



Risk Management: The importance of the Greeks in the estimation of the risk in financial portfolios compound by derivative products

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The aim of this work is to study and explain the importance of derivatives and risk management in the field of finance. These products influence significantly both on institutional (banks and financial organizations) and corporate (business investment) level. However, these products turn out to be one of the most difficult to assess and manage. With no knowledge of their functioning and risks one can take market positions that lead to large losses. For example, this happened in 1995 in Barings when the trader Nick Leeson carried out a strategy with options, but due to changes in the market Barings could not cope with the margin calls and went bankrupt [Hogan'1999; Chin'2002; McMillan'2002]. This is a classic example of poor risk management (poor market risk management carried out by Mr. Leeson and poor operational risk management carried out by Barings). In this paper we will focus on the management of the market risk since precisely this is the type of risk that you can control with the help of the Greeks [Banks&Siegal'2006; Haug'2007].

Within the group of derivatives the most used products are futures and options. Sometimes the options are preferred by investors due to the fact that they offer the option buyer the right to exercise or not to exercise the option. This is the main difference they have with respect to the futures. In

the futures both buyer and seller of the contract have the obligation to exercise what the conditions set at the contract expiration date. On the other hand, the options buyer has no obligation but the right to exercise or not depending on whether it would benefit them or not, while the option seller is obliged to always exercise when the buyer wants it. To assess and manage options one has to understand how to determine their value and risk and, therefore, how to manage said risk. Obviously there is a multitude of types of options offered on the market and each of these types is affected by market changes differently and their sensitivity to those changes is not always the same.

The first thing to be explained in this article is what are the Greek and how they relate to the risk, how are they estimated and interpreted, then the different types of options and their characteristic mechanisms will be discussed, furthermore the paper will try to give a detailed explanation to the most used option pricing models and ultimately it will explain how you can manage the risk of an option knowing its Greeks and using its pricing model. We believe that the knowledge of this subject is essential for anyone who decides to pursue a career in the finance area since precisely these assets are those that can often lead to failure for the simple reason of not knowing well their characteristics.

1. The Key Greeks

The Greeks in financial mathematics are indicators of individual risk factors (such as pass of time, volatility, underlying asset's price, etc.) and serve to measure the sensitivity of a product towards changes in one of these factors. We use the "Greeks" designation because each of these factors is indicated by a letter of the Greek alphabet. Importantly, the Greeks are partial derivatives, which means that they measure how does our position change if only one of the factors deviates while the others remain constant (*ceteris paribus*). The Black-Scholes or Black-Scholes-Merton model allows a simple form of estimation of the Greek and that is why nowadays it has become one of the most important tools in risk management [Banks&Siegal'2006; Haug'2007, Bodie et al.'2008, Hull'2008, Hong-Yi et al.'2010].

The main Greeks we use to measure risk are delta, gamma, vega, theta and rho.

- Delta (Δ)



Delta can be calculated as it is shown: $\frac{\partial \Pi}{\partial S}$

Its interpretation is as follows: when the option price increases by a certain amount, the portfolio value or price of the instrument, changes in $\Delta\%$ of this amount.

The delta is also often interpreted as a hedge against the underlying put or put another way, it indicates the position in the spot that ensures that the profits or losses of the option are completely offset by the spot position.

- Gamma (Γ)

Gamma is calculated like this: $\frac{\partial \Delta}{\partial S} = \frac{\partial^2 \Pi}{\partial S^2}$

It indicates the speed of changes in the premium when there are changes in the underlying asset's price. Gamma also provides information on the volatility of the underlying asset.

- Vega (V)

To calculate Vega we use: $\frac{\partial \Pi}{\partial \sigma}$

It shows the sensitivity of the option price to changes in the volatility. If you look at the Vega of a portfolio of derivatives, it would indicate the rate of changes of the portfolio's value with respect to the volatility of the underlying asset.

The basic interpretation of Vega is that if it is high in absolute value, the value of the portfolio is very sensitive to small changes in the volatility and if it is low in absolute value, the changes in the volatility have a relatively low impact on the value of the portfolio.

Calculate the Vega with the Black&Scholes model and its extensions may seem strange because one of the underlying assumptions of this model is that the volatility is a constant. To calculate the optimal course Vega we should consider that the volatility is stochastic. However, empirical evidence shows that the Vega calculated with the assumption of stochastic volatility takes values similar to those estimated via the plain models which consider the volatility is a constant, such as the Black- Scholes-Merton, so this model results to be quite useful in the practice.

- Rho (ρ)

Rho is calculated as: $\frac{\partial \Pi}{\partial r}$

This Greek indicates the sensitivity of the price of an option to changes in the interest rate. In other words, it helps us determine the risk in monetary terms. The biggest problem of most of the derivatives pricing models is that they assume that the interest rate is a constant which is obviously not true.

As for the interpretation of the value of Rho one must know that it increases in absolute value when the option is *at the money* and decreases when the option is *out of the money*. The explanation for this is very logical and intuitive. When options are at the money they require a bigger delta hedging, therefore, more capital to cover the risk in the case of call options or more resources for investment in the case of put options. Rho, as well as the option's price, decreases as the option is out of the money.

- Theta (θ)

Theta is calculated using the following mathematical expression: $\frac{\partial \Pi}{\partial \chi}$

Theta is an indicator of changes in the option price with respect to time. Theta could also refer to the time decay of the portfolio. It measures the aging of an option.

Theta is usually negative for an option. This is because as time to maturity decreases and everything else remains constant, the value of the option tends to decrease.

Many consider Theta is a useful in the descriptive statistics of a portfolio because in a neutral Delta portfolio, Theta is a substitute for Gamma.

The inflexibility within the options causes the crucial meaning of the aging factor in the pricing and management.

Theta affects almost always in the same direction but not with the same intensity to all types of options. Both call and put options, short or long term, at the money or out of the money, decrease in value over time if all other variables remain constants.



2. Types of Options

As we have mentioned it is important to know that not all options have the same features and therefore they are not affected by market changes in the same way. Mainly we could distinguish between standard options (plain vanilla) and non-standard options (exotic).

1. Standard Options (plain vanilla) are the most common in organized markets. They can be divided into two categories: European and American options. They differ in that the first ones must be exercised only on the specific date stated in the contract, however the American ones can be exercised at any time until maturity [Wolfinger'2008, 2013].

2. Exotic options were created by the need to meet the requirements of the individual investors. These options are not usually listed on organized markets so they are less liquid than traditional options. Because of their exotic features they are more difficult to assess and understand, they still remain less known by retail investors. They were popularized by the study of Mark Rubinstein and Eric Reiner about these instruments. Among the exotic options we can distinguish many types of options [Rubinstein&Reiner'1992, Weert'2008, Wolfinger'2013]. We could group these options as follows:

- Path dependent - the value of this type of derivatives does not depend only on the value of the underlying asset on the expiry date but also on the path taken by the risky asset from the time of recruitment to maturity. This group can be subdivided in Asian options, Extremum dependent, Stair Ways, Shorts and Chooser.

Within this group the best known are the Asian options. They are options in which the underlying asset's value is determined by an arithmetic mean of the values obtained by the risky asset over the life of the option and the strike is calculated using the average arithmetic underlying asset's values achieved over the life of the option.

The second most popular are the chooser, their most notable feature is that at the time of contracting these are not defined neither as call options or as put options. The option holder has the power to choose the nature of the option at a time known from the beginning and established in the contract.

- Compound options - these are options on options. In these contracts there are two strike

prices, two underlying securities and two maturities. The different possible combinations are: call on call, call on put, put on call and put on put.

- Leveraged Options - options with high leverage. This is due to the fact that their value is estimated with respect to a polynomial or exponential function which is referring to the performance of the underlying asset.

- Options with singular payment - they are divided into two types:

- The first type covers the options in which the investor gets all or nothing (binary options, also called digital). In these options the holders will receive only the quantities agreed in the terms of the contract if the strike is higher than the value of the underlying asset (for the purchased put) or if the value of the underlying asset is higher than the strike (for the purchased call). In many cases the amount received by the investor is tied to a notional, previously agreed by the parties.

- The second group consists of the pay later options. In this type of options no amount of money is transferred at the moment of contracting. The option premium is paid at the time the option is exercised, in the event that the option is not exercised the buyer does not need to pay said premium. The strike can be paid on the maturity date or on the date of the early exercise.

- Rainbow options - these are options which have more than one risky (underlying) assets. We could classify them into:

- Rainbow mapping options of first order: their pricing depends directly on the correlation coefficients between the various underlying assets.

- Rainbow mapping options of second order: in most cases, these options are made pretending to avoid currency exchange rate risks.

It seems that there are so many unique features in each type of options and it is evident that it is difficult if not impossible to develop a single pricing model that works equally well for all of the products. In practice there are various models but among them there are three that can be applied when pricing most of the options and also they are giving far more reliable results than the other ones. These three models are the binomial model [Georgiadis'2011], the Black-Scholes-Merton [Bodie et al.'2008, Hull'2008, Hong-Yi et al.'2010] and the Monte Carlo simulations [Kroese et al.'2011].



3. Main Options Pricing Models and Estimation of the Greeks

3.1. The Binomial Model

This model is static in discontinuous time. One of its main assumptions is risk neutrality, in other words the relative risk of the assets is not taken into account. Another assumption to consider is the lognormal behavior of the stock returns.

Keep in mind that the binomial model is used primarily to assess exotic options and American options.

To give a more detailed and simple tutorial we will study each part of the model following an example with the help of which we will first evaluate an item, then we will calculate the delta: Let's imagine there is an option offered in the market which has the following characteristics:

Asian call, strike=90, the risk free rate equals zero (in order to simplify calculations) and the expiration date is in $2\Delta t$. The option is negotiated on an underlying asset $S_0=100$ which is a financial asset that does not offer any dividends. The coefficients of variation are $d=0.5$ and $u=2$.

The first step in pricing an option using the binomial model is to build the tree that the underlying asset is following. To branch the values taken by the risky asset at all times we must first define the coefficients of variation [Kolb'2002]. The coefficient of variation corresponding to a rise in the price of the underlying asset in a time instant is denoted by the letter u and the coefficient of variation at a low in the price of the underlying asset is represented by the letter d . Please see Figure 1.

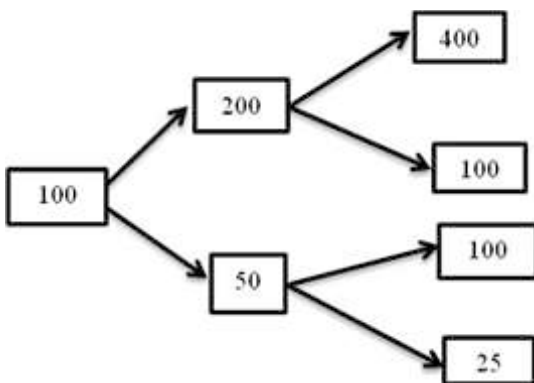


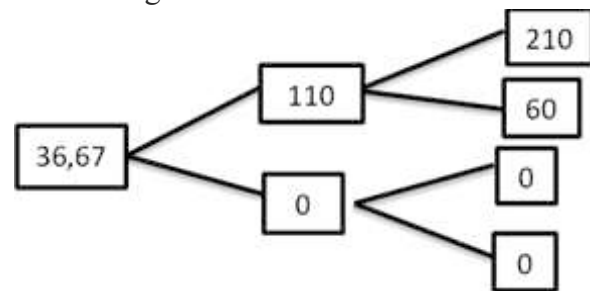
Figure 1. To obtain each of these values we have been multiplying S_0 per u and per d . This is how we have obtained the results for the following positions: $u=200$, $d=50$, $uu=400$, $ud=100$, $du=100$ and $dd=25$.

The second step is to calculate the implicit probabilities in order to be able to obtain the Price of the option at $t=0$. These probabilities we calculate as follows:

$$P_u = \frac{e^{r\Delta t} - d}{u - d} \quad P_d = 1 - P_u$$

In our particular case we have: $P_u = \frac{1}{3}$ and $P_d = \frac{2}{3}$

The last step consists in calculating the actual price of the option using the previous probabilities and the non-recombinant tree of the risky asset. Please see Figure 2.



Фигура 2

To calculate the values in $2\Delta t$ we have done the following operations:

$$\begin{aligned} \left(\frac{200+400}{2} - 90\right)^+ * e^{-r\Delta t} &= 210 \\ \left(\frac{200+100}{2} - 90\right)^+ * e^{-r\Delta t} &= 60 \\ \left(\frac{50+100}{2} - 90\right)^+ * e^{-r\Delta t} &= 0 \\ \left(\frac{25+50}{2} - 90\right)^+ * e^{-r\Delta t} &= 0 \end{aligned}$$

In our case $e^{-r\Delta t} = 1$ because the interest rate equals zero.

The superscript sign $+$ next to the parentheses indicates that we will only take into account the positive values

The rest of the numerical results (at Δt and at $t=0$) have been obtained like this:

$$\begin{aligned} 110 &= (210 * P_u + 60 * P_d) * e^{-r\Delta t} \\ 36,67 &= (110 * P_u + 0 * P_d) * e^{-r\Delta t} \end{aligned}$$

Once we have priced the option and its values at all certain periods we can proceed to calculate the delta. This model provides a fairly simple way to



calculate the delta of the product, however, the calculation of the remaining Greeks with the binomial model would be more complicated. After calculating the delta we will explain how should the delta hedge portfolio be constructed in this case.

Let's say we have decided to buy the call and want to find what the hedge portfolio at $t = 0$. To calculate delta we must use the underlying asset's binomial tree and the Asian call's binomial tree to create a system of equations as follows:

$$\begin{cases} X + 200\Delta = 110 \\ X + 50\Delta = 0 \end{cases}$$

In this case Δ indicates the number of underlying assets we need to buy or sell to create the hedging portfolio and X indicates the amount which we must invest or borrow in the risk-free asset. Solving the system we obtain:

$\Delta = 11/15$ or which is the same 0,73333 units of the underlying asset. We are talking about a call and Δ is positive, so it indicates us the quantity of underlying assets we need to sell.

$X = -110/3$ la cantidad que tendremos que invertir en el activo libre de riesgo.

Now we have the hedging portfolio:

$$\left. \begin{array}{l} \text{Sell } 11/15 \text{ units of the underlying asset} = \\ 11/15 * 100\text{€} = 220/3\text{€} \\ \text{Invest } 110/3\text{€} \text{ in the risk free asset} = -110/3\text{€} \end{array} \right\} 36,67\text{€}$$

Buying a call means that we must pay so we indicate this pay off as € -36.67 and the hedging portfolio is worth a total of €36.67, together they sum zero, so we have made the perfect delta hedging and have completely eliminated the risk of changes in the valuation of the Asian call. Importantly, in each Δt we have to recalculate the hedging portfolio

and change it so that we continue having the risk of change in valuation removed.

As we have already mentioned this model provides a quick and easy way to calculate the Δ but the calculation of the remaining Greeks would be complicated. The model which offers a relatively easy way of calculating all major Greeks and of constructing the hedging portfolio is the Black-Scholes-Merton model.

3.2. The Black-Scholes-Merton Model

This is a mathematical model used to value options. It is a particular case of the binomial model, transformed into continuous time.

The most important hypothesis of the model are:

- Perfect capital markets;
- Constant free risk rate;
- There are no restrictions on short selling;
- The shares do not pay dividends;
- The actions follow a complex stochastic process, called Ito process.

The main assumption that we do is also one of the greatest weaknesses of the model. We assume that the volatility is a constant. We should protect ourselves from this assumption. This valuation system is intended primarily for European options. To price options we need the following formulas:

$$\begin{aligned} C_0 &= S_0 * \phi(d1) - ke^{-rt} * \phi(d2) \\ P_0 &= \phi(d1) * Fe^{-rt} - \phi(d2) * ke^{-rt} + ke^{-rt} - Fe * e^{-rt} \\ d1 &= \frac{\ln\left(\frac{S_0}{k}\right) + \left(r + \frac{\sigma^2}{2}\right) * T}{\sigma * \sqrt{T}} \quad d2 = d1 - \sigma\sqrt{T} \\ \theta &= rH - \frac{1}{2} * \sigma^2 * S_0^2 * \Gamma \end{aligned}$$

To calculate the rest of the Greeks we use the Table1.

Asset\Greeks	Δ	Γ	V
Free risk asset	0	0	0
Underlying asset	1	0	0
Call	$\phi(d1)$	$\frac{\phi^1(d1)}{S_0 * \sigma * \sqrt{T}}$	$S_0 * \phi^1(d1) * \sqrt{T}$
Call on futures	$\phi(d1) * e^{-rt}$	$\frac{\phi^1(d1) * e^{-rt}}{S_0 * \sigma * \sqrt{T}}$	$S_0 * \phi^1(d1) * \sqrt{T} * e^{-rt}$
Put	$-(1 - \phi(d1))$	$\frac{\phi^1(d1)}{S_0 * \sigma * \sqrt{T}}$	$S_0 * \phi^1(d1) * \sqrt{T}$
Put on futures	$-(1 - \phi(d1) * e^{-rt})$	$\frac{\phi^1(d1) * e^{-rt}}{S_0 * \sigma * \sqrt{T}}$	$S_0 * \phi^1(d1) * \sqrt{T} * e^{-rt}$

Table 1



We will now give an example of how to price a European option and how to calculate its Greeks using the Black-Scholes-Merton.

Let's say there is a put option on a future with $F=1000$ €, the $\sigma=40\%$ (volatility) and the interest rate is zero (to simplify calculations), time to maturity is $\frac{1}{4}$ years.

$$P_0 = \Phi(d_1) * F e^{-rt} - \Phi(d_2) k e^{-rt} + k e^{-rt} - F e^{-rt}$$

$$d_1 = \frac{\ln\left(\frac{1000}{1000}\right) + \left(0 + \frac{0,4^2}{2}\right) * \frac{1}{4}}{0,4 * \frac{\sqrt{1}}{4}} = 0,1 \quad d_2 = 1 - d_1 = -0,1$$

With some help from the table of the Normal distribution we can find the following values:

$$\Phi(d_1) = 0,5398$$

$$\phi(d_2) = 0,4602$$

$$P_0 = 0,5398 * 1000 - 0,4602 * 1000 + 1000 - 1000 = 79,6€$$

$$\Delta_{\text{put}} = -(1 - \Phi(d_1)) = -0,4602$$

$$\phi^1(d_1) = (1/\sqrt{2*\pi}) * e^{-(d_1^2)/2} = 0,3969525475$$

$$\Gamma = \frac{\phi^1(d_1)}{F\sigma\sqrt{T}} * e^{-rt} = 0,001984763$$

$$V = F * \phi^1(d_1) * \sqrt{T} * e^{-rt} = 198,4762738$$

$$\theta = rH - \frac{1}{2} * \sigma^2 * S_0^2 * \Gamma = -158,78104$$

Often investors interested in hedging their positions focus on the delta risk and forget the others. Let's see what happens if in this case we only apply a delta hedging strategy and in a week the future is to be worth € 1,050 and volatility changes to 30%.

As the option's underlying asset is a future the delta hedge portfolio is static and very easy to calculate:

$$\left. \begin{array}{l} \text{Buy } 0,4602 \text{ futures} = 0€ \\ \text{Borrow } 76,9€ = +76,9€ \end{array} \right\} 76,9€$$

The payoff of a bought put option is equivalent to € -76.9 and the value of the delta hedge portfolio is + € 76.9, they sum zero, therefore, we have neutralized the delta.

To see how would the value of our portfolio "H", compound by the put option and the hedging portfolio, change given the new conditions we simply have to solve the following equation. In order to avoid confusion with the symbol indicating

the variation of the amounts and delta we will write the Greek this time as δ .

$$H = \theta * (\Delta t) + \delta * (\Delta F) + V * (\Delta \sigma) + \frac{1}{2} * \Gamma * (\Delta F)^2$$

We have already performed the delta hedging strategy so now $\delta * (\Delta F) = 0$

Solving the equation we obtain $\Delta H = -20,42015517€$, which means that by not taking into account the other Greeks while constructing the hedge portfolio we will have lost 20,4 €.

3.3. The Monte Carlo Method

It is a non-deterministic method used to evaluate investment projects or products derived by picking a random sample. It is based mainly on statistical studies using technological advances to meet the own random behavior of the systems we want to analyze. So it is quite useful in cases where it seems impossible to estimate the value of the underlying asset.

The simulation involves the development of a very large number of trajectories. We choose a very large sample so that the result shall be closer to reality. With computer assistance we obtain specific values of the variables studied. Repeating this process n times, we achieve n observations which help us to understand the functioning of the system. The greater the number of experiments is the more accurate said system becomes.

4. Value at Risk (VaR)

Value at Risk is the maximum loss not exceeded with a certain probability, defined as the confidence level for a fixed time horizon. It is a form of measuring different types of risks (market risk mainly) and given the characteristics of the portfolio the investors could use one form or another to calculate the VaR. Its disadvantage is that it does not give any information about the severity of the loss by which it is exceeded.

Estimating VaR may result very important when a financial institution is determining its Economic Capital (the amount of capital necessary for the institution to cover a main part of the risk of its operations and for preventing bankruptcy).

The calculation of VaR in lineal contracts (in portfolios compound by simple assets such as shares or bonds) is simple. For relative VaR all we have to do is:

$$n * \sigma * (\Delta t)^{\frac{1}{2}} * p$$

where n is a factor derived from the



confidence interval (i.e. 1.65 for 95% confidence intervals or 2.33 for 99% confidence intervals), σ is the standard deviation, Δt indicates the time horizon and P is the value of the portfolio.

However most of the portfolios nowadays involve derivative products, therefore they are not linear. For the nonlinear portfolios experts use another method in estimating VaR: the method Delta- Gamma normal [Juan Ignacio Peña'2002].

With this approach we know that the VaR of an option would be:

$$\text{Var}(dc) = n \cdot (\Delta^2 \cdot S^2 \cdot \sigma^2 + \frac{1}{2} \cdot (\Gamma^2 \cdot S^2 \cdot \sigma^2) \cdot 2) \cdot \frac{1}{2}$$

where S is the value of the underlying asset.

This approach has a problem because the value of an option is a function of two variables dS and dS^2 : $dc = \Delta \cdot dS + (\frac{1}{2}) \cdot \Gamma \cdot dS^2$.

If we assume that dS has a normal distribution that automatically means that dS^2 has a Chi- square distribution and since dc (the option) is a sum of both than its distribution is also a Chi- square and the method based in the normal distribution could not be done [Juan Ignacio Peña'2002].

An alternative to this method is the following one which is used for options portfolios in which the portfolio is linked to only one underlying asset S :

Note: once again in order to avoid confusions in the following equations we will use Δ as a symbol of the increase and δ for denoting the Greek.

$$\Delta P = \delta \cdot \frac{1}{2} \Delta S + \frac{1}{2} \cdot \Gamma \cdot (dS)^2$$

If we have a portfolio which depends on n underlying assets and each financial instrument included in the portfolio depends on only one underlying asset than we can use the following formula:

$$\Delta P = \sum \delta_i \cdot \Delta x_i + \sum \frac{1}{2} \cdot S_i^2 \cdot \Gamma_i \cdot (\Delta x_i)^2$$

In which S_i is the value of the corresponding underlying asset.

So once again we can affirm that the estimation of the Greeks is crucial in order to estimate the risk and to make reliable predictions. For portfolios formed by derivatives the Greeks are the main variables needed in order to estimate the Value at Risk.

Nowadays many banks and other financial institutions tend to use different computer programs in order to be much more precise when estimating the VaR [Juan Ignacio Peña'2002].

Some of the most popular programs are:

- RiskMetrics™ developed by J. P. Morgan and based on setting benchmarks in the measurement of the market risk. This program has three basic components: methodologies used to estimate VaR

(Delta- Gamma normal, Monte Carlo Simulations, etc.), a data base containing correlation and volatility measures and a group of computer programs which combine the methodologies and the data in order to create VaR reports.

- RAROC™ (Risk-Adjusted Return on Capital): this method was developed by Bankers Trust. It tries to measure all types of risks and is based on aggregation of risks by using correlations and pricing at market prices (marketing- to-market).

5. Hedging or Speculation?

The perfect hedging allows us to eliminate all the risk but it also takes away our chance to gain profits. Therefore, each investor has to decide whether to make the perfect hedging and not gain anything (eg if you are simply interested in the premium or in buying / selling the underlying asset), you could eliminate only part of the risk and limit your losses or not hedge any of the Greeks and expect favorable market movements. In the market it is impossible to achieve perfect hedging but you can eliminate a large part of the risk. Hedging and speculation indeed are not always contrary, speculation is often used precisely to achieve better hedging.

We will explain what the speculation is. This type of action in the market occurs when an investor wants to obtain benefits derived from their personal assessment of market developments, creating a risk exposure profile. Such operations can be carried out both in the cash market and the derivatives. The derivatives market, however, has two great advantages for the realization of speculation.

The first advantage can be discovered by analyzing the fact that speculative operations focus on exploiting differences in prices in different time periods, ie buy an asset that is expected to raise its price or sell an asset that is expected to lower its price. As we know the derivatives are future contracts, so it is easy to conclude that their use simplifies our work when we are speculating.

The second advantage is based on the possibility of designing complex strategies and make, impossible to perform in the cash market speculative transactions (eg speculate against the exchange rate of a currency or against the price of a financial asset with quote of shares or commodities). Moreover derivatives such as swaps and swaptions allow us to speculate on interest rates, something impossible in the spot market.

In addition, options allow us to speculate without



having to bet on a particular value, just make one bet downward or upward to win [Sanz Caballero'2000]. In fact there are plenty of strategies with options that allow us to make different bets and are appropriate for different investor profiles. In some we could bet on upward movements, descents and there are also strategies that allow us to bet on the volatility of assets. Here we will discuss some of the best known strategies.

Expectations according to which the investors decide whether to perform either strategy can be divided into two groups: bullish expectations and bearish expectations.

The Bullish imply that the investor expects that the variable in question increases (underlying asset, price or volatility), while in the Bearish ones the investor expects the variable in question to decrease.

One of the most conservative strategies are:

- Bull call spread: means buying a call with strike = k_1 and sell a call with strike = k_2 , with $k_1 < k_2$
- Bull put spread: means buying a put with strike = k_1 and sell a put with $k = k_2$, with $k_1 < k_2$
- Bear call spread: buying a call with strike = k_2 and sell a call with strike = k_1 , where $k_1 < k_2$
- Bear put spread: buy a put with strike = k_2 and sell a put with strike = k_1 , where $k_1 < k_2$

Another very popular though not as conservative strategy is the Butterfly: it consists in buying a call with strike = k_1 , buy another call with strike = k_3 and sell 2 calls with strike = k_2 , still valid the following condition: $k_1 < k_2 < k_3$. The Butterfly spreads can be created using put options. The investor buys a put option with an exercise price low, another with a high strike price and sells two put options with an exercise price of intermediate value. This strategy

generates a modest benefit in the event of a significant movement in the underlying asset's price.

Other strategies are widely used straddle (involves buying a call and a put with the same strike price and maturity) and strangle (an investor buys a call option and a put with the same maturity and different strike prices).

When an investor wants to earn risk-based strategies the most appropriate action would be buying a straddle, strangle or buy put or call. To speculate in the market in order to obtain profits the investors can study the Greeks of the options available so that they can make a more reliable prediction of those contract's position in the future. That is, if handled well the sense that goes into every option and every strategy the probability to win increases if we have analyzed the Greeks previously.

All these strategies may limit or not the gains and losses, but we must pay special attention to the fact that time does not influence identically to all strategies. Here we present (Please see Table2) a chart that helps us compare all strategies according to their basic characteristics:

Strategy	Expectative on the price	Expectative on the volatility	Potential profit	Potential loss	Effect of the time
Long call	Bullish	Bullish	Ilimited	Limited	Negative
Short call	Bearish	Bearish	Limited	Ilimited	Positive
Bull spread	Bullish	Neutral	Limited	Limited	Mixed effect
Bear spread	Bearish	Neutral	Limited	Limited	Mixed effect
Long strangle	Bullish	Bullish	Ilimited	Limited	Negative
Short strangle	Neutral	Bearish	Limited	Ilimited	Positive
Long butterfly	Neutral	Bearish	Limited	Limited	Positive
Short butterfly	Neutral	Bullish	Ilimited	Limited	Negative

Table 1



As mentioned these strategies help us gain profits based on certain predictions but they also allow us to limit our risk. The simplest examples to explain and understand are:

- If an investor fears of upward movements in the prices the best thing they can do to limit this risk is to buy a call;
- If an investor is afraid of downward movements in the prices the best thing they can do is buy a put.

Importantly, a simple sale of a call or put option is cannot eliminate the risk. Normally the sale of an option can help us to limit the risk only if it forms part of a complex strategy such as those described above.

Overall, speculative strategies can be exploited both to earn and to protect us from danger. As hedging and speculation happen to be two concepts which have opposite directions. The result of each operation with the options depends on the position of the investor, their risk aversion and the market situation.

Conclusions:

Risk management is a determining factor when making financial investments. It is useful for both the individual investor and the institutional investors. Often excessive investment risk is produced due to operations with derivatives that are complicated to handle.

One of the most important derivative products on the market today are the options. The problem is mainly that often these can be dangerous if their risk has not been studied before. For the market players who are to make decisions on whether they should buy or sell shares or options or whether they should perform a certain strategy it is essential to study the Greeks of these products.

The Greeks are indicators of different types of risks (market risks) affecting the outcome of the investment. Overall derivatives allow us to gain profits betting on certain future changes in the market. Obviously in order to use the options betting on certain fluctuations one must first develop their own prediction of what will happen. To make these predictions more reliable the investor has to base them on certain indicators such as the Greeks.

The calculation of the Greeks today is not complicated as pricing models such as Black-Scholes- Merton and the Binomial model present us fast and effective ways to calculate the main Greeks with sufficient reliability.

Bibliography:

[Banks&Siegal'2006] E. Banks, Siegel P., The options applications handbook: hedging and speculating techniques for professional investors, McGraw-Hill Professional, 2006, pp 263, ISBN 9780071453158.

[Bodie et.al.'2008] Bodie, Zvi; Alex Kane; Alan J. Marcus, Investments, New York: McGraw-Hill/Irwin, 7th Edition, 2008, ISBN 978-0-07-326967-2.

[Chin'2002] Chin, Yee Wah. "Risk Management Lessons from the Collapse of Barings Bank." Japan Insurance News, March–April, 2002, pp 12–17.

[Georgiadis'2011] Georgiadis, Evangelos, Binomial options pricing has no closed-form solution, Algorithmic Finance, IOS Press, 1 (1), 2011, p 13–16

[Haug'2007] Haug, Espen Gaardner (2007). The Complete Guide to Option Pricing Formulas. McGraw-Hill Professional. ISBN 9780071389976.

[Hogan'1999] W. Hogan, Two failures: Barings in 1890 and 1995, Accounting and Business Review 6 (2), 1999, pp 203-223.

[Hong-Yi et al.'2010] Hong-Yi Chen, Cheng-Few Lee and Weikang Shin, Derivations and Applications of Greek Letters: Review and Integration, Handbook of Quantitative Finance and Risk Management, Springer Us, 2010, Chapter III, pp 491–503, ISBN 978-0-387-77116-8.

[Hull'2008] Hull John C., Options, Futures and Other Derivatives, 7th Edition, 2008, Prentice Hall, ISBN 0-13-505283-1.

[Kolb'2002] Kolb, Robert W., Financial Derivatives, Wiley, 3rd Edition, 2002, pp 323, ISBN 9780471232322

[Kroese et al.'2011] Kroese D.P., T. Taimre, Z.I. Botev (2011). Handbook of Monte Carlo Methods, Wiley Series in Probability and Statistics, John Wiley and Sons, New York 2011, ISBN 978-0-470-17793-8.

[McMillan'2002] McMillan, Lawrence G. (2002). Options as a Strategic Investment, 4th Edition, 2002, Prentice Hall, ISBN 0-7352-0197-8.

[Juan Ignacio Peña'2002] Peña, Juan I. (2002). La gestión de riesgos financieros de mercado y de crédito, 2002, Prentice Hall, ISBN 84-205-3776-4.

[Rubinstein&Reiner'1992] Rubinstein, M.; Reiner, E. Exotic options. 1992. Working Paper 220. Available from Internet:

<<http://www.haas.berkeley.edu/groups/finance/WP/rpf220.pdf>>



[Sanz Caballero'2000] Sanz Caballero, Juan Ignacio, Derivados Financieros, Marcial Pons, Ediciones Jurídicas y Sociales, 2000, pp 645, ISBN 8472487601.

[SAXO Group] SAXO Group, Saladeinversion.com. La importancia de las griegas para valorar opciones, Available on Internet <<https://latin.tradingfloor.com/articulos/http-wwwsaladeinversioncom-formacion-importancia-letras-griegas-valorar-opciones-acciones-cfds-divisas-commodities-futuros-819907>>

[Weert'2008] Weert, De F. 2008. Exotic options trading. John Wiley & Sons. eBook. 205p. Available from Internet: eBook Academic Collection <<http://web.ebscohost.com>>.

[Wolfinger'2008] Mark Wolfinger, American Vs. European Options, Available on Internet <<http://www.investopedia.com/articles/optioninvestor/08/american-european-options.asp>>

[Wolfinger'2013] Mark Wolfinger, The Rookie's Guide to Options, Evanston IL, ISBN 978-0-988439-1-2.