IMPLEMENTING VOLATILITY TRADES IN THE ATHENS DERIVATIVES EXCHANGE

AUTHOR

GEORGIOS PAPPAS

FEBRUARY 2003

ABSTRACT

In February 2001, the Athens Derivatives Exchange published a research entitled 'Trading opportunities through ADEX derivative products'. That paper provided the incitement to research further on that subject. According to this paper fund managers invested in the Greek equities market had to face a continuous recession in the equities market since 1999. As a result, more and more effort had to be put into picking winning stocks. The paper identifies trading opportunities using the corresponding listed derivatives in ADEX in order to enhance their portfolios overall returns or to reduce their portfolio risk exposure.

The purpose of this dissertation is to demonstrate how investors can benefit from volatility by constructing portfolios of options and futures based on the FTSE/ASE-20 ADEX listed derivatives. Furthermore, this paper provides an insight into the risks associated with such trades as well as addresses the question of whether such a trade can be profitable when transaction costs and margin requirements are taken into account. Its purpose is to serve as a practical guide to trading volatility using data from the Athens Derivative Exchange.

TABLE OF CONTENTS

Aims and Objectives

The aims and objectives of this dissertation are as follows:

- Introduce the concept of historical volatility and implied volatility, and estimate its numerical and statistical significance.

- Identify gamma trade opportunities based on the volatility gap between the historical volatility and implied volatility in the FTSE 20 index futures and options.

- Introduce the concept of volatility trading and how investors can profit from the volatility, or lack of volatility.

- Examine more complex volatility trades using combination of options with different strike prices.

- Use real-time data, by obtaining the closing prices for all derivatives

- Introduce transaction costs and margin requirements in all the volatility trading scenarios and evaluate the profitability of such trades.

- Design a prototype Information System based on selected trades to measure the expected return on each given trade.

LIST OF FIGURES

List of Tables

1

INTRODUCTION TO VOLATILITY TRADING

1.1 INTRODUCTION

Based on the fact that researchers are only just beginning to address the question of what we mean precisely by risk or volatility, and how best to model it, investment opportunity is clearly indicated. This opportunity reflects the potential for generating abnormal returns through identifying and executing trades based on volatility.

The evidence to support this in favour of traditional portfolio strategies is that volatility processes are eminently more persistent and forecastable than asset return processes. Following this, there is a view that volatility arbitrage is likely to prove one of the most fruitful investment opportunities in the next decade, providing adequate means can be found to describe and model the underlying process. (Volatility Analytics 2001)

This paper investigates the full history of the FTSE/ASE-20 index options from September 2000 until the time this project is being written- July 2002. Using data from the Athens Derivatives Exchange, the purpose of this project is to demonstrate the ways of benefiting from volatility trades, by identifying possible trading opportunities through ADEX FTSE/ASE-20 listed index options. In summary the project may be characterised by the following trading style:

i) Asset class: FTSE-20 index futures, options on the FTSE-20 index
ii) Strategy: Volatility Arbitrage

1.2 LITERATURE REVIEW

Despite their importance to well functioning derivative markets and their popularity among option traders, volatility trades have received little attention in the financial research literature[1]. While every derivatives textbook discusses such volatility trades as straddle, strangle and butterflies, to my surprise there was no paper devoted to their design[2] or trading[3].

Furthermore, to my knowledge no one has used real time data to construct a volatility trade portfolio in practice, assuming transaction cost and margin requirements. Without a doubt, the most important "imperfection" of real financial markets is the existence of transaction costs. Broadly speaking, transaction costs create bounds around the theoretical price within which the market price may fall without giving rise to a profitable arbitrage or volatility trade, large enough to cover the cost of exploiting it.

The main scope of this paper is to fill this gap by examining Volatility Trades on a recently established market, the Athens Derivatives Exchange. In the following chapters we will introduce some of the market's most liquid products and the common practices used by major financial institutions acting as market-makers/traders in the ADEX.

1.3 VOLATILITY TRADING VS TRADITIONAL INVESTMENT

In considering traditional investment most of the people think of stock or equity. Whether an investment on a stock or an equity will produce profit or not, depends on the direction of the market. If the stock rises then the investor can capitalise on this price and accumulate the profits. On the other hand if the price of the stock falls the investor is accumulating losses. Only by using derivative products the investor could establish a short position and benefit from the falling prices. In both cases the investor has to have a clear view on the direction of the price. (Connolly 1999)

[1] Refer to an excellent book by K. Connolly entitled 'Buying and Selling Volatility'.
[2] For example of a textbook discussion see Hull (2000) or Kolb (2000).For a particularly good treatment in the practitioner literature see Natberg (1994).
[3] Apart from a unique research paper on volatility Trade Design published in March 2002 by Louis Ederington and J. Scott Chaput.

Most fund managers will agree that despite the progress made in technical and fundamental analysis, view takers can hope to be on the winner side more times[4] than they lose.

On the other hand volatility trading offers another dimension to investing, which is trading the volatility of the price and not the direction. The volatility trader is not interested in whether the price is going to rise or fall, since he can benefit from both and can almost completely ignore the first dimension. He is primarily interested in whether the market is going to be volatile or not.

The very position of the volatility trader is based on exploiting the volatility of the portfolio constructed. In order to do this, the portfolio will have to be fully hedged and this way have no exposure to the market. This is a crucial point to the volatility trade when constructing volatility portfolios.

The most attractive feature of trading volatility is that, volatility portfolios often produce gains at times when directional strategies are performing poorly. For this purpose, in the following section we will introduce the concept of volatility and introduce it's numerical and statistical significance.

[4] Refer to K. Connolly (1999), *Buying and Selling Volatility*, Wiley, p.3

1.4 VOLATILITY

Almost everyone has a concept of volatility when used in connection with finance or investment. For example, volatile markets or stocks involve higher risk since volatility is used as a measure of uncertainty about the returns provided by the stock or the market.

1.4.1 MEASURING VOLATILITY

The volatility of a price series is a measure of the deviation of price changes around the trend. One use of the volatility measure is to make probability statements about the approximate likely range of the range of the stock price in the future (Connolly 1999). According to the strict mathematical terminology, volatility represents the standard deviation of the lognormal distribution. If a volatility of a series is x%, then in one years time:

- 68.30 % of all stock prices that are expected to occur under the lognormal distribution within the limits set by the mean +/- one standard deviation (volatility) are covered.

- 95.40% of all stock prices that are expected to occur under the lognormal distribution within the limits set by the mean +/- two standard deviation (volatility) are covered.

- 99.70% of all stock prices that are expected to occur under the lognormal distribution within the limits set by the mean +/- three standard deviation (volatility) are covered.

1.5 DIFFERENT TYPES OF VOLATILITY

When discussing volatility we have to be aware that there are different types of volatility. To avoid confusion, we should look at the different types and their main characteristics.

1.5.1 FUTURE VOLATILITY

This is the type of volatility every market participant would like to know, because it describes the future fluctuation of stock prices. If we knew a way of exactly determining the future volatility, we would be in a position to calculate correctly the theoretical options price applicable in the future already today. This information edge would among other things, enable a trader to sell overpriced options and buy underpriced ones.

However, since market participants cannot foretell the future, they are equally dependent on forecasts when it comes to determining future volatility. Many different models have been developed for this purpose although the pace of theoretical development has slowed somewhat in the last decade, since the popularisation of ARCH[5] and GARCH[6] models in the 1980's. A common approach has also been typified by JP Morgan's Risk Metrics system[7].

It should be noted that Economists have become increasingly intrigued of late by the possibilities afforded by the high frequency data. The key point is that precise estimation of volatility does not require long spans of data, but volatility can be measured arbitrarily well from return series that are sampled sufficiently frequently. The tendency towards the use of high frequency data to construct volatility estimates is now becoming standard research practice[8].

1.5.2. HISTORICAL VOLATILITY

Historical Volatility on the other hand is the volatility that can be calculated by the price series of the past. The purpose of this paper is to provide a detailed analysis of the historic and implied volatility of the FTSE/ASE-20 index in order to identify possible trading opportunities.

The data series extents from September 2000, when the first options on the FTSE/ASE-20 were listed in the ADEX until July 2002. The formula for calculating the standard deviation is as follows:

---

[5] See Engle, R.F. 'Autoregressive Conditional Heteroskedasticity with Estimates of the variance of UK inflation" Econometrica, 50 (1982), 987-1008.

[6] See Bollerslev, T. "Generalized Autoregressive Conditional Heteroskedasticity", Journal of Econometrics, 31 (1986), 307-27.

[7] J.P. Morgan, Risk Metrics Monitor, Fourth Quarter, 1995.

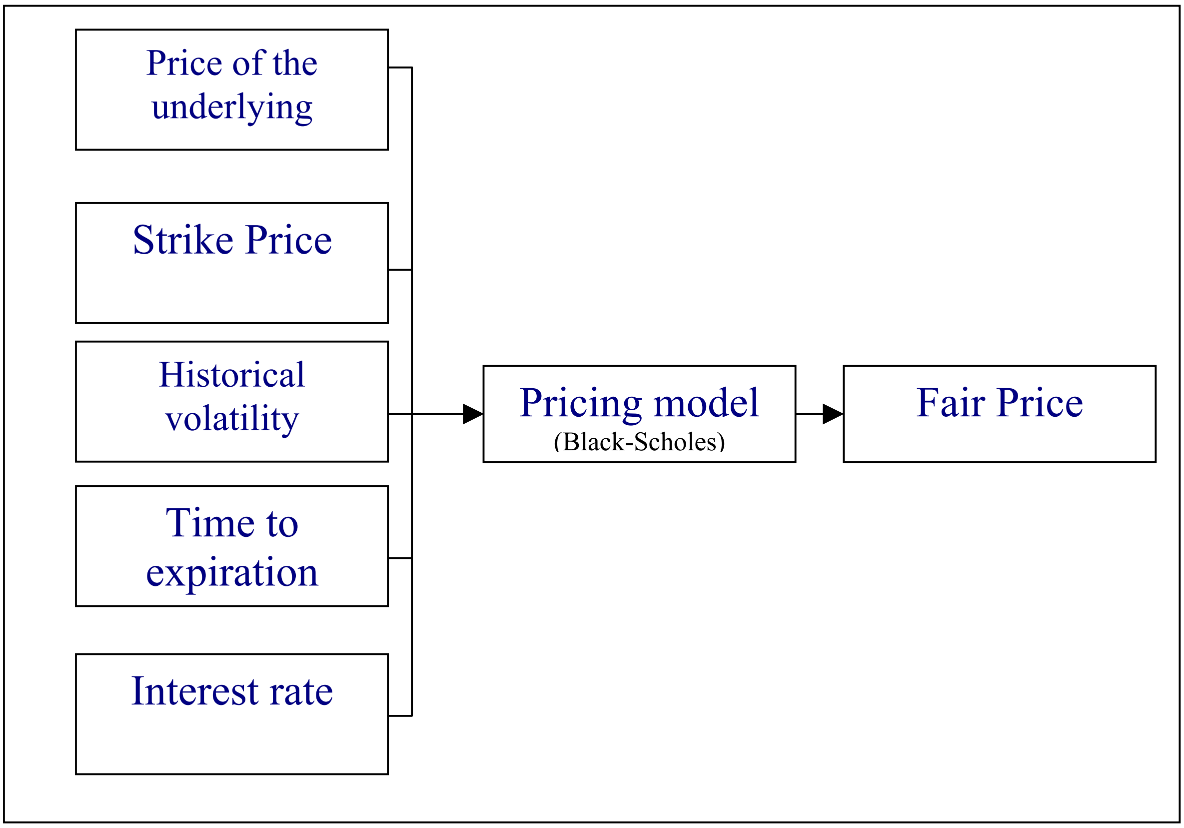
[8] See Andersen et al (1999), 'Forecasting Financial Market Volatility: Sample Frequency vis-à-vis Forecast Horizon", Journal of Empirical Finance,6, 457-47 as well as Andersen, T.G. , and Bollerslev T. (1998),

$$\sigma_T(t) = \sqrt{\frac{1}{T-1}\sum_{i=1}^{T}[R_i - R_m]^2}$$

where R_m is the average index return for the time period that is considered (T= 22 days). The annualized 1 month historic volatility is calculated from the daily returns of the index R_i. Daily volatility is annualized assuming 252 trading days per year.

The importance of historical volatility is that this volatility is used for the fair pricing of an option as input in the Black-Scholes formula to calculate the fair value of an option as shown in Figure 1.

Figure 1.
Calculation method for a theoretical option value



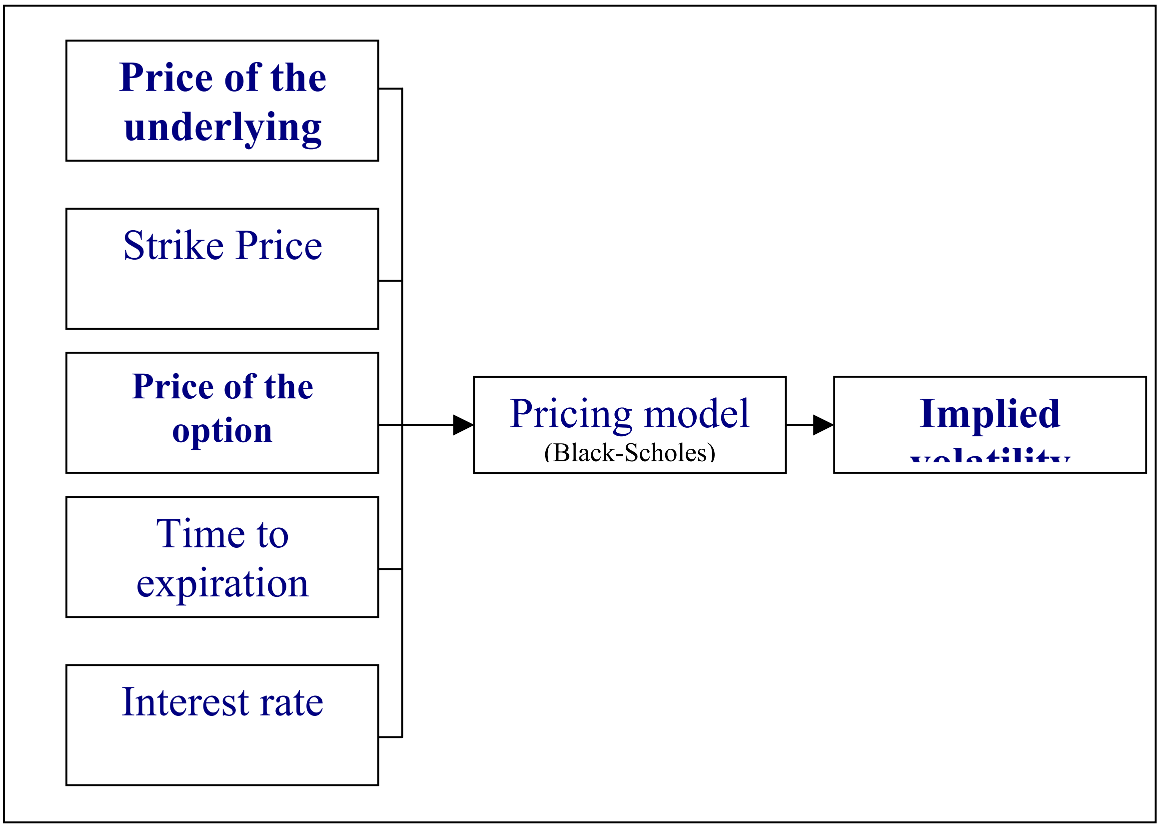
"Answering the Skeptics: Yes, Standard Volatility Models Do Provide Accurate Forecasts" , International Economic Review, 39, 885-905.

1.5.3 Implied Volatility

Historical as well as future volatility are associated with the price of the underlying (the FTSE/ASE-20 index in our case) and say something about how the prices of the underlying are distributed over time. On the other hand, a different type of volatility, the implied volatility, is derived from the option price itself.

In Figure 2, the calculation method for deducing the implied volatility from an option's price in the market is presented.

Figure 2.
Calculation method for the implied volatility

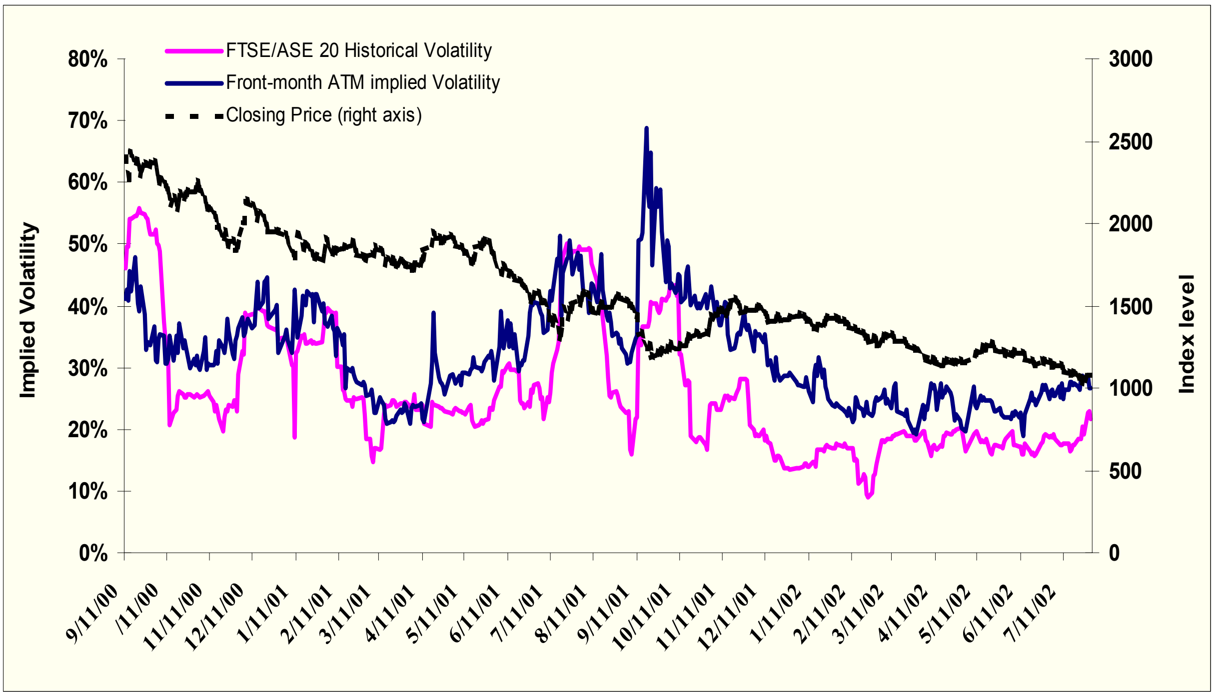


A time series is obtained for the implied volatility of the front-month at-the-money options by inverting the Black-Scholes pricing formula for the options closing price. Moreover, in order not to be confounded with interest rate and discounting effects, the FTSE/ASE-20 Futures settlement price has been used as underlying instrument rather than the FTSE/ASE-20 closing price itself. This is also consistent with the trading practices in the market, where quotations are mostly based on reversal and conversions (ADEX 2001).

Furthermore, because of put-call parity an average implied volatility for the at-the-money calls and puts is used. Finally, in order to avoid expiration effects three days before the third Friday of each month we switch to the at-the-money options of the second closest to expiration month

Figure 3 presents the time series of the front month, at-the –money implied volatility compared to the corresponding annualized 1-month historic volatility calculated from the daily returns of the index.

Figure 3.
Comparison between front-month at-the-money implied volatility and 30-days historical volatility for the FTSE/ASE-20 Index.



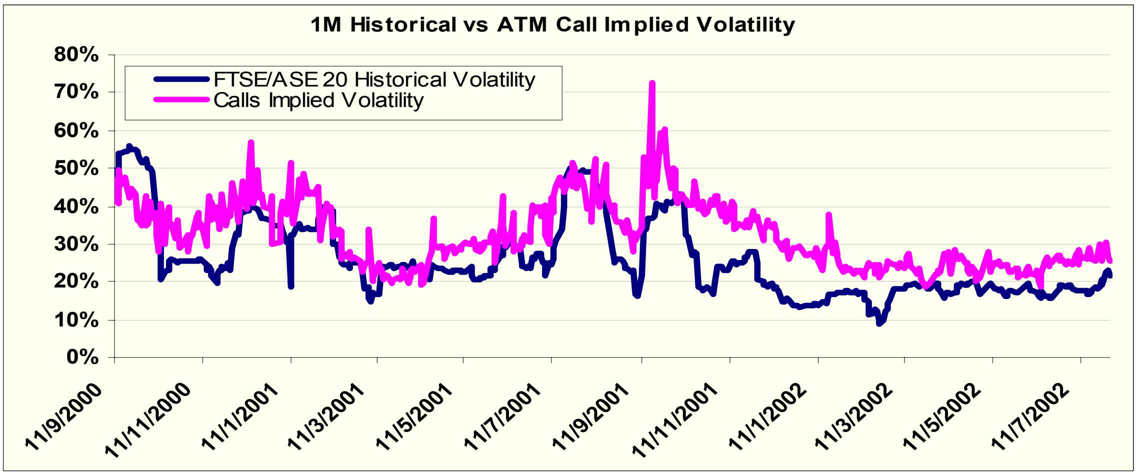
Source: P&K Securities S.A./ Derivatives Department

Looking at Figure 3, representing the historical volatility of the FTSE/ASE-20 index versus the front month at-the-money average implied volatility, we arrive to the following conclusions. Except from mid September to mid October 2000 and mid-March to May 2001, implied volatility remained at a premium to historical volatility.

In order to identify trading opportunities in the newly established options market of ADEX, Figure 4 and 5 present the corresponding at-the-money put and call implied volatility to the FTSE/ASE-20 index historic volatility. The average historic volatility from September

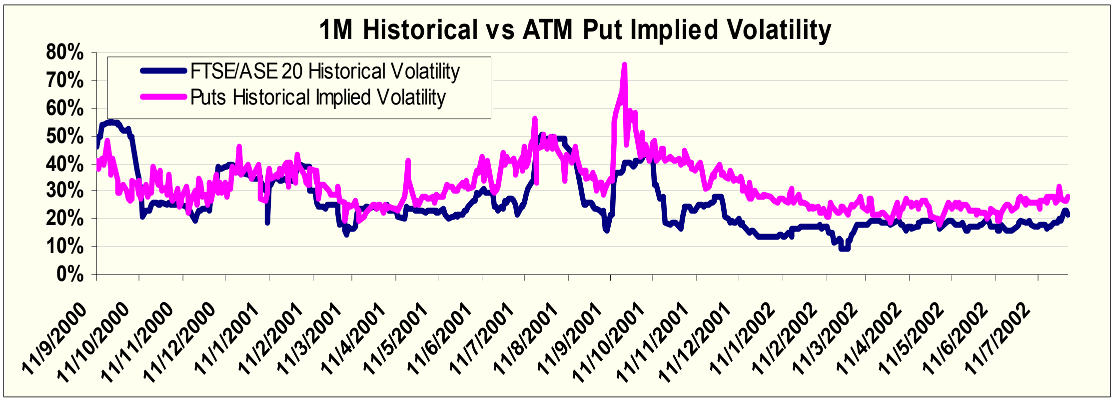
2000 to July 2002 for the FTSE/ASE-20 is measured to be 25,83% while the long term average implied volatility is 32,83% for the front at-the-money calls and 32,09% for the front at-the-money puts respectively.

Figure 4.
Comparison between front at-the-money calls implied volatility and 30-days historical volatility for the FTSE/ASE-20 Index



Source: P&K Securities S.A./ Derivatives Department

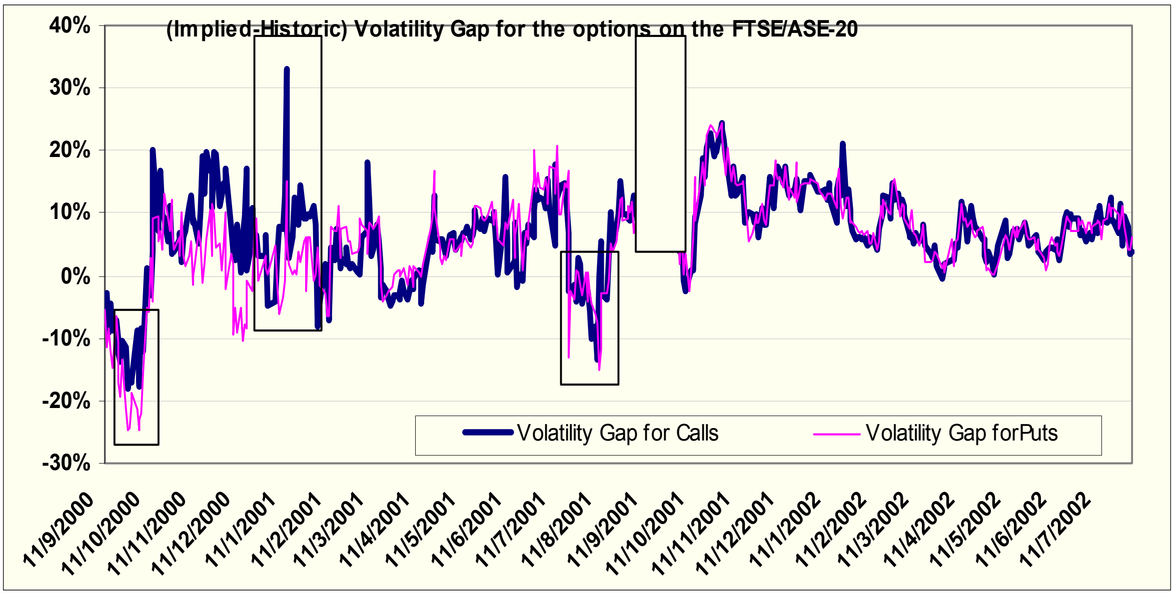
Figure 5.
Comparison between front at-the-money puts implied volatility and 30-days historical volatility for the FTSE/ASE-20 Index



Source: P&K Securities S.A./ Derivatives Department

In Figure 6, the one-month gap between implied and historical volatility of both the front-month at-the-money puts and calls is presented. We can identify at least two gamma trading opportunities (Volatility Trades) by buying cheap puts (start of October 2000) and selling expensive calls (mid Jan 2001). The average volatility gap is 6.5% and except from the first two months of options trading and mid-July 2001 to August 2001, options have been trading on a premium to historical volatility. The maximum value of September 2001(gray scaled area) is connected to the aftermatch of the sad event of September 11th in the U.S. This period is not considered in the paper, since margin requirements had been raised from 12 to16 percent, eliminating any possible profits from Volatility Trading.

Figure 6.
Volatility Gaps between implied and historic volatility of the front month at-the-money options and the underlying index.

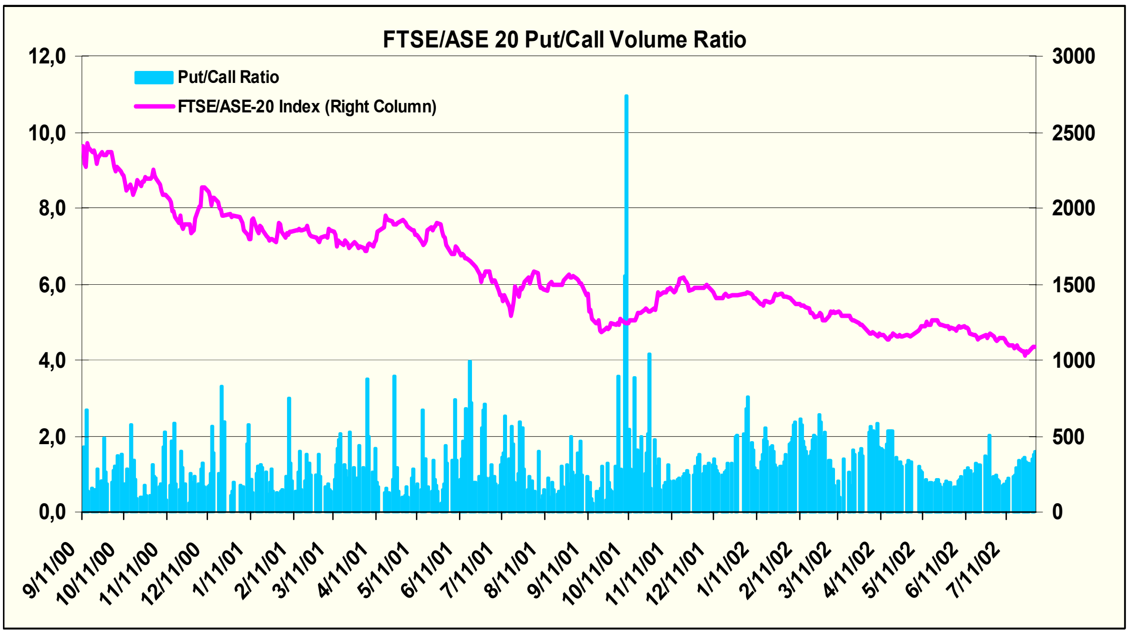


Source: P&K Securities S.A./ Derivatives Department

While front at-the-money puts started trading at implied volatility below the historical volatility the continuous recession combined with the unfortunate events of September the 11th, reversed market sentiment and at-the-money puts became more expensive. In Figure 7, the volume ratio of puts to calls[9] is presented along with the index closing price. The increasing demand for puts is consistent with the market decline throughout 2000 to 2002 and the increasing implied volatility for the front-month at-the-money puts. The extreme 12:1 ratio is a result of the markets reaction to the September 11th events, when investors sought refuge from the declining market expectations. In general, the Put/Call Volume ratio provides an indication of whether investors are willing to buy calls, thus expecting a rising market, or buying puts expecting a declining market.

[9] Total traded volume of puts/ Total traded volume of calls, when the ratio is close to 1, investors are equally calls and puts buyers

Figure 7.
Put/Call Volume ratio and the corresponding index level



Source: P&K Securities S.A./ Derivatives Department

1.6 OUTLINE OF THIS DISSERTATION

In chapter 2, we begin with an introduction to the notion of the simple Long Volatility Trade. This chapter explores the meaning of volatility trading as well as provides numerical examples of the long volatility trade using puts or calls. We then present the sensitivities of the long volatility trade to parameters affecting its returns. Finally, in order to illustrate the profitability of such trades, we construct a long volatility portfolio using at-the-money puts and evaluate its performance when transaction costs and margin requirements are taken into account.

In chapter 3, we investigate the price profile of the Short Volatility Trade. We begin by illustrating how a short volatility portfolio can be constructed in order to exploit the lack of volatility and illustrate where the profits of this trade come from. We continue by presenting how time decay and volatility affects the profits of this trade and construct a short volatility portfolio for this purpose. The return of this portfolio is then evaluated. By using real-time data from the settlement prices of the Athens Derivative Exchange, the profitability of the long and short volatility trading scenarios are compared. The effect of transaction costs and margin requirements in these returns is also illustrated.

In chapter 4, we explore the use of combinations of options of different series in volatility trading. Following this, we illustrate the price profile and sensitivities of the commonly used volatility strategies to parameters such as theta and Vega. We conclude by implementing trading scenarios using at-the-money straddles and strangles and examine their returns. This way the reader can compare the performance of the two trading strategies with the returns produced by the simple long and short volatility trade.

In chapter 5, we identify the functional requirements in order to built a prototype volatility trading system. We continue by introducing the limitations and constraints of the system under development.

In chapter 6, we introduce the concept of Visual Modelling and graphically illustrate the business domain of the volatility trading system using a class diagram. We document the decision of using Rapid Application Development in constructing the prototype and employ the Dynamic Systems Development Method to develop that prototype. Finally we illustrate the prototypes conceptual level using the entity-relationship diagram.

In chapter 7, we end this dissertation with all the concluding remarks.

THE SIMPLE LONG VOLATILITY TRADE

2.1 OUTPERFORMING INDEX PORTFOLIOS

In this chapter we will examine the profile of one the most straightforward volatility trade in the market. The trade consists of a long position in a call option and short the underlying instrument in such a ratio in order to achieve delta neutrality.

It is due to the curved profile of options, that a volatility trade can profit in a rising as well as a declining market.

In order to prove this we construct a theoretical portfolio of long two at-the-money calls in the FTSE/ASE-20 and short 1 future[10] in the FTSE/ASE-20. The index is currently at 2000. The ratio of two options to one future is dictated by the delta of the at-the-money call, discussed in later chapters. The performance of the option as well as the shorted index future is presented in Table1. The profile of this trade is presented in Figure 8.

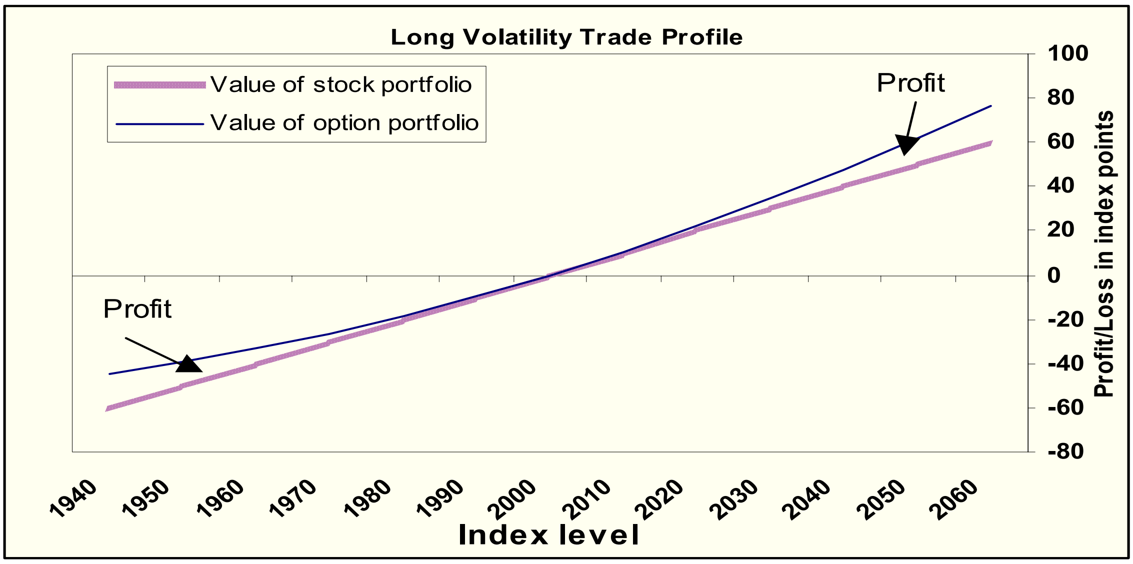
Table 1. Performance of index future versus option

(Short 1 future) (Long two options)

Index level	Value of index portfolio = 1 future	Change in value of index points from start point	Option Price	Value of option portfolio= 2 x price	Change of value of option portfolio	Total portfolio value in index points
2060	2060	60	72,75	145,49	76,86	16,86
2050	2050	50	65,32	130,64	62,00	12,00
2040	2040	40	58,27	116,54	47,90	7,90
2030	2030	30	51,62	103,25	34,62	4,62
2020	2020	20	45,41	90,81	22,18	2,18
2010	2010	10	39,63	79,27	10,63	0,63
2000	2000	0	34,32	68,63	0,00	0,00
1990	1990	-10	29,46	58,93	-9,71	0,29
1980	1980	-20	25,07	50,15	-18,49	1,51
1970	1970	-30	21,14	42,28	-26,35	3,65
1960	1960	-40	17,65	35,31	-33,33	6,67
1950	1950	-50	14,59	29,19	-39,45	10,55
1940	1940	-60	11,94	23,88	-44,76	15,24

[10] The at-the-money call has 30 days to expiry. The strike price of the option is set at 2000.The example serves our illustration purposes and demonstrates a static hedging replication of an index move from 2000 to as high as 2060 and as low as 1940 in one day period time. Both future and option expire the same day.

Figure 8.
Performance of option versus future



As mentioned earlier the profit of the trade comes from the different rate of increase/decrease of the price of the option responding to changes in the underlying asset. As the index rises the option price outperforms the loss from the short position in the future. In a decreasing market, the short side of the future outperforms the decline in the options price, thus producing profit to the volatility trader. In a nutshell, the option portfolio outperforms the future portfolio both in the rising as well as the declining market.

The simplest and most straightforward way of benefiting from this trade is to completely liquidate. Sell the option portfolio and buy the futures in the index to close the two positions set at start point. However, there may be still profit to be made in this trade providing the market continues to be volatile and the investor wishes to capitalize on the option price curvature. By rehedging his position (ratio of option to futures) the investor can not only lock his profit, but also continue to benefit from volatility, without having to exit his position or set up another volatility portfolio.

It appears from our simplified approach that the above outperformance will always be achievable by going long on options and short the underlying. The answer to this is that this is not exactly true, as we will witness later. It is the purpose of this chapter to show that several parameters and risks have to be taken into consideration for a volatility trade to be profitable.

At this point it would be useful to define basis risk. According to Hull basis risk is defined as follows:

Basis = spot price of asset to be hedged – futures price of contract used

In our scenario the basis risk involves the difference between the underlying instrument, the FTSE/ASE-20, and the futures in the FTSE/ASE-20 used to hedge[11] the options position. In a situation were we are short futures, a strengthening of the base could result in losses, even when the underlying asset exhibits increased volatility. Basis risk can thus easily affect the effectiveness of the rehedging process. According to the Value basis of the front-month contract Figure (Appendix), basis risk can be as high as 3 percent illustrating the risk associate with the trade and potential losses-profits resulting from the rehedging[12] activity.

Another interesting parameter affecting the rehedging process should also be noted. According to practitioners acting as market-makers in the ADEX, profit and losses can often result from the difference between the implied volatility the ADEX uses to estimate the settlements price of all options and the volatility exhibited intraday (during the day) on which options have been bought or sold.

2.2 The Price Profile of the Call

In order to further illustrate where the profits in a long volatility trade come from, it is necessary to examine the price profile of a call. For this we will have to examine what determines the value of a call and how this value changes over time.

---

[11] When the spot price increases by more than the futures price the basis is said to be strengthening, when the futures price declines more than the spot price the basis declines.

[12] According to Hull (2000), investments such as stock indices the basis risk tends to be fairly small.

2.3 THE OPTION SENSITIVITIES

An option's price is sensitive, having a tendency to change in response to certain key variables. These key variables, called "the sensitivities" or "the Greeks", measure a change in the price of an option or combination of options in response to a change in one of the key variables.

The Greeks (Delta, Gamma, Theta, Vega and Rho) enable, among other things:

- Prediction of a movement in an option's price, given a change in a variable
- Calculation of the number of options required to hedge a change in a variable

2.3.1. DELTA

At this point it would be useful to discuss delta, an important parameter in the pricing and more importantly in our case, the hedging of options. Being the first derivative of option price with respect to the underlying, the delta is represented by the formula:

$$\textit{Delta:} \quad \frac{\textit{change in the option price}}{\textit{change in the underlying price}}$$

According to Hull's definition:

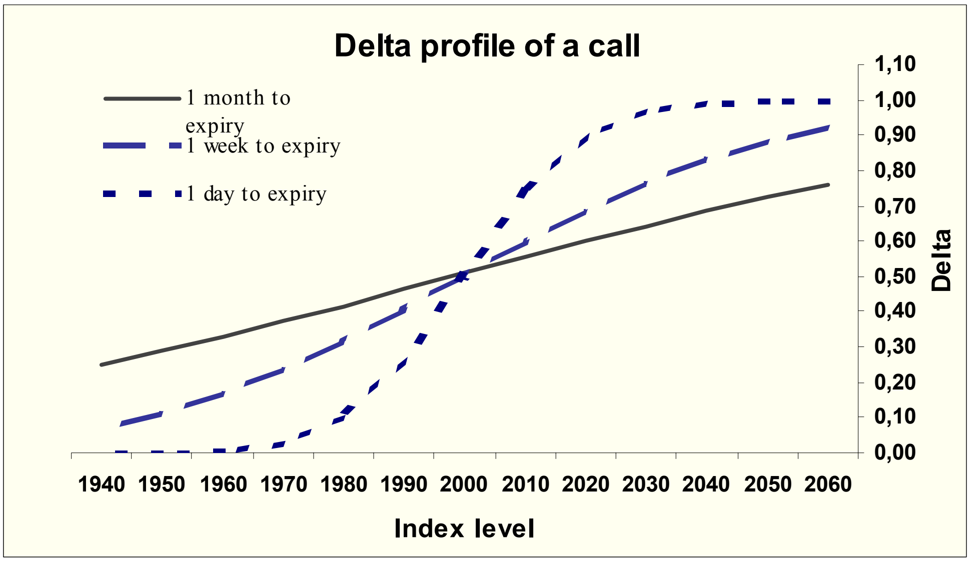
The delta of a stock option is the ratio of change in the price of the stock option to the change in the price of the underlying stock. It is the number of units of the stock we should hold for each option shorted in order to create a riskless hedge.

Keeping this in mind, a riskless portfolio is said to be delta neutral, when having a delta equal to zero. The delta of a call option is positive and can vary between 0 and 1, whereas the delta of a put option is negative and can vary between 0 and -1.

In Figure 9, where the delta profile of an index call option is presented, the delta is minimum for out-of-the money calls and maximum for in-the-money calls. Moreover, the closer to expiry the option is, the more sensitive the price of an option is to index movements.

Figure 9.

Time decay effects on the delta of an at-the money index call option



Back to our portfolio, at any point in time the slope of the curve, the delta gives the equivalent exposure of the option position in futures as presented in Figure 9. In order to rehedge the position and lock the profits made, additional futures have to be bought or sold. With the index rising from 2000 to 2010 the last day of the options trade, an additional 0,24 futures[13] would have to be sold to offset the delta rise from 0,5 to 0,74 for every option in our portfolio. In a declining market, additional futures would have to be bought to minimize the exposure of the futures portfolio to match the one of our option portfolio.

For the volatility trader, who's basic concern is to keep the delta of his portfolio neutral this curve profile is very important in constructing/rehedging his portfolio. As the call reaches maturity, more and more futures have to be bought/sold to offset the change in price (premium) of the option and keep his position market neutral. This is why the dream of every volatility trader is for the underlying asset to be highly volatile when the option reaches maturity and the option finishing near-the-money.

[13] The delta of a long position in the underlying asset is always +1, for a short position –1.

2.3.2 GAMMA

As described in the previous section, the trade profits from volatility are a result of the options curvature. And the price profile is only curved because of the kink to expiry. For a given index price move, say x%, the more curved the profile the more significant the rehedging profit.

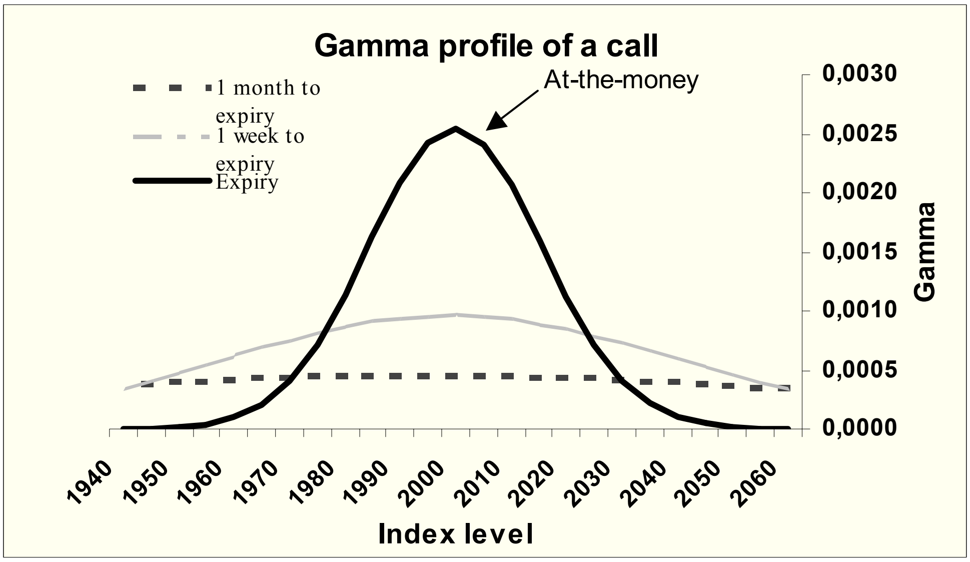
Curvature is so important in the option market that it has also been assigned a Greek letter –Gamma. Since the slope of the curve is the delta, the curvature is the rate of change of delta. According to ADEX:

Gamma measures the rate of change for a given movement in the underlying price. Gamma compensates for the convexivity of the near-day option value curve by measuring the rate at which delta changes for an identical change in the underlying value. It equals the increase in the delta of an underlying asset for every increase in the asset's price. Having the following formula, gamma is the second derivative of the option price with respect to the underlying;

$$\textit{Gamma:} \quad \frac{\textit{change in option price}}{\textit{change in the underlying price}}$$

The practice behind the use of at-the-money options in constructing the portfolio of options in a volatility trade can easily be educed by looking at Figure 10. According to the gamma profile of the call option, gamma is maximum for at-the-money options and falls to zero for deep in-the-money and out-of-the-money options. Unfortunately, these very near-the-money options suffer the most time decay as demonstrated in Figure 11. The gamma of a long call is positive and this is because as the underlying index increases, so does the slope of the curve.

Figure 10.
Time decay effects on the gamma of an at-the money index call option



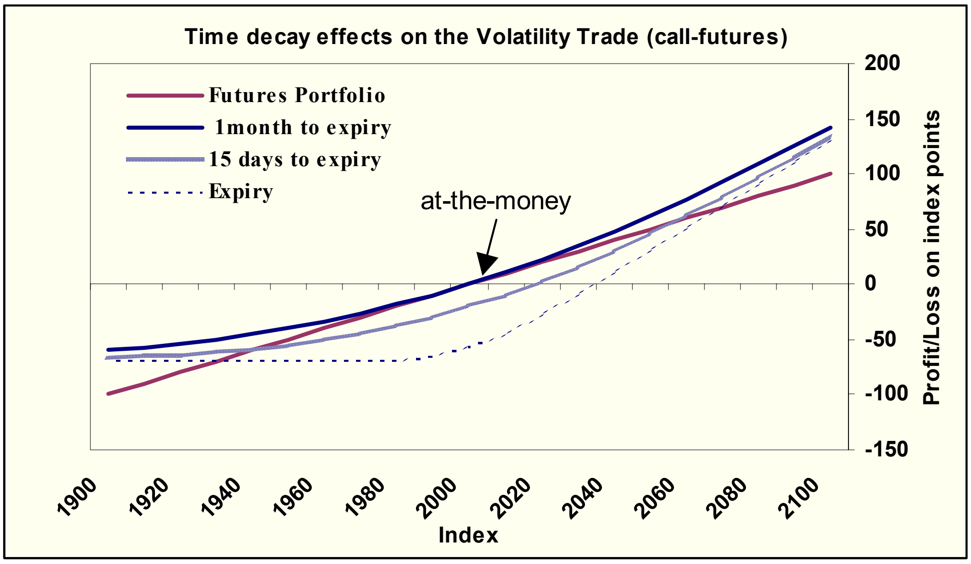
The real use of gamma to the option trader and the volatility trader is in the estimation of the future rehedging activity. More importantly, the gamma of a position is a direct measure of the potential profit due to volatility and often the term *long gamma* is used instead of *long volatility.*

2.3.3 THETA

The theta of a portfolio of options, is the rate of change of the portfolio's value with respect to the passage of time *ceteris paribus.* In other words, it is the rate of change of the value of a portfolio with respect to a decrease in the time to maturity of the options in a portfolio.(Hull 2000)

Theta is also sometimes referred to as *time decay*. Presented in Figure 11, *time decay* can, and often does, ruin the volatility trade. When initiating this trade, we hope to experience price movements. Every day that the underlying stays still is a day of a time value lost. In a completely stagnant market, losses due to time erosion can build up. Long volatility traders in such situations talk of "bleeding to death" through theta. (Connolly 1999)

Figure 11.
Time decay versus volatility profits



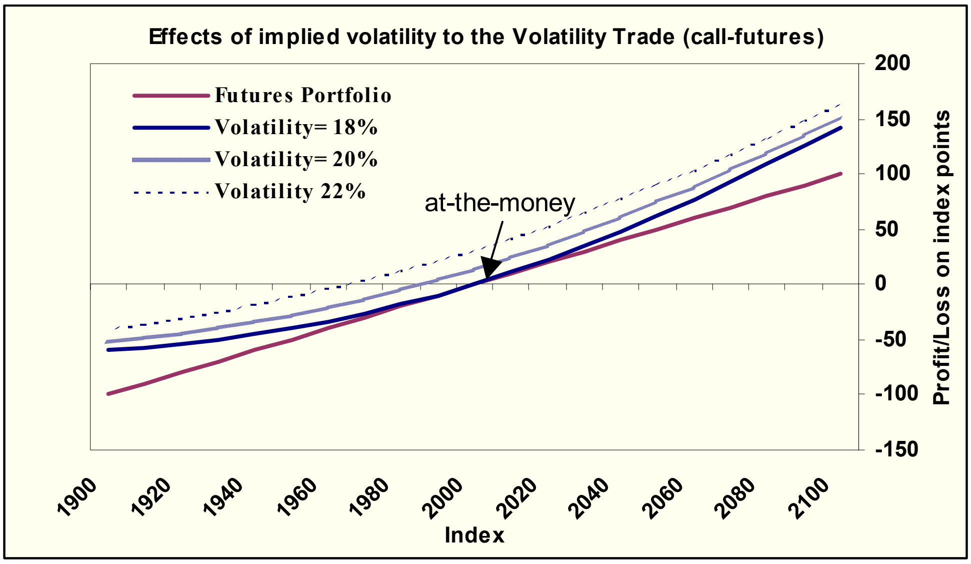
At-the-money options suffer the most from the passage of time, but also have the highest curvature (gamma) and thus can produce the biggest profits. It is instructive to see what degree of volatility or price movement is necessary to cover the cost of time decay. The profits from the trading should at least compensate the loss arising in the portfolio of options from theta. Out-of-the-money as well as in-the-money options suffer the least time decay. This observation might tempt one to think that the solution for the long volatility player is to get involved only in those options with little or no time decay. However it is not that simple. Unfortunately, the very options that have no time decay also have very little price curvature. As explained previously we need price curvature for the volatility trade.

2.3.4 VEGA

Vega (κ) (actually a star, not a Greek letter), also known as kappa, measures changes in the option premium per 1% shift in volatility. Vega is always positive and maximum for at-the-money options, decreasing to zero for in-the-money and out-of the money options. It is the first derivative of option price with respect to volatility.

The sensitivity of options to volatility changes is similar to the sensitivity exhibited to time passage. Near-the-money options are most sensitive and deep out-of-the money and deep in-the-money options are less sensitive. The importance of getting volatility right is illustrated in figure 12. Rising volatility results in additional profits to the long volatility trader.

Figure 12.
Vega versus volatility profits



It should also be noted that all other things being equal, shorter dated options have lower Vegas. As time passes options become less sensitive to volatility changes or uncertainty in volatility estimation. The higher the implied volatility, the higher the risk associated with the particular option and subsequently the higher the premium of the option.

2.4 ADDITIVITY OF SENSITIVITIES

Before proceeding to the trading simulations, it would be useful to present a special feature of the price profile of portfolio of options.

In deriving the price profile of option portfolios, consisting by many different combinations of different options, weighted for position sizes, we simply have to add them together[14]. This concept of price additivity can be extended to even the most complex portfolios, containing large numbers of different series of calls and puts.

[14] This is because the individual options are depended in the price of the underlying and not on each other.

Deriving the price profile of a combination of options is very useful and with experience, most volatility players will have a fairly good idea even without the use of software. (Connolly, 1999) For any general portfolio the price would be given by:

Combination price= (size#1) x (price#1) + (size#2) x (price#2) + …. etc. (2.1)

More importantly, the same applies to the various sensitivities of the various components of the option portfolio. So if we are long volatility we will know when we need to rehedge or what the gamma of our position is. If we are short volatility we will know the time decay we will earn every day and what the rehedging costs might be. The formula for a general portfolio (2.1) applies to all the sensitivities such as gamma, delta, vega and theta just by substituting the price with the corresponding sensitivities.

2.5 TRADING SCENARIO

In chapter 1, we have identified the trading opportunities in the Athens Derivative Exchange. In order to benefit from the underpriced options, we will perform a long volatility trade for the period from mid September 2000 to October 2000. Instead of using at-the-money calls in order to construct our long volatility trade, at-the-money puts are preferred since they exhibit lower implied volatility thus are cheaper to buy from the corresponding calls.

2.5.1 INTRODUCTION

The FTSE/ASE-20 index includes the twenty shares with the highest capitalization[15] in the Athens Stock Exchange. It is the first index that has been used as the underlying instrument for futures and options traded in the Athens Derivative Exchange (ADEX).

More specifically, FTSE/ASE-20 stock index options have been launched in ADEX in the beginning of September of 2000. They are European type calls and put options contracts guaranteed by the Athens Derivatives Clearing House (ADECH). The contract multiplier is 5€, and in-the-money options are automatically exercised on the third Friday of the month.

[15] Refer to the Appendix

At any point in time there are at least eleven strike prices for each of the six expiration months traded[16]. Six ADEX Members operate as market makers for option contracts. They have the obligation to provide liquidity in the front two-month series. These series are the most liquid and heavily traded, and are the ones used in our volatility portfolio. Both futures and options mature the same day

2.5.2 DATA

At-the-money October puts are bought in order to construct the option portfolio of the long volatility trade. Due to the fact that, puts have a negative delta, October futures have to be bought to construct a delta neutral portfolio. Both. puts and futures expire the third Friday of October. All the data on the options and futures closing prices were generously provided by P&K Securities S.A.

The delta of the front-month at-the-money put is obtained for the examined time series by inverting the Black-Scholes pricing formula for the option prices. In order to be confounded with interest rate and discounting effects, we have used the front-month FTSE/ASE-20 Futures settlement price as underling instrument, rather than the FTSE/ASE-20 closing price itself. This is consistent with the trading market where quotations are mostly based on reversal and conversions.(ADEX 2001)

If we were to use the delta obtained by the FTSE/ASE-20 closing price instead, the following formula would have to be used to derive the corresponding put delta according to Hull:

$$\Delta = e^{-qT} e^{-(r-q)T*} [1 - N(d_1)] = e^{q(T*-T)} e^{-rT*} [1 - N(d_1)] \qquad (2.2)$$

where T* is the maturity date of the futures contract and T is the maturity date for the put.

[16] The three consecutive months closest to expiration and the three nearest months of March, June, September, and December cycle.

The trading period considered extends from the 25st of September to the 6th of October. The calendar-trading year consists of 252 days and the option has 26 days to maturity since its launch in the market, the 15th of September. The closest to the money put is used with a strike price of 2400 index points. The FTSE/ASE-20 future index stands at 2367, while the October futures settlement price is 2403 index points.

2.5.3 METHODOLOGY

The rehedging process is based on daily closing prices. At the end of each trading day our position is fully hedged. For each trading day the delta of our option position is calculated according to the Black-Scholes model. The futures daily prices are also obtained by the settlement prices provided by the ADEX. In order to avoid expiration effects our position is closed well before the third Friday of the month.

By decomposing the portfolio into its constituents the performance of the investments can be formulated as followed:

$$R_{V\,t} = (P_t - P_{t-1}) - N(d_{1,t-1})(F_t - F_{t-1}) \qquad (2.3)$$

where V_{t-1} the settlement price of the futures contract for the previous day and P_t , F_t the futures and options settlement prices today. Hence we can define the following returns:

$$R_{F\,t} = F_t - F_{t-1} \qquad (2.4)$$

$$R_{P\,t} = P_t - P_{t-1} \qquad (2.5)$$

where R_{Ft} and R_{Pt} the return of the futures and put options portfolio. By substituting these definitions in equation (2.3) the actual return can be written as follows:

$$R_{V\,t} = R_{P\,t} - R_{F\,t} \qquad (2.6)$$

where R_{Vt}, the return of the volatility trade using puts and futures on the FTSE/ASE-20 index.

The margin required for the futures position is borrowed at the risk-free rate and the initial transaction commissions are subtracted from the profits. The interest payments for the margin requirement is calculated using the rate charged for margin calls[17] and subtracted from the profits. The commissions paid to rehedge the futures position are also subtracted from the profits[18]. Equation (2.6) is converted to:

$$R_{Vt} = R_{Pt} - R_{Ft} - \sum_{t} C_R - \sum_{t} L_t \qquad (2.7)$$

where C_R the commission paid for the rehedging process as well as the initial transactions and L_t the interest payments on the loan for the margin requirements.

2.5.4 RESULTS

The results of the Long Volatility trade using at-the-money puts are presented in Table 2. In fact, two volatility portfolios have been constructed on different initial dates using the at-the-money put. (Table 3)

The commissions charged on the trades are the base commissions[19] charged according to P&K Securities, the leading market-maker in the ADEX . This commission is the highest charged and is used to illustrate the profitability of the trade. For trade of this magnitude the commission for Institutions & Investment Houses is more likely to be negotiated. By introducing margin requirements and transaction costs, arbitrage relationships , that hold in theory are examined in practice.

---

[17] The interest rate is 10%, and it is credited to all the capital required for the futures investment.

[18] Commissions as well as interest payments on the margin, could also, and usually are, subtracted daily before the profits or losses are debited/credited to the margin account. The difference between the two figures is almost insignificant in our scenario.

[19] The table containing the commissions charged is shown in the Appendix.

Table 2.
The simple Long Volatility Trade using puts

Date	FTSE/ASE-20	Change of value of option portfolio	Change of value of futures portfolio	Margin requirements	Interest	Transaction Cost	Profit
22/9/2000	2328,85	€ 0,00	€ 0,00	€ 78.406,94	€ 12,52	€ 0,00	€ 0,00
25/9/2000	2366,88	-€ 15.500,00	€ 19.188,40	€ 67.738,37	€ 32,45	€ 315,00	€ 3.688,40
26/9/2000	352,48	1.300,00	-€ 5.741,05	€ 74.182,37	€ 11,84	€ 175,00	-€ 4.441,05
27/9/2000	2350,74	-€ 575,00	-€ 429,00	€ 75.556,48	€ 12,06	€ 35,00	-€ 1.004,00
28/9/2000	2346,85	€ 2.750,00	-€ 63,60	€ 74.123,40	€ 11,83	€ 35,00	€ 2.686,40
29/9/2000	2371,64	-€ 6.200,00	€ 4.009,20	€ 71.735,10	€ 45,82	€ 70,00	-€ 2.190,80
2/10/2000	2369,78	-€ 7.450,00	€ 60,00	€ 71.742,30	€ 11,45	€ 0,00	-€ 7.390,00
3/10/2000	2316,48	€ 13.200,00	-€ 10.445,00	€ 84.586,68	€ 13,50	€ 350,00	€ 2.755,00
4/10/2000	2275,07	€ 11.700,00	-€ 13.200,00	€ 99.603,22	€ 15,90	€ 420,00	-€ 1.500,00
5/10/2000	2243,38	€ 14.500,00	-€ 10.396,80	€ 102.453,75	€ 16,36	€ 105,00	€ 4.103,20
6/10/2000	2272,23	€ 1.750,00	€ 11.013,75	€ 87.171,34	€ 13,92	€ 420,00	€ 12.763,75

Volatility trades require a highly liquid market, with large volumes of options and futures traded. Liquidity risk can be minimized this way. In Table 3, the results of volatility trades set at two different dates and for decreasing volume of options and portfolio values are presented.

Table 3.
Performance of Volatility Trades in three portfolios of different volumes at two distinctive periods.

	22/9/2000 to 6/10/2000			29/9/2000 to 6/10/2000		
	100 options	50 options	20 options	100 options	50 options	20 options
Total Profit	€ 9.470,90	€ 4.723,70	€ 1.905,45	€ 10.731,95	€ 5.292,55	€ 2.204,15
Initial Futures Transaction Cost	€ 1.960,00	€ 980,00	€ 385,00	€ 1.750,00	€ 875,00	€ 350,00
Initial Options Transaction Cost	€ 2.500,00	€ 1.250,00	€ 500,00	€ 2.500,00	€ 1.250,00	€ 500,00
Interest	€ 323,35	€ 160,57	€ 63,26	€ 191,33	€ 95,30	€ 37,90
Transaction Cost	€ 1.925,00	€ 945,00	€ 385,00	€ 1.295,00	€ 630,00	€ 280,00
Net Profit	€ 2.762,55	€ 1.388,13	€ 572,19	€ 4.995,62	€ 2.442,25	€ 1.036,25

As liquidity[20] was still picking up in the second half of 2000, volatility trades of the second and third column can give a more realistic aspect of the profits made by trading volatility in the ADEX. The second Volatility portfolio is more profitable in all three columns, due to the increased gamma trading profits.

[20] See Appendix for traded volumes, open interest and average trading volumes of futures and options on the FTSE/ASE-20.

3

THE SIMPLE SHORT VOLATILITY TRADE

3.1 INTRODUCTION

In Chapter 2, we presented the simplest form of the long volatility trade; that of having a long call or a long put position and an opposing position on the underlying future. The idea behind this strategy is to capitalize on the future volatility of the index. If the option is cheap enough or future volatility is high enough a profit results. (Connolly 1999).

In this chapter we will introduce the concept behind the Short Volatility Trade. While, the Long Volatility Strategy, exploits volatility, the Short Volatility Trade does exactly the opposite. It benefits from the absence of volatility. As we will witness later, under circumstances, such as the ones in the long volatility trade profits can result. So, if an option is considered expensive enough or future volatility is expected to fall, the volatility trader will choose to sell volatility. The basic strategy involves selling call options and hedging with a long position in the future.

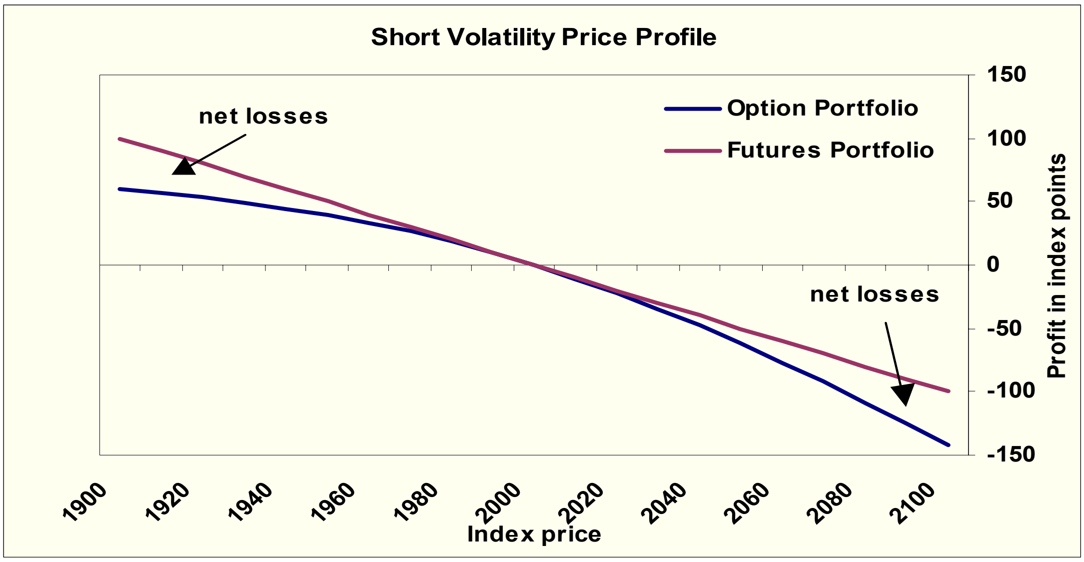
3.2 CONSTRUCTING THE LONG VOLATILITY TRADE

As with the Long Volatility trade, the Short Volatility trade can be constructed with calls and puts. The only difference is that the volatility trader will have to sell puts and keep the delta of the position neutral by selling the underlying index.

The short volatility trader expects to gain more from the expensive premium received by the buyer, to cover any future index price movements. Shorting call or put options is equivalent to establishing a short position in the underlying and if the market moves the wrong way , large losses can result. The short volatility trader has no view of the direction of the market, and so he will have short call options perfectly hedged with a long position in the index futures.

The delta of the short call is negative, meaning that an increase in the index results in a decrease in the value of the short call position. The delta for at-the-money short calls is –0.5 and for out-of –the money and in-the-money calls -1 and 0 respectively. The gamma of the short option position is again the opposite of the long call position, is highly negative for short at-the-money calls and almost zero for far in-the-money and far out-of-the money short call positions. In Figure 12, the price profile at different index prices for the short call position and the long index futures position is illustrated. Again, due to the curved profile (delta) of the call price the short call position now accumulates more losses, than the long futures position.

Figure 13.
Option versus future performance in the short volatility trade.



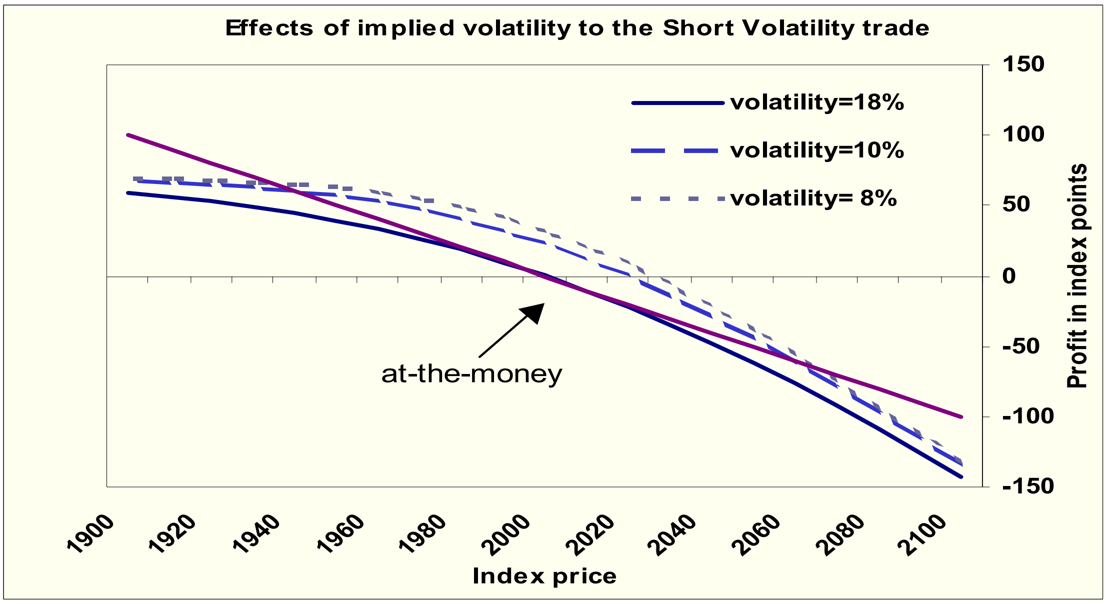
By looking at Figure 12, presenting the relative performance of the two opposing portfolios, the option and the future, one can easily see that our option portfolio is decreasing in value when the index exhibits increasing volatility (rises or falls) beyond certain levels. This is consistent with the price profile of the short call as well as the short put. The volatility trade also seems to be generating certain net losses! This is not true as we will see later in analyzing the sensitivities of the strategy.

It should be noted that in Figure 12, as well as all the next Figures representing the profile of the Short Volatility trade, the futures profit and loss line is displayed as a negative slopping line but of course in reality it is positive. Illustrated this way it is easier to see that the net profit and loss to the hedged portfolio will be the difference between the two value profiles.

3.2.1 VEGA

Our short volatility trade is profitable in any case where the premium for the calls or puts decreases. As shown in Figure 13, when volatility decreases the value of the calls sold decreases and our portfolio of options can be bought back at a lower price. The decrease in volatility affects at-the-money calls more than far out-of-the money and far in-the-money calls.

Figure 14.
Vega versus Short Volatility profits



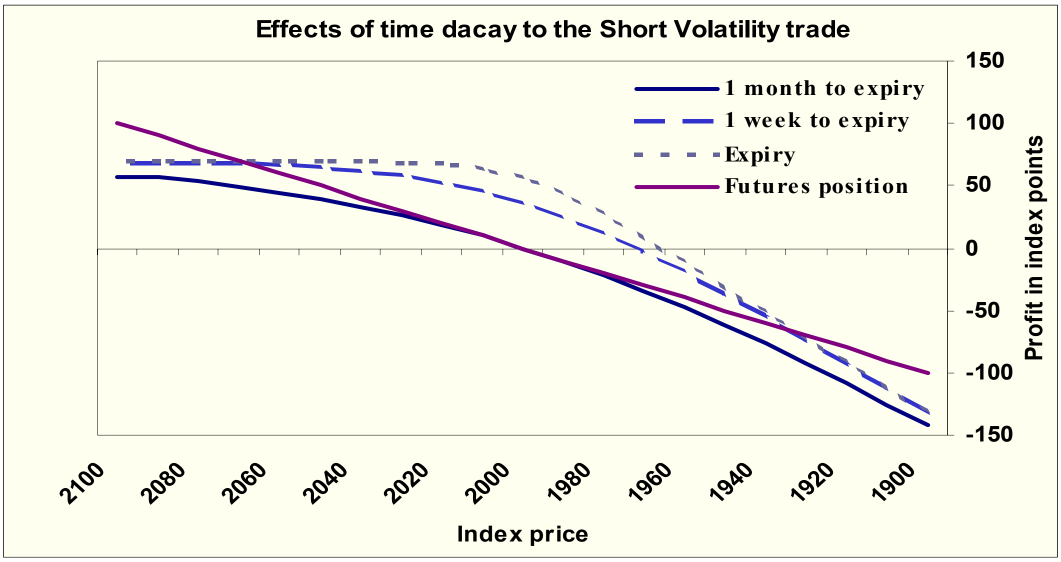
The best case scenario for our short volatility position would be for volatility to drop to zero immediately after the trade is being set up. In another case, the volatility trader could sit and do nothing while watching the time eat away all the profits of the long volatility trader and increase his own margin account!

On the other hand, the worst case scenario for the short volatility trader would be for the market to exhibit increased volatility as soon as the trade is set up. A market ramp or crash will result in huge losses. Both the short put as well as the short call position has a limited profit potential and an unlimited loss potential.

3.2.2 THETA

As we have seen so far, the short volatility trade is the opposite to the long volatility trade. When one position looses, the other position gains. At the end of the day nothing is lost, it is a zero sum game, where profit and losses exchange hands. It just so happens the same is true for the passage of time. While the long volatility trader is "bleeding to death" through theta, the short volatility trader is happy to be seeing his option position increase in value. Again the different price profiles for the short volatility trade are presented with respect to time to maturity.

Figure 15.
Theta versus Short Volatility profits



As with gamma, at-the-money calls are mostly effected by the passage of time. Since we are short calls, every day that passes by with no or lower volatility than the previous one increases our profits.

3.3 TRADING SCENARIO

In constructing our volatility trade, we are again based in our ex-post analysis of the historical volatility of the FTSE/ASE-20 versus the implied volatility of the front month calls during the period from September 2000 to July 2002. According to our analysis, in mid

January 2001, the implied volatility gap was calculated to have been as high as 30%, while the average volatility gap till this time was 4,8% for calls and puts on the FTSE.ASE-20.

This rise in implied volatility suggested that expensive calls could be sold initially and then repurchased at lower prices when implied volatility would stabilize at the previous lower levels.

The short volatility portfolio is constructed according to theory by selling at-the-money January calls on the FTSE/ASE 20. The futures portfolio is constructed by buying January futures on the FTSE/ASE 20 index. The ratio of short calls to futures is dictated by the delta of the short call position, since our position has to be delta neutral. The January 2001 calls have been traded since the beginning of the year, and are held till the 16th of the month, three days before their expiration on the 19th of January.

3.3.1 METHODOLOGY

The hedge position is based on daily closing prices. For each trading day the delta of our option position is calculated according to the Black-Scholes model. The futures daily prices are also obtained by the settlement prices provided by the ADEX. In order to avoid expiration effects our position is closed before the third Friday of the month. Equation (2.7) is again used to calculate the net return of the short volatility trade. Only the signs in the equation will be changed, since the options are being held short.

$$R_{V_t} = -(R_{P_t} - R_{F_t}) - \sum_t C_R - \sum_t L_t$$

Transaction costs for the initial investment as well as the interest paid for margin requirements are taken into account. The results of the trade are presented in the next section.

3.3.2 RESULTS

Table 4, presents the return of the short volatility trade resulting from the option and futures position. The time series extends from the 11th of January 2001 to the 16th of January

2001. According to the calculations, although a significant profit results-consistent with theory- when transaction costs are taken into account this profit disappears.

Table 4.
Short Volatility Trade results at three different commission levels

11/1/2001 to 16/1/2001									
	BASE			SECOND			INST. & INV. HOUSES		
	100 options	50 options	20 options	100 options	50 options	20 options	100 options	50 options	20 options
Total Profit	€ 5.576,30	€ 2.846,40	€ 1.134,70	€ 5.576,30	€ 2.846,40	€ 1.134,70	€ 5.576,30	€ 2.846,40	€ 1.134,70
Initial Futures Transaction Cost	€ 2.030,00	€ 1.015,00	€ 385,00	€ 1.740,00	€ 870,00	€ 330,00	€ 870,00	€ 435,00	€ 165,00
Initial Options Transaction Cost	€ 2.000,00	€ 1.000,00	€ 400,00	€ 1.500,00	€ 750,00	€ 300,00	€ 800,00	€ 400,00	€ 160,00
Interest credited on the margin requirements	€ 74,66	€ 36,89	€ 14,58	€ 74,66	€ 36,89	€ 14,58	€ 74,66	€ 36,89	€ 14,58
Transaction Cost	€ 1.820,00	€ 910,00	€ 385,00	€ 1.820,00	€ 910,00	€ 385,00	€ 1.820,00	€ 910,00	€ 385,00
Net Profit	-€ 348,36	-€ 115,49	-€ 49,88	€ 441,64	€ 279,51	€ 105,12	€ 2.011,64	€ 1.064,51	€ 410,12

The short volatility trade is then examined under three different commission levels, charged for transactions in ADEX. Based on the results, a short volatility trade can produce significant profits only when transaction costs are limited to the minimum for the above period. It should also be noted that margin requirements for the short call position have not been taken into account-which can reduce profits even more.

Although the margin requirements required for the short call position are unknown, since they are a product of a complex formula available to the ADEX and members of the ADEX, an approximate figure of these requirements for the portfolio under examination can be found by multiplying the daily settlement price of the call by four. Even having accounted for this cost, profits are still significant.

3.4 CONCLUSION

Having presented both the long volatility trade and short volatility trade profile and sensitivities of each position, one can see that the worst case scenario for the short volatility trader is the best case scenario for the long volatility trader.

In a market crash as well as in a market ramp the losses for the short volatility trader can be enormous. The short volatility trade is a strategy, which we can calculate beforehand what the maximum possible profit is but not the extent of the losses. This strategy has a limited profit potential and an unlimited loss potential, thus should be used with great caution.

On the other hand in a long volatility trade position a market ramp or crash is the dream of every trader (and nightmare of the short volatility trader). The profit depends on the severity of the price moves. The long volatility strategy provides an unlimited profit potential and this together with the limited loss feature makes it a very attractive strategy.

It is a common ground for both practices that a highly liquid derivatives market is imperative. As the market becomes more liquid larger positions can be built, transaction costs can be decreased and profits increased. Market makers actively involved in the Athens Derivative market are eligible to lower transaction costs and can benefit from smaller movements in volatility or lack of it.

At the end of the day market makers are concerned in being delta neutral and gamma or *vega* positive having to manage combination of options of different series and classes and numerous positions in futures.

4

Combinations of Options

So far we have concentrated on simple portfolios either containing a long or short position in a call or a put option. In reality by facilitating speculation on whether actual volatility will exceed or fall short of implied volatility and whether implied volatility will rise or fall, volatility trades, such as straddles, strangles and butterflies are created.

In this chapter we will describe the price profile of the most commonly used volatility strategies of those three and their characteristics- straddles and strangles. In all combinations (not just volatility trades), two or more options are combined in order to exploit one or more determinants of option value: the price, its volatility, the time-to-expiration, or the interest rate while minimizing exposure to other risks.

By definition volatility traders, will seek to exploit either predicted changes in implied volatility and/or anticipated changes between actual and implied volatility (as in our case) implying that they should seek positions with large v*egas* or *gammas* respectively. In most cases we desire to also minimize the price risk, so we will also seek/construct positions which are delta neutral.

4.1 Straddles

A combination is an option trading strategy that involves taking a position in both calls and puts of the underlying instrument. One popular combination is the straddle. The straddle involves buying a call and a put with the same strike price and expiration date. In creating a straddle we face only one design choice-which strike price to use.

According to Black’s model, if a straddle trader wishes to construct a straddle both delta neutral and highly sensitive to changes in actual or implied volatility, a strike price just above the current futures price should be chosen. The formula for calculating this price is:

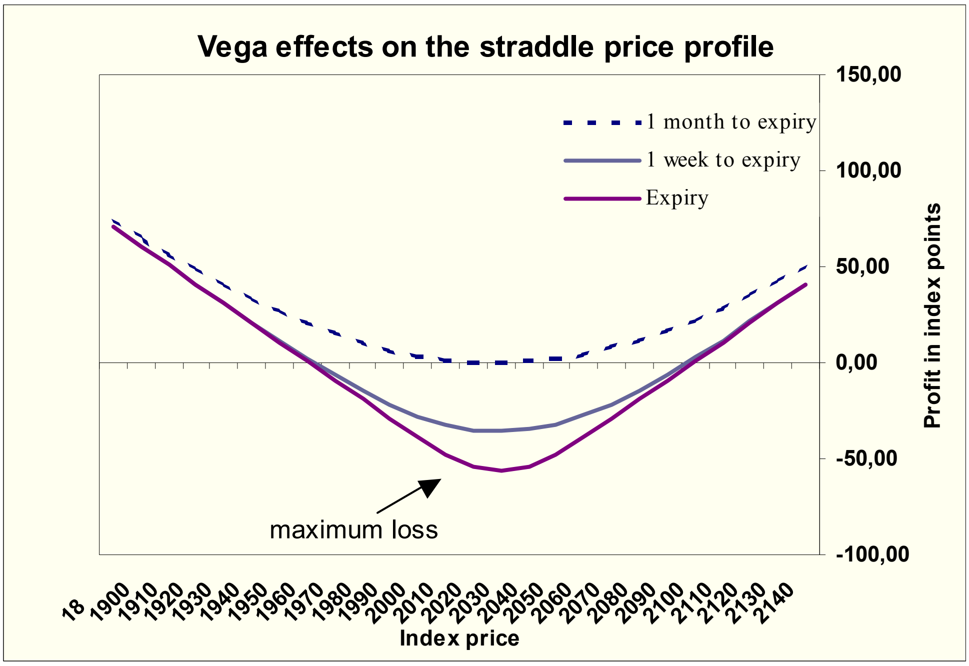
$$F^* = Fe^{0,5\sigma^2 t} \tag{4.1}$$

where F is the underlying futures price and σ is the instantaneous volatility while t is time to expiration. Unfortunately since only a limited number of strikes are traded in practice, straddles are rarely completely delta neutral, thus volatility traders can rarely completely maximize *gamma* and *vega*. The common practice is to use the closest to the money strikes. The profit pattern of the straddle is shown in Figure 14.

A straddle is appropriate when a trader is expecting a large move in the market. Maximum loss occurs only when the position is kept up to the expiration date and the price of the underlying exactly equals the strike price of the options. Since a straddle requires the purchase of two options, it is a very expensive strategy an requires for the index to rise/fall more than the sum of the premiums paid for the options to construct the position for a profit to result.

Figure 16.

Profit pattern of a straddle

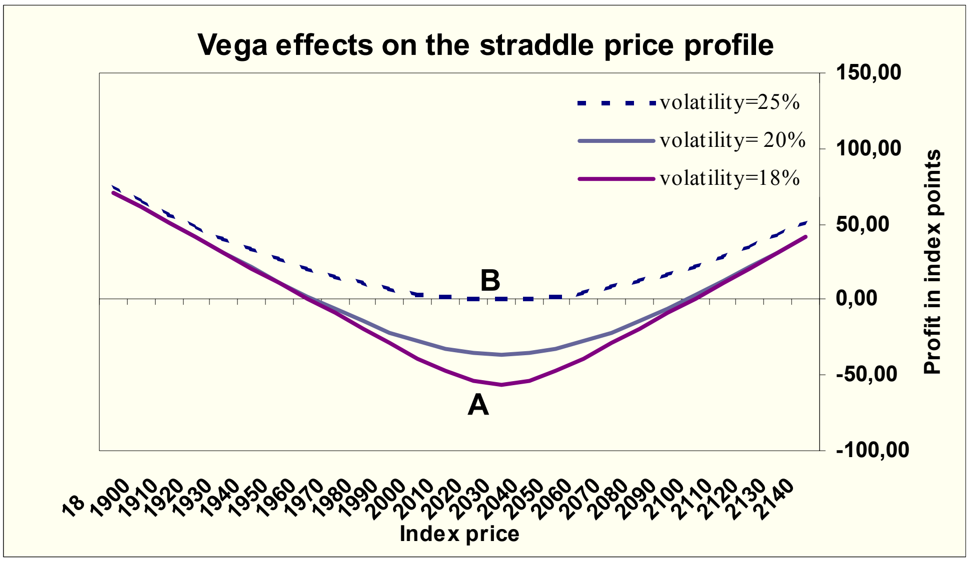


4.1.1 THE VEGA OF THE LONG STRADDLE

Long straddles limit the investor's risk but involve a relatively high loss probability at expiration. The probability of incurring losses in the long run is offset by the chance of making large profits. In the case of a volatility increase, the price of both legs of the trade, the call and the put will rise giving rise to the probability of enjoying big profits.

In a case where a decrease in volatility is expected the investor could take the opposite position by selling a put and a call at the same strike price, thus creating a short straddle. Figure 15, presents the price profile of the long straddle. In the fortunate event of a volatility rise from 18 to 25 percent the price curve will move upwards from A to B thus compensating the volatility trader for all the premium paid for the strategy and enhancing his chances to close out the position with profits.

Figure 17.
Price pattern of the long straddle vs Vega effects



The short straddle position on the other hand just like the short volatility position examined in chapter 3, profits from declining volatility and time decay. Both legs of the short straddles, the short call and the short put have negative *vegas* and positive *thetas*. The short straddle makes a profit where the long one accumulates losses. In order to further illustrate the effect of volatility in the long straddle position the Profit-Loss profile of the two legs of the trade is presented in table A-3 in the Appendix.

4.2 Strangles

A strangle involves the simultaneous purchase or sale of an equal number of puts and calls on a given underlying instrument with the same expiration date but different strike prices. Typically the call will have a strike above the current futures price, while the put'a strike will be below the stock price. As with the straddle, the strangle purchase is looking for a large move in the underlying that exceeds either strike level by more than the amount paid for both options.

Sellers of strangles are looking for little or no movement from the underlying. These sellers of short volatility, will look for options with higher implied volatilities that provide more premium. The short positions will be profitable if the stock price stays within the range bounded by the strike prices of the sold options plus the premium collected. Sellers will also benefit if the options implied volatilities decrease, which would make the options cheaper to buy back if the seller wishes to close the position.

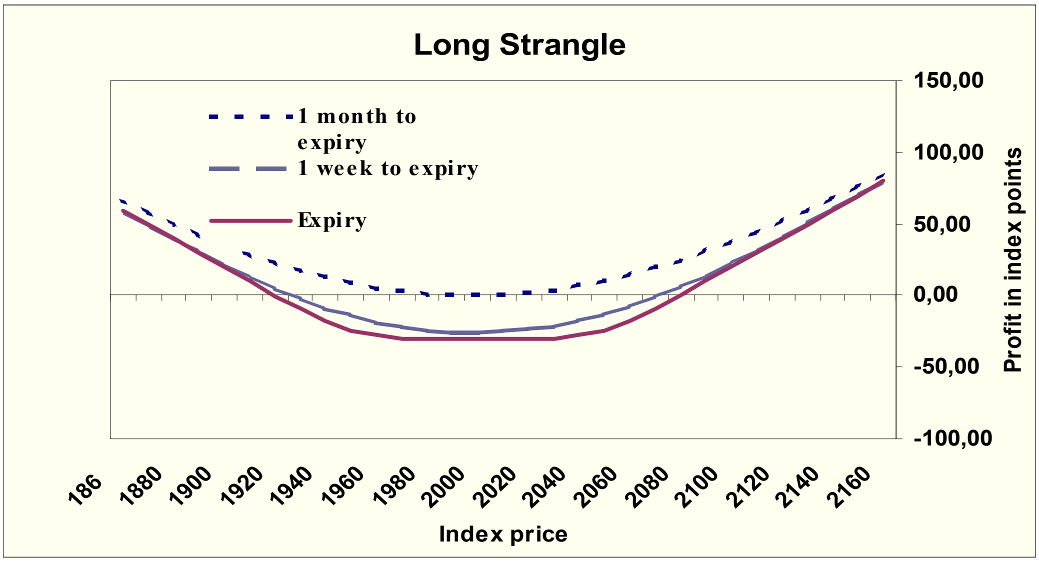
4.2.1 Minimising the Price Risk of Strangles

According to Black, a strangle's *delta* is zero if $N(d_c) + N(d_p) = 1$. This occurs when the geometric mean of the two strikes, which we will designate as $\overline{\mathrm{X}}$ is equal to F^* denoted by equation (4.1). Choosing a pair whose geometric mean is far from F^* will result in maximizing the price risk as well as sacrificing *vega* and *gamma* trading opportunities.

In practice, most traders choose a pair whose arithmetic mean rather than the geometric mean is closer to F^* though by doing so they accept some delta risk (and slightly lower *gammas* and *vegas*) according to Blacks model.

Figure 18

The price profile of the Strangle



In Figure 16, the price profile of the long strangle is presented. According to this, time decay affects both legs of the strangle moving the curve profile of the strangle downwards. At expiry and with no significant index move the buyer of the strangle is accumulating losses, since all the time value[21] of his options has been lost and so in closing his position the options held are priced at a lower premium. The short strangle trader on the other hand gains the equivalent time decay by having sold the two options and buying them back at a lower premium.

Note that the important distinction between straddles and strangles is that the buyer of the strangle is willing to give up profits the straddle buyer would achieve on modest moves for the big profits on the very large moves. The seller of the strangle is willing to forego bigger gains on smaller moves in exchange for having more "wiggle room" that will keep the sold option out-of-the money.

[21] Premium= intrinsic value+ time value, intrinsic value is the difference between the strike price and the price of the underlying instrument.

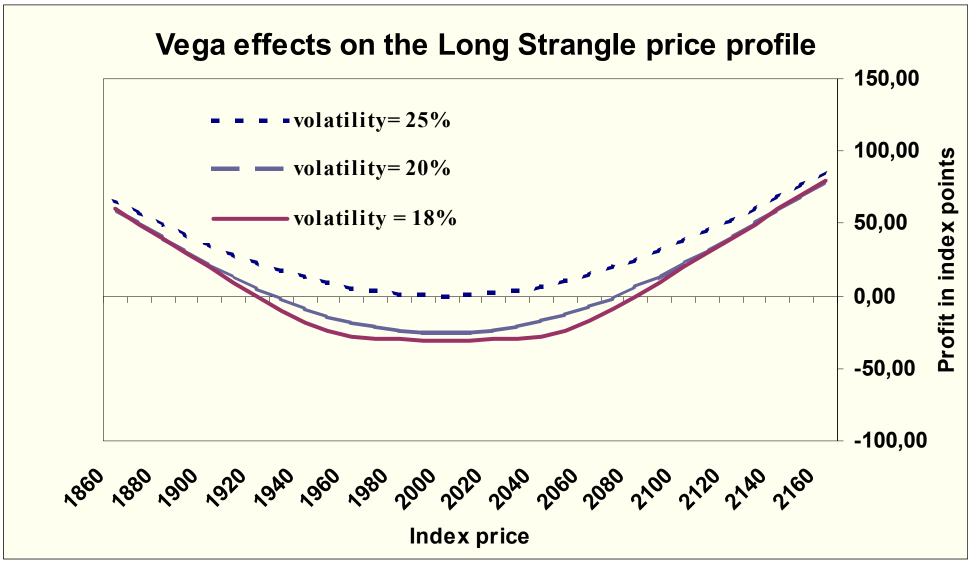
4.2.2 THE VEGA OF THE LONG STRANGLE

The *vega* of the strangle is presented in Figure 17. According to this, we can see that an increase in the implied volatility-used to calculate the premium of the two legs- would result in a shift of the profit/loss profile of the strategy upwards. The decrease in implied volatility on the other hand will shift the profit/loss curved downwards creating losses.

The strangle exhibits similar pattern to the straddle, the difference is that a strangle is cheaper to construct, since both of the options bought are out-of-the-money, hence priced at a lower premium than at-the-money options. To my experience, there is a tendency to use strangles in short positions while straddles are used to construct long positions.

Figure 19.

Implied volatility effects on the price profile of the Strangle



This tendency might be related to the slope of the implied volatility smile in the case where traders view implied volatility differences as exploitable by selling overpriced options and buying underpriced ones.

4.3 TRADING SCENARIO

The trading scenario involves the simultaneous purchase of a straddle and a strangle on the 29th of September. The position is kept till the 6th of October, when both positions are closed. The trading period under examination exactly matches that of the simple long volatility trade. This way useful results can be deduced from the comparison between the two strategies profitability and the simple long volatility trade. (Chapter 7). The same concept is applied to the short strangle and straddle position presented next The two strategies are expected to be profitable since both calls and puts are priced at a lower implied volatility than the historical volatility of the underlying index.

The options are therefore categorized as underpriced and long volatility trades are constructed with the use of straddles and straddles. The returns of the two strategies are calculated after transaction costs. The formula in use is the following:

$$V_{STD,STG} = C + P \tag{4.2}$$

$$R_{STD,STG} = V_{STR(t),STG(t)} - V_{STR(t-1),STG(t-1)} - TC \tag{4.3}$$

where $V_{STD,STG}$ and $R_{STD,STG}$, the value and return of the straddle and strangle strategy while t-1 refers to the time of constructing the trade and t to the time of closing the trade. In the case of a short position only the signs in equation (4.3) will be changed and the formula will be:

$$R_{STD,STG} = -(V_{STR(t),STG(t)} - V_{STR(t-1),STG(t-1)}) - TC$$

4.3.1 RESULTS

The results of the long straddle and long strangle trades are presented in Table 5. The same at-the-money October calls and puts have been used, as in the long volatility trade in chapter 3. The position involves the simultaneous purchase of 20 calls and puts expiring in the third Friday if October 2000 (21st October).

The straddle position is the most expensive, but surprisingly has not produced higher returns from the strangle. This is mainly attributed to the fact that the strangle position finishes closer-to-the money exploiting not only the decline of the index, but among others the rise in implied volatility. The straddle finishes out-of-the money, thus the two legs of the strategy gain less from the rise in implied volatility.

Table 5.
Long Volatility Strategies returns

	Long Volatility Trades (20 options)	
29/9/2000-6/10/2000	Straddle (2400)	Strangle (2350,2450)
Initial Value	€ 14.625,00	€ 10.230,00
Value on liquidation	€ 17.150,00	€ 13.625,00
Transaction costs	€ 960	€ 960
Net Profit	€ 1.565,00	€ 2.435,00

Accordingly, in Table 6, the short volatility trading scenarios are presented. The portfolios are constructed initially by selling 50 January 2001 calls and the same number of January puts. The futures settlement price was 1922 index points, while the available strike prices for the options are at 50 index points increments. Two portfolios consisting of short close to the money options were thus created and evaluated. The closer-to-the-money straddle and strangle, in the second and third column respectively are the only profitable volatility trades. This is due to the fact that they are mostly affected by the decline of volatility. The decline of the index to 1846 points has generated an enormous loss for the far-out of the money positions, that could not be absorbed by the profits from the decline in volatility, even if transaction costs are set at zero. The example presented illustrates the fact that a short straddle or strangle position can generate enormous losses and must be handled with great caution.

Table 6.
Short Volatility strategies returns

	Short Volatility Trades (50 options)			
	Short Straddles		Short Strangles	
11/1/2001 to 16/1/2001	Straddle (1950)	Straddle (1900)	Strangle (1850,1900)	Strangle (1900,1950)
Initial Value	€ 21.487,50	€ 23.250,00	€ 20.000,00	€ 15.887,50
Value on liquidation	€ 27.612,50	€ 17.662,50	€ 9.637,50	€ 16.162,50
Transaction costs	€ 2.400,00	€ 2.400,00	€ 2.400,00	€ 2.400,00
Net Profit	-€ 8.525,00	€ 3.187,50	€ 7.962,50	-€ 2.675,00

5

IMPLEMENTING THE VOLATILITY TRADING SYSTEM

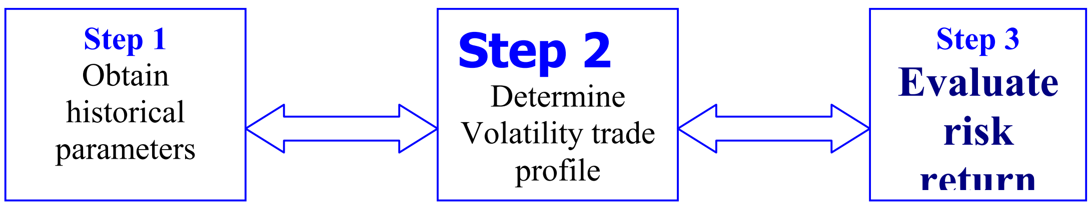
---

5. 1 INTRODUCTION

The implementation of a system that can evaluate volatility trades is similar to one that can process transactions in a derivatives market. The implementation process is illustrated in Figure 18. The Volatility trade in use is dependent on the risk/return parameters at present and in the future, the historical parameters as well as estimates of the historical and implied volatilities. There is also an element of iteration among the steps three processes.

Figure 20.

Volatility Trading System



5.2 THE SYSTEMS FUNCTIONAL REQUIREMENTS

The first stage of implementing a Volatility trading System involves capturing the functional requirements of the system. According to these. the system must be able to:

1. Store and display portfolio holdings.

2. Store and display the settlement prices of the components of each trade.

3. Calculate store and display daily returns of each asset.

4. Calculate transaction costs as well as margin requirements.

5. Store and display daily transactions.

6. Calculate returns of volatility trades consisting of combinations of options

7. Calculate risk/returns of volatility trades consisting of different derivatives (futures, options).

In addition to above requirements, the system could:

8. Calculate the sensitivities of combination of options and future positions.

9. Calculate regulatory capital requirements

10. Calculate risk/ return under different commission levels

5.3 FUNCTIONAL REQUIREMENTS ANALYSIS

The second stage of the volatility trading system involves the analysis of the initial functional requirements. This stage involves the identification of the inputs, transformations (processes), and outputs. We also identify the types of data required to built a prototype system. The analysis will begin by identifying the entities. The list of entities is as follows:

1. Options

2. Option types

3. Deal Type

4. Futures

5. Commissions

6. Option Transactions

7. Futures Transactions

8. Futures Commissions

9. Volatility Strategies

In identifying the futures as well as options used in the trading scenarios the ADEX derivative codes defined by the FTSE Global Industry Classification System are used. According to this, the classification for options on the FTSE/ASE-20 index is FTASE20E0A-Z. The call options are identified by the A to L last letter for the expiration months from January to December, while the put options are identified with the M to X final letters. The year of trading is identified by the number following the FTASE20 prefix, E0 for 2000, E1 for 2001 and E2 for 2002. The futures identification codes are similar to the ones used for the call options.

5.4 Constrains and Limitations

In order to construct the system under analysis, certain constrains and limitations need to be considered. According to these, the prototype system will only deal with the four specific volatility strategies under examination and the transactions required. Historical price data involve the period from September to October 2000 and January 2001 to March 2001.

The delta of the at-the money call and put options were calculated using Excel worksheets and transferred to the database. Finally, margin requirements for short positions were not taken into account.

6

VOLATILITY TRADING SYSTEMS ANALYSIS

6.1 INTRODUCTION

The Financial Services sector is a highly competitive and rapidly growing sector. This requires financial institutions to plan and construct Information Systems that can meet the evolving nature of the business. This is why a successful information strategy is crucial and must enable business flexibility.

In order to provide business solutions at a rate that matches the rapid changes in the business, there needs to be a way of capturing the business knowledge and representing it in a form that can be understood by both the business and the professions.

6.2 VISUAL MODELLING

A successful software is one that meets the needs of its users. Visual Modeling, can help organisations visualize, specify, construct and document the artifacts of a software intensive system (Booch et al.1999). The main benefit of Visual Modelling contrary to other methods is that it can help built component-based designs that enable reusability.

In order to develop software rapidly, efficiently and effectively, with a minimum of scrap and rework, you have to have the right people, the right tools and the right focus. One of the most successful Visual Modelling tools, the Unified Modelling Language is used in identifying and documenting the needs and processes involved in developing our volatility trading system.

Through modeling we achieve four aims.

1. Models help us to visualize a system as it is or as we want it to be.

2. Models permit us to specify the structure or behavior of the system.

3. Models give us a template that guides us in constructing a system.

4. Models document the decisions we have made.

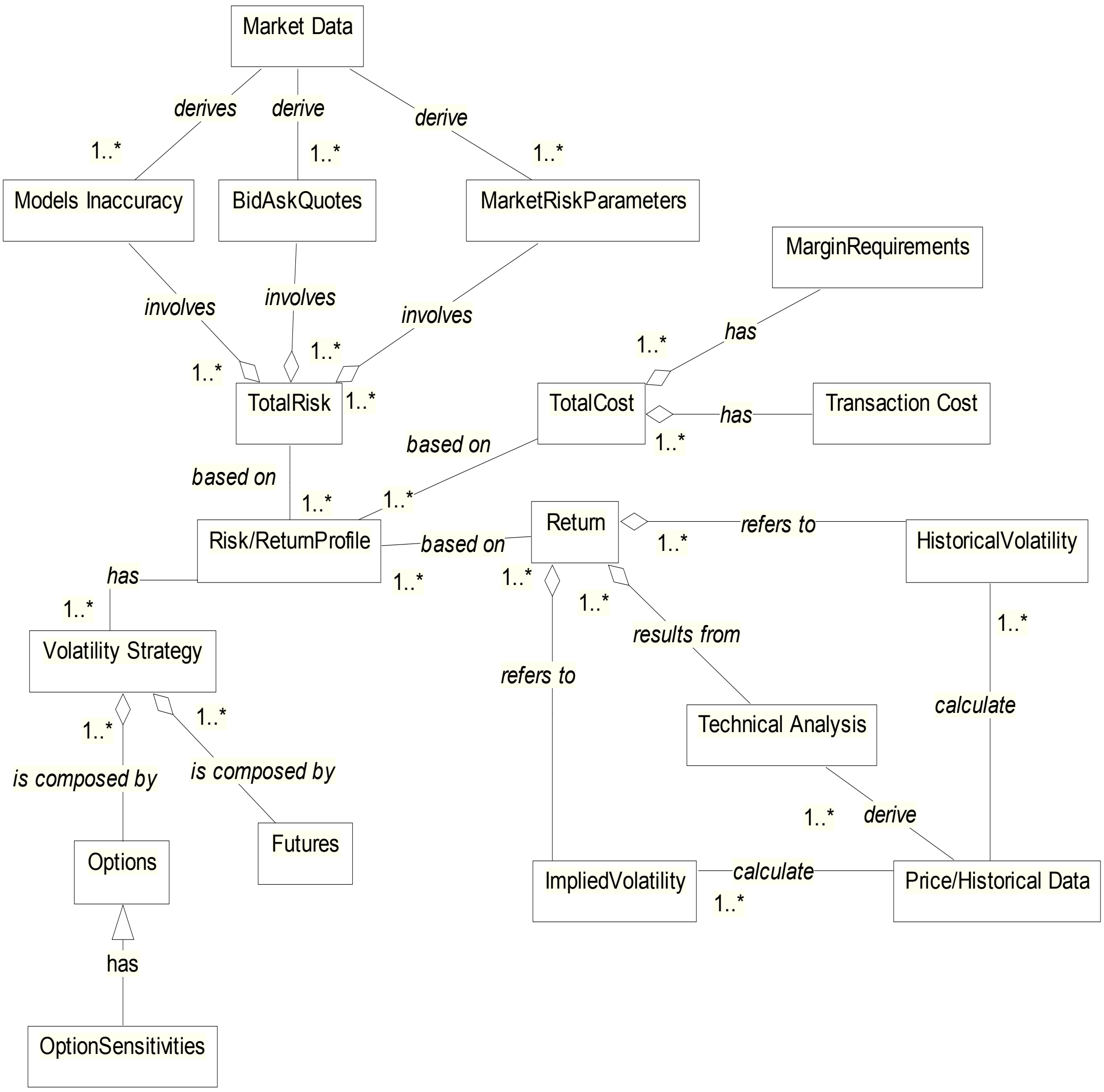
The business case for Visual Modeling is that it provides a natural and intuitive tool for representing the complex structures that we have in our business environments and consequently in the IT architectures and application programs. It also helps support collaboration and team orientation since the overall model can be understood by all the participants in the project.

The UML is a standard language for writing software blueprints. It is a very expressive language that enables iterative and incremental approach in building the information system in need. The lifecycle of the product can thus be minimized and the product can be refined successively. This way the product addresses the business needs as they grow. Built into the iterative approach the process provides flexibility in accommodating new requirements or needs. Risks can also be identified easier and dealt with in the early stages.

The structure and behaviour of the system is presented in Figure 19, the objects involved in the business environment of a volatility trade are represented using classes and relationships. The relationships provide a pathway for communication between the objects-drawn as lines between the objects. Aggregation is a special kind of association, representing a structural relationship between a whole and its parts.(e.g. TotalCost - MarginRequirements, TransactionCost)

Figure 21.

Volatility Trade Class Diagram



Description of Figure 19

In Figure 19, we can see a number of classes drawn from the Volatility trading system. Starting from down and left and class *VolatilityStrategy*. The class is composed by one or more *Options* and/or one and more *Futures* . Furthermore, the class has one to many relationship to *Risk/ReturnProfile*. This class has one to many association to *TotalRisk*, *TotalCost* and *Return*. *MarginRequirements* and *TransactionCost* are part of the *TotalCost.* In the same way *ModelsInnacuracies*, *BidAsk Quotes* as well as MarketRiskParameters -all of them derived from the *MarketData*- compose *TotalRisk*. The *MarketRiskParameters* involve liquidity risk, credit risk as well as default risk. The *BidAskQuotes* involve the risk created from the fact that we can rarely find options with strike prices that exactly matches the strike price for creating a delta neutral position. The *Return* of the Volatility Trades has a one to many association with the *TechnicalAnalysis*, *ImpliedVolatility* and *HistoricalVolatility* all calculated from the *Price/HistoricalData* of the Options and Futures in use.

6.3 Development Process

Having represented the business domain and the needs of the proposed system under construction we can move to identifying a process for the development of the project. The Unified Modelling Language was chosen for the characteristic of being largely process independent. It is not tied to any particular software development cycle, however to get the most benefit from the UML, one should consider a process that is:

- Use-case driven
- Architecture-centric
- Iterative and incremental

Traditional life cycle methods often fail to provide an accurate solution on time even when having the above characteristics. The system development cycle constists of logical series of development phases:

- Business Modeling/Business Study.
- Feasibility Study.
- Requirements Analysis.
- Design and Design of the System.
- Implementation.
- Testing.

- Deployment.

Many different approaches to developing Information Technology projects are available, among them the waterfall model, spiral model and rapid application development.

6.3.1 WATERFALL MODEL

The series of phases in the waterfall model suggests that each stage must be completed, tested and implemented before moving to the following stage. The assumption of this development method was that no step ever needs to be revisited. The main problem of this approach is that problems often arise when a project requires often revisits to previously constructed components for reassign or redevelopment.

Lacking the iterative and incremental approach of the spiral and rapid application development methods it is not as flexible as the other two development processes. Reassessing previous complete stages could result in painful delays and costs to the project, parameters of prime concern in every IT project.

6.3.2 SPIRAL MODEL

Contrary to the waterfall model, the spiral model is an iterative development method that consists of planning, risk analysis, engineering and customer evaluation activities. The requirements capture and feasibility study is determined before the commencement of the first spiral of iteration.

Although it resembles much of the characteristics of the rapid application development and does not have the problems of the waterfall approach, it has received little appreciation by the IT practitioners.

6.3.3 RAPID APPLICATION DEVELOPMENT

The Rapid Application Development is the most modern approach in developing applications based on the prototyping approach. It is used to manage large scale software projects and schedules.

Rapid Application development grew out of specific needs for software projects. According to Stapleton (1997):

1. Speed is often the prime concern.

2. Prototyping is a recognized development strategy that is being refined continually.

3. It can cut development time and increase quality and acceptability.

By introducing prototyping and Joint Application Development, RAD recognizes the importance of gaining users, particularly senior management's involvement in the development process. Therefore, the risk of building systems that do not meet the needs of the customer is decreased.

Nowadays, rapid application development has become synonymous to any approach that emphasizes in the fast development of IT systems. But, while using RAD two problems previously not identified became apparent:

1. There was a lack of understanding about RAD.

2. Organizations were inable to buy into RAD without using proprietary methods.

In January 1994, a consortium including major UK user organizations in both the private and the public sector was formed with the aim to define a public domain method for

RAD. The result was to define a framework of standards for RAD called the Dynamic Systems Development Method (DSDM Manual 1997).

6.4 Dynamic Systems Development Method

Being used successfully by various well-known organizations-such as BT, Boston Globe and Shema Group- DSDM provides a framework of controls for building and maintaining systems which meet tight time constrains and provides a recipe for repeatable RAD success. The method not only addresses the developer's view of RAD, but also that of the other parties who are interested in effective system development, including the users, project managers and quality assurance personnel (DSDM Manual 1997).

The advantage of using DSDM is that it provides a development life-cycle supported by all the necessary controls needed to ensure success. Furthermore, the assumptions underlying this framework enhance its iterative and incremental approach to software development, enabling cooperation with any iterative and incremental method or tool to produce business system solutions rapidly. These assumptions are:

- Nothing is built perfectly first time.
- 80 percent of the solution built in 20 percent of the time.
- All previous steps can be revisited.
- Current step need only be completed sufficiently to support incremental move.
- Business requirements will probably change.

Based on these assumptions some may think that it is a very loose framework that probably will not work. This is not so, as illustrated by the success of this framework. DSDM is a very solid framework, were time is of major importance.

The following nine principles are the foundations on which DSDM is based.

1. Active user involvement is imperative.
2. DSDM teams must be empowered to make decisions.
3. The focus is on frequent delivery of products.
4. Fitness for business purpose is the essential criterion for acceptance of deliverables.
5. Iterative and incremental development is necessary to converge on an accurate business solution.
6. All changes during development are reversible.
7. Requirements are baselined at a high level.
8. Testing is integrated throughout the lifecycle.
9. A collaborative and co-operative approach between all stakeholders is essential.

According to the DSDM framework some projects are ideal for DSDM, while others need early monitoring and clear risk management. The choice of methodology employed depends on the characteristics of the required system. DSDM will be especially effective for systems demonstrating the following characteristics:

- Interactive, where the functionality is clearly demonstrated at the user interface.
- Has clearly defined group.
- If computationally complex, the complexity can be decomposed or isolated.
- If large, possesses the capability of being split into smaller functional components.

- Time-constrained.
- The requirements can be prioritized.
- The requirements are unclear or subject to frequent change.

6.5 Selection of Development Tools

The selection of the appropriate tools and development process is dependent on the type of system to be built. In this section the choice of the development tools and methodology will be displayed and documented.

The characteristics of the volatility system show that it requires active user participation throughout the development lifecycle. The complexity of the system can be decomposed into smaller systems or modules (Figure 19) and involves the cooperation of different groups of people (technical analysts, derivatives analysts, traders, IT professionals, managers). The functional requirements presented in chapter 5, may change depending on the type of volatility trade and instruments. Moreover, the system has a clearly defined user group. Therefore, DSDM is the most appropriate framework for the development process.

The system is dealing with volatility trading. This means that, it will have to deliver results in a highly liquid market, were trading operations will be large and systems are required to handle large amounts of data. The computational part of the system also requires the use of a large amount of data and algorithms delivering accurate results at high speeds.

In order to build our prototype volatility trading system, we will use a Microsoft Access database and Microsoft Visual Basic. The sensitivities of the options will be calculated using the DerivaGem Software, running on Microsoft Excel. All the data inserted in the relations of the database were imported from the MS Excel working environment. Microsoft Access was preferred for its user friendly environment and compatibility with the tools in use. It should be noted that the majority of systems implemented by financial institutions involve large-scale development, were Oracle products running on SQL databases are preferred.

6.6 Database Design

A Database can be defined as, a shared collection of logically related data-and a description of this data- designed to meet the information needs of an organisation.

A Database Management System on the other hand is software that enables users to define, create and maintain the database and which provides controlled access to the database. According to Ritchie, to be worthy of being called a database a system must have two essential properties:

1. It holds data as an integrated system of records.

2. It contains self-describing information.

All the data pertaining in our application are held under one software management system, so that it can be available and exploited by application programs. The database holds descriptions of the data in the form of relational schemas. The relational schemas for our relations(tables) held in the database are presented in Figure 20. The Primary and Foreign Keys are also identified.

The primary key is an attribute (or set of attributes) whose value(s) can belong to at most one entity. A primary key is therefore used to uniquely identify each entity occurrence. A foreign key on the other hand is a primary key occurrence from one entity to another related entity. A primary key can consist of one or more foreign keys. In order to create a relationship we need to be able to combine information from more than one table. This is were the primary and foreign keys come in. They act as common attributes in the two tables to create a 'value-based' relationship.

Finally, the type or domain describes the range of possible values that the attribute can have. The attributes of the entity define its purpose and use.

Figure 22.

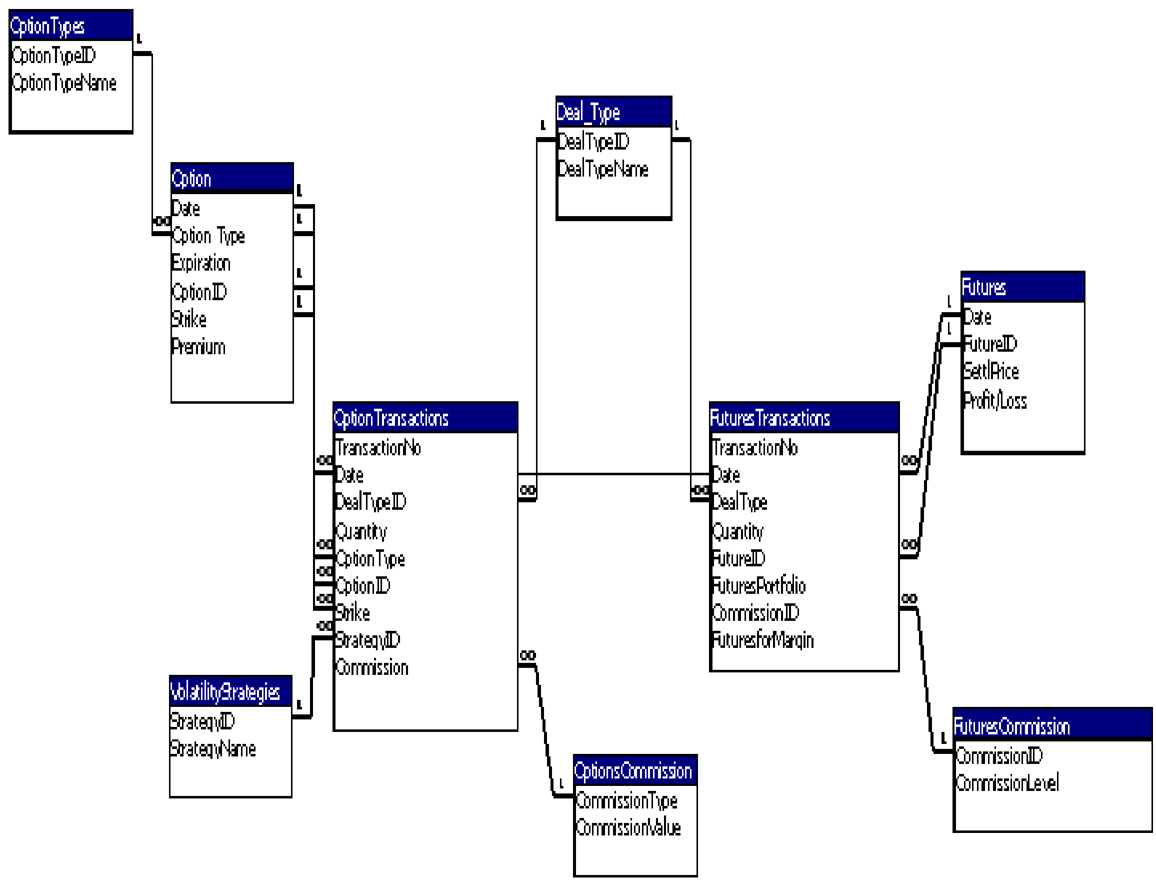
The Relational Schema of the database components

RELATIONAL SCHEMA OF TRADING COMPONENTS			
ENTITY	**ATTRIBUTES**	**TYPE OF DATA**	**PRIMARY KEY OR FOREIGN KEY**
OptionTypes	OptionTypeID	CHAR	PK
	OptionTypeName	CHAR	
Option	Date	DATE	PK
	OptionType	CHAR	PK
	Expiration	CHAR	
	OptionID	CHAR	PK
	Strike	CHAR	PK
	Premium	NUM	
DealType	DealTypeID	CHAR	PK
	DealTypeName	CHAR	
VolatilityStrategies	StrategyID	CHAR	PK
	StrategyName	CHAR	
OptionTransactions	TransactionNo	NUM	PK
	Date	DATE	FK
	DealTypeID	CHAR	FK
	Quantity	NUM	
	OptionType	CHAR	FK
	OptionID	CHAR	FK
	Strike	CHAR	FK
	StrategyID	CHAR	FK
	Commission	CHAR	FK
OptionsCommission	CommissionType	CHAR	PK
	CommissionValue	NUM	
FuturesTransactions	TransactionNo	NUM	PK
	Date	DATE	FK
	DealTypeID	CHAR	FK
	Quantity	NUM	
	FutureID	CHAR	FK
	FuturesPortfolio	NUM	
	CommissionID	CHAR	FK
	FuturesforMargin	NUM	
Futures	Date	DATE	PK
	FutureID	CHAR	PK
	SettlPrice	NUM	
	Profit/Loss	NUM	
FuturesCommission	CommissionID	CHAR	PK
	CommissionLevel	NUM	

Relational databases are the most commonly used databases. The simplest view of relational database is that they represent the application data as two dimensional tables. The entity relationship diagram is used to model the organizations data structure with the use of three objects-entity, relationship and attribute. The entity relationship diagram of the volatility trading system is presented in Figure 21. The relationships describe the interaction or association between two or more entities.

Figure 23

Entity Relationship Diagram



Entities and relationships do not show all of the information about a system, in particular they do not show functional dependency and multi-valued dependencies particularly well. This is why the cardinality of each relationship is included in the Entity-Relationship diagram to emphasize this. The cardinality of all relationships is one-to-many. The primary key from the source entity is placed as foreign key in the related entity -the many side of the relationship.

7

SUMMARY

7.1 INTRODUCTION

In this dissertation we have demonstrated how investors can benefit from volatility by constructing portfolios of options and futures based on the FTSE/ASE-20 ADEX listed derivatives. We have introduced the concept of volatility trading by constructing a short volatility and a long volatility portfolio, and identified two long gamma trades for this purpose. Finally, we have introduced the Dynamic Systems Development Method (DSDM) as the appropriate framework for implementing a prototype in Volatility Trading.

7.2 VOLATILITY TRADING

This project embodies two aspects in developing a prototype volatility trading software system, the financial markets and the information systems.

The financial area deals with the construction and managing of a portfolio trading volatility. The portfolio has to be *delta* neutral, in order to have minimum exposure to the market. The profits in a volatility-trading portfolio are a result of the curved profile of the options price in contrast to the linear profile of the stock or future.

While a long volatility portfolio is built in order to profit from volatility, the short volatility portfolio is built to profit from the lack of volatility. Both portfolios can be constructed with the use of options and futures or combination of options. The simple volatility-trading portfolio combining futures and options is kept delta neutral by rehedging the futures position, according to the delta exposure of the options portfolio.

The effect of changes in the implied volatility, time decay and volatility of the underlying instrument in the price profile of the volatility trade was also illustrated using diagrams and trading scenarios.

The trading portfolios were constructed according to an ex-post analysis on the volatility gap identified between the front-month at-the-money options on the FTSE/ASE-20 Index and the front-month futures on the FTSE/ASE-20. All the returns were calculated using the settlement prices of the options and futures in use. Additionally, all the positions were liquidated long before the third Friday of the month, when the options and futures mature to avoid expiration effects.

The traders main objective is to decrease the risk of his position and increase his profits. According to theory, volatility trading can achieve this objective when directional strategies perform poorly. The main objective of the financial part of this project was to examine if such trades can be profitable in the real trader's world, were transaction costs and margin requirements must be taken into account.

The results deduced from the volatility portfolios provide evidence for the necessity of including transaction costs and margin requirements when initiating a volatility-trading portfolio. Even when transaction costs are kept to a minimum, their effect on the profits of the trade are significant. According to the results, the volatility portfolios constructed by combinations of options are more profitable than the ones requiring continues rehedging in both the short and long position, due to the increased transaction costs. Finally, the results of the short volatility trade are not that encouraging, involving increasing risk with low profits and requiring additional margin requirements in comparison to the long volatility trading positions.

The aim of the systems area of the project is to suggest an appropriate methodology for developing the proposed volatility trading system. The first step in identifying the methodology to be used is to analyze the business domain and identify the requirements of the system in development.

The only way to built a system that can be reusable and can meet the requirements of its users is by analyzing the business domain. Visual Modeling and the Unified Modeling Language was used to visualize, specify and document the artifacts of our software system according to the processes and objects identified in the business study of the volatility trading system.

The Dynamic Systems Development framework provided the framework of controls to be used in our Rapid Application Methodology. The choice of DSDM and RAD is documented and suggested as the right project development path, since the project requirements successfully passed the suitability filters identified in the DSDM Manual.

The prototype was created in MSAccess and Visual Basic. The Entity-Relationship diagram provided the logical/conceptual view of the database. The relational schemas of each entity were also produced. Finally, the constrains and limitations of the system were also presented.

BIBLIOGRAPHY

Achelis Steven B.(1995), Technical Analysis from A to Z, Probus Publishing.
Blake D. (2000), financial Market Analysis, 2nd edition, Wiley.

Booch Grady, James Rumbaugh, Jacobson, The Unified Modelling Language User Guide, Addison Wesley Longman, Inc., 1999.

Booch et al., The Unified Modelling Language Reference Manual, Addison Wesley Longman Inc., 1999.

Boyle,P.P., and D. Emanuel, Discretely Adjusted Option Hedges ,Journal of Financial Economics,8 (1980), 259-82.

Budgen D. (1994), Software Design, Addison-Wesley.

Chaput J. Scott, Ederinngton L.H. (May 2002), Volatility Trade Design ,research paper.

Clewlow, Les and Strickland Chris, Implementing Derivatives Models, John Wiley & Sons, 1998.
Coad, P. and E. Yourdon (1991) Object-Oriented-Analysis, 2nd edition, Prentice Hall.

Coleman et al., Object –Oriented Development: The Fusion Method, Prentice Hall, 1994.

Connolly, Kevin B.(1999), Buying and Selling Volatility, Wiley.

Curtis, G. (1998) Business Information Systems, 3rd edition, Addison-Wesley Longman.
Date, C. (2000), An Introduction to Database Systems, Addison Wesley Longman.

Dynamic Systems Development Methods manual Version 3 (1997), DSDM Consortium.

Dillman,S., and J. Harding. Life after Delta:The Gamma Factor, Euromoney, Supplement (February 1985),14-17.

Eales, B., Financial Engineering, Palgrave 2000.

Figlewski, S., Options Arbitrage in Imperfect Markets, Journal of Finance, 44 (December 1989), 1289-1311.

Figlewski S., Landskroner Y. and Silber W., Tailing the Hedge: Why and How, Salomon Brothers Center, NYU Working Series.

Franke G., Stapleton R. and Subrahmanyam M (1997), When are options overpriced? The Black-Scholes Model and alternative characterisations of the pricing kernel, Stern school of Business, NYU Working Series.

French, K.R., G.W. Schwert and R.F. Stambaugh (1987), Expected Stock Returns and Volatility, Journal of Financial Economics, 19, 3-29.

Galai, D., The Components of the Return from Hedging Options Against Stocks, Journal of Business, 56 (January 1983), 45-54.

Graham, I. (1998), Requirements Engineering and Rapid Development, Addison Wesley.

Gupta, U. (2000) Information Systems, Prentice Hall.

Haugen, R.A. (2000), Modern Investment Theory, (5th edition), Prentice Hall,

Halvorson M.(1998), Microsoft Visual Basic 6.0 Step by Step, Microsoft Press.

Hull, J., (2000), Option, Futures and Other Derivative Securities, 4th edition, Prentice Hall.

Hull, J. and A. White, Hedging the Risks from Writing Foreign Currency Options, Journal of International Money and Finance, 6 (June 1987), 131-52.

Hung, K. (1998), A Reusable Business Object Architecture developed in a Dynamic Systems Development Method Lifecycle for Financial/Insurance Industries, University of Sheffield.

Jacobson I., Erricson M., Jacobson A. (1997), The object Advantage: business Process Reenginering for Business success. Addisson-Wesley.

Jacobson I, Booch G., Rumbaugh J.,(1999), The Unified Software Development Process. Addison Wesley Longman Inc.

Kellard, N. (2000), Lecture notes on Financial Derivatives, London Guildhall University.

Kinlay J.(2002), Volatility Report, Investment Analytics Inc, vol 2, Issue 1.

Kendall, K., and Kendall J. (1999), System Analysis and Design, 4th edition, Prentice Hall.

Kolb, R. W. (2000), Futurees, Options and Swaps, 3rd edition, Cambridge, Blackwell.

Natenberg, S. (1994), Option Volatility and Pricing: Advanced Trading Strategies and Techniques, 2nd edition, Chicago, Probus.

Li, K., (2000), Yes, historical volatility does contain incremental information beyond option implied volatility, Working Paper Series, S-00-34, Stern Scholl of Business, New York University.

Longerstay, J. and P. Zangari (1995), Five questions about Risk Metrics. New York: Morgan guaranty Trust Company.

Mordzynski S. and Mauer L.(1998), How to use visual Basic 6, Sams Publishing.

Ritchken P. (1996),Derivative Markets, Harper Collins College Publishers

Ritchie C.(1998), Relational Database Principles, Continuum.

Smith C. and Amudsen M. (1999), Database Programming with Visual Basic 6.0, Sams Publishing.

Stapleton, J. (1998), Dynamic Systems Development Methods: The Method in Practice. Addison Wesley.

Steinherr, A. (2000), Derivatives: The wild Beast of Finance, a path to effective Globalization, Wiley,

Taleb, N. (1998), Dynamic Hedging: Managing vanilla & exotic options, Wiley,.

Vintcent C., (1997), The investors guide to Short-Term Trading & Long-Term Investing, Pitman Publishing.

Vintcent C.(1997), Short-Term Trading & Long-Term Investing, Pitman Publishing.

APPENDICES

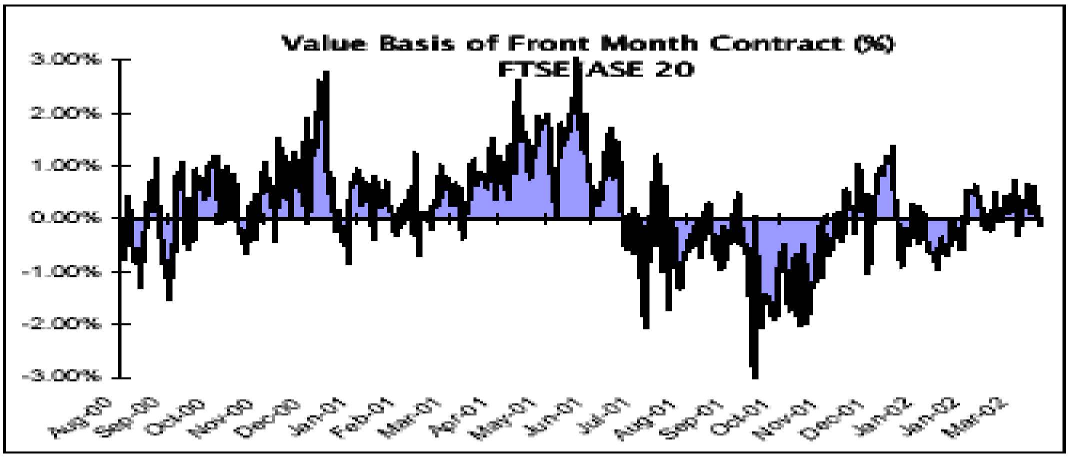
APPENDIX A: GREEK EQUITY DERIVATIVES

APPENDIX B: VOLATILITY TRADING SOFTWARE

APPENDIX A

GREEK EQUITY DERIVATIVES

Figure A-1
Value Basis of the front-month contract from Aug-00 to Mar-02



Source: P&K Securities S.A./ Derivatives Department

Figure A-2

FTSE/ASE-20 Index Futures Trading Calendar until December 2001

- FTSE/ASE 20 Index Futures and Options Trading Calendar until December 2001.
- FTSE/ASE Mid40 Index Futures Trading Calendar until December 2001.

FTSE/ASE 20 Futures & Options

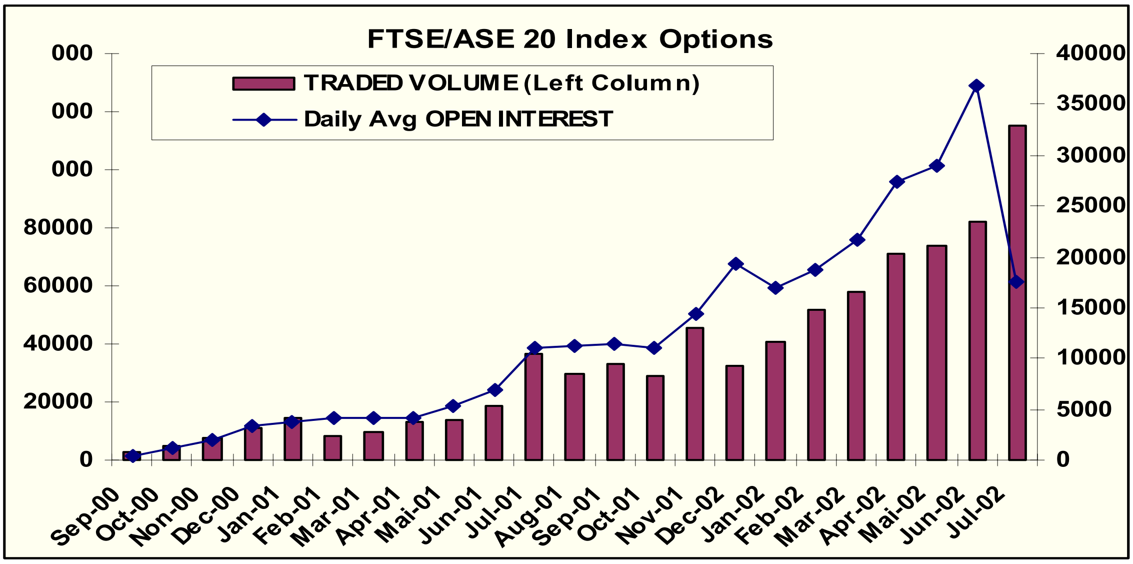
Expiry Month	First Listing Date	Last Trading Date	Last Clearing Date
March 2001	Mar 20, 2000	Mar 16, 2001	Mar 19, 2001
April 2001	Jan 22, 2001	Apr 20, 2001	Apr 23, 2001
May 2001	Feb 19, 2001	May 18, 2001	May 21, 2001
June 2001	June 20, 2000	June15, 2001	Jun 18, 2001
July 2001	Apr 23, 2001	July 20, 2001	July 23, 2001
August 2001	May 21, 2001	Aug 17, 2001	Aug 20, 2001
September 2001	Sep 18, 2000	Sep 21, 2001	Sep 24, 2001
October 2001	July 23, 2001	Oct 19, 2001	Oct 22, 2001
November 2001	Aug 20, 2001	Nov 16, 2001	Nov 19,2001
December 2001	Dec 18, 2000	Dec 21, 2001	Dec 24, 2001

Figure A-3
FTSE/ASE-20 Index Composite Constituents

/N	SecurityName	ASESector	MarketCap
1	AGRICULTURAL BANK OF GREECE S.A (CR)	BANKS	428.244.000,00
2	NATIONAL BANK OF GREECE S.A (CR)	BANKS	4.557.047.430,96
3	EFG EUROBANK ERGASIAS BANK S.A (CR)	BANKS	3.252.161.412,24
4	ALPHA BANK A.E. (CR)	BANKS	2.581.291.546,40
5	PIRAEUS BANK S.A (CR)	BANKS	1.190.161.286,08
6	COMMERCIAL BANK OF GREECE S.A (CR)	BANKS	1.762.015.868,56
7	ETVA BANK(CR)	BANKS	187.958.070,78
8	VIOHALCO (CB)	HOLDING & CONSULTING COMPANIES	984.691.092,60
9	COSMOTE -MOBILE TELECOMMUNICATIONS S.A	TELECOMMUNICATIONS	649.549.952,16
10	VODAFONE - PANAFON S.A (CR)	TELECOMMUNICATIONS	779.112.276,00
11	HELLENIC TELECOM. ORGANISATION (CR)	TELECOMMUNICATIONS	3.982.028.172,10
12	HELLENIC PETROLEUM S.A (CR)	OIL REFINERIES	641.491.970,34
13	MOTOR OIL (HELLAS) REFINERIES SA (CR)	OIL REFINERIES	173.707.712,64
14	PUBLIC POWER CORPORATION SA (CR)	ELECTRICITY	657.952.000,00
15	ATHENS WATER SUPPLY & SEWERAGE S.A (CR)	WATER SUPPLY	152.082.000,00
16	ALUMINIUM OF GREECE S.A (CR)	METALS	234.423.826,56
17	INTRACOM S.A (CR)	ELECTRONIC EQUIPMENT	841.164.535,68
18	TITAN CEMENT COMPANY S.A (CR)	INDUSTRIAL MINERALS	1.115.744.954,94
19	COCA-COLA E.E.E. S.A (CB)	ALCOHOLIC & NON ALC. BEVERAGES	1.603.666.406,50
20	ELLINIKI TECHNODOMIKI A.E. (CR)	CHANGE OF ACTIVITY	469.500.000,00

Source: P&K Securities S.A./ Derivatives Department

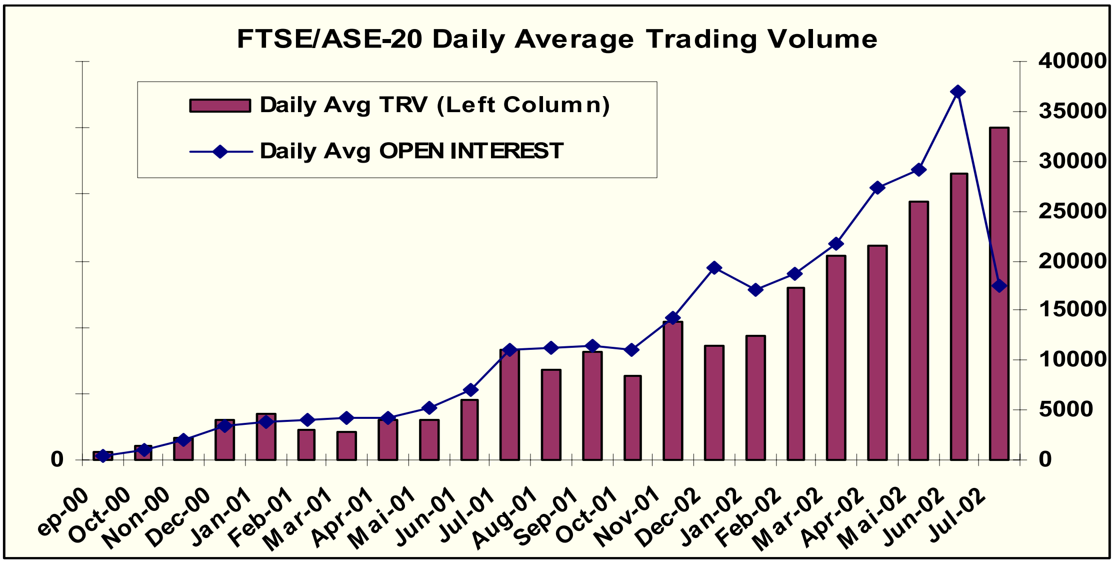
Figure A-4
FTSE/ASE-20 Index Options Traded Volume vs Daily Average Open Interest (Sep-2000 to Jul-2002)



Source: P&K Securities S.A./ Derivatives Department

Figure A-5

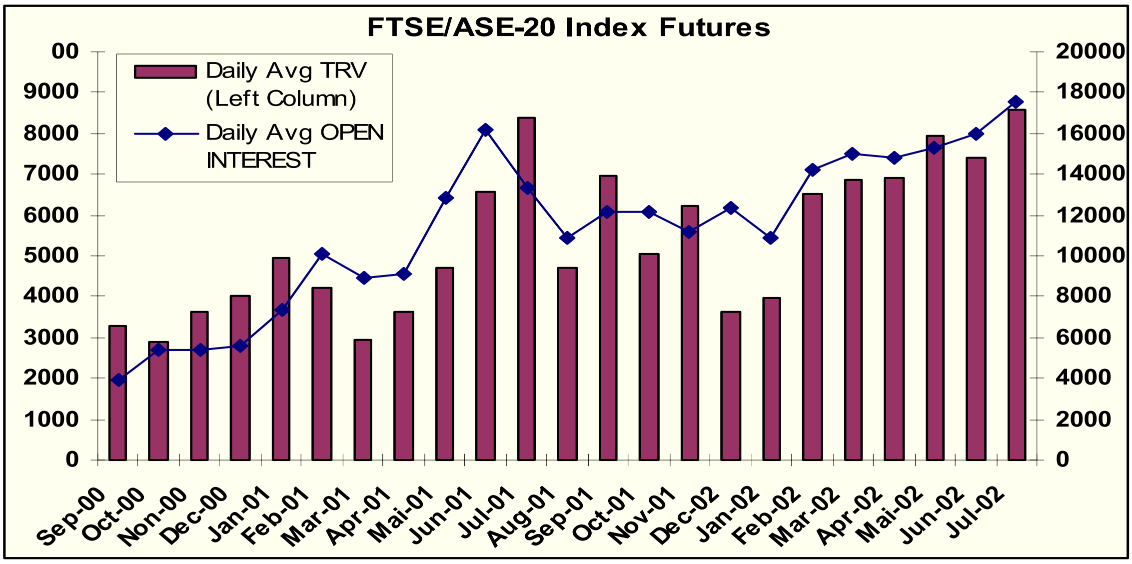
FTSE/ASE-20 Index Options Daily Average Trading Volume vs Daily Average Open Interest (Sep-2000 to Jul-2002)



Source: P&K Securities S.A./ Derivatives Department

Figure A-6

FTSE/ASE Futures Trading Volumes



Source: P&K Securities S.A./ Derivatives Department

Table A-1
Commissions charged on the futures transactions by P&K Securities S.A.

FUTURE

	BASE	SECOND	THIRD	FOURTH	INSTI & In HOUSE
contract	FTASE20	FTASE20	FTASE20	FTASE20	FTASE20
0-200	35	30	25	20	15
201-500	30	25	20	20	15
501-1000	25	20	15	15	15
>1001	15	15	15	15	15

Table A-2
Commissions charged on the options transactions by P&K Securities S.A.

OPTIONS

	OFTASE20				
point	**Euro range down-up**	**BASE**	**SECOND**	**THIR-FOUR**	**INSTI & In HOUSE**
0-20	0-100	12	8	6	6
20-50	100-250	15	12	8	7
50-80	250-400	20	15	12	8
80-120	400-600	25	18	15	10
120-170	600-850	25	20	15	12
170+	>850	25	25	15	12

Table A-3

The Long Straddle (2000) Profile at different implied volatility levels. (Both legs of the trade are presented).

Index Level	Long Call			Long Put			Straddle		
	implied volatility			implied volatility			implied volatility		
	25%	20%	18%	25%	20%	18%	25%	20%	18%
2160	115.04	110.08	110.00	0.27	0.00	0.00	85.00	79.77	79.69
2150	106.24	100.17	100.00	0.37	0.00	0.00	76.30	69.85	69.69
2140	97.67	90.31	90.00	0.50	0.00	0.00	67.86	60.00	59.69
2130	89.36	80.56	80.00	0.68	0.00	0.00	59.72	50.25	49.69
2120	81.33	70.98	70.00	0.90	0.00	0.00	51.92	40.66	39.69
2110	73.62	61.63	60.00	1.19	0.00	0.00	44.50	31.32	29.69
2100	66.26	52.64	50.00	1.56	0.00	0.00	37.51	22.33	19.69
2090	59.26	44.10	40.04	2.03	0.00	0.00	30.98	13.79	9.72
2080	52.67	36.16	30.20	2.61	0.01	0.00	24.97	5.86	-0.11
2070	46.48	28.93	20.84	3.34	0.03	0.00	19.51	-1.36	-9.47
2060	40.73	22.52	12.64	4.24	0.05	0.00	14.65	-7.74	-17.68
2050	35.42	17.02	6.42	5.33	0.11	0.00	10.43	-13.19	-23.89
2040	30.56	12.44	2.61	6.64	0.22	0.00	6.89	-17.65	-27.70
2030	26.14	8.78	0.81	8.21	0.42	0.00	4.04	-21.11	-29.50
2020	22.18	5.96	0.19	10.07	0.76	0.00	1.94	-23.59	-30.12
2010	18.64	3.89	0.03	12.26	1.33	0.00	0.58	-25.09	-30.28
2000	15.52	2.43	0.00	14.79	2.23	0.00	0.00	-25.66	-30.31
1990	12.80	1.45	0.00	17.71	3.57	0.02	0.20	-25.29	-30.29
1980	10.45	0.82	0.00	21.04	5.51	0.15	1.17	-23.97	-30.16
1970	8.44	0.45	0.00	24.80	8.19	0.70	2.92	-21.68	-29.61
1960	6.74	0.23	0.00	29.01	11.71	2.38	5.44	-18.37	-27.93
1950	5.33	0.11	0.00	33.69	16.19	6.11	8.70	-14.02	-24.20
1940	4.16	0.05	0.00	38.84	21.63	12.35	12.69	-8.63	-17.96
1930	3.21	0.02	0.00	44.46	28.04	20.67	17.36	-2.25	-9.64
1920	2.45	0.01	0.00	50.55	35.32	30.14	22.68	5.02	-0.17
1910	1.84	0.00	0.00	57.09	43.37	40.02	28.62	13.06	9.71
1900	1.37	0.00	0.00	64.07	52.03	50.00	35.12	21.72	19.69
1890	1.00	0.00	0.00	71.45	61.16	60.00	42.14	30.85	29.69
1880	0.72	0.00	0.00	79.22	70.63	70.00	49.63	40.32	39.69
1870	0.52	0.00	0.00	87.33	80.33	80.00	57.53	50.01	49.69
1860	0.36	0.00	0.00	95.76	90.16	90.00	65.81	59.85	59.69

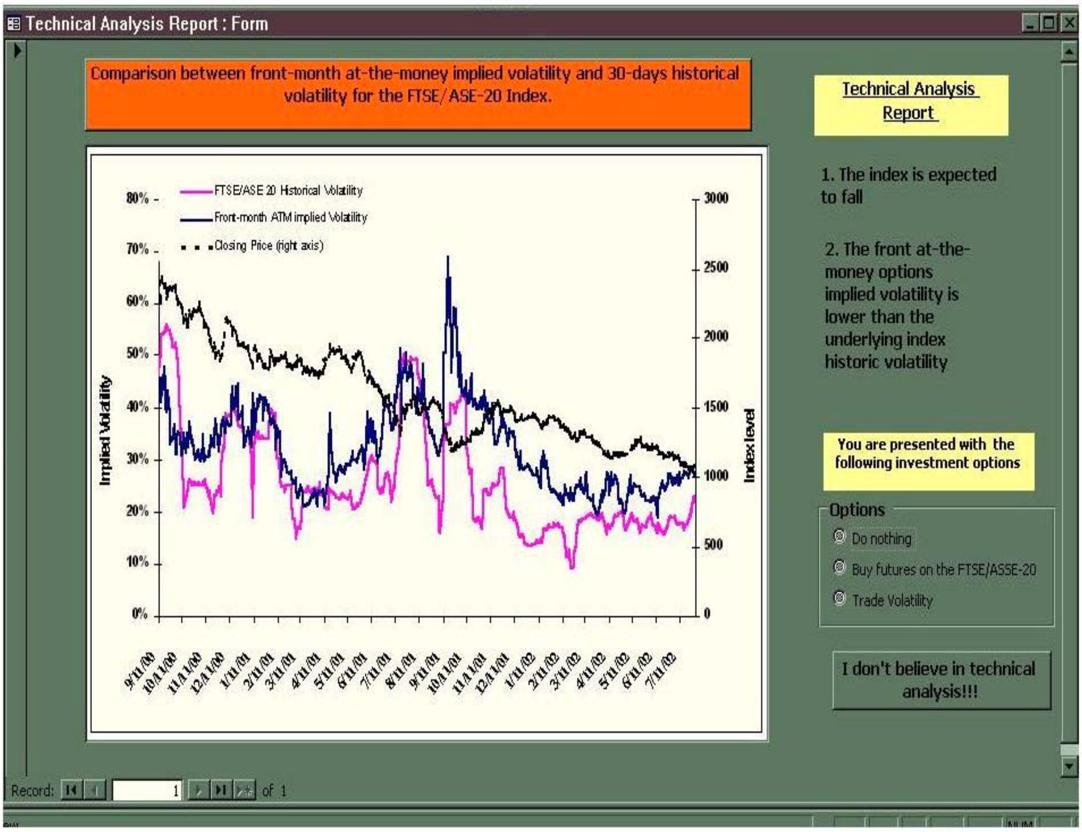
APPENDIX B

VOLATILITY TRADING SOFTWARE

RUNNING THE VOLATILITY TRADING SOFTWARE

The Volatility Trading Software is run with the use of Microsoft Access. The main screen is displayed as soon as you open the Volatility Trading database. The first choice is set as default choice, so the initial message "You just lost a great opportunity" is displayed before the Technical Analysis form.

Figure B-1
Technical Analysis Form

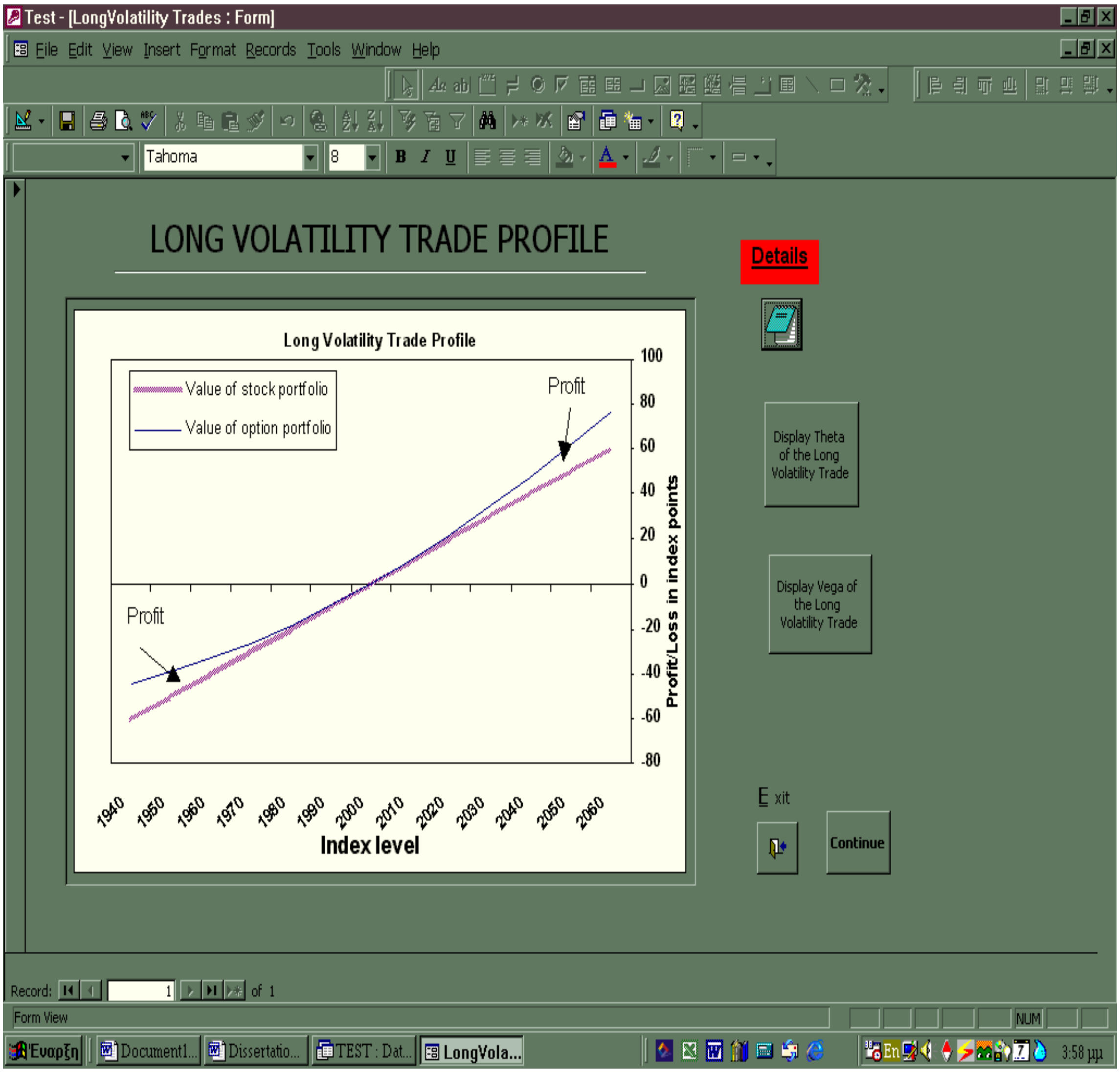


Users can view a diagram, where the comparison between front-month at-the-money options implied volatility and 30 days historical volatility of the underlying FTSE/ASE-20 is illustrated. The ex-post analysis is used as if it was a prediction of the future index historic and option implied volatility. The user is presented with three options "Do nothing", "Buy Futures" and "Trade Volatility".

As soon as the user chooses the option "Trade Volatility", the user is transferred to the next form. The form presents the Long Volatility Trade Profile. The user can view the details of this trade by clicking on the Details text icon. The code behind this choice initiates the Notepad application, while a message prompting the user to open the **lvt.txt** file is displayed.

Figure B-2

Long Volatility Trade Form



The user can view the profile of Theta as well as Vega of the Long Volatility Trade by clicking the appropriate buttons. The *Continue* command button transfers the user to the next Form. The user can exit the application at any time using the Exit command button or using Alt + E (whenever Exit is displayed). The corresponding forms when the Vega and Theta profile view is on focus are displayed next.

Figure B-3

The vega effects on the Long Volatility Trade profile

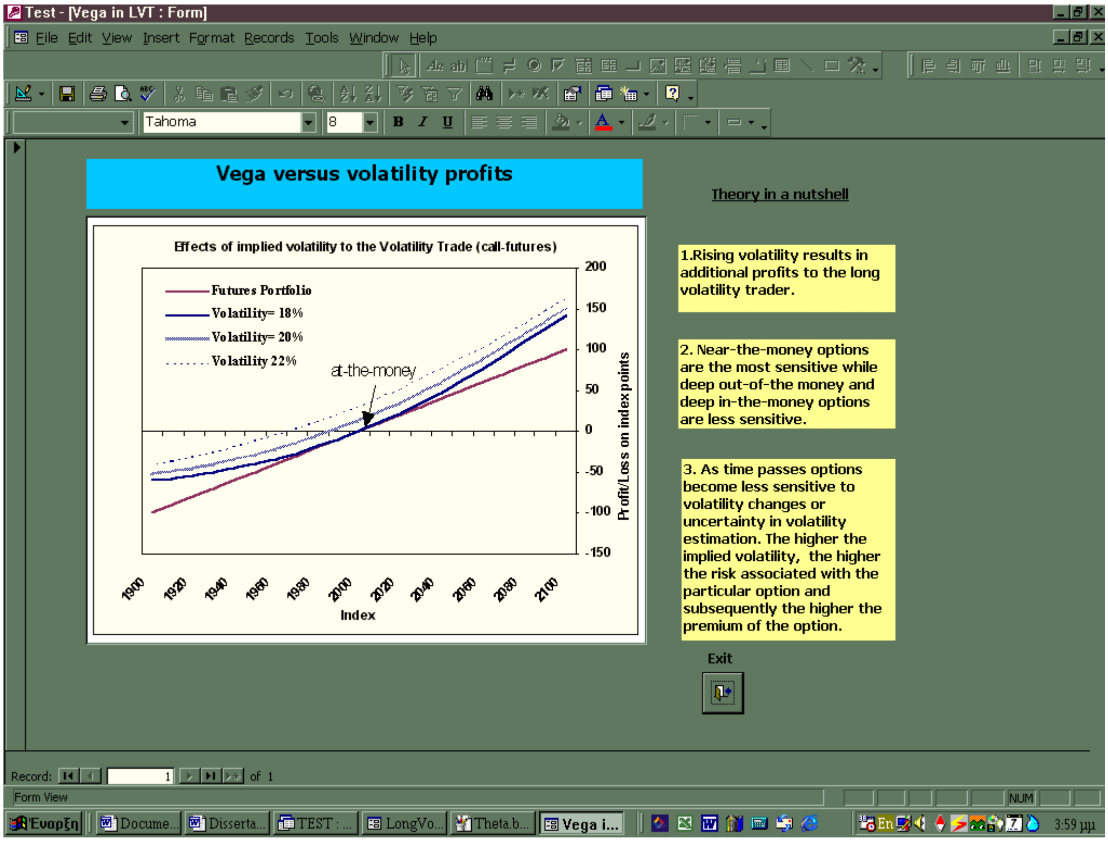
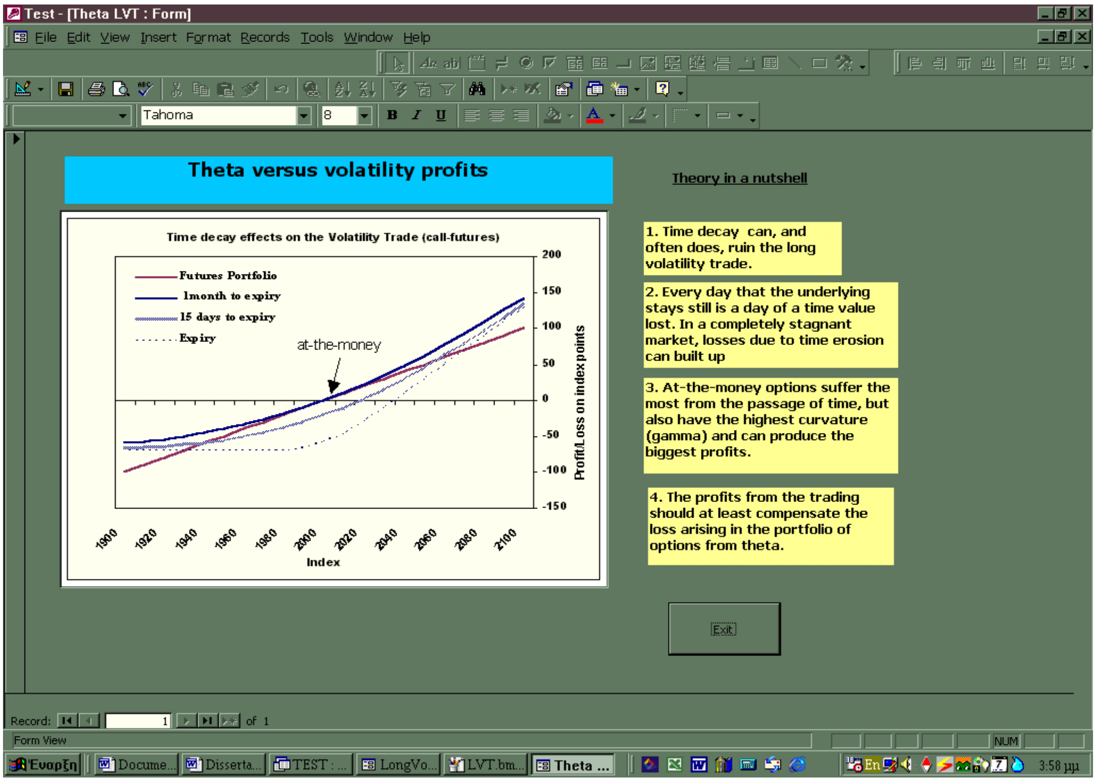


Figure B-4

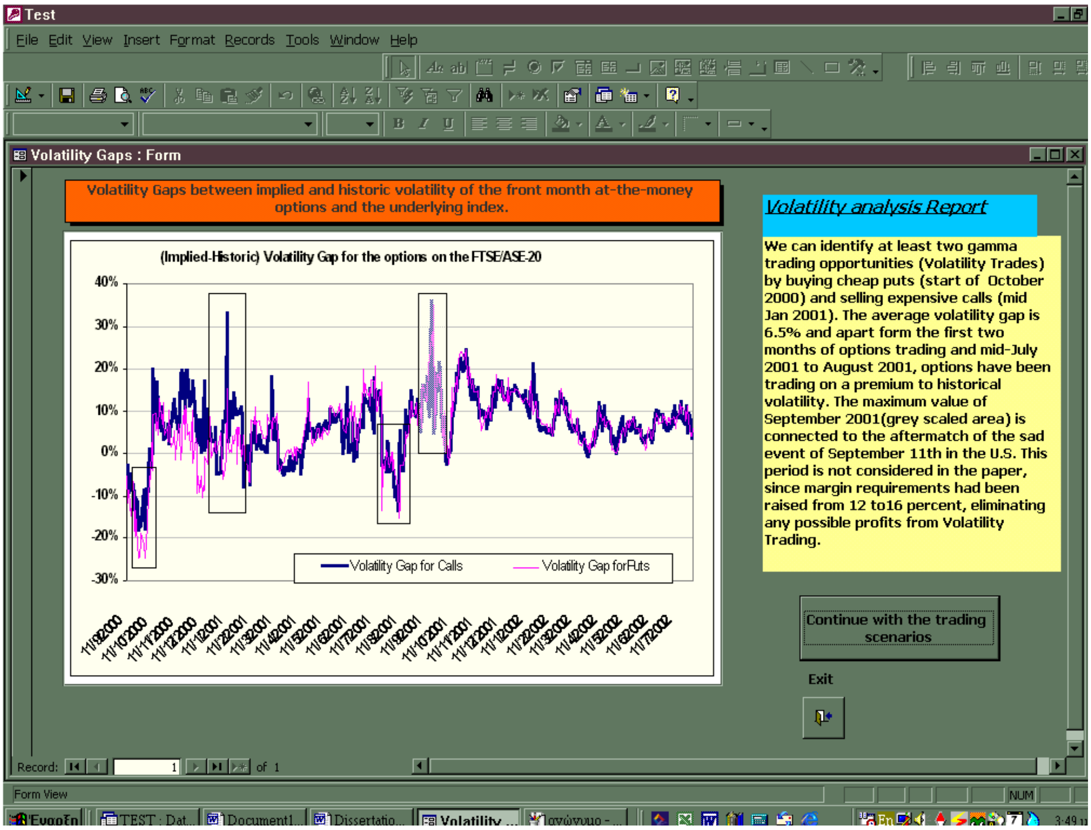
The theta effect on the Long Volatility Trade profile



The *Volatility Gap* Form, presents the diagram of the volatility gap between the implied and historic volatility of the front-month at-the money puts and calls and the FTSE/ASE-20 underlying index. This way the two gamma trading opportunities by buying cheap puts (start of October 2000) and selling expensive calls (mid Jan 2001) are displayed.

Figure B-5

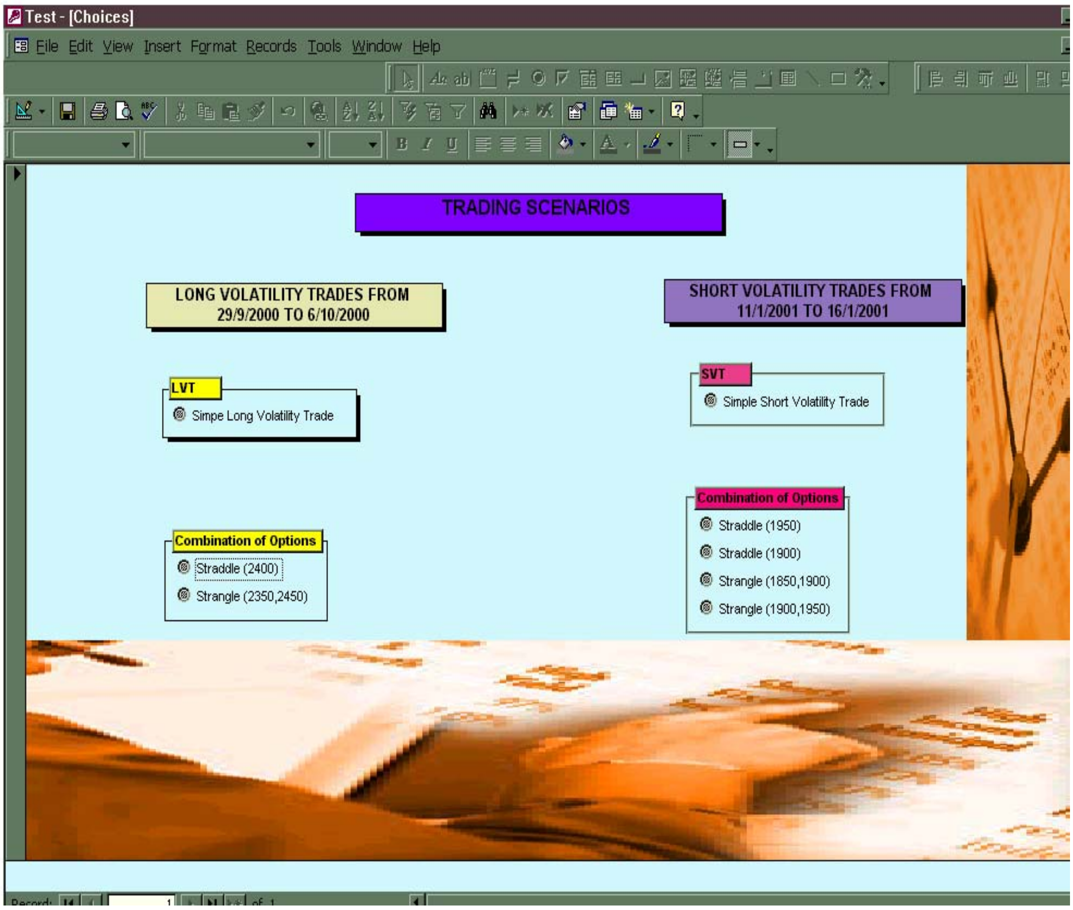
The Volatility Gap Form



The Volatility Analysis Report highlights some of the details of the trades that are presented in the next form. The user can exit the application or continue with the trading scenarios.

The final form is were all the calculations of the database are displayed. The user can choose from two major categories of Volatility trades. When the Simple Long or Short Volatility option is active the return of the option and future position is displayed.

Figure B-6
The Trading Scenario Form



The user can also choose to view the returns resulting from combinations of options. In the case of the Long Volatility trades a message prompts the user to identify the Strategy used (Straddle or Strangle) using capital letters . When choosing one of the short volatility straddle strategies, a message prompts the user to enter the strike price of the straddle (1900.0 or 1950.0).