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FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION
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PhD THESIS

SUMMARY

TESTING THE EFFICIENCY OF ROMANIAN FINANCIAL DERIVATIVES MARKET – THE SIBEX CASE

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Cluj-Napoca
2012

PhD Thesis structure

Key words: futures contracts, options, volatility, early exercise premium, pricing efficiency, informational efficiency, Generalized Hurst exponent test, General Spectral test.

Introduction

Whether a few decades ago financial derivatives where part of several privileged foreign persons' vocabulary, nowadays there are frequently used financial terminology like *forward, futures, option, swap* by less informed people. Therefore, we have to make a segregation between financial derivatives instruments within a standardised form, i.e. a stock exchange and over the counter negotiated instruments, because the latter one, have brought a bad fame to financial derivatives market beginning with the financial crisis that started in 2007. Analists highly influenced and encouraged by Warren Buffet, consider that the financial derivatives, so called toxic assets, are the main cause of this turmoil. It has to be emphasised that these „mass distruction weapons" refer to non regulated financial instruments that were designed to answer to various requirements and that were not traded on a regulated market. The present scientific paper is aimed to analyse the regulated financial instruments field, given the high current importance of this matter and the opportunities offered by their usage.

Any investor, institutional or individual, that owns assets is subject to price fluctuation risk, being forced to protect himself against such risks. Financial derivatives have been the best solution to these needs, being a nonreplaceable risk management instrument. It is highly acknowledged that the main purpose of financial instruments' utilization is the control and management of risk. The risk that the price changes until the maturity date is very high. In Romania, the most influenced category is formed by importers and exporters. Financial derivatives market provides these users with instruments that protect against foreign currency risk.

Financial institutions use the financial derivatives not only for hedging purposes but also for speculative reasons. The speculators provide market liquidity, contributing to enhancing its price efficiency, because they reduce the differences between call price and put price. They contribute to ensuring the futures market stability through assuming risks and offering liquidity and capital.

Another important category on the futures market is the arbitragers that interfere for a gain when they identify arbitrage opportunities on the market, resetting the market equilibrum. The mixed presence of the three categories of market participants increases the market efficiency.

In the last decades the regulated financial instruments market has known a continuous expansion, becoming more and more important in the finance field. In what concerns the domestic situation, the Romanian futures market trend follows the global dynamics, validating the expansion expectations. 2006 was an important year for Sibiu Stock Exchange (SIBEX) because the number of positions have increased by six times in comparison with the previous year. Nevertheless, the financial derivatives market is not used at its full potential regarding both risk management and speculation opportunities. The lack of interest towards the financial derivatives might be determined by the fact that the Romanian market participants are not properly informed on the advantages embedded in futures and options contracts utilization.

Even though the Romanian futures market is in an incipient phase, the financial derivaties have represented a main concern for many financial analysts, but this interest was represented only in theoretical level, without supported by the empiric level. In the international specific literature there are studies that analyse the efficiency of most developed futures' markets. Oftenly, these analyses generate contradictory results due to different timelines of the study or different theoretical approach. Therefore, the efficiency of futures market remains a disputed matter opened for further analysis, especially in Romania. This is another reason for our concern about this direction and our strive in bringing several arguments for the increase of the educational and informational among financial derivatives and also their utilization for risk management purposes.

In the thesys's first part we outlined the theoretical framework of financial derivatives instruments which are of utmost popularity in Romania, i.e. the futures and options contracts. Further to a synthetical presentation of the main theoretical aspects referring to futures contracts and to their typology, we presented, by examples, the main operations with futures contracts: hedging, speculation and arbitrage. In what concerns the latter operation, we identified all the cash and carry arbitrage opportunities existing for DESIF5 futures on the Sibiu Stock Exchange for the period 3 January 2005 – 26 August 2011. Subsequently, our concern was directed to defining options, their price sensitive influencing factors, as well as simple and mixed strategies that may be built up by using them. For each type of strategy, we created an example graphically represented as chart using MATLAB, which is a programme that offers a friendly environment for pricing and representing such assets.

The options contracts' typology is more and more wide, determining the necessity of developing news complex pricing models, that contain all the potential price influencing variables. In the first part of the second chapter we presented classical options pricing models, Black-Scholes model for European options and the binomial model for American options, and also newer valuation models for American options (Barone-Adesi Whaley model).

For testing the Romanian options market efficiency we have chosen the most traded contract on Sibex, i.e. options having underlying asset the futures contract on SIF5 shares and we have tested the assumptions in which the early exercise premium of an American put option is positively corelated with the degree in which the option is in the money, with the period remaining until maturity, with the risk free rate and the volatility.

The third chapter concentrates on the price sensitivity coeficients influence depending on the influencing factors variation in developing strategies aimed to manage optimally all the associated risks. The volatility is also very important because the way in which this parameter is estimated depends on the option's theoretical price. One of the Black-Scholes model assumptions according to which the volatility is a constant parameter and may be determined based on historical data does not corespond to reality. In practice, the volatility of the underlying asset is a variable parameter that may be estimated through reversing the Black-Scholes equation, begining with the option market price. This volatility for which the theoretical price is equal to the market price is called implied volatility. There exists specific literature dedicated to estimating the volatility and its connection with the strike price, correlation known as volatility smile, or the conection between the volatility and the options maturity – the term volatility structure. Testing these corelations on the Romanian options market is quite difficult because of the low market's liquidity.

If the concept of efficiency is not quite unknown for the Romanian spot market, this matter being treated within many scientifical papers, in what concernes the futures market efficiency there are very few analyses. Investors may be interesed to establish the futures market efficiency because this could provide them with usefull information for setting profitable strategies the would beat the market. Therefore, in order for the study to be complete the final chapter is dedicated to testing the two components of DESIF5 futures market efficiency: pricing efficency and informational efficiency. We can consider the pricing efficency as a component of informational efficiency. Thus we can conclude that an informational efficient market is also pricing efficient.

There is no doubt that the concept of perfect efficiency is utopian, but it would be unfair to classify all the markets as inefficient, irrespective of their development stage. In this context it is expected that developed markets have higher efficiency degree than the emergent markets. The explanation consists in the fact that a more detailed analysis realized by traders on higher liquidity markets should ensure the rapid elimination of arbitrage opportunities generated by either linear or non-linear dependencies. That's why in the specific literature is introduced a new concept of markets ranking, depending on their efficiency – relative efficiency.

The summary of PhD thesis’s chapters

The summary of chapter 1

The financial derivatives – Theoretical approaches, trading strategies

1.1. Futures contracts – Definition, typology, transactions
1.2. Options - Definition, typology, transactions

The thesis’s first chapter is dedicated to the theoretical framework of financial derivatives instruments which are of utmost popularity in Romania, i.e. the futures and options contracts. Adequate use of these financial products represents a delicate problem and, as a consequence, a good knowledge and understanding of both specific elements and operations and strategies formed by using them is necessary. The main purpose of the first chapter is to provide fundamental information without which this scientific paper could not continue.

A synthetic definition of financial derivatives could be the following: financial derivatives are future contracts whose value depends on the spot market price of an underlying asset (shares, bonds, currencies, interest rates, stock indices, goods etc.). The main categories of financial derivatives that are currently traded in Romania are futures and options contracts.

Each time when defining the futures contracts, the start point in the specific literature is the basis fomr, i.e. the forward contracts. Similar to forwards contracts[1], a ***futures contract*** represents an agreement between two parties to buy or to sell an asset at a future date and at a price fixed set when the transaction is concluded. In contrast with forward contracts, the futures contracts are standardized. Except for the price that is negociated between parties, all the elements are standardized (the maturity, the contract volume,

[1] A forward contract is an agreement concluded on the *over the counter* (OTC) market, to sell or to buy an asset at a future date and a certain price.

quotation steps, maximum addmited variation, decrease/ increase risk) according to the specifications of each futures contract. Futures are used for the follwing three main purposes:

- for hedging against various risks
- for financial market speculations
- for arbitrage operations

As a preamble to analysing the futures market efficiency, we have identified the arbitrage opportunities on SIBEX market for DESIF5 futures contract, with 3 months maturity, in the period 3 January 2005 – 26 August 2011. Initially we identified 1393 possibilities that could have been realized in the indicated timeline, and after we took into account the transaction costs, the number of possibilities has significantly decreased to 349.

Options are contract whose value depends on one or more underlying elements' evolution, as follows: interest rate, foreign currency rate, stock excahnge indices, shares, bonds, futures contracts etc. (NBR Norm 10/2002). In constrast with futures contract, an option is a sell - buy contract concluded between two parties, which gives the buyer the right, but not the obligation to buy (*call option*) or to sell (*put option*) a certain quantity of goods, currencies, commodities or financial derivatives, at a fixed predetermined price *(strike price)*, at maturity *(European options)* or another date before the maturity *(American options)*. In order to be granted this right, the buyer pays the seller a price called premium.

In order to develop a strategy on the options market, investors have to define their expectations regarding the trend of the underlying asset and its volatility degree. Options trading srategies may be clasified in simple strategies (long call, short call, long put, short put, spread) and mixed strategies (straddle, strip, strap, strangle). For being sure that these strategies, most of the times complicated ones, are understood, we included an example for each of them, and subsequently presented it through MATLAB program.

The summary of chapter 2

Models for pricing options and the efficiency of options market

2.1. Black-Scholes model
2.2. Models for pricing American options
2.3. Empirical study on efficiency of options market

In the first part of chapter two we presented the main models for pricing options that we were needed for empirical testing of the efficiency options market.

Pricing options theory has its roots in Bachelier's research (1900) who used Brownian motion to evaluate French options on government bonds. Only in the early '70s options valuation methods have begun to gain consistency by the determining by Fischer Black and Myron Scholes formula for calculating the price of European options.

Black and Scholes (1973) are pioneers in pricing option theory. They started from the premise that if options are properly evaluated, there can be certainly no gain from the sale and purchase of options and underlying assets. Using this principle, they introduced a formula for determining the theoretical value of an option. Black-Scholes model for determining the price of a European option is widely used in practice because it requires knowledge of observable parameters: the underlying asset price, the strike price, the time to maturity of the option, the continously compounded risk-free rate and a parameter to be estimated independently, the underlying assets volatility. The model is based on a set of assumptions of which the most restrictive are: the underlying asset yield are normally distributed, volatility remains constant throughout the life of the option, there are no transaction costs and it can borrow money at the risk free rate.

Unlike Black and Scholes who used the principle of continuous valuation, Cox, Ross and Rubenstein designed the binomial model for calculating the price of an American option, based on the approximation of a continuous process with a discreet one. This model was presented in 1979 in *Option Pricing: A Simplified Approach.* Model summary consists in simulation of underlying asset price evolution by dividing the time to maturity in a certain number of short periods. Binomial method is useful and very popular for American call and put on a stock providing dividends. The basic principle of this model is that the underlying asset price can either increase or decrease in the next period.

Barone-Adesi & Whaley (1987) presented in the paper *"Efficient Analytic Approximation of American Option Values"* a model for pricing American options on stocks, stocks index, currencies and futures. BAW model is based on an analitical aproximation but it has a high accuracy, errors are generaly small even for options on underlying asset with a high volatility. Some errors ocurr for options with longer maturities, the method being recommended for options with maturity up to one year.

The efficiency of options market can be analyzed with some models based on tests or by checking the principle of non arbitrage opportunities. Since the second approach involves both testing efficiency market and elements of options valuation, most empirical studies are bazed on the principle that the market is efficient if the condition of absence of arbitrage opportunities is validated.

The principle of non arbitrage is based on two conditions: the lower boundary conditions and the put-call parity relationship. The firs condition refers to the fact that the value of an option can never be less than its intrinsic value. The put-call parity relationship was first sugested by Stoll (1969), and later extended and modified by Merton (1973a,1973b). Further, many papers have analised the put-call parity: Gould and Galai (1974), Galai (1978), Klemkosky and Resnick (1979), Bhattacharya (1983), Geske and Roll (1984), Evnine and Rudd (1985), Gray (1989), Taylor(1990), Brown and Easton (1992), Easton (1994), Wagner, Ellis and Dubofsky (1996), Broughton, Chance and Smith(1998), Mittnik and Rieken (2000), Brunetti and Torricelli (2005), Weiyu Guo and Tie Su (2006), Hoque, Chan and Manzur (2008), etc.

The put-call parity formula is not identically valid for American options. Yet, the principle of non arbitrage is useful in calculation of the value of early exercise premium. The early exercise premium is the difference in price between an American option and an otherwise identical European option.

The estimate of early exercise premium (EEP) is difficult because simultaneous liquid markets for American and European identical options do not exist. In this study we have used American put options with futures contracts on SIF5 as underlying asset (common stocks issued by SIF Oltenia S.A.), these being the most liquid options on Sibex. The analysed period is January 2009 - June 2010, and options' maturity is three months.

In this study we will try to investigate if the exercise premium EEP of an American put option is dependent on the degree in which the option is in the money, the time to maturity, the risk free rate and the volatility. The following model was used in this sense:

$$EEP_{p_{i,t}} = c_1 + c_2 M_t + c_3 T_t + c_4 r_{ft} + c_5 \sigma_t + \varepsilon_{i,t} \qquad (1)$$

where

EEP_p – the exercise premium before maturity for the American put option;

M – the degree in which the option is in the money;

T – the time to maturity;

r_f – risk free rate;

σ – volatility;

ε – residual variable.

In order to estimate EEP_p we have subtracted the put premium, calculated with the aid of the PCP relationship for European options, from the market price of the American option:

$$EEP_p = P - p \qquad (2)$$

where:

P - the price of the American put option on Sibex;

Table 1 presents the results obtained when historical volatility is used. Using historical volatility leads to a surprising result opposite to investors' expectations. Yet, other financial studies (Lee J., Xue M., 2006) using the same type of volatility, have identified the same negative impact of the volatility on the exercise premium.

***Table 1.* Modeling EEP for American put options using moneyness, time to maturity, risk free rate and historical volatility as exogenous variables.**

$EEP_p = c_1 + c_2 M + c_3 T + c_4 r_f + c_5 \sigma_{ist}$ - + + - -	
R^2	0.821648
Adjusted R^2	0.807660
C_1	-0.348376*** (-5.903748)
C_2	0.539612*** (12.70999)
C_3	0.227811** (1.861853)
C_4	-0.009743 (-0.790925)
C_5	-0.152022*** (-2.458741)

Source: Authors' processing

Note: ** significance at a confidence level of 95%;
*** significance at a confidence level of 99%;.

As it was expected, the coefficient of M (defined as a proportion between X and F) is positive and statistically significant, which means that the EEP increases with M. as M increases and the option is more in the money, it becomes more valuable.

The value of the put option increases with the time to maturity which leads to a more valuable exercise premium before maturity.

The interest rate and volatility effects depend on the degree in which the option is in the money. As shown in table 1, the risk free rate and volatility coefficients are negative. As far as the interest rate is concerned, as it increases the present value of the strike price diminishes leading to the superiority of the current price of the futures contract on the option' strike price. As the interest rate increases, the put option will probably be more out of the money, diminishing the value of the exercise premium.

The majority of the studies is modeling the early exercise premium using the implied volatility under the assumption that the market price equals the theoretical value of the option. The results of these studies are more conclusive, confirming investors' expectations through a positive impact of the volatility on the exercise premium. Table 2 presents the results of the econometric model when using the implied volatility.

***Table 2.* Modeling EEP for American put options using moneyness, time to maturity, risk free rate and implied volatility as exogenous variables.**

$EEP_p=c_1+c_2*M+c_3*T+c_4*r_f+c_5*\sigma_{impl}$ - + + - +	
R^2	0.868627
Adjusted R^2	0.858323
C_1	-0.394308*** (-7.732621)
C_2	0.570962*** (15.41261)
C_3	0.527626*** (4.761319)
C_4	-0.041749*** (-5.493082)
C_5	0.097745*** (5.142466)

Source: Authors' processing

Note: ** significance at a confidence level of 95%;
*** significance at a confidence level of 99%;.

Opposite to the previous case, we observe that all coefficients except for the interest rate are positives, confirming the results acknowledged in the financial literature. The estimated coefficients are statistically significant. The coefficient of the implied volatility indicates that the exercise premium increases with the increase in volatility.

Concluding, we may assert that the early exercise premium for short-term American put options is revealing in identifying arbitrage opportunities. The probability of early exercise is positively influenced by the degree in which the option is more in the money. The EEP of a put option is likely to increase with the proportion of the strike price in the price of the underlying asset.

The time to maturity was also expected to have a positive effect on the premium as the owner of a long term option has the same opportunities as the owner of a short term one, plus other opportunities derived from the time excess to maturity.

As far as the interest rate is concerned, an increase will lead to a reduction of the present value of exercising the option. As a result, the opportunity of exercising becomes more attractive, and the EEP is expected to increase with the reduction of the interest rate.

The effect of the implied volatility confirms what investors might expect: a higher volatility leads to a more consistent exercise premium. The volatility estimation method remains the main challenge in modeling the exercise premium and evaluating the options. This is a controversial issue both in theory and practice. A more rigorous analysis of different volatility estimation methods will make the subject of future research.

The empirical results of our study are in accordance to those obtained by Zivney and Sung pointing out the importance of the exercise premium before maturity in constructing evaluation models for American put options. In this study we have computed the exercise premium for American put options based on the put-call parity. According to some approaches, the exercise premium is estimated based on American options' evaluation models. We consider exciting this alternative and we intend to further develop this methodology in our future research.

The summary of chapter 3

Management of financial risks with options

3.1. Delta hedging
3.2. Gamma hedging
3.3. Vega hedging
3.4. Static hedging
3.5. Historical volatility vs. implied volatility

The easiest and known hedging strategy that uses derivatives is static hedging which involves opening a certain position and waiting the result at the end of the period. The investor does not modify the structure of the portfolio between the beginning and the end of the period even if the price changes, what matters is the portfolio value at maturity. This technique provides only partial protection because delta remains constant during the hedging. The alternative is therefore to adjust periodically the portfolio, this strategy being known as *dinamic hedging*. The most popular dinamic strategies are: delta hedging, gamma hedging, vega hedging.

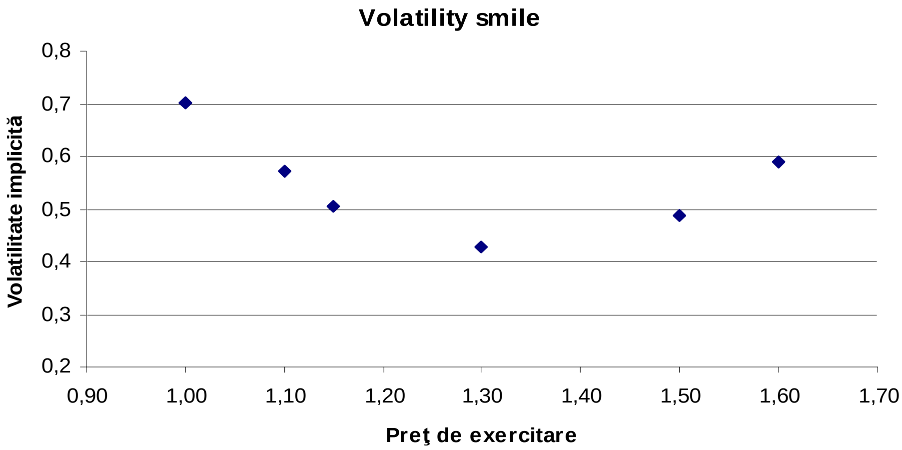
Estimating volatility is the most delicate aspect in the evaluation of an option as the option price is very sensitive to the changes of volatility. This approach has been criticized especially because investors' perceptions on risk are linked exclusively to the past variation of prices. Therefore we can say that it is a subjective estimate of market volatility, that is a significant difference between the option market price and its theoretical value. Thus it is considered that a more appropriate estimate of volatility is implied volatility.

Implied volatility is the future theoretical volatility of the underlying asset obtained with the current price of the option. Implied volatility is calculated by the reversal running of the valuation options models (Notger C., 2005).

The researches on evolution of volatility concluded that it is strongly correlated with the maturity and the option strike price. The function that reflects the relationship between implied volatility and the strike price is called *volatiliy smile*.

The next figure presents a *volatility smile* for a call option on DESIF5 futures contract with the maturity in December 2009, traded on 31.07.2009, close price for DESIF5 DEC09 being 0,9801 lei/share.

***Figure 1.* Volatility smile for options on DESIF5 DEC09**

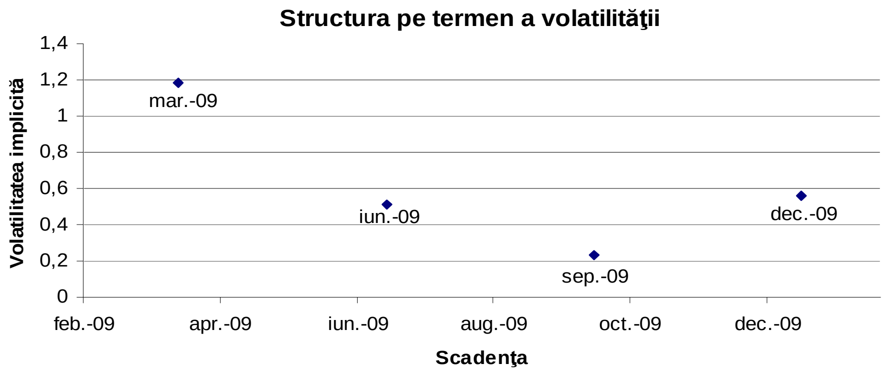


Source: Authors' processing

As we can see, the correlation between implied volatility and strike price observed on the well-developed world market are also confirmed by the Romanian options market: calls deep *in the money* have a higher implied volatility decreasing until options become *at the money* and then to rise again as options approach *out of the money*. So, the previous figure confirm the presence of volatility smile on the Romanian market.

In addition to the volatility smile, traders take into account the volatility term structure in pricing options. This notion reflects the correlation between volatility and maturity. Figure 2 shows the evolution of volatility to the time to maturity for options that were traded on 13.03.2009, with the underlying on DESIF5, the strike price 0,4 lei/share and the maturity on March, June, September and December 2009.

***Figure 2*. Volatility term structure**



Source: Authors' processing

As can be seen in previous figure, the volatility term structure for the most liquid options on the Romanian market has approximate the same curve as that observed on the developed markets. Surprisingly, the contract with the maturity in December has a high level of implied volatility (56,09%). A possible explanation could be the low liquidity facing the Romanian futures market.

Volatility surface combine the volatility smile and the volatility term structure. An example of volatility surface that might be used for foreign currency options is shown in table 3. The entries in the table are the implied volatilities calculated from the Black-Scholes model. At any given time, this entries correspond to options for which reliable market data are available.

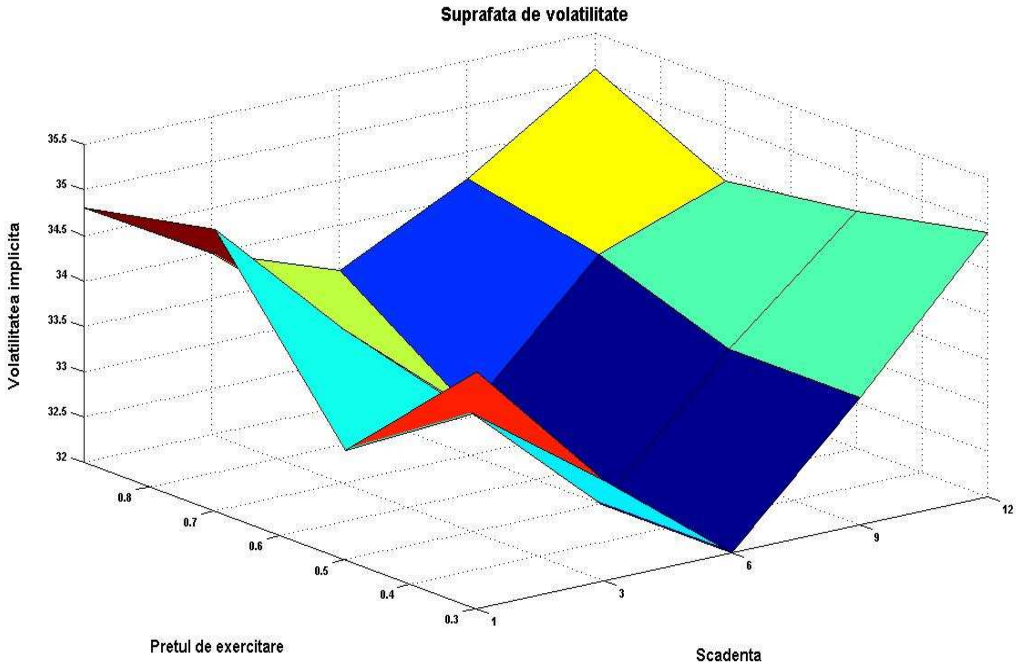
***Table 3*. Example of volatility surface**

Strike / Maturity	0,4	0,5	0,6	0,7	0,8
1 month	34,6	33,1	32,0	33,4	34,9
6 months	33,2	33,3	32,0	33,4	34,6
9 months	35,1	33,7	32,5	33,9	34,4
12 months	34,8	34,0	33,5	34,2	35,1

Source: Authors' processing

The graph below shows the volatility surface from the previous table.

***Figure 3.* Volatility surface**



Source: Authors' processing

Since there are no available data for al strike prices and all maturities and the prices of out of the money options with longer maturities remain unchanged for a long time, to complete the volatility surfaces can be used interpolation techniques.

The summary of chapter 4

Empirical study on Romanian futures market

4.1. Pricing efficiency
4.2. Informational efficiency

The most studies on informational efficiency of futures market test the efficiency on the premise that the futures should be unbiased estimates of the future spot prices. Chen Leig & Zheng Zhenlong (2008) distinguished between pricing efficiency and informational efficiency and point out that the two concepts should not be confused.

Pricing efficiency of futures market refers to how futures price is established by the market so there is no arbitrage opportunities and how the investors' expectations on the future evolution of spot price. We consider pricing efficiency as part of informational efficiency so that we can say that if a futures market is informational efficiency is also pricing efficiency.

In the empirical study effectuated for testing the pricing efficiency of futures market we have used American put options with futures contracts on SIF5 as underlying asset (common stocks issued by SIF Oltenia S.A.), these being the most liquid futures contracts on Sibex. We have grouped the DESIF5 futures by maturity into four categories. The analysed period is January 2005 - August 2011.

The first step in testing the pricing efficiency of futures market involves testing the stationarity of the series of f_t, s_t and $(r_t\text{-}q_t)(T\text{-}t)$. For this, in the present study we applied Augmented Dickey – Fuller test and obtained the following results:

***Table 4.* Results of the Augmented Dickey – Fuller test**

DESIF5 3 months	f_t	Δf_t	s_t	Δs_t	f_t-s_t	$(r_t$-$q_t)(T$-$t)$
Intercept	-1,263634	-40,30426***	-1,306426	-35,23780***	-7,530081***	-4,851951***
Trend and intercept	-1,920899	-40,32651***	-1,962410	-35,26215***	-8,509438***	-5,205633***
No trend and no intercept	-0,818224	-40,31654***	-0,821476	-35,24807***	-6,356603***	-4,558341***
DESIF5 6 months	f_t	Δf_t	s_t	Δs_t	f_t-s_t	$(r_t$-$q_t)(T$-$t)$
Intercept	-1,092801	-33,43237***	-1,109457	-32,37186***	-5,517736***	-2,892383**
Trend and intercept	-1,881543	-33,44417***	-1,847133	-32,38434***	-6,688765***	-3,033649
No trend and no intercept	-0,759051	-33,44495***	-0,788851	-32,38407***	-3,190723***	-2,712147***
DESIF5 9 months	f_t	Δf_t	s_t	Δs_t	f_t-s_t	$(r_t$-$q_t)(T$-$t)$
Intercept	-0,778358	-30,69679***	-0,938982	-28,75995***	-4,298409***	-5,085488***
Trend and intercept	-1,195860	-30,68148***	-1,270130	-28,74616***	-6,142988***	-6,252168***
No trend and no intercept	0,928868	-30,70020***	-1,041502	-28,76555***	-2,116391**	-2,350949**
DESIF5 12 months	f_t	Δf_t	s_t	Δs_t	f_t-s_t	$(r_t$-$q_t)(T$-$t)$
Intercept	-0,935604	-26,22542***	-1,239667	-24,61899***	-4,560376***	-2,090650*
Trend and intercept	-0,865380	-26,22352***	-1,074415	-24,61716***	-5,797715***	-2,104947
No trend and no intercept	-1,059585	-26,22549***	-1,368018	-24,62176***	-1,953520**	-2,091407**

Source: Authors' processing

Note: *** denotes significance at 1% level
** denotes significance at 5% level
* denotes significance at 10% level

Table 4 reports the ADF results of the series of log futures prices, the first difference of log futures prices, log spot prices, the first differences of log spot prices, the basis and the cost of carry. It shows that futures prices and spot prices series H_0 is not rejected while the first difference of log futures prices, the first differences of log spot prices, the basis and the cost of carry are stationary series. According to the result of table 4, the pricing efficiency of DESIF5 futures could be tested by implementing cointegration tests for f_t and s_t or with the regression analysis using the model $f_t - s_t = \alpha + \beta(r_t - q_t)(T-t) + \varepsilon_t$.

To test the cointegration of nonstationary series is used the Johansen test.

Table 5. **Results of Johansen cointegrations test between f_t and s_t**

Hypothesized No. of CE(s)	**Eigenvalue**	**Trace statistic**	**Max-eigen statistic**
DESIF5 3 months			
None	0,028631	46,14520*	44,56163*
At most 1	0,001032	1,583570	1,583570
DESIF5 6 months			
None	0,016589	23,79695*	22,04706*
At most 1	0,001327	1,749884	1,749884
DESIF5 9 months			
None	0,016811	19,10773*	17.69971*
At most 1	0,001348	1,408024	1,408024
DESIF5 12 months			
None	0,025004	23,02573*	19,87796*
At most 1	0,004002	3,147771	3,147771

Source: Authors' processing

Note: * denotes significance at 5% level

Since the serios f_t-s_t and $(r_t$-$q_t)(T$-$t)$ are stationary, we can test the following $f_t-s_t=\alpha+\beta(r_t-q_t)(T-t)+\varepsilon_t$ and obtain:

Table 6. **Results of regression analysis**

$f_t-s_t=\alpha+\beta(r_t-q_t)(T-t)+\varepsilon_t$				
	$\hat{\alpha}$	$\hat{\beta}$	R^2	$\overline{R}^2$
DESIF5 3 months	0.013154*** (8.754344)	1.922828*** (7.827199)	0.257847	0.257365
DESIF5 6 months	0.050038*** (20.42327)	0.948681 (9.461038)***	0.257849	0.257291
DESIF5 9 months	0.083825*** (27.30145)	0.679279 (10.23043)***	0.329304	0.328668
DESIF5 12 months	0.113352*** (30.68978)	0.499111*** (8.761136)	0.329290	0.328448

Source: Authors' processing

Note: *** denotes significance at 1% level

We can notice that $\hat{\alpha}\neq 0$ and $\hat{\beta}\neq 1$, which is contrary to the requirements of pricing efficiency. In other words, the two coefficients deviate siginificantly from the desiteratum of pricing efficiency[2]. Therefore, DESIF5 futures is not eficient in pricing. For testing the

[2] $\alpha=0$ şi $\beta=1$.

causality between Δf_t and Δs_t we establisehed a vector error correction model on which we have implemented the Granger causality test.

Table 7. **Results of Granger causality test**

Dependent variable	**Chi-sq**	**Df**	**Prob.**
DESIF5 3 months			
Δf_t	51,56029	6	0,0000
Δs_t	22,30536	6	0,0011
DESIF5 6 months			
Δf_t	25,65858	12	0,0120
Δs_t	40,37483	12	0,0001
DESIF5 9 months			
Δf_t	32,18401	12	0,0013
Δs_t	45,01934	12	0,0000
DESIF5 12 months			
Δf_t	61,43579	12	0,0000
Δs_t	33,8305	12	0,0007

Source: Authors' processing

In all cases, the null hypothesis is rejected at 1% level. In other words, we can not establish with certainty which of the variable play a leading role because Δs is a cause for Δf and the reverse is also true.

Following the empirical results obtained, we conclude that the manner in which the futures price is fixed for DESIF5 futures for all the four maturities does not satisfy the conditions of the pricing efficiency.

Most studies on the informational efficiency submit on the idea that the deviation from random walk process is perceived as a deviation from the hypothesis of informational efficiency. This deviation is caused by the presence of long or short run dependencies.

Long run dependencies can be tested with Hurst exponent. For testing the short run dependencies of futures market we used the General Spectral Test (GST) proposed by Escanciano & Velasco (2006) which can capture the possible nonliniar dependencies unlike the variance ratio test which captures only the liniar dependencies.

P-values for GST were calculated using a code implemented in MATLAB. For each category of contracts, we determined the percentage of time windows for which p-value is less than 0,5. The next table summarizes the results of testing the short run dependencies of DESIF5 futures market.

***Table 8.* Relative informational efficiency ranking for DESIF5 futures**

% of windows for which *p*<0,05	
DESIF5 3 months	64,38
DESIF5 9 months	75,65
DESIF5 6 months	75,73
DESIF5 12 months	78,5

Source: Authors' processing

If we follow each contract, we observe an alternation of subperiods in which prices follow a martingale process with subperiods in which futures prices are characterised by nonmartingale.

Further to aplying GHE test both static and dynamic for testing the long range dependencies on DESIF5 futures market, we noted that the market has a persistent behaviour having a long range dependency for all four groupps of contracts. The results of GHE test are presented in the nex table.

***Table 9.* Results of static GHE test**

	H(1)	**SE**	**W**
DESIF5 3 months	0,5638	0,0193	10,92765**
DESIF5 6 months	0,598	0,0121	65,59661**
DESIF5 9 months	0,58	0,0111	51,94384**
DESIF5 12 months	0,623	0,0184	44,68632**

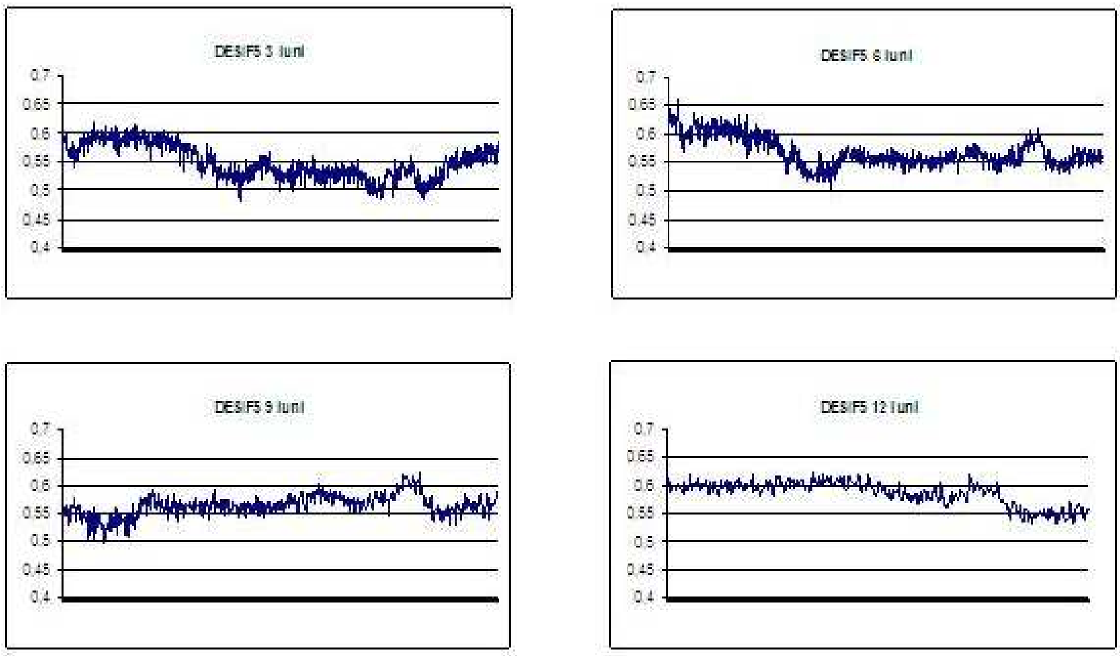
Source: Authors' processing

Note: *** denotes significance at 1% level
** denotes significance at 5% level

It is noted that fosr all four contracts reviewed, the market has a persistent behavior, so long run dependencies are indentified.

The implementation of GHE test on rolling windows allows for robust results concerning the degree of marrkets' informational efficiency in time.

Figure 4. **The time evolution of H(1) of GHE test on rolling windows**



Source: Authors' processing

Regarding the informational efficiency of DESIF5 futures market, we can say that the futures contract market with a three months maturity is ”the most efficient” according to the classification established by the General Spectral test. This is confirmed by both indicators of relative efficiency, *p*-value, respectively the percentage of windows for which the value of *p* is below 0,05.

The GHE test results, both over entire period as well as rolling windows, each of 512 observations, reflect the hypothesis acceptace of long memory for all four contracts over all analysed period. The results of this study show that the efficiency market is not a static concept, and its intensity can vary over the time.

In conclusion, in order to serve its basic functions, i.e. competitive price descovery, management of risk, facilitating financing and promotion of efficient resource allocation, the Romanian futures market must „submit” on the efficient market hypothesis, thus the price must reflect all available information.

Finally, this hypothesis is reduced to the fact that the futures prices should be unbiased estimates for future spot prices. The novelty of our study is that beside testing this hypoyhesis reduced at testing pricing efficiency, we used two tests of predictability, the General Spectral test and the Genelized Hurst exponent test, which identified the presence of long and short dependencies on the Romanian futures market.

General conclusions

The present thesis has as main objective the presentation of financial derivatives in Romania not only regarding the theoretical fundamentals but also empirical testing its efficiency. Although the Romanian spot market is still young, it has the the international trend of continue expansion, because the multiple benefits offered by this category of less known financial instruments: high efficiency of managing foreign exchange risks, flexibility, low trading costs, diversifying portfolio possibility and the placement strategies, and the list may continue.

In the first part of our analysis we have realized an introduction in the theoretical area of futures and options contracts, the most traded derivatives on the main futures market in Romania – SIBEX. In order to increase the attractivity level of these theoretical guidance, we illustrated within the first chapter with examples for each trading strategy presented, the examples being followed by chart representations in MATLAB, that offer elegant solutions in this respect. Moreover, as a preambul for analyzing the futures market efficiency, we identified arbitrage opportunities for the last seven years referring to the most liquid contract on SIBEX, that has as underlying asset SIF5 shares. Initially we identified 1393 possibilities that could have been realized in the indicated timeline, and after we took into account the transaction costs, the number of possibilities has significantly decreased to 349.

The option market efficiency can be analyzed either with the aid of testing based models or checking the lack of arbitrage opportunities' principle. Given that the second approach involves, besides testing the efficieny market, options valuation elements, most of the empirical analyses are based on the principle that the market is efficient if the non arbitrage oportunities principle is observed. The empirical results of our study follow the same trend with those obtained by Zivney and Sung and emphasize the importance of the exercise premium before the maturity in setting the American put options valuation models. Further to analyzing these results we can conclude that the exercise premium before maturity for the American short term put options is relevant in identifying arbitrage opportunities. The probability that an option is exercised before maturity is correlated with the period in which the option is in the money.

The range of strategies regarding financial risk hedging offered by derivatives insttruments in general and options in particular is very wide. The most simple and well known strategy is static hedging that involves adopting a certain position and waiting for the result at the end of the period. Therefore this strategy is closely dependent on the established time horizon. The investor does not modify the portfolio structure between the start and the end of the hedging period even though the prices are fluctuating, the most relevant aspect being the portfolio value at maturity. In fact, the parameters that measure the option price sensitivity depending on the influenceing factors do not remain constant towards the hedging period. In this way, a new alternative arises, the operation called dinamic hedging.

The sharpness of options theoretical price calculation is influencing the accuracy of estimating the volatility. The historical volatility has been challenged because the investors' perception regarding risk is exclusively based on the way in which the underlying asset's price fluctuated in the past. Therefore we can argue that it represents subjective estimation of market volatility because of the significant differences between market prices and theoretical prices. A top solution for estimating volatility is implied volatility that offers an image on the market expectations regarding volatility.

The correlation between implied volatility and exercise price (volatility smile) identified on the most developed markets in the world is also observed in the Romanian options market: deep in the money call options have an increased implied volatility, decreasing untill the options are at the money, and afterwards increase again untill the options tend to become deep out of the money. Besides volatility smile traders take into account the volatility term structures for pricing options. On the Romanian market the volatility term structure is not quite identical to the structure observed on international markets even for the most liquid options. A possible explanation might be the low liquidity of the Romanian futures market.

Most studies in the term market efficiency field test the efficiency assuming that the futures prices should be unbiased estimates for future spot prices. Chen Leig & Zheng Zhenlong (2008) make the distinction between pricing efficiency and informational eficiency and underline the fact that the two must not be confused.

Futher to analizing the pricing efficiency of DESIF5 contract the empirical results conduct to the conclusion that the way in which the futures price is established for all four maturities do not correspond to the efficiency conditions relevant for establishing the price and implicitly to the assumption that the market is informationally efficient. This could be a consequence of the lack of maturity of term market in our countryl the values of estimated parameters significantly differ from the values that caracterize the efficiency.

In what concerns the relative informational efficiency DESIF5 futures contract with three months maturity is the most efficient probably because of an increased liquidity. Further to aplying GHE test both static and dynamic for testing the long range dependencies on futures market, we noted that the market has a persistent behaviour having a long range dependency for all four groupps of contracts.

In conclusion, we emphasize that the results obtained within this thesis are useful for both theoreticians and practicioners the more the Romanian futures market was not a top research subject. The Romanian futures market has considerably developed in the last few years offering investment opportunities, portfolio diversification, risk hedging for investors that trade both domestic and global level, and we hope to follow the same trend in the future.

Bibliography

1. Abhyankar, A.H. (1995), Return and volatility dynamics in the FTSE 100 stock index and stock index futures market, *Journal of Futures Market*, Vol. 15, Issue 4: 457-458
2. Allayannis, Y., Weston, J. (2001), The use of foreign currency derivatives and firm market value, *Review of Financial Studies*, Vol. 14: 243-276.
3. Alessio, E., Carbone, A., Castelli, G., Frappietro, V. (2002) Second-order moving average and scaling of stochastic time series, *European Physical Journal B*, Vol. 27: 197-200
4. Ancuţa, T., Cozgarea, M., Utan, L., Nan, S. (1999), *Totul despre futures şi opţiuni*, SIBEX, Sibiu
5. Baillie, R. (1989), Econometric tests of rationality and market efficiency, *Econometric Review*, Vol. 8: 151-186.
6. Barabasi, A.L., Vicsek, T. (1991) Multifractality of self-affine fractals, *Physical Review A*, Vol. 44: 2730-2733.
7. Barhart, S. W., Szakamary, A. C. (1991), Testing the unbiased uate hypothesis: Evidence on unit roots, cointegration and stochastic coefficients, *Journal of Financial and Quantitative Analysis*, Vol. 26: 245-67.
8. Barone-Adesi, G., Whaley, R. (1987), Efficient analytic approximation of American option values, *Journal of Finance*, No. 42: 301-320
9. Bartram, Sohnke M., Brown, Gregory W. and Conrad, Jennifer S. (2009), The Effects of Derivatives on Firm Risk and Value, SSRN, Accesat la: http://ssrn.com/abstract=1210422.
10. Beck, S. E. (1994), Cointegration and market efficiency in commodities futures markets, *Applied Economics*, Vol. 26: 249-57.
11. Bernstein, J. (2000), traducere C. Baroga, *Piaţa contractelor futures*, Editura Hrema (How Wall Street Work), Bucureşti
12. Bhattacharya, M. (1983), Transactions data tests of efficiency of the Chicago Board Options Exchange, *Journal of Financial Economics*, No.12: 161-185
13. Black, F., Scholes, M. (1973), The pricing of options and corporate liabilities, *Journal of Political Economy*, Vol. 81, Issue 3: 637-654
14. Bodurtha, J.N., Courtadon, G.R. (1987), Tests of an American option pricing model on the foreign currency option market, *Journal of Financial and Quantitative Analysis*, 153-168
15. Boyle, P. (1977), Options: a Monte Carlo approach, *Journal of Financial Economics*, No. 4: 323–338
16. Brennan, M., Schwartz, E. (1977), The valuation of American put options, *Journal of Finance*, No. 32: 449–462
17. Brenner, M., Galai, D. (1986), Implied interest rates, *Journal of Business*, No. 59: 493–507
18. Brenner, R J., Kleier, K F.(1995), Arbitrage, cointegration and testing the unbiasedness hypothesis in financial markets, *The Journal of Financial and Quantitative Analysis*: 23-42
19. Broadie, M., Detemple, J., Ghysels, E., & Torres, O. (2000), American options with stochastic dividends and volatility: A non parametric investigation, *Journal of Econometrics*, Vol. 94: 53–92

20. Brooks, C., Rew, A., Ritson, S. (2001), A trading strategy based on the leadlag relationship between the spot index and futures contract for the FTSE 100, *International Journal of Forecasting*, Vol.17, Issue 1: 31-44

21. Broughton, J.B., Chance, D.M., Smith, D.M. (1998), Implied standard deviation and put-call parity relations around primary security offerings, *The Journal of Applied Business Research*, No. 15: 1-12

22. Brown, R.L., Easton, S.A. (1992), Empirical evidence on put-call parity in Australia: A reconciliation on further evidence, *Australian Journal of Management*, No. 17: 11-20

23. Bruner, R.F. (2004), Applied Mergers and Acquisitions, Wiley Finance

24. Brunetti, M., Torricelli, C.(2005), Put-call parity and cross-markets efficiency in the index options markets: Evidence from the Italian market, *International Review of Financial Analysis*, No. 14: 508-532

25. Cajueiro, D.O., Tabak, B.M. (2005) Ranking efficiency of emerging equity markets II, *Chaos, Solitions & Fractals*, Vol. 23: 671-675.

26. Cajueiro, D.O., Tabak, B.M. (2004a) The Hurst exponent over time: testing the assertion that emerging markets are becoming more efficient, *Physica A*, Vol. 336: 521-537.

27. Cajueiro, D.O., Tabak, B.M., (2004b) Ranking efficiency for emerging markets, *Chaos Soliton &Fractals*, Vol. 22: 349-352.

28. Cajueiro, D.O., Tabak, M.B. (2006) Testing for predictability in equity returns for European transition markets, *Economic Systems*, Vol. 30: 56-78.

29. Campbell, J.Y., Lo. A.W., MacKinlay, A.C. (1997), *The econometrics of financial markets*, Ed. Princeton University Press, Princeton

30. Carbone, A., Castelli, G., Stanley, H.E. (2004) Time-dependent Hurst exponent in financial time series, *Physica A*, Vol. 344: 267-271.

31. Carr, P., Madan D., (1999), Towards a theory of volatility trading, Volatility, *Risk Publications*, R. Jarrow: 417–427.

32. Chance D.M. (1986), Empirical tests of the pricing of index call options, *Advances in futures and options research*, Vol. 1: 141-166

33. Chance D.M. (1998), *An introduction to derivatives*, Drezden Press, Forth Worth

34. Chance, D., Kumar, R., & Rich, D. (2002), European option pricing with discrete stochastic dividend, *Journal of Derivatives*, Vol. 9, No.3: 39–45.

35. Charles A., Darné O., Foilloux J. (2010), Testing the martingale difference hypothesis in CO_2 emission allowances, Economic Modelling, No. 28: 27-35.

36. Chen, R., Zheng, Z. I. (2007), Can futures prices predict future spot prices?, *Studies of International Finance*: 70-74

37. Chen, R., Zheng, Z. I. (2008), Unbiased Estimation, Price Discovery and Market Efficiency: Futures Prices and Spot Prices, *Systems Engineering Theory & Practice*, Vol. 28, Issue 8: 2-11

38. Chiang, R., Fong, W. M. (2001), Relative informational efficiency of cash, futures and options market. The case of an emerging market, *Journal of Banking and Finance,* Vol.25, Issue 2: 355-375

39. Chiras, D., Manaster, S. (1978), The information content of option prices and a test of market efficiency, *Journal of Financial Economics*: 213-234

40. Chowdhury, A. R. (1991), Futures market efficiency: evidence from cointegration tests, *The Journal of Futures Markets*, Vol. 11: 577-89

41. Codîrlaşu, A.(2007), *Econometrie aplicată utilizând EViews 5.1*, Note de curs, Bucureşti

42. Cornell, B., Reinganum, M. (1981), Forward and futures prices: evidence from foreign exchange markets, *Journal of Finance*, Vol. 36: 1035-1045.

43. Cox, J., Ross, S., Rubinstein, M. (1979), Option pricing: a simplified approach, *Journal of Financial Economics*, No. 7:229-263,

44. Cristea, L. şi colectiv (2000), *Investiţii pe pieţele la termen, analize şi strategii pentru investitori*, SIBEX, Sibiu

45. Crowder, W. J., Phengpis, C. (2005), Stability of the S&P 500 futures market efficiency conditions, *Applied Financial Economics*, Vol. 15, Issue 12: 855-866

46. Dash, M., Babu, N., Kodagi, M., (2007), Speculation strategies using investment in options, Indian Journal of Finance, Vol. 1, No. 4, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=13381655.

47. Derman E. (1999), Regimes of volatility, *Risk*: 55-59

48. Di Matteo, T., Aste, T., Dacorogna, M. (2005) Long-term memories of developed and emerging markets: Using the scaling analysis to characterize their stage of development, *Journal of Banking and Finance*, 29, 827-851.

49. Doffou, A. (2008), Estimating the early exercise premium of American put index options, *International Journal of Banking and Finance*, Vol. 6, Issue 1: 31-47

50. Drăgoi, A. (2003), *Modelarea riscului financiar în cadrul teoriei opţiunilor*, teză de doctorat, ASE Bucureşti, accesată la: www.biblioteca.ase.ro/downres.php?tc=1632

51. Easton, S.A. (1994), Non-simultaneity and apparent option mispricing in test of put-call parity, *Australian Journal of Management*, No. 19: 47-60

52. Elam, E., Dixon, B.L. (1988), Examining the validity of futures market efficiency, The *Journal of Futures Markets*, Vol. 8: 365-372.

53. El Karoui, N., Jeanblanc, M., Shreve, S. (1998), Robustness of the Black and Scholes formula, Mathematical Finance, Vol. 8, Issue 2: 93-126.

54. Engström, M., Nordén, L. (2000), The early exercise premium in American put option prices, *Journal of Multinational Financial Management*, No. 10: 461-479

55. Escanciano J.C., Velasco C. (2006), Generalized spectral tests for the martingale difference hypothesis, *Journal of Econometrics*, No. 134: 151-185.

56. Evnine, J., Rudd, A. (1985), Index options: The early evidence, *Journal of Finance*, No. 11: 743-756

57. Fama, E. (1965), The behaviour of stock prices, *Journal of Business*, Vol. 38: 34–106.

58. Fama, E. (1970), Efficient capital markets: A review of theory and empirical work, *Journal of Finance* 25: 383–417.

59. Făt, C. (2004), *Derivate financiare. Tranzacţii cu contracte futures*, Ed. Casa Cărţii de Ştiinţă, Cluj-Napoca

60. Făt, C. (2007), *Contracte futures şi opţiuni*, Ed. Casa Cărţii de Ştiinţă, Cluj-Napoca

61. Făt, C., **Pochea, M.** ((2008), Evaluarea tranzacţiilor swap, *Revista de Studii şi Cercetări Economice „Virgil Madgearu”*, Nr. 2 , Ed. Alma Mater, Cluj-Napoca

62. Fătu, S. (1998), *Piaţa românească de capital*, Editura Vox, Bucureşti.

63. Filip, A., Beju, D.G., **Pochea, M.**, Ulici, M. (2010), Estimarea costului capitalului la nivelul marilor companii. Evidenţe privind bunele practice, Vol. conferinţei *Stabilitatea financiară şi monetară în ţările emergente*: 281-285

64. French, K. (1983), A comparison of futures and forward prices, *Journal of Financial Economics*, Vol. 12: 311-342.

65. Frenkel, J. A. (1979), Further evidence on expectations and the demand for money during the german hyperinflation, *Journal of Monetary Economics*, Vol. 5: 81-96.

66. Galai, D. (1977), Tests of market efficiency and the Chicago Board Options Exchange, *Journal of Business*, Vol. 50: 167-197

67. Galai, D. (1978), Empirical tests of boundary conditions for CBOE options, *Journal of Financial Economics*, No. 6: 187-211

68. Galai, D.(1983), The components of the return from hedging options against stocks, Journal of business, Volume 56, Issue 1: 45-54.

69. Garman, M. (1976), An algebra for evaluating hedge portfolios, *Journal of Financial Economics*, 403-427

70. Geske, R. (1979), A note on an analytical formula for unprotected American call options on stocks with known dividends, *Journal of Financial Economics*, No. 7: 375–380

71. Geske, R., Johnson, H.E. (1984), The American put valued analytically, *Journal of Finance*, No. 39, 1511-1524

72. Geske, R., Roll, R. (1984), On valuing American call options with the Black-Scholes European formula, *Journal of Finance*, No. 39: 443-455

73. Geweke, J., Porter-Hudak, S. (1983) The estimation and application of long memory time series models, *Journal of Time Series Analysis*, Vol. 4: 221-38.

74. Goss, B. A. (1986), The forward pricing function of the London Metal Exchange, In: Goss (ed.), *Futures Markets: Their Establishment and Performance*, Croom and Helm, London, 157-173.

75. Gould, J.P., Galai, D. (1974), Transactions costs and the relationship between put and call prices, *Journal of Financial Economics*, No.1: 105-129

76. Gray, S.F. (1989), Put call parity: An extension of boundary conditions, *Australian Journal of Management*, No. 14: 151-169

77. Gray, P., Gray S., (2001), A Framework for Valuing Derivative Securities, *Financial Markets Institutions & Instruments*, Vol. 10, Issue 5: 253-276

78. Guay, W. (1999), The impact of derivatives on firm risk: an empirical examination of new derivatives users, *Journal of Accounting & Economics*, Vol. 26, Issue 1-3: 319-351.

79. Guay, W., Kothari, S.P. (2003), How Much do Firms Hedge with Derivatives?, *Journal of Financial Economics*, No.70: 423-461

80. Guo, W., Su, T. (2006), Option Put-Call Parity Relations When the Underlying Security Pays Dividends, *International Journal of Business and Economics*, Vol. 5, No. 3: 225-230

81. Hakkio, C., Rush, M. (1989), Market efficiency and cointegration: An application to Sterling and Deutschmark exchange rates, *Journal of International Money and Finance*, Vol. 8: 75-88

82. Hentschel, L., Kothari, S.P. (2001), Are corporations reducing or taking risks with derivatives?, *Journal of Financial and Quantitative Analysis*, Vol. 36: 93-118.

83. Hoque, A., Chan, F., Manzur, M. (2008), Efficiency of the foreign currency options market, *Global Finance Journal*, No. 19: 157-170

84. Huang, R. (1984), Some Alternative Tests of Forward Exchange Rates as Predictors of Future Spot Rates, *Journal of International Money and Finance*, Vol. 3: 153-68.

85. Hull, J. C. (2004), *Options, Futures and Other Derivatives*, Fifth Edition, Prentice Hall, New Jersey.

86. Hull, J. C. (2006), *Options, Futures and Other Derivatives*, Sixth Edition, Prentice Hall, New Jersey.

87. Hurst, H.E. (1951) Long-term storage capacity of reservoirs, *Transaction of the American Society of Civil Engineers*, Vol. 116: 770-808.

88. Jerbi, Y. (2006), *Evaluation des options et gestion des risques financiers par les réseaux de neuleies et par les modèles à volatilité stochastique*, accesată la: http://hal.archives-ouvertes.fr/docs/00/30/86/23/PDF/JerbiTH.pdf

89. Jin, Y, Jorion, P. (2006), Firm value and hedging: evidence from U.S. Oil and Gas producers, Journal of Finance, Vol. 61, No. 2: 893-919.

90. Jorion, P., Stoughton, N. (1989), An empirical investigation of the early exercise premium of foreign currency options, *Journal of Futures Market*, No. 9: 365-375

91. Kantelhardt, J., Zschiegner, S., Koscielny-Bunde, E., Bunde, A., Havlin, S. and Stanley, E. (2002) Multifractal detrended fluctuation analysis of nonstationary time series, *Physica A*, Vol. 316: 1-4.

92. Klemkosky, R., Resnick, B. (1979), Put-Call Parity and Market Efficiency, *The Journal of Finance*, Vol. 34, No. 5: 1141-1155

93. Kodres, L. E. (1993), Tests of unbiasedness in the foreign exchange futures markets: An examination of price limits and conditional heteroscedasticity, *The Journal of Business*, Vol. 6, No. 3: 463-490

94. Kolb, R. (2003), *Futures, Options and Swaps*, Fourth Edition, Blackwell Publishers

95. Lai, K. S. and Lai, M. (1991), Cointegration test for market efficiency. The Journal of Futures Markets, Vol. 11: 567-75.

96. Laws, J., Thompson, J. (2004), The efficiency of financial futures markets: Tests of predicition accuracy, *European Journal of Operational Research*, Vol. 155, Issue 2: 284-298

97. Lazăr, D. (2009), *Econometrie financiară*, Notiţe de curs, Cluj- Napoca

98. Leuthold, R.M. (1974), The price performance on the futures market of a nonstorable commodity: Live beeh cattle, *American Journal of Agricultural Economics*, Vol. 56, Issue 2: 271-279.

99. Lim, K-L. (2007), Ranking of efficiency for stock markets: A nonlinear perspective, *Physica A*, No. 376: 445–454.

100. Lioui, A. (2006), Black-Scholes-Merton revisited under stochastic dividend yields, *Journal of Futures Markets*, Vol. 26, Issue 7: 703–732

101. Lo, A.W. (1991) Long-term memory in stock market prices, *Econometrica*, No. 59: 1279-1313

102. Loudon, G.F. (1990), American put pricing: Australian evidence, *Journal of Business Finance & Accounting*, No.17: 297-321

103. Lupu, R. (2003), *Gestiunea riscului în afacerile internaţionale. Rolul produselor financiare derivate*, teză de doctorat, ASE Bucureşti, accesată online la adresa www.biblioteca.ase.ro/downres.php?tc=6766

104. MacBeth, J. D., Merville, L. J. (1979), An empirical examination of the Black-Scholes call option pricing model, *Journal of Finance*, Vol. 34, Issue 5: 1173-1186

105. MacDonald, R., Taylor, M. P. (1988), Metal Prices, efficiency and cointegration: some evidence from the L.M.E., *Bulletin of Economic Research*, Vol. 40: 235-239.

106. MacMillan, L.W. (1986), An analytic approximation for the American put option, *Advances in Futures and Options Research*, No.1: 141-183

107. Mandelbrot, B., Wallis, J. (1968) Joah, joseph and operational hydrology, *Water Resources Research*, Vol. 4: 909-918.

108. Mandelbrot, B. B. (1971) When can price be arbitraged efficiently? A limit to the validity of the random walk and martingale models, *Review of Economics and Statistics*, Vol.53 225-236.

109. Mandelbrot, B.B. (1963) The variation of certain speculative prices, *Journal of Business*, Vol.36, 394-419.

110. Martin, L., Garcia, P. (1981), The price-forecasting performance of futures market for live cattle and hogs: A disaggregated analysis, *American Journal of Agricultural Economics*, Vol. 63, Issue 2: 209-215.

111. Merton, R. (1973a), Theory of rational option pricing, *The Bell Journal of Economics and Management Science*, No. 4: 141-183

112. Merton, R. (1973b), The relationship between put and call option prices: comment., *Journal of Finance*, No. 28: 183–184

113. Miclăuş, P.G., Lupu, R. (2008), Piaţa instrumentelor financiare derivate, Ed. Economică, Bucureşti

114. Mittnik, S., Reiken, S. (2000), Put-call parity and the information efficiency of the German DAX-index option market, *International Review of Financial Analysis*, No.9: 259-279

115. Negrea, B. (2001), *Evaluation des options par la transformée de Fourier*, Cahiers de la MSE, no.31, accesat la: ftp://mse.univ-paris1.fr/pub/mse/cahiers2001/Bla01031.pdf

116. Nye, Z., Johnson, T. (2005), Market efficiency's hidden teeth: an unambiguous test for derivative securities, Accesat la: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=742567

117. Notger, C. (2005), Volatility and its measurements: the design of a volatility index and the execution of its historical time series at the Deutsche Borse AG, Accesat la:

http://www.eurexchange.com/download/documents/publications/Volatility_and_its_Measurements.pdf

118. Oomen, R., Jiang, G. (2001), Hedging derivatives risks - a simulation study, Accesat la: SSRN: http://ssrn.com/abstract=302525 or DOI: 10.2139/ssrn.302525.

119. Park, H.Y., Chen, A.H. (1985), Difference between futures and forward prices: a further investigation of marking to market effects, *Journal of Futures Markets*, Vol. 5: 77-88.

120. Peng, C., Buldyrev, S., Havlin, S., Simons, M., Stanley, H., Goldberger, A. (1994) Mosaic organization of dna nucleotide, *Physical Review E*, Vol.49, No. 2: 1685-1689.

121. **Pochea, M.**, Filip, A. (2011), The early exercise premium for american options. Empirical study on Sibex market, *Revista Finanţe-Provocările viitorului*, articol în curs de publicare

122. **Pochea, M.**, Moşoni, A., Morar, A. (2009), Financial crisis – challenges in stress testing the banking system, *Globalization and Higher Education in economics and Business Administration*, The 3rd International Conference, Vol. II: 280-284

123. **Pochea, M.,** Tulai, H. (2010), Dynamic implications of delta hedging, *Financial Trends in the global economy*, Part II, Chapter V, Casa Cărţii de Ştiinţă, ISBN 978-973-133-702-9

124. Pop, C.M. (2011), *Investiţii pe pieţele la termen*, Editura Universităţii din Oradea, Oradea

125. Popa I. (1994), *Bursa*, vol II, Bucureşti

126. Popa, I.(1997), *Tranzacţii comerciale internaţionale*, Ed. Economică , Bucureşti

127. Prisacariu, M., Ursu S., Andrieş A. (2009), *Pieţe & instrumente financiare*, Ed. Universităţii Al. I. Cuza, Iaşi

128. Prisman, E. (2000), *Pricing derivative securities. An interactive dynamic envileiment with Maple V and Matlab*, Ed. Academic Press, Londra

129. Rendleman, R., Carabini, C. (1979), The efficiency of the treasury bill futures markets, *Journal of Finance*, Vol. 34: 895-914.

130. Rentzle,r J., Tandon, K., Yu, S. (2006), Short-term market efficiency in the futures markets: TOPIX futures and 10-year JGB futures, *Global Finance Journal*, Vol. 6, Issue 3: 330-353

131. Roll, R. (1977), An analytical valuation formula for unprotected American options on stocks with known dividends, *Journal of Financial Economics*, No. 5: 251–258

132. Roman, M., Petreanu, N. (2002), *Statistică financiar-bancară şi bursieră*, Editura ASE, Bucureşti

133. Saadi S., Gandhi D., Elmawazini K. (2006), On the validity of conventional statistical tests given evidence of non-synchronous trading and non-linear dynamics in returns generating process, *Applied Economics Letters*, No. 13: 301–305.

134. Santomero, A., Babel, D. (2001), *Financial Markets, Instruments & Institutions*, Editura McGraw-Hill, New-York

135. Satyajit D. (1998), Measuring option price sensitivity – the “Greek Alphabet” of risk, *Risk Management and Financial Derivatives*, McGraw-Hill.

136. Schroder, M. (1999), Changes of numèraire for pricing futures, forwards, and options, Review of Financial Studies, 12: 1143–1163

137. Shastri, K., Tandon, K. (1986), Valuation of foreign currency options: some empirical tests, *Journal of Financial and Quantitative Analysis*, No. 32: 145-160

138. Simion, D. M. (2004), *Piaţa produselor financiare derivate*, Editura Sitech, Craiova

139. Spulbăr, C. (2006), *Instrumente financiare derivate*, Editura Sitech, Craiova,

140. Stroe, R., Arsene, C., Focşeneanu, G. (2001), *Active financiare derivate, determinări cantitative*, Editura Economica, Bucureşti

141. Stoll, H.R. (1969), The relationship between put and call option prices, *Journal of Finance*, Vol. 24: 801-824

142. Sung, H. M. (1995),The early exercise premia of American put options on stocks, *Review of Quantitative Finance and Accounting*, No. 5: 365—373.

143. Taylor, S.L. (1990), Put-call parity: Evidence from the Australian options market, *Australian Journal of Management*, No. 15: 203-216

144. Todea, A. (2001), Cointegrarea şi eficienţa contractelor la termen pe indicele BET, *Revista Română de Statistică*

145. Todea, A. (2005), Eficienţa informaţională a pieţelor de capital. Studii empirice pe piaţa românească,Ed. Casa Cărţii de Ştiinţă, Cluj-Napoca

146. Todea, A. (2009), Investiţii, Ed. Casa Cărţii de Ştiinţă, Cluj-Napoca

147. Todea, A. (2011), The influence of foreign portfolio investment on informational efficiency: Empirical evidence from Central and Eastern European stock markets, *working paper*

148. Trenca, I., Morar, A., **Pochea, M.** (2009), Impactul credit default swap-ului asupra crizei financiare, Vol. Conferinţei Internaţionale *„The Financial and Economic Crisis: Causes, Effects and Solutions”*, Cluj-Napoca, 236-242

149. Trenca, I., Mutu, S., **Pochea, M.** (2010), Using stress testing methodology in evaluating banking institution's exposure to risk**,** *Revista Finanţe. Provocările viitorului*, vol. 1, issue 11: 208-217

150. Trenca, I., **Pochea, M.**, Morar, A.(2009), Swap-ul pe valute - instrument modern de gestionare a riscului valutar, *Revista de Studii şi Cercetări Economice „Virgil Madgearu”*, Anul II, Nr. 2: 113-127

151. Trenca, I., **Pochea, M.**, Filip, A.(2010), Option evaluation – Black-Scoles model vs. Binomial options pricing model, *Finanţe-Provocările viitorului*, No.12: 137-146

152. Tulai, H. (2004), *Pieţe financiare*, Editura Casa Cărţii de Ştiinţă, Cluj-Napoca

153. Tulai, H., **Pochea, M.** (2009), Saving and investment behaviour of the Romanian people, *Financial Trends in the global economy*, Part II, Chapter V, Editura Casa Cărţii de Ştiinţă, Cluj-Napoca, 2009

154. Wagner, D., Ellis, D.M., Dubofsky, D.A. (1996), The factors behind put-call parity violations of S&P 100 index options, *The Financial Review*, No.31: 535-552

155. Wahab, M., Lashgari, M. (1993), Price dynamics and error correction in stock index and stock index futures market: A cointegration approach, *Journal of Futures Market*, Vol. 13, Issue 7: 711-742

156. Weizmann, A. (2007), Construction of the implied volatility smile, Accesat la: http://www.math.uni-frankfurt.de/~fmfi/Diplom_Weizmann.pdf

157. Whaley, R. (1981), On the valuation of American call options on stocks with known dividends, , *Journal of Financial Economics*, No. 9: 207–211.

158. Wilmott, P. (2000), *Paul Wilmott on Quantitative Finance*, John Whiley & Sons

159. Zivney, T.L. (1991), The value of early exercise in option prices: an empirical investigation, *Journal of Finance*, No. 41: 127-150

160. ***Legea nr. 297/2004 – Legea pieţei de capital*** Norma nr. 10/2002 a BNR privind instrumentele financiare derivate, M.O. Partea I nr. 610/16 august 2002

161. www.bnro.ro

162. www.cmegroup.com

163. www.cnvmr.ro

164. www.derivativestrategy.com

165. www.futuresindustry.org

166. www.isda.org

167. www.sibex.ro