ASPECTS REGARDING THE INFLUENCE OF VOLATILITY ON THE OPTION'S PRICE

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Abstract: : The most important advantage of the option transactions resides in the fact that it offers, through the existing relations between the derivatives market and the spot market, improved solutions of portfolio management, the put options constituting an insurance policy against the decrease of the prices, and the call options acting as a guarantee for the purchase of the support asset at the pre-set price. The volatility represents a measure of the size of the price fluctuations of the support asset and thus it can be assimilated with a random variable. The analysis of the essential factors that influence the price of the option contracts has demonstrated that the volatility of the support asset's price shows how risky it is for it to be one of the main and most difficult to determine factor, because this is the only parameter that is not known exactly at the moment of the contract conclusion. Under these conditions, due to the profound importance of volatility in the option evaluation and due to the fact that volatility is difficult to estimate, observe or predict, we must model it as a random variable for many of the option contracts for which the model of constant volatility (as the Black Scholes model is) is inadequate.

JEL classification: G11, G12

Key words: options contract, historical volatility, stochastic volatility, exercise price, standard deviation

1. Introduction

The last few years, within a relatively short period, we have been witnessing an unprecedented evolution of the markets and the stock exchange techniques. An adaptation to the new economic context has been necessary, a consequence of some very unpredictable events: the problems with the oil, followed by the decrease of the oil price, the sudden inflation, followed by a prolonged deflation, chaotic movements of the interest rates and of the exchange rate, the financial crisis of our times.

The reaction in front of such instabilities is very difficult to predict. It is imperative to adapt the banking and financial techniques to the moving universe and to perfect the financing and protection instruments against the economic and financial crisis.

Together with the liberalisation tendency of the capital circulation, another tendency that has been characterising the capital markets in the last few years is the

spectacular increase of the derivatives markets. These rise numerous problems regarding the risk management, but also bring a series of benefits.

The derivatives offer a valuable means for the creation of the manners of managing the financial risk, through their use being able to transfer, for a price, any unwanted risk to other parts, which either have risks that compensate or wish to assume that risk.

The derivatives exist under different forms (futures contracts, option contracts, swaps), but in this article we have decided to discuss the option contracts because their transaction has increased everywhere in the world at an explosive rate.

The traditional participants on the options market, as well as the speculators, hedgers and the judges must know not only the laws of the market, but also the usual features of the option contracts and, what is the most important; they have to know the techniques for the setting of the contracts' prices.

An option offers the holder the right, but not the obligation, to transact a certain asset support at a future date, at a pre-set price. Thus, if the asset's price is not favourable, the option's holder is not forced to transact upon the due date of the contract.

There are two large option categories: call and put. A call option gives the right to buy a certain asset at a certain agreed price and at a certain specified future date. The buyer of a call option will exercise the option upon the due date, if the asset's price is larger than the exercise price and otherwise will not exercise it. So, the option represents the maximisation of the profit and loss function:

Max(St-X,0)

where: St = asset's price and X = the exercise price.

A put option gives the right to sell a certain asset at an agreed price and at a certain specified future date. The put option holder wants that the asset's price to decrease so that he/she can sell it at a higher price than the one upon the due date. The profit and loss function for the put option is:

Max(X-St,0)

The presented relationships represent the definitions of the intrinsic value for options. According to the asset's course (upon the due date or along the lifespan of the option) the option can be defined as being:

- In-the-money, if $S_t > X$ for the call options or $S_t < X$ for the put options;
- Out-the-money, if $S_t < X$ for the call option or $S_t > X$ for the put option;
- At-the-money, if $S_t = X$

The difference between the course of the support asset and the exercise price for the call or vice-versa, for the put option, represents the intrinsic value of the option.

The value of the option is influenced by more factors, but there is a parameter which has a major impact on the option price, respectively the volatility.

The volatility represents a measure of the size of the price fluctuations of the support asset and thus it can be assimilated with a random variable.

The analysis of the essential factors that influence the price of the option contracts has demonstrated that the volatility of the support asset's price shows how risky it is for it to be one of the main and most difficult to determine factor, because this

is the only parameter that is not known exactly at the moment of the contract conclusion.

Within many models regarding the setting of the option price, it has been assumed that the volatility of the support assets is constant, but this is not true. The volatility varies, fact that can be observed indirectly through the means of the market prices for the transacted contracts.

In this article we have decided to evaluate the volatility factor of the support asset's price as a random variable which measures the fluctuations, taking into account the changes of the market conditions, by analysing the following aspects:

- the description of the theoretical meaning of volatility;
- the presentation of the meaning of volatility within the evaluation of the option price;
- the evaluation of volatility as a random number;

2. THE PRINCIPLES OF THE OPTIONS PRICE

The options, under the shape we meet them nowadays, have been transacted since 1973 when they appeared at the Chicago Board of Options Exchange - the largest option exchange in the world, even currently as well. Before that moment, resembling the situation from Romania of last decade, the investors had very few possibilities to invest the money (share purchases and governmental bonds). Being the oldest exchange specialized in options; CBOT also has the most elaborated products.

The options help the financial markets become more efficient and provide opportunities for the risk management. Due to the occurrence of more and more complex risks, people have acted on the protection mechanism development as well.

By their nature, the options meet the diversified and complex needs that occur in the current global financial context.

The most important advantage of the option transactions resides in the fact that it offers, through the existing relations between the derivatives market and the spot market, improved solutions of portfolio management, the put options constituting an insurance policy against the decrease of the prices, and the call options acting as a guarantee for the purchase of the support asset at the pre-set price.

The options contracts have a large use, really answering to the investors' needs, offering significant advantages towards the other financial instruments. These can be used for:

- *Covering the risk*, offering the possibility of protection against the decrease of the asset's prices. Unlike the futures contract, where the investor is forced to take a position related to the asset until the due date of the contract, in the case of the options, the investor takes a position related to the support asset only if its price is favourable (as their name implies, options offer the right, but not the obligation, to buy or sell the asset). The option buyer's risk is limited to the paid initial sum (bonus), the maximum loss that can be recorded being the bonus itself.
- *Speculating*, through anticipations on the fluctuations of the assets course, being relatively easy to enter and leave the position without the intention of exercising.
- *The lever effect* that offers the possibility to obtain a large gain from a smaller investment than in the case of the classic investments. We must mention the

fact that the lever implies a larger risk than the one afferent to the direct investment in quoted titles.

- *The arbitration*, which occurs when the market price of the options is over or under evaluated. The arbitration strategies are more complex. They are used in different combinations; they allow the achievement of some equivalent synthetic positions. In principle, the operators buy under evaluated options and sell over evaluated options, maintaining a null variation on the portfolio's global position.

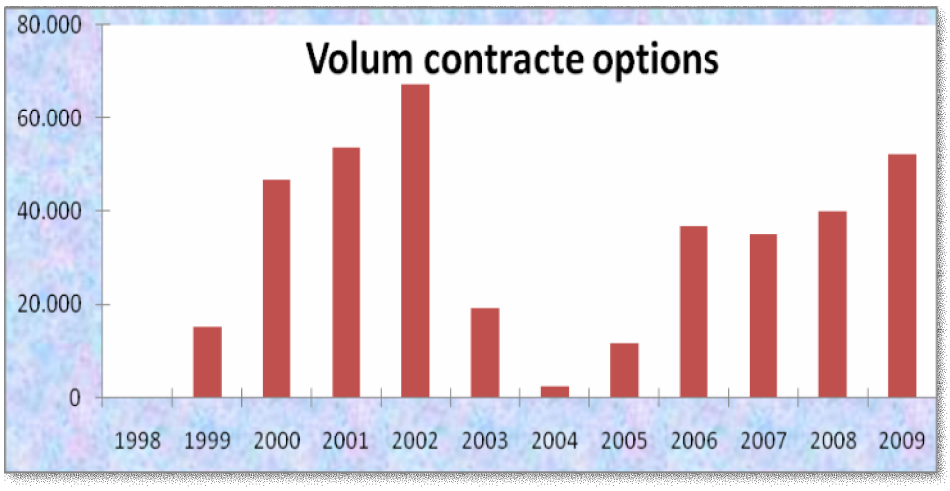
As it can be observed, the main aspect of the use of options contracts is the management and the risk coverage. Currently, in the majority of the cases the economic and financial factors are considered as factors that sit at the origin of the risk, fact that has determined a major interest of the participants in the transaction of the options contracts.

Thus, presently, this type of instruments is transacted on over 50 exchanges around the world.

In Romania, the only exchange that transacts options is the Monetary-Financial and Merchandise Exchange in Sibiu, being launched in November 1998.

In the negative international context and the one of the economic unbalances brought by the global crisis, on the options market, an increase of the interest for these instruments has been observed, thus the total of the contract has been larger year after year.

In the graphic below, one can see the evolution of the total volume of option contracts at SIBEX.



On the options market, the year 2009 closed with 52,079 contracts. The total mentioned included 30,549 call options and 21,530 put options. Their value rose at 5.2 million lei. The best volume was recorded in June when 7332 contracts were concluded. The options market can be used as a means of protection of the portfolios owned by the investors on the spot market or of the futures placements, but also for the speculations with a limited lower risk at the value of the paid bonus.

Despite the increase of the options transfers, these instruments hold a share of only 2.1% of the total transfers on the derivatives market in Romania, thus one of the

major objectives for the future is the increase of the options liquidity. The main models of setting the options price contain five factors used in determining the theoretical value of an option:

a) The course of the support asset
b) The exercise price
c) The duration until the due date
d) The interest rate without the risk
e) The expected dividends along the lifespan of the option.

The course of the support asset and the exercise price. The value of the option is generated by the difference between the course of the asset and the exercise price. Thus, the call option is more valuable the higher the course of the asset is upon the due date, and the value of the put option decreases with the increase in the course of the support asset.

The duration until the expiration. Both types of option become more valuable with the increase of the duration until the expiration, because the larger the interval of time the greater chances has the holder to exercise the option in a favourable way.

The interest rate without the risk. The interest rate affects the option price according to the type of the option, through the means of the time value of the money. The increase of the interest rate determines the decrease of the present value of the exercise price and, as a consequence, the value of the call option increases and the value of the put option decreases. In practice, if the interest rate increases, the price of the call option increases because the asset's price is lower, the difference being invested at the interest rate without risk. For the put option, the increase of the interest rate determines the decrease of the option's price because the purchase of the derived asset postpones the cashing of the asset's price until the option is exercised, and the increase of the interest rate represents an opportunity loss.

The dividends. The dividends have as an effect the reduction of the asset's price in the ex-dividend periods. The value of the call options is reducing, if the payment of the dividends is performed during the lifespan of the option, and the value of the put option will increase.

In determining the option's price there is a very important parameter, the volatility, which is an unpredictable factor that is very difficult to be measured.

3. THE OPTIONS' VOLATILITY AND ITS ESTIMATION

The volatility of the asset's price represents the key factor in determining the option's price. Unlike the other quantifiable factors, the volatility is not directly observable and its measurement is very difficult. The importance of volatility has been emphasised in the studies of the different researchers [2, 3, 4] through mathematical models of evaluation of the options' price, finding that among all the parameters which interfere as input data in a model, volatility has the greatest influence.

The simplest definition of volatility: it is the measure of the movement of the asset's prices during a given time period.

The changes in the predictions of the investors referring to volatility can have dramatic effects for the option's value, and the manner in which the market evaluates volatility can have significant effects on the price of the option.

Within the classic model, volatility is considered a constant along the lifespan of the option, being approached in two different ways: *the volatility measured as dispersion* (an average squared flaw) of the log-normal distribution of the asset's price

and the *implicit volatility*, measured as a parameter contained implicitly by the market price of the option.

However, in reality, the things are not as simple as that. Volatility is not constant; it is not predictable, not even directly observable. This makes the model take into account the volatility as a random variable, dealing with the *stochastic volatility*. The measured volatility as dispersion, called historic volatility as well, is the measure of the asset price exception to the average of the historic prices.

The calculation of the ***historic volatility*** means the following steps:

1. The daily measurement of the changes in the asset's price on the market. Tasking into account that productivity has a greater informational value, the daily productivity is calculated. By using Pt as symbol for the productivity of the t day, then the productivity of the periods (t, t+1) is:

$$R_t = \frac{P_{t+1} - P_t}{P_t}$$

2. The average of the daily changes on a certain T period is calculated, there resulting the average of the productivity distributions:

$$R_T = \frac{\sum_{t=1}^{T} R_t}{T}$$

3. In order to find out how much the prices vary related to the calculated average in step 2, we will calculated the historic volatility, meaning the average of the variation from the standard exception, calculated with the formula:

$$V_I = \sqrt{\frac{\sum_{t=1}^{T} R_t}{T-1}}$$

Considering the daily productivity of the SIF OLTENIA shares, on a period of 5 months (Oct 1st, 2009 - March 1st, 2010), the average of the productivity distributions is 0.2046, and the standard exception is 0.7491.

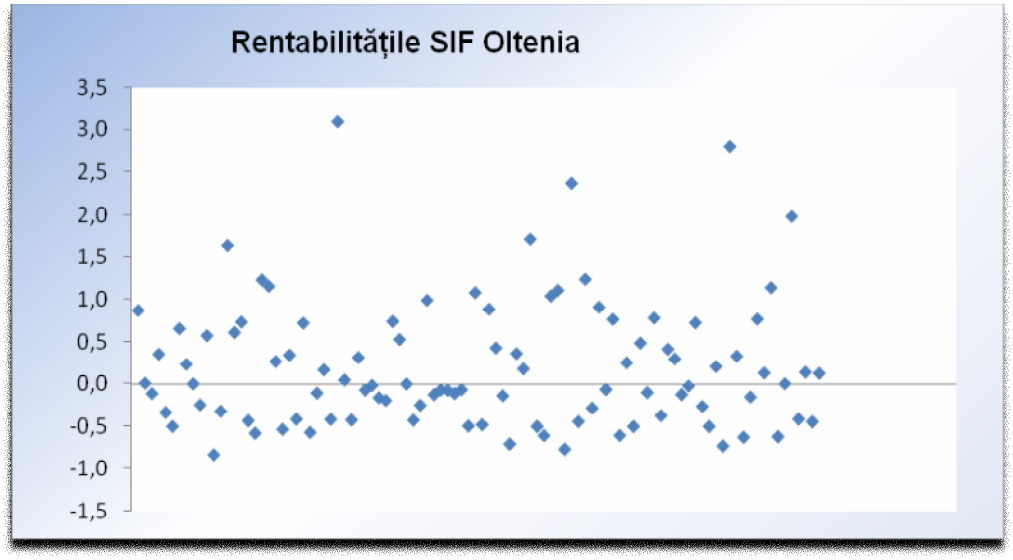


Figure no. 1. Daily productivity of the SIF OLTENIA shares

The distribution frequency of this series of daily productivity is very suggestive through graphic representation.

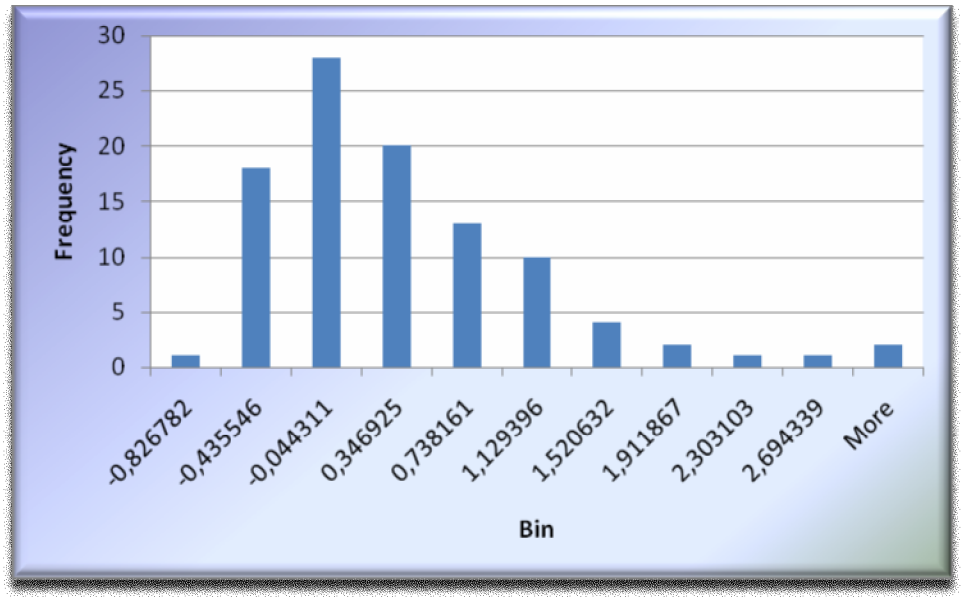


Figure no 2. The distribution frequency normalised for SIF OLTENIA

Regarding the implicit volatility, this represents the perspective of the market on the volatility along the lifespan of the option. Because there is not a simple formula of implicit volatility, in order to find it out, we have to find its value, from the following equation [2]:

$$V(P_0, t_0, \sigma, r, E, T) = \text{known value}$$

where V is the function from the Black - Scholes formula, P0 is the current price of the support asset, at the moment t0, E - exercise price, T - the expiration duration of the option, r - the interest rate without risk, all these elements being known, except for σ .

If the investor knows the price for an option and all the entries from above, except for the volatility, then he/she can change the model of setting the option's price calculating the implicit volatility.

The implicit volatility is not known for options with different exercise prices, when the other features of the options are unchanged.

Thus, for different options on the same support asset, with different exercise prices and expiration dates, each option shall have a different implicit volatility. Even within the same expiration dates, the options with different exercise prices shall have a different implicit volatility.

In the practical applications, the implicit volatility is generally associated with a non-flexible fixed time horizon. Also, obtaining the coefficient for the very small time intervals (a few days for instance) is very complicated. Moreover, the direct observable prices of the options are limited, not being able to generate complete sets of information for the value estimation of a portfolio, for instance [3].

A high implicit volatility means the fact that the market is waiting for the assets to continue being volatile, with very ample movements, either in the same direction or in an opposite direction. On the contrary, a low implicit volatility means that the market considers that the movements of the asset's price are relatively constant. Nevertheless, the study of the implicit volatility reveals much information, because this acts on the option's price, being the only parameter which cannot be directly observable on the market and cannot be covered or compensated with other financial instruments.

Because volatility is not constant, predictable or directly observable, its modelling as a random variable of the option's price evolution is necessary, through defining some models of equations with stochastic partial derivatives.

If the asset's price keeps having an evolution under the normal distribution law, and volatility is a stochastic process, the differential equation is obtained:

$$dR = \mu R dt + \sigma R dy_1$$

and we suppose that volatility satisfies the equation:

$$d\sigma = f(R, \sigma, t)dt + g(R, \sigma, t)dy_2$$

where dy1 and dy2 are correlated through the correlation coefficient ρ . The choice of the f(R, σ, t) and g(R, σ, t) functions is important for the evolution of volatility and thus for the options evolution.

Within the volatility modelling, it is allowed to behave in any way, provided that it stays within a given interval. With this model we will not calculate only one value of the option as the best and the worst price for the option. The result is a non-linear differential equation. Thus, we obtain a safety interval for the option's price, according to the introduced volatility.

5. CONCLUSIONS

The influence of the main variables on the price of the option contracts are the current prices on the market of the support assets, the volatility of the asset's price, the exercise price, the expiration duration of the option contract and the interest rate.

The analysis of the influences of the essential factors on the option contracts have lead to the conclusion that the volatility of the asset's price indicates the risk of the assets and it is one of the main and the most difficult factor to be determined. This parameter is the only one that is not known exactly at the moment of the option contract conclusion.

Under these conditions, due to the profound importance of volatility in the option evaluation and due to the fact that volatility is difficult to estimate, observe or predict, we must model it as a random variable for many of the option contracts for which the model of constant volatility (as the Black Scholes model is) is inadequate.

Although, during the last decade, the transaction of the derived products has known an ascending trend, increasing the interest in these, there still are a lot of unknown aspects. An important element in this analysis is the volatility, whose behaviour is often unpredictable.

The insufficient knowledge of the aspects connected to the evaluation of the option contracts implies their exclusion from the investment portfolio of many investors.

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