The Time Value of Options and Writing Strategies

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ABSTRACT

This study examines the pattern of stock option time value decay and the implications of the time value decay pattern for option writing strategies. I also consider the returns to various options writing strategies. The central question is whether option writers can utilize a writing strategy that captures the time value of options as revenue to cover their risks and provides return on their investments.

Using transaction data, I find that the time value of options that are near-the-money decays at a decreasing rate. The implications of this result are that a significant portion of the time value of near-the-money options decays in the early days of writing an option and the decay slows down as time to expiry approaches. This motivates us to compare over the same holding periods the writing returns of options with long times to expiry with the returns of options with short times to expiry. Overall, the results suggest that trading of options face significant transaction costs and it is mainly motivated by hedging or speculation as I did not find a systematic way to profit from option writing strategies.

In addition, I examine the impact of market sentiment on the time value of options. The period of the study includes a sub-period when the general trend in the stock market was positive and another sub-period when the trend was negative. In particular, I study the price of puts relative to the price of calls during these two distinct market periods. I find that during bear markets both call and put options are more expensive than call and put options during bull markets. Yet, the ratio of put premiums to call premiums during rising markets is generally higher than the same ratio during bear markets. This observation suggests that speculators may be the dominant traders in options markets.

Overall, I find that option writing strategies are not profitable. One of the reasons for this observation is transaction costs, which are significant in all the strategies that I examine. The bid-ask spread in the options market is large in comparison to the bid-ask spread in the underlying stock market.

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TABLES OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 INTRODUCTION

It has been more than 35 years since options began trading on the CBOE (Chicago Board Options Exchange) and options markets have become more and more active ever since. Now there are more than 2,500 options traded on the CBOE. Theoretically, academics argue that the options market serves a desirable role as it completes the market for the underlying security. It improves the efficiency of the underlying market and allows market participants to take advantage of small deviations between price and value. Furthermore, it increases the efficiency by allowing investors to hedge risky positions and increases their willingness to take positions in the underlying securities. Risk-averse investors often buy options to hedge risk exposure, whereas speculators often buy them to bet on market direction and leverage their position.

However, options are financial assets that have zero net supply, so every buyer must find a writer. Since there is a natural demand for options, but no natural supply, it could be that option writers would require some additional compensation or rent to entice them to write options. On the other hand, there are very few barriers to entry for writing options, so the market should be quite competitive, which should reduce the required additional compensation, (reducing it to zero in a perfectly competitive market). Nelson (1997) finds that the majority of financial options expire worthless, which suggests that option writing may be quite lucrative. He indicates that the time value of options is the premium writers receive for writing options and if the price of the underlying asset remains stable until expiry the writer will pocket the time value unharmed. However, option writers face the possibility of losses far beyond the premium collected from writing. Surprisingly, there is limited literature examining the profitability of stock option writing. My research adds to the literature by examining empirically the pattern of stock option time value decay and the return characteristics of various stock option writing strategies. The particular strategies I consider include writing naked options, covered options, a portfolio of individual options that make up the index and using index options to hedge the portfolio, and writing index options and buying options on the individual assets that make up the index to hedge.

Green and Figlewski (1999) suggest that writing naked options is highly risky and that writing longer maturity options leads to larger losses. Although it has a lower mean return, I could not conclude that writing longer-term options is less profitable than writing shorter-term options because their returns are based on different holding periods. Even if the return is measured as annual return, it is better to compare shorter- and longer-term option writing return during the same holding period.

Tannous and Lee-Sing (2008) reach two important conclusions by employing simulation and the model of Merton (1976) to price options. First, they find that as time passes the expected time value decays at a decreasing rate.[1] Second, they show that the option rolling strategy does not decrease the long position's risk exposure.[2] Their results suggest that a profitable strategy for longer-term option writers would be to hold the option while the decay is fastest in order to collect the majority of the time value and as the decay slows down the writer should buy back the option and write a new one that has fast time value decay. This finding motivates us to compare the writing return on shorter-term and longer-term options during the same time period. I write both longer-term and shorter-term options and buy back longer-term options when the shorter-term options expire. Although the simulation results show that under the assumptions of Merton (1976), the expected time value of writing a one-month option is equal to that of writing a three-month option with the same strike price and closing the short position in one month, as yet no empirical research has tested this theory. Furthermore, the shape of the expected time value decay curve has not been tested by using transaction data. To the best of my knowledge, this work is the first to study these issues.

I extend Tannous and Lee-Sing (2008) to consider the impact of market conditions (or market sentiment) on time value. On the one hand, market sentiment may lead to option price differences in up-trending and down-trending markets. In an up-trending market, there may be more demand for calls, which drives call prices up, while there may be more demand for puts in a down-trending market, which decreases call prices. On the

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1 This means that the expected time value curve is convex. The expected time value is defined as the average time value of an option at a unit of time preceding expiration where the average is calculated assuming that the option will be purchased many times under similar conditions.

2 An option rolling strategy requires buying a series of options to hedge a given risk over a long period of time as opposed to buying a single option that covers the risk over the entire period of concern. The rolling option strategy starts by purchasing an option and after holding it for a period of time the option will be sold and replaced by another option with the same underlying asset.

other hand, Bollen and Whaley (2004) find evidence that net buying pressure does affect options' implied volatility function. They find that the stock volatility increases in severely down-trending markets. Therefore, the option price will increase due to higher volatility, which means both call and put options will be more expensive. In addition, Li (2009) finds that the put-call parity holds well for American options. This result suggests that the call and put price will move in the same direction, assuming other inputs in the equation hold constant. I use the time value of put to time value of call ratio to test whether market conditions affect option values. This measure also helps to explain call and put writing performance during different market conditions.

I also test various stock option writing strategies to determine whether writers could make profit by simply writing stock options to collect the time values. Covered call writing, one of the simplest and most popular strategies, involves writing a call option and at the same time buying its underlying stock. This strategy allows the writer to collect the up-front call premium to reduce the initial cost of buying the stock, and holding the underlying asset provides a hedge to the risk of a stock price rise for which the option writer would otherwise be liable. However, the future return on this strategy is capped at the option's strike price. Previous research focuses mainly on covered call writing on stock indices. Given that individual stock options are quite different from index options in many dimensions, such as the trading patterns, and the patterns of implied and realized volatility, a study of covered call writing on individual stocks is warranted. Research, such as Whaley (2002), Feldman and Roy (2004), and Kapadia and Szado (2007), shows that covered call writing on stock indices can offer a superior return to that of simply buying the underlying index.[3] I expect that writing a portfolio of covered stock call options has similar characteristics.

Investigating covered call writing on individual stocks provides useful implications for portfolio investment. Index option premiums are generally lower than those of stock options due to their lower underlying asset volatility and higher liquidity. If I hold a portfolio consisting of stock call options, I could diversify the individual stock price volatility and enjoy higher option premiums. Therefore, I propose alternative covered writing

[3] In their research, monthly covered call writing return is calculated as the total effect of daily return during the month.

strategies. One such strategy would be writing a portfolio of call options on the individual stocks of an index (in proportion to their index weight) and buy the index call option to hedge. Another strategy would be to write an index call option and buy a portfolio of call options (in proportion to their index weight) on the individual stocks that make up the index. In this study, I use the S&P 100 index as the benchmark for option portfolio writing. Compared to buying the underlying stocks to cover a short position, buying index options is much easier and will reduce the opportunity costs of executing large stock positions. Buying index options only includes transactions in the options market. If stock calls are relatively more expensive than buying index calls, I expect writing stock calls and buying index calls to hedge is a profitable strategy.

The stock options that I consider are American style. Therefore, I must consider early exercise. I assume that if the option's time value is equal to or less than zero, the holder of the long position would exercise.

In this study, I am interested in measuring the relative performance of the various option writing strategies on a risk-adjusted basis. For assets whose returns are normally distributed, previous studies recommend the use of the Sharpe Ratio (Sharpe; 1994) and Jensen's Alpha (Jensen; 1967) to measure the risk-adjusted return. However, these measures may not be appropriate for option returns as these returns are not normally distributed. I use the Sortino ratio, proposed by Sortino and Van Der Meer (1991) and Sortino and Forsey (1996), and Leland's Alpha (Leland; 1999) to measure the risk-adjusted option writing returns. The Sortino ratio and Leland's Alpha are similar to the Sharpe Ratio and Jensen's Alpha but they are designed specifically to measure returns on assets characterised by non-normal return distributions.

I test the impact of transaction costs on option writing returns. For this purpose, I measure returns in two different ways. One way includes transaction costs and calculates return by using the bid price to write options and the ask price to buy options. The other way assumes zero transaction costs and calculates return by using the mid-point of the bid and ask price to write or buy options. The results suggest that transaction costs for stock option trading is significant and option writing is not profitable due to the high transaction cost.

This research contributes to the option writing field in several ways. First, I substantially extend previous research on the pattern of option time value decay. Second, I examine the impact of market sentiment on stock option pricing and find that the one-month option trading volume has more significant impact on the call option pricing than on the put option pricing. Third, I analyse the return for naked option writing, covered call writing and various types of option portfolio writing.

The remainder of the thesis is organized as follows. Chapter 2 reviews the literature related to option writing, stock option characteristics, option's time value, and outlines the research directions. Chapter 3 proposes the research hypotheses and the expected results. Chapter 4 describes the sample data used in the study. Chapter 5 describes the methodology. Chapter 6 presents the empirical findings. Chapter 7 discusses the robustness tests, and Chapter 8 summarizes the conclusions.

CHAPTER 2 LITERATURE REVIEW

2.1 The Pattern of Option Time Value Decay

Time value is defined as the option premium less the option's intrinsic value. Previous studies, for example Figlewski et al (1993), Chidambaram and Figlewski, (1995), and Radoll (2001) argue that the time value decays at an accelerating rate following a concave curve as shown in Figure 1. This pattern suggests that a large portion of an option's time value decays in the later stage of the option's life when it approaches expiration. Thus, writing short-term options may be more profitable than writing long term options. Several previous studies, for example Green and Figlewski (1999) and Hill et al. (2006), examine this proposition and find that writing longer-term options seems to provide a lower return compared to that of shorter-term options.

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However, the decaying pattern reported by Figlewski et al (1993), Chidambaram and Figlewski, (1995), and Radoll (2001) is based on the unrealistic assumption that the underlying stock price stays constant over the option's life. In a more recent study, Tannous and Lee-Sing (2008) use simulation, based on the stock price dynamics developed by Merton (1976), to take the stochastic effect of the stock price into account. They demonstrate that the time value decays at decreasing rate (convex curve) which implies that a large portion of the expected time value decay happens in the early stage of an option's life. In addition, they argue that the expected time value decay is the same for a strategy of writing a shorter-term option or a strategy of writing a longer-term option with the same strike price and buying it back at the expiration of the shorter-term option (see Figure 2). They conclude that although writing a longer-term option could provide a higher premium, it is less risky to write a shorter-term option. For long-term options, the early period is more valuable to the writer and the latter period is highly risky.

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Furthermore, their simulation uses put-call parity to calculate the time value decay for put options. Previous research on whether put-call parity holds in practice has mixed results (e.g. Klemkosky and Resnick; 1979, Nisbet; 1992, and Kamara and Miller; 1995). The explanations for why the equality does not hold include using American option data, the effect of transaction costs, trading restrictions, and the liquidity risk. Recently, Li (2009) examines cross-border listed American style options and observes that the American option put-call parity inequalities hold very well in both US and Canadian markets and arbitrage opportunities are very rare. Therefore, I expect that the call and put options will have similar expected time value decay patterns.

The observed pattern of expected time value decay may differ from the simulation due to model misspecification. Previous research (Green and Figlewski; 1999, Hill et al.; 2006) argues that writing longer-term options underperforms writing shorter-term options. However, these studies do not compare returns during the same holding period. In particular, the return from writing a three-month option and buying it back in one month has not been studied. I compare the returns based on this strategy to the returns that may be obtained from buying a one-month option. The results will empirically explore the theoretical predictions of Tannous and Lee-Sing (2008).

This research takes transaction costs into account by writing at the bid price and buying at the ask price. Copeland and Galai (1983) build an out-of-the-money straddle model and conclude that the bid-ask spread is positively related with the underlying asset price volatility and price level but negatively related with the trading volume. Vijh (1990) argues that the CBOE is highly liquid as its bid-ask spread is nearly equal to the corresponding NYSE stock market bid-ask spread. Cho and Engle (1999) propose a new market microstructure theory (called derivative hedge theory) and argue that the option market bid-ask spread is affected by the illiquidity of the underlying stock market, but surprisingly the option market trading volume has no direct impact on the option bid-ask spread. This is confirmed by examining S&P 100 index options. This interesting finding suggests that the options market behaves quite differently from the stock market. I also explore whether higher stock option trading volume leads to the lower stock option bid-ask spread.

In addition to the above extensions, I also test whether the time value pattern is affected by the market conditions. According to the Black and Scholes (1973) option pricing model, the option price is determined only by five input factors and the supply and demand ought to have no impact on it. Bollen and Whaley (2004) find evidence suggesting that net buying pressure affects options' implied volatility, which suggests that option prices are affected by demand. According to their research, there are more index puts traded than index calls. However, the opposite is observed for individual stock options. Their findings suggest that the index put buying pressure drives the change in volatility of index options, while the stock call buying pressure drives the change in volatility of stock options. Intuitively, the demand for calls and puts would be different in rising and falling markets. I explore whether the time value pattern is different in bull and bear markets. When the market becomes more volatile, the increasing volatility results in higher prices for both calls and puts. The put-call parity also implies that the prices for calls and puts move in a similar pattern. If the market is efficient, I expect that the time value is mainly related to the underlying asset volatility and that the pricing patterns of calls and puts during bull markets to be similar to the patterns during bear markets. I use the ratio of the time value of the put to the time value of the call to test whether the call or put options become relatively more or less expensive under different market conditions.

2.2 Naked Option and Covered Call Option Writing

Merton, Scholes and Gladstein (1978) examine the covered call writing strategies by checking six-month returns with different strike to initial stock price ratios. They use real stock return data and simulated option prices using the Black-Scholes formula. They assume that the six-month options are all held to maturity. The four categories of options, in-the-money, at-the-money, out-of-the-money, and deep-out-of-the-money, each exhibits higher mean return and higher return volatility with the increase of exercise price to initial stock price ratio. The volatility is measured by the standard deviation and the return range. The returns and return volatilities of the four strategies are also lower than those of the underlying stock portfolio. Merton, Scholes and Gladstein (1982) extend the analysis to put options and argue that writing a portfolio of put options produces lower risk and return compared to holding a portfolio of underlying stocks. Trennepohl and Dukes (1981) is among the earliest empirical research to test option writing and buying return. They find that covered call writing improves mean return and lowers return volatility, but the positive skewness of return is cut off. They also argue that assuming no early exercise covered call writing strategies perform better with that involve out-of-the-money options perform better than the covered call writing strategies that involve in-the-money call options. However, due to data limitations, the options included in the sample do not have the same strike to initial stock price ratios. Green and Figlewski (1999) examine the forecast of stock volatility and return of option writing. They find that at-the-money stock index calls have a high probability of producing large losses, with larger losses for longer time to maturity. A reasonable explanation is that the market during the research period (1975 to 1996) was dominated by an upward trend. Writing options with a delta hedge reduces the writer's risk exposure compared to naked writing, but risk is still considerable. They also increase the forecasted volatility input and find a higher mean return and a reduced probability of losses. They suggest that volatility forecasting is crucial to option writing risk management.

The practice of option writing has increased steadily in recent years, and some practitioners apply relatively complicated hedging techniques to manage writing risks (Collins; 2007). However, covered call writing, as the simplest hedged and passive investment strategy, is extensively examined in academic research, especially after the construction of the BXM, the CBOE S&P 500 buy write monthly index. Whaley (2002) constructs the BXM to simulate the passive write-and-hold option strategy of taking a long position in the S&P 500 index at the third Friday of each month, and at the same time, writing a just out-of-the money call option expiring on the third Friday of the next month. He argues that the buy-write strategy outperforms the S&P 500 index on a risk adjusted basis. Feldman and Roy (2004) use a longer data period for the BXM and take skewness and kurtosis of the covered call return into account.[4] They conclude that the BXM index is a good investment choice. Hill et al. (2006) test various fixed strike strategies based on the S&P 500 index. They show that the slightly out-of-the-money strategy (2% OTM) is superior to an at-the-money strategy, and that the three-month writing strategy underperforms the one-month writing strategy.

Some scholars also examine covered call writing based on other stock indices. Guo (2003) uses both simulated and real Dow Jones Industrial Average (DJIA) option prices to test covered call writing performance. He argues that out-of-the-money covered call writing dominates the underlying portfolio, and in-the-money covered call writing was an attractive investment during a bear market using simulated option prices. How-

[4] Whaley (2002) does not consider the skewness effect.

ever, his empirical analysis finds that in-the-money covered call writing performed poorly. He explains that this result might be obtained due to the relative overpricing for out-of-the-money calls. Kapadia and Szado (2007) study covered call writing of the Russell 2000 Index and argue that writing one-month covered calls has a favourable return performance, whereas writing two-month covered calls lags both the index and the one-month writing strategy. They also suggest that transaction costs and the differences between implied and realized volatility are crucial to writing return.

McIntyre and Jackson (2006) examine the returns on covered call writing on 27 randomly selected stocks from the FT-SE 100 index constituents. They find that fewer than 50% of covered calls outperform the underlying stock.

In general, covered call writing is expected to underperform a passive buy-and-hold strategy during up-trending markets, and outperform when markets are stable or down-trending. Covered call returns are limited to an upper bound (the strike price) and exhibit negative skewness and lower standard deviation. Therefore, standard risk measures, such as the Sharpe Ratio and Jensen's Alpha, are not appropriate for covered call returns. The Sortino Ratio, Leland's Alpha (Leland, 1999) and Stutzer index (Stutzer, 2000) are more appropriate to measure the performance of returns characterized by negative skewness.

Is covered call writing a safe and attractive way to invest? The benefit mainly comes from the writing premium which provides limited downside risk protection relative to the uncovered position. Researchers find that the implied volatility is greater than the realized volatility (Balyeat; 2002, Bondarenko; 2003, Hill et al.; 2006). Hill et al. (2006) list four sources of writing return: the fair call premium, the volatility premium, the exercise cost, and the trading cost. They point out that traders usually emphasize the first two premiums but ignore the importance of the costs.

Surprisingly, there is little research on covered stock option call writing, although the characteristics of stock options are quite different from index options. Bakshi and Kapadia (2003b) argue that the implied volatility and the realized volatility for individual stock options are smaller than the implied volatility and the realized volatility of index options. This result is contrary to intuition, since the index options are more liquid and should be more "correctly" priced. Bakshi et al. (2003) find that the volatility smile is steeper and shows more negative skewness for index options than for stock options. This result suggests that index option prices are more sensitive to the strike price. Branger and Schlag (2004) find similar results using German option data and explain this phenomenon by employing a jump diffusion model. Bollen and Whaley (2004) show that there are more index puts traded than index call, and more stock calls traded than stock puts. This suggests that market participants trade index option and stock option for different purposes, which motivates us to explore the writing return on individual stock options.

McIntyre and Jackson (2006) use randomly selected stock options to test covered call writing on individual stocks. However, they fail to conclude whether writing a portfolio of covered calls on individual stocks could beat the benchmark. I plan to examine the returns of writing a portfolio of covered calls on the S&P 100 index stocks. The portfolio is structured so that the weight of each option will be equal to the weight of the underlying security in the S&P 100 index. The main difference from index covered call writing is that the portfolio of covered options may change due to a change of an index constituent. The stock portfolio is built to track the underlying index and its return is close to index return. However, the portfolio of stock options should be more expensive than the index option that has the same time to maturity and a strike price equal to the weighted average of the strike prices of the individual securities that make up the index.[5] Therefore, this strategy should have performance that is different from writing covered calls on the index.

I also analyse the returns from writing a portfolio of call options on individual stocks and covering by buying a call option on the index. Buying an index call rather than individual stocks significantly reduces the transactions costs associated with the strategy. It also helps us to understand the characteristics of stock and index options by checking their return performance. Intuitively, the stock price movement leads to index price change. Buying index call could hedge upside risk and the index option could be exercised to pay the long positions of the stock options if the market goes up. When the mar-

[5] This follows from Jensen's Inequality: $\sum_i w_i \max\{S_T^i - K_i, 0\} \geq \max\{\sum_i w_i (S_T^i - K_i), 0\} = \max\{\sum_i w_i S_T^i - \sum_i w_i K_i\}$. This means that the weighted average of the intrinsic values of the individual stock options is greater than the intrinsic value of the option on the weighted average of the stocks with the exercise price being the weighted average of the individual option strike prices. As the payoff is greater, the value will be greater as well.

ket goes down, the index option becomes out-of-the-money but fewer of the stock options may be exercised. The portfolio of individual stock options is more expensive than the option on the portfolio, so there is an initial cash inflow to the writer. I also consider the opposite strategy of writing an index call and buying the corresponding portfolio of individual stock calls to hedge. Without transactions costs, the return on this strategy is just the negative of the return on the counterpart. By analysing both, I can see how significant the effects of transactions costs are in the options markets.

2.3 Other Passive Writing Strategies

There are some other passive option writing strategies developed from simple covered calls, such as covered combinations, straddles, and collars. A covered combination involves buying a stock and simultaneously writing out-of-the-money call and out-of-the-money cash-secured put. On the upside, the strategy mimics a covered call and the put expires moneyless. On the downside, the strategy performs as a cash-secured put and the writer has to buy additional stock using the deposited cash. If the stock price at expiration ends up between the strike price of the call and the strike price of the put, both options will expire worthless and the premiums become profit. The combination has a limited profit but may result in a large loss if the put option expires deep in-the-money.

A straddle involves writing both call and put options with the same strike price. In order to compare straddles with covered call writing, I include a long stock position in this strategy, forming a "modified straddle." The payoff from a modified straddle is similar to that of a covered call plus the payoff from a put option. This strategy leads to a substantial loss if the put closes deep in-the-money, but outperforms the covered call in an up-trending market.

A collar involves buying a stock and a put option and writing a call option. It is often designed so that both options are out-of-the-money. The put provides insurance to protect against downside risk, which is different from the covered combination and the straddle. This strategy reduces the initial capital outlay to buy the put and the return range is predetermined by the strike price of the call and the strike price of the put. It outperforms buying the stock in a bear market, but underperforms buying the stock in a bull market. It is interesting to see how a collar compares to buying the underlying asset.

Previous research, for example Bondarenko (2003), Jones (2006), and Coval and Shumway (2001), examine the returns of strategies that involve puts and calls. They report that strategies involving put options offer good returns and that put options are more expensive than calls of comparable distance from the money. Yet, little research has been done to explore the returns from combinations, straddles, and collars. Coval and Shumway (2001) test the OEX (the S&P 100 index option) and SPX (the S&P 500 index option) zero-beta straddle writing returns. They reject the hypothesis that zero-beta writing return is equal to the risk-free rate, and suggest that the short position has a positive average weekly return of 3 percent. Their result suggests that writing both call and put options is expected to increase the writer's chance to beat simple covered calls.

2.4 Option Writing Return Measurement

In this study, I use the Sortino Ratio and Leland's Alpha to measure the option writing performance. The Sharpe ratio uses the standard deviation to measure absolute risk and thus it penalizes the up risk and the down risk equally. It is not the best instrument to measure option related strategies given that option returns are not normally distributed. Goetzmann et al. (2002) suggest that fund managers might boost the Sharpe Ratio for their portfolio through derivative trading and mislead investors. The return of option writing is usually characterized by limited upside exposure and significant probability of loss, which exhibits negative skewness due to a long left tail. The Sortino ratio replaces the standard deviation, which is used as a measure of risk in the Sharpe ratio, by the downside standard deviation. The downside standard deviation is the standard deviation of the observations that have value lower than a specific threshold, such as zero or the sample mean. Essentially, the Sortino ratio measures the expected excess return per unit of downside risk.

Jensen's Alpha (Jensen, 1967) is derived from the famous Capital Asset Pricing Model (CAPM) and frequently used by practitioners to measure ex-post investment performance. It is affected by systematic risk. The CAPM assumption that the market portfolio, represented by a broad index of stocks, is mean-variance efficient is usually invalid in practice. Jensen's Alpha also doesn't account for the impact of negative skewness. Leland (1999) defines a method to modify the beta coefficient in order to account for more general return distributions. He argues that in this setting, the resulting alpha (Leland's Alpha) of a fairly priced option would be zero. This measurement does not require additional information beyond that of the CAPM. Therefore, for option writing strategies it is a better instrument to measure risk-adjusted return than Jensen's Alpha.

2.5 Early Exercise of American Options

The valuation of American options is different from the valuation of European options. Theoretically, the price of an American option is higher than the price of a European option due to the early exercise premium.[6] The possibility of early exercise by the counterparty makes it more challenging to study the returns on American option writing strategies. The treatment of the early exercise scenario may be important for this research. In fact, except for a few stock index options (such as the S&P 100 index European option), the options traded in North America are all American style.

For call options on non-dividend-paying stocks, it is never optimal to exercise before the expiration date. For American calls on dividend-paying stocks, early exercise would only occur immediately prior to an ex-dividend date, if at all. More specifically, if the option is near-the-money and the dividend yield on the stock is less than the risk-free rate, then early exercise would most likely occur immediately prior to the ex-dividend date.[7]

Usually the dividend is small relative to the stock price and early exercise is unlikely. However, Finucane (1997) finds that twenty percent of early exercise events are non-dividend related. He speculates that some of these early exercise events might be explained by transaction costs. Hao et al. (2009) examine the option trading behaviour surrounding ex-dividend dates. They find that only a small fraction of the open interest is exercised prior to an ex-dividend date and it is possible for writers to collect this profit through active short-term trading. Pool et al. (2008) study the return to the long position when the call should be exercised early before an ex-dividend date but remains unexercised. They report that approximately half of the holders do not exercise their options and the lack of action leads to significant losses to option holders. Their findings emphasize

[6] An exception to this rule would be a call on a non-dividend-paying stock. In this case, the value of the early exercise option is zero.

[7] See Hull (2008) page 300.

the importance of rationally exercising trading activities. Poteshman and Serbin (2003) find that early exercise behaviour is related to the classes of investors. They separate option investors into three groups: customers of discount brokers, customers of full-service brokers, and firm proprietary traders. The first two categories exhibit a significant number of irrational exercises, but firm proprietary traders exhibit no irrational early exercising. They argue that the rational and irrational early exercising generated by discount and full-service customers is triggered by specific patterns of stock price movement.

For American put options, it can be optimal to exercise early if the option is sufficiently deep in-the-money. Barone-Adesi and Whaley (1987, 1988) explore valuation issues relating to optimal early exercise. More recently, Whaley (2002) and Kapadia and Szado (2007) acknowledge that early exercising of put options is possible and suggest ways to avoid the data errors that may be created by exercising early.

In this study, I assume that it is optimal for the buyer to exercise an option when the time value is zero or negative.

CHAPTER 3 HYPOTHESES

Using simulation under the assumptions outlined by Merton (1976), Tannous and Lee-Sing (2008) find that the expected time value of options decays at a decreasing rate. In addition, they show that on average the expected time value loss from holding a one-month option until expiry is the same as the time value loss from holding a three-month option on the same asset for only one month. In other words, a strategy of holding a one-month option until expiry should have on average the same return as a strategy of rolling three-month options on the same security on a monthly basis. Green and Figlewski (1999) report that writing long-term options has a lower return than writing short-term options. However, they do not compare the two returns based on the same holding period. Longer-term options have riskier payouts. Although this is compensated by a higher option premium, the premium may not be enough to cover the potential loss to the option writer. In this study, I buy back the longer-term option at the expiration date of the shorter-term option. As a result, the underlying stock price movement for the two strategies is the same for both and the writer eliminates the risk of holding the longer-term option in the future. Therefore, the writing returns for shorter- and longer-term option are compared during the same holding periods. I use one-month options as the shorter-term options, and two- and three-month options as the longer-term options.

In practice, the returns of the two strategies may not be the same as suggested by simulation. Transaction costs may affect the writing return. Since shorter-term options are more actively traded I expect the option writing return is higher for shorter-term option. As suggested by Wei and Zheng (2010), actively traded options are expected to have lower transaction costs and higher liquidity. Therefore, investors who are buying long-term options are willing to pay more for these options to encourage writers to supply such options. The liquidity is measured by trading volume and open interest.

Hypothesis 1: On average, a strategy of writing one month options and holding them until expiry produces higher returns than the strategy of writing two-month or three-month options and closing the positions one month later.

I examine Hypothesis 1 using the bid price to measure the writing premium and the ask price to buy the option back and close the short position. Therefore, a lower bid-ask spread represents smaller transaction costs to the writer. Wei and Zheng (2010) show that short-term options have higher proportional bid-ask spreads than long-term options. I re-examine this observation to determine whether it holds for the data used in this study. Furthermore, I examine the relationship between the proportional bid-ask spread and option liquidity as measured by the daily trading volume and open interest. I expect the proportional bid-ask spreads to be negatively related to liquidity.

Hypothesis 1a: The proportional bid-ask spread of stock options is negatively related to trading volume and open interest.

Previous studies, for example Figlewski, Chidambaram and Kaplan (1993), Chidambaram and Figlewski (1995), and Ragdoll (2001), suggest that option time value decays at an increasing rate, so it is better for the buyer to close the position three or four weeks before expiration in order to avoid the loss of the majority of the time value. However, these arguments are based on the simple and unrealistic assumption that the stock price holds constant during the life of option. Tannous and Lee-Sing (2008) employ simulation to demonstrate that when the price of the underlying asset is stochastic the expected time value decays at a decreasing rate. They observe the same pattern for both put and call options suggesting that a big portion of the time value of any option written at the money decays early in the option's life. Therefore, it may be more profitable to the long-term option writer to close the short position before maturity. In addition, they find that during the first month after writing the expected time value decay is the same for one-month and three-month options. This study estimates the expected time value decay curve using daily data. The objective is to find whether the theoretical pattern shown by Tannous and Lee-Sing (2008) holds true in practice. In addition, this study compares the rates of time value decay for long-term and short-term options.

Hypothesis 2: The expected time value for both put and call options decays at a decreasing rate.

Bollen and Whaley (2004) find evidence suggesting that net buying pressure could affect option prices. Intuitively, in a down-trending market there may be more demand for puts and less demand for calls. Hence, puts may become relatively more expensive than calls. However, according to the put-call parity, the difference between the price of a call and a put on the same security and with the same expiry dates should be fixed regardless of demand. This study examines whether option trading in practice is or is not affected by the demand conditions of bear and bull markets. I propose that the demand for puts and the supply of calls would increase during bear markets while the supply of puts and the demand for calls would decrease. These forces would increase the prices of puts relative to the prices of calls.

Hypothesis 3: Market sentiment has no impact on the relative price differences between put and call options.

Previous studies, for example Guo (2003), Feldman and Roy (2004), and Kapadia and Szado (2007), find that covered call writing strategies on stock indices are superior to investing in the underlying indices. The covered call writing strategies typically have lower return volatility and higher reward to risk measurements. This finding may suggest that on a risk-adjusted basis a covered call writing strategy on individual stocks would outperform investing in the underlying stocks.

Furthermore, Hill et al. (2006) and Kapadia and Szado (2007) find that the slightly out-of-the-money index covered calls outperform at-the-money covered calls. Similarly, one would expect that writing out-of-the-money covered stock options will outperform at-the-money covered call options.

I test these propositions following a strategy of writing covered calls on the components of a portfolio of individual stocks. The large basket of options diversifies unsystematic risk, reducing risk exposure of the writer.

Hypothesis 4: Covered call option writing on the S&P 100 index constituents outperforms the S&P 100 index. Furthermore, writing out-of-the-money options is more profitable than writing near-the-money options.[8]

I propose an alternative covered call writing strategy based on covering with an index call rather than using the underlying stocks. Similar to writing naked options, this strategy will provide initial cash inflow. However, the cash outflow should have a lower variance and less negative skewness than writing a portfolio of naked options. Therefore, I expect it to have a better reward-to-risk risk profile.

[8] Writing near-the-money options involves writing the option which is closest to the money regardless of whether it is in-the-money or out-of-the-money.

I test both at-the-money and nearest out-of-the-money option writing and I expect the later strategy will have better performance. This expectation is based on the results of previous studies, for example Hill et al. (2006) and Kapadia and Szado (2007), who show for index calls that at-the-money option writing underperforms out-of-the-money writing.

Hypothesis 5: Writing call options on each stock of the S&P 100 index weighted in the same way as the S&P 100 index constituent weights and buying an S&P 100 index call to cover systematic risk is profitable. Furthermore, writing out-of-the-money stock options is more profitable than writing at-the-money options.

CHAPTER 4 DATA

For this research, all data are from United States (US) options markets. I use daily options data from February 2002 to June 2009. Options data are provided by Delta Neutral. The database contains time-stamped daily stock and index option closing information, including last trade price, last ask, last bid, daily trading volume, and open interest. Abnormal observations, such as negative daily trading volume and negative bid-ask spread, are excluded from the sample.

The US stock data are acquired from the CRSP database, including stock prices, shares outstanding, and dividend information. The stock daily data from CRSP is limited to December 2008 or earlier. Therefore, the writing strategies involving stock positions are limited to the period from February 2002 to December 2008. I calculate the return using bid and ask prices in order to account for transaction costs. Monthly returns for options are calculated based on the third Thursday of each month. (All options expire on the third Friday of each month and can be exercised before market closing on that day.) Following Hill et al (2006), I use monthly observations based on the third Thursday to avoid calculating the specific exercise value.

Figure 3 shows that the data period covers both bull and bear markets. The price index is generally rising from 2002 to the end of the first half of 2007 and generally falls after that. The Chow test for a structural break after June 1, 2007 is significant at the 1% level and suggests separating the data between bull and bear market time periods.[9] Therefore, I select the bull market sample period to be from February 2002 to June 21, 2007, and the bear market sample period is June 22, 2007 to December 31, 2008.[10] Previous research is mainly based on data observed during up-trending markets (data before 2006). Therefore, analysing the performance of writing strategies in the period between July 2007 and December 2008 inclusive deserves special attention.

= = = = = Insert Figure 3 Here = = = = =

[9] The Chow test is the statistical tool that is often used to test structural breaks in a series of data. I separate the daily S&P 100 index closing prices of March 2003 to May 31 2009 into two parts: data before June 2007 and data after June 1, 2007. The Chow test produced an F value of 8.24 for which the corresponding P-Value is 0.0041. The null hypothesis of the Chow test is no structural break. Therefore, the result implies rejecting the null hypothesis and suggests a structural break in the data after June 1, 2007.

[10] I include the options data for June 1 to 21 as June 21 is the end of the options cycle.

In this research, I use one-month and three-month options to compare shorter- and longer-term option writing strategies.[11] One-month options are typically the most frequently traded. Generally, one-month options are available every month and three-month options are available at a lower frequency, such as every three to six months. Longer-term options, such as six-month or one-year options, have much fewer observations.

I choose the S&P 100 index as the portfolio performance benchmark. Information on the index constituents is available at the Standard and Poor's website.[12] I choose to use the S&P 100 index for the following reasons: First, the S&P 100 index includes 100 blue chip companies selected from a wide range of industries. It represents more than 40% of the total U.S. market capitalization and its performance provides a good measure of total market performance. Second, the S&P 100 constituents are large companies and their options are actively traded for near-the-money options. Hence, I expect their options would have smaller bid-ask spreads and that should make the empirical findings more consistent with the theoretical relations. Third, options on the S&P 100 constituents have relatively long histories of trading which make their data more reliable.

[11] Tannous and Lee-Sing (2008) use the one-month and three-month times to expiry.

[12] http://www2.standardandpoors.com/portal/site/sp/en/us/page.topic/indices_100/2,3,2,2,0,0,0,0,0,2,1,0,0,0,0,0.html

CHAPTER 5 METHODOLOGY

5.1 Hypothesis 1

Hypothesis 1 compares the returns of writing short- and long-term options for one-month holding periods. The short- and long-term option writing return is compared during the same holding period. I use nearest out-of-the-money naked options to calculate writing return. For strategies that generate a positive initial cash inflow, I calculate the return as follows:

$$R_i = 1 - \frac{C_{it}^{ask}}{C_{i0}^{bid}}$$

This is just the negative of the return from buying an option with transaction costs inverted. To examine the effects of transactions costs, I compare this return to the return computed using the midpoint of the bid and ask prices.

I examine the option time value to determine whether the option is exercised early or held until expiry. For call options, the time value is defined as:

$$TimeValue_t = Premium_t - IntrisivValue_t = \frac{1}{2}(C_{it\_Ask} + C_{it\_Bid}) - Max(0, P_t - S) .$$

I use the mid-point of the bid and ask prices to measure option premium. When time value is less than or equal to zero, the option will be exercised. Otherwise it is will be held to maturity. For example, assume that 15 days after writing the option the time value becomes negative. Then, the holder of the long position would exercise on that day and the writing position is closed.

I need to match the different maturity options with the same option symbol and strike price. To more accurately measure the writing return, I only choose options which have non-zero trading volume at the beginning of the month. The one-month and three-month option portfolio is different from the one-month and two-month option portfolio. I use the arithmetic mean to measure the portfolio writing return:

$$R_P = \frac{1}{N}\sum_{i=1}^{N}(1 - \frac{C_{it\_Ask}}{C_{i0\_bid}}) .$$

Ignoring transaction costs yields,

$$R_P = \frac{1}{N}\sum_{i=1}^{N}(1 - \frac{\frac{1}{2}(C_{it\_Ask} + C_{it\_bid})}{\frac{1}{2}(C_{i0\_Ask} + C_{i0\_bid})}) \ .$$

Put option return is calculated in the same way.

5.2 Hypothesis 2

Hypothesis 2 examines the expected time value curve using transaction data. Tannous and Lee-Sing (2008) employ simulation and find that the expected time value curve is a convex curve and option time value decays at a decreasing rate as the time to maturity decreases. In order to test this hypothesis, some adjustments to the theoretical model are needed as some of the assumptions could not be perfectly matched in practice. First, the authors use at-the-money options but in practice option prices are rarely at the money. As a compromise I use the nearest out-of-the-money options to start a position. Second, using simulation the authors use the same stock and thousands of trials to get the expected time value curve. I use a portfolio of stock options as an approximation (the initial portfolio stock price, strike price and volatility are different in each month) and for each observation of time remaining to expiry I calculate the mean time value over all options and all months to get the expected time value curve. Only options that have both calls and puts traded are included in the sample. Initially, the options have positive trading volume, but it is possible that during the month they have zero trading volume for some days. Even so, I calculate the time value using daily closing prices for each option. To generate a consistent set of time value estimates, I follow the same options throughout each month. A new set of options is chosen for each month. I match one- and three-month options at the beginning to compare their expected time value curves.

5.3 Hypothesis 3

Hypothesis 3 proposes that market sentiment has effects on option prices. I propose that call options may be more expensive in a rising market due to higher demand from speculators while put options may be more expensive in a falling market due to the higher demand from hedgers. I use the ratio of the time value of the put divided by the time value of the call to test this hypothesis. I compare the value of this ratio during the bull market with its value during the bear market. If the ratio increases in value during bear markets it means that puts become relatively more expensive than calls. In addition, I use the trading volume and the trading volume as a percentage of open interest as proxies for the market sentiment.

5.4 Hypothesis 4

Hypothesis 4 examines the return from covered call writing on the S&P 100 index stocks and compares it with the underlying index return. I write covered calls on single stocks following the index constituent weights (approximated by market capitalization weights) to match the portfolio with the index. The return on covered call writing for individual stocks is given as follows

$$R_i^{cov} = \frac{P_{it}^{bid} - C_{it}^{ask} + div_i}{P_{i0}^{ask} - C_{i0}^{bid}} - 1$$

where *P* represents the stock price, *C* represents the call price, and *Div* is the dividend paid during the holding period, if any. The portfolio return is then calculated as:

$$R_p^{cov} = \sum_i w_i R_i^{cov}$$

Since I use the stock portfolio to track the index, I need to check whether the structured index is close to the real index. The S&P 100 index is a value weighted index. Index value is calculated as:

$$Index\ Level = \frac{\sum_i P_i Q_i}{Divisior}$$

where P is the stock price and Q is the float-adjusted number of shares outstanding. Closely held shares are excluded from the index calculation. Q_i is modified by accounting for the Investable Weight Factor (IWF):

$$Q_i = IWF_i \times TotalShare_i$$

The divisor is also adjusted due to changes in share outstanding, capital action, and changes in index constituents. I do not have information for these adjustments. Therefore, I use market capitalization divided by previous month's daily average divisor value to approximate the index value.

$$BuildIndex_t = \frac{\sum P_{it} \times Q_{it}}{Divisor_t}$$

$$Divisor_t = \frac{1}{T}(\sum_{i=t-T}^{t} \frac{MarketCap_i}{IndexLevel_i})$$

5.5 Hypothesis 5

Hypothesis 5 proposes an alternative covered call writing strategy. Rather than buy the underlying stocks to cover, I buy index call options to hedge a portfolio of call options written on individual stocks. In order to find the matched index strike price, I calculate the value weighed portfolio strike price and stock price. The weights of index stocks are calculated in the same way as described before. The value weighted portfolio strike price and stock price are calculated as:

Portfolio Strike Price $S_P = \sum_{i=1}^{100} w_i S_i$,

Portfolio Stock Price $P_P = \sum_{i=1}^{100} w_i P_i$,

where S_i is the strike price of Stock Option i and P_i is the initial price of the underlying Stock i. Then I find the index strike price using the index price multiplier M, and I write $M \times w_i$ options on Stock i and buy one index option to hedge. This procedure ensures that the ratio of the strike price of the index option to the initial index level is equal to the ratio of the weighted average portfolio strike price to the weighted average portfolio price.

$$M = \frac{IndexLevel}{P_p} = \frac{S_{Index}}{S_p}$$

$$\frac{\text{Weighted Average Portfolio Strike Price}}{\text{Weighted Average Portfolio Price}} = \frac{\text{Index Strike Price}}{\text{Index Level}}$$

Since the portfolio of stock options is more expensive than the index option due to higher volatility, there is initial cash inflow for this writing strategy and the return measurement is:

$$R_P = 1 - \frac{C_{Pt\_Ask} \times M - C_{Indext\_Bid}}{C_{P0\_Bid} \times M - C_{Index0\_Ask}}.$$

5.6 Option Writing Return Measurement

Since option writing strategies may have skewed return distributions, the standard return evaluation measures may not be appropriate. Instead I use the Sortino ratio and Leland's Alpha to measure return performance.

The Sortino ratio is similar to the Sharpe ratio but it only penalizes returns falling below some level of required return. Define semi-variance as

$$\sigma_s^2 = \frac{1}{N}\sum_{R<T}(R-T)^2 ,$$

where σ_s^2 denotes the semi-variance of return, R denotes the asset return, and T denotes the target return level. Define the Sortino ratio as

$$SR = \frac{E(R)-T}{\sigma_s} .$$

This represents the excess reward per unit of downside risk.

Leland (1999) modifies the standard capital asset pricing model to allow investor's preferences to depend on return characteristics besides the mean and the variance. Let R denotes asset return, R_m and R_f represent the market portfolio return and the risk-free rate respectively. Leland's Alpha is defined as

$$Leland'Alpha = E[R] - R_f - B(E[R_m] - R_f)$$

where

$$B = \frac{\text{cov}(R, -(1+R_m)^{-b})}{\text{cov}(R_m, -(1+R_m)^{-b})}$$

and

$$b = \frac{\log(1+E[R_m]) - \log(1+R_f)}{\text{var}[\log(1+R_m)]}$$

The higher alpha value also means a stronger performance. The market portfolio's Alpha is equal to zero.

CHAPTER 6 EMPIRICAL RESULTS

6.1 Descriptive Statistics

Before testing the hypotheses, I analyze the daily option transaction information. My research focuses on one-, two-, and three-month near-the-money options (nearest in-the-money and nearest out-of-the-money options). Therefore, I only show descriptive statistics for options whose time to maturity is within three months. More specifically, I split the sample into seven groups according to the time to maturity. Group N contains all options with times to maturity greater than (N-1) x 15 days and less than or equal to N x 15 days. For example, Group 7 contains the options whose times to maturity in days are greater than 90 days and less than or equal to 105 days.

Table 1.1 reports statistics related to the trading volume of calls and puts. One-month call options (Groups 1 and 2) are the most frequently traded while three-month call options (Groups 5, 6 and 7) are the least traded. Mean trading volume increases from Group 1 to Group 2 and then decreases from Group 3 to Group 6. It suggests that one-month call options are more frequently traded than two- and three-month call options. The mean trading volume is much higher than the median in all groups, which implies that the majority of options do not trade actively. This characteristic is confirmed by the large positive value of the skewness measure. Similar observations can be made for put options.

= = = = = Insert Table 1.1 Here = = = = =

Table 1.2 shows statistics related to the open interest. For calls and puts, the open interest is highest for Group 3 (31 to 45 day maturity). The open interest decreases steadily as maturity increases beyond 45 days. Open interest also drops as I move from Group 3 to Group 2 and then it rises slightly from Group 2 to Group 1. Open interest exhibits significant positive skewness.

= = = = = Insert Table 1.2 Here = = = = =

Table 1.3 shows that the proportional bid-ask spread is negatively related to time to maturity. It ranges between 0, corresponding to a situation in which the bid and ask prices are equal, and 2, corresponding to a situation in which the bid price is equal to 0.[13] I exclude options with zero bid prices because they lead to a zero denominator in the naked writing return calculation. This result is consistent with the findings of Wei and Zheng (2010). In addition, Table 1.3 shows that the median proportional bid-ask spread for each group is less than the mean suggesting that the data exhibits skewness.

= = = = = Insert Table 1.3 Here = = = = =

The negative relation between the proportional bid-ask spread and time to maturity is counter intuitive since shorter-term options have the higher trading volume. As a partial attempt to explain this observation, I examine the dollar bid-ask spread, which is measured as the option ask price less the bid price. Table 1.4 shows that for puts and calls the mean dollar bid-ask spread moderately increases as days to maturity increases. For calls (puts), the median in each of the first three (four) groups is \$0.15 while the median in each of the last four (three) groups is \$0.20 cents. The median value in each group is smaller than the group's mean value, and for some options the ask price is quite different from the bid price. Table 1.4 suggests that one possible explanation of the negative relation between the proportional bid-ask spread and time to maturity is that the higher option premiums for longer-term options outweigh the costs associated with lower liquidity.

= = = = = Insert Table 1.4 Here = = = = =

Tables 1.1-1.4 compare the means of calls versus the means of puts. Panel C in Tables 1.1, 1.2, and 1.3 show that call options have on average significantly larger trading volumes, open interests, and proportional bid-ask spreads than put options of the same maturities. Trading volume and open interest comparisons suggest that stock call options are more frequently traded than put options, which is consistent with previous research (Bollen and Whaley; 2004, and Wei and Zheng; 2010). Panel C of Table 1.4 shows that call options have larger dollar spreads than puts with one exception being the group of options with less than 15 days to expiry. Call options seem to face greater transaction costs.

[13] Equal bid and ask prices may suggest stale quotes in a dealer market but high liquidity in an electronic crossing system. In this research, I include the few observations of equal bid and ask prices. When I exclude these observations, I observe no changes in the qualitative results.

Table 2 reports descriptive statistics related to calls and puts when the samples of calls and puts are divided into three groups instead of seven. The qualitative results that may be obtained from Table 2 are similar to those obtained from Tables 1.1-1.4.

= = = = = Insert Table 2 Here = = = = =

6.2 Time value decay over one month: short-term versus long-term options

Hypothesis 1 examines the return from a strategy of writing one-month options and holding them until expiry versus the return from a strategy of writing longer-term options and closing after one month. Tannous and Lee-Sing (2008) find through simulation that the expected time value decay over a one-month period is the same regardless of whether one month options are held to maturity or longer term options are rolled monthly. However, their analysis ignores transaction costs. I propose that when I include transaction costs, the strategy that faces the lowest transaction costs will provide the highest return. I account for transaction costs by selling options at the bid price to initiate a position and buying the options back at the ask price to close the position. For completeness, I measure returns with and without transactions costs.

Tables 3.1 and 3.2 show the results of writing call options over a one-month period when transaction costs are included. Naked option writing return exhibits negative skewness, and shorter-term call option writing return is more negatively skewed than longer-term call option writing return. Table 3.1 reports the results when the long-term strategy involves writing two-month options and closing the positions after holding the options one month. Writing one-month call options generally has lower mean return than writing two-month options and buying them back in one month. However, Table 3.1 shows that the mean returns are negative in all periods including the bear market period. Consistent with intuition, I observe that writing call options during a bear market produces higher mean return than that of a bull market but the mean return remains negative and significant for both strategies. One-month writing shows higher return volatility. The maximum return is bounded at 100% when the options expire out of the money. When I consider the risk-adjusted return measured by the Sortino Ratio, the one-month writing return has a higher ratio than two-month writing. One-month writing has a lower mean return and a long left tail, and we couldn't conclude that one-month writing return is more profitable than two-month writing.

= = = = = Insert Table 3.1 Here = = = = =

= = = = = Insert Table 3.2 Here = = = = =

Table 3.2 reports the results when the long-term strategy involves writing three-month options and closing the positions one month later. The results are similar to those reported in Table 3.1. In particular, writing one-month call options generally underperforms writing three-month options and buying them back in one month. One exception to this observation happens during the bear market as the mean returns from the two strategies are not statistically different. Furthermore, Table 3.2 shows that the mean returns are negative in all periods although writing call options during a bear market produces higher mean return than writing call options during a bull market. The strategy of writing one-month call options shows higher return volatility. The maximum return is bounded at 100%, an event which takes place when the options expire out of the money.

Tables 3.1 and 3.2 provide information about the frequency of early exercise of call options. An option is considered to be exercised early if the time value of this option is equal to or less than zero. The tables show that the longer the term to expiry the lower is the early exercise ratio.[14] For the entire sample period, the early exercise ratios for one-month, two-month, and three-month calls are respectively 14.40%, 0.88%, and 0.57%. This is not surprising given that the two-month or the three-month calls are less likely to lose their entire time values with the passage of a fraction of a month. In addition, the tables show that the early exercise ratio of call options varies between bull and bear market periods.

Table 4.1 compares the results for writing one-month put options against those of writing two-month put options and closing the positions after one month. One-month put option writing return also shows greater negative skewness, which is consistent with call option writing. Writing one-month puts is superior to writing two-month puts in the entire sample period and during the bull market. However, during the bear market period the

[14] The early exercise ratio is the proportion of options that are exercised early, measured as early exercised observations divided by full sample observations.

two-month strategy outperforms the one-month strategy but the returns are not significantly different.

= = = = = Insert Table 4.1 Here = = = = =

Table 4.2 compares the results for writing one-month put options against those of writing three-month put options and closing the positions after one month. The results are mixed. Writing one-month puts is superior to writing three-month puts during the bull market but during the bear market period the three-month strategy significantly outperforms the one-month strategy. For the entire period of February 2002 to May 2009, the two strategies produce results that are not statistically different.[15]

= = = = = Insert Table 4.2 Here = = = = =

Tables 4.1 and 4.2 provide information about the frequency of early exercise of put options. The tables show that the longer the term to expiry the lower is the early exercise ratio. For the entire sample period, the early exercise ratios for one-month, two-month, and three-month puts are respectively 15.45%, 3.32%, and 2.36%. This is not surprising given that the two-month or the three-month puts are less likely to lose their entire time values with the passage of a fraction of a month. In addition, the tables show that the early exercise ratio of put options varies between bull and bear market periods.

In conclusion, the results reported in Tables 3.1, 3.2, 4.1, and 4.2 suggest that Hypothesis 1 does not hold under all circumstances. Writing one-month options does not consistently provide a higher return than writing longer-term options and closing them in one-month.

Overall, during the bull market period put option writing has higher mean return than call option writing but a lower mean return during the bear market period. Over the entire period of the study, the mean return of put option writing is greater than the corresponding return for call option writing. Similar to call option writing, the volatility of the return of one-month put writing is larger than the volatility of the return of two-month or three-month writing strategies. It seems that writing longer-term options involves less writing risk in the first month of the options' life as longer-term option prices are less sensitive to the underlying stock price movement than shorter-term options.

[15] As a robustness test I exclude the extreme return values to examine whether their inclusion affects the results significantly.

Tables 5.1, 5.2, 6.1, and 6.2 show the results of writing call and put options in the absence of transaction costs. The calculations are done assuming that the proceeds of writing or buying calls are determined by the midpoint of the quoted bid and ask prices. The one-month option writing return still shows a more negatively skewed distribution than longer-term options, but it is less negatively skewed than the return distribution when transaction costs are included. The results show for both call and put options that the return from one-month writing and holding to expiry is either superior to or not significantly different from the return obtained from writing longer-term options and buying them back in one month. These results suggest support to Hypothesis 1 and they are not consistent with the results reported in Tables 3.1, 3.2, 4.1, and 4.2. Apparently, the high proportional bid-ask spread for one-month options is contributing to these contradictory results. In the absence of transaction costs in the form of bid-ask spread, the return to the one month-strategy is superior to the return obtained from the longer term strategies. Accounting for transaction costs reverses this observation as the higher proportional spread for one-month options seems to make the one-month strategy inferior to the two-month or three-month strategies.

= = = = = Insert Tables 5.1 and 5.2 Here = = = = =

= = = = = Insert Tables 6.1 and 6.2 Here = = = = =

Tables 5.1, 5.2, 6.1, and 6.2 also report the impact of transaction costs on the returns of the various strategies. Panel D shows for the entire sample period that transaction costs reduce the returns of all strategies significantly. For example, Panel D of Table 5.1 shows that between February 2002 and May 2009 inclusive accounting for transaction costs leaves the writer of one-month call options with a net loss of 26.99%. Excluding transaction costs improves this return significantly to 2.42%. The same panel shows that accounting for transaction costs generates -18.55% return to the writer of two-month call options while excluding transaction costs improves this return significantly to -1.28%. A similar observation can be made for writing three-month calls and for writing puts with any strategy. These results suggest that transaction costs have a significant impact on option writing return.

From Tables 3.1-6.2 I observed that on average writing put options tends to provide higher mean return than writing call options. Tables 7.1 and 7.2 report respectively the risk-adjusted returns of writing calls and puts. The objective is to know whether put option writing outperforms call option writing after accounting for risk. I use Leland's Alpha as a measure of the risk-adjusted return. In order to get more accurate alpha values, only options that have continuous trading history from 2002 to 2009 are included in the sample. In this subsample, there are 154 call options and 105 put options. Only the one-month option writing strategy is considered for this analysis. The return on the S&P 100 index is used as a proxy for the market return.

= = = = = Insert Tables 7.1 and 7.2 Here = = = = =

After accounting for transaction costs, call option writing has a negative alpha in all sample periods. In contrast, put option writing has a negative alpha only during the bear market period and this alpha is not significantly different from zero. Ignoring transaction costs produces significant positive alphas for put writing under bull or bear markets. Similarly, ignoring transaction costs produces positive alphas for call writing but the mean alpha is significant only under bull market conditions.

Table 7.3 compares the returns of writing call options with the returns of writing put options under the various market conditions. It shows that during bull markets put option writing significantly outperforms call option writing on a risk-adjusted basis. This observation holds whether or not transaction costs are considered. During bear markets, put option writing continues to outperform call option writing on a risk-adjusted basis but the difference in returns is not statistically significant. Again, this observation holds regardless of whether transaction costs are or are not included in the calculations.

6.2.1 The relation between the proportional bid-ask spread and trading volume and open interest

Contrary to intuition, I find that one-month options have higher trading volume, but larger proportional bid-ask spreads than two- and three-month options. I conduct regression analysis to examine the degree by which trading volume and open interest determine the proportional bid-ask spread. The analysis is based on the beginning of the month observations. The regression results, reported in Table 8, suggest that trading volume is negatively related with the proportional bid-ask spread within all groups and all coefficients are significant. Similarly, open interest is negatively related to the proportional spread but the coefficients are not significantly different from zero for all puts and calls. In particular, the relation is significant only for three-month calls and puts and for two-month calls. Therefore, Hypothesis 1a is partly supported. However, the adjusted R-Square is very small in all regressions. The explanatory power of trading volume and open interest on the proportional bid-ask spread is very limited. Wei and Zheng (2010) show that in addition to trading volume and open interest the volatility of the underlying security also explains the variations in the proportional bid-ask spread of stock options.

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6.3 Empirical investigation of the pattern of time value decay of options

Hypothesis 2 examines the shape of the expected time value curve. Tannous and Lee-Sing (2008) consider the effects of stochastic stock price movements on the decay of time value of options. Using simulation, they find that the time value is expected to decay at a decreasing rate. Using transaction data, I depict the expected time value curve of one- and three-month options and explore whether the shape is consistent with that predicted by Tannous and Lee-Sing (2008).

First, I compare the expected time value curve of one-month and three-month options during the same month. Figure 4.1 shows the time value curves for calls while Figure 4.2 shows the time value curve of put options. The horizontal axis denotes the days to maturity of one-month options and the days to maturity of three-month options are the corresponding value plus 60 days. The horizontal axis is contrary to ordinary measurement because the number decreases from left to right. The vertical axis denotes the expected time value. The one- and three-month expected time value curves are highly correlated and the correlation coefficient is almost equal to one.

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= = = = = Insert Figure 4.2 Here = = = = =

Figures 5.1 and 5.2 depict the full expected time value curve for three-month options. The objective is to investigate whether the time value decays at a decreasing rate as time passes. The shapes of the curve for call and put options are very similar and they are both similar to the curve obtained from simulation and shown in Figure 2.

= = = = = Insert Figure 5.1 Here = = = = =

= = = = = Insert Figure 5.2 Here = = = = =

I run OLS regressions to see whether there is a nonlinear relation between an option's days to maturity and the time value. I set the time value as the dependent variable and days to maturity, days to maturity squared, and days to maturity raised to power 3 as the independent variables. The higher powers of the days to maturity variable are used to examine the existence of a nonlinear relation. The regression results show that the option's time value is well explained by days to maturity and its quadratic and cubic terms. The adjusted R^2 of each of the two regressions is almost equal to one. The positive coefficient of squared days to maturity of the first regression, which is significant at 1% level for both call and put options, implies that the expected time value curve is predominantly convex. Therefore Hypothesis 2 is supported. However, when I consider the impact of days to maturity, days to maturity squared and cubic terms together, the coefficient of the squared term is negative and only significant for the put option. The cubic term of days to maturity is positive and significant. The results suggest that the time value curve slightly changes convexity over the option's life.

According to the theory, the time value of a three-month option decays most during the first month and least during the last month. I examine this proposition. I compare option time value cumulative decay during the first month with the cumulative decay during the second month, and the cumulative time value decay during the second month with the cumulative time value decay during the last month. I find that the mean time value decay is highest in the first 30 days and lowest in the last 30 days for both call and put options. The mean difference between the decay during the first 30 days of a three-month option and the decay during the last 30 days is significant at the 1% level. Similarly, the mean difference between the decay during the second 30 days of a three-month option and the decay during the last 30 days is significant at the 1% level. These results suggest that the option time value do decay at a decreasing rate.

Since the option market closes on weekends, I also test whether option time value decays more on weekends than on weekdays. Based on end of day data, three days pass from Friday to Monday (Saturday, Sunday and Monday) and time value is expected to decay more on weekends than weekdays. Our findings are consistent with the expectation and the results are significant for both call and put options.

The empirically observed expected time value curves seem to be flatter than and slightly different from the expected time value curves obtained by simulation. I propose several possible explanations. First, the simulation method runs thousands of trails based on the same input parameters, so the initial stock price and stock return volatility are the same in each trail. In the empirical tests, I choose a portfolio of stock options to test the time value rather than a single stock option. The stock price volatility changes continuously unlike the constant volatility of the simulation model. Second, the simulation uses at-the-money options to test time value. As shown in Tannous and Lee-Sing (2008), the expected time value curve of an at-the-money option has greater convexity than that of an out-of-the-money option or an in-the-money option.[16] I use the nearest out-of-the-money options to calculate the observed expected time value curve to approximate the simulation assumption of at-the-money options. However, the remaining difference may have an impact on the degree of convexity. Third, the simulation is based on Merton's (1976) option pricing formula. Model misspecifications may also lead to differences between the theoretical time value curve and the curve which is observed from transaction data. Fourth, it is possible that arbitrage opportunities are forcing a near linear relationship rather than a significantly convex one. As shown earlier, in the presence of transaction costs, the performance of a strategy of writing a three-month call and closing the position after one month is better than writing a one-month option and holding it until expiry.

6.4 The impact of market sentiment on option prices

Hypothesis 3 tests whether market sentiment has an impact on option prices. On the one hand, call options may become in high demand during a rising market while supply drops due to the higher risk and these forces may lead to higher call prices. Similarly, put options may become more expensive during a falling market due to higher demand and lower supply. On the other hand, when markets become more volatile the changes in the volatility of the underlying would affect both call and put option prices simultaneously. This is a consequence of the put-call parity. Li (2009) finds that the put-call parity holds well for American options. Therefore, I expect that market sentiment would have little explanation of option price differences between the bull and bear market periods. I

[16] See Figure 7 in Tannous and Lee-Sing (2008).

define the PC ratio of a given security as the time value of the nearest-out-of-the-money put option divided by the time value of the nearest out-of-the-money call option on the same underlying security. The strike price is based on the stock price at the beginning of the month. I use the PC ratio to measure the price of the put option relative to the price of the call option. In the absence of market sentiment effects, I expect that the average PC ratio (APC) for a given time to maturity would be the same in both the bull and bear market periods.

6.4.1 Descriptive statistics related to the time values, APC ratio, trading volume, and open interest

Table 9.1 reports descriptive statistics for options that have one-month remaining to expiry and reports the same statistics for these options as their times to maturity decrease to zero. The results suggest that the average time value of calls and puts during bear markets is generally higher than the time value during bull markets. This observation suggests that volatility increases in a bear market.

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The APC ratio during the bull market rises as time to expiry drops from 30 days to approximately 7 days to expiry and then decreases continuously as the time to maturity decreases. Similarly, the APC ratio during the bear market rises from the beginning and slightly decreases at the end of the month. For a given time to maturity between 30 days and 9 days to expiry the APC ratio during the bull market is higher than the APC ratio during the bear market and this relation reverses in three days when time to expiry drops below 9 days. Furthermore, Table 9.1 shows that the trading volume during bear markets is generally higher than the trading volume during bull markets.

Table 9.2 shows that the majority of these differences are significant. In particular, the bear market APC ratio is significantly smaller than its bull market counterpart during the first half of the month and the relation reverses when options are very close to maturity date. This result suggests that contrary to expectations the market sentiment is affecting the prices of options.

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In both the bull and bear market periods, call options have higher trading volume than puts. I also consider the standardized trading volume defined as the ratio of trading volume to open interest. The table shows that the call option standardized trading volume is frequently larger than that of the put in both bull and bear markets (CTrOp and PTrOp columns in Table 9.1), but the t-test results do not show that the differences are frequently significant for the bear market period. This implies that put options trading activity increases relative to call options in falling markets and it is consistent with expectation. Furthermore, I find that the one-month call has more trading volume during the bear market period than during the bull market period. This is contrary to the intuition since I expect that the demand for calls in a falling market would decrease. It may also be explained as a consequence of the natural growth in the equity options market given that the bear market period is the later period. On the other hand, it may be expected that puts are more actively traded in the bear market period and our results confirm this expectation. It is possible that the higher trading volume of calls in the bear market period leads to the higher call prices. Therefore, in the bear market period the PC ratio may decrease during the first 20 days of the month because of a larger denominator. When the maturity date approaches, there is no significant difference in trading volume for calls between the bull and bear market periods, but there is higher put trading volume in the bear market period. This could lead to higher put prices, hence larger PC ratio in the bear market period. Therefore the trading volume may lead to the variation of one-month option prices across different market periods and call option trading dominates put option trading.

Tables 10.1 and 10.2 present descriptive statistics for options that start at 3-months to maturity and they are traced until they reach 60 days to expiry. For three-month call and put options the time value for calls and puts is significantly higher during the bear market period. This implies the bear market period is characterized by higher volatility. The APC ratio of three-month options moderately increases during the first month during both bull and bear markets while the APC ratio during bear markets has a clearer upward trend. Table 10.2 shows that the difference in APC between bull and bear markets varies slightly but the differences are significant for only few observations. The significant observations mainly show higher APC ratio in bear markets. Call option trading volume decreases in the bear market period. Table 10.2 shows that the drop is some-times significant but for the majority of the times to expiry the differences are not significant. Similarly, the puts trading activity seems to increase during bear markets for a few observations. The trading characteristics suggest that one-month option and three-month option trading are quite different. Traders may prefer using one-month puts to hedge downside risk rather than longer-term puts. Standardized trading volume shows that three-month call options are still more actively traded than puts in both bull and bear market periods. However, the T-tests reported in Table 10.2 suggest that the differences in standardized trading activity between bull and bear markets are mostly insignificant.

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In summary, the descriptive statistics shown in Tables 9.1, 9.2, 10.1, and 10.2 suggest that the patterns of changes in APC ratios, trading volume, and trading volume to open interest between bull and bear markets for one-month options are significantly different from those of three-month options. Furthermore, the changes in APC, trading volume, and open interest seem to give contradictory results regarding the impact of a recession on option prices and activities. It appears that the final impact is a combination of conflicting changes. The following section examines the impact of market sentiment on option prices after controlling for other factors such as trading volume, open interest, and time to expiry.

6.4.2 The impact of market sentiment on the time value of puts relative to the time value of calls

In this section, I use regression analysis to examine the impact of market sentiment on the PC ratio. The PC ratio of a given security is the time value of the nearest-out-of-the-money put option divided by the time value of the nearest out-of-the-money call option on the same underlying security. If all else are equal, I expect that the PC during a bear market would be higher than the PC during a bull market.

Therefore, the dependent variable for this analysis is put to call time value (PC). The regression equation is:

$$PC_{it} = \beta_0 + \beta_1 LgCVol_{it} + \beta_2 LgCOp_{it} + \beta_3 LgPVol_{it} + \beta_4 LgPOp_{it} + \beta_5 DM_{it} + \beta_6 MC_{it} + \square_{it}$$

Where i ranges over the various underlying assets, t ranges over the days to maturity (DM_{it} = t), LgCVol, LgCOp, LgPVol, and LgPOp denote respectively the natural logarithms of call volume, call open interest, put volume, and put open interest, and DM denotes days to maturity. MC is a market conditions dummy variable that takes the value of 1 if the observation belongs to a bull market and 0 if the observation belongs to a bear market. The regression equation proposes that the PC ratio is a function of call and put volumes, open interests, and times to maturity. The regression is a panel data regression as each stock PC ratio is treated as an observation. I analyze one- and three-month options separately.

Table 10.3 reports the regression results. Panel A shows that for one-month options, all the coefficients are positive and significant except for call trading volume, call open interests and days to maturity. But only call trading volume has significant impact among the negative coefficients. It implies that higher one-month call trading volume leads to lower PC ratio, which is consistent with the observation that higher call trading volume could increase the call price as well as its time value. Open interest has smaller impact on PC ratio than trading volume. The coefficient of the open interest is smaller than the absolute value of the corresponding trading volume coefficient. The coefficient of days to maturity suggests that the PC ratio declines as the options approach expiration. The market dummy shows that the bull market PC ratio is greater than the bear market PC ratio, which is also consistent with the previous observation. It suggests that during bull markets put options are relatively more expensive than call options. This result may be obtained if market participants use the options market to hedge temporary market gains. They will buy put options following some positive movements in the stock market to avoid losing the gains if the market subsequently drops. At the same time, traders during bull markets may prefer buying securities directly rather than buying call options. Buying directly saves the premium required to buy the calls and the leverage provided by buying options can be obtained through margin buying.

===== Insert Table 10.3 Here =====

Panel B of Table 10.3 reports the regression results for three-month options. The results are slightly different from those obtained from one-month options. The coefficient of call open interests becomes positive and significant, while the market dummy shows the negative impact of the bull market on the PC ratio. Call trading volume is still negative and significant suggesting that greater three-month call trading volume could increase call price and lead to a lower PC ratio. The absolute value difference between open interest and trading volume coefficients is smaller in comparison to one-month option regression. The days to maturity coefficient suggests that the PC ratio generally increases as time to maturity moves lower than three months. The market dummy shows that during the bull market the PC ratio for options whose maturities are between two and three months is lower than the comparable ratio during the bear market, which reflects the market sentiment. However, the R square of three-month option regression is much lower than that of one-month option regression. The explanatory power of the regression is limited.

Note that the market sentiment may be explained differently from the perspective of hedgers and speculators. For example, during the bull market period, a rise in stock prices may lead speculators to expect the market to go up further and as a result they would buy call options to place a bet on the market direction. In contrast, hedgers may buy put options to lock-in the return that was earned. The results of this study suggest that during bull markets hedgers have a stronger impact on options than speculators.

Our bull and bear market periods are based on the assumption that investors would know the change in direction at a given point in time. In the robustness tests section, I exclude one month before and one month after the point of time to redo the tests. Investors will have clearer expectation in two different periods.[17]

6.5 Writing covered options on the stocks that make up the S&P 100 index

Hypothesis 4 examines whether writing call options on the individual stocks that make up a portfolio improves the overall returns to the owner. Previous research has demonstrated that writing covered calls on equity indices can be a successful passive investment strategy. However, there is little research addressing covered call writing on individual stocks, especially writing call options on the stocks that make up a portfolio.

For this analysis, I use the S&P 100 index as the portfolio of interest. I buy stocks according to their weight on the index to track the index performance. Simultaneously, I

[17] I excluded the data of May, June, and July of 2007

write calls on these stocks. Writing a portfolio of stock options allows the writer to collect higher premiums than writing an index option. I expect that the portfolio of covered calls would outperform the underlying index on a risk-adjusted basis.

Due to data limitations in the early years of 2002-2004, the option portfolio cannot fully match the S&P 100 index constituents. Some of the index constituents do not have options trading or the options data is not included in the dataset. The average monthly stock option coverage is approximately 98.6%. The tracking error as measured by the mean absolute difference is 1.1 percent.

Table 11.1 shows the results when transaction costs are included in the analysis. I include transaction costs by executing buy transactions at the ask prices and sell transactions at the bid prices. Table 11.1 shows that the monthly mean writing return is not significantly different from the index return. This observation is obtained whether near-the-money or nearest-out-of-the-money options are written. Panel A shows that the Jensen's and Leland's alphas are both negative under the two scenarios of writing. Panel B shows that the return to the covered call writing is inferior to the index return during the bull market. The Jensen's and Leland's alphas are both negative under this scenario. However, Panel C shows that the return to the covered call writing is superior to the index return during the bear market. The Jensen's and Leland's alphas are both positive under this scenario.

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Table 11.2 shows the results when transaction costs related to options are ignored. I exclude transaction costs of options by executing buy and sell options transactions at the midpoint of the ask and bid prices. The table confirms the results obtained from Table 11.1. The monthly mean writing return over the entire sample period continues to be not significantly different from the index return. This observation is obtained whether near-the-money or nearest-out-of-the-money options are written. Similar to Table 11.1, Panel B shows that the return to the covered call writing is inferior to the index return during the bull market. The Jensen's and Leland's alphas are both negative under this scenario. The difference between the index return and the return on the strategy of writing nearest-out-of-the-money calls is significant. However, Panel C shows that the return to the covered call writing is superior to the index return during the bear market. The Jensen's and

Leland's alphas are both positive under this scenario. As expected, Table 11.2 shows that ignoring transaction costs of option trading improves the returns to the covered call strategy. Panel D reports that transaction costs have a significant impact on returns regardless of the writing strategy.

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6.6 Writing a portfolio of stock calls and buying index call to hedge

Hypothesis 5 proposes a strategy of writing a portfolio of stock options and hedging the risk of a major market movement by buying a call option on the index. As opposed to buying the underlying stocks to hedge, this strategy reduces the risk at a lower cost to the writer. I speculate that writing stock calls and buying the index call could generate more profits than writing covered calls on individual stocks. It generates initial positive cash inflow because the price of the portfolio of stock options is higher than the price of the index option. It also reduces transaction costs by avoiding the necessity of buying the individual stocks.

Table 12.1 reports the results obtained from this strategy. Panel A shows that during the entire sample period it produces significantly lower returns than the market. This observation is obtained whether near-the-money or nearest-out-of-the-money options are written. In addition, the panel reports that the Jensen's and Leland's alphas are both negative under the two scenarios of writing. Similarly, Panel B shows that the return to the covered call writing is significantly inferior to the index return during the bull market. The Jensen's and Leland's alphas are both negative under this scenario. However, Panel C shows that the return to the covered call writing is inferior to but not significantly different from the index return during the bear market. The Jensen's and Leland's alphas are both positive under this scenario.

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Table 12.2 reports the results obtained from following an opposite strategy. I write index calls and hedge by purchasing calls on the individual stocks that make up the index. The table shows that this strategy produces better results than the strategy of writing individual stock options and buying index calls to hedge. Panel A shows that during the entire sample period it produces significantly lower returns than the market. This observation is obtained whether near-the-money or nearest-out-of-the-money options are written. In addition, the panel reports that the Jensen's and Leland's alphas are both negative under the two scenarios of writing. Similarly, Panel B shows that the return to the covered call writing is significantly inferior to the index return during the bull market. The Jensen's and Leland's alphas are both negative under this scenario. However, Panel C shows that writing out-of-the-money index calls produces returns better than the index but writing near-the-money index calls produces inferior returns. Yet, the returns to the covered call writing are not significantly different from the index return during the bear market. The Jensen's and Leland's alphas are both positive under this scenario. Therefore, covered call writing performs insignificantly better than the index only during bear market conditions and when the index options are purchased out-of-the money.

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Tables 12.3 and 12.4 are the results of repeating the analysis that produced Tables 12.1 and 12.2 under the assumption that transaction costs of options can be ignored. As expected, ignoring transaction costs improves the returns of the two strategies. However, the strategy of writing individual call options and buying index calls to hedge continues to underperform the index. In contrast, the opposite strategy of writing index calls and buying individual stock calls to hedge will perform better than the index when transaction costs are ignored. However, the differences in returns are not significantly large suggesting that the returns of the two option writing strategies are not significantly different from the returns on the index. In addition, Table 12.4 shows that the risk–adjusted return of the strategy of writing index calls and buying a portfolio of stocks to hedge will be positive if I ignore transaction costs. As well, this strategy seems to have lower transactions costs. Panel D of Table 12.3 shows that transaction costs reduce the return from writing individual call options and buying index calls by 26.43% when out-of-the-money options are written and by 31.33% when near-the-money options are written. In contrast, Table 12.4 shows that for the strategy of writing index calls and buying individual stock calls to hedge, the transaction costs reduce returns by 18.89% and 21.63% respectively.

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= = = = = Insert Table 12.4 Here = = = = =

Table 12.4 also shows that writing index calls and buying stock calls to hedge performs better in the bear market period. Even when the index has a negative mean return during the bear market period, the strategy's mean return is still positive and it has positive alpha. Apparently, some of the stock options end in-the-money despite the downturn in the overall market, allowing the strategy to make a profit. Nearest out-of-the-money index call writing is superior to near-the-money index call writing. It has a higher mean return and better Sharpe and Sortino ratios in the three sample periods. I conclude that index option writing return is sensitive to the strike price setting. In addition, I note that although writing index calls and buying the portfolio of stock calls to hedge has an attractive mean return, it also involves considerable risk.

In conclusion, writing calls on individual stocks that make up the S&P 100 index and buying the S&P 100 call option to hedge is unprofitable even when I ignore transaction costs. Therefore, Hypothesis 5 is rejected. I provide a possible explanation. An individual stock option has higher volatility than the index. Therefore, an individual stock option has a higher probability than an index option to expire in-the-money. For example, it is conceivable that the market remains stable at a time when some stock prices are up while other stocks are down. The stocks that experienced price increases will generate losses to the writer of the related options but the writer cannot recover these losses if the index remains stable or increases by a lesser amount. Even when the overall market goes down and a trader ends up with a worthless index call, some stocks may still perform well and generate losses to the writer of the related call options. When I implement the strategy in the opposite way, writing an index call and buying stock calls, the returns are positive if transaction costs are ignored. The writer may benefit from exercising calls of some stocks that outperform the market. However, the transaction costs make this strategy unsuccessful even if it generates impressive profits in the absence of transaction costs.

CHAPTER 7 ROBUSTNESS TESTS

7.1 Hypothesis 1 Robustness Tests

Tables 1.1-1.4 show that the group means of trading volume, open interest, proportional spread, and dollar spread are consistently higher than the group medians by significant margins. This raises the concern that some of the results may be affected by a small number of extreme observations. Therefore, I repeat the investigations related to Hypothesis 1 after excluding outliers with extremely low returns and extremely low trading activity. The objective is to examine whether the results obtained from the full sample remain valid.

7.1.1 Robustness test: excluding options with very low one-month writing returns

In this section, I repeat the analysis that lead to Tables 3.1, 3.2, 4.1, and 4.2 after excluding the options that produce one-month writing returns among the lowest 1% returns of all observations. The results are reported respectively in Tables 13.1, 13.2, 14.1, and 14.2.

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= = = = = Insert Table 14.1 Here = = = = =

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One-month options writing return has a smaller skewness value in most groups than longer-term options since we exclude the lowest one-month options writing return. As expected, the sample mean returns in Tables 13.1 and 13.2 are much higher than those of Tables 3.1 and 3.2. In addition, I observe that the exclusion of extremely low one-month returns changes the performance of the two-month and the three-month strategies relative to the one-month strategy. In the entire sample (Tables 3.1) the one-month writing strategy produces more losses or lower profits than the strategy of writing two-month call options and closing after one month. In the absence of the extremely low returns (Table 13.1), the relative performance reverses. The one-month writing strategy produces less losses or higher profits than the strategy of writing two-month call options and closing after one month. However, the one-month strategy still has a higher standard deviation and semi standard deviation. The two strategies remain highly unprofitable.

Similarly, in the entire sample (Table 3.2) the one-month writing strategy produces more losses or lower profits than the strategy of writing three-month call options and closing after one month. In the absence of the extremely low returns (Table 13.2), the relative performance reverses. The one-month writing strategy produces less losses or higher profits than the strategy of writing three-month call options and closing after one month. The two strategies remain highly unprofitable except for the one-month strategy during the bear market when the extreme losses are avoided.

Tables 14.1 and 14.2 report the results for writing put options. Similar to calls, the sample mean returns in these tables are much higher than those of Tables 4.1 and 4.2. In addition, I observe that the exclusion of extremely low one-month returns changes the performance of the one-month strategy relative to the performance of the two-month or three-month strategies. In the entire sample (Tables 4.1) the one-month put writing strategy produces more losses during the bear market and more profits during the bull market than the strategy of writing two-month put options and closing after one month. In the absence of the extremely low returns (Table 14.1), the relative performance during the bear market period reverses. The one-month writing strategy during the bear market produces lower loss than the strategy of writing two-month put options and closing after one month. The two strategies remain highly profitable during the bull market period.

Similar observations can be made about the three-month put writing strategy. In the entire sample (Tables 4.2) the one-month put writing strategy produces more losses during the bear market and more profits during the bull market than the strategy of writing three-month put options and closing after one month. In the absence of the extremely low returns (Table 14.2), the relative performance during the bear market period reverses. The one-month writing strategy during the bear market produces lower loss than the strategy of writing three-month put options and closing after one month. The two strategies remain highly profitable during the bull market period.

7.1.2 Robustness test: excluding options with low volume

It is possible that writing inactive options may involve larger transaction costs. Furthermore, the data of these options may be inaccurate due to stale prices which may subject the results to unusual biases. As a result, the measured returns may not provide good approximations to returns in practice. I explore this possibility by repeating the analysis presented in Tables 3.1, 3.2, 4.1, and 4.2 after excluding the one-third of the observations with the lowest trading volumes based on one-month options.

Although I exclude one-month options with low trading volume, one-month writing return still exhibits greater negative skewness than longer-term writing. Table 15.1 compares the strategy of writing one-month call options with the strategy of writing two-month options and closing after one-month. This table is comparable to Table 3.1 which reports the results for the entire sample. I observe that the sample mean returns in Table 15.1 are much higher than those of Table 3.1. However, I observe that the exclusion of the 1/3 of observations with the lowest trading volume did not change the performance of the two-month strategy relative to the one-month strategy. In the entire sample (Tables 3.1) the one-month writing strategy produces more losses or lower profits than the strategy of writing two-month call options and closing after one month. In the absence of the low volume observations (Table 15.1), the relative performance remains unchanged. The one-month writing strategy produces more losses or lower profits than the strategy of writing two-month call options and closing after one month. The two strategies remain highly unprofitable.

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Similarly, in the entire sample (Table 3.2) the one-month writing strategy produces more losses or lower profits than the strategy of writing three-month call options and closing after one month. In the absence of the extremely low volume options (Table 15.2), the relative performance remains unchanged. The one-month writing strategy produces more losses or lower profits than the strategy of writing three-month call options and closing after one month. The two strategies remain highly unprofitable except for the one-month strategy during the bear market.

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Tables 16.1 and 16.2 report the results for writing put options. Similar to calls, the sample mean returns in these tables are much higher than those of Tables 4.1 and 4.2. However, I observe that the exclusion of extremely low volume options does not change the performance of the one-month strategy relative to the performance of the two-month or three-month strategies. In the entire sample (Tables 4.1) the one-month put writing strategy produces more losses during the bear market and more profits during the bull market than the strategy of writing two-month put options and closing after one month. In the absence of the extremely low volume options (Table 16.1), the relative performance during the bear market period reverses but the two mean returns are not statistically different. The one-month writing strategy during the bear market produces almost the same loss as the strategy of writing two-month put options and closing after one month. The two strategies remain highly profitable during the bull market period.

= = = = = Insert Table 16.1 Here = = = = =

Similar observations can be made about the three-month put writing strategy. In the entire sample (Tables 4.2) the one-month put writing strategy produces more losses during the bear market and more profits during the bull market than the strategy of writing three-month put options and closing after one month. In the absence of the extremely low volume options (Table 16.2), the relative performance during the bear market or the bull market periods remain unchanged. The one-month writing strategy produces more losses during the bear market and more profits during the bull market than the strategy of writing three-month put options and closing after one month.

= = = = = Insert Table 16.2 Here = = = = =

7.1.3 Conclusion of Hypothesis 1 robustness tests

My analysis of Hypothesis 1 does not produce a consistent pattern of relative performance between the two strategies of writing one-month options versus writing two-month options and closing positions after one month. Similarly, no consistent pattern emerges regarding the relative performance of the strategy of writing one-month options and the strategy of writing three-month options and closing positions after one month. One explanation is that the two-month sample of options and the three-month sample of options are significantly different. I find that many companies have two-month options but no three-month options simultaneously listed while others have three-month options but no two-month options simultaneously listed. Indeed, there are only few stocks on which one-, two-, and three-month options are simultaneously listed. Therefore, the sample of one-month options that is used in the comparison of the one-month and two-month writing strategies is different from the sample of one-month options that is used in the comparison of the one-month and three-month writing strategies. Such difference may be affecting the results. A formal study of the impact of variations in the underlying securities is not feasible.

7.2 Hypothesis 3 Robustness Tests

The market sentiment tests compare the PC ratio during the bull market period with the PC ratio during the bear market period. A concern with this analysis is that it would be difficult to identify a single point in time to separate the market into two different trend periods because investors would have different market expectations, especially in the neighbourhood of the point in time when one trend ends and another trend begins. Therefore, as a robustness test I separate the data into two periods by excluding the data that belongs to the month during which the data break point occurs, one month before and one month after. In Table 17, I repeat the market sentiment tests assuming the bull market period to be from February 2002 to April 2007 inclusive and the bear market period to be from August 2007 to May 2009 inclusive. I exclude three months to redo the PC ratio regression analysis.

= = = = = Insert Table 17 Here = = = = =

When I compare the regression results in Table 17 with those of Table 10.3, I observe that the only difference is that the coefficient of the market condition dummy of the three-month option in Table 17 is insignificant. Yet, the sign of the coefficient is consistent with the previous regression. Based on this result, we may conclude that the three-month option trading activity is not strongly affected by the market sentiment. In contrast, for the one-month option, the PC ratio during the bull market period is on average higher than the PC ratio during the bear market period.

CHAPTER 8 CONCLUSIONS

Most empirical research on option writing focuses on index options rather than individual stock options. This study empirically investigates the characteristics of stock options and examines the results of passive writing strategies. In particular, I examine the pattern of stock option time value decay and the effects of time value decay for writing naked options. I empirically examine previous theoretical research of Tannous and Lee-Sing (2008). I also consider various passive writing strategies such as covered calls and the use of index options to hedge a portfolio of the individual stock options making up the index. Covered call writing is frequently employed by practitioners, but the effectiveness of covered call writing on individual stocks is unclear. I also propose a new hedging strategy which only involves trading in the options markets. It is developed from the standard covered call writing strategy. Instead of buying the underlying assets, I suggest buying index call options to hedge the portfolio of individual stock options.

I compare writing return of shorter- and longer-term options during the same holding periods. This is a better way to compare return than using annualized return since the underlying asset price change is the same for both options. Tannous and Lee-Sing (2008) show, through simulation, that on average, writing one-month options and writing longer-term options and closing the position in one month have the same expected time value decay, hence return. My empirical findings are not conclusive and show that the relative performance depends on whether the period of writing is a bull or a bear market. In addition, the analysis shows that option writing returns exhibit a negatively skewed distribution. Furthermore, I use two methods to calculate returns. One method accounts for transaction costs by assuming that securities are bought at the ask price and sold at the bid price. Another method excludes the effects of transaction costs by assuming that securities are bought and sold at the mid-point of the bid and ask prices. In the absence of transaction costs, the one-month option writing has a higher mean return and better risk-adjusted return than the longer-term option writing. In contrast, when I account for transaction costs I find that the one-month option writing strategy has a lower mean return, but higher risk-adjusted return than the longer-term option writing strategy. The higher risk-adjusted return of the one-month call option is generated because the Sortino ratio is negative and the one-month writing return has a long left tail.

One-month options have greater proportional bid-ask spread than longer-term options, even though they also have greater trading activity. The dollar spread is not substantially different for options of different maturities, but the midpoint price does decrease substantially as maturity decreases which explains why the proportional spread is larger for shorter maturity contracts. Writing naked put options provides a higher mean return and higher risk-adjusted return than that provided by writing naked call options. Consistent with previous research, I confirm that there are more stock calls traded than stock puts and that put options are relatively more "expensive" than calls.

Tannous and Lee-Sing (2008) find through simulation that an option's expected time value decays at a decreasing rate, describing a convex curve. Their result suggests that a writer may benefit from closing a short position before expiration as the majority of the time value would be earned after the initial part of the option's life. Using transaction data, I find that the expected time value decays almost as theoretically suggested by simulation. The time value curves of 90-day calls and puts are convex as the options approach expiry. This implies that there may be a benefit for writers to write 90 day options and close their short positions after one month but this benefit is small and may be significantly lower than the transaction costs of frequent trading. The empirical findings suggest that the rate of time value decay of options is almost constant in terms of the passage of time.

I examine the effect of market sentiment on option writing return and time value by analysing call and put options during two sub-periods in which the market is generally rising and falling respectively. I find that the ratio of the time value of the put to the time value of the call during the bull market is higher than the same ratio during the bear market. This result is obtained after controlling for the effects of trading volume, open interest, and time to expiry. It is consistent with the possible activities of traders who use put options to hedge gains in the cash market. The hedging activities of this group will increase during bull markets leading to higher put premiums relative to call premiums.

I implement various stock option writing strategies to test whether an option's time value covers the risks of writing and provides reasonable return on investment to the writer. I find that transaction costs have a significant impact on writing return. When midpoint prices are used, the return is much higher than the return when the ask and bid prices are used. I write a portfolio of stock options according to their index constituent weights to analyse various option writing strategies. The stock option portfolio return lags the index return for both near-the-money and nearest out-of-the-money options. Transaction costs play a significant role in reducing the return on all of the strategies I consider. Even when I ignore transaction costs, some of the strategies still underperform relative to the index.

I propose a covered call writing strategy that involves writing a portfolio of individual stock call options and buying an index call option to hedge. In addition, I test the opposite strategy of buying a portfolio of individual stock call options and writing an index option to hedge. Both strategies are unprofitable when I use bid and ask prices to calculate return. When transaction costs are ignored, writing an index call and buying the portfolio of stock calls to hedge has a positive mean return and positive risk-adjusted return.

Generally, I find writing stock call options to be unprofitable primarily because the transaction costs involved are high. Reducing transaction costs is crucial for successful writing strategies, especially for strategies that require frequent rebalancing.

I also acknowledge a number of limitations of this study. First, I assume that option holders may exercise American options early if the time value becomes zero. This simple rule may not be the one that practitioners use. For example, holders may exercise their options when the time value drops below a level higher than zero. My simple rule may bias the results. If the holder of the long position doesn't exercise the option when its time value is negative, it benefits the writer. In this case, our results report conservative writing returns.

Second, the options data used in this study ends in June 2009 while the CRSP stock data ends on December 31, 2008. Therefore, the analysis of the writing returns is based on data up to December 31, 2008. This is a time when the US economy was still weak as it continued to be in a declining trend until April 2009. Therefore, the analysis does not cover the full duration of the recession and the bear market period is much shorter than the bull market period. A more complete dataset may provide better insight on option writing return during the bear market period.

Third, this study uses daily closing bid and ask prices. Therefore, the spreads that are implicit in the trading strategies may not reflect the actual spreads experienced by active option traders who are likely to trade prior to closing. In the cash markets, it is well known that the bid-ask spread changes significantly during the trading hours. I speculate that the spreads in the options market also vary during the trading hours. Therefore, the conclusion that transaction costs may be affecting the liquidity and efficiency in the options market may be the result of wider spreads at the close of trading. A good way to clarify this conclusion is to test writing returns using intraday data of actively traded options. I leave this step to future studies.

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APPENDIX A: TABLES

Table 1.1: The relation between the trading volume and the time to maturity for calls and puts

This analysis is based on daily option transaction data of near-the-money put options (nearest in-the-money and nearest out-of-the-money options). Daily data from February 2002 to June 2009 is included. Trading volume measures the number of contracts. Data is separated into seven groups according to times to maturity. Group N contains options whose times to maturity is greater than (N-1) x 15 and less than or equal to N x 15. For example, Group 5 contains options whose times to maturity are greater than 60 days and less than or equal to 75 days. The mean difference in panel C denotes the mean value of call options minus the mean value of put options.

Expiry Group	Num of Obs	Mean	Median	Std dev.	Minimum	Maximum	Skewness	Kurtosis
Panel A: Call Options								
1	1968389	321.1	10.0	4248.1	0	2019034	190.4	62877.2
2	1888700	363.7	25.0	2588.9	0	1122127	129.9	39907.9
3	834009	303.4	20.0	2218.7	0	986765	154.0	53599.6
4	655696	202.7	15.0	1131.7	0	190367	41.2	4027.5
5	655119	140.3	9.0	1240.4	0	488564	159.1	49540.6
6	597711	137.4	10.0	884.2	0	208973	59.2	8504.1
7	148317	182.4	20.0	1052.7	0	200459	60.8	9310.8
Panel B: Put Options								
1	1564787	270.1	5.0	1996.5	0	501076	40.7	4195.1
2	1496026	322.4	20.0	2248.6	0	751758	68.1	13256.3
3	621331	293.0	15.0	2212.1	0	751673	93.1	23810.4
4	470932	197.9	10.0	1399.1	0	177593	36.9	2434.3
5	460879	128.0	4.0	1182.1	0	255034	96.8	16802.8
6	419763	114.8	3.0	735.7	0	94880	33.2	2372.5
7	102463	163.7	15.0	1046.4	0	150551	47.2	4851.9

Panel C: T-Statistics for the Equality of Groups Mean

Group	Mean difference	T-statistic	P-Value
1	51.0	14.91	<0.0001
2	41.3	15.69	<0.0001
3	10.4	2.79	0.0053
4	4.8	1.94	0.0519
5	12.2	5.27	<0.0001
6	22.6	14.02	<0.0001
7	18.7	4.39	<0.0001

Table 1.2: The relation between the open interest and the time to maturity for calls and puts

This analysis is based on daily option transaction data of near-the-money put options (nearest in-the-money and nearest out-of-the-money options). Daily data from February 2002 to June 2009 is included. Data is separated into seven groups according to times to maturity. Group N contains options whose times to maturity is greater than (N-1) x 15 and less than or equal to N x 15. For example, Group 5 contains options whose times to maturity are greater than 60 days and less than or equal to 75 days. The mean difference in panel C denotes the mean value of call options minus the mean value of put options.

Expiry Group	Num of Obs	Mean	Median	Std dev.	Minimum	Maximum	Skewness	Kurtosis
Panel A: Call Options								
1	1968389	3903.5	1079.0	11060.9	0	876650	13.6	420.0
2	1888700	3537.1	917.0	10230.7	0	963095	14.4	541.4
3	834009	4327.2	1179.0	12965.3	0	1889612	35.6	3952.8
4	655696	4205.8	1175.0	13131.6	0	1761876	44.8	5179.8
5	655119	3991.4	1141.0	11002.8	0	1661697	20.0	1720.4
6	597711	3719.4	1030.0	10297.2	0	504903	12.0	277.7
7	148317	3471.1	908.0	10063.8	0	448415	12.6	282.5
Panel B: Put Options								
1	1564787	3506.8	963.0	11321.3	0	702909	17.2	528.0
2	1496026	3182.3	804.0	10740.0	0	656851	17.7	547.3
3	621331	4088.1	1060.0	13351.8	0	1540873	28.4	2330.3
4	470932	3975.4	1065.0	13117.3	0	1578845	44.1	4643.3
5	460879	3762.3	1045.0	10459.2	0	1523051	21.4	2003.2
6	419763	3494.5	936.0	9515.7	0	316571	9.9	163.5
7	102463	3285.5	822.0	9276.5	0	291791	9.8	151.7

Panel C: T-Statistics for the Equality of Groups Mean

Group	Mean difference	T-statistic	P-Value
1	396.7	33.05	<0.0001
2	354.8	30.82	<0.0001
3	239.1	10.82	<0.0001
4	230.4	9.19	<0.0001
5	229.1	11.15	<0.0001
6	224.9	11.34	<0.0001
7	185.6	4.76	<0.0001

Table 1.3: The relation between the proportional bid-ask spread and the time to maturity for calls and puts

This analysis is based on daily option transaction data of near-the-money put options (nearest in-the-money and nearest out-of-the-money options). Daily data from February 2002 to June 2009 is included. Data is separated into seven groups according to times to maturity. Group N contains options whose times to maturity is greater than (N-1) x 15 and less than or equal to N x 15. For example, Group 5 contains options whose times to maturity are greater than 60 days and less than or equal to 75 days. The mean difference in panel C denotes the mean value of call options minus the mean value of put options. The proportional bid-ask spread is calculated as: (Ask-Bid)/0.5(Ask+Bid).

Expiry Group	Num of Obs	Mean	Median	Std dev.	Mini-mum	Maxi-mum	Skew-ness	Kurto-sis
Panel A: Call Options								
1	1968389	0.696	0.240	0.789	0	2	0.9	-1.0
2	1888700	0.344	0.148	0.488	0	2	2.4	5.2
3	834009	0.276	0.121	0.419	0	2	3.0	8.8
4	655696	0.221	0.111	0.332	0	2	3.7	15.2
5	655119	0.221	0.105	0.344	0	2	3.6	14.4
6	597711	0.179	0.098	0.265	0	2	4.5	24.4
7	148317	0.151	0.092	0.209	0	2	5.4	37.8
Panel B: Put Options								
1	1564787	0.659	0.237	0.760	0	2	1.0	-0.7
2	1496026	0.295	0.138	0.421	0	2	2.9	8.2
3	621331	0.229	0.116	0.340	0	2	3.6	14.4
4	470932	0.174	0.098	0.254	0	2	4.6	26.4
5	460879	0.170	0.095	0.254	0	2	4.7	27.1
6	419763	0.145	0.088	0.204	0	2	5.5	39.8
7	102463	0.127	0.083	0.171	0	2	6.3	55.2

Panel C: T-Statistics for the Equality of Groups Mean

Group	Mean difference	T-statistic	P-Value
1	0.036	43.93	<0.0001
2	0.049	99	<0.0001
3	0.047	72.48	<0.0001
4	0.046	83.74	<0.0001
5	0.050	89.11	<0.0001
6	0.034	72.63	<0.0001
7	0.023	30.64	<0.0001

Table 1.4: The relation between the dollar bid-ask spread and the time to maturity for calls and puts

This analysis is based on daily option transaction data of near-the-money put options (nearest in-the-money and nearest out-of-the-money options). Daily data from February 2002 to June 2009 is included. Data is separated into seven groups according to times to maturity. Group N contains options whose times to maturity is greater than (N-1) x 15 and less than or equal to N x 15. For example, Group 5 contains options whose times to maturity are greater than 60 days and less than or equal to 75 days. The mean difference in panel C denotes the mean value of call options minus the mean value of put options. Dollar bid-ask spread is calculated as ask price minus bid price.

Expiry Group	Num of Obs	Mean	Median	Std dev.	Mini-mum	Maxi-mum	Skew-ness	Kurto-sis
Panel A: Call Options								
1	1968389	0.210	0.150	0.331	0	51	30.2	3233.7
2	1888700	0.216	0.150	0.322	0	66.8	26.9	2887.3
3	834009	0.226	0.150	0.351	0	50	38.7	4358.3
4	655696	0.233	0.200	0.320	0	50	22.6	2081.2
5	655119	0.242	0.200	0.302	0	50	16.0	1266.8
6	597711	0.245	0.200	0.309	0	69.8	28.3	4454.9
7	148317	0.246	0.200	0.338	0	48.9	33.1	3352.1
Panel B: Put Options								
1	1564787	0.220	0.150	0.388	0	50	35.4	3672.6
2	1496026	0.215	0.150	0.322	0	50	22.5	1814.5
3	621331	0.222	0.150	0.352	0	50	27.3	2478.4
4	470932	0.231	0.150	0.341	0	37.7	18.3	888.1
5	460879	0.241	0.200	0.319	0	20	9.7	179.9
6	419763	0.240	0.200	0.332	0	59.4	31.9	3689.5
7	102463	0.241	0.200	0.334	0	20.3	16.5	637.7

Panel C: T-Statistics for the Equality of Groups Mean

Group	Mean difference	T-statistic	P-Value
1	-0.010	-26.49	<0.0001
2	0.001	3.86	0.0001
3	0.003	5.91	<0.0001
4	0.001	2.01	0.0445
5	0.001	1.78	0.0744
6	0.005	8.07	<0.0001
7	0.005	3.49	0.0005

Table 2: Descriptive statistics for near-the-money options divided according to time to maturity

This analysis is based on daily option transaction data of near-the-money put options (nearest in-the-money and nearest out-of-the-money options). Daily data from February 2002 to June 2009 is included. Data is separated into three groups according to times to maturity. Group 1 includes options whose time to maturity is 1 day or more and less than or equal to 30 days, Group 2 includes options whose time to maturity is greater than 30 days and less than or equal to 60 days, and Group 3 includes options whose time to maturity is greater than 60 days and less than or equal to 105 days. The mean difference in panel C denotes the mean value of call options minus the mean value of put options. Proportional bid-ask spread is calculated as: (Ask-Bid)/0.5(Ask+Bid). Dollar bid-ask spread is calculated as ask price minus bid price.

Expiry Group	Num of Obs	Mean	Median	STD	Mini-mum	Maxi-mum	Skew-ness	Kurto-sis
Panel A: Call Options								
Proportional Bid-Ask Spread								
1	3857089	0.523	0.182	0.682	0	2	1.5	0.5
2	1489705	0.252	0.118	0.384	0	2	3.3	11.0
3	1401147	0.196	0.100	0.301	0	2	4.1	19.4
Dollar Bid-Ask Spread								
1	3857089	0.213	0.150	0.327	0	66.8	28.7	3075.0
2	1489705	0.229	0.200	0.338	0	50	32.8	3581.3
3	1401147	0.244	0.200	0.309	0	69.8	23.6	2952.4
Trading Volume								
1	3857089	342.0	15.0	3534.4	0	2019034	193.7	72589.0
2	1489705	259.1	19.0	1822.7	0	986765	159.9	66163.5
3	1401147	143.5	10.0	1081.9	0	488564	131.8	42530.5
Open Interest								
1	3857089	3724.1	999.0	10664.0	0	963095	14.0	472.8
2	1489705	4273.8	1177.0	13038.9	0	1889612	39.8	4508.7
3	1401147	3820.3	1065.0	10610.7	0	1661697	16.3	1059.6
Panel B: Put Options								
Proportional Bid-Ask Spread								
1	3060813	0.481	0.169	0.644	0	2	1.6	1.2
2	1092263	0.206	0.105	0.307	0	2	4.0	18.2
3	983105	0.155	0.090	0.226	0	2	5.2	33.7
Dollar Bid-Ask Spread								
1	3060813	0.217	0.150	0.358	0	50	31.2	3197.5
2	1092263	0.226	0.150	0.347	0	50	23.7	1842.6
3	983105	0.240	0.200	0.326	0	59.4	20.5	1843.0
Trading Volume								
1	3060813	295.6	10.0	2123.6	0	751758	56.8	9821.5
2	1092263	252.0	12.0	1905.2	0	751673	89.2	24928.6
3	983105	126.1	5.0	1000.2	0	255034	86.2	16269.0
Open Interest								
1	3060813	3348.2	881.0	11042.2	0	702909	17.5	537.8
2	1092263	4039.5	1062.0	13251.3	0	1578845	35.0	3288.3
3	983105	3598.3	973.0	9947.0	0	1523051	16.2	1218.9

Table 2: Descriptive statistics for near-the-money options divided according to time to maturity (continued)

Panel C: T-Statistics for the Equality of Group Means

	Call Options		Put Options				
Expiry Group	Num of Obs	Mean	Num of Obs	Mean	Mean Diff	T-statistics	P-Value
Proportional Bid-Ask Spread							
1	3857089	0.523	3060813	0.481	0.042	83.4	<0.0001
2	1489705	0.252	1092263	0.206	0.046	107.25	<0.0001
3	1401147	0.196	983105	0.155	0.040	118.29	<0.0001
Dollar Bid-Ask Spread							
1	3857089	0.213	3060813	0.217	-0.005	-17.31	<0.0001
2	1489705	0.229	1092263	0.226	0.003	6	<0.0001
3	1401147	0.244	983105	0.240	0.003	7.72	<0.0001
Trading Volume							
1	3857089	342.0	3060813	295.6	46.3	21.33	<0.0001
2	1489705	259.1	1092263	252.0	7.1	3	<0.0001
3	1401147	143.5	983105	126.1	17.4	12.78	0.0027
Open Interest							
1	3857089	3724.1	3060813	3348.2	375.9	45.15	<0.0001
2	1489705	4273.8	1092263	4039.5	234.3	14.13	<0.0001
3	1401147	3820.3	983105	3598.3	222.0	16.5	<0.0001

Table 3.1: Writing one-month calls versus writing two-month calls and closing after one month: returns after accounting for transaction costs

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The average monthly risk-free rate is 0.203%.

	One-Month Call	Two-Month Call	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	23437				
Mean Return	-26.99%	-18.55%	-8.44%	-7.18	<0.0001
STD	272.46%	148.57%			
Semi STD	395.69%	180.29%			
Sortino Ratio	-6.87%	-10.40%			
Skewness of Return	-12.16	-9.51			
Significance of Mean Return					
T-statistics	-15.17	-19.11			
P-Value	<0.0001	<0.0001			
Minimum Return	-125.00	-63.09			
Maximum Return	1.00	1.00			
Early Exercise	3375	207			
Early Exercise Ratio	14.40%	0.88%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	15385				
Mean Return	-29.87%	-21.56%	-8.31%	-6.39	<0.0001
STD	261.93%	138.12%			
Semi STD	369.24%	158.76%			
Sortino Ratio	-8.14%	-13.71%			
Skewness of Return	-8.96	-5.63			
Significance of Mean Return					
T-statistics	-14.15	-19.36			
P-Value	<0.0001	<0.0001			
Minimum Return	-93.00	-43.67			
Maximum Return	1.00	1.00			
Early Exercise	2134	141			
Early Exercise Ratio	13.87%	0.92%			
Panel C: Sample Period Jul 07 To May 09					
Observation	8052				
Mean Return	-21.49%	-12.80%	-8.69%	-3.69	0.0002
STD	291.48%	166.58%			
Semi STD	445.95%	220.02%			
Sortino Ratio	-4.86%	-5.91%			
Skewness of Return	-16.51	-13.55			
Significance of Mean Return					
T-statistics	-6.61	-6.89			
P-Value	<0.0001	<0.0001			
Minimum Return	-125.00	-63.09			
Maximum Return	1.00	0.99			
Early Exercise	1241	66			
Early Exercise Ratio	15.41%	0.82%			

Table 3.2: Writing one-month calls versus writing three-month calls and closing after one month: returns after accounting for transaction costs

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The average monthly risk-free rate is 0.203%.

	One-Month Call	Three-Month Call	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	23948				
Mean Return	-25.25%	-16.12%	-9.13%	-8.11	<0.0001
STD	248.36%	106.49%			
Semi STD	346.46%	111.83%			
Sortino Ratio	-7.35%	-14.60%			
Skewness of Return	-10.46	-3.97			
Significance of Mean Return					
T-statistics	-15.73	-23.42			
P-Value	<0.0001	<0.0001			
Minimum Return	-124.00	-27.92			
Maximum Return	1.00	1.00			
Early Exercise	3417	136			
Early Exercise Ratio	14.27%	0.57%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	16038				
Mean Return	-35.98%	-22.34%	-13.64%	-9.49	<0.0001
STD	258.66%	108.14%			
Semi STD	350.64%	112.56%			
Sortino Ratio	-10.32%	-20.03%			
Skewness of Return	-10.16	-4.35			
Significance of Mean Return					
T-statistics	-17.62	-26.16			
P-Value	<0.0001	<0.0001			
Minimum Return	-124.00	-27.92			
Maximum Return	1.00	1.00			
Early Exercise	2423	115			
Early Exercise Ratio	15.11%	0.72%			
Panel C: Sample Period Jul 07 To May 09					
Observation	7910				
Mean Return	-3.48%	-3.50%	0.03%	0.01	0.9885
STD	224.50%	101.92%			
Semi STD	335.18%	225.64%			
Sortino Ratio	-1.10%	-1.64%			
Skewness of Return	-11.25	-3.13			
Significance of Mean Return					
T-statistics	-1.38	-3.06			
P-Value	0.1681	0.0022			
Minimum Return	-89	-17.75			
Maximum Return	1	0.99			
Early Exercise	994	21			
Early Exercise Ratio	12.57%	0.27%			

Table 4.1: Writing one-month puts versus writing two-month puts and closing after one month: returns after accounting for transaction costs

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The average monthly risk-free rate is 0.203%.

	One-Month Put	Two-Month Put	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	16057				
Mean Return	-0.12%	-4.08%	3.96%	4.37	<0.0001
STD	197.09%	119.93%			
Semi STD	277.08%	141.26%			
Sortino Ratio	-0.17%	-3.03%			
Skewness of Return	-6.33	-3.91			
Significance of Mean Return					
T-statistics	-0.08	-4.31			
P-Value	0.9367	<0.0001			
Minimum Return	-47.86	-23.25			
Maximum Return	1.00	1.00			
Early Exercise	2481	533			
Early Exercise Ratio	15.45%	3.32%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	9911				
Mean Return	13.51%	5.44%	8.07%	8.17	<0.0001
STD	175.42%	107.00%			
Semi STD	261.33%	131.95%			
Sortino Ratio	5.09%	3.97%			
Skewness of Return	-6.85	-4.98			
Significance of Mean Return					
T-statistics	7.67	5.06			
P-Value	<0.0001	<0.0001			
Minimum Return	-47.86	-23.25			
Maximum Return	1.00	1.00			
Early Exercise	1121	180			
Early Exercise Ratio	11.31%	1.82%			
Panel C: Sample Period Jul 07 To May 09					
Observation	6146				
Mean Return	-22.11%	-19.44%	-2.67%	-1.53	0.127
STD	226.03%	136.86%			
Semi STD	293.16%	211.70%			
Sortino Ratio	-7.61%	-9.28%			
Skewness of Return	-5.68	-2.90			
Significance of Mean Return					
T-statistics	-7.67	-11.13			
P-Value	<0.0001	<0.0001			
Minimum Return	-47.00	-18.00			
Maximum Return	1.00	0.98			
Early Exercise	1360	353			
Early Exercise Ratio	22.13%	5.74%			

Table 4.2: Writing one-month puts versus writing three-month puts and closing after one month: returns after accounting for transaction costs

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The average monthly risk-free rate is 0.203%.

	One-Month Put	Three-Month Put	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	15859				
Mean Return	-13.16%	-13.11%	-0.05%	-0.04	0.9712
STD	248.82%	101.49%			
Semi STD	277.08%	141.26%			
Sortino Ratio	-4.82%	-9.42%			
Skewness of Return	-6.33	-3.91			
Significance of Mean Return					
T-statistics	-6.66	-16.26			
P-Value	<0.0001	<0.0001			
Minimum Return	-149.00	-18.20			
Maximum Return	1.00	1.00			
Early Exercise	2740	374			
Early Exercise Ratio	17.28%	2.36%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	10160				
Mean Return	8.12%	1.30%	6.82%	5.37	<0.0001
STD	190.00%	86.09%			
Semi STD	261.33%	131.95%			
Sortino Ratio	3.03%	0.83%			
Skewness of Return	-6.85	-4.98			
Significance of Mean Return					
T-statistics	4.31	1.52			
P-Value	<0.0001	0.1291			
Minimum Return	-32.00	-15.00			
Maximum Return	1.00	1.00			
Early Exercise	1240	147			
Early Exercise Ratio	12.20%	1.45%			
Panel C: Sample Period Jul 07 To May 09					
Observation	5699				
Mean Return	-51.09%	-38.78%	-12.30%	-3.66	0.0003
STD	325.10%	120.08%			
Semi STD	293.16%	149.88%			
Sortino Ratio	-17.50%	-26.01%			
Skewness of Return	-5.68	-2.90			
Significance of Mean Return					
T-statistics	-11.86	-24.38			
P-Value	<0.0001	<0.0001			
Minimum Return	-149.00	-18.20			
Maximum Return	1.00	1.00			
Early Exercise	1500	227			
Early Exercise Ratio	26.32%	3.98%			

Table 5.1: Writing one-month calls versus writing two-month calls and closing after one month: ignoring transaction costs

Transaction costs are ignored in the return calculation by selling and buying options at the midpoint of the bid and ask prices. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. Panel D is based on the full sample mean writing return. The average monthly risk-free rate is 0.203%.

	One-Month Call	Two-Month Call	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	23437				
Mean Return	2.42%	-1.28%	3.70%	5.28	<0.0001
STD	190.63%	121.75%			
Semi STD	255.85%	142.37%			
Sortino Ratio	0.87%	-1.04%			
Skewness of Return	-5.36	-5.77			
Significance of Mean Return					
T-statistics	1.95	-1.61			
P-Value	0.0517	0.1079			
Minimum Return	-49.40	-44.88			
Maximum Return	1.00	1.00			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	15385				
Mean Return	0.32%	-4.46%	4.77%	5.68	<0.0001
STD	191.77%	117.67%			
Semi STD	255.56%	131.67%			
Sortino Ratio	0.05%	-3.54%			
Skewness of Return	-5.04	-3.70			
Significance of Mean Return					
T-statistics	0.2	-4.7			
P-Value	0.8383	<0.0001			
Minimum Return	-49.40	-25.67			
Maximum Return	1.00	1.00			
Panel C: Sample Period Jul 07 To May 09					
Observation	8052				
Mean Return	6.45%	4.79%	1.66%	1.32	0.1885
STD	188.40%	128.97%			
Semi STD	256.44%	163.09%			
Sortino Ratio	2.44%	2.81%			
Skewness of Return	-6.00	-8.81			
Significance of Mean Return					
T-statistics	3.07	3.33			
P-Value	0.0021	0.0009			
Minimum Return	-42.50	-44.88			
Maximum Return	1.00	1.00			

Panel D: The impact of transaction costs

	One-Month Call	Two-Month Call
Mean return including transaction costs	-26.99%	-18.55%
Mean return excluding transaction costs	2.42%	-1.28%
Mean Difference	-29.41%	-17.27%
T-statistics	-37.85	-60.54
P-Value	<0.0001	<0.0001

Table 5.2: Writing one-month calls versus writing three-month calls and closing after one month: ignoring transaction costs

Transaction costs are ignored in the return calculation by selling and buying options at the midpoint of the bid and ask prices. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. Panel D is based on the full sample mean writing return. The average monthly risk-free rate is 0.203%.

	One-Month Call	Three-Month Call	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	23948				
Mean Return	3.62%	-2.22%	5.84%	7.4	<0.0001
STD	192.27%	95.35%			
Semi STD	261.75%	99.24%			
Sortino Ratio	1.31%	-2.44%			
Skewness of Return	-8.51	-3.62			
Significance of Mean Return					
T-statistics	2.91	-3.61			
P-Value	0.0036	0.0003			
Minimum Return	-97.00	-26.05			
Maximum Return	1.00	1.00			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	16038				
Mean Return	-4.35%	-8.26%	3.90%	3.75	0.0002
STD	203.43%	97.53%			
Semi STD	274.57%	101.11%			
Sortino Ratio	-1.66%	-8.37%			
Skewness of Return	-9.46	-4.05			
Significance of Mean Return					
T-statistics	-2.71	-10.72			
P-Value	0.0067	<0.0001			
Minimum Return	-97.00	-26.05			
Maximum Return	1.00	1.00			
Panel C: Sample Period Jul 07 To May 09					
Observation	7910				
Mean Return	19.78%	10.02%	9.77%	8.74	<0.0001
STD	166.23%	89.52%			
Semi STD	225.64%	94.17%			
Sortino Ratio	8.68%	10.42%			
Skewness of Return	-4.59	-2.52			
Significance of Mean Return					
T-statistics	10.58	9.95			
P-Value	<0.0001	<0.0001			
Minimum Return	-34.20	-12.77			
Maximum Return	1	0.99			

Panel D: The impact of transaction costs

	One-Month Call	Three-Month Call
Mean return including transaction costs	-25.25%	-16.12%
Mean return excluding transaction costs	3.62%	-2.22%
Mean Difference	-28.86%	-13.90%
T-statistics	-53.23	-95.26
P-Value	<0.0001	<0.0001

Table 6.1: Writing one-month puts versus writing two-month puts and closing after one month: returns ignore transaction costs

Transaction costs are excluded in the return calculation by selling and buying options at the midpoint of the bid and ask prices. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. Panel D is based on the full sample mean writing return. The average monthly risk-free rate is 0.203%.

	One-Month Put	Two-Month Put	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	16057				
Mean Return	19.66%	9.54%	10.12%	15.53	<0.0001
STD	160.80%	104.96%			
Semi STD	216.32%	120.59%			
Sortino Ratio	8.99%	7.74%			
Skewness of Return	-4.96	-3.26			
Significance of Mean Return					
T-statistics	15.49	11.52			
P-Value	<0.0001	<0.0001			
Minimum Return	-44.20	-22.33			
Maximum Return	1.00	1.00			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	9911				
Mean Return	32.11%	18.33%	13.78%	18.12	<0.0001
STD	147.90%	94.04%			
Semi STD	220.24%	114.74%			
Sortino Ratio	14.49%	15.80%			
Skewness of Return	-6.68	-4.26			
Significance of Mean Return					
T-statistics	21.61	19.4			
P-Value	<0.0001	<0.0001			
Minimum Return	-44.20	-22.33			
Maximum Return	1.00	1.00			
Panel C: Sample Period Jul 07 To May 09					
Observation	6146				
Mean Return	-0.41%	-4.62%	4.21%	3.58	0.0003
STD	177.86%	119.15%			
Semi STD	211.70%	125.28%			
Sortino Ratio	-0.29%	-3.85%			
Skewness of Return	-3.28	-2.31			
Significance of Mean Return					
T-statistics	-0.18	-3.04			
P-Value	0.8567	0.0024			
Minimum Return	-23.86	-13.00			
Maximum Return	1.00	0.99			

Panel D: The impact of transaction costs

	One-Month Puts	Two-Month Puts
Mean return including transaction costs	-0.12%	-4.08%
Mean return excluding transaction costs	19.66%	9.54%
Mean Difference	-19.78%	-13.62%
T-statistics	-39.46	-57.78
P-Value	<0.0001	<0.0001

Table 6.2: Writing one-month puts versus writing three-month puts and closing after one month: returns ignore transaction costs

Transaction costs are excluded in the return calculation by selling and buying options at the midpoint of the bid and ask prices. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. Panel D is based on the full sample mean writing return. The average monthly risk-free rate is 0.203%.

	One-Month Put	Three-Month Put	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	15859				
Mean Return	10.31%	-0.60%	10.91%	13.19	<0.0001
STD	171.95%	89.59%			
Semi STD	216.32%	120.59%			
Sortino Ratio	4.67%	-0.67%			
Skewness of Return	-4.96	-3.26			
Significance of Mean Return					
T-statistics	7.55	-0.85			
P-Value	<0.0001	0.397			
Minimum Return	-47.40	-13.95			
Maximum Return	1.00	1.00			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	10160				
Mean Return	29.12%	12.55%	16.57%	17.83	<0.0001
STD	151.45%	76.76%			
Semi STD	220.24%	114.74%			
Sortino Ratio	13.12%	10.76%			
Skewness of Return	-6.68	-4.26			
Significance of Mean Return					
T-statistics	19.38	16.49			
P-Value	<0.0001	<0.0001			
Minimum Return	-23.27	-11.19			
Maximum Return	1.00	1.00			
Panel C: Sample Period Jul 07 To May 09					
Observation	5699				
Mean Return	-23.23%	-24.06%	0.83%	0.52	0.6006
STD	199.07%	104.75%			
Semi STD	211.70%	125.28%			
Sortino Ratio	-11.07%	-19.37%			
Skewness of Return	-3.28	-2.31			
Significance of Mean Return					
T-statistics	-8.81	-17.34			
P-Value	<0.0001	<0.0001			
Minimum Return	-47.40	-13.95			
Maximum Return	1.00	1.00			

Panel D: The impact of transaction costs	One-Month Call	Two-Month Call
Mean return including transaction costs	-13.16%	-13.11%
Mean return excluding transaction costs	10.31%	-0.60%
Mean Difference	-23.47%	-12.50%
T-statistics	-24.1	-64.09
P-Value	<0.0001	<0.0001

Table 7.1: The risk-adjusted return of writing call options

The risk-adjusted return is measured by the Leland's Alpha test. All written options are nearest out-of-the-money one-month options. Only options that have continuous trading history from 2002 to 2009 are included in the sample. Monthly return is used in Leland's Alpha calculation. Return 1 is obtained by writing options at the bid price and buying them back at the ask price to close the position. Return 2 uses the mid-point of the option's bid and ask price. Mean alpha difference is calculated as the alpha of Return 1 less alpha of Return 2. The market return is the S&P 100 index return. Monthly risk-free rate equals 0.203%.

	Return 1	Return 2	Mean Differ-ence	T-Statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	154				
Mean Alpha	-14.45%	2.41%	-16.86%	-24.67	<0.0001
STD	26.11%	22.18%			
Significance of Mean Alpha					
T-statistics	-6.87	1.35			
P-Value	<0.0001	0.1798			
Minimum Alpha	-107.20%	-76.26%			
Maximum Alpha	35.54%	48.91%			
Panel B; Sample Period Feb 02 To Jun 07					
Mean Alpha	-14.08%	4.15%	-18.23%	-20.6	<0.0001
STD	30.50%	24.24%			
Significance of Mean Alpha					
T-statistics	-5.73	2.13			
P-Value	0.0001	0.0352			
Minimum Alpha	-146.29%	-78.94%			
Maximum Alpha	38.22%	47.66%			
Panel C: Sample Period Jul 07 To May 09					
Mean Alpha	-9.69%	2.59%	-12.29%	-17.51	<0.0001
STD	39.78%	35.73%			
Significance of Mean Alpha					
T-statistics	-3.02	2.9			
P-Value	0.0029	0.3694			
Minimum Alpha	-135.43%	-93.78%			
Maximum Alpha	86.29%	90.04%			

Table 7.2: The risk-adjusted return of writing put options

The risk-adjusted return is measured by the Leland's Alpha test. All written options are nearest out-of-the-money one-month options. Only options that have continuous trading history from 2002 to 2009 are included in the sample. Monthly return is used in Leland's Alpha calculation. Return 1 is obtained by writing options at the bid price and buying them back at the ask price to close the position. Return 2 uses the mid-point of the option's bid and ask price. Mean alpha difference is calculated as the alpha of Return 1 less alpha of Return 2. The market return is the S&P 100 index return. Monthly risk-free rate equals 0.203%.

	Return 1	Return 2	Mean Difference	T-Statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	105				
Mean Alpha	11.04%	23.42%	-12.38%	-23.32	<0.0001
STD	18.55%	16.25%			
Significance of Mean Alpha					
T-statistics	6.1	14.76			
P-Value	<0.0001	<0.001			
Minimum Alpha	-40.46%	-27.39%			
Maximum Alpha	51.22%	57.79%			
Panel B; Sample Period Feb 02 To Jun 07					
Mean Alpha	15.55%	28.81%	-13.26%	-19.5	<0.0001
STD	22.03%	18.81%			
Significance of Mean Alpha					
T-statistics	7.23	15.7			
P-Value	<0.0001	<0.0001			
Minimum Alpha	-55.27%	-38.90%			
Maximum Alpha	57.11%	64.00%			
Panel C: Sample Period Jul 07 To May 09					
Mean Alpha	-4.65%	5.92%	-10.57%	-15.26	<0.0001
STD	34.51%	30.93%			
Significance of Mean Alpha					
T-statistics	-1.38	1.96			
P-Value	0.1703	0.0523			
Minimum Alpha	-121.47%	-99.62%			
Maximum Alpha	55.78%	58.58%			

Table 7.3: Comparison of the mean alphas of call and put options

Sample period	Mean alpha of call option	Mean alpha of put option	Mean alpha difference	T-Stat	P-Value
Panel A: Considering transaction costs of option writing					
February 02 to May 09	-14.45%	11.04%	-25.49%	-9.18	<0.0001
February 02 to June 07	-14.08%	15.55%	-29.63%	-9.07	<0.0001
July 07 to May 09	-9.69%	-4.65%	-5.04%	-1.08	0.2801
Panel B: Ignoring transaction costs of option writing					
February 02 to May 09	2.41%	23.42%	-21.01%	-8.79	<0.0001
February 02 to June 07	4.15%	28.81%	-24.66%	-9.2	<0.0001
July 07 to May 09	2.59%	5.92%	-3.33%	-0.8	0.4259

Table 8: The relation between the proportional bid-ask spread, trading volume, and open interest

Regression equation: Proportional Bid-Ask Spread = a + b*Trading Volume + c*Open Interest. In order to facilitate comparisons of option returns across times to maturity, the comparison groups are matched in terms of strike price and underlying stock so that the time to expiry is the only difference. Thus, the one-month call option sample that matches the two-month call sample is different from the one-month call option sample that matches the three-month call sample. The same note applies to the one-month put option samples. The proportional bid-ask spread, trading volume, and open interest are based on beginning of the month data. The proportional bid-ask spread is measured as: (Ask-Bid)/(0.5(Ask+Bid)). ***, **, and * denote respectively significance at the 1%, 5%, and 10% levels.

	Intercept	Trading Volume	Open Interest	Adjusted R Square
One-Month Call Option Bid-Ask Spread	0.09159 102.91(***)	-0.00000293 (8.53) (***)	-8.38E-08 (0.96)	0.0108
Two-Month Call Option Bid-Ask Spread	0.05945 114.5(***)	-0.00000111 (3.36)(***)	-4.43E-08 (1.27)	0.0029
One-Month Call Option Bid-Ask Spread	0.09314 95.31(***)	-0.0000032 (9.81)(***)	-7.71E-09 -0.08	0.012
Three-Month Call Option Bid-Ask Spread	0.04956 113.84 (***)	-0.00000134 (4.90)(***)	-1.30E-07 (4.01)(***)	0.005
One-Month Put Option Bid-Ask Spread	0.06982 89(***)	-0.00000124 (5.73)(***)	-4.64E-09 (0.08)	0.0087
Two-Month Put Option Bid-Ask Spread	0.04911 106.34(***)	-6.22E-07 (2.67)(***)	-1.25E-07 (3.87)(***)	0.0046
One-Month Put Option Bid-Ask Spread	0.0701 76.90(***)	-0.00000148 (5.07)(***)	-5.92E-08 (0.87)	0.0081
Three-Month Put Option Bid-Ask Spread	0.04145 92.51 (***)	-3.60E-07 (2.12)(**)	-1.18E-07 (3.76)(***)	0.0031

Table 9.1: The time value, trading volume, and open interest of one-month options in bull (February 2002 to June 2007) and bear (July 2007 to May 2009) market periods

Only stocks that have both call and put options are included in my sample. TV1C and TV1P denote respectively the average time value of one-month call and put options. APC denotes the average PC ratio while PC is determined as the ratio of the time value of the nearest-out-of-the-money put divided by the time value of the nearest-out-of-the-money call on the same underlying security. CVol and PVol denote respectively the average daily trading volume of call options and put options. CTrOp and PTrOp denote respectively the ratios of call trading volume to call open interest and put trading volume to put open interest. Only nearest out-of-the-money options are used. The call and put of a PC ratio have the same underlying stock but have different strike prices.

Days To Maturity	TV1C	TV1P	APC	CVol	PVol	CTrOp	PTrOp
Panel A: Bull Market Sample Period							
29	0.94	0.93	1.82	999.3	771.1	0.43	0.83
28	0.88	0.87	1.99	1000.6	825.0	0.25	0.54
25	0.80	0.76	2.10	1136.0	843.4	0.25	0.22
24	0.75	0.69	2.20	980.5	707.7	0.31	0.30
23	0.71	0.64	2.26	979.4	692.1	0.18	0.15
22	0.66	0.61	2.36	979.0	663.8	0.13	0.12
21	0.62	0.54	2.38	762.1	553.1	0.10	0.10
18	0.55	0.50	2.49	763.0	514.3	0.10	0.10
17	0.51	0.47	2.65	741.0	602.8	0.10	0.10
16	0.48	0.41	2.60	791.8	605.1	0.10	0.09
15	0.45	0.36	2.59	767.1	522.9	0.10	0.17
14	0.41	0.31	2.68	726.9	516.2	0.09	0.07
11	0.36	0.30	2.63	683.3	443.2	0.11	0.07
10	0.33	0.27	2.73	690.1	507.7	0.08	0.11
9	0.29	0.24	2.76	758.2	500.9	0.08	0.07
8	0.25	0.21	2.78	695.6	482.1	0.08	0.07
7	0.22	0.18	2.78	640.0	438.3	0.07	0.06
4	0.17	0.15	2.55	581.0	397.6	0.07	0.06
3	0.14	0.11	2.40	589.6	391.9	0.07	0.05
2	0.10	0.09	1.97	592.1	391.2	0.08	0.05
1	0.06	0.06	1.41	664.9	404.0	0.07	0.05
Panel B: Bear Market Sample Period							
29	1.56	1.67	1.62	1100.8	884.9	0.57	1.49
28	1.36	1.48	1.77	1179.6	904.1	0.36	0.38
25	1.22	1.29	1.91	1337.6	902.6	0.31	0.27
24	1.17	1.23	2.10	1171.9	896.8	0.23	0.22
23	1.13	1.11	1.95	1187.8	873.7	0.19	0.18
22	1.05	1.04	2.16	1123.2	891.5	0.17	0.17
21	0.99	0.93	2.12	936.1	714.5	0.13	0.13
18	0.91	0.88	2.28	823.3	642.6	0.12	0.11
17	0.79	0.74	2.30	858.5	616.6	0.12	0.11
16	0.78	0.70	2.27	949.2	703.4	0.13	0.13
15	0.67	0.62	2.45	860.4	647.6	0.11	0.11
14	0.61	0.53	2.41	873.3	671.8	0.11	0.10
11	0.52	0.46	2.57	812.4	571.9	0.09	0.09
10	0.47	0.40	2.68	930.6	634.8	0.10	0.09
9	0.41	0.35	2.62	884.1	635.8	0.10	0.09
8	0.37	0.31	2.85	874.9	641.3	0.14	0.08
7	0.32	0.21	1.94	714.9	551.4	0.19	0.09
4	0.24	0.19	2.47	642.9	498.0	0.07	0.07
3	0.18	0.14	2.23	746.1	568.6	0.10	0.08
2	0.13	0.11	2.14	633.6	551.4	0.08	0.07
1	0.07	0.09	1.86	597.7	615.9	0.07	0.09

Table 9.2: Comparison of bull and bear markets statistics for one-month options

This table compares the values obtained during bull markets with the values obtained during bear markets. ***, **, and * denote respectively significance at the 1%, 5%, and 10% levels.

Days to Maturity	APC Bull minus APC Bear	T-Stat	CVol Bull minus Cvol Bear	T-Stat	PVol Bull minus Pvol Bear	T-Stat
29	0.19	5.10***	-101.5	-1.59	-113.9	-1.36
28	0.21	4.90***	-179.0	-2.97***	-79.0	-1.18
25	0.19	3.68***	-201.6	-2.64***	-59.2	-0.69
24	0.10	1.71*	-191.5	-2.79***	-189.1	-2.85***
23	0.31	5.23***	-208.4	-2.79***	-181.7	-2.73***
22	0.19	2.93***	-144.2	-1.85*	-227.7	-3.45***
21	0.27	4.17***	-174.0	-2.82***	-161.4	-2.70***
18	0.22	3.19***	-60.2	-1.11	-128.2	-2.57***
17	0.35	4.93***	-117.4	-1.97**	-13.8	-0.24
16	0.32	4.53***	-157.4	-2.61***	-98.4	-1.62
15	0.15	2.01*	-93.3	-1.51	-124.8	-2.42**
14	0.26	3.35***	-146.4	-2.03**	-155.6	-2.54**
11	0.06	0.70	-129.1	-1.80*	-128.7	-2.74***
10	0.05	0.61	-240.5	-2.46**	-127.2	-1.91*
9	0.14	1.65*	-125.9	-0.98	-134.9	-2.22**
8	-0.07	-0.74	-179.3	-1.98*	-159.2	-2.63**
7	0.84	7.91***	-74.9	-1.00	-113.1	-2.29**
4	0.08	0.79	-61.9	-1.11	-100.4	-2.23**
3	0.17	1.55	-156.5	-2.08**	-176.7	-3.63***
2	-0.17	-1.87*	-41.5	-0.73	-160.3	-2.97***
1	-0.45	-5.55***	67.2	0.58	-211.9	-1.73*

Table 9.2 (Continued): Comparison of bull and bear markets statistics for one-month call options

Days to Maturity	CTrOp minus PTrOp Bull	T-Stat	CTrOp minus PTrOp Bear	T-Stat
29	-0.40	-1.82*	-0.92	-1.63
28	-0.29	-1.23	-0.02	-0.34
25	0.03	2.44**	0.04	1.78*
24	0.02	0.10	0.01	0.50
23	0.03	1.04	0.01	0.81
22	0.02	2.94***	0.00	0.25
21	0.00	-0.24	0.01	0.84
18	0.00	-0.57	0.00	0.17
17	0.00	-0.54	0.01	2.12**
16	0.00	1.34	0.00	0.16
15	-0.08	-0.82	0.00	-0.54
14	0.01	2.54**	0.01	1.59
11	0.04	1.35	0.00	-0.17
10	-0.02	-0.76	0.00	0.44
9	0.00	0.59	0.02	1.20
8	0.01	1.35	0.06	1.26
7	0.02	2.51**	0.10	0.88
4	0.01	2.13**	0.00	0.27
3	0.02	2.96***	0.02	1.08
2	0.02	3.39***	0.01	0.87
1	0.02	3.80***	-0.02	-0.88

Table 10.1: The time value, trading volume, and open interest of three-month options in bull (February 2002 to June 2007) and bear (July 2007 to May 2009) market periods

Only stocks that have both call and put options are included in my sample. TV1C and TV1P denote respectively the average time value of one-month call and put options. APC denotes the average PC ratio while PC is determined as the ratio of the time value of the nearest-out-of-the-money put divided by the time value of the nearest-out-of-the-money call on the same underlying security. CVol and PVol denote respectively the average daily trading volume of call options and put options. CTrOp and PTrOp denote respectively the ratios of call trading volume to call open interest and put trading volume to put open interest. Only nearest out-of-the-money options are used. The call and put of a PC ratio have the same underlying stock but have different strike prices.

Days To Maturity	TV3C	TV3P	A'PC	CVol	PVol	CTrOp	PTrOp
Panel A: Bull Market Sample Period							
89	2.12	1.98	1.17	391.0	257.8	0.21	0.12
88	2.06	1.93	1.21	442.0	244.4	0.12	0.10
85	1.98	1.82	1.23	383.4	213.7	0.10	0.08
84	1.94	1.77	1.24	327.0	204.2	0.07	0.07
83	1.91	1.71	1.23	334.7	215.4	0.07	0.06
82	1.86	1.68	1.26	320.7	216.4	0.06	0.06
81	1.84	1.62	1.24	263.4	162.3	0.04	0.04
78	1.74	1.55	1.27	312.6	147.3	0.06	0.04
77	1.70	1.53	1.31	296.3	187.7	0.05	0.04
76	1.70	1.47	1.28	318.2	175.8	0.05	0.04
75	1.66	1.41	1.28	288.9	178.6	0.05	0.04
74	1.63	1.38	1.30	280.8	184.1	0.05	0.05
71	1.59	1.35	1.30	278.8	171.6	0.06	0.04
70	1.56	1.33	1.33	289.5	235.4	0.05	0.05
69	1.53	1.31	1.35	303.7	210.8	0.04	0.04
68	1.49	1.30	1.38	357.3	202.1	0.05	0.05
67	1.47	1.28	1.39	247.4	185.4	0.04	0.04
64	1.44	1.23	1.35	290.9	175.2	0.04	0.04
63	1.41	1.18	1.40	296.5	188.6	0.05	0.05
62	1.39	1.16	1.38	306.2	218.5	0.05	0.05
61	1.36	1.11	1.38	340.5	212.0	0.05	0.04
Panel B: Bear Market Sample Period							
89	3.12	3.15	1.18	351.7	319.8	0.19	0.21
88	2.91	2.96	1.23	356.5	260.9	0.12	0.10
85	2.80	2.81	1.27	335.4	232.0	0.10	0.09
84	2.74	2.75	1.28	369.8	213.6	0.09	0.06
83	2.76	2.65	1.22	302.6	232.7	0.08	0.07
82	2.68	2.58	1.26	318.8	240.1	0.11	0.09
81	2.62	2.51	1.25	244.2	208.4	0.06	0.05
78	2.56	2.46	1.29	236.0	182.8	0.06	0.07
77	2.41	2.27	1.27	283.9	203.1	0.07	0.05
76	2.43	2.27	1.27	269.7	210.8	0.06	0.06
75	2.29	2.16	1.30	261.7	193.6	0.06	0.05
74	2.24	2.06	1.27	267.8	185.6	0.05	0.05
71	2.13	1.99	1.33	250.3	192.4	0.05	0.04
70	2.08	1.94	1.33	266.1	197.0	0.05	0.04
69	2.02	1.92	1.37	278.7	187.9	0.06	0.04
68	2.02	1.89	1.37	274.4	199.0	0.06	0.05
67	1.96	1.83	1.33	210.4	155.2	0.05	0.04
64	1.89	1.83	1.40	231.6	194.4	0.05	0.04
63	1.83	1.77	1.44	246.4	176.2	0.05	0.04
62	1.73	1.69	1.46	278.2	220.3	0.05	0.05
61	1.65	1.65	1.56	246.8	209.1	0.04	0.05

Table 10.2: Comparison of bull and bear markets statistics for three-month options

This table compares the values obtained during bull markets with the values obtained during bear markets. ***, **, and * denote respectively significance at the 1%, 5%, and 10% levels.

Days to Maturity	APC Bull minus APC Bear	T-Stat	CVol Bull minus Cvol Bear	T-Stat	PVol Bull minus Pvol Bear	T-Stat
89	-0.02	-1.27	39.3	1.78*	-62.0	-1.97**
88	-0.02	-1.11	85.5	3.13***	-16.4	-0.73
85	-0.04	-1.80*	48.0	2.25**	-18.3	-0.96
84	-0.04	-2.16**	-42.8	-1.62	-9.3	-0.54
83	0.01	0.45	32.1	1.51	-17.2	-0.93
82	0.00	-0.01	1.9	0.07	-23.7	-1.13
81	-0.01	-0.65	19.2	0.94	-46.2	-2.02**
78	-0.02	-0.95	76.6	3.30***	-35.5	-2.18**
77	0.04	1.51	12.3	0.42	-15.5	-0.66
76	0.01	0.55	48.5	2.17**	-35.0	-1.98**
75	-0.02	-0.71	27.2	1.39	-15.0	-0.83
74	0.03	1.13	13.0	0.55	-1.4	-0.08
71	-0.02	-0.82	28.5	1.15	-20.8	-1.07
70	0.00	0.14	23.4	0.93	38.4	1.03
69	-0.03	-0.97	25.1	0.89	22.9	0.98
68	0.01	0.41	82.9	1.27	3.1	0.17
67	0.06	2.25**	37.0	2.32**	30.2	1.58
64	-0.05	-1.79*	59.3	3.03***	-19.1	-0.53
63	-0.04	-1.21	50.0	2.66***	12.4	0.76
62	-0.08	-2.49**	28.1	1.11	-1.8	-0.08
61	-0.18	-5.39***	93.7	4.12***	2.9	0.13

Table 10.2 (Continued): Comparison of bull and bear market statistics for three-month options

Days to Maturity	CTrOp minus PTrOp Bull	T-Stat	CTrOp minus PTrOp Bear	T-Stat
89	0.09	1.70**	-0.02	-0.57
88	0.02	1.59	0.02	2.10**
85	0.02	1.71*	0.02	1.35
84	0.00	-0.01	0.03	4.96***
83	0.01	1.94*	0.00	0.53
82	0.00	-0.16	0.01	0.43
81	0.00	-0.16	0.01	1.30
78	0.03	2.27**	-0.01	-0.56
77	0.01	2.20**	0.02	2.48**
76	0.01	2.29**	0.01	0.91
75	0.01	1.63	0.01	2.18**
74	0.00	-0.15	0.00	0.96
71	0.02	1.25	0.01	2.01**
70	-0.01	-1.01	0.01	1.80*
69	0.00	0.10	0.02	1.24
68	0.00	-0.29	0.01	1.48
67	0.00	0.58	0.00	0.41
64	0.00	0.14	0.01	1.65*
63	0.00	0.34	0.01	2.63***
62	0.00	0.20	0.00	-0.45
61	0.00	1.40	0.00	-0.22

Table 10.3:The impact of market sentiment on the ratio of put time value to call time value of nearest out-of-the-money put and call options on the same underlying security

The dependent variable is put to call time value (PC) determined as the ratio of time value of the nearest-out-of-the-money put divided by the time value of the nearest-out-of-the-money call on the same underlying security. The regression equation is:

$PC_{it} = \beta_0 + \beta_1 LgCVol_{it} + \beta_2 \, LgCOp_{it} + \beta_3 LgPVol_{it} + \beta_4 \, LgPOp_{it} + \beta_5 DM_{it} + \beta_6 \, MC_{it} + \square_{it}$

Where i ranges over the various underlying assets and t ranges over the days to maturity ($DM_{it} = t$)

Panel 1: One-month options

Independent Variable	Regression coefficient	T-Statistics	P-Value
Intercept	1.74029	33.79	<.0001
Log of call volume (LgCVol)	-0.5756	-160.95	<.0001
Log of call open interest (LgCOp)	-0.014	-1.7	0.0896
Log of put volume (LgPVol)	0.43092	123.05	<.0001
Log of put open interest (LgPOp)	0.18849	23.61	<.0001
Days to maturity (DM)	-0.0009	-1.05	0.2947
Market conditions dummy (MC)	0.1692	11.39	<.0001
R^2	0.1246		
Adjusted R^2	0.1246		

Panel 2: Three-month options

Independent Variable	Regression coefficient	T-Statistics	P-Value
Intercept	1.19112	43.28	<.0001
Log of call volume (LgCVol)	-0.0796	-54.93	<.0001
Log of call open interest (LgCOp)	0.07667	27.56	<.0001
Log of put volume (LgPVol)	0.02694	20.15	<.0001
Log of put open interest (LgPOp)	0.01441	5.48	<.0001
Days to maturity (DM)	-0.005	-18.73	<.0001
Market conditions dummy (MC)	-0.0221	-4.19	<.0001
R^2	0.0154		
Adjusted R^2	0.0153		

Table 11.1: Covered call writing with transaction costs: holding a portfolio of stocks and writing calls on the individual securities that make up the portfolio

The underlying portfolio of this strategy is the S&P 100 index. I write calls on each constituent stock of the index. I match the weight of the option in the portfolio of options with the weight of the underlying stock in the index. Stock options are held to maturity if they are not exercised early. Early exercise happens if the option's time value is equal to or less than zero. Index constituents are updated monthly. Built Index Value Bias denotes the absolute value of the average difference between the built S&P 100 index value and the real S&P 100 index value. Transaction costs are included by selling stocks or options at the bid prices and buying them at the ask prices. Due to data limitation in early years, I are unable to fully match the index stock list and the portfolio of options. Hence, the average number of stocks in the portfolio is slightly different from 100. The average monthly risk-free rate is 0.203%.

	Covered writing of nearest-out-of-the-money calls	Covered writing of near-the-money calls	S&P 100 Index
Average Number of stocks in the Portfolio	98.6	98.6	
Built Index Value Bias	1.10%	1.10%	
Panel A: Sample Period February 2002 To December 2008			
Mean Return	-0.528%	-0.444%	-0.207%
STD	3.988%	3.254%	5.286%
Covered portfolio return minus index return	-0.321%	-0.237%	
T-Statistics	-1.53	-0.78	
P-Value	0.1310	0.4376	
Semi STD (Return<Rf)	3.629%	3.145%	4.721%
Minimum Return	-12.971%	-11.691%	-18.962%
Maximum Return	12.461%	10.124%	15.584%
Sharpe Ratio	-18.343%	-19.888%	-7.764%
Sortino Ratio	-20.156%	-20.574%	-8.693%
Jensen's Alpha	-0.436%	-0.419%	
Leland's Alpha	-0.436%	-0.420%	
Panel B: Sample Period February 2002 To June 2007			
Mean Return	-0.273%	-0.292%	0.440%
STD	3.135%	2.530%	3.888%
Covered portfolio return minus index return	-0.713%	-0.732%	
T-Statistics	-3.76	-2.68	
P-Value	0.0004	0.0093	
Semi STD (Return<Rf)	3.100%	2.711%	3.210%
Minimum Return	-11.532%	-9.995%	-11.748%
Maximum Return	4.361%	2.556%	6.871%
Sharpe Ratio	-15.182%	-19.546%	6.092%
Sortino Ratio	-15.352%	-18.244%	7.379%
Jensen's Alpha	-0.653%	-0.625%	
Leland's Alpha	-0.659%	-0.633%	
Panel C: Sample Period July 2007 To December 2008			
Mean Return	-1.506%	-1.027%	-2.682%
STD	6.397%	5.310%	8.634%
Covered portfolio return minus index return	1.176%	1.655%	
T-Statistics	1.98	1.82	
P-Value	0.0656	0.0880	
Semi STD (Return<Rf)	4.240%	3.789%	6.318%
Minimum Return	-12.971%	-11.691%	-18.962%
Maximum Return	12.461%	10.124%	15.584%
Sharpe Ratio	-26.712%	-23.171%	-33.416%
Sortino Ratio	-40.303%	-32.469%	-45.666%
Jensen's Alpha	0.409%	0.485%	
Leland's Alpha	0.433%	0.487%	

Table 11.2: Covered call writing with no transaction costs: holding a portfolio of stocks and writing calls on the individual securities that make up the portfolio

The underlying portfolio of this strategy is the S&P 100 index. I write calls on each constituent stock of the index. I match the weight of the option in the portfolio of options with the weight of the underlying stock in the index. Stock options are held to maturity if they are not exercised early. Early exercise happens if the option's time value is equal to or less than zero. Index constituents are updated monthly. Built Index Value Bias denotes the absolute value of the average difference between the built S&P 100 index value and the real S&P 100 index value. Transaction costs are excluded by selling or buying options at the midpoint of the bid and ask prices. Stock transaction costs are included. Due to data limitation in early years, I are unable to fully match the index stock list and the portfolio of options. Hence, the average number of stocks in the portfolio is slightly different from 100. The average monthly risk-free rate is 0.203%.

	Covered writing of nearest-out-of-the-money calls	Covered writing of near-the-money calls	S&P 100 Index
Average Stock Num in Portfolio	98.6	98.6	
Built Index Value Bias	1.10%	1.10%	
Panel A: Sample Period Feb 02 To Dec 08			
Mean Return	-0.286%	-0.148%	-0.207%
STD	3.989%	3.264%	5.286%
Writing return compared to index return	-0.079%	0.059%	
T-Statistics	-0.38	0.20	
P-Value	0.7046	0.8428	
Semi STD (Return<Rf)	3.596%	3.125%	4.721%
Minimum Return	-12.614%	-11.305%	-18.962%
Maximum Return	13.089%	10.933%	15.584%
Sharpe Ratio	-12.266%	-10.754%	-7.764%
Sortino Ratio	-13.608%	-11.232%	-8.693%
Jensen's Alpha	-0.193%	-0.121%	
Leland's Alpha	-0.192%	-0.121%	
Panel B: Sample Period Feb 02 To Jun 07			
Mean Return	-0.038%	0.000%	0.440%
STD	3.129%	2.516%	3.888%
Writing return compared to index return	-0.478%	-0.440%	
T-Statistics	-2.62	-1.66	
P-Value	0.0109	0.1020	
Semi STD (Return<Rf)	3.070%	2.723%	3.210%
Minimum Return	-11.217%	-9.635%	-11.748%
Maximum Return	4.608%	2.802%	6.871%
Sharpe Ratio	-7.707%	-8.085%	6.092%
Sortino Ratio	-7.857%	-7.470%	7.379%
Jensen's Alpha	-0.419%	-0.336%	
Leland's Alpha	-0.425%	-0.343%	
Panel C: Sample Period Jul 07 To Dec 08			
Mean Return	-1.235%	-0.712%	-2.682%
STD	6.416%	5.372%	8.634%
Writing return compared to index return	1.447%	1.970%	
T-Statistics	2.42	2.18	
P-Value	0.0279	0.0442	
Semi STD (Return<Rf)	4.200%	3.745%	6.318%
Minimum Return	-12.614%	-11.305%	-18.962%
Maximum Return	13.089%	10.933%	15.584%
Sharpe Ratio	-22.411%	-17.040%	-33.416%
Sortino Ratio	-34.238%	-24.440%	-45.666%
Jensen's Alpha	0.683%	0.818%	

Leland's Alpha	0.724%	0.840%

Table 11.2 (Continued): Covered call writing with no transaction costs: holding a portfolio of stocks and writing calls on the individual securities that make up the portfolio

Panel D: Comparison of the mean returns for the full sample: the impact of transaction costs		
	Covered writing of nearest-out-of-the-money calls	Covered writing of near-the-money calls
Return including transaction costs	-0.528%	-0.444%
Return excluding transaction costs	-0.286%	-0.148%
Mean Difference	-0.242%	-0.296%
T-statistics	-20.43	-21.04
P-Value	<0.0001	<0.0001

Table 12.1: Return including transaction costs of writing a portfolio of stock calls and buying index call to hedge.

The weight of a particular call is equal to the weight of the underlying security in the S&P 100 index. Option writing strategy return is monthly return. Sample period from February 2002 to December 2008. I account for transaction costs by using option bid and ask prices to calculate writing return. The average monthly risk-free rate is equal to 0.203%.

	Write OTM Stock Calls and Buy Index Call	Write NTM Stock Calls and Buy Index Call	S&P 100 Index
Panel A: Sample Period Feb 02 To Dec 08			
Mean Return	-34.262%	-33.826%	-0.207%
STD	85.346%	85.434%	5.286%
Writing return compared to index return	-34.054%	-33.619%	
T-Statistics	-3.46	-3.51	
P-Value	0.0009	0.0007	
Semi STD (Return<Rf)	74.215%	65.131%	4.721%
Minimum Return	-284.993%	-255.326%	-18.962%
Maximum Return	91.030%	262.919%	15.584%
Sharpe Ratio	-40.382%	-39.831%	-7.764%
Sortino Ratio	-46.439%	-52.248%	-8.693%
Jensen's Alpha	-36.557%	-34.769%	
Leland's Alpha	-36.582%	-34.629%	
Panel B: Sample Period Feb 02 To Jun 07			
Mean Return	-31.341%	-29.775%	0.440%
STD	82.060%	75.075%	3.888%
Writing return compared to index return	-31.781%	-30.215%	
T-Statistics	-3.01	-3.21	
P-Value	0.0037	0.0021	
Semi STD (Return<Rf)	70.695%	54.069%	3.210%
Minimum Return	-284.993%	-219.004%	-11.748%
Maximum Return	88.332%	262.919%	6.871%
Sharpe Ratio	-38.441%	-39.930%	6.092%
Sortino Ratio	-44.620%	-55.444%	7.379%
Jensen's Alpha	-27.787%	-29.055%	
Leland's Alpha	-27.942%	-28.918%	
Panel C: Sample Period Jul 07 To Dec 08			
Mean Return	-46.125%	-49.317%	-2.682%
STD	102.057%	120.582%	8.634%
Writing return compared to index return	-43.443%	-46.635%	
T-Statistics	-1.66	-1.58	
P-Value	0.1180	0.1331	
Semi STD (Return<Rf)	88.521%	84.791%	6.318%
Minimum Return	-284.791%	-255.326%	-18.962%
Maximum Return	91.030%	149.468%	15.584%
Sharpe Ratio	-45.394%	-41.068%	-33.416%
Sortino Ratio	-52.335%	-58.403%	-45.666%
Jensen's Alpha	-62.107%	-52.389%	
Leland's Alpha	-59.787%	-45.641%	

Table 12.2: Return including transaction costs of writing index calls and buying a portfolio of stock calls to hedge.

The weight of a particular call is equal to the weight of the underlying security in the S&P 100 index. Option writing strategy return is monthly return. Sample period from February 2002 to December 2008. I account for transaction costs by using option bid and ask prices to calculate writing return. The average monthly risk-free rate is equal to 0.203%.

	Write OTM Index Call and Buy Stock Calls	Write NTM Index Call and Buy Stock Calls	S&P 100 Index
Panel A: Sample Period Feb 02 To Dec 08			
Mean Return	-11.064%	-19.134%	-0.207%
STD	56.317%	62.225%	5.286%
Writing return compared to index return	-10.856%	-18.926%	
T-Statistics	-1.87	-2.74	
P-Value	0.0652	0.0075	
Semi STD (Return<Rf)	28.899%	47.623%	4.721%
Minimum Return	-99.584%	-251.572%	-18.962%
Maximum Return	137.669%	128.368%	15.584%
Sharpe Ratio	-20.006%	-31.076%	-7.764%
Sortino Ratio	-38.986%	-40.604%	-8.693%
Jensen's Alpha	-9.841%	-19.010%	
Leland's Alpha	-9.841%	-19.186%	
Panel B: Sample Period Feb 02 To Jun 07			
Mean Return	-13.601%	-18.273%	0.440%
STD	51.557%	58.032%	3.888%
Writing return compared to index return	-14.041%	-18.713%	
T-Statistics	-2.34	-2.61	
P-Value	0.0224	0.0114	
Semi STD (Return<Rf)	30.027%	46.484%	3.210%
Minimum Return	-99.584%	-251.572%	-11.748%
Maximum Return	101.351%	128.368%	6.871%
Sharpe Ratio	-26.775%	-31.837%	6.092%
Sortino Ratio	-45.973%	-39.747%	7.379%
Jensen's Alpha	-16.406%	-18.728%	
Leland's Alpha	-16.321%	-18.920%	
Panel C: Sample Period Jul 07 To Dec 08			
Mean Return	-0.754%	-22.425%	-2.682%
STD	75.126%	79.738%	8.634%
Writing return compared to index return	1.982%	-19.743%	
T-Statistics	0.05	-1.02	
P-Value	0.9597	0.3224	
Semi STD (Return<Rf)	24.857%	49.626%	6.318%
Minimum Return	-96.358%	-188.130%	-18.962%
Maximum Return	137.669%	119.385%	15.584%
Sharpe Ratio	-1.274%	-28.378%	-33.416%
Sortino Ratio	-3.850%	-45.598%	-45.666%
Jensen's Alpha	9.596%	-21.135%	
Leland's Alpha	6.878%	-26.399%	

Table 12.3: Return excluding transaction costs of writing a portfolio of stock calls and buying index calls to hedge.

The weight of a particular call is equal to the weight of the underlying security in the S&P 100 index. Option writing strategy return is monthly return. Sample period from February 2002 to December 2008. I exclude transaction costs by using the midpoint of the option bid and ask prices to calculate writing return. The average monthly risk-free rate is equal to 0.203%.

	Write OTM Stock Calls and Buy Index Call	Write NTM Stock Calls and Buy Index Call	S&P 100 Index
Panel A: Sample Period Feb 02 To Dec 08			
Mean Return	-7.829%	-2.501%	-0.207%
STD	65.949%	69.471%	5.286%
Writing returns compared to index return	-7.621%	-2.293%	
T-Statistics	-1.01	-0.29	
P-Value	0.3151	0.7696	
Semi STD (Return<Rf)	50.315%	46.786%	4.721%
Minimum Return	-199.224%	-161.368%	-18.962%
Maximum Return	94.023%	255.793%	15.584%
Sharpe Ratio	-12.178%	-3.892%	-7.764%
Sortino Ratio	-15.962%	-5.779%	-8.693%
Jensen's Alpha	-9.727%	-3.273%	
Leland's Alpha	-9.735%	-3.101%	
Panel B: Sample Period Feb 02 To Jun 07			
Mean Return	-5.011%	-2.042%	0.440%
STD	61.008%	63.392%	3.888%
Writing returns compared to index return	-5.451%	-2.482%	
T-Statistics	-0.68	-0.31	
P-Value	0.4965	0.7557	
Semi STD (Return<Rf)	43.528%	40.385%	3.210%
Minimum Return	-157.728%	-161.368%	-11.748%
Maximum Return	94.023%	255.793%	6.871%
Sharpe Ratio	-8.546%	-3.541%	6.092%
Sortino Ratio	-11.978%	-5.559%	7.379%
Jensen's Alpha	-2.146%	-1.714%	
Leland's Alpha	-2.260%	-1.537%	
Panel C: Sample Period Jul 07 To Dec 08			
Mean Return	-19.276%	-4.254%	-2.682%
STD	86.203%	93.039%	8.634%
Writing returns compared to index return	-16.594%	-1.572%	
T-Statistics	-0.77	-0.07	
P-Value	0.4519	0.9460	
Semi STD (Return<Rf)	55.625%	63.050%	6.318%
Minimum Return	-199.224%	-149.838%	-18.962%
Maximum Return	93.784%	171.718%	15.584%
Sharpe Ratio	-22.597%	-4.790%	-33.416%
Sortino Ratio	-35.019%	-7.069%	-45.666%
Jensen's Alpha	-32.192%	-7.115%	
Leland's Alpha	-29.497%	-1.121%	

Panel D: Comparing mean writing returns with and without transaction costs

	Write OTM Stock Calls and Buy Index Call	Write NTM Stock Calls and Buy Index Call
Return including transaction costs	-34.262%	-33.826%
Return excluding transaction costs	-7.829%	-2.501%
Mean Difference	-26.433%	-31.326%
T-statistics	-8.22	-10.32
P-Value	<0.0001	<0.0001

Table 12.4: Return excluding transaction costs of writing index calls and buying a portfolio of stock calls to hedge.

The weight of a particular call is equal to the weight of the underlying security in the S&P 100 index. Option writing strategy return is monthly return. Sample period from February 2002 to December 2008. I exclude transaction costs by using the midpoint of the option bid and ask prices to calculate writing return. The average monthly risk-free rate is equal to 0.203%.

	Write OTM Index Call and Buy Stock Calls	Write NTM Index Call and Buy Stock Calls	S&P 100 Index
Panel A: Sample Period Feb 02 To Dec 08			
Mean Return	7.829%	2.501%	-0.207%
STD	65.949%	69.471%	5.286%
Writing return compared to index return	8.036%	2.708%	
T-Statistics	1.11	0.35	
P-Value	0.2682	0.7253	
Semi STD (Return<Rf)	29.031%	51.690%	4.721%
Minimum Return	-94.023%	-255.793%	-18.962%
Maximum Return	199.224%	161.368%	15.584%
Sharpe Ratio	11.563%	3.307%	-7.764%
Sortino Ratio	26.267%	4.445%	-8.693%
Jensen's Alpha	9.321%	2.867%	
Leland's Alpha	9.329%	2.695%	
Panel B: Sample Period Feb 02 To Jun 07			
Mean Return	5.011%	2.042%	0.440%
STD	61.008%	63.392%	3.888%
Writing returns compared to index return	4.571%	1.642%	
T-Statistics	0.64	0.21	
P-Value	0.5263	0.8381	
Semi STD (Return<Rf)	28.781%	51.972%	3.210%
Minimum Return	-94.023%	-255.793%	-11.748%
Maximum Return	157.728%	161.368%	6.871%
Sharpe Ratio	7.880%	2.901%	6.092%
Sortino Ratio	16.705%	3.538%	7.379%
Jensen's Alpha	1.740%	1.308%	
Leland's Alpha	1.854%	1.131%	
Panel C: Sample Period Jul 07 To Dec 08			
Mean Return	19.276%	4.254%	-2.682%
STD	86.203%	93.039%	8.634%
Writing returns compared to index return	21.958%	6.936%	
T-Statistics	1.03	0.31	
P-Value	0.3211	0.7617	
Semi STD (Return<Rf)	30.634%	46.941%	6.318%
Minimum Return	-93.784%	-171.718%	-18.962%
Maximum Return	199.224%	149.838%	15.584%
Sharpe Ratio	22.126%	4.354%	-33.416%
Sortino Ratio	62.262%	8.629%	-45.666%
Jensen's Alpha	31.786%	6.709%	
Leland's Alpha	29.091%	0.715%	

Panel D: Comparing mean writing returns with and without transaction costs

	Write OTM Index Call and Buy Stock Calls	Write NTM Index Call and Buy Stock Calls
Return including transaction costs	-11.064%	-19.134%
Return excluding transaction costs	7.829%	2.501%
Mean Difference	-18.892%	-21.634%
T-statistics	-12.01	-14.04
P-Value	<0.0001	<0.0001

Table 13.1: Writing one-month calls versus writing two-month calls and closing after one month: returns after accounting for transaction costs and excluding observations with the lowest 1% one-month option writing returns

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The average monthly risk-free rate is 0.203%.

	One-Month Call	Two-Month Call	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	23203				
Mean Return	-10.01%	-11.79%	1.78%	2.75	0.0059
STD	169.78%	119.40%			
Semi STD	190.78%	129.75%			
Sortino Ratio	-5.35%	-9.24%			
Skewness of Return	-2.28	-6.34			
Significance of Mean Return					
T-statistics	-8.99	-15.05			
P-Value	<0.0001	<0.0001			
Minimum Return	-9.4	-55.0			
Maximum Return	1	1			
Early Exercise	3207	190			
Early Exercise Ratio	13.82%	0.82%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	15230				
Mean Return	-13.16%	-14.94%	1.78%	2.34	0.0195
STD	171.43%	112.50%			
Semi STD	193.73%	114.73%			
Sortino Ratio	-6.90%	-13.20%			
Skewness of Return	-2.29	-2.53			
Significance of Mean Return					
T-statistics	-9.47	-16.38			
P-Value	<0.0001	<0.0001			
Minimum Return	-9.4	-19.0			
Maximum Return	1	1			
Early Exercise	2023	128			
Early Exercise Ratio	13.28%	0.84%			
Panel C: Sample Period Jul 07 To May 09					
Observation	7973				
Mean Return	-4.01%	-5.79%	1.78%	1.39	0.1357
STD	166.42%	131.36%			
Semi STD	184.42%	157.62%			
Sortino Ratio	-2.28%	-3.80%			
Skewness of Return	-2.25	-10.85			
Significance of Mean Return					
T-statistics	-2.15	-3.94			
P-Value	0.0313	<0.0001			
Minimum Return	-9.4	-55.0			
Maximum Return	1.0	1.0			
Early Exercise	1184	62			
Early Exercise Ratio	14.85%	0.78%			

Table 13.2: Writing one-month calls versus writing three-month calls and closing after one month: returns after accounting for transaction costs and excluding observations that produce the lowest 1% one-month option writing returns

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The one- and two-month option portfolio has a composition different from the one- and three-month option portfolio. Therefore, the observations for the two portfolios are different. The average monthly risk-free rate is 0.203%.

	One-Month Call	Three-Month Call	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	23709				
Mean Return	-10.39%	-11.87%	1.48%	2.09	0.0365
STD	173.52%	94.40%			
Semi STD	197.75%	92.01%			
Sortino Ratio	-5.36%	-13.12%			
Skewness of Return	-2.33	-2.96			
Significance of Mean Return					
T-statistics	-9.22	-19.37			
P-Value	<0.0001	<0.0001			
Minimum Return	-9.5	-27.9			
Maximum Return	1	1			
Early Exercise	3263	128			
Early Exercise Ratio	13.76%	0.54%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	15853				
Mean Return	-19.03%	-17.54%	-1.50%	-1.65	0.0997
STD	179.29%	94.33%			
Semi STD	201.32%	90.64%			
Sortino Ratio	-9.55%	-19.58%			
Skewness of Return	-2.24	-3.11			
Significance of Mean Return					
T-statistics	-13.37	-23.41			
P-Value	<0.0001	<0.0001			
Minimum Return	-9.5	-27.9			
Maximum Return	1	1			
Early Exercise	2313	108			
Early Exercise Ratio	14.59%	0.68%			
Panel C: Sample Period Jul 07 To May 09					
Observation	7856				
Mean Return	7.04%	-0.45%	7.48%	6.88	<0.0001
STD	159.85%	93.50%			
Semi STD	188.16%	95.45%			
Sortino Ratio	3.63%	-0.68%			
Skewness of Return	-2.50	-2.74			
Significance of Mean Return					
T-statistics	3.9	-0.42			
P-Value	<0.0001	0.672			
Minimum Return	-9.3	-17.8			
Maximum Return	1.0	1.0			
Early Exercise	950	20			
Early Exercise Ratio	12.09%	0.25%			

Table 14.1: Writing one-month puts versus writing two-month puts and closing after one month: returns after accounting for transaction costs and excluding the observations that produce the lowest 1% one-month option writing return

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The average monthly risk-free rate is 0.203%.

	One-Month Put	Two-Month Put	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	15897				
Mean Return	11.90%	1.24%	10.67%	18.03	<0.0001
STD	142.20%	103.01%			
Semi STD	158.18%	110.59%			
Sortino Ratio	7.39%	0.93%			
Skewness of Return	-2.28	-2.57			
Significance of Mean Return					
T-statistics	10.55	1.51			
P-Value	<0.0001	0.1306			
Minimum Return	-7.3	-18.0			
Maximum Return	1	1			
Early Exercise	2364	488			
Early Exercise Ratio	14.87%	3.07%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	9841				
Mean Return	22.08%	9.50%	12.58%	18.16	<0.0001
STD	130.81%	89.55%			
Semi STD	156.84%	95.79%			
Sortino Ratio	13.95%	9.71%			
Skewness of Return	-2.58	-2.29			
Significance of Mean Return					
T-statistics	16.74	10.52			
P-Value	<0.0001	<0.0001			
Minimum Return	-7.3	-8.0			
Maximum Return	1	1			
Early Exercise	1073	163			
Early Exercise Ratio	10.90%	1.66%			
Panel C: Sample Period Jul 07 To May 09					
Observation	6056				
Mean Return	-4.63%	-12.20%	7.57%	7.08	<0.0001
STD	157.60%	120.55%			
Semi STD	158.65%	125.01%			
Sortino Ratio	-3.05%	-9.92%			
Skewness of Return	-1.90	-2.54			
Significance of Mean Return					
T-statistics	-2.29	-7.87			
P-Value	0.0223	<0.0001			
Minimum Return	-7.3	-18.0			
Maximum Return	1.00	0.98			
Early Exercise	1291	325			
Early Exercise Ratio	21.32%	5.37%			

Table 14.2: Writing one-month puts versus writing three-month puts and closing after one month: returns after accounting for transaction costs and excluding the observations that produce the lowest 1% one-month option writing return

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The one- and two-month option portfolio has a composition different from the one- and three-month option portfolio. Therefore, the observations for the two portfolios are different. The average monthly risk-free rate is 0.203%.

	One-Month Put	Three-Month Put	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	15701				
Mean Return	0.85%	-8.76%	9.61%	12.72	<0.0001
STD	155.98%	88.02%			
Semi STD	170.68%	86.32%			
Sortino Ratio	0.38%	-10.38%			
Skewness of Return	-2.20	-1.88			
Significance of Mean Return					
T-statistics	0.68	-12.47			
P-Value	0.4959	<0.0001			
Minimum Return	-8.0	-9.0			
Maximum Return	1	1			
Early Exercise	2615	341			
Early Exercise Ratio	16.65%	2.17%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	10079				
Mean Return	18.92%	4.59%	14.33%	16.42	<0.0001
STD	139.04%	74.24%			
Semi STD	167.83%	73.25%			
Sortino Ratio	11.15%	5.99%			
Skewness of Return	-2.61	-2.00			
Significance of Mean Return					
T-statistics	13.66	6.21			
P-Value	<0.0001	<0.0001			
Minimum Return	-8.0	-9.0			
Maximum Return	1	1			
Early Exercise	1176	130			
Early Exercise Ratio	11.67%	1.29%			
Panel C: Sample Period Jul 07 To May 09					
Observation	5622				
Mean Return	-31.55%	-32.70%	1.15%	0.81	0.4156
STD	177.94%	104.23%			
Semi STD	172.86%	96.79%			
Sortino Ratio	-18.36%	-33.99%			
Skewness of Return	-1.68	-1.51			
Significance of Mean Return					
T-statistics	-13.29	-23.52			
P-Value	<0.0001	<0.0001			
Minimum Return	-8.0	-7.9			
Maximum Return	1.00	1.00			
Early Exercise	1439	211			
Early Exercise Ratio	25.60%	3.75%			

Table 15.1: Writing one-month calls versus writing two-month calls and closing after one month: returns after accounting for transaction costs and excluding the one-third of observations with the lowest trading volume of one-month option

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The average monthly risk-free rate is 0.203%.

	One-Month Call	Two-Month Call	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	15626				
Mean Return	-18.13%	-14.61%	-3.52%	-2.61	0.009
STD	251.35%	135.65%			
Semi STD	365.01%	158.71%			
Sortino Ratio	-5.02%	-9.33%			
Skewness of Return	-14.38	-7.19			
Significance of Mean Return					
T-statistics	-9.02	-13.46			
P-Value	<0.0001	<0.0001			
Minimum Return	-125.0	-55.0			
Maximum Return	1	1			
Early Exercise	2183	131			
Early Exercise Ratio	13.97%	0.84%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	10144				
Mean Return	-19.71%	-17.63%	-2.08%	-1.59	0.1111
STD	220.94%	126.39%			
Semi STD	294.37%	138.55%			
Sortino Ratio	-6.76%	-12.87%			
Skewness of Return	-5.39	-3.11			
Significance of Mean Return					
T-statistics	-8.99	-14.05			
P-Value	<0.0001	<0.0001			
Minimum Return	-50.6	-16.9			
Maximum Return	1	1			
Early Exercise	1351	88			
Early Exercise Ratio	13.32%	0.87%			
Panel C: Sample Period: Jul 07 To May 09					
Observation	5482				
Mean Return	-15.21%	-9.02%	-6.19%	-2.07	0.0383
STD	299.60%	151.13%			
Semi STD	475.94%	194.08%			
Sortino Ratio	-3.24%	-4.75%			
Skewness of Return	-20.24	-11.50			
Significance of Mean Return					
T-statistics	-3.76	-4.42			
P-Value	0.0002	<0.0001			
Minimum Return	-125.0	-55.0			
Maximum Return	1.0	1.0			
Early Exercise	832	43			
Early Exercise Ratio	15.18%	0.78%			

Table 15.2: Writing one-month calls versus writing three-month calls and closing after one month: returns after accounting for transaction costs and excluding the one-third of observations with the lowest trading volume of one-month option

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The average monthly risk-free rate is 0.203%.

	One-Month Call	Three-Month Call	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	15967				
Mean Return	-18.41%	-14.07%	-4.34%	-3.46	0.0005
STD	233.98%	107.13%			
Semi STD	324.20%	114.62%			
Sortino Ratio	-5.74%	-12.45%			
Skewness of Return	-12.20	-4.70			
Significance of Mean Return					
T-statistics	-9.94	-16.6			
P-Value	<0.0001	<0.0001			
Minimum Return	-124.0	-27.9			
Maximum Return	1	1			
Early Exercise	2286	84			
Early Exercise Ratio	14.32%	0.53%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	10529				
Mean Return	-29.10%	-20.34%	-8.76%	-5.08	<0.0001
STD	255.33%	110.37%			
Semi STD	353.29%	117.96%			
Sortino Ratio	-8.29%	-17.42%			
Skewness of Return	-13.51	-5.30			
Significance of Mean Return					
T-statistics	-11.7	-18.91			
P-Value	<0.0001	<0.0001			
Minimum Return	-124.0	-27.9			
Maximum Return	1	1			
Early Exercise	1593	69			
Early Exercise Ratio	15.13%	0.66%			
Panel C: Sample Period: Jul 07 To May 09					
Observation	5438				
Mean Return	2.30%	-1.93%	4.23%	2.76	0.0058
STD	184.05%	99.45%			
Semi STD	238.04%	106.04%			
Sortino Ratio	0.88%	-2.01%			
Skewness of Return	-3.49	-3.15			
Significance of Mean Return					
T-statistics	0.92	-1.43			
P-Value	0.3569	0.1525			
Minimum Return	-21.7	-17.8			
Maximum Return	1.0	1.0			
Early Exercise	693	15			
Early Exercise Ratio	12.74%	0.28%			

Table 16.1: Writing one-month puts versus writing two-month puts and closing after one month: returns after accounting for transaction costs and excluding the one-third of observations with the lowest trading volume of one-month option

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The average monthly risk-free rate is 0.203%.

	One-Month Put	Two-Month Put	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	10705				
Mean Return	5.58%	-1.27%	6.85%	7.43	<0.0001
STD	179.34%	115.83%			
Semi STD	241.15%	135.47%			
Sortino Ratio	2.22%	-1.09%			
Skewness of Return	-5.21	-3.48			
Significance of Mean Return					
T-statistics	3.22	-1.14			
P-Value	0.0013	0.256			
Minimum Return	-46.0	-18.0			
Maximum Return	1	1			
Early Exercise	1671	354			
Early Exercise Ratio	15.61%	3.31%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	6600				
Mean Return	18.56%	7.88%	10.67%	11.09	<0.0001
STD	154.69%	100.12%			
Semi STD	211.70%	187.78%			
Sortino Ratio	8.67%	4.09%			
Skewness of Return	-3.97	-3.54			
Significance of Mean Return					
T-statistics	9.75	6.4			
P-Value	<0.0001	<0.0001			
Minimum Return	-22.0	-15.2			
Maximum Return	1	1			
Early Exercise	761	120			
Early Exercise Ratio	11.53%	1.82%			
Panel C: Sample Period Jul 07 To May 09					
Observation	4105				
Mean Return	-15.28%	-15.99%	0.71%	0.39	0.6971
STD	211.43%	136.10%			
Semi STD	270.21%	151.77%			
Sortino Ratio	-5.65	-3.18			
Skewness of Return	-5.73%	-10.67%			
Significance of Mean Return					
T-statistics	-4.63	-7.53			
P-Value	<0.0001	<0.0001			
Minimum Return	-46.0	-18.0			
Maximum Return	1.0	1.0			
Early Exercise	910	234			
Early Exercise Ratio	22.17%	5.70%			

Table 16.2: Writing one-month puts versus writing three-month puts and closing after one month: returns after accounting for transaction costs and excluding the one-third of observations with the lowest trading volume of one-month option

Transaction costs are included in the return calculation by selling options at the bid price and buying options the ask price to close short positions. All options are nearest out-of-the-money options and the return is monthly return. The shorter-term and longer-term options are matched to have the same strike price and underlying stock. An option is exercised before expiry if the option's time value is equal to or less than zero. The early exercise ratio measures the percentage of options that are early exercised. The mean return difference is calculated as one-month mean return minus the mean return of the competing strategy. The average monthly risk-free rate is 0.203%.

	One-Month Put	Three-Month Put	Mean Return Difference	T-statistics	P-Value
Panel A: Sample Period Feb 02 To May 09					
Observation	10573				
Mean Return	-8.20%	-11.72%	3.51%	2.41	0.0161
STD	217.93%	99.27%			
Semi STD	306.26%	105.93%			
Sortino Ratio	-2.74%	-11.26%			
Skewness of Return	-11.77	-2.89			
Significance of Mean Return					
T-statistics	-3.87	-12.14			
P-Value	<0.0001	<0.0001			
Minimum Return	-99.0	-15.0			
Maximum Return	1	1			
Early Exercise	1857	255			
Early Exercise Ratio	17.56%	2.41%			
Panel B: Sample Period Feb 02 To Jun 07					
Observation	6708				
Mean Return	11.88%	2.15%	9.73%	6.67	<0.0001
STD	181.75%	85.34%			
Semi STD	265.21%	95.18%			
Sortino Ratio	4.40%	2.05%			
Skewness of Return	-5.25	-3.73			
Significance of Mean Return					
T-statistics	5.35	2.07			
P-Value	<0.0001	0.0388			
Minimum Return	-32.0	-15.0			
Maximum Return	1	1			
Early Exercise	843	110			
Early Exercise Ratio	12.57%	1.64%			
Panel C: Sample Period Jul 07 To May 09					
Observation	3865				
Mean Return	-43.05%	-35.79%	-7.27%	-2.36	0.0184
STD	265.87%	115.79%			
Semi STD	343.73%	114.68%			
Sortino Ratio	-12.58%	-31.39%			
Skewness of Return	-14.62	-2.09			
Significance of Mean Return					
T-statistics	-10.07	-19.21			
P-Value	<0.0001	<0.0001			
Minimum Return	-99.0	-10.1			
Maximum Return	1.0	1.0			
Early Exercise	1014	145			
Early Exercise Ratio	26.24%	3.75%			

Table 17: Robustness Test: The impact of market sentiment on the ratio of put time value to call time value of nearest out-of-the-money put and call options on the same underlying security

In this section, bull market period is from February 2002 to April 2007, and bear market period is from August 2007 to May 2009.

The dependent variable is put to call time value (PC) determined as the ratio of time value of the nearest-out-of-the-money put divided by the time value of the nearest-out-of-the-money call on the same underlying security. The regression equation is:

$PC_{it} = \beta_0 + \beta_1 LgCVol_{it} + \beta_2\ LgCOp_{it} + \beta_3 LgPVol_{it} + \beta_4\ LgPOp_{it} + \beta_5 DM_{it} + \beta_6\ MC_{it} + \varepsilon_{it}$

Where i ranges over the various underlying assets and t ranges over the days to maturity (DM_{it} = t)

Panel 1: One-month options

Independent Variable	Regression coefficient	T-Statistics	P-Value
Intercept	1.73241	33.65	<.0001
Log of call volume (LgCVol)	-0.57517	-160.86	<.0001
Log of call open interest (LgCOp)	-0.01455	-1.76	0.0784
Log of put volume (LgPVol)	0.43126	123.2	<.0001
Log of put open interest (LgPOp)	0.188776	23.52	<.0001
Days to maturity (DM)	-0.00084253	-1	0.3168
Market conditions dummy (MC)	0.19717	13.43	<.0001
R^2	0.1248		
Adjusted R^2	0.1247		

Panel 2: Three-month options

Independent Variable	Regression coefficient	T-Statistics	P-Value
Intercept	1.18778	43.14	<.0001
Log of call volume (LgCVol)	-0.07969	-54.96	<.0001
Log of call open interest (LgCOp)	0.07514	27.01	<.0001
Log of put volume (LgPVol)	0.02715	20.31	<.0001
Log of put open interest (LgPOp)	0.01514	5.76	<.0001
Days to maturity (DM)	-0.00508	-18.96	<.0001
Market conditions dummy (MC)	-0.00027788	-0.05	0.9574
R^2	0.0153		
Adjusted R^2	0.0153		

APPENDIX B: FIGURES

Figure 1:The expected time value curve for a 90-day call option, assuming constant stock price during the life of the option.

Option prices are obtained by the Black-Scholes (1973) option pricing model and the parameters are set as in Tannous and Lee-Sing (2008): volatility of the asset return, $\sigma = 25\%$, the risk free rate, $r = 6\%$, the exercise price, $K = \$100$, and the price of the underlying asset, $S = \$100$.

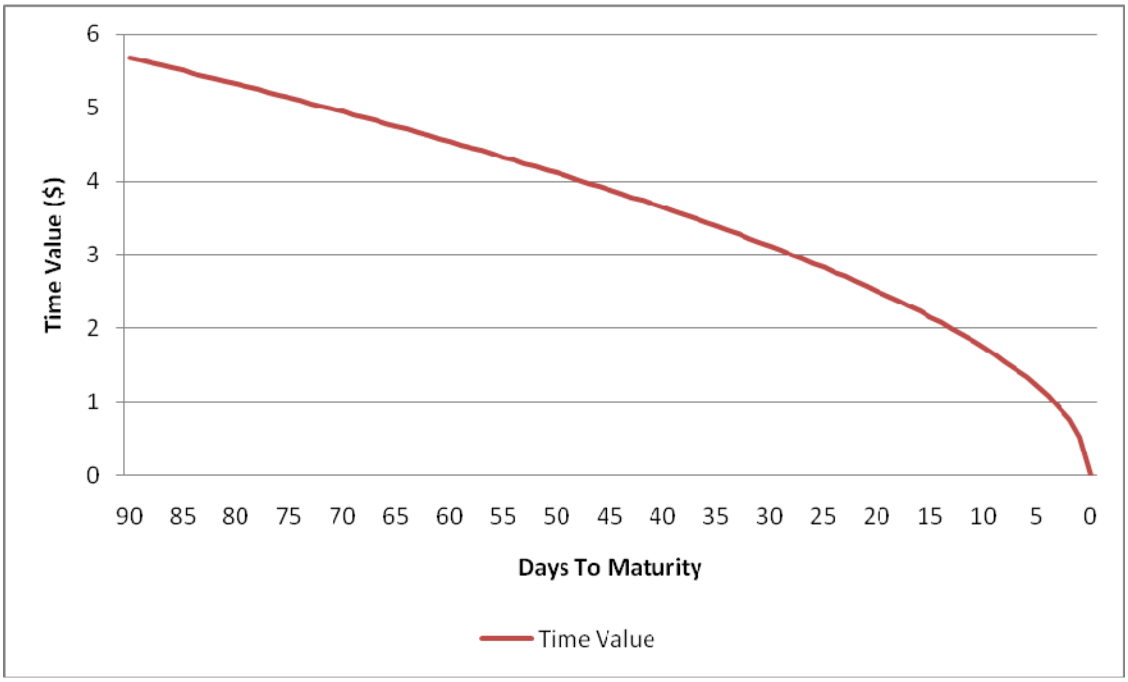


Figure 2: Expected time value curve: 90-day European call and three 30-day European calls rolled every 30 days.

Option prices are obtained by the Merton (1976) option pricing model and the parameters are set as in Tannous and Lee-Sing (2008). For the 90-day strategy, the 90-day call is purchased at-the-money. For the 3 30-day call strategy, the exercise price for each of the three calls is \$100 and the time to expiry of each call is 30 days. The first call is purchased at-the-money while the other two are purchased either in- or out-of-the-money depending on how the asset price evolved over time. The initial underlying asset price is \$100 after which it changes stochastically following a jump diffusion motion whose parameters are the volatility σ = 25%, the risk-free rate r = 6%, the exercise price K = \$100, the time to expiry T = 90 days, λ = 10%, y = -0.1%, δ = 25%, and ξ = 1.25%.

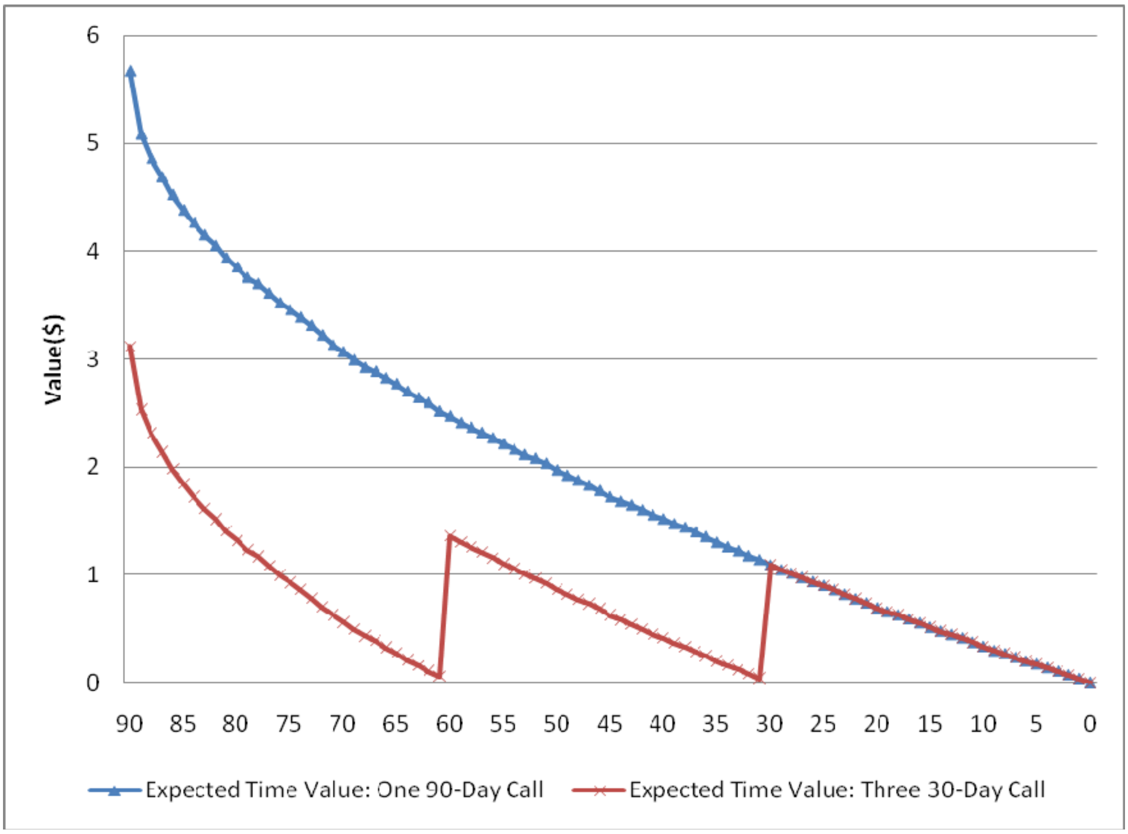


Figure 3: The S&P 500 Index and S&P 100 Index price level: March 1, 2000 – May 31, 2009

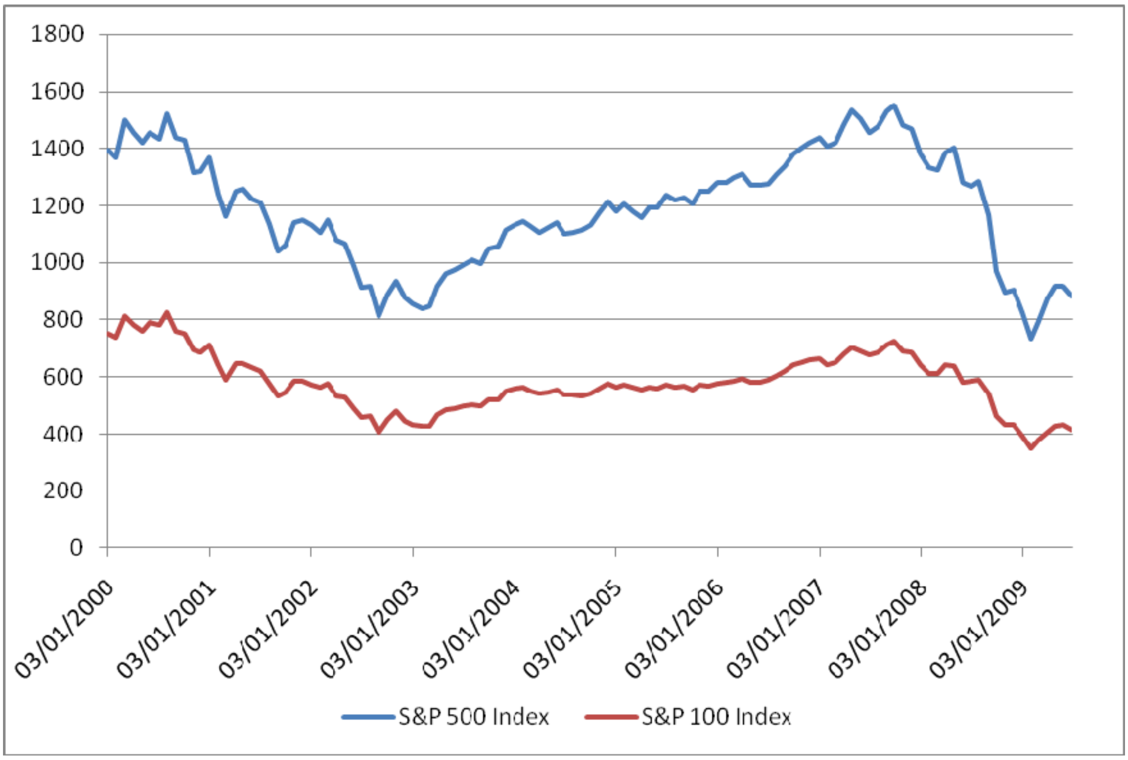
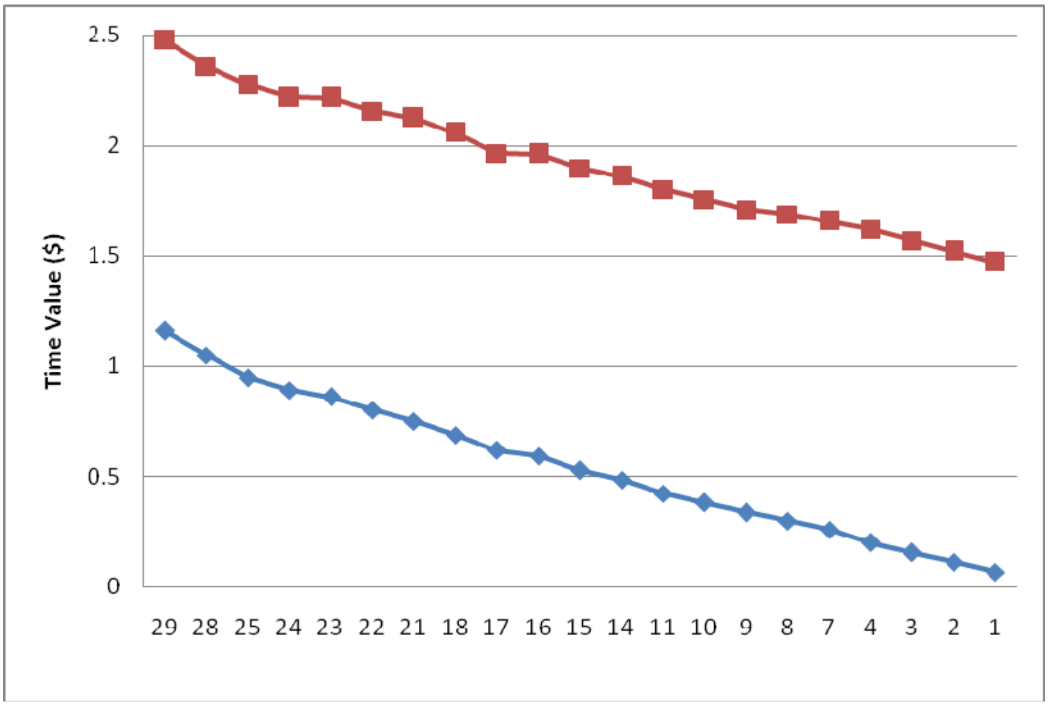


Figure 4.1: The expected time value curve of one- and three-month call options determined from transactions data

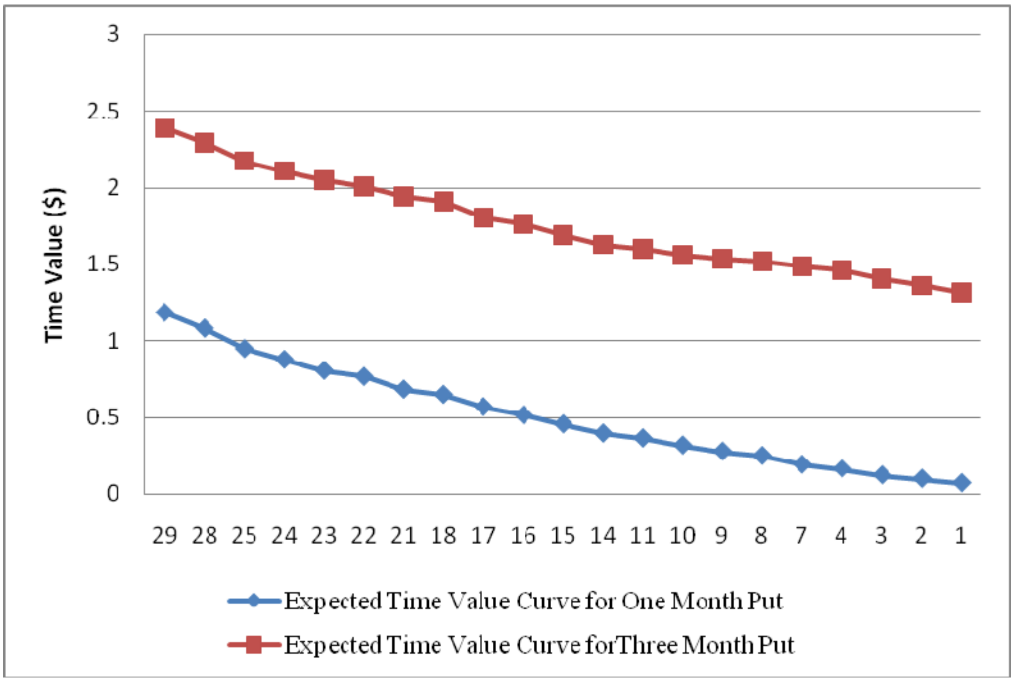
The data belongs to the period from March 1, 2000 to May 31, 2009. I match three-month and one-month options at the beginning of the month and trace the time value every day for one month. The horizontal axis denotes the days to maturity for the one-month option and the days to maturity of the three-month option minus 60 days. The vertical axis denotes the expected time value of the options.



Days to Maturity of One-Month Option	One-Month Call Time Value	Days to Maturity of Three-Month Option	Three-Month Call Time Value
29	1.1593716	89	2.4746243
28	1.0476346	88	2.3586964
25	0.9463662	85	2.272343
24	0.8913981	84	2.2159144
23	0.8582569	83	2.21545
22	0.8002696	82	2.1547574
21	0.7504348	81	2.1236351
18	0.6866583	78	2.0559241
17	0.6157315	77	1.9641525
16	0.5911593	76	1.9616226
15	0.5277085	75	1.8959897
14	0.4833856	74	1.8587421
11	0.4213341	71	1.7989088
10	0.3800223	70	1.7540972
9	0.3361056	69	1.7102708
8	0.2977632	68	1.6864149
7	0.257831	67	1.6552044
4	0.1996149	64	1.6176355
3	0.1530569	63	1.568087
2	0.1126295	62	1.5189576
1	0.0657988	61	1.4680509
Correlation between the time values:		99.93%	

Figure 4.2: The expected time value curve of one- and three-month put options

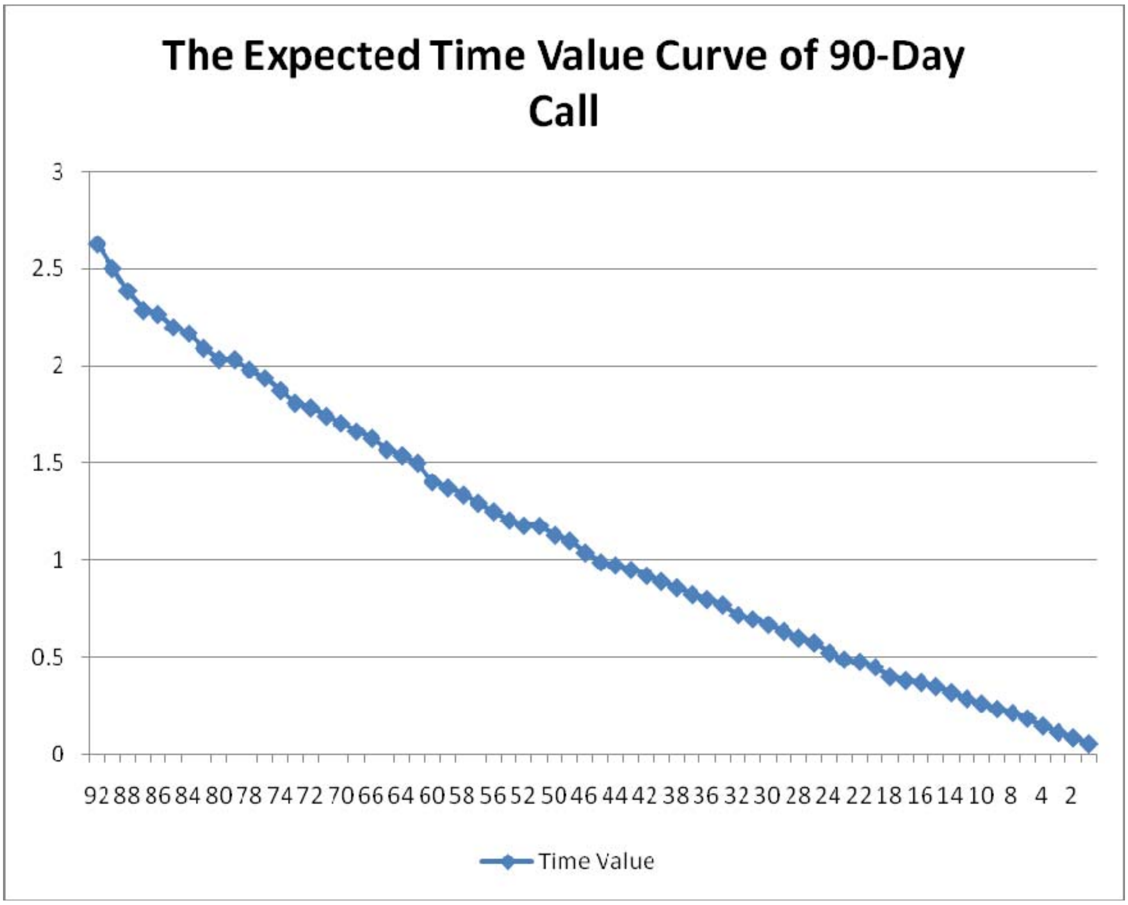
We match three-month and one-month options at the beginning of the month and trace the time value for one month. The horizontal axis denotes the days to maturity for the one-month option and the days to maturity of the three-month option minus 60 days. The vertical axis denotes the expected time value of the options.



Days to Maturity of One-Month Option	One-Month Put Time Value	Days to Maturity of Three-Month Option	Three-Month Put Time Value
29	1.1858068	89	2.3897773
28	1.0818516	88	2.2905385
25	0.9487415	85	2.1734286
24	0.8779617	84	2.106928
23	0.8060854	83	2.0469991
22	0.7667509	82	2.0062183
21	0.6830238	81	1.9417972
18	0.6488324	78	1.9075508
17	0.568641	77	1.8027559
16	0.5146377	76	1.761338
15	0.4557212	75	1.6909427
14	0.3948966	74	1.6283181
11	0.3635191	71	1.5998419
10	0.3174495	70	1.559386
9	0.2776105	69	1.5356978
8	0.2481671	68	1.5206989
7	0.1908433	67	1.4860656
4	0.1631234	64	1.4613367
3	0.1217063	63	1.4049418
2	0.0985148	62	1.3609006
1	0.0705714	61	1.314782
Correlation between the time values:		99.86%	

Figure 5.1: The expected time value curve for a portfolio of three-month call options

The horizontal axis denotes the days to maturity and the vertical axis denotes the expected time value.



The theoretical relation between the expected time value and time to expiry is examined by fitting the data to the regression model:

Time Value = Intercept + a*Days to maturity + b* (Days to maturity)^2 + c*(Days to maturity)^3

The results are:

Intercept	Days to Maturity	(Days to Maturity)^2	(Days to Maturity)^3	Adjusted R^2
0.08882	0.01462	0.00012583		0.9985
8.74***	28.76***	23.58***		
0.04584	0.02023	-0.00002623	1.10E-06	0.999
4.25***	19.99***	-1.03	6.05***	

*** denotes significance at the 1% level.

Figure 5.1: (Continued)

I also calculate the time value decay during the first 30 days, the second 30 days, and the last 30 days for 90- day call options:

Time value decay during the first 30 days = average (options 90-day time value – options 60-day time value);

Time value decay during the second 30 days = average (options 60-day time value – options 30-day time value);

Time value decay during the first 30 days = average (options 30-day time value – options 1-day time value).

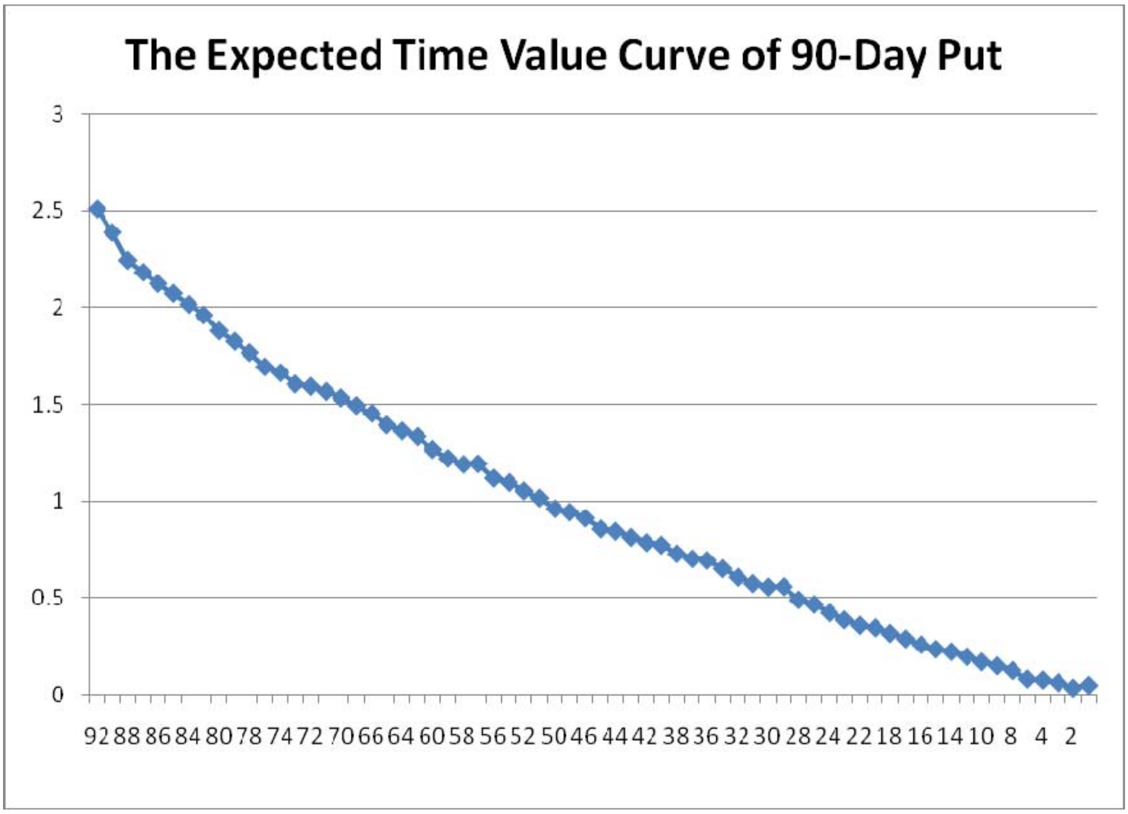
	Diff TV Between 90 and 60 Day	Diff TV Between 60 and 30 Day	Diff TV Between 60 and 30 Day	Diff TV Between 30 and 1 Day
Mean Value	1.0164	0.7373	0.7373	0.6267
Mean Difference	0.2791		0.1106	
T-Stat	12.21		5.91	
P-Value	<0.0001		<0.0001	

Furthermore, I compare the time value decay during weekends with the time value decay during weekdays.

	Average Time Value Decay During Weekend	Average Time Value Decay During Weekday
Mean Value	0.0587	0.0350
Mean Difference	0.0240	
T-Stat	13.79	
P-Value	<0.0001	

Figure 5.2: The expected time value curve for a portfolio of three-month put options

The horizontal axis denotes the days to maturity and the vertical axis denotes the expected time value.



The theoretical relation between the expected time value and time to expiry is examined by fitting the data to the regression model:

Time Value = Intercept + a*Days to maturity + b* (Days to maturity)^2 + c*(Days to maturity)^3

The results are:

Intercept	Days to Maturity	(Days to Maturity)^2	(Days to Maturity)^3	Adjusted R^2
0.04229	0.01165	0.00014576		0.9968
2.96***	16.31***	19.45***		
-0.02212	0.02006	-0.00008217	1.65E-06	0.9981
-1.52	14.73***	(2.41)***	6.74***	

*** denotes significance at the 1% level.

Figure 5.2: (Continued)

I also calculate the time value decay during the first 30 days, the second 30 days, and the last 30 days for 90- day put options:

Time value decay during the first 30 days = average (options 90-day time value – options 60-day time value);

Time value decay during the second 30 days = average (options 60-day time value – options 30-day time value);

Time value decay during the first 30 days = average (options 30-day time value – options 1-day time value).

	Diff TV Between 90 and 60 Day	Diff TV Between 60 and 30 Day	Diff TV Between 60 and 30 Day	Diff TV Between 30 and 1 Day
Mean Value	1.0339	0.7030	0.7030	0.5374
Mean Difference	0.3309		0.1656	
T-Stat	15.18		9.54	
P-Value	<0.0001		<0.0001	

Furthermore, I compare options time value decay during weekends with weekdays.

	Average Time Value Decay During Weekend	Average Time Value Decay During Weekday
Mean Value	0.0557	0.0389
Mean Difference	0.0170	
T-Stat	9.00	
P-Value	<0.0001	