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DOCTORAL THESIS

- SUMMARY-

UNIT-LINKED LIFE INSURANCE IN ROMANIA - MARKET ANALYSIS AND PRICING OF CONTRACTS WITH GUARANTEES

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Keywords: unit-linked life insurance, investment guarantees, conceptual framework, legislation, market analysis, RSLN-2 model, pricing, dynamic hedging, financial options.

Introduction

One of the life insurance products of great interest among practitioners and theoreticians in the field to have emerged in the international financial market in recent years is the **unit-linked life insurance policy** (Boyle & Schwartz, 1977). Unit-linked insurance contracts have become very popular in several international insurance markets (United States, Canada, Asia, Europe) since the mid-1970s (Gaillardetz, 2006). The financial benefit generated by these insurance contracts depends on two important elements: *the performance of an investment fund* (Argeșanu, 2004) and *some insurance-type event* in the life of the policyholder according to the concluded insurance contract (death, retirement, survival to a certain date, etc.) (Romanyuk, 2006). Due to financial instability caused by the global crisis and the increasing competitiveness in the financial market, insurance companies in international markets have begun to include ***investment guarantees*** in unit-linked products. Investment guarantees are very popular features in unit-linked life insurance policies because in addition to the payment of benefits payable in case of death or at the maturity of the insurance contracts, these policies are tied to the return of an underlying asset or an actively managed portfolio. Thus, the unit-linked life insurance policy with embedded guarantee acts as a regular financial investment because the investor's capital is credited with a minimum return. In exchange for this protection, the insured person pays a higher premium, reflecting the market risk assumed by the insurance company (Augustyniak & Boudreault, 2012).

Pricing and evaluating unit-linked insurance contracts has generated much interest among researchers and practitioners in the last two decades (Romanyuk, 2006). The total benefit generated in the case of unit-linked contracts includes both *financial, investment* (related to the financial market) and *actuarial risk elements* (possibility of occurrence of insured risk) (Argeșanu, 2004), which have to be priced so that the insurance premium is fair to both the seller and the buyer of the contract (Romanyuk, 2006). The unit-linked life insurance has two important components: *protection and investment.* The protection component refers to the insured sum in case of the occurrence of insured risks and the investment component refers to the policyholder’s account that represents the present value of the units from the chosen investment funds (Gavriletea, 2009). At the same time, an important component of the activity carried out by the insurance companies is the investment of the premiums paid by policyholders in various types of assets, in order to obtain higher returns than those guaranteed by the insurance contracts. As a consequence, the benefits of the insured can be guaranteed or immunized with different types of financial assets, especially with fixed-interest instruments (Hardy, 2003).

The ***purpose*** of this paper is to develop a theoretical and empirical analysis of unit-linked life insurance, with and without guarantees for embedded investments. In order to achieve this goal,

we considered the following main ***objectives*** of the study: the presentation of some legislative changes regarding the unit-linked life insurance contracts; the conceptual framework of unit-linked life insurance products; the analysis of the Romanian unit-linked life insurance market dynamics; modeling the returns of the prices of financial assets which are the basis of guaranteeing the value of the investment benefits in the case of unit-linked insurance policies, and researching some methods of pricing, assessing and hedging unit-linked insurance contracts with investment guarantees.

Thesis structure

The research is structured as follows:

- ***The preamble*** of the research aims to present the previous studies on the issue. Within this section are analyzed the main scientific researches "focused" on the study of aspects related to the evaluation, hedging and risk management of unit-linked life insurance products.
- ***The first chapter*** had the objective to propose a change in the design of these innovative products in order to respect the Solvency II regulation regarding the management of risk exposure and the policyholders' protection. Therefore, this section of the study focuses on proposing some legislative changes in the Romanian legislation regarding unit-linked life insurance market, meant to authorize the Romanian insurers to offer unit-linked contracts, with and without investment guarantees.
- In the ***second chapter*** we intend to present and analyze: the general and specific elements of a life insurance; the issue related to the typology of life insurance contracts; the defining features of unit-linked policies; the main types of investment guarantees commonly used in unit-linked insurance products; the most common categories of life insurance contracts that offer guarantees for investments; a comparative theoretical analysis between traditional and unit-linked life insurance policies; presentation of the risks associated with these insurance products and the operating mechanism of a unit-linked insurance product; last but not least, this section summarizes the issues regarding the advantages, limits and opportunities for the development of these insurance products.
- The ***third chapter*** aimed at a comparative analysis of the evolution of assets and investments of unit-linked life insurance companies. Also, this section focused on a comparative analysis of the main unit-linked investment programs offered by life insurance companies in Romania, according to their associated risk levels and the composition of the portfolios of the unit-linked investment programs. At the same time, within this section we intend to analyze the dynamics of the Romanian unit-linked life insurance market, in terms of the following: gross premiums written, unit-linked life insurance penetration, density and gross claims, maturities and redemptions for unit-linked policies. Finally, this chapter provides a comparative analysis of financial investments in unit-linked life insurance and other alternative investment strategies: treasury bills, bank deposits, shares, gold and currency.

- The ***fourth chapter*** has as main objective the presentation of the main stochastic models and the choice of a suitable model for a certain unit-linked life insurance contract. In order to choose the optimum model (RSLN-2), its parameters were estimated by the maximum likelihood method.
- The ***fifth chapter*** has considered unit-linked stochastic and deterministic profit testing methods, modeling the guarantees liability and methods for hedging the associated risks.
- The ***sixth chapter*** addresses the following issue: although Romanian legislation authorizes the insurance companies to offer unit-linked contracts without investment guarantees, this section proposes a theoretical and empirical basis for calculating the expected financial payoffs, the "prices", and for evaluating unit-linked insurance contracts with investment guarantees.
- Finally, I presented the ***conclusions*** that summarize the main aspects reached in the presented chapters and the personal contribution to the researched topic.

Research methodology and motivation for choosing the research topic

Depending on the purpose and objectives of the research presented above, we believe that the use of the two ***approaches (quantitative and qualitative)*** allows a complete and mutual verification and thus it provides a better base for research and representation of the results. The ***field of research*** is an interdisciplinary one that has specific elements of the life insurance market and the capital market.

Personal motivation of choosing this research issue lies in the desire to identify that specific financial product to meet, on the one hand, high needs of policyholders, who have become investors increasingly sophisticated and on the other hand, to stimulate the interest of insurers offering innovative products that combine the concept of indemnity (protection) with the investment opportunity and which ensures the highest rate of profitability for both the client and the insurer. Thus, by approaching this theme we aimed to answer the following questions: *What are the main categories of investment guarantees offered by unit-linked life insurance products? What are the most common types of life insurance contracts that include guarantees in the product benefits package, for investments in different investment funds? What changes should occur in national and European legislation regulating the unit-linked life insurance market in Romania in order to authorize insurers to offer unit-linked life insurance products, with and without investment guarantees? How profitable are the investments in unit-linked life insurance products compared to other alternative investments from the insured person's perspective? What is the method of guaranteeing the minimum benefit to the insured persons to which the insurance companies willing to offer unit-linked insurance products with investment guarantees can appeal? How profitable are these innovative products from the insurer's perspective? What are the most effective profit testing and hedging methods to these insurance policies? What are the advantages, limitations and opportunities to develop these modern products on the Romanian insurance market?*

Originality elements, limitations and future research directions

The uniqueness of this research lies in the extrapolation of the methods and techniques found and used in the international markets of unit-linked life insurance and their transposition on the Romanian market, in the course of approach and development of this typology of modern products. The main novelty feature is the proposal of a theoretical and practical basis for finding the optimal legislative, financial, operational, commercial framework for offering for sale, on the Romanian market, life insurance products with different forms of guarantees attached.

On a timely basis, this approach contributes to the presentation of the studies concerned with: the analysis of the national and European legislation, which regulates the life insurance market, by presenting some proposals for normative modification of the legal aspects, which aim at authorizing the Romanian insurers to expand their insurance product portfolio by offering unit-linked insurance policies with investment guarantees; antithesis presentation of unit-linked life insurance products, with and without investment guarantees attached; outlining the elements favorable to Romanian policyholders and insurers, as well as the limits and opportunities for developing these products on the national market; comparative analysis of the evolution of the Romanian unit-linked life insurance market and of the unit-linked investment programs (funds) proposed by the main life insurance companies in Romania; comparative study of the most profitable financial investments, and in particular we considered the comparative presentation of the investment in unit-linked life insurance products and other investment alternatives; modeling the returns of the prices of the underlying assets which are the basis of guaranteeing the value of the investment benefits in the case of unit-linked insurance policies - finding the optimal model for the Romanian financial market; simulation of investment guarantees modeling for unit-linked life insurance contracts on the Romanian insurance market; applying the testing methods of the potential profitability of these innovative contracts; stochastic simulation of hedging methods against risks associated with unit-linked policies; determining the expected values of the guarantees related to the unit-linked type insurance contracts with a single and respectively, periodically insurance premium and at the same time, this study proposes an optimal investment option for the insurance companies that sell these innovative policies; as well as the analysis and proposal of the methods of pricing and evaluation of unit-linked life insurance policies with investment guarantees.

Beyond the attractiveness of the exploitation of this research topic, this study presents a series of limitations due mainly to the contextual factors: the legal impossibility of providing unit-linked insurance products with investment guarantees leads this research only to a theoretical proposal that can be implemented in the future in the practice of insurance, at the same time, the Romanian financial market itself "unsupporting", most of the times, the introduction of forms of guarantee (through a low liquidity on the derivatives market), etc. Another drawback of this

study is the „non-elaboration" of the actuarial life tables with subannual time intervals. Thus, in order to achieve the modeling of a sufficient number of returns of the underlying asset, we used an approximation of the monthly probabilities of death and survival, based on the assumption that the force of mortality is constant between integer ages. Last but not least, another limitation of the study is the lack of complete and relevant data, published over the entire time period considered in the research (2002-2017), for certain indicators (gross claims, maturities and redemptions, assets and investments, etc.). Being a relatively new topic and not very intensely exploited in international literature and particularly the national one, there are many topics for future research concerning contracts for life insurance unit-linked products, with or without guarantees investment: analysis of new types of unit-linked contracts, construction of new forms of guarantee, forecasting uncertainty in the case of these products value, testing new econometric models for data modeling, applying other hedging and protection strategies against the associated risks, analyzing the demand of these products on the Romanian insurance market, analyzing the psychological profile of the potential insured person, etc.

PREAMBLE: REVIEW AND COMPLEMENTATION OF THE LITERATURE IN THE RESEARCH FIELD

The research is based on the study of a vast literature on pricing, hedging and risk management in the case of unit-linked life insurance contracts: Brennan and Schwartz (1976), Boyle and Schwartz (1977), Brennan and Schwartz (1979), Bacinello and Ortu (1993), Ekern and Persson (1996), Boyle and Hardy (1997), Tiong (2001), Moeller (2000), Hardy (2003), Argeșanu (2004), Gaillardetz (2006), Romanyuk (2006), Boyle and Tian (2008), Mao and Ostaszewski (2008), Dickson, Hardy and Waters (2009), Pinon and Randrianarivony (2009), Bernard and Boyle (2011), Sweet (2013), Ceci, Colaneri and Cretarola (2015), Bansal and Kaur (2016), Ceci, Colaneri and Cretarola (2017), Huber and Schlager (2018), Luca (2018) and other studies.

This section includes the fundamental works that represented the foundation of the personal research, regarding the analysis of the methods of: pricing, evaluation, hedging and risk management of unit-linked policies, with and without investment guarantees.

SUMMARY OF CHAPTER I: LEGAL FRAMEWORK

Within this chapter, we intend to analyze for the segment of unit-linked life insurance the structure of general and specific regulations, as well as certain normative changes in the Romanian legislation regarding the unit-linked life insurance market, being presented synthetically, in the antithesis, the elements of the current and suggested legislation, regarding unit-linked life insurance contracts. An important role for the development of life insurance market, in particular the unit-linked life insurance market, according to the ***ASF 2016 annual report***, is the alignment of the supervision and risk management with the norms of Solvency II regime and the confirmation of the market consolidation measures through the application of the adopted legislation. According to ***art. 97, paragraph 1-2 of the Law no. 237/2015***, ***on the authorisation and supervision of the business of insurance and reinsurance***, the insurance companies shall only invest in assets and instruments whose risks can be properly identified, measured, monitored, managed, controlled and reported, and appropriately taken into account in the assessment of their overall solvency needs, identified in accordance with ***ORSA*** (Own risk and solvency assessment). All investments, in particular those establishing assets covering the Solvency Capital Requirement (SCR) and the Minimum Capital Requirement (MCR), shall be made in such a manner as to ensure the security, quality, liquidity, profitability and accessibility of the portfolio as a whole. In general, ***European and national requirements*** are common for all life insurance products offered by an insurance company, as it is difficult to make a clear distinction between national and European legislation related to unit-linked products and that corresponding to traditional life insurance products. In accordance with the Romanian legislation regulating the unit-linked life insurance market, unit-linked life insurance contracts involve assuming the investment risk by the insured person and ***do not involve assuming any investment risk for the insurer.*** As a result, an opportune legislative change in the Romanian legislation, which regulates the unit-linked life insurance market, represents ***the authorization and approval given to insurance companies to offer to policyholders unit-linked life insurance policies, with and without investment guarantees***. Although, on the Romanian market, we do not find, until this moment of the analysis, unit-linked products with investment guarantees, the legislation in force (***art. 132, paragraph 4 of Directive 2009/138 / EC)*** discusses the following details regarding the benefits mentioned in this chapter (which includes guarantees on investment performance or other guaranteed benefits): the use of derivatives is made with the purpose of contributing to a reduction of risks or facilitate efficient portfolio management; investment and assets which are not admitted to trading on a regulated financial market shall be maintained to prudent levels; investments shall be sufficiently diversified in such a way as to avoid excessive reliance on any particular asset, issuer, group of undertakings or geographical area and excessive concentration of risk in the portfolio; and investments in assets issued by the same entity or by entities belonging to the same group, shall not expose the insurance undertakings to excessive risk concentration. All these potential regulatory changes should be supported and proposed by the supervisory authorities of the insurance market at national and EU level, to be implemented by the legislative and judicial forum.

SUMMARY OF CHAPTER II. THE CONCEPTUAL FRAMEWORK OF UNIT-LINKED LIFE INSURANCE PRODUCTS

In this section we intend to present and analyze the main general and specific elements that define a life insurance policy.

The fundamental objective of a life insurance is to provide ***financial security to insured persons and their families***. Traditionally, life insurance products offer to policyholder the certainty of obtaining a fixed and guaranteed amount at the time of death or at the expiration of the insurance contract. *The policyholder will pay a single premium or more premium rates during the term of the contract, for the right to the sum insured amount* (Hardy, 2003).

Currently, the design of life insurance products has undergone a radical evolution, and in recent years the competition between Romanian insurance companies has intensified by increasing the offers of life insurance policies with investment funds attached (Dickson et al., 2009). Unit-linked contracts: are life insurance contracts whose financial benefits are linked to the performance of an investment fund (Dickson et al., 2009). Insurances linked to investment funds depend on the duration of human life and are dependent on the funds performance (Ciumaș, 2009b). As a result, a life insurance linked to investments can have in its structure the following components, presented below:

The protection component: which is represented by a term life insurance. In the event of the death of the insured, the beneficiary will collect the maximum value between the insured amount and the value of his account at that time, where the insured sum is set by the insured between a maximum and a minimum value, depending on his age and the value of the premium, and the account value is represented by the value equivalent of units held in the investment funds selected by the insured (Șerbănescu, 2009). ***Investment component***: consists of the purchase of account units in the investment funds established for this type of insurance (Șerbănescu, 2009). ***Annuity (rent) component*** is present only for unit-linked products where there is the possibility of transforming the insured's account at the end of the period of payment of the premiums (at the retirement age) into monthly annuities, payable as long as the insured is alive (Șerbănescu, 2009).

Unit-linked life insurance is characterized as one of the *most dynamic insurance products in Romania*. Unit-linked products invest most of the premium paid by the insured person in the funds managed by the insurance company or an external administrator, from which the insured person then receives a share (a certain number of units), and the lower part of the premium is intended to cover the insured risk (death, disability, etc) (Șerbănescu, 2009). At the same time, the insurance premium is not fixed, the insured can change the size of the insurance premiums at any time (Șeulean et., 2007). The policyholder has the right to choose the structure and the funds

in which he will invest the paid premiums, having the possibility that, during the term of the contract, to change this structure (Șerbănescu, 2009).

A *disadvantage* of unit-linked contracts as compared to traditional life contracts is that the insured person is exposed to the whole investment risk, a risk he has a certain degree of reluctance to bear. As a consequence, the insurance companies were determined to attach the guarantees of these contracts to ensure a certain minimum level of benefits, regardless of the investment results. In other words, the insurance company undertakes to bear part of the investment risk in addition to the actuarial risk (Boyle & Schwartz, 1977). *Without any guarantee for investments, unit-linked life insurance does not imply any investment risk for the insurer* that plays the role of administrator of the insured funds. The total benefit to be received by the policyholder (the insured person or the policy beneficiaries), according to the contract conditions, represents the maximum value between the value of the investment guarantee and the market value of the units from the chosen investment funds.

Generally, investment guarantees are presented under the following models: ***the guaranteed minimum maturity benefit (GMMB)*** - guarantees the policyholder a certain amount of money at the maturity (expiration) of the insurance contract; ***the guaranteed minimum death benefit (GMDB)*** - guarantees the insured person (nominated beneficiaries under the insurance contract) a certain monetary sum upon death during the term of the insurance contract; ***the guaranteed minimum accumulation benefit (GMAB)***: the insured person has the possibility to renew the contract at the end of the original term, at a new level of guarantee corresponding to the maturity value of the maturity contract; ***the guaranteed minimum surrender benefit (GMSB)*** - is a variation of the guaranteed minimum maturity benefit, and after a certain date the monetary value of the contract, payable on surrender, is guaranteed; ***guaranteed minimum income benefit (GMIB)*** - ensures that the lump sum accumulated under a separate account contract can be converted into an annuity at a guaranteed rate. (Hardy, 2003).

The life insurance policies present a number of advantages for both the insurance companies and the insured persons, but there are also certain factors that limit the full development of these innovative products on the international insurance market, implicitly on the Romanian life insurance market. ***Advantages for the insured***: unit-linked products are very attractive for the insured persons during periods of stock market growth (Helfenstein, 2003), the value of the policyholders account will increase to a favorable evolution of the investment funds; high transparency regarding the distribution of financial benefits to insured persons or nominated beneficiaries; purchasing unit-linked life insurance products with investment guarantees, the insured will obtain a total capital represented by the maximum value between the guaranteed value and the value of the insured's account from the investment funds; through life insurance products with attached investment guarantees, the insured transfers some of the investment risk to the insurance company.

Advantages for insurance companies: in the case of unit-linked products without investment guarantees, insurance companies assume only the actuarial risk, and the investment one is borne by the insured; insurers have the possibility of attracting new clients, potential insured persons and retaining those seeking to obtain high returns (who would otherwise have surrendered their policies) (Helfenstein, 2003), thus, the presence of unit-linked life insurance policies with investment guarantees on the Romanian insurance market could lead to a revival of the insurance market, an increase of the policyholders confidence in the Romanian insurance system, by introducing investment guarantees to the offered insurance policies.

Growth opportunities of unit-linked life insurance products: introducing in Romania life insurance products with investment guarantees will contribute to the development of the life insurance segment, the increase of customer portfolio, increasing competition between companies and quality increase of offered services and insurance products; the increase of unit-linked insurance premiums may be influenced by the decreasing interest in traditional life insurance products, which are generally characterized by low transparency regarding the allocation of invested amounts (Helfenstein, 2003); starting from the prospects of reviving or falling the financial markets, as a consequence will be the increase or decrease of sales of these innovative products (Helfenstein, 2003), the unit-linked life insurance policies issued by insurers in Romania will generate high expected financial returns depending on the evolution of the Romanian financial market; the reforms of the pension systems may be a growth factor in the sale of these innovative products (Helfenstein, 2003) on the international insurance markets and, implicitly, on the Romanian life insurance market; the consolidation of financial services industry will stimulate the emergence of new products in the field of unit-linked life insurance and, implicitly, an increase of the subscribed premiums (Helfenstein, 2003), thus, in the case of Romania it could represent the introduction of unit-linked insurance policies with investment guarantees (guaranteed minimum death benefits, guaranteed minimum maturity benefits, etc.).

Limits of unit-linked life insurance products: one of the limits of the unit-linked life insurance market in Romania is the lack of legal norms that allow the authorization of the sale of the unit-linked products with investment guarantees; the Romanian legislation, which regulates the insurance market in Romania, does not present sufficient legal requirements and specifications related to the functioning mechanism of unit-linked life insurance products, but rather encompasses global requirements for all insurance products; the lack of sufficient liquidity in the derivatives market; lack of tax facilities for the insurance sector; the unfamiliarity of certain insurance consultants and, implicitly, this shortcoming can lead to unfamiliarity and not properly informing the potential insured related to the offers of innovative products, and the lack of minimal knowledge in the financial field can contribute to the choice of insurance products that do not correspond to their earning needs and risk aversion.

SUMMARY OF CHAPTER III. THE EVOLUTION OF THE UNIT-LINKED LIFE INSURANCE MARKET IN ROMANIA

In this chapter, we aimed to analyze the dynamics of the unit-linked life insurance market in Romania, in terms of the following elements: gross written premiums, penetration rate, density and gross claims paid for the unit-linked policies; at the same time, we intend to address the topic of the evolution of insurance companies assets and a comparative analysis of the investment programs proposed by the unit-linked life insurance companies.

- ***The evolution of insurance premiums value***

In the period 1998-2017, there was an increase in the value of the premiums of life insurance companies by 101.18 times in 2017 compared to 1998. At the same time, in the period 2002-2017, there was an increase in the value of the insurance companies premiums that subscribe unit-linked policies 2.72 times in 2017 compared to 2002, accounting for 27.46% of the total premiums of life insurance companies at the level of the year 2017 compared to 46.36% in the reference year, beginning of the analyzed period, 2002. Although we can see a high volume of gross premiums subscribed for the life insurance policies in 2008, the effects of the global economic crisis began to be felt in the Romanian economy starting with the third quarter of that year. In that hostile economic climate, starting with 2009, the Romanian insurance market has experienced a decrease in the purchasing power of financial products consumers, as a result of their reduced incomes, but also of increasing the unemployment rate. The data presented show that although in 2010-2012 gross written premiums for life insurance recorded a positive growth rate, gross written premiums for life insurance, registered in the years 2013-2014, is below the level recorded in 2009, and since 2015 we see a positive trend of this indicator. At the end of the analyzed period, the year 2017, we can see a significant increase of the gross premiums subscribed for the life insurance policies in general, respectively for the unit-linked policies in particular. The statistics provided by the market supervisory authority show that this increasing evolution was possible, due to the returns obtained through the unit-linked investment programs, which have contributed to a positive evolution of these forms of life insurance.

- ***Penetration rate and insurance density***

The decreased weight, for example of 5.71% in 2017 and 10.64% in 2002, held by the gross premiums subscribed for unit-linked life insurance in the total market subscriptions, significantly reduces the influence of this sector on the two indicators. In the period 2002-2017, we observe an oscillatory evolution of the penetration rate indicator of unit-linked life insurances, so in the first part of the analyzed period the indicator shows an upward trend, following that after the critical moment of 2008 this indicator will present a decreasing evolution. Thus, in 2017 (0.06%) we can see a decrease by half the percentage value of the indicator in the reference year, beginning of the analyzed period, 2002 (0.13%). In 2017, the density of unit-linked life insurances is increasing compared to the previous year (by 4.23 lei / inhabitant) and it is also 3.02 times higher than in 2002.

- ***Gross claims, maturities and redemptions for unit-linked policies***

Between 2011-2017, it can be seen a generally increasing evolution of the value of gross claims, maturities and redemptions paid for unit-linked policies 2.18 times higher in 2017 compared to 2011, with a weight of 58.19% in total gross claims, maturities and redemptions paid for the life insurance class at the level of 2017, compared with 38.89% in 2011. Also during 2003-2014 (knowing that for the period 2015-2017, no data are available relating only to gross claims for unit-linked policies), a positive evolution of the value of the gross claims subscribed for the unit-linked policies can be observed 140 times higher in 2014 compared to 2003, accounting for 37.29% of total gross claims paid on life insurance class in 2014 compared with 1.87% in the reference year, beginning of the analyzed period, 2003. At the same time, it can be observed a continuous increase in the ratio between gross claims, maturities and redemptions paid and gross written premiums for unit-linked life. Thus, in 2017, this ratio increased more than in previous years (by 61.41 percentage points compared to 2011), an evolution that is explained by the fact that the claims paid were not affected by the difficult economic context, by the repercussions of the Global financial and economic Crisis, as opposed to the gross written premiums that registered a slight decrease. Also, this increase is explained by the fact that the policies concluded since 1998 (19 years) reach maturity.

- ***The evolution of insurance companies assets value***

In the period 2003-2013, there was a continuous increase in the insurance companies assets value by 5.23 times in 2013 compared to the year 2003, respectively by 7.40 times of the assets of the life insurers holding investments related to the unit-linked insurance with a share of 62.46% in total assets of insurance companies in 2013 compared to 44.16% in the reference year, beginning of the period analyzed, 2003. At the same time, there was an increase in the value of the assets of the insurance companies 5.32 times in 2014 compared to 2003. Unfortunately for the period 2014-2017, there are no data available regarding the insurance companies assets value.

- ***The evolution of the insurance companies investments value***

During 2008-2013, there was a continuous increase in the total value of the investments of the life insurance companies that hold investments related to the unit-linked life insurance 2.27 times in 2013 compared to 2008, respectively 2.88 times of the investments for life insurance where the investment risk is transferred contractors, with a share of 33.12% in the total investments of life insurance companies that hold investments related to unit-linked life insurance at the level of 2013 compared to 26.10% in the reference year, the beginning of the analyzed period, 2008. Also, in 2014, the value of the life insurance investments in which the investment risk is transferred to the contractors increased 3.13 times compared to 2008. This positive evolution of investments related to life insurance with an investment component was supported by the interest expressed by the insured for such innovative products.

- ***The issue of the main investment programs proposed by the Romanian life insurance companies that offer unit-linked life insurance products***

Insurance companies offer a number of types of financial instruments to which a certain level of risk and profit are associated, and the policyholder opts for those investment programs according to his risk aversion and willingness to earn. The investment programs of 10 insurance companies were analyzed: NN, ALLIANZ-TIRIAC, BCR ASIGURĂRI DE VIAȚĂ, GRAWE, ASIROM, GENERALI, BRD ASIGURĂRI DE VIAȚĂ, ERGO ROMÂNIA, EUROLIFE ERB ȘI GROUPAMA. For low risk, investment programs suitable for an insured person with low risk appetite, but in return secure, stable earnings are provided by 7 insurers, less Eurolife ERB, Asirom and Groupama. At the same time, for a medium risk profile, investment programs suitable for an insured person with moderate risk appetite and relatively stable earnings are offered by 9 insurers, less Groupama. NN (former ING insurance company), the market leader for this customer segment has 3 offers. The same generous offer of 8 out of 14 programs is subject to the subscription of potential insured persons and for those with a high risk profile. In contrast, Allianz-Tiriac comes with the highest number of investment programs: 2 for the low risk profile, 7 for the medium risk profile and the remaining 6 are for the high risk profile. Although in the years preceding the period 2016-2017, the most profitable investment programs were only those expressed in the national currency, as well as those that had in the portfolio of the investment fund a significant proportion of money market instruments and government bonds, during the analyzed period (2016-2017), the most profitable investment programs were those expressed in both national and foreign currency (EURO), which held in the portfolio of the investment fund a significant part of the shares belonging to companies listed on the international and national stock exchanges.

- ***Comparative analysis between unit-linked products and other investment alternatives***

Also, within this chapter we set out to achieve for the unit-linked life insurance segment a comparative analysis between financial investments in unit-linked life insurance and other alternative investment options: treasury certificates, bank deposits, stocks, gold and currency. Thus, for the analyzed period (2001-2010), **the most profitable investment option is the investment in gold and the least profitable is the investment in shares**. These results are linked to the global financial markets situation and it is known that since 2008 the Financial Crisis has negatively influenced the worldwide financial markets. As a consequence, investors try to reduce the investment risk and place their financial resources in bonds and other fixed income securities, and also in bank deposits, which generate a stable and secure gain. Analyzing the option of investing in unit-linked life insurance compared to other alternative investments, it can be concluded that although the financial crisis has negatively influenced the financial sector, implicitly and the insurance sector, *the investment in unit-linked life insurance has generated gains not very significant at the end of the insurance contract* (2.546 lei), and the insured person could also benefit from the protection component, knowing that the insured sum is 25.000 LEI.

SUMMARY OF CHAPTER IV. MODELING OF FINANCIAL ASSETS RETURNS

In order to quantify the risks associated with investment guarantees, it is necessary to model the returns of the underlying assets, on which the value of the guaranteed benefit depends. In the specialized literature, a series of **stochastic models** are proposed that can be used to model the returns of financial assets. In the following, we will restrict the analysis to *the stochastic modeling of returns of underlying assets of the type of stock portfolios*. These investment products usually have the highest level of risk and can have significant financial effects on the financial liabilities of the insurer. We will exemplify the application approach, assuming that the insurer invests the part destined for the investment component of the premiums paid (by the insured) exclusively in shares, ***the portfolio having the structure identical to that of the BET stock index***. Similar procedure will apply to any product that invests in certain proportions in shares of listed companies on stock exchanges. For this type of unit-linked life insurance contract, which has an investment portfolio consisting of stocks, we will present the main stochastic models found in the literature, respectively we will select the most suitable model for the stochastic modeling of the BET stock index return.

According to the study proposed by Hardy (2003), respectively a stochastic analysis of the financial liabilities generated by this type of contracts, in order to cover the investment guarantees it will be necessary to use a credible long-term model for the return of the underlying financial assets. However, actuarial studies have not reached a general agreement on the form of such a model. Traditionally, the log-normal model has been used, although at present a variety of other approaches are applied in financial theory. Thus, among the models proposed in the literature we mention: the log-normal model, econometric models of autoregressive type, various specifications in the family of GARCH models, Hamilton type models (1989) with several regimes (states). As a result, Hardy (2001) recommends using the regime-switching model, introduced by Hamilton (1989), which allows a distinct autoregressive AR econometric model for each regime. The regime-switching lognormal model (RSLN) has the following features, according to Hardy (2001) and Hardy (2003) studies: *this approach retains some of the simplicity of the log-normal model, but more accurately captures the extreme observed behaviour, the model allows fat tails for the return distribution (higher probabilities of the occurrence of extreme negative returns); regime switching allows the stock price process to randomly switch between K regimes; each regime is characterized by different set of parameters, and thus, the volatility of the rate of return can be changed randomly from one regime to another; the regime-switching process is assumed to be Markov, so the probability of changing regime depends only on the current regime (not on the process history).*

In the following, we will consider the model with two RSLN-2 regimes. Hardy (2001) highlights its advantages, by capturing the state changes that may occur on the market from time to time, moving from a stable low-volatility state, to a more volatile regime, characterized by high

volatility. In general, periods of high volatility can be triggered by unexpected events, short-term political or economic uncertainties (for example: election periods, market crashes, regulations, etc.).

The data presented in the empirical study: for unit-linked life insurance contracts, most of the studies that model the assets return refer to portfolios with the structure of a stock index: Tiong (2000), Hardy (2001), Hardy (2003), Romanyuk (2006), Dickson et al. (2009), Ng and Li (2013) and others. Thus, for modeling the unit-linked products on the Romanian insurance market, we will assume that the insurer invests the part destined for the investment component in a portfolio, having the structure of the BET stock index. For the BET index we will consider monthly data, provided by the Bucharest Stock Exchange database, starting from September 1997 to July 2015 (respectively a total of 215 monthly observations). A specific feature of financial data, not surprised (with great accuracy) by the log-normal model are the periods of high volatility, such as the financial crisis of 2008. This feature is better captured by the regime switching model (Hardy, 2001).

Estimation of the RSLN-2 model for the Romanian market: The maximum likelihood method, implemented in Excel 2007 (Solver, VBA modules) is used for estimation, the steps followed as described in Hardy (2001) and Hardy (2003). Logarithmic returns Y_t are considered to be generated by a Markov process with two states and each regime applying in the interval t and $t+1$ is denoted by $\rho_t = 1,2$ și and within each regime, the returns are normally distributed; the distribution parameters are specific to each regime. The parameters to estimate $\Theta = \{\mu_1, \mu_2, \sigma_1, \sigma_2, p_{1,2}, p_{2,1}\}$ are: mean μ and standard deviation σ for each regime, noted $\mu_1, \sigma_1, \mu_2, \sigma_2$, respectively the two transition probabilities $p_{1,2}$ (from regime 1 to regime 2) și $p_{2,1}$ (from regime 2 to regime 1).

The likelihood function for observations $y = (y_1, y_2, \dots, y_n)$ is defined by $L(\Theta) = f(y_1|\Theta) f(y_2|\Theta, y_1) f(y_3|\Theta, y_1, y_2) \dots f(y_n|\Theta, y_1, \dots, y_{n-1})$, where f is the probability density function for variable y. The estimation of the 6 parameters, specific to the RSLN-2 model, was performed based on the methodology described in Hardy (2003).

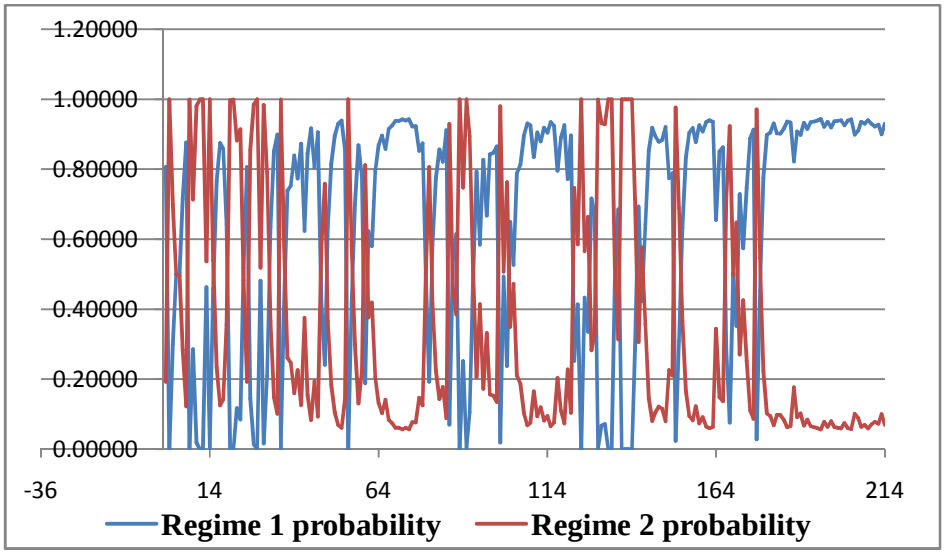
Tabel 1: The parameters of the RSLN-2 model for the BET index returns

Regime	**Parameters**		
I	$\hat{\mu}_1 = 0{,}0218$	$\hat{\sigma}_1 = 0{,}0480$	$\hat{p}_{1,2} = 0{,}1247$
II	$\hat{\mu}_2 = -0{,}119$	$\hat{\sigma}_2 = 0{,}1533$	$\hat{p}_{2,1} = 0{,}2224$

Source: Author's processing in Excel Solver 2003 based on the folowing scientific papers: Hardy, M., (2003), Investment guarantees, Modeling and Risk Management for Equity-Linked Life Insurance, John Wiley & Sons, pp. 57-60, Hardy, MR, (2001), A Regime-Switching model of long-term stock returns, North American Actuarial Journal, vol. 5, no. 2, pp. 43-45.

The estimated parameters for the RSLN-2 model, suitable for the series of BET index returns, are presented in the table above. As can be seen, the high-volatility regime is characterized by a negative mean (-1.18%) and a high volatility; the standard deviation for this regime is 15.3%. In general, periods of high volatility are associated with decreases of financial assets prices. This is also confirmed by the negative mean of the monthly logarithmic returns from the high volatility regime. For the low-volatility regime, the mean return is positive (2.17%) and the standard deviation is 4.8%. The probability of transition from high-volatility regime to low-volatility regime is 0.2224, respectively the probability of moving from low-volatility regime to high-volatility regime is 0.1247. The average period (total number of months) spent in a given regime is determined as follows: $1/p_{ij}$ (Hardy, 2001). As a result, the average period spent in the high-volatility regime is 4.5 months, respectively the average duration spent in the low-volatility regime is higher, being 8 months. The graph below shows the monthly probabilities for each regime, which allows identifying the time periods in which the financial market was in either of the two regimes.

Graph 1: The probabilities related to the two regimes for the BET index



Source: Author's processing in Excel Solver 2003 based on the folowing scientific papers: Hardy, M., (2003), Investment guarantees, Modeling and Risk Management for Equity-Linked Life Insurance, John Wiley & Sons, pp. 57-60, Hardy, MR, (2001), A Regime-Switching model of long-term stock returns, North American Actuarial Journal, vol. 5, no. 2, pp. 43-45.

As can be seen in the graph above: regime 1 (characterized by high mean, low volatility and high duration) is presented in blue color, and regime 2 (characterized by low mean, high volatility and low duration) is indicated in red color. We can observe that the RSLN-2 model identifies relatively correctly the two low and high volatility regimes, if we associate these results with the evolution of the BET index returns and volatility. From a historical perspective, the RSLN-2 model accurately reflects the time periods characterized by high volatility and negative returns, from the evolution of the BET index. These periods overlap, usually, with various political

(political instability, electoral elections, Romania's accession to NATO), financial and economic events (2008 global financial crisis, inflation targeting, capital account liberalization), events that have had a significant influence on the financial market. Also, the time intervals with low volatility are properly identified, these being associated with a positive return.

Comparative analysis of candidate econometric models for the return series: within this section, we will estimate the parameters of other candidate models for describing the process of generating the BET index returns, respectively: the log-normal model, the autoregressive model, the autoregressive conditionally heteroskedastic model. A comparative analysis is performed between the RSLN-2 model and this set of econometric models. For the selection of the most appropriate model, the informational criteria are used, respectively: the likelihood ratio test, the Akaike information criterion (AIC) and the Schwartz Bayes criterion (SBC). According to Hardy (2001; pg. 62), for models with a smaller number of parameters than those of RSLN-2 model (6 parameters), the null hypothesis is that the simple model is more appropriate than RSLN-2. For a significance level of 5%, the likelihood ratio test rejects the null hypothesis H_0 for all comparative analyzes between the RSLN-2 model and the other models used (according to the p-value). The value of the AIC criterion, respectively of the Schwartz Bayes criterion (SBC), is maximum for the RSLN-2 model. In conclusion, we can say that the RSLN-2 model is optimal for the analyzed data, compared to the other models. The value of the AIC criterion, respectively of the Schwartz Bayes criterion (SBC), is maximum for RSLN-2 model. Therefore, RSLN-2 model is most appropriate for the considered data set. The main objective of this chapter was to identify suitable stochastic models for the series of returns of the BET index portfolio - considered to be support for unit-linked type contracts that invest in shares on the Romanian capital market. According to the considered statistical criteria we can conclude that the RSLN-2 model shows a significant improvement compared to the other candidate specifications.

The RSLN-2 model, based on the obtained results, can represent a theoretical and empirical basis for identifying and predicting the periods of time characterized by high/low volatility, respectively negative/positive returns. Both the insured and the insurer can benefit from such an analysis, because they can amplify their gains or reduce their losses as a result of adequate investment of insurance premiums in the various underlying assets, on the Romanian stock market. In the context of the present paper, the results of this chapter, mainly the RSLN-2 model, will be used in the following chapters to exemplify the stochastic simulation method in assessing the investment risk specific to unit-linked products.

SUMMARY OF CHAPTER V. STOCASTIC PROFIT TESTING METHODS AND MEASURES OF ESTABLISHING RESERVES - PASSIVE APPROACH

Within this chapter, we considered the stochastic analysis of the insurance companies' liabilities, the deterministic and stochastic evaluation of unit-linked policies with investment guarantees profitability and the methods of protection against the investment risk, regarding these investment guarantees attached to the insurance contracts. The guarantees assumed by the insurance company to “ensure” the “benefit” - fixed amount at the time of death - insured event, at maturity (of the insurance policy), respectively redemption represents for the insurer a *"risk"* that must be managed, and it does not simply fall to the insured's task. What is the level, *dimension* of this risk? What are the *factors* that determine it and what are the *techniques, management tools*, in fact, for hedging?

To know the risk level for different types of subscribed policies - unit-linked contract with *guarantee of the sum insured in case of death* and, respectively, *at the maturity of the contract* and unit-linked contract with *minimum guaranteed accumulation benefit in case of redemption of the policy, respectively renewal*, the author performed simulations of the cash flow involved.

After establishing the optimal model to simulate the returns of the underlying asset, a series of scenarios were designed to evaluate the financial commitment and protect the insurer's capital, starting from the same initial situation. In order to find the most suitable method of evaluation, pricing and hedging of unit-linked products with investment guarantees, we considered the following initial elements, respectively: a 40-year-old insured who concludes a unit-linked policy with a maturity of 120 months, the payment of the premiums is monthly, and to this contract will have attached a guaranteed minimum benefit at death/maturity or a guaranteed minimum accumulation benefit. Generally, we have considered two scenarios of the same contract: the first scenario involves guaranteeing a minimum benefit upon the death of the insured, weighing **100%** of the value of the insured's fund (in this case the minimum guaranteed death benefit is payed only from the insured's fund), and the second scenario was aimed at ensuring a minimum guaranteed amount in the event of death at **105%** of the insured's value (knowing that this guarantee is partially paid from the insured's fund and the rest of 5% from the insurer's fund). The stochastic modeling of the investment guarantees aimed at analyzing the financial liabilities of an insurance company that offers unit-linked policies with investment guarantees, by generating 1,000 simulations of the same scenario, using the RSLN-2 model, for a contract which offers minimum guaranteed benefits at the death or maturity of the contract and, respectively, a contract that offers a minimum guaranteed accumulation benefit, which allows for contract renewals and redemptions. All the statistical present values in this section have been calculated at the following annual discount rates: the rate of return (yield) of the discount

certificates (6.35%/year), the interest rate on deposits (6.20%/year) and the rate of return of the BET index (-14.49% / year), for the period 2006-2015.

Starting from these simulations, we aimed to test the profitability of the unit-linked insurance contracts with incorporated guarantees, from both the insured and the insurer's perspective, and the essential elements being - the rates of return of the insured fund (for the stochastic method we will had the rates of return of the BET index, simulated using the RSLN-2 model, and in the case of the deterministic method we used the rates of return of the investment funds offered by NN Asigurări: 65.61%/year, 48.50%/year and 4.72% / year) and respectively the rate of return of the insurer fund (the rate of return on equity for the company NN Asigurări - ROE of 19.67%/year).

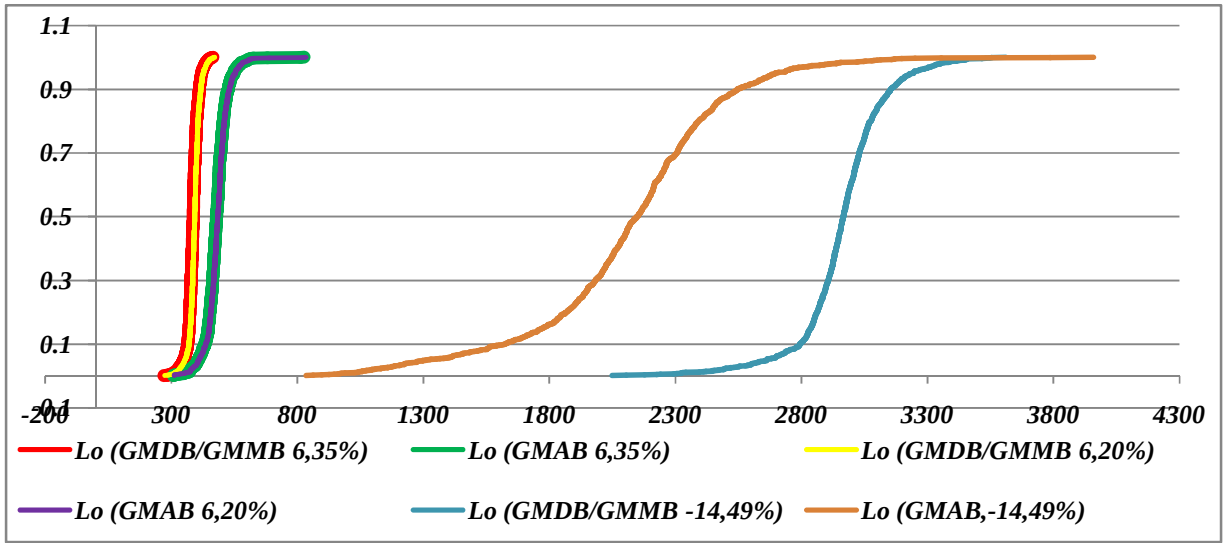
The appreciations on the stochastic method, for testing the profitability of these unit-linked insurance policies, were highlighted through the comparative analysis with the deterministic profit testing method of the unit-linked policies. Generally speaking, the stochastic method reflects much better the reality of the Romanian financial market, generating the random estimated values of the investment funds and not an ascending, unrealistic value according to the deterministic method. According to the study proposed by Hardy (2003), the stochastic simulation presents a number of advantages to the detriment of the deterministic approach from the risk management perspective associated with these innovative products, namely: the existence of transaction costs, the rebalancing of the hedge will be at discrete time intervals, the returns of the underlying asset will follow a real model, and the parameters of the estimated model will reflect more accurately the reality than a model built by the deterministic method, etc.

In order to highlight the advantages of the stochastic method to the detriment of the deterministic method (whose results do not reflect the real situation on the financial market), the scientific approach consisted in calculating the present values of liabilities/profits of the insurance companies that attach the investment guarantees to the unit-linked insurance policies, respectively we considered two main scenarios: one, in which the guaranteed amount is equal to the amount of the premium and the second, in which the guaranteed value exceeds (by 5%) the monthly premium paid by the insured. Thus, for all the situations considered, in the case of the second scenario, we will have an increase of the present value of future liabilities, respectively a decrease of the expected profit compared to the situation of first scenario, where the guaranteed value is equal to the premiums value. Basically, higher protection for the occurrence of the insured risks also implies an increase of the insurance company's commitments.

In the case of the liabilities stochastic analysis regarding these minimum guaranteed benefits, the results for the 120-month maturity generated positive values, respectively losses for the insurance company. If, on the one hand, in the case of the policy that offers GMDB or GMMB, we obtain negative results, respectively gains, for a maturity of 12 months, on the other hand for higher maturities (120 months), the company will record losses at the end of the contract.

Knowing that unit-linked policies with minimum guaranteed accumulation benefit offer the possibility of contract renewals/redemptions, with several predetermined maturities, they will implicitly generate additional costs for the insurance company compared to the unit-linked contracts that have minimum guaranteed benefits at death/maturity. At the same time, by establishing a minimum guarantee equal to the initial value of the investment fund, for a contract with GMAB attached, the fund value at the time of renewal will reach the level of the guarantee of the previous month, leading to the need of the insurance company to increase the fund value and, implicitly, the allocation of resources to cover the investment guarantee. The graph below shows the cumulative distribution function for the net present value of the future liabilities (Lo) of the insurance company for a unit-linked contract offering a GMDB/GMMB and one with GMAB attached, knowing that the guaranteed value is equal with the initial value of the investment fund (1.000 lei), taking into consideration all three levels of discount rates (6.35%/year, 6.20%/year and -14.49%/year).

Graph 2: Simulated cumulative distribution function for the net present value of future liabilities related to a unit-linked contract with GMDB/GMMB versus one with GMAB attached



Source: Author's processing.

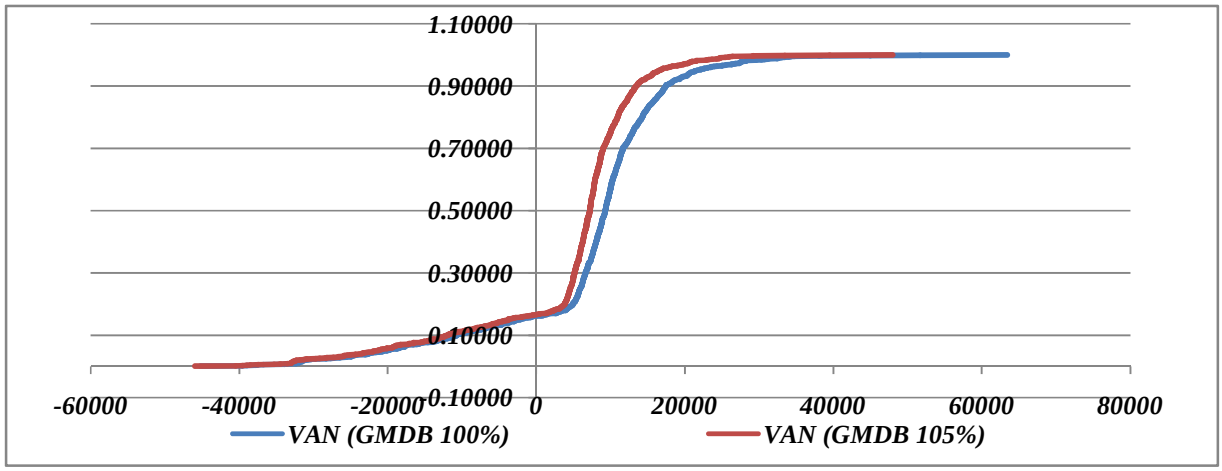
As we can see above, for all three discount rates, the value of the discounted liabilities, in the case of a contract with GMAB attached, exceeds the level of the discounted liabilities in the case of a contract with GMDB/GMMB attached. This higher level of liabilities of the insurance company is due to the possibility of contract renewals in the case of the unit-linked contract with GMAB attached. Also, as can be expected, we will have higher values of the obligations related to these guarantees for lower levels of discount rates.

At the same time, in this chapter we considered the presentation of the advantages of the stochastic profit testing method to the detriment of the deterministic approach in the case of unit-linked policies with investment guarantees. For this analysis, the net present value of the cash flows of the insurers was determined, and a favorable situation involved obtaining positive

results for the insurer. Although in the case of the deterministic method we obtained gains at the maturity of the contracts, directly proportional to the level of the rate of return of the insured fund, the rate of the margin offset, the rate of return of the insurer and inversely proportional to the level of the discount rate and the management charges of the insurer, these positive results do not reflect the real situation on the financial market as in the case of the stochastic method. Also, following the synthesis of the stochastic modeling of the net present value of the insurance company's liabilities, it was deduced that for 800 random simulations obtained using the RSLN-2 model (out of the total 1,000 simulations) there will be no financial obligations related to providing additional protection to cover the investment guarantee. In other words, the evolution of the investment fund is favorable and does not imply any liability for the insurer related to that guaranteed minimum maturity benefit, under the same payment conditions (1,000 lei being the monthly insurance premium) for both scenarios of the guaranteed amount and all the three discount rates.

Despite the fact that for about **16-18%** of the generated simulations, in the case of the stochastic profit testing approach, financial losses will be recorded at the end of the contract, due to the unfavourable evolution of the underlying asset and the need to set up financial resources for the investment guarantee, this method of evaluating the profitability is more realistic in reflecting the reality on the financial market than the deterministic method, which implies an increasing evolution of the investment fund value (being an unlikely situation).

Graph 3: The simulated cumulative distribution function for the net present value of future cash flows of a unit-linked contract with GMDB in weigh of 100% of the insured fund value versus one with GMDB of 105% of this value



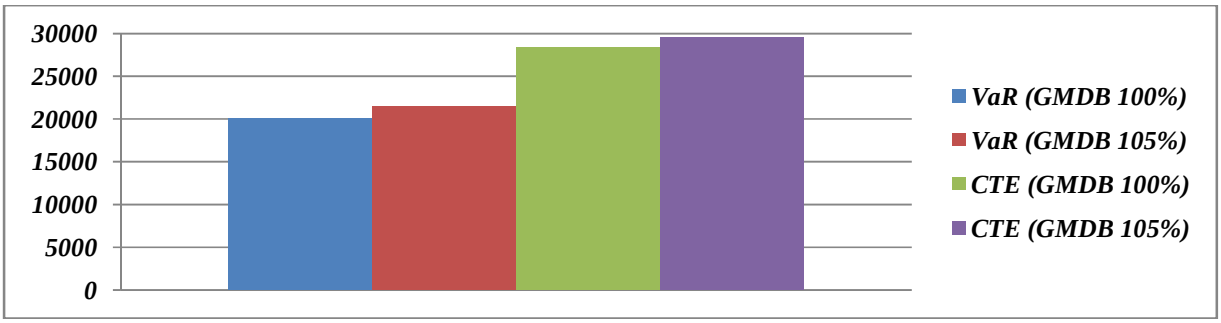
Source: Author's processing.

The above graph shows the situation of a unit-linked contract with GMDB, in a proportion of 100% of the insured fund's value, compared with a unit-linked contract with GMDB, in a 105% share of the insured's fund value, knowing that the initial value of the fund is equal to the value of the guarantee, and the discount rate is equal to the rate of return of the treasury certificates. As

we can see above, a high share of the guaranteed minimum death benefit level can have a significant influence on the insurer's final profits. This situation is found for all the other cases where we have used other levels of the discount rate, other than the 6.35%/year level.

In order to prevent financial losses, the insurance companies appeal to a series of methods of protection against the investment risk, related to these unit-linked policies with guarantees, respectively opting for the establishment of reserves. In this case, two passive risk methods were used to calculate the financial reserves needed in case of financial losses: the VaR and CTE reserves. The comparative statistical results obtained from the 1,000 stochastic simulations built for scenario 1 (GMDB - 100%) and scenario 2 (GMDB -105%) are summarized below.

Graph 4: Comparative analysis of VaR and CTE reserves for a unit-linked policy with GMDB at 100% and one with GMDB, at 105% of the insured fund's value



Source: Author's processing.

As expected, the reserves established in the second scenario (GMDB = 105%) have a higher absolute value, due to the need for insurers to meet significant financial liabilities related to these guarantees, by 105% from the value of the insured fund. Also, the CTE reserve more realistically reflects the potential financial loss and, hence, greater caution in setting up financial reserves to cover future liabilities, reflected by increasing the share from 17-18% (in the case of the VaR reserve) to 24- 25% (in case of CTE reservation) of the amount of premiums paid during the contractual period. These methods of hedging the investment risk, related to these guarantees, by holding a large amount of VaR and CTE reserves, reduce the risk, but involve a high cost for the insurance company, in the sense of blocking very large amounts of capital in relation to the overall contract. This is a passive approach to risk management and is not usually the most favorable method of managing the profitability of insurers.

According to Dickson et al. (2009), we can observe the importance of modern financial theory in the active approach of financial guarantees, which for most unit-linked policies involve a lower risk and, since the active approach requires a lower capital allocation, it will generally improve the profitability when the required risk discount rate is high enough to direct very expensive capital.

SUMMARY OF CHAPTER VI. MODELING INVESTMENT GUARANTEES USING OPTIONS AND DYNAMIC HEDGING - ACTIVE APPROACH

Knowing that *investment guarantees* involve the creation of reserves, within this section we studied the possibility of using *options* as an alternative variant of financial protection, from the perspective of the costs involved. Thus, within this section the aim was to generate simulations meant to evaluate the costs of such risk management technique, respectively of the insurer risk to assume these guarantees. After investing the insurance premiums in the risk-free asset portfolios and the reference portfolio consisting of risky assets (in this case, the stocks listed on the Romanian stock market, having as a benchmark the BET index, for the period 30.*09.1997-31.07.2015*[1]), the main objective of this chapter is the issue of constructing the "*option*" as: a management tool, "insurance" of guarantees, value of the guarantee to be hedged, price of the option. Insurance companies can guarantee a fixed or variable monetary value at a certain interest rate, but usually they provide at least the value of the insurance premium or premiums paid by the insured.

Knowing that a viable solution from the perspective of the costs involved represents the utilization of European options for ensuring the guaranteed minimum amounts to the insured, in this chapter we have considered: the methods of pricing and evaluating them by determining the financial commitments related to the investment guarantees values and the total expected benefits due to the insured, as well as the optimal investment variants, using these calculated values of the guarantees incorporated in unit-linked contracts; construction of portfolios of fixed income instruments (treasury certificates) and call options to ensure the minimum guaranteed amount; calculating the guarantees values through a monthly rebalancing of the assets portfolio (treasury certificates and stocks) and, last but not least, the quantification of the hedging error, respectively the insurer additional liabilities, besides the hedging itself, in order to ensure the minimum value to the insured at the occurrence of the insured risks.

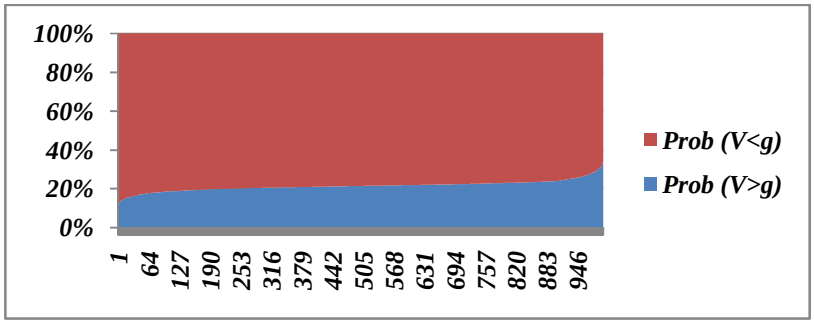
Although at present moment the Romanian legislation allows insurers to offer unit-linked life insurance policies without investment guarantees, this research offers a proposal of a methodological and empirical basis for pricing and evaluating unit-linked insurance contracts with investment guarantees. In order to gradually present the proposed methods in the research, we started from the most restrictive to the most permissive, respectively to those that allow a relaxation of the hypotheses of Black, Scholes and Merton theory. Therefore, starting from the studies proposed by Brennan and Schwartz (1976), Dickson et. al. (2009), respectively Boyle and Schwartz (1977), we used an algorithm (built in JavaFXML programming language) to

[1] Our analysis period started on 30.09.1997, representing the day of the launch of transactions on the BET index and ended on 31.07.2015, considering that the number of observations (215) are sufficient and relevant to the objectives of our study.

evaluate these investment guarantees incorporated into these unit-linked contracts. Starting from these theoretical models consecrated in the literature, the investment strategy suggested by the famous authors involves investing the premium in the reference portfolio and the risk-free asset, in order to reduce the investment risk related to these embedded guarantees.

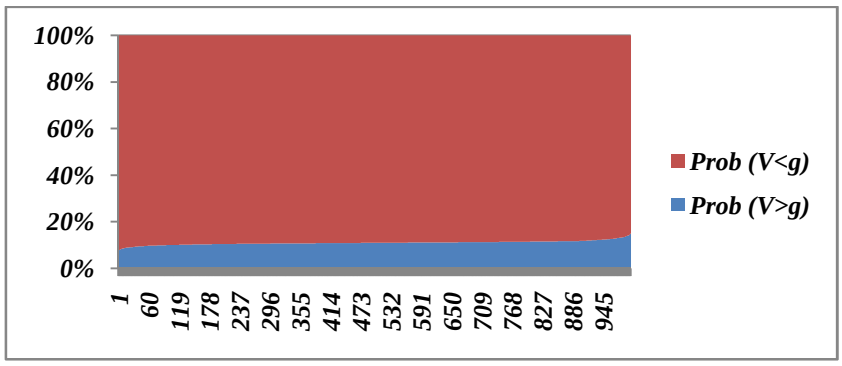
In the following, starting from the 1,000 sets of simulated values of the underlying asset (the investment fund, the reference portfolio), using the RSLN-2 model, we made a summary of the calculation of the values related to the investment guarantees and the expected final commitments due to the insured according to the contractual conditions. The simulated scenario was applied for a unit-linked contract with investment guarantees, for the two variants of the guaranteed amount, considering the three cases of the underlying asset volatility, with a maturity of 120 months (10 years). In order to observe if, at maturity, the value of the reference portfolio (the investment fund, the underlying asset) will be higher/lower than the guaranteed value, we have illustrated in the graphs below the probabilities as $V > g$, respectively $V < g$, for the three levels of the annual volatility value (34.98%/year, 69.96%/year and 17.49%/year), according to Scenario 1 ($P = g = 1.000\ lei$):

Graph 5: The probability that the value of the investment fund will be higher/lower than the guaranteed amount, for a maturity of 120 months, at the annual volatility of the investment fund



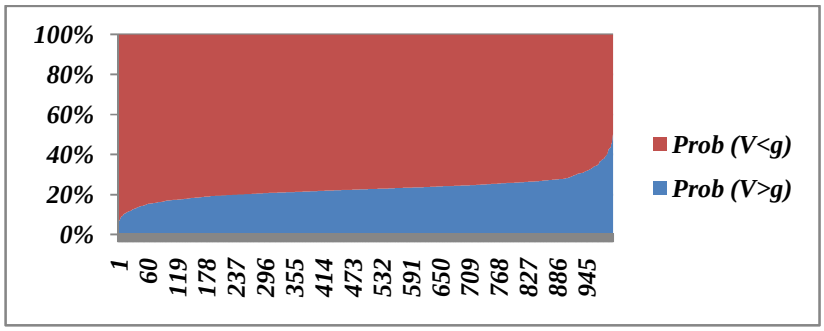
Source: Author's processing.

Graph 6: The probability that the value of the investment fund will be higher/lower than the guaranteed amount, for a maturity of 120 months, to a double value of the annual volatility of the investment fund



Source: Author's processing.

Graph 7: The probability that the value of the investment fund will be higher/lower than the guaranteed amount, for a maturity of 120 months, at half the value of the annual volatility of the investment fund



Source: Author's processing.

Thus, in the case of the first proposed scenario, it can be observed that for all the 3 variants of the annual volatility rate, the probability that the guaranteed amount exceeds the investment fund units value is on average about 80-90%. As expected, in the case of a higher volatility rate, we will have a lower probability that the value of the units in the investment funds will be higher than the guaranteed amount. Also, in the case of the second scenario, if the guaranteed amount will increase by 5% compared to the one in Scenario 1, we will have higher probabilities that the guaranteed amount will exceed the value of the account units at the maturity of the contract. In other words, the values simulated using the RSLN-2 model show that at maturity, for the contractual specifications used in this study, the insurer will have to cover in most cases the difference between the guaranteed amount (for both scenarios) and the value of the account units, in order to be able to meet the financial obligations to the insured. At the same time, the dynamic investment strategy is appropriate, as it involves the allocation of amounts both in the portfolio of stocks and in the treasury certificates, avoiding the allocation exclusively in a category of financial assets. In conclusion, the insurance companies must have these amounts (the guarantees values) to insure the guaranteed minimum amount in case of insured risks, the rest of the part of the total benefit being assured by the account units value from the investment funds chosen by the insured. As a result, the insurance companies have included the value of the guarantees in the form of supplementary insurance premiums in addition to the basic ones, in order to ensure the payment of the amounts guaranteed at maturity, the death of the insured person, etc. Also, beyond the limits (for example: the impossibility of rebalancing in continuous time, etc.) of this method of protection, by appealing to dynamic hedging strategy, it can be a starting point in the evaluation, pricing and hedging of these innovative contracts on the Romanian market.

Considering financial options as an optimal variant, from the perspective of the lower costs, to guarantee the investment guarantee in the case of a unit-linked contract, we appealed to the classic principle formulated and supported by the famous authors Black, Scholes and Merton, which implies the establishment of a portfolio from fixed income instruments (treasury certificates, in this case), variable income securities (BET shares) and financial options (call).

Thus, within the subsection allocated to the research issue, we considered the approach of this hedging method against the investment risk associated with these guarantees, by simulating possible scenarios on the Romanian financial scene. Knowing that the guaranteed amounts can be fixed or variable (in the form of a guaranteed rate), in the following pricing and hedging method we considered a unit-linked contract with a guaranteed return rate, equal to the rate of return of the treasury certificates, maintaining the same contract specifications. Thus, the company will have to purchase approximately 466 call options after allocating the monthly insurance premiums in treasury certificates (to guarantee the minimum amount under the concluded contract), respectively 86% of the premiums paid will be allocated to ensure the minimum guaranteed benefit at maturity. Also, we considered two possible scenarios: optimistic - characterized by financial boom, increasing purchasing power, economic and financial stability, etc., and also pessimistic - economic, financial and political crises, incomes reduction, increasing unemployment, etc. Thus, according to the empirical results in the case of an investment, for a period of 10 years (120 months), in a portfolio of unit-linked life insurance products, *the final value of the portfolio of unit-linked insurance contracts is equal to the sum of the value of the treasury certificates portfolio (the minimum value guaranteed to the insured) and that of the call options portfolio at the maturity of the insurance contracts* - optimistic scenario. In the case of a pessimistic scenario, the final value of the unit-linked life insurance product portfolio will coincide with the value of the treasury certificate portfolio (the minimum amount guaranteed to the insured) at the maturity of the insurance contracts.

This chapter proposes another variant of valuation and pricing of investment guarantees, but also of hedging against the associated risk, using the theory of options. In other words, we considered *a method of evaluating and protecting unit-linked contracts with investment guarantees using the Black-Scholes theory, but with a monthly rebalancing of the constituted portfolio*. This dynamic hedging method involves a relaxation of the hypothesis of a continuous rebalancing of the financial assets portfolio, respectively it refers to a rebalancing in discrete time (in our case being a monthly one) of the financial assets portfolio - shares on BET and treasury certificates with discount; being a more probable and realistic situation on the Romanian financial market. At the same time, this method of monthly rebalancing of the portfolio proves its effectiveness, if the put option (the guarantee) reaches maturity "in the money", otherwise the hedge portfolio would be worth nothing at maturity, and the insurer will lose the cost of establishing the hedge portfolio in the first place (the initial hedge costs). Thus, following the summary simulated results, the total cost of the dynamic hedging is positive, being directly proportional to the value of the guarantee, and the highest costs, as expected, are observed for Scenario 2 (the invested value of the premiums is lower than the amount of the guaranteed amount). Basically, the cost of the initial hedge will be compensated by the monthly gains following the rebalancing, and if we take into account the monthly results (without the initial hedge cost) we will obtain gains in 2.4-2.6% of the total simulations, for both scenarios considered. However, this method can be effective in reducing final costs compared to other possible methods.

Another topic addressed in this chapter concerned *the stochastic modeling of the unhedged liability, namely the discrete hedging error with certain maturity date, referring the additional costs on top of the hedge portfolio for a dynamic hedge strategy.*

The last method addressed in the research concerned the stochastic analysis to the part of the liability that is not covered by the hedge itself. This procedure involved the relaxation of the assumption of the Black, Scholes and Merton classic model, regarding the continuous trading (being an unlikely situation), and in our research we used a monthly trading, according to the same initial conditions of the unit-linked contract. According to the specifications of the policy, respectively of the three proposed variants of the underlying asset volatility related to the two considered scenarios of the guaranteed amount, this method leads to a profit at the end of the contractual period, the gain being influenced by the increase of the guaranteed amount and the volatility of the underlying asset. For example, when the initial value of volatility is halved (17.49%/year), we will observe that by 19.4% the company will obtain a loss at the end of the contract as a result of this pricing and hedging method. Despite this, according to the risk-neutral measure - Q, the stochastic analysis method of the hedging error will lead to profit for most of the considered situations, being a favourable factor in increasing the profitability of insurers selling such innovative products. However, in general, the negative/positive values of the hedging error are determined by the different values of the real volatility of the financial market, and at a sufficiently large number of stochastic simulations, the average value of the hedging error will be almost null, provided that the volatility experienced on the market is equal to the volatility used in the dynamic approach, according to the Q measure. As a result, for these considered cases, the volatility experienced over the whole period analyzed is lower than the value of the annual logarithmic volatility, used in the dynamic approach, according to the Q measure and, for this reason, negative values of the hedging error have resulted. In conclusion, this part of the research highlights *the significant influence of the underlying asset volatility on the profitability of the insurance company* and, at the same time, outlines *a more realistic picture of the actual volatility*, experienced on the market of the underlying asset, determined for the two volatility regimes, through model RSLN-2.

The sixth chapter discusses a proposal of pricing, evaluation and protection methods against the investment risk for an insurance company that sells unit-linked insurance policies with investment guarantees. Although these methods present, in part, a number of shortcomings, notably regarding certain limits of the theory assumptions proposed by Black, Scholes, and Merton, but on the other hand there are series of deviations, relaxations from the classic model that favoured the reflection in a more realistic way of the financial commitments to which insurers are exposed. At the same time, these active methods of hedging proved to be much more advantageous in terms of the costs involved compared to the passive methods of protection.

FINAL CONCLUSIONS

The present paper intends to present in a most objective way the issue regarding the regulation, evaluation and risk management related to the unit-linked contracts on the Romanian insurance market. A novelty important aspect is the analysis of the investment guarantees that can accompany these innovative contracts, namely the deterministic and stochastic simulations of their pricing and hedging of the insurers' capital through various active and passive approaches. The architecture of this work takes into account the complexity of the unit-linked contract particular elements that being analyzed in a certain specific order will include a unitary whole, a harmonious whole of this theme. At the same time, the paper itself aims to address some of the topics of high interest "focused" on these innovative products on the Romanian insurance market, arousing the curiosity to continue the study and researching other topics related to these insurance products. The uniqueness of this research lies in: the legislative proposals, the analysis of the construction and the features of these products, the study of the dynamics of the main indicators corresponding to the unit-linked policies, continuing with the simulations performed for the pricing, evaluation and hedging of the involved risks. Also, this paper intended to make a more objective presentation of these products and their implications on the Romanian insurance market. An important contribution of the research is the analysis of the investment guarantees attached to these unit-linked products, knowing that on the Romanian market, till the present moment, there is not an offer of unit-linked contracts with investment guarantees as opposed to the largest markets of unit-linked life insurance from developed countries (USA, Canada, UK, Germany, etc.). In addition to presenting the legislation in force regarding these insurance products, this research encourages the launch of such innovative products on the Romanian insurance market, by *proposing regulations designed to support the introduction of unit-linked policies with investment guarantees*.

At the same time, we intended to present an objective analysis of the *advantages, opportunities and limitations of the unit-linked products from the insurers and the insured perspectives*, and the conclusions suggest that it would be beneficial to introduce all types of unit-linked products on the Romanian market, with the mention of construction and supporting a legal, financial, economic, political framework favourable to the inclusion of the unit-linked policies in the offers of insurance products in Romania, thus increasing the competition on the Romanian financial market, in terms of attractiveness of the offered financial products. In order to achieve a relevant analysis on unit-linked contracts, another topic of great interest was addressed, namely the analysis of the dynamics of the main indicators that characterize the unit-linked life insurance market (without investment guarantees), respectively: *the evolution of the insurance premiums, the penetration rate and the insurance density, the evolution of gross claims, maturities and redemptions paid and the value of the insurance companies assets* that subscribe such innovative products. Throughout the analyzed period (2002-2017), the values of the insurance premiums for these innovative products had generally an upward evolution (except for the decrease of the value of the insurance premiums for the years 2011, 2013-2014 and 2016), due to the interest of

the insured persons for these products, the increasing profitability of investment funds and, at the same time, the avoidance of investing the insured premiums exclusively in risky assets, especially during the financial crisis when the insured persons faced decreases in income, increasing unemployment and decreasing purchasing power. In other words, these categories of contracts have suffered lower decreases than other types of life insurance policies. In order to reflect as realistic as possible the situation on the Romanian financial market and to predict as objective as possible, the evolution of the unit-linked life insurance market, our research focused on identifying the optimal stochastic model to simulate the returns of the underlying asset, in our case of BET index values. Thus, based on the application of the usual analysis criteria, it was deduced that the RSLN-2 model is much more efficient in reflecting the Romanian financial market, to the detriment of other analyzed stochastic models. As a result, by applying the *RSLN-2 model*, a number of 1,000 sets of returns for a 120-month period were generated, respectively 120,000 returns of the underlying asset (based on the BET index prices, for the period September 1997 - July 2015). This model accurately captures the time periods characterized by *high volatility and negative returns*, respectively those with *low volatility and positive returns.* At the same time, it can be a starting point in forecasting the periods characterized by economic growth, increasing purchasing power, decreasing unemployment, etc. and, respectively, those characterized by economic depression, financial blockages, incomes decreasing, rising inflation, decrease in purchasing power, etc. After establishing the optimal model to simulate the returns of the underlying asset, a series of scenarios were designed to evaluate the liability and protect the insurer's capital, starting from the same initial situation. In order to highlight the advantages of the stochastic method in comparison with the deterministic method (whose results do not reflect the real situation on the financial market), the scientific approach consisted in calculating the discounted liabilities/profits of the insurance companies that attach investment guarantees to the unit-linked policies, considering the two main scenarios: scenario 1, where the guaranteed amount is equal to the amount of the premium paid and scenario 2, where the guaranteed value exceeds (by 5%) the monthly premium paid by the insured. Thus, for all the considered situations, a higher protection in the occurrence of the insured risks also implies an increase of the insurance company's liabilities. At the same time, following the synthesis of the stochastic modeling of the net present value of the insurance company's liabilities, it was deduced that for the 800 random simulations obtained using the RSLN-2 model (out of the total 1,000 simulations), the evolution of the investment fund is favourable and does not imply any commitment for the insurer related to the establishment of additional protection to cover the investment guarantee, for both scenarios considered. Also, for 16-18% of the simulations, considering both scenarios, there is a risk that the insurance company will face losses at the end of the unit-linked contract. Therefore, in order to protect the capital and avoid an unfavourable financial situation, the insurance company must establish additional financial reserves, in case it will not be able to meet the contractual commitments. As a result, in this study, the stochastic analysis of the establishment of *VaR and CTE reserves* was simulated. Thus, at a return rate equal to the rate of the treasury certificates, the insurance company will set up its VaR and CTE

reserve, at 17-18%, respectively 24-25% of the total amount of premiums paid, for both scenarios of the minimum guaranteed amount. Although the CTE reserve is much more protective and efficient compared to the VaR reserve, it will present a number of disadvantages regarding the high cost related to blocking the respective amounts and, last but not least, the update of the reserves has to be done at various time intervals and not just at the beginning of the contract, as it was considered in the present case. As a result, insurance companies may use various techniques to guarantee the minimum amount to the insured, by *establishing reserves – passive approach to financial protection*, but with higher costs or by *appealing to the derivatives market (options) - dynamic approach to financial protection*. Towards the end of the present research, we considered the analysis of the various methods of pricing, evaluation and financial protection of unit-linked contracts with investment guarantees. All the methods of financial hedging (active approaches) considered the allocation of financial premiums in a portfolio consisting of *securities - risk-free assets*, the risk-free asset being represented by the treasury certificates with discount, with a maturity of 10 years, *risky assets, stocks* listed on the Romanian stock market, having as a benchmark the BET index, and respectively *financial options*. Although these applied active methods have some advantages (especially regarding the costs reduction for the insurer compared to the passive ones), there are certain disadvantages (related to the low probability of achieving an ideal situation on the market, respectively of the financial equilibrium, the rebalancing cannot be carried out in a continuous time, the low liquidity in the derivatives market, etc.), but on the whole they can represent a starting point for insurers in order to evaluate as objective as possible the guarantees attached to the policies.

All the variants of investments present a series of more or less similar aspects, with advantages or disadvantages, not necessarily having a standard ranking of the most suitable method of pricing, evaluation and protection. Thus, each procedure itself can be used depending on the availability of data, the economic-financial situation, the financial resources of the insured persons and the type of the unit-linked product, and obviously the active protection measures are better and more recommended than the passive ones from the prospect of reducing costs. However, the variants presented and used in research represent a viable alternative for evaluation and hedging, while there are also other methods not presented in this study or others that can be constructed starting from those existing in this paper. The objective of these particular scenarios and variants is to simulate the financial commitment assumed by the insured (by paying an additional insurance premium corresponding to the investment guarantee) in order to guarantee that minimum amount in case of occurrence of the insured risks. The present paper does not intend to present a perfect product, but one adapted to the Romanian insurance market, the main objective was to familiarize the market with other investment alternatives, to expand the competition of the Romanian insurance products. We consider that this research may represent a starting point in the construction of a unit-linked product with investment guarantees suitable for both the insurer and the insured, emphasizing the strengths, weaknesses, challenges and opportunities of introducing this innovative product in Romania.

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