these percentages suggest that protective puts are only about one-fifth as frequent as naked purchased puts. This conclusion must be qualified by the recognition that some bought calls have been incorrectly classified as bought puts and some bought puts have been incorrectly classified as bought calls due to the limitation of the Odean data described above. In the row "Bought calls," however, one can see that bought options that are in the accounts of households that hold the underlying stock and that are

classified as calls comprise only 5.8% of option positions and bought options that are in the accounts of households that do not hold the underlying stock and that are classified as calls comprise 19.9% of option positions. The conclusion that protective puts are less frequent than puts purchased in order to profit from stock price declines would be reversed only if when the household owns the underlying stock misclassifications consist predominantly of puts incorrectly classified as calls (so the correct proportion of protective puts is considerably greater than 3.8%) and when the household does not own the underlying stock misclassifications consist predominantly of calls incorrectly classified as puts (so the correct proportion of naked bought puts is considerably smaller than 14.3%). While possible, this seems unlikely. There is no reason to believe the misclassifications are correlated with households' ownership of the underlying stock, because there is no reason to believe the discount brokerage's deviation from the standard option coding system is related to its account holders' ownership of the underlying stocks.

Turning to written calls, 23.1% of the options consist of written calls when the household holds the underlying stock and only 8.8% of options consist of written calls when the household does not own the underlying stock.[23] Lower down, 20.2% of the option positions consist of written calls exclusively when the household holds the underlying stock, and 7.3% of positions contain exclusively written calls when the household does not own the underlying stock. Taking these percentages at face value, for customers of the large discount broker written calls are predominantly covered calls. These percentages indicate that covered call writing is the leading option strategy. This conclusion about the dominance of covered call writing would be reversed only if when the household owns the underlying stock misclassifications consist predominantly of puts being incorrectly classified as calls (so that the correct proportion of written calls is considerably smaller than 23.1%) and when the household does not own the underlying stock misclassifications consist predominantly of calls being incorrectly classified as puts (so that the correct proportion of written calls is much greater than 8.8%). Once again, while possible, this seems unlikely.

3.4 Summary

Overall, we can reach the following conclusions about the motivations for option trading. Volatility trading through straddles, strangles, and butterflies—whether for speculative or hedging purposes—explains at most a small fraction of option trading. This finding indicates that most option market activity speculates on or hedges directional changes in stock prices. Covered calls constitute an appreciable fraction of this activity. Covered calls hedge stock price declines to some extent, but their effectiveness as such hedges is limited to the premium obtained when the calls are sold. Protective puts provide a more complete hedge against stock price declines, but there are two reasons to believe that this type of directional hedging is not common. First, our main data set indicates that purchasing puts is less common than writing puts or purchasing or writing calls. Second, at least for the Odean investors, purchased puts are more often held naked than held in conjunction with the underlying stock. Indeed, speculation on directional moves of the underlying stocks appears to be a leading motivation for the use of options. A large fraction of option market activity is comprised of purchasing calls and writing puts. Since short stock positions are known to be uncommon, this activity is most likely motivated by speculation that underlying stock prices are going to increase.

4. Investor Behavior in the Option Market During the Stock Market Bubble

This section of the paper explores changes in option market activity over time by the various classes of investors with a special emphasis on the stock market bubble of the late 1990s and early 2000. We will compare option market activity by the different investor classes during the bubble period with their activity before and after the bubble. In order to simplify the discussion, we define 1990-1994 as the pre-bubble period, 1995-1997 as the beginning of the bubble, 1998-March 2000 as the height of the bubble, and April 2000-2001 as the post-bubble period.

4.1 Option market activity through time

Tables 8 and 9 report the average daily open volume and average daily open interest, respectively, as percentages of shares outstanding for each of the subperiods of 1990-2001 and for each of

the investor groups, as well as results for aggregate non-market makers which are simply the sums of the open volume or open interest of the four investor groups. For each investor class the tables report the statistics for purchased calls, purchased puts, written calls, and written puts, as well as the net open volume or open interest. The net open volume (interest) is defined as the sum of the purchased call and written put open volume (interest), minus the sum of the written call and purchased put open volume (interest). Thus, net open volume and net open interest measure the delta-equivalent net option volume and option open interest, respectively.

Table 8 shows that the option trading activity of discount customers changed during the bubble period. The open buy call volume for the discount investors approximately doubles from the pre-bubble period to the beginning of the bubble and increases by about another 50 percent from the beginning of the bubble to the height of the bubble. It then falls by a factor of three from the height of the bubble to the post-bubble period. Written puts, which also have positive exposure to underlying stock prices, show a similar pattern, though the volumes are smaller and the percentage decrease in the post-bubble period is not as pronounced. Discount customers also increased their call writing and put buying to open new positions, though the increase in put buying was smaller than the increases for the other three categories, and the relative increases in call writing and put buying were smaller than the changes in call buying and put writing. For all four types of volume the differences between the open volumes at the height of the bubble and the averages of the open volumes during the other three periods are highly significant, with *t*-statistics ranging between 8.2 and 14.3.[24] The overall net long buying is shown in the right-most column headed "Net," and displays a pattern similar to the call buying, with the average open volume at the height of the bubble again being significantly different from the average of the other periods. This similarity is not surprising, as call buying constituted 56% of discount customer option activity during the bubble.

Table 9 showing the open interest by period and investor class confirms that the option activity of discount customers changed during the bubble period. Purchased call, written put, and written call open interest increased during the bubble period. For these three types of positions, average open interest

during the height of the bubble was significantly different from the average during the other three periods, with *t*-statistics ranging from 3.8 to 7.4.[25] To the extent that written calls are covered calls, all three of these types of positions involve delta-equivalent net long positions in the underlying stock. Open interest in purchased puts, the only positions that unambiguously create negative exposure (or offset positive exposure) to the underlying stocks, decreased. The net open interest displays a pattern similar to the purchased calls, increasing from the pre-bubble to the beginning of the bubble and then increasing again at the height of the bubble, and finally decreasing by a factor of almost two during the post-bubble period. Taken together, Tables 8 and 9 make it clear that discount customers used the option market to create positive exposure to stock prices during the bubble period. These patterns suggest that the least sophisticated investors in the market substantially increased their option market speculation that stock prices would rise throughout the bubble and then dramatically cut their option market bets that stock prices would increase after the bubble burst. The option market activity of discount customers also would put some upward pressure on stock prices as option market makers who took the opposite sides of the transactions hedged their positions by buying stocks.

In contrast, for all types of trades the full-service customer open volume is stable from the pre-bubble to the beginning of the bubble period and then falls a bit at the height of the bubble and more substantially in the post-bubble period. Open interest in all categories increased somewhat, but not markedly, at the height of the bubble. However, the net open interest in the rightmost column is smaller during the beginning and height of the bubble than it was during the pre-bubble period, and then increases a bit during the post-bubble period. Hence, it appears that the full-service customers did not increase their option market speculation that stock prices would increase during the bubble period. Similarly, the bubble does not appear to have been an important event for the firm proprietary traders. Their buy and sell open call volume gradually decreased throughout the four sub-periods and their put volume was higher during the pre-bubble period than it was during both the beginning and height of the bubble. Open interest in all categories was highest during the height of bubble, but the net open interest at the height of the bubble was only very slightly higher than during the pre-bubble period.

The fourth group, "Other Public Customers," was responsible for relatively little option activity with no clear patterns in either opening volume or open interest, with the exception of increases in purchased and written put open interest during the post-bubble period.

One of the most interesting results in Tables 8 and 9 relates to the put activity of full-service customers. There is a large literature on the difficulties of establishing short positions in the stock market. Ofek and Richardson (2003) even suggest that short sales constraints were a major contributor to the stock market bubble. Our results, however, reveal that at the height of the speculative bubble option market investors had no special appetite for purchased puts. Panel C of Table 8 shows that full-service open buy put volume decreased during both the beginning and height of the bubble. The corresponding panel of Table 9 shows that purchased put open interest increased somewhat, but was only slightly higher during the height of the bubble relative to the pre-bubble period. Interestingly, Panel E of Table 9 reveals that during the bubble period aggregate non-market maker written put open interest exceeded non-market maker purchased put open interest, implying that during the bubble on average market makers had a net purchased position in puts. This fact suggests that they would have been quite willing to sell additional puts to customers, and thus the failure of other market participants to buy puts during the bubble was not due to unwillingness of market makers to sell.[26]

Finally, Panels A, C, and D of Table 9 reveals that the put open interest, both purchased and written, of firm proprietary traders, full service customers, and other public customers increased markedly during the post-bubble period. Because firm proprietary traders sometimes take positions in order to facilitate the trading of their customers, the increase in their purchased and written put open interests might be due to the positions of the full service customers. Regardless, the changes in the purchased put positions relative to the earlier periods indicate that during the post-bubble period some investors increased their bets that stocks would decline. Because some investors write puts in order to buy the underlying stocks at prices they consider favorable, the put writing could be due to beliefs that some stocks were undervalued.

4.2 Value versus growth

Since the stock market bubble of the late 1990s and early 2000 was concentrated in growth stocks, we next investigate the trading of options on large growth and large value stocks during the four subperiods from 1990-2001. As above, large growth stocks are defined as those in the bottom BM ratio quartile among the 500 largest market capitalization firms and large value stocks are defined as those in the top BM ratio quartile among the 500 largest market capitalization firms.

Table 10 contains for each investor group and each of the four subperiods the average daily open volume as a percentage of shares outstanding separately for underlying growth and value stocks. Table 11 contains the corresponding measures of average open interest. Panels B and G of Table 10 show that for the discount customers, for all of the subperiods and for both growth and value stocks, the most important activity is buying calls. The activity in the other three types of option positions is much smaller, and the call buying drives the net buying in the rightmost column. Panels B and G of Table 11 showing open interest confirm that for discount customers purchased calls are most important.

Focusing on the growth stocks, Panel B of Table 10 shows that discount customer open buy volume for calls on growth stocks doubled from the pre-bubble to the beginning of the bubble periods and doubled again during the height of the bubble. It then dropped by nearly a factor of four from the height of the bubble to the post-bubble period. The difference between the average open buy volume at the height of the bubble and the average during the other three periods is highly significant, with a *t*-statistic of 10.6. The corresponding changes in open interest in Panel B of Table 11 were not as striking, but still large and significant. These results are consistent with discount customers chasing returns and perhaps contributing to the bubble. Interestingly, their activity drops substantially when the markets start to correct. Panels G of Tables 10 and 11, on the other hand, indicate that discount customers did not increase their activity in options on value stocks during the bubble period. Open call volume in large value stocks at the height of the bubble was actually less than the average open volume during the other three periods, though the difference is not significant, and purchased call open interest decreased slightly from the beginning to the height of the bubble. Net open volume and open interest increased slightly, but

not significantly, at the height of the bubble. It is also interesting to note from Panels B of Tables 10 and 11 that during the height of the bubble discount customers markedly increased their selling of calls on growth stocks. Insofar as the results from the Odean investors generalize to the universe of discount investors during this later time period, most of these call sales were part of covered call positions that also involve long positions in the underlying stocks. Apart from this generalization, it should be borne in mind that the main activity of discount customers during the bubble was in buying calls. Their call selling activity was small on a relative basis.

Full-service customers, at least relative to discount customers, show a very mild increase in call buying on underlying growth stocks during the bubble. Panel C of Table 10 shows that the open volume increased from 0.00382% in the pre-bubble period to 0.00482% during the height of the bubble, while Panel C of Table 11 shows that purchased call open interest increased from 0.11363% in the pre-bubble period to 0.16199% during the height of the bubble. The increase in the activity in other options was even smaller. The results for options on value stocks are quite different. Relative to the earlier periods, Panels H of Tables 10 and 11 reveal that there is a noticeable reduction in open buy call volume and some reduction in purchased call open interest during the bubble. Puts and written calls have either decreases or small increases in the activity measures. However, for options on both value and growth stocks, there is much less volume in the post-bubble period when the market underwent a substantial correction, and less open interest in calls.

Contrary to the behavior of discount and full-service customers, for firm proprietary traders the bubble period seems to be a non-event in terms of their option open volume, and an event of limited importance in terms of open interest. The option activity of other public customers shows no clear patterns, except for the increase in put open interest during the post-bubble period. In summary, discount customers were most impacted by the dramatic rise in the stock market and substantially increased their activity in growth stocks that performed especially well during that period. Full-service customers responded in a similar fashion to discount customers, although their response was much milder. Neither

of these investor groups seemed to find value stocks of interest during the bubble; they decreased their activity in this segment of the market.

5. Conclusion

Despite the tremendous amount of research over the past three decades into methods for computing the prices and hedge ratios of stock options, very little is known about how investors actually trade these securities. This paper takes advantage of a unique and detailed data set of open interest and volume for all CBOE traded options to investigate the option market activity of several types of investors.

We establish a number of stylized facts about option market activity. We find that for non-market maker investors written positions are more common than bought positions, for both calls and puts. This result is due to full service customers, whose positions comprise the bulk of the aggregate non-market maker open interest. Written put open interest is especially high for value stocks. We also demonstrate that calls dominate puts: non-market maker investors have about four times more purchased call than purchased put open interest, and almost three times as much written call open interest as written put open interest. This predominance of call relative to put open interest holds for all four investor groups. Finally, purchased put positions account for only a small fraction of option activity. This finding is surprising, both because protective puts are a leading strategy discussed in option textbooks and also because naked purchased puts potentially circumvent the costs and difficulties of taking short positions directly in individual stocks.

We also examine a number of option trading strategies that have the potential to account for these stylized facts. We show that the main volatility trading strategies involving straddles and strangles explain at most only a small fraction of option activity. In light of the prominence of such strategies in option textbooks, this finding is also surprising. The fact that volatility trading is not a significant determinant of option activity is important, because it suggests that speculating on or hedging the direction of underlying stock price movements are the main motivations for non-market makers to trade options. Examination of another dataset provides evidence that a large fraction of the call writing that we

observe is part of covered-call strategies. Aside from call writing, however, directional hedging appears to explain a small fraction of option trading. The next two most common positions—bought calls and written puts—are unlikely to hedge the direction of underlying stock price movements because this would require that they hedge short stock positions which are known to be uncommon (see, e.g., Dechow et al. 2001, Lamont and Stein 2004.) Purchased puts that can be used either to bet on stock price declines or to hedge the downside risk of long stock positions account for a small fraction of option activity.

Finally, we assess option trading during subperiods of 1990 through 2001. We find that for our least sophisticated investors both call purchases to open new positions and purchased call open interest increased substantially during the stock market bubble from 1998 through March 2000. Furthermore, this increase was the result of activity in options on growth stocks. In fact, these investors increased their option volume on growth stocks by a factor of four at the height of the bubble but did not increase their activity in value stocks at all. The more sophisticated full-service customers, on the other hand, did not increase their overall open volume in options during the bubble, although they did moderately increase their open volume in call options on growth companies and decrease their volume in options on value companies. In contrast to the other investors, the bubble was a non-event for the firm proprietary traders in terms of their option market activity. Finally, it is quite interesting that none of the investor groups showed any substantial increase in opening put purchases during the bubble period.

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Notes

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[1] The Berkeley Options Database and the CBOE MDR data provide time-stamped trade-by-trade information on option transactions. They do not, however, break down option volume by different investor types or according to whether it is being used to open a new option position or close an existing one. They also do not indicate whether option transactions are buys or sells —although an approximate classification can be achieved through the use of the Lee and Ready (1991) algorithm.

[2] These include Chance (1998), Cox and Rubinstein (1985), Edwards and Ma (1992), Hull (2003), Jarrow and Turnbull (2000), Kolb (2000), MacDonald (2003), Ritchken (1996), and Stoll and Whaley (1993).

[3] Note that the relative popularity among customers of written over purchased puts, and more generally written over purchased options, implies that market makers on average had both net bought put positions and overall net bought option positions. This fact suggests that market makers would have been quite willing to write additional puts had option end users wanted to buy them. Battalio and Schultz (2005) use a different set of arguments to reach the similar conclusion that during the bubble investors could have used the option market to establish bearish positions in internet stocks. The main focus of the Battalio and Schultz paper and the section of our paper on the bubble, however, are different. Battalio and Schultz investigate the question of how investors could have traded in the option market during the bubble but do not address the question of how they actually traded. We concentrate on how investors actually traded in the option market and limit our discussion of whether they could have traded differently to pointing out that in order to balance their inventories market makers in all likelihood would have been happy to satisfy further end user demand for purchased puts.

[4] The other public customer category includes option activity from transactions that originated from registered broker-dealer's personal accounts, foreign broker-dealer accounts, CBOE floor broker error accounts, and customers of brokerage houses that were not classified as discount or full-service by the CBOE analyst.

[5] Each option contract is written on 100 shares of stock. In the empirical work we use Black-Scholes deltas for $\Delta^k_{s,j,t}$. The volatility of the underlying asset for the Black-Scholes delta computation is set to the annualized sample volatility from its weekly log returns over the last 52 weeks excluding the two most extreme values. The assumptions of the Black-Scholes model are violated in a number of ways (e.g., the options are American rather than European and the volatility of the underlying stocks is not constant.) However, since our main results are not altered if we do not delta adjust at all, we believe the Black-Scholes model provides an adequate approximation to delta for our purposes.

[6] The results are not sensitive to reasonable variations in the procedure for computing the averages.

[7] We calculate this percentage in the following way. We first multiply the average daily open interest aggregated across types of open interest and all non-market makers for large stocks (i.e., 0.62%) by two, since there are typically two transactions for a given amount of open interest (one to open the position and the other to close it.) We then multiply this number by 5.3 (= 252/47.5), where 47.5 is the open interest-weighted average trade dates to turnover for large stocks which implies that 5.3 is the average number of times new positions are opened in a year.

[8] These differences are statistically significant at the one percent level using either a *t*-test for the difference in means or the Wilcoxon signed-rank test for the difference in medians.

[9] Ni, Pearson, and Poteshman (2005) show that the corresponding positive net option positions of market makers contributes to the clustering at strike prices of optionable stock prices on expiration dates.

[10] See Gârleanu, Pedersen, and Poteshman (2006) for an analysis of the impact on option prices of risk-averse market makers holding non-zero net option positions.

[11] For each type of investor and for each type of underlying stock the purchased call open interest is statistically greater than the purchased put open interest at the one percent level using either a *t*-test for the difference in means or a Wilcoxon signed-rank test for the difference in medians.

[12] It might be thought that the obstacles to shorting in the stock market will be transferred to the option market through the following mechanism. When an investor buys a put to take a short position on a stock, the market maker who sells the put will typically hedge his position by shorting the stock. Consequently, it might appear that any obstacles to shorting the stock will be transmitted through the market maker to an option market investor who wants to buy a put. This is not the case, however, because option market makers earn higher interest rates on the proceeds from their short sales and are able to short shares without actually locating anybody who is willing to lend them. On the latter point see Evans et al. (2003).

[13] Unreported results for close volume display patterns similar to those for open volume. This is unsurprising, as an investor cannot make a closing transaction unless he or she has first made an opening transaction.

[14] All of these differences are significant at the one percent level except for the cases of large value calls for firm proprietary traders and large value puts for full-service customers. In these two cases, the differences are close to statistically significant for both the *t*-test and the Wilcoxon signed-rank test.

[15] A notable exception is that for firm proprietary traders open volume is negatively related to volatility for all four types of option trades.

[16] The theoretical role of options in helping to complete the market suggests that options also might play a role in allowing investors to trade synthetic state-contingent claims and attain desired lifetime consumption plans that might not otherwise be feasible. However, the hypothesis that investors trade options in order to implement optimal lifetime state-contingent consumption plans is rendered implausible by the short times to expiration and high transaction costs for exchange-traded options.

[17] See, for example, Hull (2003, Section 9.3), McDonald (2003, Section 3.4), Ritchken (1996, Chapter 5), and Stoll and Whaley (1993, Section 12.1). Although not highlighted in the textbooks, straddles and strangles are also natural ways to hedge changes in volatility.

[18] Ni, Pan, and Poteshman (2006) show that option volume that has the potential to be part of straddle trades contains more information about the future volatility of underlying stocks than option volume that could not have been part of straddles.

[19] In order for it to be possible for a large fraction of call purchases to be hedges for short stock positions, option investors who purchase calls would need to have a much greater propensity than other investors for shorting stocks.

[20] Again, such hedging could only be important if option investors who write puts have a much greater propensity than other investors to short stocks.

[21] Specifically, the strategy is to sell out-of-the-money puts on stocks the investors consider to be cheap. The put writing is characterized as a win-win situation. Either the buyer will not exercise and the put seller will just keep the put premium or the buyer will exercise in which case the seller will keep the premium and buy the stock at a price lower than the current price which is already perceived to be attractive.

[22] These CUSIPs are not regular CUSIPs, in that they are not assigned by the CUSIP Service Bureau and are not used by the Options Clearing Corporation. Rather, they are assigned by the discount brokerage and used in its internal operations.

[23] It is interesting to note that the disparity is greater for larger accounts. For accounts with balances over $100,000, 29.4% of the options consist of written calls when the household holds the underlying stock and only 10.6% of options consist of written calls when the household does not own the underlying stock. For accounts with balances over $500,000, the percentages are, respectively, 33.8% and 11.1%.

[24] Wilcoxon rank sum tests of differences in medians also confirm that the differences between the height of bubble and the averages of the other three periods are highly significant.

[25] As with the open volume, Wilcoxon rank sum tests support the same inferences.

[26] The aggregate non-market maker open interests in purchased and written calls in Panel E of Table 9 also reveal that market makers on average had a net purchased position in calls during the bubble.

Table 1
Average Daily Open Interest as a Percentage of Shares Outstanding, 1990-2001

This table reports the average daily open interest of individual stock options traded at the Chicago Board Options Exchange (CBOE) during 1990-2001. The data were obtained directly from the CBOE and include information on the type of investor behind each transaction. Four types of investors are analyzed: firm proprietary traders, customers of discount brokers, customers of full-service brokers, and other public customers. All refers to all stocks with CBOE traded option contracts and available stock price data on CRSP. Large refers to the largest 500 market capitalization stocks in the CRSP universe at the end of the previous calendar quarter. Large growth (value) stocks are those in the lowest (highest) book-to-market equity ratio quartile of the 500 largest stocks based on the ratios at the end of each quarter. First, average daily delta-adjusted open interest as a percentage of shares outstanding is calculated for each underlying stock. Next, for each calendar month, market capitalization weighted average daily open interests are calculated over each group for each investor type. Finally, the averages across all calendar months during 1990-2001 are calculated and reported in this table. Net open interest is delta-adjusted purchased call plus written put minus purchased put minus written call open interest.

	Type of Open Interest				
Underlying Stocks	Purchased Call	Purchased Put	Written Call	Written Put	Net
Panel A: Firm Proprietary Traders					
All	0.042%	0.013%	0.031%	0.010%	0.007%
Large	0.043%	0.014%	0.031%	0.010%	0.008%
Large Growth	0.045%	0.014%	0.033%	0.011%	0.008%
Large Value	0.039%	0.019%	0.041%	0.011%	-0.010%
Panel B: Discount Customers					
All	0.033%	0.004%	0.026%	0.009%	0.012%
Large	0.032%	0.004%	0.024%	0.008%	0.012%
Large Growth	0.040%	0.004%	0.027%	0.009%	0.018%
Large Value	0.032%	0.004%	0.024%	0.010%	0.014%
Panel C: Full-Service Customers					
All	0.132%	0.031%	0.198%	0.048%	-0.048%
Large	0.128%	0.029%	0.194%	0.045%	-0.049%
Large Growth	0.136%	0.032%	0.215%	0.046%	-0.064%
Large Value	0.161%	0.035%	0.192%	0.067%	0.001%
Panel D: Other Public Customers					
All	0.024%	0.007%	0.028%	0.006%	-0.004%
Large	0.024%	0.007%	0.027%	0.006%	-0.004%
Large Growth	0.025%	0.008%	0.031%	0.006%	-0.008%
Large Value	0.032%	0.009%	0.027%	0.009%	0.004%
Panel E: All Non-Market Makers					
All	0.232%	0.055%	0.282%	0.072%	-0.033%
Large	0.227%	0.053%	0.276%	0.068%	-0.034%
Large Growth	0.246%	0.057%	0.305%	0.071%	-0.046%
Large Value	0.265%	0.068%	0.285%	0.097%	0.009%

Table 2
Average Daily Non-Market Maker Open Interest for All Underlying Stocks as a Percentage of Shares Outstanding Disaggregated by Option Moneyness and Time-to-Expiration, 1990-2001

This table reports the average daily open interest of individual stock options traded at the Chicago Board Options Exchange (CBOE) during 1990-2001 for short, medium, and long-term options and three different ranges of moneyness K/S. The data were obtained directly from the CBOE. The results in this table are for all underlying stocks. A short-term option is defined to be one with time to expiration τ falling in the interval $\tau \leq 6$ weeks; a medium-term option is one with time to expiration τ falling in the interval 6 weeks $< \tau \leq 18$ weeks; and a long-term option is one with time to expiration greater than 18 weeks. The average daily open interest is computed as follows. First, average daily delta-adjusted open interest as a percentage of shares outstanding is calculated for options in each category for each underlying stock. Next, for each calendar month, market capitalization weighted average daily open interests are calculated for options falling in each category. Finally, the averages across all calendar months during 1990-2001 are calculated and reported in this table. Net open interest is delta-adjusted purchased call plus written put minus purchased put minus written call open interest.

	Type of Open Interest				
Moneyness	Purchased Call	Purchased Put	Written Call	Written Put	Net
Panel A: Short-term options, $\tau \leq 6$ weeks					
$K/S < 0.9$	0.025%	0.001%	0.032%	0.001%	-0.007%
$0.9 \leq K/S \leq 1.1$	0.045%	0.017%	0.061%	0.018%	-0.015%
$K/S > 1.1$	0.002%	0.007%	0.002%	0.008%	0.000%
Panel B: Medium-term options, 6 weeks $< \tau \leq 18$ weeks					
$K/S < 0.9$	0.026%	0.001%	0.032%	0.002%	-0.007%
$0.9 \leq K/S \leq 1.1$	0.036%	0.009%	0.051%	0.012%	-0.013%
$K/S > 1.1$	0.007%	0.006%	0.008%	0.009%	0.001%
Panel C: Long-term options, $\tau > 18$ weeks					
$K/S < 0.9$	0.044%	0.002%	0.037%	0.003%	0.008%
$0.9 \leq K/S \leq 1.1$	0.031%	0.006%	0.035%	0.009%	-0.001%
$K/S > 1.1$	0.017%	0.005%	0.017%	0.008%	0.002%

Table 3
Average Daily Open Volume as a Percentage of Shares Outstanding and Average Turnover Time in Trade Dates, 1990-2001

This table reports the average daily trading volume and average turnover time of individual stock options traded at the Chicago Board Options Exchange (CBOE) during 1990-2001. Only those transactions that are used to open new positions are included in this table. The data were obtained directly from the CBOE and include information on the type of investor behind each transaction. Four types of investors are analyzed: firm proprietary traders, customers of discount brokers, customers of full-service brokers, and other public customers. All refers to all stocks with CBOE traded option contracts and available stock price data on CRSP. Large refers to the largest 500 market capitalization stocks in the CRSP universe at the end of the previous calendar quarter. Large growth (value) stocks are those in the lowest (highest) book-to-market equity ratio quartile of the 500 largest stocks based on the ratios at the end of each quarter. First, average daily delta-adjusted open trading volume as a percentage of shares outstanding is calculated for each underlying stock. Next, for each calendar month, market capitalization weighted average daily open trading volumes are calculated over each group for each investor type. Finally, the averages across all calendar months during 1990-2001 are calculated and reported in this table. The net volume is delta-adjusted purchased call plus written put minus purchased put minus written call open volume. The average trade dates to turnover are calculated by dividing the average daily open interest by the average daily open trading volume.

Underlying Stocks	Purchased Call	Purchased Put	Written Call	Written Put	Net
Panel A: Firm Proprietary Traders					
All	0.00081%	0.00033%	0.00067%	0.00028%	0.00009%
Large	0.00079%	0.00032%	0.00066%	0.00027%	0.00008%
Large Growth	0.00070%	0.00033%	0.00057%	0.00031%	0.00010%
Large Value	0.00089%	0.00040%	0.00084%	0.00029%	-0.00006%
Panel B: Discount Customers					
All	0.00059%	0.00015%	0.00027%	0.00009%	0.00026%
Large	0.00582%	0.00203%	0.00493%	0.00149%	0.00035%
Large Growth	0.00061%	0.00014%	0.00029%	0.00010%	0.00028%
Large Value	0.00057%	0.00015%	0.00026%	0.00009%	0.00026%
Panel C: Full-Service Customers					
All	0.00407%	0.00139%	0.00365%	0.00106%	0.00009%
Large	0.00479%	0.00155%	0.00406%	0.00110%	0.00028%
Large Growth	0.00370%	0.00129%	0.00353%	0.00101%	-0.00012%
Large Value	0.00474%	0.00141%	0.00379%	0.00128%	0.00082%
Panel D: Firm Proprietary Trader Average Trade Dates to Turnover					
All	51	42	45	36	
Large	53	43	46	36	
Large Growth	63	44	56	37	
Large Value	44	49	48	39	
Panel E: Discount Customer Average Trade Dates to Turnover					
All	55	25	93	91	
Large	5	2	5	5	
Large Growth	65	28	93	88	
Large Value	55	29	92	111	
Panel F: Full-Service Customer Average Trade Dates to Turnover					
All	32	22	53	46	
Large	26	19	47	42	
Large Growth	36	25	60	47	
Large Value	34	25	50	53	

Table 4
Average Daily Non-Market Maker Open Volume for all Underlying Stocks as a Percentage of Shares Outstanding Disaggregated by Option Moneyness and Time-to-Expiration, 1990-2001

This table reports the average daily non-market maker open trading option volume on all underlying stock traded at the Chicago Board Options Exchange (CBOE) during 1990-2001 for short, medium, and long-term options and three different ranges of moneyness K/S. The data were obtained directly from the CBOE and include information about whether the transaction opens a new position or closes an existing position. Only those transactions that are used to open new positions are included in this table. A short-term option is defined to be one with time to expiration τ falling in the interval $\tau \leq 6$ weeks; a medium-term option is one with time to expiration τ falling in the interval 6 weeks $< \tau \leq 18$ weeks; and a long-term option is one with time to expiration greater than 18 weeks. The average open trading volume is computed as follows. First, average daily delta-adjusted open trading volume as a percentage of shares outstanding is calculated for options in each category for each underlying stock. Next, for each calendar month, market capitalization weighted average daily open trading volumes are calculated over each group for each investor type. Finally, the averages across all calendar months during 1990-2001 are calculated and reported in this table. The net volume is delta-adjusted purchased call plus written put minus purchased put minus written call open volume.

	Type of Open Volume				
Moneyness	Purchased Call	Purchased Put	Written Call	Written Put	Net
Panel A: Short-term options, $\tau \leq 6$ weeks					
$K/S < 0.9$	0.00042%	0.00004%	0.00021%	0.00004%	0.00021%
$0.9 \leq K/S \leq 1.1$	0.00283%	0.00119%	0.00188%	0.00067%	0.00043%
$K/S > 1.1$	0.00012%	0.00020%	0.00012%	0.00008%	-0.00012%
Panel B: Medium-term options, 6 weeks $< \tau \leq 18$ weeks					
$K/S < 0.9$	0.00023%	0.00004%	0.00011%	0.00004%	0.00011%
$0.9 \leq K/S \leq 1.1$	0.00124%	0.00034%	0.00117%	0.00029%	0.00002%
$K/S > 1.1$	0.00017%	0.00005%	0.00019%	0.00004%	-0.00003%
Panel C: Long-term options, $\tau > 18$ weeks					
$K/S < 0.9$	0.00025%	0.00004%	0.00014%	0.00004%	0.00012%
$0.9 \leq K/S \leq 1.1$	0.00060%	0.00013%	0.00061%	0.00016%	0.00002%
$K/S > 1.1$	0.00019%	0.00003%	0.00022%	0.00004%	-0.00002%

Table 5
Tobit Regressions with Open Volume Dependent Variables, 1990-2001

This table reports the results of Tobit regressions of purchased call, purchased put, written call, and written put open volume on a number of explanatory variables for all stocks with CBOE traded options over the 1990-2001 period. One tobit panel regression is run for every calendar month and the time-series averages of the monthly point estimates are reported along with autocorrelation adjusted *t*-statistics in parentheses. For the monthly panel regressions the unit of observation is a moneyness/time-to-expiration category for an underlying stock and a trade date. There are nine moneyness/time-to-expiration categories defined by short, medium, and long time-to-expiration and low, medium, and high moneyness. The time-to-expiration categories are less than or equal to six weeks, greater than six and less than or equal to 18 weeks, and greater than 18 weeks. The moneyness categories are strike price divided by closing stock price less than 0.9, greater than or equal to 0.9 and less than or equal to 1.1, and greater than 1.1. The explanatory variables include returns of underlying stocks, the same day return (*Rsameday*), the return from trade dates –5 through –1 (*Rweek*), from trade dates –21 through –6 (*Rmonth*), from trade dates –252 through –22 (*Ryear*), and from trade dates –504 through –253 (*R2years*). The book-to-market ratio (*BM*), the volatility of the underlying stock (*Volatility*), the dividend yield of the underlying stocks (*DY*), and a number of dummy variables also serve as explanatory variables. There are dummy variables for a trade date being one of the five trade dates leading up to an ex-dividend date for the underlying stock (*DExDiv*), and for the low moneyness (*DMoneyLow*), high moneyness, (*DMoneyHigh*), medium time-to-expiration (*DMatMed*), and long time-to-expiration (*DMatLong*) categories. Interaction terms are also included as indicated in the table. All coefficients are multiplied by 10,000.

Table 5 – *Continued*
Panel A: Open Volume of All Non-Market Makers

	Dependent Variables							
	Purchased Call		Purchased Put		Written Call		Written Put	
Independent Variables	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat
Intercept	-2.224	-(11.05)	-2.607	-(6.83)	-1.875	-(11.10)	-1.690	-(9.23)
Rsameday	5.977	(5.69)	-4.404	-(6.52)	6.672	(9.89)	-3.092	-(8.11)
Rweek	2.268	(4.76)	0.111	(0.77)	2.473	(6.60)	-0.602	-(6.56)
Rmonth	1.590	(4.82)	0.666	(5.70)	1.066	(5.56)	0.046	(0.50)
Ryear	0.894	(5.07)	0.885	(7.80)	0.575	(5.06)	0.387	(5.57)
R2year	0.471	(5.62)	0.650	(6.19)	0.381	(5.01)	0.356	(6.00)
Ln(1+BM)	-0.220	-(4.45)	-0.417	-(4.13)	-0.187	-(4.56)	-0.179	-(3.58)
Volatility	2.028	(5.07)	0.149	(0.87)	1.666	(6.32)	0.580	(3.52)
DY	0.085	(3.43)	0.148	(3.16)	0.078	(3.13)	0.086	(4.10)
DExDiv	-5.501	-(2.49)	-2.242	-(0.62)	6.122	(2.61)	4.536	(2.89)
DExDiv×DY	-4.958	-(2.16)	-19.600	-(3.46)	-3.421	-(1.33)	-9.051	-(4.25)
DMoneyLow	-1.498	-(6.98)	-1.191	-(10.02)	-2.170	-(12.48)	-0.855	-(10.68)
DMoneyHigh	-1.007	-(7.76)	-1.976	-(10.01)	-0.735	-(7.19)	-1.009	-(10.87)
DMatMed	0.023	(0.64)	-0.366	-(5.94)	0.100	(2.20)	0.048	(1.97)
DMatLong	0.033	(0.58)	-0.797	-(7.82)	0.154	(3.57)	0.187	(6.52)
DMoneyLow ×Rsameday	1.329	(5.66)	4.296	(8.00)	-1.602	-(6.36)	1.816	(7.74)
DMoneyLow ×Rweek	1.378	(6.26)	2.205	(7.39)	0.949	(5.18)	1.280	(7.50)
DMoneyLow ×Rmonth	0.355	(3.29)	0.730	(5.71)	0.584	(5.98)	0.437	(4.77)
DMoneyLow ×Ryear	-0.228	-(5.18)	-0.035	-(0.65)	-0.040	-(0.97)	0.090	(3.11)
DMoneyLow ×R2year	-0.032	-(1.03)	0.066	(1.72)	0.001	(0.04)	0.107	(4.47)
DMoneyHigh ×Rsameday	-5.561	-(5.44)	-5.514	-(6.81)	-3.994	-(7.27)	-0.733	-(3.37)
DMoneyHigh ×Rweek	-4.037	-(6.36)	-4.312	-(8.57)	-3.633	-(6.78)	-1.962	-(8.18)
DMoneyHigh ×Rmonth	-2.252	-(6.06)	-2.679	-(8.58)	-1.959	-(7.22)	-1.511	-(10.38)
DMoneyHigh ×Ryear	-0.799	-(5.94)	-0.984	-(5.91)	-0.601	-(6.11)	-0.592	-(8.27)
DMoneyHigh ×R2year	-0.147	-(3.61)	-0.068	-(0.95)	-0.055	-(1.26)	-0.079	-(2.10)
DMatMed×Rsameday	-3.126	-(5.00)	3.371	(6.72)	-0.716	-(3.95)	0.934	(5.69)
DMatMed×Rweek	-1.154	-(4.02)	0.387	(2.87)	0.058	(0.28)	-0.027	-(0.45)
DMatMed×Rmonth	-0.678	-(5.91)	0.103	(1.88)	-0.083	-(1.16)	-0.169	-(3.84)
DMatMed×Ryear	-0.299	-(5.59)	-0.144	-(3.94)	-0.194	-(5.14)	-0.208	-(9.10)
DMatMed×R2year	-0.205	-(6.62)	-0.198	-(8.00)	-0.168	-(8.10)	-0.136	-(6.84)
DMatLong×Rsameday	-5.164	-(6.54)	5.065	(7.80)	-2.086	-(7.71)	1.327	(5.50)
DMatLong×Rweek	-1.954	-(6.13)	0.627	(3.62)	-0.362	-(1.64)	-0.278	-(3.71)
DMatLong×Rmonth	-1.362	-(6.95)	0.138	(1.31)	-0.296	-(2.40)	-0.413	-(5.59)
DMatLong×Ryear	-0.551	-(6.88)	-0.302	-(5.01)	-0.257	-(4.20)	-0.359	-(9.13)
DMatLong×R2year	-0.324	-(5.40)	-0.414	-(6.95)	-0.312	-(7.04)	-0.262	-(7.30)

Table 5 – *Continued*
Panel B: Closing Volume of All Non-Market Makers

	Dependent Variables							
	Purchased Call		Purchased Put		Written Call		Written Put	
Independent Variables	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat
Intercept	-1.967	-(10.14)	-2.045	-(9.51)	-2.224	-(11.12)	-3.072	-(7.29)
Rsameday	2.550	(4.47)	0.838	(3.77)	12.961	(6.82)	-8.732	-(8.27)
Rweek	2.668	(6.45)	-0.315	-(2.28)	6.467	(5.91)	-3.942	-(6.73)
Rmonth	1.804	(7.31)	-0.307	-(2.13)	2.294	(4.84)	0.202	(1.36)
Ryear	0.641	(5.32)	0.218	(3.36)	0.949	(4.67)	0.882	(7.09)
R2year	0.349	(5.58)	0.367	(5.80)	0.492	(6.14)	0.672	(6.57)
Ln(1+BM)	-0.366	-(7.17)	-0.262	-(4.01)	-0.331	-(6.06)	-0.470	-(4.01)
Volatility	0.642	(3.81)	0.240	(1.78)	1.172	(3.86)	-0.101	-(0.59)
DY	0.139	(4.12)	0.095	(3.04)	0.098	(2.17)	0.238	(3.90)
DExDiv	6.274	(1.93)	6.154	(2.97)	-2.054	-(0.66)	-0.359	-(0.09)
DExDiv×DY	-9.964	-(2.80)	-11.792	-(3.53)	-9.146	-(2.35)	-31.540	-(4.04)
DMoneyLow	-1.087	-(8.66)	-0.644	-(8.79)	-1.019	-(4.78)	-1.753	-(9.94)
DMoneyHigh	-0.542	-(6.01)	-0.584	-(7.96)	-1.440	-(7.20)	-1.480	-(9.51)
DMatMed	-0.331	-(9.77)	-0.376	-(8.76)	-0.502	-(11.60)	-0.844	-(8.37)
DMatLong	-0.678	-(8.16)	-0.656	-(9.27)	-0.842	-(4.77)	-1.570	-(9.25)
DMoneyLow ×Rsameday	3.917	(5.42)	3.653	(9.64)	5.789	(4.86)	8.525	(9.26)
DMoneyLow ×Rweek	4.614	(8.35)	3.974	(10.25)	5.844	(6.48)	6.417	(7.54)
DMoneyLow ×Rmonth	2.527	(7.57)	1.984	(9.69)	2.687	(5.73)	1.760	(6.62)
DMoneyLow ×Ryear	0.278	(4.73)	0.175	(4.68)	-0.026	-(0.74)	0.098	(1.58)
DMoneyLow ×R2year	-0.002	-(0.06)	0.029	(1.43)	-0.026	-(0.63)	0.138	(2.26)
DMoneyHigh ×Rsameday	-6.455	-(8.63)	-5.102	-(9.54)	-10.792	-(6.07)	-8.495	-(5.67)
DMoneyHigh ×Rweek	-6.712	-(8.48)	-4.567	-(10.61)	-7.772	-(5.76)	-6.573	-(7.87)
DMoneyHigh ×Rmonth	-3.552	-(7.79)	-2.572	-(10.18)	-3.429	-(5.95)	-3.726	-(7.95)
DMoneyHigh ×Ryear	-0.683	-(6.67)	-0.693	-(8.69)	-0.853	-(5.48)	-0.934	-(5.93)
DMoneyHigh ×R2year	-0.029	-(0.75)	-0.042	-(0.92)	-0.041	-(0.94)	-0.070	-(1.06)
DMatMed×Rsameday	-1.918	-(3.68)	1.721	(6.90)	-4.801	-(4.48)	4.477	(5.59)
DMatMed×Rweek	-1.315	-(4.24)	1.479	(9.31)	-1.428	-(3.47)	0.971	(5.02)
DMatMed×Rmonth	-0.704	-(6.51)	0.879	(7.00)	-0.366	-(3.73)	-0.090	-(0.79)
DMatMed×Ryear	-0.251	-(6.28)	-0.085	-(3.76)	-0.294	-(5.76)	-0.090	-(1.78)
DMatMed×R2year	-0.135	-(6.95)	-0.145	-(5.22)	-0.186	-(5.80)	-0.240	-(6.79)
DMatLong×Rsameday	-2.748	-(4.72)	2.134	(7.99)	-6.922	-(5.13)	6.577	(6.48)
DMatLong×Rweek	-1.854	-(5.55)	2.005	(8.88)	-2.336	-(5.91)	2.008	(6.50)
DMatLong×Rmonth	-1.033	-(5.97)	1.043	(7.08)	-0.961	-(5.42)	-0.146	-(1.32)
DMatLong×Ryear	-0.341	-(5.69)	-0.129	-(2.45)	-0.527	-(5.56)	-0.350	-(4.16)
DMatLong×R2year	-0.208	-(4.43)	-0.246	-(5.38)	-0.324	-(3.71)	-0.485	-(6.42)

Table 6
Averages of Upper Bounds on Proportions of Open Buy and Open Sell Volume Due to Various Straddles and Strangles, 1990-2001

This table reports averages of upper bounds on the proportions of option open volume that could possibly be due to at-the-money (ATM) straddles, at-or-near-the-money (ANTM) straddles, narrow strangles, and narrow or broad (NB) strangles, for the three customer classes. An ATM straddle is defined to be a straddle for which the strike price is within the day's high-low price range for the underlying stock, while an Aα%NTM straddle is one in which the strike price is within α percent of the day's high-low range for the underlying stock. A bought (written) narrow strangle is defined to be a bought (written) call at the smallest strike price greater than or equal to the closing price of the underlying stock together with a bought (written) put at the largest strike price less than or equal to the closing underlying price and not equal to the strike price of the call, while a bought (written) narrow or broad strangle is defined to be a bought (written) call at either of the two smallest strike prices greater than or equal to the day's closing underlying price and a bought (written) put at either of the two largest strike prices less than or equal to the underlying closing underlying price and not equal to the lesser of the call strike prices. The upper bounds are computed using equation (4) and either (5) or (6) for straddles and strangles, respectively. Large refers to the largest 500 market capitalization stocks in the CRSP universe at the end of the previous calendar quarter, Medium refers to the next largest 500 market capitalization stocks, and Small refers to the rest.

	Straddles						Strangles			
Underlying stocks	ATM bought	ATM written	A5%NTM bought	A5%NTM written	A10%NTM bought	A10%NTM written	Narrow bought	Narrow written	NB bought	NB written
Panel A: Firm Proprietary Traders										
Small	0.45%	0.30%	0.91%	0.48%	1.17%	0.60%	0.25%	0.16%	0.39%	0.22%
Medium	0.51%	0.26%	1.09%	0.53%	1.22%	0.62%	0.32%	0.24%	0.41%	0.36%
Large	0.74%	0.42%	1.81%	0.95%	2.04%	1.06%	0.74%	0.34%	0.80%	0.36%
All	0.65%	0.34%	1.46%	0.74%	1.67%	0.85%	0.55%	0.28%	0.64%	0.33%
Panel B: Discount Customers										
Small	0.22%	0.28%	0.37%	0.48%	0.43%	0.59%	0.29%	0.35%	0.34%	0.43%
Medium	0.38%	0.35%	0.69%	0.71%	0.79%	0.81%	0.59%	0.55%	0.69%	0.67%
Large	0.78%	0.43%	1.73%	0.99%	1.91%	1.14%	1.49%	0.85%	1.56%	0.93%
All	0.50%	0.35%	1.04%	0.74%	1.16%	0.86%	0.92%	0.60%	0.99%	0.69%
Panel C: Full Service Customers										
Small	0.35%	0.69%	0.63%	1.32%	0.81%	1.66%	0.57%	1.05%	0.71%	1.41%
Medium	0.60%	0.78%	1.24%	1.63%	1.53%	1.98%	0.94%	1.42%	1.10%	1.82%
Large	0.97%	0.90%	2.45%	2.31%	2.88%	2.75%	1.82%	2.12%	1.95%	2.44%
All	0.68%	0.80%	1.60%	1.82%	1.92%	2.21%	1.25%	1.62%	1.38%	1.98%

Table 7
Frequency of Equity Option Positions Based on Pooled Month-End Positions of the Customers of a Large Discount Broker

This table shows the frequencies with which various options and option positions appear in the month-end position summaries of the customers of a large discount brokerage firm. An option position consists of all options (both calls and puts, bought and written) on a particular underlying held in an account at a month-end. The discount brokerage firm database from which the position summaries were taken covers the period January 1991 through November 1996, and is described in Odean (1998) and Barber and Odean (2000).

	All positions	Positions for which account holds the underlying stock	Positions for which account does not hold the stock
Number of equity options positions	94,544	45,691	48,853
Percentages of options consisting of:			
Bought calls	25.7%	5.8%	19.9%
Written calls	31.9%	23.1%	8.8%
Bought puts	18.1%	3.8%	14.3%
Written puts	24.3%	15.6%	8.7%
Total	100.00%	48.3%	51.7%
Percentages of positions consisting of:			
Bought calls only	22.5%	4.5%	18.1%
Written calls only	27.5%	20.2%	7.3%
Bought puts only	15.4%	2.8%	12.6%
Written puts only	20.5%	13.0%	7.5%
Multiple types	14.1%	7.8%	6.2%
Total	100.00%	48.3%	51.7%

Table 8
Large Stock Average Daily Open Volume as a Percentage of Shares Outstanding for Subperiods of 1990-2001

Panels A through E of this table reports the average daily trading volume of individual stock options traded at the Chicago Board Options Exchange (CBOE) for large underlying stocks during subperiods of 1990-2001. Only those transactions that are used to open new positions are included in this table. The data were obtained directly from the CBOE and include information on the type of investor behind each transaction. Four types of investors, firm proprietary traders, customers of discount brokers, customers of full-service brokers, and other public customers, are analyzed. The large underlying stocks are the largest 500 market capitalization stocks in the CRSP universe at the end of the previous calendar quarter. First, daily average delta-adjusted open trading volume as a percentage of shares outstanding is calculated for each underlying stock. Next, for each calendar month, daily market capitalization weighted average open trading volumes are calculated over each group for each investor type. Finally, the averages across all calendar months during each subperiod are calculated and reported in this table.

	Type of Open Volume				
Underlying Stocks	Buy Call	Buy Put	Written Call	Written Put	Net
Panel A: Firm Proprietary Traders					
1990-1994	0.00091%	0.00034%	0.00078%	0.00029%	0.00007%
1995-1997	0.00077%	0.00024%	0.00062%	0.00020%	0.00011%
1998-March 2000	0.00065%	0.00028%	0.00055%	0.00020%	0.00003%
April 2000 - 2001	0.00050%	0.00042%	0.00041%	0.00035%	0.00003%
Panel B: Discount Customers					
1990-1994	0.00047%	0.00014%	0.00018%	0.00006%	0.00022%
1995-1997	0.00082%	0.00018%	0.00029%	0.00011%	0.00045%
1998-March 2000	0.00119%	0.00023%	0.00049%	0.00021%	0.00068%
April 2000 - 2001	0.00034%	0.00009%	0.00034%	0.00011%	0.00001%
Panel C: Full-Service Customers					
1990-1994	0.00432%	0.00141%	0.00388%	0.00103%	0.00006%
1995-1997	0.00433%	0.00137%	0.00353%	0.00104%	0.00048%
1998-March 2000	0.00380%	0.00125%	0.00316%	0.00114%	0.00053%
April 2000 - 2001	0.00165%	0.00095%	0.00207%	0.00078%	-0.00058%
Panel D: Other Public Customers					
1990-1994	0.00086%	0.00031%	0.00087%	0.00018%	-0.00014%
1995-1997	0.00039%	0.00016%	0.00025%	0.00009%	0.00006%
1998-March 2000	0.00077%	0.00027%	0.00037%	0.00016%	0.00030%
April 2000 - 2001	0.00041%	0.00022%	0.00029%	0.00012%	0.00003%
Panel E: All Non-Market Makers					
1990-1994	0.00655%	0.00220%	0.00570%	0.00156%	0.00021%
1995-1997	0.00631%	0.00195%	0.00469%	0.00144%	0.00110%
1998-March 2000	0.00641%	0.00203%	0.00457%	0.00171%	0.00153%
April 2000 - 2001	0.00290%	0.00168%	0.00310%	0.00136%	-0.00052%

Table 9
Large Stock Average Daily Open Interest as a Percentage of Shares Outstanding for Subperiods of 1990-2001

Panels A through E of this table reports the average daily open interest of individual stock options traded at the Chicago Board Options Exchange (CBOE) for large underlying stocks during subperiods of 1990-2001. The data were obtained directly from the CBOE and include information on the type of investor behind each transaction. Four groups of investors, firm proprietary traders, customers of discount brokers, customers of full-service brokers, and other public customers, are analyzed. The large underlying stocks are the largest 500 market capitalization stocks in the CRSP universe at the end of the previous calendar quarter. First, daily average delta-adjusted open trading volume as a percentage of shares outstanding is calculated for each underlying stock. Next, for each calendar month, daily market capitalization weighted average open trading volumes are calculated over each group for each investor type. Finally, the averages across all calendar months during each subperiod are calculated and reported in this table.

	Type of Open Interest				
Underlying Stocks	Purchased Call	Purchased Put	Written Call	Written Put	Net
Panel A: Firm Proprietary Traders					
1990-1994	0.02840%	0.00626%	0.02029%	0.00715%	0.00899%
1995-1997	0.04113%	0.00959%	0.03159%	0.00505%	0.00500%
1998-March 2000	0.06230%	0.01678%	0.04517%	0.00872%	0.00907%
April 2000 - 2001	0.06323%	0.03763%	0.04547%	0.02567%	0.00579%
Panel B: Discount Customers					
1990-1994	0.01874%	0.00346%	0.01449%	0.00535%	0.00614%
1995-1997	0.03811%	0.00465%	0.02839%	0.00718%	0.01224%
1998-March 2000	0.04971%	0.00342%	0.03303%	0.00995%	0.02320%
April 2000 - 2001	0.03498%	0.00274%	0.02969%	0.01212%	0.01468%
Panel C: Full-Service Customers					
1990-1994	0.10853%	0.02276%	0.16733%	0.03834%	-0.04324%
1995-1997	0.14053%	0.02167%	0.21094%	0.03752%	-0.05455%
1998-March 2000	0.14889%	0.02764%	0.22069%	0.04608%	-0.05337%
April 2000 - 2001	0.13717%	0.06076%	0.20403%	0.07576%	-0.05185%
Panel D: Other Public Customers					
1990-1994	0.02616%	0.00569%	0.04000%	0.00631%	-0.01321%
1995-1997	0.01747%	0.00337%	0.01345%	0.00295%	0.00360%
1998-March 2000	0.02454%	0.00720%	0.01915%	0.00462%	0.00281%
April 2000 - 2001	0.02778%	0.01693%	0.02225%	0.01020%	-0.00120%
Panel E: All Non-Market Makers					
1990-1994	0.18182%	0.03817%	0.24213%	0.05716%	-0.04132%
1995-1997	0.23724%	0.03928%	0.28437%	0.05270%	-0.03371%
1998-March 2000	0.28543%	0.05504%	0.31804%	0.06937%	-0.01828%
April 2000 - 2001	0.26316%	0.11806%	0.30144%	0.12375%	-0.03258%

Table 10
Large Growth (Low BM) and Large Value (High BM) Stock Average Daily Open Volume as a Percentage of Shares Outstanding for Subperiods of 1990-2001

This table reports the average daily trading volume of individual stock options traded at the Chicago Board Options Exchange (CBOE) for large growth underlying stocks during subperiods of 1990-2001. Only those transactions that are used to open new positions are included in this table. The data were obtained directly from the CBOE and include information on the types of investor behind each transaction. Four types of investors, firm proprietary traders, customers of discount brokers, customers of full-service brokers, and other public customers are analyzed. Large growth (value) stocks are those in the lowest (highest) book-to-market equity ratio quartile of the 500 largest stocks based on the ratios at the end of each quarter. First, daily average delta-adjusted open trading volume as a percentage of shares outstanding is calculated for each underlying stock. Next, for each calendar month, daily market capitalization weighted average open trading volumes are calculated over each group for each investor type. Finally, the averages across all calendar months during each subperiod are calculated and reported in this table.

	Type of Open Volume				
Underlying Stocks	Buy Call	Buy Put	Sell Call	Sell Put	Net
Panel A: Firm Proprietary Traders, Large Growth					
1990-1994	0.00073%	0.00029%	0.00057%	0.00028%	0.00014%
1995-1997	0.00075%	0.00021%	0.00064%	0.00020%	0.00010%
1998-March 2000	0.00067%	0.00027%	0.00057%	0.00019%	0.00003%
April 2000 - 2001	0.00055%	0.00068%	0.00046%	0.00056%	-0.00002%
Panel B: Discount Customers, Large Growth					
1990-1994	0.00046%	0.00012%	0.00019%	0.00007%	0.00023%
1995-1997	0.00092%	0.00018%	0.00036%	0.00012%	0.00050%
1998-March 2000	0.00188%	0.00033%	0.00070%	0.00031%	0.00116%
April 2000 - 2001	0.00050%	0.00014%	0.00044%	0.00015%	0.00007%
Panel C: Full-Service Customers, Large Growth					
1990-1994	0.00382%	0.00133%	0.00384%	0.00102%	-0.00034%
1995-1997	0.00440%	0.00137%	0.00370%	0.00103%	0.00037%
1998-March 2000	0.00482%	0.00150%	0.00384%	0.00134%	0.00082%
April 2000 - 2001	0.00216%	0.00105%	0.00237%	0.00094%	-0.00033%
Panel D: Other Public Customers, Large Growth					
1990-1994	0.00060%	0.00030%	0.00076%	0.00014%	-0.00031%
1995-1997	0.00036%	0.00013%	0.00022%	0.00007%	0.00007%
1998-March 2000	0.00113%	0.00035%	0.00046%	0.00021%	0.00052%
April 2000 - 2001	0.00053%	0.00026%	0.00037%	0.00013%	0.00003%
Panel E: All Non-Market Makers, Large Growth					
1990-1994	0.00561%	0.00203%	0.00536%	0.00150%	-0.00028%
1995-1997	0.00642%	0.00188%	0.00492%	0.00142%	0.00104%
1998-March 2000	0.00850%	0.00245%	0.00558%	0.00205%	0.00252%
April 2000 - 2001	0.00373%	0.00213%	0.00364%	0.00178%	-0.00026%

Table 10 – *Continued*

Panel F: Firm Proprietary Traders, Large Value					
1990-1994	0.00105%	0.00045%	0.00107%	0.00036%	-0.00011%
1995-1997	0.00080%	0.00029%	0.00067%	0.00016%	0.00000%
1998-March 2000	0.00066%	0.00031%	0.00059%	0.00016%	-0.00009%
April 2000 - 2001	0.00056%	0.00043%	0.00045%	0.00032%	0.00000%
Panel G: Discount Customers, Large Value					
1990-1994	0.00070%	0.00021%	0.00026%	0.00010%	0.00033%
1995-1997	0.00049%	0.00008%	0.00023%	0.00008%	0.00026%
1998-March 2000	0.00054%	0.00009%	0.00025%	0.00012%	0.00031%
April 2000 - 2001	0.00032%	0.00008%	0.00032%	0.00011%	0.00003%
Panel H: Full-Service Customers, Large Value					
1990-1994	0.00633%	0.00185%	0.00469%	0.00159%	0.00138%
1995-1997	0.00382%	0.00101%	0.00330%	0.00102%	0.00053%
1998-March 2000	0.00312%	0.00096%	0.00260%	0.00114%	0.00070%
April 2000 - 2001	0.00175%	0.00086%	0.00204%	0.00086%	-0.00028%
Panel I: Other Public Customers, Large Value					
1990-1994	0.00125%	0.00038%	0.00102%	0.00023%	0.00008%
1995-1997	0.00041%	0.00024%	0.00029%	0.00011%	-0.00001%
1998-March 2000	0.00054%	0.00017%	0.00033%	0.00013%	0.00017%
April 2000 - 2001	0.00052%	0.00023%	0.00032%	0.00013%	0.00010%
Panel J: All Non-Market Makers, Large Value					
1990-1994	0.00933%	0.00289%	0.00704%	0.00227%	0.00167%
1995-1997	0.00552%	0.00162%	0.00450%	0.00137%	0.00078%
1998-March 2000	0.00486%	0.00154%	0.00378%	0.00156%	0.00110%
April 2000 - 2001	0.00316%	0.00159%	0.00313%	0.00142%	-0.00014%

Table 11
Large Growth (Low BM) and Large Value (High BM) Stock Average Daily Open Interest as a Percentage of Shares Outstanding for Subperiods of 1990-2001

This table reports the average daily open interest of individual stock options traded at the Chicago Board Options Exchange (CBOE) for large growth underlying stocks during subperiods of 1990-2001. The data were obtained directly from the CBOE and include information on the types of investor behind each transaction. Three types of investors, firm proprietary traders, customers of discount brokers, customers of full-service brokers, and other public customers, are analyzed. Large growth (value) stocks are those in the lowest (highest) book-to-market equity ratio quartile of the 500 largest stocks based on the ratios at the end of each quarter. First, daily average delta-adjusted open trading volume as a percentage of shares outstanding is calculated for each underlying stock. Next, for each calendar month, daily market capitalization weighted average open trading volumes are calculated over each group for each investor type. Finally, the averages across all calendar months during each subperiod are calculated and reported in this table.

	Type of Open Interest				
Underlying Stocks	Purchased Call	Purchased Put	Written Call	Written Put	Net
Panel A: Firm Proprietary Traders, Large Growth					
1990-1994	0.02780%	0.00726%	0.01781%	0.00736%	0.01009%
1995-1997	0.04088%	0.00762%	0.03346%	0.00461%	0.00442%
1998-March 2000	0.07323%	0.01260%	0.05058%	0.00763%	0.01769%
April 2000 - 2001	0.06514%	0.04854%	0.05367%	0.03480%	-0.00227%
Panel B: Discount Customers, Large Growth					
1990-1994	0.02179%	0.00359%	0.01596%	0.00612%	0.00837%
1995-1997	0.04534%	0.00436%	0.03162%	0.00714%	0.01651%
1998-March 2000	0.06953%	0.00381%	0.04185%	0.01199%	0.03585%
April 2000 - 2001	0.04678%	0.00376%	0.03109%	0.01475%	0.02669%
Panel C: Full-Service Customers, Large Growth					
1990-1994	0.11363%	0.02439%	0.18550%	0.04033%	-0.05593%
1995-1997	0.14558%	0.01930%	0.22966%	0.03125%	-0.07212%
1998-March 2000	0.16199%	0.02780%	0.25718%	0.04046%	-0.08253%
April 2000 - 2001	0.14814%	0.07775%	0.21670%	0.09590%	-0.05041%
Panel D: Other Public Customers, Large Growth					
1990-1994	0.02495%	0.00619%	0.04587%	0.00569%	-0.02142%
1995-1997	0.01689%	0.00296%	0.01385%	0.00237%	0.00246%
1998-March 2000	0.02781%	0.00592%	0.02204%	0.00384%	0.00369%
April 2000 - 2001	0.03246%	0.02148%	0.02646%	0.01339%	-0.00209%
Panel E: All Non-Market Makers, Large Growth					
1990-1994	0.18816%	0.04143%	0.26513%	0.05950%	-0.05889%
1995-1997	0.24871%	0.03423%	0.30858%	0.04538%	-0.04873%
1998-March 2000	0.33255%	0.05012%	0.37164%	0.06392%	-0.02530%
April 2000 - 2001	0.29252%	0.15153%	0.32791%	0.15884%	-0.02808%

Table 11 – *Continued*

Panel F: Firm Proprietary Traders, Large Value					
1990-1994	0.02606%	0.00836%	0.03287%	0.00935%	-0.00583%
1995-1997	0.04394%	0.01788%	0.04653%	0.00655%	-0.01392%
1998-March 2000	0.04655%	0.02567%	0.04665%	0.01036%	-0.01541%
April 2000 - 2001	0.06057%	0.04325%	0.04944%	0.02514%	-0.00698%
Panel G: Discount Customers, Large Value					
1990-1994	0.02827%	0.00527%	0.01980%	0.00912%	0.01231%
1995-1997	0.03838%	0.00469%	0.02914%	0.00907%	0.01362%
1998-March 2000	0.03274%	0.00327%	0.02193%	0.01017%	0.01771%
April 2000 - 2001	0.03273%	0.00252%	0.03112%	0.01576%	0.01486%
Panel H: Full-Service Customers, Large Value					
1990-1994	0.16795%	0.03275%	0.18821%	0.06525%	0.01225%
1995-1997	0.16384%	0.02805%	0.20637%	0.05895%	-0.01163%
1998-March 2000	0.15497%	0.03249%	0.17663%	0.06309%	0.00894%
April 2000 - 2001	0.14745%	0.05963%	0.20059%	0.09223%	-0.02053%
Panel I: Other Public Customers, Large Value					
1990-1994	0.03866%	0.00834%	0.03704%	0.00995%	0.00322%
1995-1997	0.02493%	0.00573%	0.01798%	0.00543%	0.00665%
1998-March 2000	0.02514%	0.00933%	0.02108%	0.00752%	0.00226%
April 2000 - 2001	0.03162%	0.01577%	0.02256%	0.01184%	0.00513%
Panel J: All Non-Market Makers, Large Value					
1990-1994	0.26094%	0.05472%	0.27792%	0.09366%	0.02196%
1995-1997	0.27108%	0.05635%	0.30001%	0.08001%	-0.00527%
1998-March 2000	0.25940%	0.07075%	0.26629%	0.09114%	0.01349%
April 2000 - 2001	0.27238%	0.12116%	0.30370%	0.14496%	-0.00752%