The Turkish option market

By: N.A.W. Kreuk

Istanbul, Turkey / Enschede, the Netherlands
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Management summary

The ISE-100 is the most important composite index to measure the performance of the Istanbul Stock Exchange –ISE-, the only stock market in Turkey. Since 2000 its situation obviously improved, compared to the enormous fluctuations mainly due to political instability since its start in 1986. In 2003, after an influential change in Turkish regulation, Başak Emeklilik received authorization to establish a pension fund and began offering private retirement plans. In February 2005 the first derivatives were traded at the recently founded TurkDEX. Initially futures on the ISE-100 were traded among a few other future contracts. Trading of option contracts will be introduced soon. In this light the main question for this report was raised. The question whether the Turkish option market could be a valuable investment vehicle for the pension funds of Başak Emeklilik. This main question led to an explanatory research as trading of option contracts in Turkey still has to be established.

The exploration shows that the option market could be a valuable investment vehicle for pension funds. The main advantage of options could be a decrease in volatility of the pension funds, which will already be the focus in the near future. There are several conditions however. After the introduction of option trade it will take some years before the market will be deep enough. When the Turkish political situation destabilises that period can be a lot longer, since the markets are very sensitive for political turmoil. Since both options and private pension plans are very new products, regulation might change in the near future. Besides, whether options are suitable for the specific relation between assets and liabilities typical for pension funds can only be investigated after their introduction when there is real data.

An exploratory research modeling virtual options on the ISE-100 for the period from January 2004 until June 2006 and evaluating the performance of portfolios combining those virtual options with the stock fund of Başak Emeklilik, showed an average improvement of the daily fluctuation of the fund of 29,3%. A maximum of 20% of the value of these portfolios is invested in options, because of regulation.

The model contained several variables, of which two – the risk-free interest rate and the volatility of the underlying value of the options- were not directly observable and therefore had to be estimated. A sensitivity analysis shows that the conclusion that the volatility of the fund improves is robust for –slight- changes in the values of these estimates.

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Preface

This report concludes my internship at Başak Emeklilik in Istanbul, which was an impressive period in my life. This way I would like to thank all the people I worked with again. I had the opportunity to improve my knowledge on several financial and mathematical topics, to develop my social and intercultural skills, to improve my English, my German and my Turkish and above all, to meet inspiring people and get to know another culture from within.

This experience would also not have been possible without the great help of AIESEC Twente and AIESEC Istanbul and all their members who helped me with the practical issues involved and provided me with great weekends during my time in Istanbul.

This report will also serve as my bachelor thesis at the University of Twente, concluding my bachelor degree in Industrial Engineering and Management. I will continue with a master degree in Financial Engineering and Management and a master degree in Organisational Psychology, both at the University of Twente. The last, but not the least people I need to thank are my coordinator from university ir. drs. A.C.M. de Bakker, who advised me several times on the content of this report and ir. T. de Graaf, a former student of the University of Twente currently working at Ernst & Young, who gave me an initial advice how to approach this problem.

Teşekkür ederim / Thank you very much

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1. Introduction to Turkey's emerging economy and capital markets

For decades Turkey faced major political problems, both internally and externally. Severe political instability left the country lagged behind others at the turn of the millennium. However Turkey has achieved a remarkable turnaround since its last economic crisis in 2001. A comprehensive economic stabilization program was implemented in March 2001, complementing a broader restructuring initiative introduced in January 2000. The program has been producing favourable results. Since the election of the centre-right Justice and Development Party (AKP) in late 2002 many influential reforms took place in Turkey. This government seemed to be supported and able to restore order. Many key issues, which had been postponed for decades, are currently being addressed, partially because this administration has the ambition to join the European Union. Resulting in sometimes-painful debates on for example the restrictions on the Kurdish cultural identity, the role of the powerful military, the recognition of Greek Cyprus and the controversy on the Armenian genocide in the early twentieth century. The reforms include dismantling the restrictions on the media, the privatization of more and more state companies, loosening the restrictions on import and export, permitting foreign parties on the national capital markets and struggling to decrease inflation and budget deficits even further than the program for economic stability did. These circumstances provided a stimulating environment for economic growth.

On the other hand there are some threats to the position of this government, which could disturb the stable, but fragile situation. The AKP has its roots in a banned Islamist movement and was founded only one year before the elections in 2002. Critics fear that it aims to include amendments in line with Islamic tenets in the laws it is passing to harmonize with European Union practices. In 2004 the army, which still wields considerable influence over politicians, forced the government to abandon the draft legislation attempting to lift the ban on headscarves. Since 1960 generals have staged three coups and forced Turkey's first Islamist-led government to resign in 1997, proclaiming to be the guardians of secular Turkey. A new coup, or even a new major conflict between the government and the military could lead to a new political and economical crisis (Oxford Business Group, 2005, pages 11-15). Another major threat of the relatively stable situation is the sharp decline in support for the government, which is expected when it will officially recognize Greek Cyprus, because of pressure from the European Union.

Fast growing economy

Turkey boasted one of the world's fastest-growing economies for the last few years. The real growth of the Turkish economy in 2004 was 8,9% in terms of gross domestic product -GDP- conversed to US Dollar and corrected for inflation, which is triple the OECD average and nearly seven times the average in the Euro zone. During 2005 Turkey's GDP rose again with 7,4%, above most expectations. This enormous growth extended Turkey's ongoing expansion to four consecutive years, starting with 2002 (Euromonitor International, 2006). In May 2006 the projected growth for 2006 is again 6%. These figures made Turkey being mentioned as 'promising investment opportunity' by the Oxford Business Group (2005, pages 52-53).

Inflation

The most salient achievement of the stabilization program has been in controlling the level of inflation, which was one of the main problems the Turkish economy faced. As of halfway 2006, inflation seems to be under control and fiscal management improved substantially. In terms of yearly changes in the consumer price index, inflation subsided from a devastating 68,5% during 2001 to 29,7% in 2002 and further to 18,4% in 2003. Then there were promising single-digit amounts of 9,32% in 2004 and 7,72 % during 2005 (TCMB, 2006). This is still above international norms, but the rate and the consistency of improvements are promising at the very least (Oxford Business Group, 2005, pages 47-51). A new clash between the military and the government however would ruin this promising trend and also weaken the position of the Turkish Lira against other main currencies like the Euro and the US Dollar.

Capital Markets

The Istanbul Stock Exchange -ISE-, the only stock market in Turkey has been very unstable and volatile since it's opening in 1986, due to the political and economical situation. The ISE-100 is the most important composite index to measure the performance of the stock market, the ISE-30 is another major index. Several years the ISE-100 index showed fluctuations of more than 300% of its value and the average yearly fluctuation in the value of the index in the period 1986-1999 was a staggering 159,6% (Istanbul Stock Exchange, 2006). Since 2000 this situation obviously improved. In early 2004 a private corporation named TurkDEX acquired permission of the Capital Markets Board and the Turkish Ministry of Finance to establish a derivative exchange market. Under current regulation there can only be one derivative exchange market in Turkey (Reva, 2006). In February 2005 the exchanged opened in Izmir and the first derivatives were traded. Initially there were futures traded on the ISE-100, the other index the ISE-30, the Turkish interest rate, US Dollars, Euros and on commodities such as Turkish wheat and cotton. In March 2006 TurkDEX added the possibility to trade future contracts on gold and in April 2006 the possibility to trade futures on treasury bills – bonds maturing in less than one year- of the Turkish government was added. In April 2006 TurkDEX announced that the trading of option contracts would be introduced soon. Not officially, the introduction of option contracts on the ISE-100 and ISE-30 indexes is announced for January 2007. Future contracts give the buyer the obligation to buy a specified amount of the underlying asset at a predetermined price and date. An option is slightly different; it gives the buyer the right, but not the obligation to buy -or sell- a specified amount of the underlying asset, at a predetermined price and date. This difference has influential implications for the behaviour of these products.

Başak Emeklilik

Başak Emeklilik was established in 1997 as Başak Hayat Sigorta, a joint venture between two giants in the Turkish finance sector, TC Ziraat Bankası and Başak Sigorta. In 1998 it began its business activities in life, health and personal accident insurances. In 2003 after an influential change in regulation it received authorization to establish a pension fund and began offering private retirement plans. A rapidly growing emerging economy after severe political and economical crises, an enormous youth population, growing influence from the West and enormous marketing efforts in a recently privatized market have all set the scene in Turkey for a fast growth of the market of private retirement (EGM, 2006). The growth of the private pension sector in 2005 was 294% in terms of the amount of contributions. The growth rate of Başak Emeklilik in terms of the amount of contributions for 2005 was 784%, increasing its market share from 2,0% to 5,9% (Başak Emeklilik, 2006). This growth rate was the highest in the market, which was one the

reasons to award the company the title 'Superbrand' (Superbrands, 2005, pages 28-29). A rough estimate is that the coming ten years another 8 million consumers will sign up for a private pension plan, with 400.000 consumers in 2005 this means that the market will maintain strong growth rates the coming years (Superbrands, 2005, pages 28-29).

The company's vision of itself is young, open-minded, progressive and dynamic, with 41% of the employees being female, an average age of 33 and 84% of the employees having attended university or post-graduate education (Başak Emeklilik, 2006). In this respect they want to explore new opportunities in the Turkish market and set trends and products instead of copy them. In this light the main question for this report was raised. The question whether the Turkish option market, which will soon be established, could be a valuable investment vehicle for the pension funds of Başak Emeklilik. This main question will lead to an explanatory research as trading of options in Turkey still has to be established.

2. Problem definition and outline

This chapter will define the problem put forward in the introduction and set a few research questions to divide the problem in different areas. As already introduced, the main problem will be the following.

> *Will the Turkish option market form a valuable investment vehicle for the pension funds of Başak Emeklilik?*

To be able to answer this question it has to be divided in a few areas. As a first step the specific requirements a Turkish pension fund has for an investment vehicle will be explored in chapter three. This framework will include all general requirements. The focus on Turkey, where both options and private pension plans are a new phenomenon, makes it hard to draw comparisons with other countries. In order to explore whether options can be valuable, chapter four will provide a model of virtual options on the Turkish ISE-100 index for the years 2004, 2005 and 2006. The model describes options on the ISE-100, since index options are most likely the first options to be introduced in January 2007. With the data obtained by this model the performance of -virtual- portfolios combining current vehicles with options can be determined in chapter five. This approach is a simplification of reality, where options and current vehicles would be determined in relation to eachother, instead of only determining options after the other vehicles are fixed. This simplified approach suits the explorative approach of this paper well. More extensive research can only be conducted after option trading has started. Performance will be measured both in terms of return and volatility, using a Markowitz analysis. Chapter six will determine how robust these findings are and discuss the predictive value of these explorations. This results in the following questions:

> *What are the specific requirements of a Turkish pension fund for an investment vehicle?*
>
> *What would be the daily prices of virtual put and call index options on the ISE-100 for 2004, 2005 and 2006?*
>
> *What would be the performance in terms of return and volatility of portfolios combining the virtual options with current investment vehicles?*
>
> *What is the robustness of the outcomes?*

The answers to these questions will lead to conclusions on the main problem in chapter seven, as well as to some recommendations for further research.

3. Specific Requirements

This chapter will explore the specific requirements an investment vehicle has to meet in order to be an alternative worth consideration for a Turkish pension fund, bearing in mind the focus on options.

Regulation

Private pension plans are in most countries a very common concept. In Turkey however, it is a relatively new phenomenon. Over the last few years more and more banks and insurance companies were being privatized, for the coming years even a few more are scheduled (Oxford Business Group, 2005, pages 55-56). Since a recent change in regulations there are major tax advantages in participating in a pension fund, those were implemented to promote the concept. Contributions to pension funds may be claimed as tax deductible expenses, up to 10% of the gross income. Earnings of pension funds are exempt from corporation tax. When a participant leaves the system at retirement age only 5% income tax is deducted over 75% of the benefits of the program. When a participant wants to opt out earlier than at retirement age, both percentages are higher depending on the duration of participation.

In general there are two types of pension funds. Funds with a fixed contribution and therefore flexible benefits and funds with fixed benefits after retirement age and therefore –slightly- flexible contributions. The Turkish pension funds can be categorized as the former of these two, often called 'defined contribution'.

Regulation by the Capital Markets Board of Turkey divides pension funds into six categories and assigns each category minimum and maximum percentages of fund value to be invested in different investment vehicles, for example common stock, or government bonds. Besides it sets a few rules to decrease volatility in fund returns. The maximum amount of a fund to be invested in a single stock is 10%. Furthermore the maximum total value of stocks which each represent 5% or more of the portfolio value, is 40%. The maximum value of a fund invested in more volatile assets as futures and options is currently determined at 20% for the stock and flexible types and at investing in options is not allowed for the other four types. Since these products are rather new in Turkey, regulations might change over the coming years (EGM, 2006).

Foreign Markets

On average, Turkish pension funds invested only 1,11% of their total value in foreign securities during the year 2005 (EGM, 2006, page 36). Explanations for this low figure vary from culture, remaining of the near past when the pension funds were still government companies, to still present subtle indirect influence by the government. This research will explore the Turkish option market only. When the interest of Turkish pension funds shifts partially towards foreign capital markets in the –near- future there will be the need of some research on foreign opportunities.

Risk

Generally, the better the financial situation and the younger the plan participants, the riskier the investments that can be held by the plan (EGM, 2006). Risk is in this case is mainly measured in terms of volatility. In theory, volatility is not a directly observable characteristic. In this case it is measured by the average fluctuation in the daily returns of the fund. The average fluctuation in daily returns for Başak Emekliliks stock fund was

133,7% measured from January 2004 until June 2006. The average return of the fund over that period was 25,5% on a yearly basis. The main focus for pension funds in the -near- future will be to decrease their risk by lowering their volatility (EGM, 2006, page 52).

Therefore one of the main limitations to investing in options will be that the volatility is not allowed to increase. A main advantage of investing in options could be a decrease in the total funds volatility, because diversification always reduces variability (Brealy & Myers, 2003, pages 169-172). Especially two vehicles having very small, or maybe even negative correlation, can provide a decrease in volatility.

Depth of the market

Last years market growth in private pension funds mentioned in the introduction, combined with recently implemented promotion by the government through tax benefits and the strong growth of economy and welfare in Turkey in general, leads to big estimated values of pension funds in the near future. It also creates a major uncertainty of these estimates. As a result the depth of the market of a potential investment vehicle has to be substantial. The total value of Başak Emeklilik's stock fund was 9,7 million Turkish Lira on the first of January 2004 and 41,4 million on the first of January 2005. On the first of January 2006, this amount had grown to 257,5 million Turkish Lira and this growth doesn't seem to stop since the value at the first of June 2006 was 503,7 million. A rough estimate therefore puts the total fund value on 1 billion at the first of January 2007. Since a maximum of 20% can be invested in options, the maximum value invested in options will be 200 million Lira. Taking into account the market share of 5,9%, the total amount invested by all pension funds can reach a maximum of 3,4 billion Lira. This estimate is the maximum and is a very high estimate for three reasons. Firstly the growth of Başak Emeklilik is the fastest in the market, therefore the market share is likely to rise again during 2006 so the 200 million will be more than 5,9% of the total

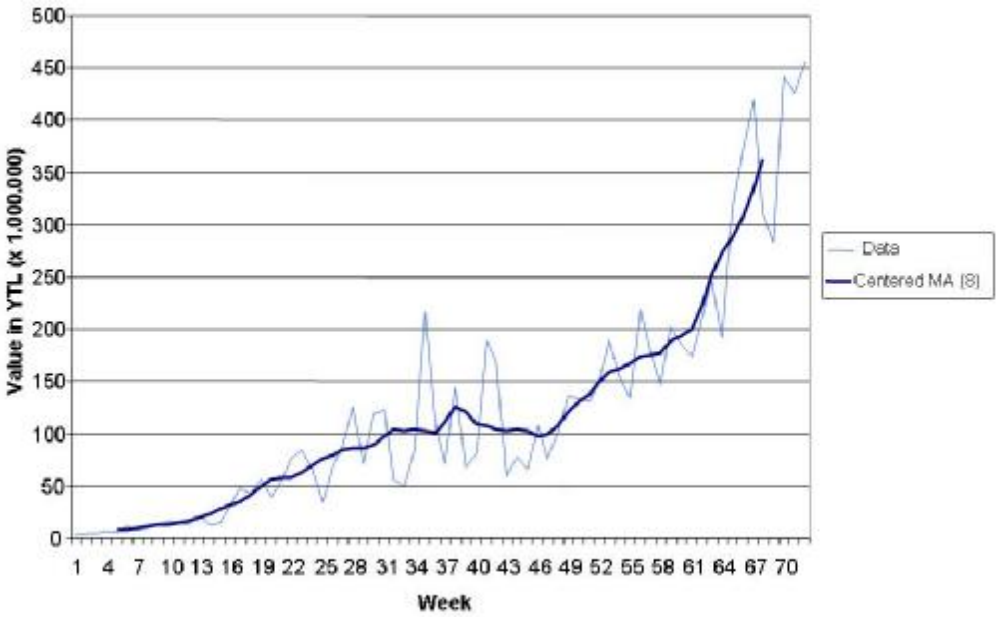

Figure 1 Weekly traded value on TurkDEX

amount to be invested. Secondly other companies might be less innovative for various reasons, making it very unlikely for all the players in the market to enter the options market at the same time. The third reason is simply that the 20% of the value is the maximum allowed by regulations, so the estimate of 200 million out of one billion is likely to be lower in practice.

The only figures that might provide some expectations on trading volumes of the option market are the trade volumes of the Turkish future market that already started trading in February 2005. Figure 1 shows the weekly traded value in millions of Lira on TurkDEX since its start in February 2005 until June 30 in 2006. The trend, shown with the thick blue line is clearly upwards. The techniques used to calculate this trend line with a centered moving average over eight weeks are explained in appendix one. This shows that the option market could be expected to grow rapidly over the coming few years, however it might take some time before it is considered big enough for institutional investors. The average weekly traded value in future contracts on TurkDEX over the last eight weeks is only 10% of the estimated investment possible by pension funds, showing that the market will need some years to grow big enough.

Figure 2 shows the distribution of this traded value in currency futures, index futures and other futures for an average week between February 2005 and the end of June in 2006. The category other futures includes future contracts on gold, the interest rate and future contracts on commodities such as wheat and cotton. Once some institutional investers enter the market, they will provide further growth to this market making it more reliable. Figure 2 shows that investers are interested in futures on the index, indicating that there is a market for options on the index. However it also means that whenever options on currency will be introduced later, the trade in index options might decline, at least temporarily. A very confident view on the growth of these capital markets is provided in an interview with Osman Birsen, the Chairman of the Istanbul Stock Exchange. He states that 50% of shares traded at ISE are owned by foreign investers, showing confidence and opportunities in Turkey's capital markets (Oxford Business Group, 2005, page 94).

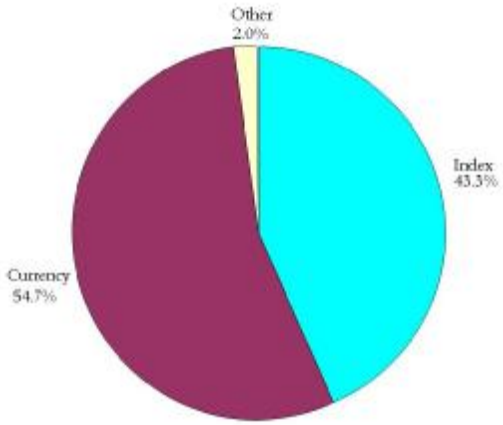

Figure 2 Distribution of traded value on TurkDEX

This optimism should be connotated with the condition that the political situation in Turkey doesn't destabilise. As mentioned in the introduction, the political situation was a few times on the brink of a crisis recently, which would definitely have a devastating effect on the economy and change outlooks dramatically.

Relation between assets and liabilities

Usually the relationship between assets and liabilities is an influential factor in making investment decisions for pension funds. Capelleveen, Kocken and Kat (2003) argued that recent developments show that options should be used by pension funds in 'defined contribution' markets and even by pension funds in 'defined benefits' markets, because there are always combinations that fit this relationship and diminish fluctuations.

Specific requirements

To conclude this chapter, the answer to the first question raised in the problem definition can be summarised.

> *What are the specific requirements of a Turkish pension fund for an investment vehicle?*

Firstly a pension fund is limited by regulation. In the case of options regulation limits the investment to a maximum of 20% of the total value of the fund for stock and flexible funds and doesn't allow any investment in options for other categories of funds. This regulation might change in the near future however, because both pension funds and the option market are very recent phenomenons in the Turkish economy.

Secondly risk is the main limitation. Turkey's young population and high retirement age give plans and therefore investments a long duration. This makes a little more fluctuation acceptable according to literature; fluctuation however is already high in Turkish capital markets and the economy not really stable. A main advantage of options could therefore be a decrease in fluctuation.

The third issue is the depth of the market. This will make the use of options right after their introduction fairly impossible. It will take some time before the market will be deep enough to offer possibilities for big institutional investors, making an estimate is fairly impossible and would be unreliable. Experts as for example the Oxford Business Group have optimistic expectations for the coming years, provided that the political situation doesn't destabilise.

4. Virtual options

This fourth chapter will introduce a model of virtual options on the ISE-100 for the years 2004, 2005 and 2006 and discuss the validity of the assumptions of this model. This model will be used to value –virtual- portfolios consisting of both current investments and virtual options in chapter five. These portfolios will be constructed according to the limitations formulated in chapter three. The robustness of conclusions drawn on value of portfolio's including virtual options will be determined conducting a sensitivity analysis in chapter six.

The model

An option contract gives the buyer the right, but not the obligation to buy –or sell in the case of a put option- a specified amount of shares –usually 100- at a specified date for a specified price. Options on Indexes are comparable, but the underlying value is not one stock, but a stock index. Because the stocks in an index are not perfectly divisible –one can only buy discrete amounts of stock- it is rather impossible to buy the exact composition of an index in real shares, without buying an enormous amount of stock. Therefore index options are settled in cash after their maturity date. A classic, but extremely influential and still widely used model to price options is the Black-Scholes model; this model has proven to be reliable (Brealy & Myers, 2003, pp 601-603).

The model was originally published by Black and Scholes (1973). It uses the following formula for the price *C* of a call option on a stock currently trading at price *S*, where the option has an exercise price of *K*, *T* years left to the maturity date. The constant risk-free interest rate is *r* and the constant volatility in the price of the underlying stock is σ. The Φ symbol means the standard cumulative normal distribution function and e is the base of the natural logartihm.

(1) $$C(S,T) = \Phi(d_1)S - \Phi(d_2)Ke^{-rT}$$

(2) $$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r + \frac{s^2}{2}\right)T}{s\sqrt{T}} \qquad d_2 = d_1 - s\sqrt{T}$$

Next to call options, there are put options. These contracts give the buyer the right, but not the obligation, to *sell* a specific amount of shares at a specified date and time. The price *P* of a put option can be computed by what is called the put-call-parity, which leads to equation (3).

(3) $$P(S,T) = \Phi(-d_2)Ke^{-rT} - \Phi(-d_1)S$$

This version of the model can be used to model the prices of so called European style options, which is the type that will be introduced on TurkDEX (Reva, 2006). The main alternative to European style options is American style options, in those options contracts the buyer of the contract can exercise his rights to buy –or sell- at every point in time until the maturity date, instead of just at the maturity date itself as is the case with European style options.

Model extension for dividend

The basic model can be used to value option contracts with non-dividend paying shares as underlying value. It can be extended to model options on indexes consisting of 100 stocks or more, because the dividend payments can be modeled as a flow. Models with discrete dividend paying underlying value are also possible, but more complex.

The dividend payment paid over the time period $[t,t + dt]$ is then modelled as (4) for some constant q, which models the yearly average dividend yield.

(4) $$qS_t dt$$

Under this formulation the arbitrage-free price implied by the Black–Scholes model can be shown to be (5) this model uses a modified forward price F in d_1 and d_2, as shown in (6) and (7).

(5) $$C(S_0,T) = \Phi(d_1)S_0 e^{-qT} - \Phi(d_2)Ke^{-rT}$$

(6) $$F = S_0 e^{(r-q)T}$$

(7) $$d_1 = \frac{\ln\left(\frac{F}{K}\right) + \left(\frac{s^2}{2}\right)T}{s\sqrt{T}} \qquad d_2 = d_1 - s\sqrt{T}$$

Assumptions

The Black–Scholes model for option prices involves several assumptions. This section will show they are reasonable in the case of the ISE-100 index. The extension of the model to dividend-paying underlying value accounts for the first assumption, the other seven are the basic assumptions of the classic Black-Scholes model (Black and Scholes, 1973).

1. Dividend payments can be modeled as a constant flow.
2. It is possible to short sell the underlying stock.
3. There are no arbitrage opportunities.
4. Trading in the stock is continuous.
5. There are no transaction costs or taxes.
6. All securities are perfectly divisible.
7. The risk-free interest rate exist and is constant.
8. The price of the underlying instruments follows a geometric Brownian motion S_t in particular with constant drift μ (expected return) and volatility σ.

(8) $$dS_t = mS_t dT + sS_t dW_t$$

Modeling dividend payments as a constant flow, could be regarded as a reasonable additional assumption (Merton, 1973). Since companies pay dividend twice a year and the index consists of a hundred stocks, there will be a dividend payment almost every trading day. Under current regulation it is possible to trade contracts, short selling the ISE-100.

Also all the stocks within the ISE-100 can be sold short. Since the stocks included in the ISE-100 index are all Turkish companies, which are not traded on foreign stock markets, there are no arbitrage opportunities. The ISE-100 is an index and the option contracts traded on it will be settled in cash, so the securities are perfectly divisible. The only assumption which might prove an oversimplification of reality is a constant risk-free interest rate. In Turkey inflation is significant enough to take into consideration determining the risk-free interest rate. In contrast to the situation a few years ago, inflation and therefore the real interest rate are relatively stable, as described in the introduction. Fluctuations are still considerable, but their size is acceptable and decreasing. Different choices for the interest rate in the model, will account for only slight differences in outcomes. Therefore the model is reasonable to model index options for the ISE-100 for the years 2004, 2005 and 2006. Before 2004, fluctuations in both inflation and interest were significantly higher and the outcomes of the model could become too unreliable.

A geometric Brownian motion is a model originally applied in physics to describe the motion of a particle that is subject to a large number of small molecular shocks, but was later found to be very useful in describing stock prices (Hull, 2000). If a stochastic process follows a Brownian motion it exhibits the following two properties. The changes in the value of *S* over time follow a normal distribution and the changes for any two non-overlapping intervals are independent (Marate & Ryan, 2005).

The case of stock prices is slightly different from the generalized Brownian motion process. For stock prices, the return on investment is assumed to be constant, where the rate of return at a given time is the ratio of the drift rate to the value of the stock at that time. Hence the constant expected drift rate assumption needs to be replaced by an assumption of constant expected rate of return (Hull, 2000). A geometric Brownian motion is a reasonable assumption for the return on stocks if the following two assumptions are satisfied. The logarithms of daily return $-X_t$- ratios follow a normal distribution and the logarithms are independent of their past values (Marate & Ryan, 2005). When *G* is the distribution function of (9), then (10) should apply.

(9) $$Y_t = \ln \frac{X_t}{X_{t-1}}$$

(10) $$G \sim N(m, s) \qquad m \in \Re \qquad s \geq 0$$

A research on the period of 1989-2003 by Yumlu, Okay and Gurgen (2004) showed the daily returns of the ISE-100, and their logarithms can't be described with a normal distribution. They appoint the political instability to be the main reason, as stated in the introduction this situation arguably improved, but it still sensitive.

There are several ways to test data for normality. Of course they can never prove that the proces which produced the data is behaving as a normal distribution, they can prove whether there is a statistical reason to doubt that these data could have been generated by a normal distribution.

The basic and intuitive method of the plotting the values -put in order- against a set of data generated by a standard normal distribution results in the diagram shown in figure 3. Where Y_i – all values of Y_t put in order- on the vertical axis are plotted against (11) on the horizontal axis, shows that a normal distribution seems a reasonable assumption. The blue line would be a perfect normal distribution. Equation (11) uses the inversed standard normal distribution function on fractions. These fractions divide the interval between 0 and 1 in similar parts. For example ten observations with a standard normal distribution would divide the interval in eleven similar parts, therefore the denominator states the total amount of observations plus one (Kallenberg, 2003, pages III.2 – III.15).

$$\Phi^{-1}\left(\frac{i}{n+1}\right) \tag{11}$$

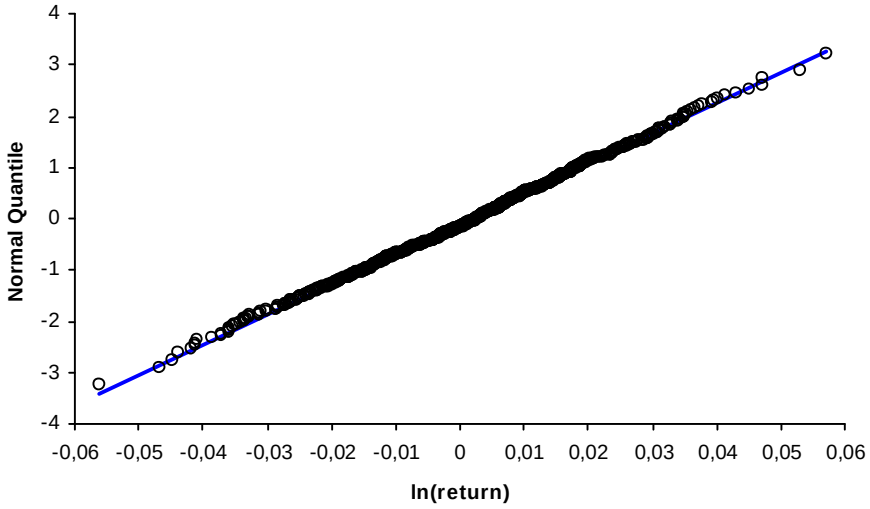

Figure 3 Normal Quantille plot of ISE-100 return logarithms.

The data used are the daily closing values of the ISE-100 index for the period of March 2003 until June 2006, totalling 805 trading days. From the range of more advanced techniques, the test known as Shapiro-Wilk is particularly suitable for series of data with less than 2000 observations (Speelman, 1998, section 3). The test statistic W is shown in equation (12).

$$W = \frac{\left(\sum_{i=1}^{n} a_i x_i\right)^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{12}$$

The *x*-values are the observations put in increasing order, so x_i is the *i*-th smallest observation, $\bar{x}$ is the mean of the sample and the *a*-values are constants determined by the expected value of the order statitics of the standard normal distribution. The a-values are given in tables in most textbooks on statistics, for example by Kallenberg (2003). These tables typically give a-values for n values up to 50 or 100. For higher values of n,

the a-values can be calculated with the formula give in (13). The $m_1,\ldots,m_n$ are the expected values of the order statistics of a sample from the standard normal distribution and V is the covariance matrix of those order statistics.

$$(13) \qquad (a_1, a_2, \ldots, a_n) = \frac{m^{\mathrm{T}} V^{-1}}{\left(m^{\mathrm{T}} V^{-1} V^{-1} m\right)^{1/2}} \qquad m = (m_1, m_2, \ldots, m_n)^{\mathrm{T}}$$

It can be shown that W is always smaller than 1. The test rejects the null hypothesis of normal distribution if values of W are too small, or in other words too far from 1 (Shapiro & Wilk, 1965). For the daily closing values of the ISE-100 index for the period of March 2003 until June 2006 –the same period as used in the Quantille plot before- the value of W was calculated to be 0,9991. Meaning it is plausible that these data could have been generated with a normal distribution with α=0,10. However the slight negative skewness of the sample of –0,0931 shows there is a little more mass concentrated on the right side.

To test the assumption of independency of the past values Pearson's χ^2 model can be applied. This model divides the total spread of the observations in a number of intervals. The division is designed to give the different intervals the same probability of occuring under the presumed distribution function. In this case the distribution can plausibly be considered normal. The next step is to test whether an observation being in a certain interval *i* gives the next observation a significantly different chance to be in a certain interval *j* (Kallenberg, 2003, pages VIII.9 – VIII.10). The test compares the found co-occurrence of intervals *i* and *j* with the expected number of times interval *j* is found to follow interval *i*. The test statistic is χ^2, the equation is shown in equation (14).

$$(14) \qquad c_f^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{\left(N_{ij} - \frac{N_{i+} N_{+j}}{N}\right)^2}{\frac{N_{i+} N_{+j}}{N}} \qquad f = (k-1)(r-1)$$

The χ^2distribution which can be used to interpret the result has *f* degrees of freedom. Conducting the test to the daily closing values of the ISE-100 index for the period of March 2003 untill June 2006, dividing them in three intervals with equal probability under the normal distribution assumption, χ^2_4 equals 4,27. This shows with α= 0,05 that there is no statistical reason to doubt independence of past values.

Conducting the test again somewhat stricter, dividing the values in nine intervals with equal probability, the value of χ^2_{64} is 76,6. Showing there is no reason to doubt the assumption of daily returns being independent from past values with α=0,05. The danger of using a higher number of intervals to provide more extensive testing is that the expected number of observations in the cells can get to low for the χ^2 model to be a good approximation (Kallenberg, 2003, note on page VIII.12). A way to quantify the deviance from the χ^2 model is the formula shown in (15) (Verbeek & Kroonenberg, 1985).

$$(15) \qquad \frac{0{,}05}{kr} = \sum_{i=1}^{k} \sum_{j=1}^{r} \frac{1}{E_{ij}}$$

Where the E_{ij} is the expected number of observations in interval *j*, where the previous observation is in interval *i*. The total amount of deviation of the model from a χ^2_{64} is only 0,005. Since all the assumptions of the model are reasonable, the Black-Scholes model as shown in equations (5), (6) and (7) can be applied to model options on the ISE-100 for the period of 2004, 2005 and 2006.

The first reason to choose options on the ISE-100 index was that these are likely the first options to be introduced on TurkDEX, as was stated in chapter 2, the problem definition. A second and more important reason was the main alternative of currency options not meeting the assumptions of the Black-Scholes model. The basic Black-Scholes model, as shown in equations (1), (2) and (3) can be extended to describe options on currency (Garman & Kohlhagen, 1983). A research of Aysoy and Balaban (1996, 2005) showed however that the term structure of volatility in the Turkish foreign exchange is not in accordance with the assumption of underlying value behaving as a geometric Brownian motion. The modeling of prices for Turkish currency options will therefore inevitably require more complex models. For example Monte Carlo analyses could be applied.

Application of the model

The average risk-free interest rates *r* for 2004, 2005 and 2006 were estimated on respectively 9,5%, 6,25% and 5,2%. These are the official estimates (TCMB, 2006) these figures were corrected for respectively 9,32%, 7,72% and 8,83% inflation. The average dividend yield *q* for the stocks in the ISE-100 index was 27,18% during 2005 (ISE, 2006). The standard deviation σ on the daily returns of the ISE-100 for the period of January 2004 until June 2006 was 1,08. An example of the calculation of one option price is added to the report as appendix two. Tables with the modeled prices for call and put options on the ISE-100 with an exercise price of 20.000 and maturity date 30-12-2004 for all trading days in 2004, with exercise price 25.000 and maturity date 30-12-2005 for all trading days in 2005 and with exercise price 40.000 and maturity date 30-06-2006 for all trading days in the first half of 2006 are added to this report as appendix three. Graphs summarising them are shown in figure 4 to conclude this chapter. The first graph shows the call options on the left vertical scale, the second graph shows the put options on the left vertical scale, both graphs show the ISE-100 index on the right vertical scale. These graphs provide an answer to the second question raised in the problem definition.

What would be the daily prices of virtual put and call index options on the ISE-100 for 2004, 2005 and 2006?

The amount of 20.000 as exercise price is close to the value of the ISE-100 in late December 2003 and early January 2004 and a round number, which makes it an amount likely to quote on an option contract issued in January 2004. The same logic applies to the amounts of 25.000 in January 2005 and 40.000 in January 2006. In practice the index options introduced will presumably be quoted in hundredths or even thousandths parts of the index, in order to make trading them more accessible and markets more liquid. Since this doesn't influence the returns these options would generate this report will quote the original high option prices to prevent confusion.

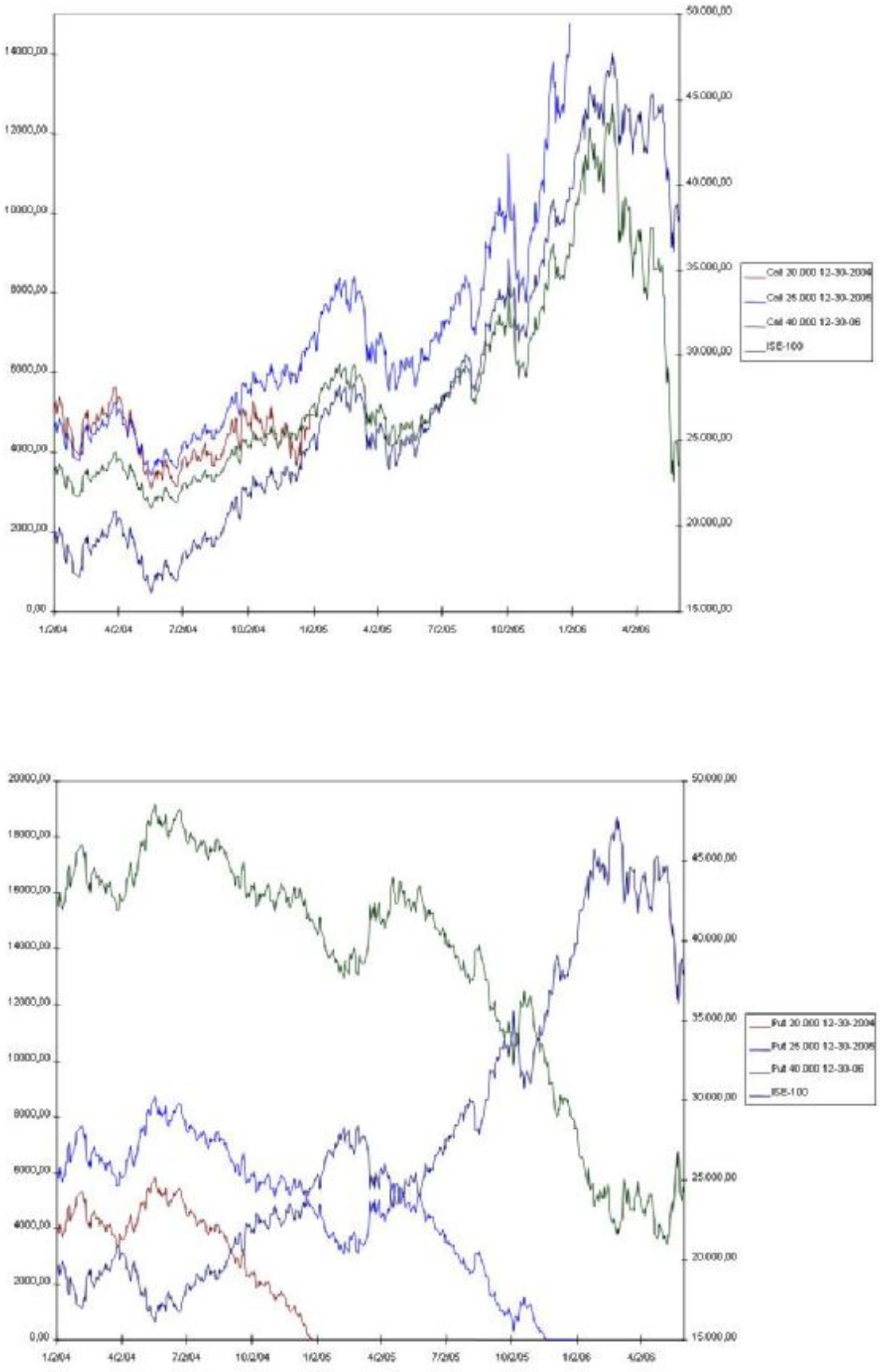

Figure 4 Modeled prices for options on ISE-100

5. Portfolio performance

This chapter will answer the third question raised in the problem definition. The question what the performance in terms of return and volatility would be for portfolios combining the virtual options with current investment vehicles. A method to explore which portfolios could be interesting is the Markowitz analysis. It compares portfolios on their relation between volatility and return. To calculate which portfolios are most efficient in the Markowitz analysis, a technique called quadratic programming will be applied. Optimal portfolios for 2004, 2005 and 2006 will be calculated to see whether they contain the modeled options or only the fund itself.

Calculating performance

A Model to explore the expected performance of portfolios in terms of their return and their volatility and moreover the relation between these two, is the model published by Markowitz (1952). This analysis calculates the return and volatility for portfolios as a whole of portfolios containing different combinations of investments and plots the results. These plots will show which combinations of investments are more efficient. Markowitz considered a portfolio efficient if there is no portfolio having the same standard deviation with a greater expected return and there is no portfolio having the same return with a lesser standard deviation. The efficient frontier is the collection of all efficient portfolios.

The expected return of a portfolio, $E(r_p)$ can be computed straightforward by taking the mean of the expected returns $E(r_i)$ of the i investments, weighted for their relative weights w_i in the portfolio, as shown in equation (16).

(16) $$E(r_p) = \sum_{i=1}^{n} w_i E(r_i)$$

The variance of a portfolio σ_p^2 equals the sum of the product of every asset pair's weights and covariance σ_{ij} this sum includes the squared weight and variance σ_{ii} (or σ_i^2) for each individual asset, because the indexes i and j can also be equal. The expression for the volatility of a portfolio is shown in (17). Covariance is often expressed as correlation, scaled for individual standard deviations, as shown in (18).

(17) $$s_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j s_{ij} = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j s_i s_j r_{ij}$$

(18) $$s_{ij} = s_i s_j r_{ij}$$

From (17) and (18) follows that any two investments in the portfolio having a correlation of less than 1 –in other words, which are not perfectly correlated- will lead to a portfolio variance and hence volatility of less than the weighted average of the individual instruments' volatilities.

Finding efficient portfolios

To calculate exactly which portfolio in a Markowitz analysis is the most efficient one, a technique called quadratic programming can be applied (Chang et all, 1998, 1999). However there is not one single efficient portfolio, there are many. Therefore models would in practice include a decision variable determining how much volatility is

acceptable for a certain gain in return. A choice for the value of this variable would depend on how much volatility is acceptable for the invester and how much return is expected in the long run. Since this research is conducted as an exploration and the lack of real data restricts the formulation of a detailed investment strategy, the main focus will be exploring efficient portfolios that offer the same return as the actual fund, but where possible with a lower amount of volatility. Besides, a decision how much volatility is allowed, providing a certain gain in returns, should be made taking into consideration the portfolio as a whole and will involve complex and time specific analyses. The choice to focus on decreasing volatility only, simplifies the interpretation of the results later on and was based on the general focus of Turkish pension funds in the near future as predicted by the pension monitoring system, EGM (2006). A comparable analysis could be made in the future searching for portfolios improving the expected return of the fund or improving both the return and the volatility partially to some specified proportion.

The objective function is shown in (19) and aims to minimize the volatility, which it calculates as was shown in (17). Then there are the constraints to solutions, shown in (20), (21) and (22). In this case both the *r*-values and the σ-values can be calculated directly from the tables with the modeled options. The w-values are the so-called decision variables, which will be given in the solution. The values for r^*, L and U will also be determined as input. The objective function and the constraints together are called a program. Optimal or close to optimal solutions for programs like this –quadratic programs- can be computed by several effective algorithms, where most of them use some sort of 'intelligent trial and error' method that keeps improving it's attempts with every iteration (Chang et all, 1998, 1999).

(19) $$\min \quad \sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j s_{ij}$$

(20) $$\sum_{i=1}^{n} w_i r_i = r^*$$

(21) $$\sum_{i=1}^{n} w_i = 1$$

(22) $$L_m \le \sum_{i \in \Gamma_m} w_i \le U_m \quad ; \quad m = 1,..,M$$

(23) $$\Gamma_k \cap \Gamma_l = \varnothing \quad ; \quad \forall k \ne l$$

Constraint (20) calculates the expected return for the portfolios, applying the method shown in (16) and makes sure it equals a certain value r^*. For this value the expected return for a portfolio consisting of only the fund will be chosen in this case. Resulting in solutions with the same expected return as the fund, but where possible a lower amount of volatility. Constraint (21) makes sure solutions are only allowed to have distributions with proportions adding up to 100%. Constraint (22) is an extension of the basic model called a class constraint; it is used to restrict all decision variables concerned with options to add up to a maximum of 20%. Let $\Gamma_m,\ m = 1,..,M$ be M sets of investments that are mutually exclusive, in other words restriction (23) holds. Now setting values for L_m and U_m limits the proportion of the portfolio that can be invested in investments of class *m*.

In this exploration there are only two classes to be distinguished, being the fund and the options, where the class of the options is limited to hold an investment of a maximum of 20% of the value. The result is shown in (24).

(24)
$$\Gamma_1 = \{1\} \quad ; \quad \Gamma_2 = \{2,3,4,5\}$$
$$L_1 = 0,8 \quad ; \quad L_2 = 0$$
$$U_1 = 1 \quad ; \quad U_2 = 0,2$$

In practice, when modeling the fund as a whole, other classes could be restricted as well, for example related classes of stocks. In practice there should arguably be constraints comparable with the one in (22), for individual vehicles in the class of stocks, to restrict portfolios to the regulations explained in chapter 3. These constraints have to limit the amount invested in a single stock to 10%. Furthermore there has to be a slightly more advanced constraint to restrict the stocks that determine a proportion of more than 5% of the portfolio may together not determine more than 40%. Another common extension of the basic model is cardinality constraints, restricting the amount of vehicles used in optimal solutions (Chang et all, 1998, 1999). The amount of vehicles doesn't need to be restricted for the exploratory purpose and the small number of vehicles involved in this paper, but might be needed whenever investment decisions based on real data are made. Another extension of the model that will make it more useful in the dynamic environment of the Turkish capital markets for later application is the extension published by Mitchel and Brown (2002). Their extensions make the model account for transaction costs, depending on the class of investments, when changing the portfolio.

Portfolios

Applying the formulas (16), (17) and (18) on the data given in the tables in chapter four and appendix three, graphs for a Markowitz analysis can be constructed. This chapter will divide the years 2004, 2005 and 2006 into two-month periods and explores what the optimal portfolios for those periods are.

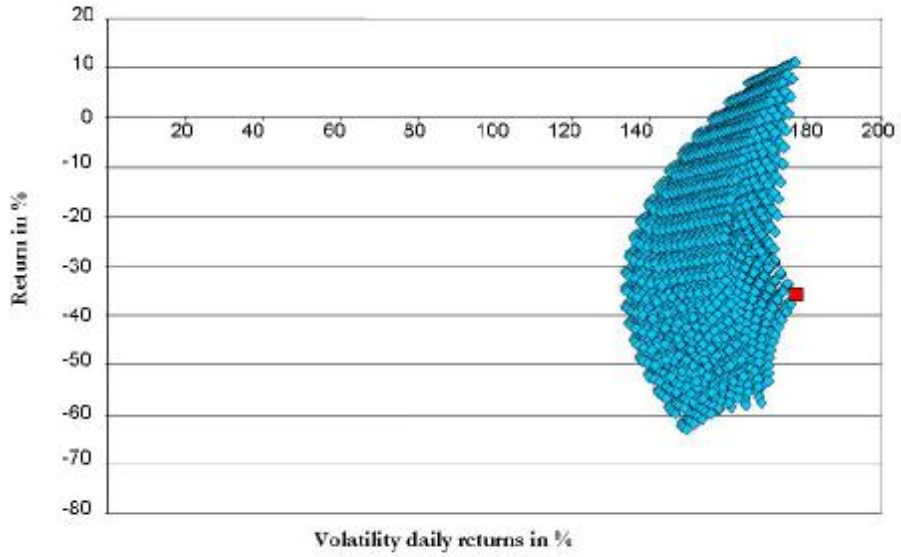

Figure 5 Markowitz analysis January 2004

January 2004

Figure 5 shows a graph of portfolios combining Başak Emeklilik's stock fund with different proportions of value up to a total of 20% invested in put or call options with exercise price 20.000 and maturity date 30-12-2004 or put or call options with exercise price 25.000 and maturity date 30-12-2005. The data modeled for January 2004 are used in this Markowitz model to determine the required returns, the volatilities and the correlations. The red square is depicting the portfolio that consists of a 100% investment in the stock fund, the blue diamonds are depicting combinations of the fund with fore-mentioned options. Obviously there are many portfolios containing options that are more efficient than just the fund by itself. To calculate the portfolio lying on the efficient frontier with the same return as the fund, quadratic programming can be applied, using equations (19), (20), (21), (22) and (23). The value for r^* is in this case – 36,1%. The values for σ_{ij} are given in the table of figure 6.

		j				
		1	2	3	4	5
	1	3,16	0,61	-0,75	0,51	-0,57
	2	0,61	24,04	-2,05	-20,01	-20,41
i	3	-0,75	-2,05	30,10	22,58	23,00
	4	0,51	-20,01	22,58	16,94	-17,15
	5	-0,57	-20,41	23,00	-17,15	17,58

Figure 6 Table with covariance's

The solution obtained is {0,80 ; 0,04 ; 0 ; 0,08 ; 0,08}, meaning a portfolio containing 80% of the stock fund, 4% of call options on the ISE-100 with exercise price 20.000 and maturity date 30-12-2004 and both 8% in call and 8% in put options with the exercise price 25.000 and maturity date 30-12-2005 is an efficient portfolio. The expected volatility of this portfolio is 135,6%, which is a promising improvement of the value of 177,9% of the fund itself. This solution is exact on a level of 0,01 for the decision variables and 0,1 for r^* and σ_p which should be fair enough for exploratory purposes. It means that the expected return of portfolios found as solutions can differ from the expected return of the fund by a maximum of 0,1%.

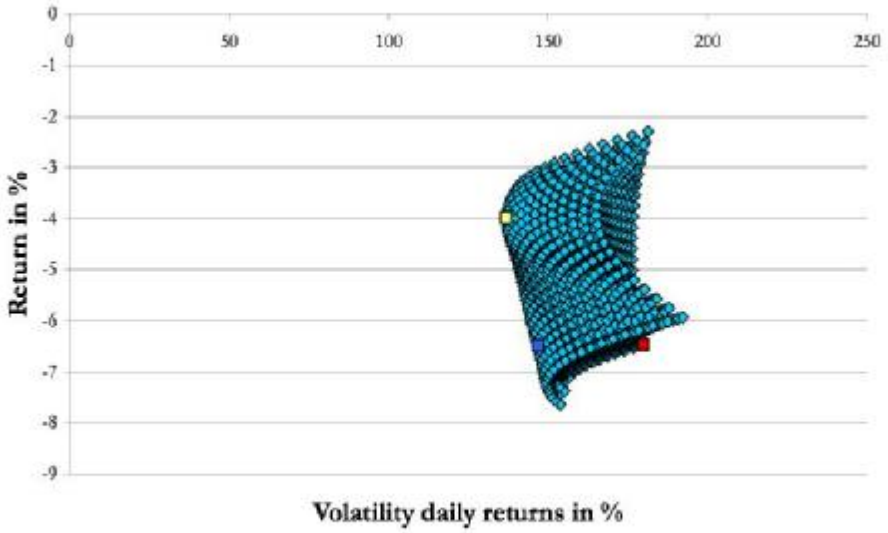

Figure 7 Markowitz January - February 2004

February 2004

Figure 7 shows a graph comparable with the one shown in figure 5, the data used is coming from January and February 2004. The value for r^*, which is the return for the fund itself, is in this case – 5,2%. The solution obtained applying (19), (20), (21), (22) and (23), is {0,80 ; 0,03 ; 0,12 ; 0,00 ; 0,05}. This solution improves the volatility of the fund from 179,7% to 142,5%. However the graph in figure 7 shows that this solution, which is depicted by the blue square, is not an efficient portfolio. The most defensive efficient portfolio, would be {0,80 ; 0,03 ; 0,00 ; 0,04 ; 0,13}. This portfolio, which is depicted by the yellow square, offers the even lower volatility of 136,7%, while also improving the return to – 4,0%.

Other periods

The efficient portfolios offering the same return as the fund itself for other two-month periods in the years 2004, 2005 and 2006 are shown in the table of figure 8.

		Options													
Begin	End	F	1	2	3	4	5	6	7	8	σ Fund	σ P	Δ	Efficient	Return
30.12.2003	30.01.2004	0,81	0,04	0,00	0,08	0,07					177,87	137,50	40,37	Yes	-36,10
27.12.2003	27.02.2004	0,80	0,03	0,12	0,00	0,05					179,73	146,71	33,03	No	-6,48
27.12.2003	27.02.2004	0,80	0,03	0,00	0,04	0,13					179,73	136,76	42,98	Yes	-3,98
29.01.2004	31.03.2004	0,92	0,02	0,01	0,05	0,00					153,59	122,30	31,29	Yes	58,77
28.02.2004	30.04.2004	0,80	0,02	0,00	0,09	0,09					182,58	146,93	35,65	Yes	-4,08
30.03.2004	31.05.2004	0,86	0,04	0,03	0,07	0,00					183,54	148,02	35,52	No	-86,83
30.03.2004	31.05.2004	0,80	0,05	0,00	0,05	0,10					183,54	143,31	40,24	Yes	-67,96
29.04.2004	30.06.2004	0,80	0,06	0,00	0,01	0,13					176,28	141,56	34,72	Yes	-7,25
29.05.2004	30.07.2004	0,87	0,05	0,02	0,06	0,00					164,44	130,81	33,63	Yes	54,58
30.06.2004	31.08.2004	0,86	0,05	0,02	0,07	0,00					157,19	125,11	32,08	Yes	68,08
30.07.2004	30.09.2004	0,91	0,06	0,00	0,03	0,00					154,97	121,57	33,40	Yes	98,23
26.08.2004	27.10.2004	0,88	0,05	0,01	0,06	0,00					151,47	118,57	32,90	Yes	82,37
29.09.2004	30.11.2004	**1,00**	0,00	0,00	0,00	0,00					146,53	146,53	0,00	Yes	59,68
28.10.2004	29.12.2004	0,93			0,01	0,02	0,04	0,00			143,84	115,67	28,17	Yes	29,82
30.11.2004	31.01.2005	0,80			0,01	0,00	0,03	0,16			140,71	113,40	27,31	Yes	18,28
28.12.2004	28.02.2005	0,96			0,02	0,01	0,01	0,00			138,04	111,72	26,32	Yes	47,94
28.01.2005	31.03.2005	0,88			0,03	0,01	0,08	0,00			139,34	111,54	27,80	Yes	-25,20
26.02.2005	29.04.2005	0,89			0,01	0,01	0,09	0,00			140,06	113,36	26,70	Yes	-56,67
29.03.2005	30.05.2005	0,80			0,06	0,01	0,07	0,06			138,91	112,41	26,50	No	-18,18
29.03.2005	30.05.2005	0,80			0,05	0,00	0,05	0,10			138,91	108,73	30,18	Yes	-17,02
29.04.2005	30.06.2005	0,96			0,02	0,00	0,02	0,00			136,15	109,16	26,99	Yes	50,47
28.05.2005	29.07.2005	0,90			0,05	0,02	0,03	0,00			133,68	107,10	26,58	Yes	80,87
30.06.2005	31.08.2005	0,80			0,05	0,00	0,02	0,13			131,64	105,24	26,40	Yes	19,63
30.07.2005	30.09.2005	0,88			0,05	0,01	0,06	0,00			130,07	103,01	27,06	Yes	52,98
30.08.2005	31.10.2005	0,89			0,05	0,00	0,06	0,00			132,86	104,09	28,78	Yes	28,38
29.09.2005	30.11.2005	0,81			0,05	0,00	0,03	0,11			131,53	106,99	24,54	Yes	18,61
29.10.2005	30.12.2005	0,90					0,04	0,03	0,03	0,00	129,70	103,64	26,05	Yes	97,79
30.11.2005	31.01.2006	0,92					0,03	0,01	0,04	0,00	129,62	102,57	27,06	Yes	111,73
28.12.2005	28.02.2006	0,88					0,05	0,02	0,05	0,00	129,23	102,27	26,96	Yes	94,28
28.01.2006	31.03.2006	0,80					0,05	0,00	0,06	0,09	130,94	103,33	27,61	Yes	-9,01
25.02.2006	28.04.2006	0,80					0,05	0,00	0,06	0,09	130,34	102,65	27,69	Yes	-12,21
30.03.2006	31.05.2006	0,80					0,03	0,00	0,05	0,12	132,71	105,42	27,28	Yes	-57,27

Figure 8 Table with computed portfolios

The columns in the middle of the table shown in figure 8 are the proportions to be invested. F is the proportion in the fund and the eight options which were used are given in the table of figure 9. The columns more towards the right show the volatility for both the fund and the modeled portfolio (σ P). Even more to the right the improvement (Δ) in volatility and the return for the portfolio are shown, as is an indication whether the modeled portfolio is efficient. Where solutions are found to be inefficient portfolios, like the one for January and February 2004, the most defensive efficient portfolio for the same period is given in the row below. The results are visualised in the graph in figure 10.

Option 1	ISE-100 Call for 20.000 on 30-12-2004
Option 2	ISE-100 Put for 20.000 on 30-12-2004
Option 3	ISE-100 Call for 25.000 on 30-12-2005
Option 4	ISE-100 Put for 25.000 on 30-12-2005
Option 5	ISE-100 Call for 40.000 on 30-06-2006
Option 6	ISE-100 Put for 40.000 on 30-06-2006
Option 7	ISE-100 Call for 40.000 on 30-12-2006
Option 8	ISE-100 Put for 40.000 on 30-12-2006

Figure 9 Table with used options

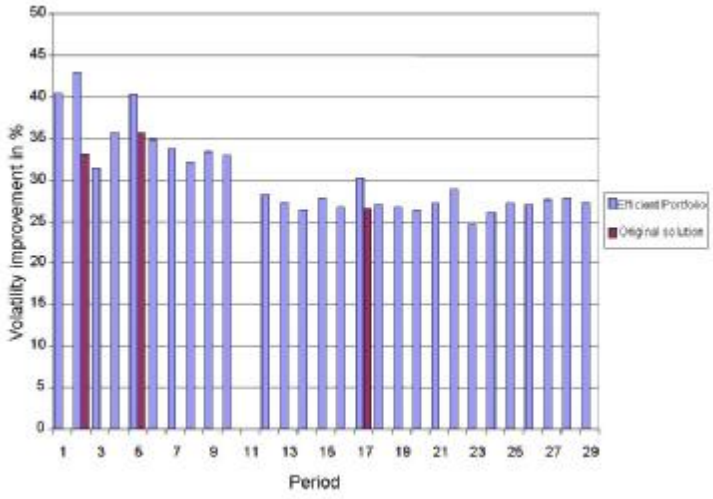

Figure 10 Graph volatility improvement for each period

Improvements

The table in figure 8 provided an answer to the third question raised in chapter two, the problem definition.

> *What would be the performance in terms of return and volatility of portfolios combining the virtual options with current investment vehicles?*

There is only one period where including option in the previously modeled portfolios offers no improvement in the amount of volatility at all, this period is indicated with the proportion invested in the fund printed in bold. The improvements in expected volatility provided by the portfolios, except for this period range from 24,5% to 43,0%. They average 29,3%, which is including the 0% period, and having the non-efficient solutions replaced with the most defensive efficient one. Both in periods where the fund shows very high returns and in periods where the fund shows very low returns, the expected volatility can be decreased with options.

6. Robustness of results

This sixth chapter answers the fourth question put forward in the problem definition. The question what the robustness of the shown results is, in other words how sensitive the results are for –slight- changes in the values of the variables that were not directly observable and therefore had to be estimated. The classic method of sensitivity analysis will be used for this purpose.

Calculating robustness

A classic method to conduct sensitivity analysis is to compare the changes in outcomes when the values of a specific input variable are decreased or increased. Such a comparison can easily be made visible with a graph.

While applying the model presented in equations (5), (6) and (7) in chapter four, only two variables required an estimation of their value, the risk-free interest rate and the volatility of the underlying value. The variance of the underlying value can be observed directly, but serves as an estimation of volatility. The other variables, such as the return of the underlying value and the dividend yield of the underlying value were directly observable since the model deals with the past. Any future model analysing real options will have to estimate all these variables as well as estimate the variance of the underlying value, which would in its turn be an estimation of the volatility of the underlying value.

Since all the calculations used throughout chapters four and five have to be done repeatedly for many different values of the risk-free interest rate and the volatility of the underlying value and for every period that was used in chapter five, the calculations to conduct this sensitivity analysis are substantial. This is done programming a macro in the spreadsheets of Microsoft Excel that were used before, in order to go through all the calculations and calculate the final improvements for different values for the estimated variables. Both variables were varied from 50% to 150% of their original value. The steps taken in this interval were 5%, resulting in 21 outcomes for one variable and 441 – which is 21^2- different outcomes for the two variables together. Therefore conducting this analysis over all the 29 periods resulted in 12.789 outcomes, which would be almost impossible to do manually.

January 2004

For the first period the sensitivity analysis varying both the risk-free interest rate and the volatility of the underlying value is shown in the graph of figure 11. The two horizontal axes show the two tested variables and the vertical axis shows the calculated improvements in the volatility of the fund. The latter shows the nominal results of the calculations, which already is a percentage being the improvement of the volatility of the fund.

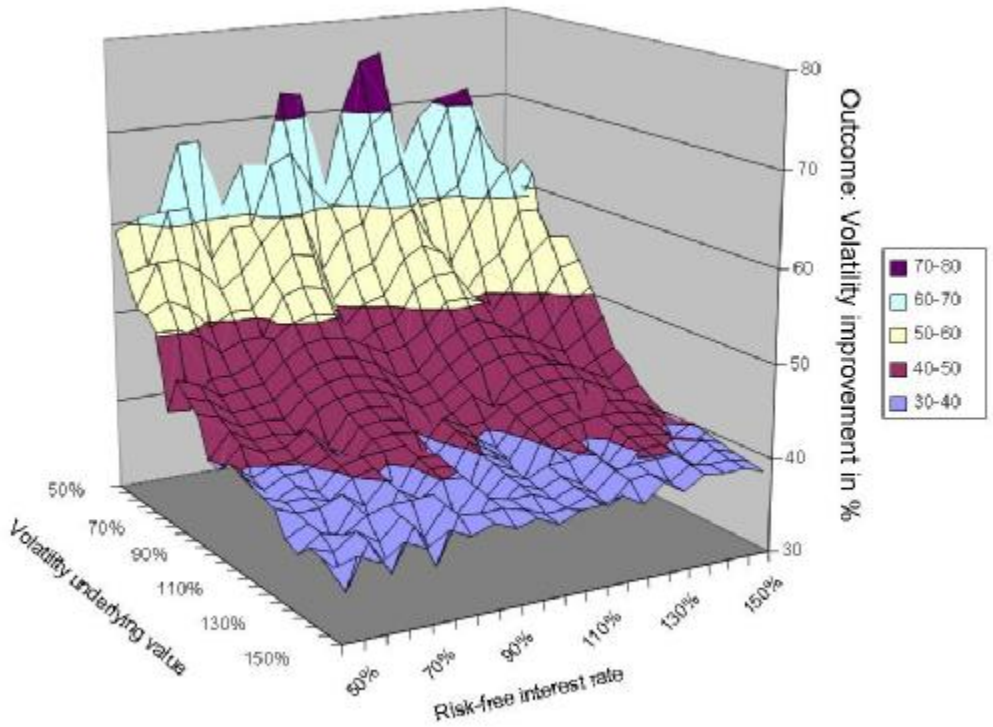

Figure 11 Sensitivity analysis two variables for January 2004

The graph shows an interesting wave-like pattern for increasing risk-free interest rates and a decreasing line for increasing volatility of the underlying value. Those two patterns are clearly visible in the graph in figure 12. This graph shows the results for the same sensitivity analysis, this time changing only one variable and keeping the other constant at the original estimate. In other words these two lines are two intersections of the surface shown in the graph in figure 11, dividing the xy-plane into four quadrants. Obviously the red line depicts the outcomes for the volatility of the underlying value and the blue line depicts the outcomes for the risk-free interest rate.

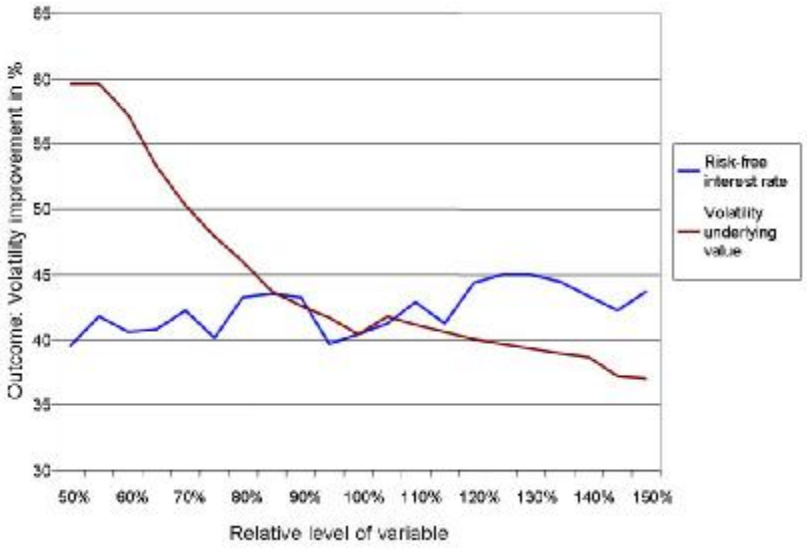

Figure 12 Sensitivity analysis one variable for January 2004

With an increasing volatility of the underlying value, the improvements decrease. However this decrease is not very sharp for values bigger than 100% of the original estimate. Actually seen from the original estimate, there is only a slight decrease in the predicted improvements with a higher estimate for the volatility of the underlying value and a relatively sharp increase in predicted improvements with a lower estimate. Therefore the findings can be called robust for the estimate of the volatility of the underlying value. Different estimates for the risk-free interest rate influence the outcomes just a few percent, although the pattern of this influence is more complex. Therefore the findings can be called robust for the estimate of the risk-free interest rate as well. Finding an explanation for the wave-like pattern is beyond the scope of this exploratory research. There seems to be no consistent pattern in the efficient portfolios chosen to obtain the improvements shown in the graph. Furthermore most of the other periods don't show this pattern in a sensitivity analysis. Most of the patterns show either a very smooth surface, like the one for the period that ends in February 2004, which will be shown in the next section, or they show a very inconsistent, chaotic surface. However, most periods, including those with no obvious pattern, show improvements that are within a reasonable range of the originally calculated improvements.

February 2004

For the second period, ending in February 2004, the sensitivity analysis varying both the risk-free interest rate and the volatility of the underlying value is shown in the graph of figure 13.

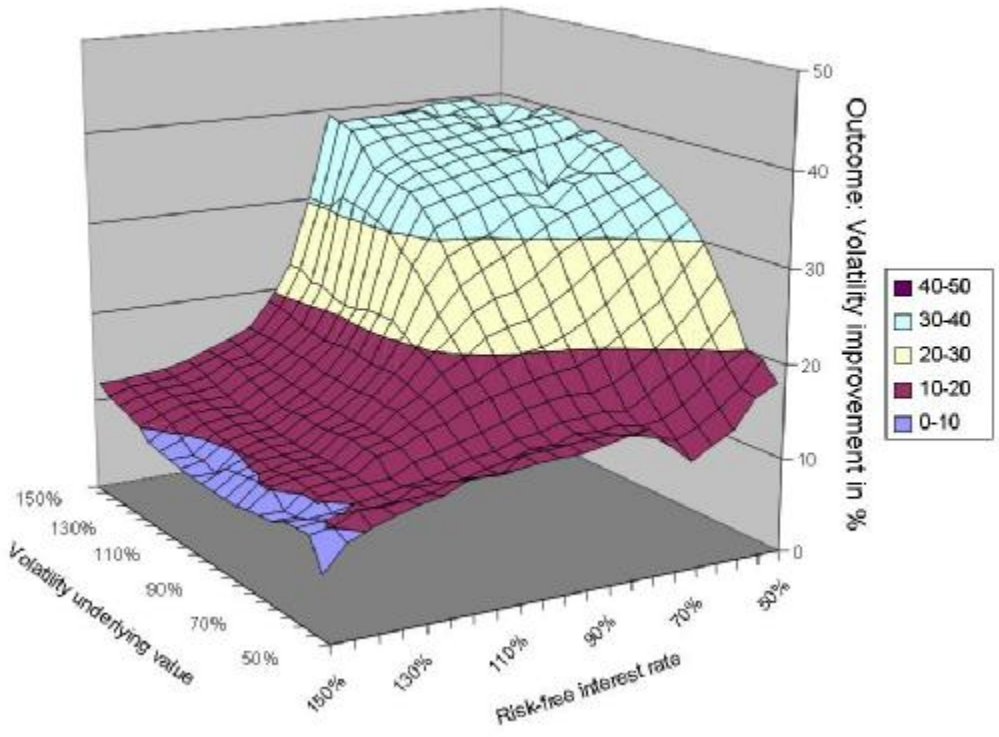

Figure 13 Sensitivity analysis two variables for February 2004

The graph shows that the values are quite sensitive to slight changes in the estimated values of both variables, especially for values around the original estimate. This is even more obvious in the graph in figure 14, which shows a sensitivity analysis for one variable, keeping the other constant at the original estimate. The difference between the highest and the lowest improvement in the graph of figure 13 is 33,5%, meaning percent point –the difference between 6,5% and 40%-. The worst case, seen in the very corner of the graph, when the risk-free interest rate would be 150% of the estimate used and the volatility of the underlying value would be only 50% of the estimate used, still offers an improvement of the volatility of the fund with 6,5%. The difference between the highest and lowest value for this period is one of the biggest of all the periods, only the period ending in January 2004 and the period ending in July 2004 have bigger differences.

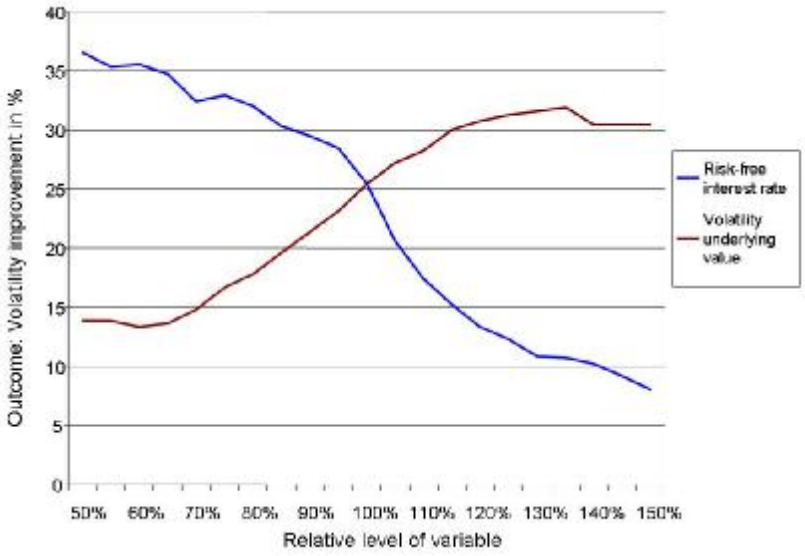

Figure 14 Sensitivity analysis one variable for February 2004

Other periods

In order to evaluate the influence of changes in the two estimated variables over all the periods, the graph in figure 15 shows a summary of their highest, lowest and average outcome.

This graph shows that all the periods in the middle of the graph are apparently less sensitive for different estimates of the variables than the periods on the left and right side. This difference could well be the result of which combination of options was used in the Markowitz analysis, since the period with the lower sensitivity starts in November 2004 and ends in November 2005, which are exactly the two points where the options were replaced for ones with later maturity dates. Since the graph shows improvements decreasing by 30 percent point for some periods and the average predicted improvement was 29,3%, quantitative conclusions could only be called robust for the period in the middle of the graph. However, as stated before, the conclusions only depend on an indication of the possibilities. There were no periods where the lowest result of the sensitivity analysis became 0%. Furthermore the average of the lowest improvements from the analysis for all the periods is still 17,2%, where the highest improvements from the analysis average 36,3%.

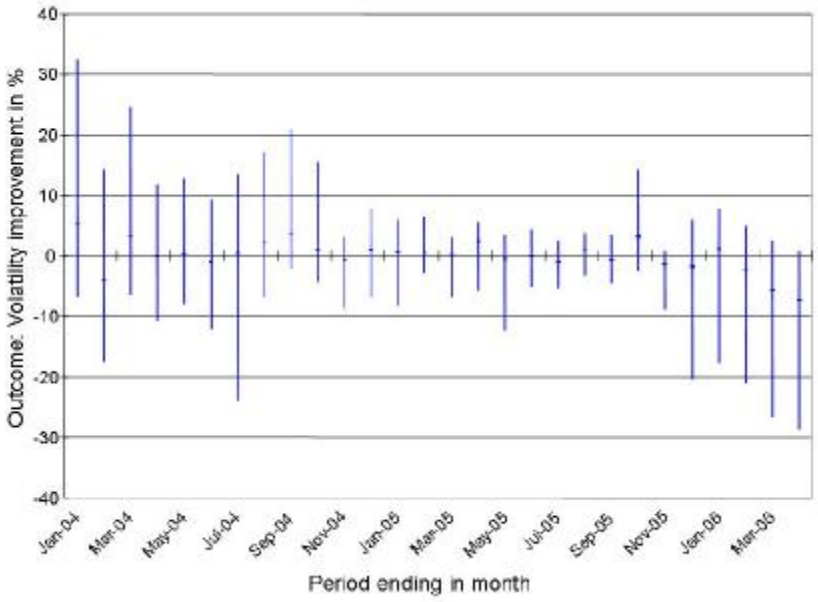

Figure 15 Summary of sensitivity analyses for all periods

Robustness

The intention of conducting a sensitivity analysis is to see how sensitive the conclusions of a research are for different values of the estimated variables. The conducted analysis provides an answer to the fourth question raised in chapter two, the problem definition.

What is the robustness of the outcomes?

The exploratory nature of this research ensures that the conclusions are not strongly influenced by the exact value of the improvements predicted while combining the fund with virtual options. The use of virtual options makes drawing strong quantitative conclusions impossible. The sensitivity analysis showed that drawing quantitative conclusions might be problematic for the periods before November 2004 and after November 2005. Qualitative conclusions, based on rough indications provided by the model are reasonable, since the sensitivity analysis didn't show any extreme differences in outcomes they are robust for slightly different values of the estimated variables. For example there was no period in which the predicted improvement became 0% and all the lowest improvements still average 17,2%. The conclusions wouldn't differ when either the risk-free interest rate or the volatility of the underlying value would have been estimated different.

7. Conclusions and Recommendations

This seventh chapter formulates the conclusions that can be drawn from this exploratory research, in other words it will answer the questions raised in the problem definition in chapter two and combine these answers into an answer to the main problem.

Answering the questions

To be able to provide an answer to the main problem, chapter two divided it into the following four questions.

> *What are the specific requirements of a Turkish pension fund for an investment vehicle?*
>
> *What would be the daily prices of virtual put and call index options on the ISE-100 for 2004, 2005 and 2006?*
>
> *What would be the performance in terms of return and volatility of portfolios combining the virtual options with current investment vehicles?*
>
> *What is the robustness of the outcomes?*

The third chapter explored the specific requirements for investment vehicles of a Turkish pension fund. This led to a few relevant results. The regulation in Turkey is already suitable for option trade on TurkDEX and for pension funds to invest in options. However since these products are so new, regulation might change over the coming years. Regulation restricts the amount of value of the pension fund to be invested in options to 20% for stock and flexible types and doesn't allow investing in options for other types. Since the average fluctuation in daily returns for Başak Emekliliks stock fund was high with 133,7% - measured from January 2004 until June 2006- the main focus for the coming years could well be decreasing the risk by lowering the volatility, which is also the general trend predicted by the pension monitoring system in Turkey. One of the relevant characteristics of a pension fund is the scale of the investments. Since the trade of options hasn't started yet and pension funds are growing incredibly rapidly, a prediction when the option market will be deep enough, would have little predictive value. One indication is the trading of futures, which already started in 2005. The amount of value traded in future contracts is growing very fast, but so do the pension funds. In any case the market will need at least a few years after its opening, in order to grow deep enough to be interesting for pension funds. Experts show optimistic outlooks on the growth of these markets. This optimism should be under the condition that the political situation in Turkey doesn't destabilise. As mentioned in the introduction, the political situation was a few times on the brink of a crisis recently, which would definitely have a devastating effect on the economy and change outlooks dramatically.

Chapter four provided a model of virtual options on the ISE-100 index for the years 2004, 2005 and 2006. The model is based on an extended version of the Black & Scholes model and the assumptions of the model were shown to be reasonable. The model was used to calculate the daily prices for the mentioned options. Graphs summarising the prices were given in figure 4 at the end of the chapter and tables with the data are added to this report as appendix three.

In order to evaluate the performance of portfolios combining these virtual options with the current funds, Markowitz analyses were conducted in chapter five. This approach is a simplification of reality, where options and current vehicles would be determined in relation to each other, instead of only determining options after the other vehicles are fixed. This simplified approach suits the explorative approach of this paper well. More extensive research can only be conducted after option trading has started. The results of these Markowitz analyses, combining the fund with several modelled options for a series of two-month periods from January 2004 and May 2006, were given in the table in figure 8. The improvements in expected volatility provided by the portfolios, except for one period without improvement, ranged from 24,5% to 43,0%. They averaged 29,3%, which is including the 0% period. A comparable analysis can be used in the future to find portfolios with higher expected returns or a combination of these two in some specific proportion. The focus on decreasing volatility in this paper follows the general trend of pension funds predicted by the Turkish pension monitoring system.

The model contained several variables, of which two – the risk-free interest rate and the volatility of the underlying value of the options- were not directly observable and therefore had to be estimated. To evaluate the sensitivity of the results for –slight- changes in the values of these estimated variables, a sensitivity analysis was conducted in chapter six. The results of the model for all periods were evaluated for values of the two variables ranging from 50% to 150% of the original estimates. The analysis showed that drawing quantitative conclusions might be problematic for the periods before November 2004 and after November 2005. Qualitative conclusions, based on rough indications provided by the model are reasonable, since the sensitivity analysis didn't show any extreme differences in outcomes they are robust for slightly different values of the estimated variables. For example there was no period in which the predicted improvement became 0% and all the lowest improvements still average 17,2%. The conclusions won't differ when either the risk-free interest rate or the volatility of the underlying value would have been estimated different.

Main problem

The main problem introduced in chapter one was specified to the following in chapter two.

> *Will the Turkish option market form a valuable investment vehicle for the pension funds of Başak Emeklilik?*

The explorations, structured by the four questions posed in chapter two showed that the answer is "yes". The main advantage of options can be a decrease in volatility of the pension funds, which will already be the focus in the near future, but there are several conditions. After the introduction of option trade it will take some years before the market will be deep enough. When the Turkish political situation destabilises that period can be a lot longer, since the markets are very sensitive for political turmoil. Since both options and private pension plans are very new products, regulation might change in the near future. Besides whether options are suitable for the specific relation between assets and liabilities typical for pension funds can only be investigated after their introduction when there is real data.

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Appendix I Centered moving average

In order to improve understanding of this method this appendix shows it's application on the same data as it was used on in chapter 3.

The technique of an n-moving average determines for each point in time of a time serie the average of the last n terms, more or less smoothing out the individual fluctuations and leaving the trend. Appointing the average of the last n terms to term n has the disadvantage of showing the trend of the past period at the current point in time, therefore moving the trend through time. A technique called the centered moving average (CMA) solves this issue by placing the moving averages in the middle of their period. When n is an even number, as it is in this case, the middle of the period is between two values of the original time series. For example the first average of eight terms should actually be placed between term 4 and 5. To solve this problem two successing averages are averaged and again placed in the middle of the interval between them, placing them at a point in time where there is a value for the original time series.

Following is a table with some weekly trade values on TurkDEX and their centered moving average for a period of eight weeks.

Week	Value	CMA (8)	CMA (8) – corrected
1	2.514.906,00 YTL		
2	4.621.170,00 YTL		
3	4.883.550,00 YTL		
4	6.554.944,00 YTL		
4,5		7.011.169,39 YTL	
5	7.338.499,60 YTL		7.645.255,92 YTL
5,5		8.279.342,45 YTL	
6	12.163.676,00 YTL		9.006.746,73 YTL
6,5		9.734.151,01 YTL	
7	8.098.383,50 YTL		10.396.230,51 YTL
7,5		11.058.310,01 YTL	
8	9.914.226,00 YTL		11.475.268,98 YTL
8,5		11.892.227,95 YTL	
9	12.660.290,50 YTL		12.761.203,44 YTL
9,5		13.630.178,94 YTL	
10	16.259.638,50 YTL		13.657.089,19 YTL
10,5		13.683.999,44 YTL	
11	15.476.822,00 YTL		14.137.963,34 YTL
11,5		14.591.927,25 YTL	
12	13.226.287,50 YTL		
13	21.242.107,50 YTL		
14	12.594.240,00 YTL		
15	15.361.806,00 YTL		

Appendix II Virtual option example

In order to improve understanding of the model this appendix shows it's application. A call option on the ISE-100 index has exercise price 40.000 and maturity date the 30th of July 2006. On the 1st of March 2006, the ISE-100 index closes at 47.492,97 points, therefore the price of this option will be:

$$F = 47.492,97e^{(0,0521-0,2718)0,3306} \approx 44.165,73$$

$$d_1 = \frac{\ln\left(\frac{44.165,73}{40.000}\right) + \left(\frac{1,12^2}{2}\right)0,3306}{1,12\sqrt{0,3306}} \approx 0,50$$

$$d_2 = 0,50 - 1,12\sqrt{0,3306} \approx -0,14$$

$$C = \Phi(0,50) \cdot 47.492,97 \cdot e^{-0,2718 \cdot 0,3306} - \Phi(-0,14) \cdot 40.000 \cdot e^{-0,0521 \cdot 0,3306} \approx 12.608,19$$

The risk free interest rate *r* for 2006 was 5,21%, the dividend yield *q* on the stocks of the ISE-100 was 27,18% and the volatility in the daily returns of the ISE-100 was 1,08 as given in chapter 4 in the section on the application of the model for virtual options. The value for *T* was determined by dividing the number of days left to the maturity date by 360, as is the standard procedure.

$$T = \frac{119}{360} \approx 0,3306$$

The contract gives the owner the right to buy at 40.000 while the actual value on the first of March is 47.492. The option contract is therefore 7.492 points in the money. This seems like a big difference, but the contract could have been bought easily in early January 2006 when the actual value of the ISE-100 was around or even below 40.000 and the contract would have been at the money. There is still 5.115 points left as the so called time value. This sounds as a very high amount, but compared to the price of 47.492, it can be considered reasonable, since it is around 10% of the value. Even more so taking the high volatility of this market into consideration.

In practice the index options introduced will presumably be quoted in a hundredth or even a thousandth part of the index, in order to make trading the contracts more accessible and markets more liquid. For the purpose of calculating the returns these options would generate, this doesn't make any difference, therefore this report will quote the original high option prices to prevent confusion.

Appendix III Tables with prices for more virtual ISE-100 options

The following pages show tables with the modeled options prices for call and put options on the ISE-100 with an exercise price of 20.000 and maturity date 30-12-2004 for all trading days in 2004, with exercise price 25.000 and maturity date 30-12-2005 for all trading days in 2005 and with exercise price 40.000 and maturity date 30-06-2006 for all trading days in the first half of 2006.

Date	ISE-100	Call	Put	Date	ISE-100	Call	Put
01.05.04	19.696,61	5.195,01	4.179,37	04.05.04	20.330,90	5.238,03	3.912,20
01.06.04	19.013,84	4.866,82	4.537,53	04.06.04	20.272,94	5.204,34	3.940,10
01.07.04	19.382,80	5.039,95	4.345,27	04.07.04	20.040,10	5.081,75	4.053,98
01.08.04	19.404,91	5.048,27	4.335,05	04.08.04	19.419,79	4.766,29	4.362,46
01.09.04	19.926,48	5.297,64	4.066,42	04.09.04	19.505,17	4.804,41	4.318,84
01.12.04	19.558,81	5.113,03	4.260,20	04.12.04	19.259,50	4.669,29	4.440,30
01.13.04	19.460,26	5.063,30	4.312,60	04.13.04	19.104,36	4.588,31	4.518,10
01.14.04	18.818,56	4.755,46	4.650,03	04.14.04	18.678,22	4.375,88	4.735,45
01.15.04	18.952,22	4.816,12	4.580,61	04.15.04	18.687,54	4.375,76	4.729,64
01.16.04	18.301,16	4.508,36	4.927,48	04.16.04	19.269,46	4.656,08	4.431,69
01.19.04	17.788,62	4.264,42	5.206,82	04.19.04	19.935,72	4.976,37	4.096,63
01.20.04	18.832,78	4.746,91	4.648,73	04.20.04	19.528,06	4.766,28	4.297,85
01.21.04	18.899,94	4.776,09	4.614,34	04.21.04	19.270,39	4.633,20	4.426,08
01.22.04	18.518,07	4.593,53	4.817,23	04.22.04	19.431,50	4.708,60	4.344,01
01.26.04	18.356,54	4.507,05	4.906,61	04.26.04	18.586,46	4.273,77	4.768,81
01.27.04	17.899,54	4.292,64	5.152,78	04.27.04	18.217,13	4.091,43	4.959,44
01.28.04	17.902,02	4.290,88	5.152,13	04.28.04	18.229,71	4.092,34	4.951,42
01.29.04	17.282,30	4.006,25	5.490,81	04.29.04	17.737,88	3.855,14	5.209,70
01.30.04	17.259,25	3.992,87	5.504,07	04.30.04	18.022,69	3.983,75	5.057,15
02.05.04	17.033,75	3.876,50	5.631,14	05.03.04	17.678,25	3.806,36	5.235,15
02.06.04	16.965,83	3.843,09	5.669,24	05.04.04	18.244,74	4.068,30	4.934,24
02.09.04	17.640,98	4.137,90	5.299,68	05.05.04	18.272,37	4.076,19	4.918,16
02.10.04	17.418,52	4.033,52	5.421,35	05.06.04	17.624,05	3.765,06	5.259,00
02.11.04	18.000,26	4.296,82	5.106,51	05.07.04	17.001,97	3.474,69	5.594,37
02.12.04	18.885,89	4.710,31	4.637,95	05.10.04	16.807,71	3.370,94	5.695,84
02.13.04	19.000,46	4.762,10	4.578,78	05.11.04	17.102,52	3.498,06	5.531,81
02.16.04	19.324,49	4.909,29	4.412,73	05.12.04	17.144,65	3.511,57	5.506,85
02.17.04	19.010,14	4.754,46	4.575,84	05.13.04	16.971,90	3.427,77	5.599,45
02.18.04	19.478,68	4.978,23	4.334,67	05.14.04	16.531,26	3.225,83	5.841,82
02.19.04	18.605,97	4.555,17	4.787,93	05.17.04	16.365,47	3.135,99	5.928,75
02.20.04	18.603,83	4.550,92	4.789,41	05.18.04	16.124,30	3.025,73	6.063,32
02.23.04	18.284,02	4.390,03	4.959,14	05.20.04	16.287,74	3.084,69	5.966,16
02.24.04	18.497,74	4.487,43	4.846,42	05.21.04	16.628,77	3.228,23	5.772,33
02.25.04	18.707,11	4.583,55	4.736,78	05.24.04	17.167,42	3.451,93	5.468,38
02.26.04	18.771,63	4.611,01	4.703,32	05.25.04	16.791,05	3.276,31	5.672,80
02.27.04	18.889,20	4.663,99	4.642,34	05.26.04	17.235,48	3.470,79	5.426,51
03.01.04	18.786,39	4.601,00	4.696,59	05.27.04	17.067,11	3.388,11	5.515,88
03.02.04	19.356,62	4.873,56	4.402,53	05.28.04	17.327,87	3.500,75	5.371,43

Date	ISE-100	Call	Put	Date	ISE-100	Call	Put
03.03.04	19.171,91	4.780,13	4.497,41	05.31.04	17.081,08	3.369,52	5.498,00
03.04.04	19.015,47	4.700,82	4.578,15	06.01.04	17.185,50	3.416,94	5.440,99
03.05.04	19.165,70	4.770,16	4.500,87	06.02.04	16.763,06	3.220,44	5.670,60
03.08.04	19.495,36	4.920,89	4.332,79	06.03.04	16.897,28	3.274,03	5.593,65
03.09.04	19.488,47	4.913,98	4.336,37	06.04.04	17.708,15	3.639,04	5.151,46
03.10.04	19.798,79	5.064,00	4.179,69	06.07.04	18.020,29	3.766,71	4.978,01
03.11.04	19.381,40	4.854,21	4.390,90	06.08.04	17.604,06	3.564,47	5.195,68
03.12.04	19.364,41	4.842,25	4.399,55	06.09.04	17.615,57	3.563,22	5.186,59
03.15.04	19.526,54	4.911,10	4.317,12	06.10.04	17.708,69	3.600,02	5.133,96
03.16.04	19.321,60	4.806,48	4.421,06	06.11.04	17.664,46	3.572,67	5.154,51
03.17.04	19.294,50	4.789,43	4.434,73	06.14.04	17.079,84	3.283,71	5.461,21
03.18.04	19.611,13	4.941,83	4.274,12	06.15.04	17.230,48	3.345,27	5.375,81
03.19.04	20.023,77	5.144,19	4.067,46	06.16.04	17.099,00	3.278,65	5.444,35
03.22.04	20.167,21	5.205,40	3.996,10	06.17.04	16.901,38	3.182,78	5.549,79
03.23.04	20.185,78	5.211,06	3.986,81	06.18.04	16.964,08	3.203,94	5.511,92
03.24.04	20.347,82	5.289,57	3.906,91	06.21.04	16.785,39	3.103,01	5.600,74
03.25.04	20.472,61	5.349,49	3.845,66	06.22.04	16.752,76	3.081,41	5.615,46
03.26.04	20.836,12	5.532,72	3.669,01	06.23.04	16.820,03	3.104,13	5.574,59
03.29.04	20.887,00	5.547,91	3.644,20	06.24.04	16.888,60	3.127,48	5.533,06
03.30.04	20.030,71	5.105,55	4.061,75	06.25.04	17.355,16	3.331,40	5.274,10
03.31.04	20.190,83	5.182,70	3.982,42	06.28.04	17.710,37	3.473,72	5.072,28
04.01.04	20.322,17	5.249,58	3.917,95	06.29.04	17.735,53	3.478,00	5.055,09
04.02.04	20.485,03	5.328,97	3.838,11	06.30.04	17.967,60	3.579,77	4.928,49
07.01.04	18.290,31	3.726,44	4.756,14	09.28.04	22.293,78	4.973,23	2.323,37
07.02.04	18.416,39	3.779,77	4.687,07	09.29.04	22.219,88	4.914,59	2.342,38
07.05.04	18.554,81	3.823,93	4.603,90	09.30.04	21.953,52	4.741,12	2.439,03
07.06.04	18.237,60	3.662,32	4.763,20	10.01.04	21.722,50	4.590,08	2.522,77
07.07.04	18.296,69	3.682,87	4.728,35	10.04.04	21.987,74	4.702,28	2.381,00
07.08.04	18.076,87	3.569,52	4.838,52	10.05.04	21.612,50	4.465,30	2.523,02
07.09.04	18.327,07	3.681,57	4.704,07	10.06.04	22.287,12	4.851,99	2.238,84
07.12.04	18.368,44	3.677,22	4.669,45	10.07.04	22.432,22	4.925,04	2.170,55
07.13.04	18.492,99	3.729,49	4.600,87	10.08.04	22.951,36	5.231,14	1.961,27
07.14.04	18.635,15	3.790,74	4.523,66	10.11.04	22.787,34	5.082,28	1.987,72
07.15.04	18.966,24	3.946,33	4.351,86	10.12.04	22.289,86	4.759,44	2.166,13
07.16.04	19.157,29	4.033,80	4.251,98	10.13.04	22.630,03	4.952,52	2.022,80
07.19.04	18.944,98	3.901,85	4.343,45	10.14.04	22.318,89	4.744,47	2.129,66
07.20.04	18.881,31	3.861,51	4.370,49	10.15.04	22.477,09	4.825,13	2.055,88
07.21.04	18.779,76	3.802,46	4.416,69	10.18.04	22.334,30	4.686,48	2.071,33
07.22.04	18.628,69	3.719,26	4.488,27	10.19.04	22.550,89	4.803,17	1.975,20
07.23.04	18.904,28	3.846,73	4.343,85	10.20.04	22.220,77	4.581,97	2.087,89
07.26.04	18.645,38	3.691,87	4.459,02	10.21.04	22.201,51	4.552,41	2.081,36
07.27.04	18.774,62	3.746,53	4.388,16	10.22.04	22.243,97	4.560,49	2.050,74
07.28.04	19.018,63	3.858,93	4.260,25	10.25.04	21.907,82	4.300,27	2.137,99
07.29.04	19.111,36	3.896,34	4.208,65	10.26.04	22.142,50	4.424,24	2.031,06
07.30.04	19.380,86	4.023,79	4.070,31	10.27.04	22.565,77	4.668,12	1.855,44
08.02.04	19.698,12	4.168,51	3.905,19	10.28.04	22.899,89	4.861,25	1.718,23
08.03.04	19.427,37	4.019,51	4.030,66	11.01.04	22.857,94	4.776,87	1.687,13
08.04.04	19.048,52	3.817,87	4.211,58	11.02.04	23.215,56	4.989,23	1.545,64

Date	ISE-100	Call	Put	Date	ISE-100	Call	Put
08.05.04	19.344,25	3.957,97	4.059,67	11.03.04	23.437,79	5.116,26	1.454,22
08.06.04	19.187,55	3.868,72	4.130,84	11.04.04	23.006,45	4.813,34	1.586,43
08.09.04	19.248,10	3.870,05	4.082,78	11.05.04	23.215,57	4.929,96	1.497,71
08.10.04	19.392,64	3.933,79	4.005,70	11.08.04	22.615,99	4.478,32	1.656,99
08.11.04	18.908,57	3.679,29	4.238,99	11.09.04	22.544,28	4.410,78	1.664,94
08.12.04	18.775,46	3.603,11	4.299,64	11.10.04	22.618,03	4.435,98	1.620,18
08.13.04	18.825,98	3.617,99	4.267,71	11.11.04	22.186,87	4.140,06	1.759,21
08.16.04	18.832,15	3.590,12	4.244,85	11.12.04	22.104,69	4.065,67	1.770,77
08.17.04	19.459,72	3.896,63	3.927,51	11.17.04	22.566,40	4.240,10	1.502,44
08.18.04	19.268,05	3.788,11	4.014,38	11.18.04	23.132,59	4.589,49	1.289,43
08.19.04	19.187,80	3.736,77	4.047,02	11.19.04	23.176,70	4.595,07	1.254,68
08.20.04	19.286,34	3.776,09	3.991,53	11.22.04	22.931,37	4.355,04	1.271,37
08.23.04	19.363,67	3.782,95	3.932,24	11.23.04	23.472,44	4.698,49	1.077,53
08.24.04	19.663,58	3.926,58	3.779,69	11.24.04	23.516,34	4.703,68	1.042,62
08.25.04	19.558,01	3.860,73	3.823,15	11.25.04	23.464,46	4.641,77	1.036,39
08.26.04	19.572,29	3.856,92	3.808,78	11.26.04	23.293,21	4.496,41	1.066,07
08.27.04	19.855,25	3.993,21	3.665,84	11.29.04	22.799,16	4.074,30	1.149,40
08.31.04	20.218,37	4.140,07	3.464,52	11.30.04	22.486,20	3.834,71	1.226,57
09.01.04	20.512,20	4.298,83	3.329,45	12.01.04	22.560,87	3.854,01	1.175,00
09.02.04	20.525,92	4.294,66	3.315,29	12.02.04	23.150,06	4.227,23	962,83
09.03.04	20.775,00	4.419,55	3.194,84	12.03.04	23.008,07	4.097,79	979,18
09.06.04	20.851,56	4.426,27	3.136,22	12.06.04	23.049,51	4.031,95	883,31
09.07.04	21.119,16	4.563,69	3.009,77	12.07.04	23.075,58	4.017,67	846,76
09.08.04	21.468,27	4.749,63	2.850,34	12.08.04	22.625,44	3.668,16	951,19
09.09.04	21.398,03	4.697,38	2.872,07	12.09.04	22.679,88	3.670,47	902,87
09.10.04	21.004,14	4.462,46	3.034,78	12.10.04	22.943,67	3.820,85	793,27
09.13.04	21.060,24	4.456,26	2.983,71	12.13.04	23.634,75	4.225,58	518,34
09.14.04	21.705,34	4.812,15	2.698,24	12.14.04	23.417,90	4.025,07	538,49
09.15.04	21.616,45	4.747,96	2.726,68	12.15.04	23.289,69	3.890,80	536,24
09.16.04	21.704,75	4.786,33	2.680,50	12.16.04	23.935,20	4.355,60	359,33
09.17.04	20.833,16	4.277,36	3.046,87	12.17.04	24.360,63	4.666,84	248,96
09.20.04	20.373,42	3.984,15	3.224,64	12.20.04	24.341,41	4.553,71	166,49
09.21.04	21.192,85	4.425,96	2.850,77	12.21.04	24.044,56	4.268,77	182,21
09.22.04	21.491,42	4.583,30	2.713,29	12.22.04	24.525,29	4.649,49	86,01
09.23.04	22.276,74	5.031,85	2.380,27	12.23.04	24.430,82	4.536,25	71,06
09.24.04	22.307,44	5.036,76	2.358,23	12.24.04	24.537,72	4.602,81	34,53
03.01.05	25.445,15	6899,73	4796,87	04.04.05	25.445,11	6568,69	4875,37
04.01.05	25.042,00	6700,34	5005,10	05.04.05	25.682,54	6685,50	4759,29
05.01.05	24.422,94	6398,62	5326,89	06.04.05	26.056,61	6874,03	4578,29
06.01.05	24.561,85	6462,67	5256,50	07.04.05	25.831,22	6752,16	4686,35
07.01.05	25.308,25	6822,58	4874,48	08.04.05	25.786,45	6723,93	4707,44
10.01.05	25.604,65	6960,63	4729,52	11.04.05	25.370,26	6494,22	4907,55
11.01.05	26.110,17	7209,06	4476,90	12.04.05	25.077,96	6339,74	5049,92
12.01.05	26.271,34	7287,21	4398,34	13.04.05	25.293,24	6444,11	4943,55
13.01.05	26.493,02	7396,13	4290,05	14.04.05	24.541,95	6058,17	5313,45
14.01.05	26.362,68	7328,11	4356,85	15.04.05	23.853,34	5710,67	5659,10
17.01.05	26.863,20	7573,76	4115,39	18.04.05	23.285,94	5416,53	5946,01

Date	ISE-100	Call	Put	Date	ISE-100	Call	Put
18.01.05	26.813,13	7545,89	4142,06	19.04.05	24.143,88	5831,01	5507,11
19.01.05	26.918,10	7596,84	4092,52	20.04.05	24.175,89	5841,05	5489,69
24.01.05	26.469,43	7356,16	4322,89	21.04.05	24.419,37	5956,65	5366,36
25.01.05	26.859,99	7552,05	4132,71	22.04.05	24.730,75	6107,43	5210,32
26.01.05	27.056,02	7649,75	4038,86	25.04.05	24.798,07	6123,77	5173,01
27.01.05	27.302,74	7774,04	3920,91	26.04.05	24.483,97	5959,20	5327,09
28.01.05	27.074,09	7653,82	4033,82	27.04.05	24.070,13	5746,31	5532,60
31.01.05	27.330,35	7777,97	3915,15	28.04.05	23.519,63	5468,93	5810,29
01.02.05	27.849,79	8047,82	3665,56	29.04.05	23.591,64	5497,83	5771,74
02.02.05	27.936,53	8090,67	3626,16	02.05.05	24.252,96	5806,10	5432,37
03.02.05	27.554,79	7889,06	3810,77	03.05.05	24.137,94	5742,28	5488,13
04.02.05	27.813,16	8021,12	3688,95	04.05.05	24.560,22	5947,81	5275,95
07.02.05	28.201,72	8217,45	3510,20	05.05.05	25.099,87	6216,25	5009,31
08.02.05	28.269,69	8250,80	3480,06	06.05.05	24.950,82	6133,52	5080,20
09.02.05	27.528,07	7858,96	3834,34	09.05.05	24.702,24	5987,34	5196,30
10.02.05	27.308,78	7742,06	3941,21	10.05.05	24.688,26	5973,63	5201,14
11.02.05	27.736,29	7962,21	3738,35	11.05.05	24.662,88	5954,08	5211,54
14.02.05	28.003,60	8094,41	3616,72	12.05.05	25.114,43	6178,35	4988,83
15.02.05	28.164,08	8176,45	3542,78	13.05.05	25.325,67	6280,82	4884,64
16.02.05	27.661,58	7908,78	3782,11	16.05.05	24.921,28	6052,10	5074,03
17.02.05	27.000,44	7561,08	4100,05	17.05.05	24.846,11	6006,71	5108,38
18.02.05	27.293,22	7710,11	3960,79	18.05.05	25.205,51	6184,75	4931,60
21.02.05	26.864,27	7477,68	4170,82	20.05.05	25.464,89	6305,68	4802,30
22.02.05	26.657,40	7367,47	4271,98	23.05.05	24.329,06	5701,25	5347,45
23.02.05	26.921,27	7500,58	4145,72	24.05.05	24.140,93	5599,24	5438,15
24.02.05	27.354,57	7723,15	3939,49	25.05.05	24.119,79	5581,23	5445,87
25.02.05	28.031,45	8076,98	3620,95	26.05.05	24.054,09	5540,86	5475,78
28.02.05	28.396,17	8262,34	3455,11	27.05.05	24.453,14	5734,49	5274,95
01.03.05	27.768,46	7918,21	3752,22	30.05.05	24.977,78	5980,46	5010,04
02.03.05	27.226,38	7628,89	4009,49	31.05.05	25.236,48	6107,02	4882,48
03.03.05	27.558,88	7800,49	3853,10	01.06.05	25.230,81	6104,07	4885,20
04.03.05	27.663,22	7852,25	3805,04	02.06.05	25.799,12	6394,87	4612,28
07.03.05	27.789,92	7909,09	3748,72	03.06.05	26.051,55	6521,54	4491,11
08.03.05	27.698,34	7856,85	3792,57	06.06.05	25.533,07	6224,01	4725,84
09.03.05	27.746,37	7878,82	3771,03	07.06.05	25.478,03	6187,29	4748,75
10.03.05	27.519,81	7754,83	3878,12	08.06.05	25.779,75	6338,77	4603,11
11.03.05	27.572,79	7779,25	3854,08	09.06.05	25.499,99	6183,11	4731,80
14.03.05	26.936,75	7431,98	4156,42	10.06.05	25.725,19	6294,12	4622,21
15.03.05	26.547,17	7224,34	4342,88	13.06.05	25.609,99	6209,06	4666,15
16.03.05	25.331,70	6596,13	4934,66	14.06.05	25.929,93	6370,99	4512,73
17.03.05	24.475,97	6163,15	5361,93	15.06.05	26.209,42	6512,81	4379,67
18.03.05	25.348,51	6595,70	4926,47	16.06.05	26.579,72	6705,34	4206,49
21.03.05	24.636,68	6224,17	5280,35	17.06.05	26.529,32	6669,80	4225,96
22.03.05	25.218,21	6511,40	4990,58	20.06.05	26.709,17	6743,39	4133,51
23.03.05	24.439,26	6116,44	5379,09	21.06.05	26.746,40	6755,50	4113,00
24.03.05	25.068,49	6426,35	5064,30	22.06.05	26.779,27	6765,20	4094,44
25.03.05	25.502,60	6641,84	4850,21	23.06.05	27.021,54	6890,43	3982,00

Date	ISE-100	Call	Put	Date	ISE-100	Call	Put
28.03.05	24.842,21	6293,03	5175,40	24.06.05	27.033,40	6888,60	3972,93
29.03.05	24.479,67	6106,79	5356,23	27.06.05	26.597,80	6622,89	4156,64
30.03.05	24.600,92	6162,17	5294,90	28.06.05	26.811,40	6731,57	4056,34
31.03.05	25.557,76	6641,24	4821,66	29.06.05	27.135,90	6902,70	3907,58
01.04.05	25.740,76	6735,20	4732,62	30.06.05	26.957,32	6794,70	3982,77
01.07.05	27.616,86	7155,10	3688,25	29.09.05	33.396,23	9841,79	1005,15
04.07.05	27.702,25	7177,10	3638,71	30.09.05	33.333,23	9783,77	1014,82
05.07.05	27.377,55	6984,72	3775,65	03.10.05	34.300,90	10439,11	716,58
06.07.05	27.781,35	7204,21	3595,96	04.10.05	35.624,79	11403,40	361,68
07.07.05	27.689,50	7142,96	3631,17	05.10.05	34.775,67	10761,48	573,58
08.07.05	27.842,43	7220,96	3560,86	06.10.05	33.510,39	9827,66	909,74
11.07.05	27.808,07	7173,72	3561,86	07.10.05	33.413,61	9744,03	927,59
12.07.05	27.689,24	7096,56	3608,15	10.10.05	33.505,96	9767,35	872,67
13.07.05	28.061,92	7300,65	3444,18	11.10.05	34.040,21	10142,03	717,80
14.07.05	28.500,87	7545,70	3254,91	12.10.05	33.118,44	9458,10	960,34
15.07.05	28.427,27	7493,48	3280,92	13.10.05	32.054,34	8686,39	1257,44
18.07.05	28.402,65	7450,64	3276,58	14.10.05	31.440,03	8241,79	1431,85
19.07.05	28.675,40	7600,71	3158,54	17.10.05	31.850,68	8474,82	1268,36
20.07.05	28.713,45	7613,48	3137,89	18.10.05	31.586,83	8272,26	1334,37
21.07.05	28.992,13	7768,58	3018,94	19.10.05	30.766,71	7687,56	1574,49
22.07.05	29.188,09	7875,60	2934,63	20.10.05	31.403,90	8107,87	1362,33
25.07.05	29.273,25	7897,44	2885,22	21.10.05	31.428,62	8106,32	1340,77
26.07.05	28.730,69	7564,41	3099,39	24.10.05	31.845,70	8343,46	1174,98
27.07.05	29.164,82	7812,68	2918,17	25.10.05	31.669,96	8199,63	1211,60
28.07.05	29.343,03	7909,66	2841,57	26.10.05	31.474,44	8041,81	1254,02
29.07.05	29.615,29	8064,17	2728,47	27.10.05	31.273,31	7880,12	1298,18
01.08.05	29.776,69	8142,33	2654,51	28.10.05	31.038,52	7695,02	1352,58
02.08.05	29.543,48	7990,31	2740,34	31.10.05	31.963,99	8291,67	1037,93
03.08.05	29.727,05	8091,77	2662,87	01.11.05	32.791,99	8897,56	815,82
04.08.05	30.123,59	8324,84	2504,05	02.11.05	33.152,10	9147,04	709,91
05.08.05	29.945,44	8204,96	2566,96	07.11.05	33.830,10	9571,26	479,76
08.08.05	29.924,83	8160,99	2557,54	08.11.05	33.749,43	9490,97	484,87
09.08.05	29.701,00	8012,85	2637,88	09.11.05	33.848,29	9549,20	448,96
10.08.05	29.683,21	7991,13	2638,60	10.11.05	34.709,65	10207,29	250,43
11.08.05	29.111,84	7632,37	2855,86	11.11.05	34.096,32	9706,42	367,61
12.08.05	28.175,93	7062,65	3226,70	14.11.05	34.171,51	9711,47	311,67
15.08.05	28.074,94	6967,57	3246,56	15.11.05	34.324,04	9814,64	267,05
16.08.05	28.257,65	7063,27	3164,22	16.11.05	34.866,57	10233,30	147,92
17.08.05	27.906,28	6844,20	3301,17	17.11.05	35.127,34	10428,95	87,53
18.08.05	28.000,00	6886,85	3254,76	18.11.05	35.314,31	10566,30	42,65
19.08.05	28.456,86	7145,06	3060,76	21.11.05	35.654,99	10803,08	1,00
22.08.05	28.951,44	7405,54	2840,64	22.11.05	35.254,14	10453,13	8,61
23.08.05	29.191,60	7539,41	2739,01	23.11.05	36.179,29	11217,31	1,00
24.08.05	29.372,23	7637,77	2661,40	24.11.05	36.907,79	11830,04	1,00
25.08.05	29.814,17	7898,98	2485,34	25.11.05	36.759,89	11691,01	1,00
26.08.05	30.020,40	8015,63	2400,42	28.11.05	36.621,47	11536,94	1,00
29.08.05	30.015,12	7975,14	2379,20	29.11.05	37.495,22	12297,04	1,00

Date	ISE-100	Call	Put	Date	ISE-100	Call	Put
31.08.05	30.908,02	8518,87	2039,37	30.11.05	38.088,65	12820,60	1,00
01.09.05	31.947,95	9197,92	1678,50	01.12.05	38.296,91	13003,26	1,00
02.09.05	31.701,62	9023,83	1755,40	02.12.05	38.573,71	13250,68	1,00
05.09.05	31.879,45	9105,72	1673,47	05.12.05	39.130,73	13758,12	1,00
06.09.05	31.832,50	9062,58	1681,95	06.12.05	38.917,82	13560,68	1,00
07.09.05	31.385,01	8754,99	1826,53	07.12.05	38.441,59	13118,06	1,00
08.09.05	31.485,39	8808,47	1784,31	08.12.05	38.587,77	13253,72	1,00
09.09.05	32.202,66	9273,19	1536,43	09.12.05	37.496,18	12237,29	1,00
12.09.05	32.711,13	9580,87	1349,67	12.12.05	38.202,19	12896,05	1,00
13.09.05	32.541,11	9453,00	1396,50	13.12.05	37.741,70	12462,35	1,00
14.09.05	32.632,44	9502,90	1359,75	14.12.05	37.870,57	12586,60	1,00
15.09.05	33.271,11	9929,82	1152,68	15.12.05	37.631,57	12362,01	1,00
16.09.05	33.294,26	9933,99	1138,38	16.12.05	37.716,70	12447,25	1,00
19.09.05	33.221,15	9846,84	1138,39	19.12.05	37.960,13	12704,57	1,00
20.09.05	33.719,30	10183,37	981,46	20.12.05	37.729,42	12490,49	1,00
21.09.05	33.863,82	10273,44	931,69	21.12.05	38.210,24	12973,81	1,00
22.09.05	33.465,61	9980,62	1041,77	22.12.05	38.353,12	13130,00	1,00
23.09.05	33.250,45	9817,19	1098,18	23.12.05	38.919,51	13707,60	1,00
26.09.05	33.516,04	9965,74	995,21	26.12.05	39.139,08	13991,64	1,00
27.09.05	33.319,18	9813,75	1044,77	27.12.05	39.015,86	13892,97	1,00
28.09.05	32.744,95	9397,65	1207,60	28.12.05	39.220,17	14121,03	1,00
02.01.06	39.790,72	9046,59	7903,27	04.04.06	44.070,94	9461,56	4723,53
03.01.06	40.665,44	9490,48	7479,83	05.04.06	44.088,59	9441,85	4693,69
04.01.06	41.362,47	9847,28	7146,98	06.04.06	43.710,59	9185,94	4823,30
05.01.06	41.722,40	10026,38	6973,54	07.04.06	44.284,17	9497,96	4569,26
06.01.06	41.905,41	10110,58	6882,13	10.04.06	43.099,34	8699,11	4977,81
09.01.06	41.905,41	10064,82	6858,54	11.04.06	42.890,29	8544,43	5039,71
16.01.06	43.628,83	10910,69	6032,80	12.04.06	42.505,02	8288,15	5176,22
17.01.06	44.076,91	11148,82	5830,26	13.04.06	41.919,25	7919,77	5401,14
18.01.06	42.622,90	10316,11	6458,97	14.04.06	42.212,03	8052,51	5248,64
19.01.06	43.645,23	10872,11	6000,05	17.04.06	41.860,66	7748,34	5318,43
20.01.06	44.465,68	11323,44	5638,33	18.04.06	42.864,85	8291,14	4864,58
23.01.06	43.851,42	10923,64	5875,04	19.04.06	43.732,47	8769,61	4482,97
24.01.06	44.434,54	11240,60	5616,29	20.04.06	43.872,79	8818,47	4399,05
25.01.06	45.746,17	11987,65	5059,13	21.04.06	45.075,89	9520,40	3905,42
26.01.06	45.784,09	11993,80	5034,78	24.04.06	45.278,39	9539,65	3744,80
27.01.06	45.315,15	11701,93	5219,27	25.04.06	45.352,51	9549,78	3688,36
30.01.06	44.891,25	11404,00	5367,51	26.04.06	44.745,54	9132,74	3885,83
31.01.06	44.590,22	11211,97	5483,94	27.04.06	43.752,02	8485,65	4239,82
01.02.06	45.250,66	11596,80	5208,33	28.04.06	43.880,43	8524,59	4157,90
02.02.06	44.841,03	11340,23	5368,82	01.05.06	44.030,35	8496,84	4002,88
03.02.06	44.228,02	10967,62	5616,64	02.05.06	44.413,62	8692,37	3822,70
06.02.06	44.855,61	11277,99	5321,71	03.05.06	44.647,82	8797,31	3701,00
07.02.06	44.652,96	11141,77	5395,58	04.05.06	44.251,44	8509,61	3817,25
08.02.06	43.842,68	10655,20	5726,72	05.05.06	44.212,76	8443,66	3797,53
09.02.06	44.117,47	10794,60	5598,78	08.05.06	44.712,89	8627,00	3503,43
10.02.06	44.772,93	11156,60	5312,75	09.05.06	44.563,26	8488,93	3522,56

Date	ISE-100	Call	Put	Date	ISE-100	Call	Put
13.02.06	44.046,29	10677,59	5582,71	10.05.06	43.598,99	7846,86	3852,33
14.02.06	43.507,51	10348,57	5799,92	11.05.06	43.713,19	7870,76	3769,60
15.02.06	43.803,98	10498,93	5661,25	12.05.06	41.970,80	6786,58	4435,38
16.02.06	45.361,34	11389,58	5001,99	15.05.06	40.268,68	5689,72	5063,36
17.02.06	46.244,32	11898,78	4635,66	16.05.06	41.044,06	6063,37	4669,21
20.02.06	46.689,01	12110,96	4425,51	17.05.06	40.439,24	5679,59	4897,83
21.02.06	46.710,93	12104,95	4405,03	18.05.06	39.643,68	5204,03	5225,41
22.02.06	46.265,39	11814,36	4567,44	22.05.06	36.351,06	3422,84	6767,17
23.02.06	46.553,57	11969,66	4442,01	23.05.06	37.235,49	3757,85	6225,34
24.02.06	46.838,10	12123,74	4319,03	24.05.06	36.100,70	3209,45	6819,31
27.02.06	47.728,50	12614,97	3942,24	25.05.06	36.730,24	3422,13	6410,04
28.02.06	47.015,88	12152,40	4199,75	26.05.06	38.593,47	4224,65	5356,92
01.03.06	47.492,97	12386,65	3979,32	29.05.06	38.908,60	4195,75	5035,67
02.03.06	46.890,80	11991,70	4194,00	30.05.06	37.860,80	3629,94	5525,26
03.03.06	46.366,23	11647,48	4381,82	31.05.06	38.132,21	3692,24	5323,76
06.03.06	45.997,07	11355,59	4481,52				
07.03.06	43.889,75	10074,20	5314,93				
08.03.06	42.340,43	9160,67	5958,20				
09.03.06	42.863,37	9433,19	5715,26				
10.03.06	42.521,94	9214,34	5845,32				
13.03.06	44.345,95	10197,76	5027,18				
14.03.06	42.906,72	9333,56	5609,70				
15.03.06	43.236,71	9498,11	5451,76				
16.03.06	44.051,34	9948,40	5094,90				
17.03.06	44.688,12	10301,33	4818,54				
20.03.06	44.426,27	10067,36	4868,90				
21.03.06	44.399,44	10024,98	4860,86				
22.03.06	44.328,80	9956,23	4870,24				
23.03.06	44.531,22	10050,36	4769,45				
24.03.06	43.273,94	9280,32	5264,20				
27.03.06	42.710,46	8869,84	5439,71				
28.03.06	41.742,09	8291,31	5837,06				
29.03.06	42.507,02	8695,20	5483,53				
30.03.06	42.941,70	8916,11	5277,27				
31.03.06	42.911,32	8868,95	5268,00				
03.04.06	44.028,40	9466,13	4763,13				