Ministry of Education and Science of Ukraine

Sumy State University

Academic and Research Institute of Business, Economics and Management

Department of Economic Cybernetics

BACHELOR'S THESIS

ECONOMIC AND MATHEMATICAL MODELING OF INSURANCE COMPANIES

Performed by: <u>4th year</u> student, group <u>АБ-71-8а.ан</u>
                (course number))   (group code)

Specialty 051 Economics (Business Analytics)

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ABSTRACT

qualifying bachelor's thesis on the topic
«ECONOMIC AND MATHEMATICAL MODELING OF INSURANCE
COMPANIES»

The urgency of the work lies in the fact that in the transition of Ukraine's economy to a market model of development there is a need for the introduction of traditional tools for its implementation, which is insurance. In developed countries, insurance companies are one of the main investors and significantly insure the activities of economic entities. In Ukraine, the insurance market is at a low level of development, but the number of insurance companies is significant and each of them is trying to increase its own risk coverage capacity. At the same time, insurance companies do not use in their activities econometric modeling of their own business processes. Therefore, in the initial stages of the emergence of a market economy in Ukraine, it is important to assess the level of competitiveness of insurers, as well as the formation of a system of measures to manage it.

The purpose of the Bachelor's qualification work is to develop an economic and mathematical model for choice model of insurance companies strategies.

The object of the study is the processes of strategies choice for insurance companies.

The subject of research is economic-mathematical methods and choice models of insurance companies strategies.

The information base is: financial statements of insurance companies, legislative and normative documents of Ukraine, analytical information of research institutions, scientific publications on insurance business development.

The main scientific contribution of this qualification work is that the developed model of choosing the strategy of insurance companies is a solution to a specific, pressing problem.

It is recommended to use the built model for the formation of strategic directions of development of specific insurance companies, identification of weaknesses and strengths of their activities.

Key words: modeling, insurance company, competition, strategy.

The content of the qualification work is presented on 32 pages. The list of used sources from 41 names, placed on 4 pages. The work contains 3 tables, 1 figure, and 2 appendices.

Year of qualification work - 2021.

Year of work defense - 2021.

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TASKS FOR THE BACHELOR'S QUALIFICATION WORK

Specialty 051 – Economics (Business Analytics)
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1. Topic of the work: *Economic and mathematical modeling of insurance companies* approved by order of the university 0382-III from 15.03.2021.

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5. The subject of research is economic-mathematical methods and choice models of insurance companies strategies.

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7. Indicative plan of qualification work, terms of submission of sections to the head and the maintenance of tasks for performance of the set purpose.

Chapter 1 Theoretical fundamentals of modeling the insurance companies operations._____
(name – submission deadline)

It needs to describe the features of insurance companies, identify practical aspects of evaluating the competitive strategies of insurance companies, analyze and characterize existing approaches to modeling the choice of competitive strategies of insurance companies and set the research task in this Chapter.

Chapter 2   Constructing the strategy choice model of insurance companies operations_____

It is necessary to form the requirements to the strategy choice model of insurance companies, develop a mathematical model for the choice strategy of insurance companies and implement the built model in Chapter 2._____

8. Consultations on work:

Section	Consultant	Signature, date	
		Task issued by	Task accepted by
1			
2			
3			

9. Date of issue of the task: «___»_____2021

Supervisor   _____   V.M. Oliinyk ___

                                            (signature)   (initials, surname)

Received the task to perform   _____   _V.S. Chernets___

                                              (signature)   (initials, surname)

CONTENTS

INTRODUCTION

The research rationale is that the insurance market plays an essential role in receiving national competitive benefits. Hence, the problem of increase in competitiveness of its subjects is particularly important today. Given the significant changes in the organization of the insurance business, the issues of expanding the scope and improving the quality of insurance services, improving the mechanism of mobilization and use of resources to ensure reliable insurance protection of all subjects of life and management are especially relevant. The interest of insurance companies in developing market positioning strategies that meet current conditions of business relations necessitates the development of the appropriate theoretical and methodological framework and methodological approaches to assessing the level of insurers competitiveness and practical mechanisms and measures to manage it.

The methodological foundation is the fundamental provisions of the theory of finance, insurance and marketing, modern concepts of operational and insurance management, and theoretical developments of domestic and foreign scientists and economists, devoted to advancing the management efficiency of insurance companies competitiveness.

The purpose of the Bachelor's qualification work is to develop an economic and mathematical model for choice model of insurance companies strategies.

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The subject of research is economic-mathematical methods and choice models of insurance companies strategies.

The following general scientific and specific methods were used:

- abstract-logical method when formulating systems and indicators of the competitiveness assessment of an insurance company and insurance services;

- comparison when studying the dynamics and patterns of the insurance market development;

- statistical method is to analyze trends in the insurance market;

- correlation-regression methods, factor analysis and modeling methods used to study the relationships between the individual components of the competitiveness management system of insurance companies.

The information base is:

- financial statements of insurance companies;

- legislative and normative documents of Ukraine,

- analytical information of research institutions;

- scientific publications on insurance business development.

SECTION 1 THEORETICAL FUNDAMENTALS OF MODELING THE INSURANCE COMPANIES OPERATIONS

1.1 Characteristics of insurance companies

The insurance market is a unique socio-economic environment, a particular area of economic relations, where the insurance protection is the object of purchase and sale. The insurance market can be considered as:

− the form of monetary relations organization for the formation and distribution of the insurance fund to ensure the insurance protection of society;

− a set of insurance companys (insurers) that carry out the insurance process.

Compulsory conditions for insurance market functioning are:

− the presence of demand for insurance products;

− availability of insurers capable of supplying this demand.

The characteristics of the insurance market, which determines its elemental structure, is of particular note.

The public need for insurance services and the presence of an insurer capable of satisfying it are the objective conditions for the insurance market existence. There is a general recognition of the insurance service in the market, and its primary function is the accumulation and distribution of the insurance fund. Therefore, the insurance market is still defined as a tool for distributing the insurance fund to ensure the insurance protection of individuals and legal entities.

The characteristics of the insurance market determines its basic structure.

The main subjects of the insurance market include insurers, policyholders, insurance intermediaries and other participants. Insurers and policyholders occupy the leading place among them. Insured persons, associations of insurers, reinsurers, mutual insurance companies, bodies of state supervision over insurance activities, professional risk assessors (underwriters, surveyors), professional loss assessors (emergency commissioners, adjusters, dispatchers) belong to the other participants

in insurance relations. The subjects of the insurance market are independent in their decisions; there is an equal partnership between them, a developed system of horizontal and vertical connections. The market provides an organic link between these entities by jointly recognizing the need for insurance services.

Following the Law of Ukraine "On Amendments to the Law of Ukraine" "On Insurance" (2001), insurers are financial institutions established in the form of joint-stock, general, limited partnerships or additional liability companies, by the Law of Ukraine "On Business Associations" considering the peculiarities of insurance legislation, as well as received a license to carry out insurance activities. There must be at least three members of the insurer. In some cases, insurers are state organizations that are established and operate in accordance with applicable insurance legislation, as well as mutual insurance companies (MIC). To coordinate their activities, protect the interests of their members and implement joint programs, insurers may form unions, associations and other associations. These associations may not engage in insurance activities. Associations such as the League of Insurance companys of Ukraine, the Motor (Transport) Insurance Bureau, the Aviation Insurance Bureau, the Marine Insurance Bureau, the National Nuclear Insurance Pool, etc. have already been established and operate in Ukraine [1].

Insurers are an important subject of the insurance market. They recognize legal entities and able-bodied citizens who have concluded insurance contracts with insurers or are insured in accordance with the legislation of Ukraine. Insurers have certain rights and obligations during the term of the insurance contract, which need to be clarified.

Insurance or reinsurance brokers, insurance agents can be insurance intermediaries.

The object of the insurance market is insurance products which are specific services provided to the insured during the performance of the insurance contract (offered on the insurance market). The price for them is formed based on

competition and is reflected in the insurance tariff. Purchase and sale is made out by the insurance contract (the insurance certificate or the policy) [3].

The features of the insurance service are the following:

− it is intangible and offered to buyers in the market as a promise due to the large number of reservations;

− it is remote from long-term performance;

− it may not be fulfilled if the risk insurance does not occur the event from which the buyer was insured by making a payment.

The legislation defines the objects of insurance as property interests related to life, health, ability to work, possession, use, disposal of property, as well as compensation for damage caused by the insured to a third party.

The specifics of the relationship of entities in the insurance market determines the level of its infrastructure development, which provides the opportunity to realize the economic interests of insurers and policyholders, strengthens the security of all spheres of economic life, helps to integrate into the world economic space, activates insurance activity. Its main elements are:

- financial and credit system;
- audit services;
- insurance expertise;
- legal and regulatory support;
- scientific research;
- information technologies, etc.

In addition to the elemental classification, the insurance market is structured by institutional, territorial and sectoral characteristics [2].

The basis of the institutional and territorial structure of the insurance market are insurance companies, the classification of which is based on the nature of the property of insurers, their specialization, the amount of authorized capital, service area, etc.

The institutional structure is based on the distinction between private, public and combined forms of ownership. According to this approach, there are markets

for joint-stock, corporate, mutual and state insurance companies. In Ukraine their activities are regulated by the Law of Ukraine "On Business Associations", considering the requirements of the Law of Ukraine "On Insurance" [5, 6, 7].

National, regional and international insurance markets are distinguished on a territorial basis.

By industry the insurance market is divided into:

- life insurance market;

- market of general insurance types.

Thus, the insurance market is complex, multifactorial, dynamic, appropriately structured, open, mobile, depending on the general economic situation in the country and the activity of the insurer system.

Here is how E.J. Dolan and D.E. Lindsay characterize this market in their textbook "The Market: A Microeconomic Model": "The main problem in analyzing an oligopoly is defining what constraints firms face in a market where there are several competing companies. Firms in oligopolies, as well as in perfect competition and monopolized markets, face constraints on the cost curve and demand conditions. But, in addition, they face another limitation the actions of competing firms. The change in profit that a firm can obtain by changing prices, output or quality characteristics of the product depends not only on consumers' reaction (as in other market structures) but also on how other firms react to this market. The behavior dependence of each firm on the competitors' reaction is called an oligopolistic relationship. But this relationship can lead not only to a fierce confrontation but also to an agreement. The latter occurs when oligopolistic firms seek opportunities to increase revenue jointly by raising prices and concluding a market-sharing agreement. If the agreement is open and formalized and includes all or a significant part of the producers in the market, the result is forming a cartel".

A monopoly does not exist in market conditions with a pure market, because the buyer has the opportunity to purchase goods only from one seller (public

organization, a private company, etc.). When we are dealing with a state monopoly, it can be established [4]:

    a) the price is below cost (the product is essential for buyers who are unable to purchase it at total cost);

    b) a price that covers costs and is designed to generate a reasonable income;

    c) a price that significantly exceeds the cost (to reduce consumption).

Free competition in each of the market segments of goods and services is the most acceptable for a market economy. However, even the most developed countries face insufficient competition in the markets of some types of goods and services. For example, the health insurance market is oligopolistic in the United States. 90% of this market is controlled by 1-2 insurers in most states. Companies that have an extensive network of branches and representative offices do not allow regional companies to grow. This situation leads to a constant increase in the cost of this type of insurance services and, at the same time to a decrease in the amount of insurance liability of the insurer.

In particular, the growth of insurance premiums under health insurance contracts in the US over the past ten years amounted to 120%, which is three times higher than inflation and four times higher than the level of wage increases for the period [8].

1.2 Practical aspects of evaluating competitive strategies in insurance companies

Starting the study of the insurance company competitiveness, we focus on the definition and characteristics of the organization's competitiveness.

The organization's competitiveness can be defined as a complex comparative characteristic that reflects the level of superiority of the set of performance indicators that determine the enterprise's success in a particular market for a certain period about the group of competitors.

The organisation's competitiveness can be found only among a group of organizations that belong to the same industry or produce substitutes, i.e.

competitiveness is a relative concept. The same organization within the regional strategic group can be considered competitive, but not on the world market or its segment. To assess the organization's competitiveness as a whole under a single strategic economic zone or each of the strategic business units created in the structure of a diversified organization, which operate in a particular strategic economic zone [12].

The competitiveness of the service sector organisation is its ability to carry out efficient business activities and achieve profitable sales of its services in a competitive market. At the same time, a generalizing indicator of the company's activity is the creation and implementation of competitive services, its ability to use financial, scientific, technical and human resources effectively [9, 10].

The competitiveness for any insurer is the result of the work of units (i.e. characterizes the state of the internal environment) and the reaction to changes in external factors. The ability of the insurance company to respond quickly and adequately to changes in customer behavior, tastes and preferences is essential. As for the competitiveness of companies in the insurance market, it is specified by the term of their work, the breadth of the range of services provided, service content and cost of insurance products offered by this company, representation in the regions, reinsurance policy, authorized capital, volumes of reserves and payments, etc.

The competitiveness of a particular service is defined as its advantage over other certain services in solving a potential buyer's problems to meet specific needs. To simplify the presentation of the material, further we introduce the symbol (abbreviation) product competitiveness – PC, the competitiveness of insurance services – CIS [13].

A competitive analysis uses its parameters and indicators, which should be distinguished and discussed below. Competitiveness parameters are most often quantitative characteristics of product (service) properties, which consider industry specifics of its competitiveness assessment. There are separate groups of competitiveness parameters which are technical, economic, regulatory [9].

It is important to remember and keep in mind that when we consider the competitiveness of a product or service, it is its relative assessment by consumers.

Technical parameters are a characteristic of the technical and physical properties of the product, which define the characteristics of the industry and methods of its use, as well as the functions performed by the product in the process of consumption. Technical parameters are divided into purpose parameters, ergonomic and aesthetic. Assignment parameters characterize the use of products and functions that it is designed to perform [11].

They can be judged on the beneficial effect achieved through these products in specific conditions of consumption.

When it comes to the insurance service, as a subject of consideration about its competitiveness, it cannot be characterised with the help of technical parameters. Technical parameters can be said in the study of insurance products, and then with a certain degree of assumption.

Economic parameters define the production costs and consumer prices of a product or service, which are perceived through the costs of acquisition, maintenance, consumption, disposal of purchased products or services.

Normative parameters define the conformity of products (services) to the established norms, standards and requirements stipulated by legislation and other normative documents (patent purity parameters, ecological parameters, safety parameters, according to which the current mandatory requirements of international, national standards, technical regulations, norms, legislation are made).

Competitiveness indicators are a set of system criteria for quantitative assessment of the competitiveness of products or services based on target parameters [14].

The business activity indicator is calculated as the ratio of insurance premiums (payments) on a specific date of the current year to the balance sheet currency on the same date for the previous year. This indicator shows how many turnovers the insurer's capital has made over time (usually six months or a year). It

characterizes the efficiency of the insurance company's resources use which compares equity and authorized capital. Equity includes authorized capital, additional capital, retained earnings, reserve fund and other means, except for unpaid and withdrawn money. We deal with the profitable activities of the insurer if the amount of equity exceeds the amount of authorized capital [15].

The indicator of the level of paid-in authorized capital demonstrates the interest of capital owners in the strategic development of the insurance company.

Indicators of the assets structure will determine the level of insurer solvency, namely, the ratio of the amount of investment and cash to the total amount of assets (should be close to 1), the percentage of investments and money to the number of insurance reserves (must be equal to or greater than 1).

The growth rate of insurance premiums is calculated as the ratio of insurance premiums in the current year to the previous year (approximately 25% because a significant increase in this indicator means a simultaneous increase in liabilities of the insurance company, which will require a corresponding increase in equity).

The coverage of insurance reserves by investment assets is the ratio of the volume of investment assets and cash to insurance reserves (reserves of unearned premiums). The indicator should be greater than or equal to 1, which will indicate a prudent investment policy of the company.

The leading indicator of the insurance company's competitiveness is the financial stability indicator. Financial stability for insurance companies is defined as ensuring a structure of profitability and liquidity of investments that minimizes the technical risk of insurance. In this case, the technical risk of insurance is understood as the risk of insufficient funds to make insurance payments. The insurance company's financial stability is also the provision of guarantees of payments to policyholders by the insurance company under insurance contracts. The guarantors include:

- insurance premiums;
- insurance technical reserves;
- insurance reserves and own free assets.

The insurance company's financial stability is ensured by sufficient and paid-up authorized capital, adequate assumed insurance reserves, as well as the accepted reinsurance system. The use of the reinsurance system implies that the insurer is liable only for the risks for which it can meet its obligations based on its financial capabilities. The criterion of insurer's financial stability is usually considered to be the sufficiency of insurance reserves and own free funds to meet the insurer's obligations. Solvency is an important indicator of the insurer's financial stability. The economic literature provides a significant number of financial indicators used to analyze the financial condition of insurance companies in accordance with the established requirements for financial stability. Here are some of them [17].

The current liquidity ratio reflects the sufficiency of the current assets of the insurance company to repay its current liabilities. The recommended value of the current liquidity ratio should be greater than 1.0. It is because the insurance company should have sufficient working capital to repay its short-term liabilities.

The level of insurance reserves is one of the essential coefficients in financial stability and shows the share of insurance reserves in the insurance company's capital. The greater the value of the ratio and its growth in the dynamics, the higher the insurer's financial stability. The importance of the coefficient is considered sufficient at 60% or more [16].

The ratio of the number of insurance premiums and insurance reserves shows the dependence of growth or decrease in the size of the insurance fund (insurance reserves) directly on the insurance business (the number of insurance premiums received for all types of insurance) should be more than 1. The increase in the coefficient values with the insurance reserves growth reflects the tendency to increase the confidence of policyholders in the insurer.

The level of equity reflects the financial structure of the insurance company's assets and shows how well insured the insurer's assets are. The sufficient value of this ratio, which ensures the stable state of the insurance company in the eyes of policyholders, creditors, partners, is determined at the level

of 20% and above. The indicator of the insurer's funds is very close to the above and it shows the ratio of equity to technical reserves, which, as a rule, should be more than 28%, which ensures the financial stability of the insurance company.

The ratio of debt and equity shows how the debt corresponds to the equity of the insurance company. The smaller the value of this ratio, the greater the financial stability of the insurance company. It is fundamentally important to have a value of this factor less than 1.0. The higher the value of the coefficient, the higher the level of solvency in the insurance company in terms of its obligations' repayment not related to insurance coverage of customers.

The level of invested capital shows the share of assets of the insurance company, directed to long-term and short-term investments. This figure should be greater than 0.5. Changes in the investment policy of the insurance company can be judged by the fluctuations and dynamics of the coefficient values.

The ratio of total turnover of insurance reserves shows the speed of their turnover and, at the same time, the ratio of the amount of income from all activities of the insurer to the average value of insurance reserves for the period under analysis. The value of this ratio, which must be greater than zero, defines the dependence of the insurer's income growth on the increase in insurance reserves.

The turnover ratio of investment capital shows the speed of its turnover for the period under analysis. It characterizes the funds' efficiency directed by the insurance company in short-term and long-term investments. This figure will also be greater than zero.

The rate of return on all assets in terms of net income should be greater than zero and shows how much net income per unit of its capital the insurance company receives. The rate of return on invested capital shows how effectively the insurance company manages the invested capital to obtain the maximum amount of income.

The profitability coefficient of all operations on pre-tax profit shows the effectiveness of the insurance company's promotion in the market in all areas of its activities and what is the share of pre-tax profit of its income.

The profitability ratio of insurance operations shows the profitability of the main activity of the insurance company, "cleaned" of other income and results.

The rate of return on investment shows how effectively and profitably the insurance company carries out investment activities.

The adequacy ratio of the actual size of the solvency margin determines the adequacy of the actual size of the solvency margin (adjusted amount of equity) about the amount of risk assumed by the insurance company. This figure should be less than 200.0% and more than 95%. In addition to the above indicators, the other can be used to consider the insurance company effectiveness.

1.3 Analysis and characteristics of existing approaches to modeling the choice of competitive strategies in insurance companies

There are many models that consider competitive strategies today, so let's look at each model in more detail.

The classic portfolio model is the BCG matrix. This is a classic portfolio model developed by leading consulting companies of the Boston Consulting Group. The BCG matrix indicates four business positions:

– high competitive positions in fast-growing markets – star;

– high competitive positions in mature saturated markets – dairy cows;

– weak competitive positions in promising markets – difficult children;

– weak competitive positions in stagnant markets – dogs.

The BCG matrix allows characterizing each type of production of the company on its share in the market concerning the essential competitors or the company's total output, considering the growth rates of the market. It can be used to define which type of product plays a leading role in the market compared to competitors and how its production should develop in the present and future.

Market growth rate (vertical axis) and relative market share (horizontal axis) are the criteria for constructing the BCG matrix.

The use of BCG matrix is advisable:

- when deciding on a strategy for each type of product or individual activity;

- in the distribution of financial resources between different departments, areas of activity;

- when adopting an investment strategy.

But it does not always assess business opportunities properly for the following reasons:

- market growth is not the only sign of the industry's attractiveness;

- insufficiently clear definition of market share;

- the division into four groups is quite conditional;

- the relative opportunities to invest in a product are not reproduced (investing in a star can bring no more benefits than investing in a dairy cow, which brings a stable income);

- the relationship between high market share and profit is not close enough.

The key success factors can be:

- production factors (product range, the level of production costs, the level of technology;

- market factors (price level, product quality, network reliability, market share, brand image, etc.);

- financial elements (the level of accounts payable, profits, liquidity, business activity and others);

- organizational factors (the level of staff, its composition, quality of management, management structure, etc.).

Then calculate the integrated competitiveness indicator according to equation 1.1:

$$K = \sum_{i=1}^{n} a_i E_i \, ,$$

(1.1)

where K is an integrated competitiveness indicator;

n is the number of allocated CFS;

a_i is a weight of the i-th factor; $\sum_{i=1}^{n} a_i = 1$

E_i is an expert assessment of the i-th factor.

In the third stage, based on the estimates made in the two previous steps, the company is positioned on the matrix.

The Ansoff matrix. The Ansoff development model allows the use of several strategies simultaneously. It is based on the fact that the most convenient approach for intensive sales growth can be found by selling existing or new products in existing or new markets. The Ansoff matrix shows a scheme that will help managers decide on the choice of strategy [27].

Thee type of product existing or new is on one axis in the matrix, and on the other – the type of market, also existing or new is considered.

Table1.1 – The Ansoff matrix

Type of market	Existing market	New market
Existing product	Improving activities	Market development strategy
New product	Commodity expansion	Diversification

Recommendations for choosing a strategy in the Ansoff matrix:

− strategy for improving activities (market penetration). When choosing this strategy, the company is recommended to pay attention to marketing measures for existing products in existing markets: to study the target market of the enterprise, to develop standards to promote products and increase efficiency in the existing market [26];

− commodity expansion (product development) – a strategy to create new or improve existing products to increase sales. The company can implement such a strategy in an already known market, finding and filling market niches. Income, in this case, is provided by maintaining market share in the future. This strategy is the best in terms of risk minimization, as the company operates in a familiar market;

‒ market development strategy. This strategy is aimed at finding a new market or a new market segment for already mastered goods. Revenue is provided through the market's expansion within the geographical region and beyond. This strategy is costly and riskier than the previous two but more profitable. However, it is difficult to enter new geographic markets directly, as other companies occupy them;

‒ diversification strategy involves the development of new products while developing new markets. In this case, the goods may be unique for all companies operating in the target market or only for this business entity. This strategy provides profit, stability and sustainability for the company in the distant future, but it is the riskiest and expensive [24].

The advantages of using planning on the I. Ansoff matrix are clarity and ease of use. The disadvantages of using planning on the matrix of I. Ansoff are the one-sided focus on growth and limitations in terms of two characteristics (product – market).

The method of comparative assessments is the most common and involves the calculation of a significant number of indicators that can be used both individually and in combination [25].

When assessing the competitiveness of an insurance company, it should be borne in mind that one of the essential factors in its formation is the competitiveness of customer services, which are minor subject to environmental influences and form the competitiveness of the company's product portfolio a whole. None of the market participants is highly specialized in the production (sale) of any product; they all have an extensive product portfolio. Therefore, if one of the insurance products is uncompetitive, the organisation's competitiveness as a whole can be ensured by other products that make up its portfolio [23].

Within the method of comparative assessment, it is possible to consider the integrated indicator of competitive advantages of a particular product (product, service).

$$КП_{т} = \sum n_{i=1} \sum m_{j=1} \alpha_i \Pi_i x \beta_{ij} \Phi_{ij} \qquad (1.2)$$

where $i = 1,2 \ldots n$ is an integrated indicator of the competitive advantages of a particular product;

$j = 1,2 \ldots m$ is a number of competitive advantage of a particular product;

α_i is the importance of the i-th competitive advantage of the product;

n is the number of product names in the product portfolio;

β_{ij} is the importance of the j-th factor of the i-th competitive advantage;

Π_i is relative or normative value of the i-th competitive advantage;

Φ_{ij} is relative or normative value of the i-th factor of the j-th competitive advantage.

When it comes to an integrated indicator of the organization's competitiveness, it is usually represented by the sum:

$$К = \sum_{i=1}^{n} W_i K_i \qquad (1.3)$$

where K_i are indicators of the competitiveness of individual aspects of the organization in total N;

W_i is the importance of individual factors in the total amount.

Different authors, depending on the field of marketing research, and based on their scientific views justify different groups of factors that need to be included in the cumulative (integrated, group) indicator. In addition, various ways of conducting expert assessments are proposed, and it is often simply stated that weighting factors are determined by experts.

The whole set of factors that affect the organizations, and thus their competitiveness, can be divided into three groups: the goals set by the organization; resources owned by the organization; environmental factors of direct and indirect action on the organization [22].

In the general case, the impact of these three groups of factors on the enterprise's competitiveness is very complex and, by the proposal expressed in the work of I.U. Zulkarnaeva and L.R. Ilyasov can be hardly reduced to their linear

combination. Therefore, they cite the integral organization's competitiveness in the form of some function of three groups of variables, the type of which we will not specify yet:

$$K_1 = K(\{Kr_i, i = 1, ..., Nr\}, \{W_i, i = 1, ..., Nr\}, \{\Phi_i, i = 1, ..., N\phi\}) \quad (1.4)$$

where K_1 is an indicator of integrated rganization's competitiveness;

Kr_i is the competitiveness of individual resources of the organization in total Nr;

W_i are weights in total Nr;

Φ_i is the number of environmental factors in total $N\phi$.

Thus, the indicator of integrated organization's competitiveness should consider environmental factors:

$$\{\Phi_i, i = 1, ..., N\phi\} \quad (1.5)$$

If we abstract from the conditions of the external environment and take into account the internal resources of the organization only, then integrated competitiveness will be expressed in the form of:

$$K_2 = K(\{Kr_i, i = 1, ..., Nr\}, \{W_i, i = 1, ..., Nr\}) \quad (1.6)$$

The indicator K_1 is an indicator of the integrated organization's competitiveness, considering the action of environmental factors, which may be called the indicator of the integrated external organization's competitiveness [21].

On the contrary, the indicator K_2, which considers the organization's resources only, i.e. only internal factors, is logical to call the indicator of integrated internal organization's competitiveness.

The whole set of internal organization's resources should be divided into two groups:

1) $(R_i, i = 1, ..., Nr)$ are resources that affect the achieved market share occupied by the organization;

2) $(R_i, i = Nr + 1, ..., Nr)$ are resources that affect the growth rate or decrease in market share of the organization.

Fatkhutdinov R.A. proposes to calculate the organization's competitiveness according to the following equation:

$$К_{org} = \sum a_i * b_j * K_{ij} \rightarrow 1 \qquad (1.7)$$

where $\quad$ a_i is the share of goods in sales;

b_j is an indicator of market importance;

K_{ij} is the competitiveness of the i-th product in the j-th market [19].

As an advantage of this method, it is indicated that the calculation of competitiveness considers the competitiveness of the market in which this organization operates. But it should be noted that this method's concept of competitiveness by this method is actually reduced to the sum of the competitiveness of the goods sold by it. It is entirely wrong. Based on the fact that the primary purpose of the organization is to make a profit, so the indicator (criterion) of profitability (in absolute and relative terms) can be used when assessing the competitive position of the insurance company in the market [24].

After analyzing the most common methods, it is necessary to draw the following generalizing conclusions:

- each method makes it possible to use a special set of factors and analyzed variables;

- research methods are different, more often uses the compilation of matrices, comparative tables, expert assessments;

- in many methods the authors leave the right to choose the studied variables at the discretion of the researcher, which makes it possible to consider industry, technical and other specific features;

-       each of these methods has its advantages and disadvantages, so it is necessary to compare the benefits that can be obtained using a particular research method.[18].

1.4 Statement of the research problem

It is necessary to develop a model in this work that will seek an approach to optimizing the activities of insurance companies based on management decisions of strategies for the behavior of competitors in the market and various combinations of these strategies [20].

The study should examine many indicators: indicators of assets of insurance companies, the size of net premiums, the guarantee fund, the payment of insurance premiums and insurance indemnities under contracts, the cost of servicing the insurance process and the cost of maintaining the insurance company.

Then we will develop a model based on the model of strategic behavior of insurance companies. It will be based on the models of Cournot and Stackelberg analysis and will allow:

-       to obtain an objective description of the insurance market entities efficiency;

-       to plan strategies for further functioning and development of insurance market participants.

SECTION 2 CONSTRUCTING THE STRATEGY CHOICE MODEL OF INSURANCE COMPANIES OPERATIONS

2.1 Forming requirements to the strategy choice model of insurance companies

The main requirements for the competitive strategies model of behavior of insurance market participants are as follows:

- the model should be adequate to the research process and give results similar to the real ones;

- to receive the efficiency characteristic of the insurance market subjects functioning;

- to plan strategies for further functioning and development of insurance market participants;

- to enable the use of the management decisions model;

- to choose from the proposed competitive strategies that have the most attractiveness.

The input data of the model must, in turn, meet the following requirements:

- fully reflect the values of real indicators;

- be available to users;

- to display current values of indicators for the given period [28].

Today the requirements for the efficiency and profitability of these markets' functioning in the national insurance market constantly increase. In addition, as part of the expansion of cooperation between insurance companies, the attention of scientists and practitioners should be paid to the development of operational and marketing strategies of behavior, considering the main activities of competitors and insurance companies that provide their services[29].

It, in turn, leads to the formation of a competitive environment and increased competition in the insurance market.

In the modern economical literature, improving the efficiency of the insurance market in developing and analyzing operational and marketing strategies for their behavior has become widespread. The most common optimisation models of activity in this direction are the models of Cournot and Stackelberg analysis. Along with these areas of thorough research and adequate models development requires an approach to optimizing the activities of insured companies based on considering management decisions strategies for the competitors' behavior in the market and various combinations of methods [30, 41].

The information analysis of operational and marketing researches in the insurance market gives the chance to form the complex subject's characteristic of the given market, directions of their activity and prospects of further development, and also to receive objective information on insurance operations and volumes of their granting in the market. The information obtained is used to plan the activities of insurance companies in the framework of situational analysis, which involves the development of such areas as review of the competitive environment and business climate in the market, positioning insurers in strategic markets, analysis of strengths and weaknesses, opportunities and threats of companies and their results [31].

The sequence and volume of significant risks transfer is one of the factors optimizing the insured companies activities, which increase their profitability. It is proposed to formalize the series of such risks transfer by determining the number of insurances and introducing many assumptions. First, the same type of insurance companies are considered; respectively, each can insure part of a significant amount of risk in proportion to other insurers. Secondly, the shares of own insurance companies of advanced insurance companies are on the same level. Therefore, we will optimize the number of insurances by modeling the profitability of insurance market participants according to the acceptable simplifications [32, 39, 40].

Having formed the tasks and requirements for the model of competitive strategies of the behavior of insurance market participants, we can proceed directly

to the description of mathematical security. However, we first consider competitive strategy depending on the number of competitive advantages obtained. Define the following competitive strategy of the insurance company:

a) Extrovert strategy: two directions depending on the level of competitiveness are within this strategy:

1) Extrovert adaptation – the application of this strategy is typical for insurance companies that accumulate internal reserves mainly to adapt to the conditions of the competitive environment, dictated by the leading companies in the insurance market;

2) Active extrovert – the characteristic of insurance companies that constantly monitor any possibility of development and use of innovative insurance services in a competitive environment in the insurance market to obtain additional competitive advantages;

b) Introvert strategy – two directions depending on the level of competitiveness are within this strategy:

1) Introvert leader – the characteristic of insurance companies that meet a significant share of effective demand in the insurance market and monitor the receipt of any opportunity to develop and use innovative insurance services within a competitive environment in the insurance market to gain additional competitive advantages constantly;

2) Passive introvert – the application of this strategy is typical for insurance companies that meet a significant share of effective demand in the insurance market, has a stable position and accumulate internal reserves mainly to maintain their financial condition at a constant level;

c) The strategy of expectation or neutral position – two directions depending on the possibility of additional competitive advantage provided by external or internal factors are within this strategy:

1) External expectation used by insurance companies that are willing to change the neutral position to extrovert because they have a much stronger position

to adapt to the conditions of a particular environment than to dictate their own due to innovation;

2) Internal expectation is inherent in insurance companies willing to change the neutral position to introvert, as they intend to increase competition in the insurance market by providing insurance services or introducing innovations. [18, 33, 34]

Therefore, it is possible to determine the main characteristics that are indicators of the insurance company's application of the relevant competitive strategy and are given in table 2.1.

Table 2.1 – Indicators of the insurance company's application of the relevant competitive strategy

Characteristic	Competitive strategy					
	extrovert		neutral position		introvert	
	active extrovert	extrovert adaptation	external expectation	internal expectation	passive introvert	introvert leader
$q_i \le 1$			+	+	+	+
$q_i \ge 2$	+	+				
The ratio of net premiums of the company $\le 50\%$					+	+
The ratio of net premiums of the company $\ge 50\%$	+	+	+	+		
The ratio of the level of payments $\ge 50\%$				+	+	+
The ratio of the level of payments $\le 50\%$	+	+	+			
The ratio of insurance reserves to insurance amounts from 1 to 5%	+	+				
The ratio of insurance reserves to insurance amounts from 5 to 10%			+	+		
The ratio of insurance reserves to insurance amounts from 10%					+	+

The information analysis from insurance market research provides an opportunity to form a comprehensive description of the subjects of this market, their activities and prospects for further development, and obtain objective

information about insurance transactions and the volume of their provision in the market. The information obtained is used to plan the activities of insurance companies in the context of situational analysis, which involves the development of such areas as a review of the competitive environment and business climate in the insurance market, positioning of insurers in strategic markets, analysis of weaknesses, opportunities and threats of companies and their results [35].

2.2 Mathematical model development for the choice strategy of insurance companies

1. To calculate the amount of reinsurance.
2. We calculate the ratio of net premiums for the i-th insurance company. To do it we find the maximum value among 5 insurance (S_{max}) companies and then calculate by the equation:

$$P_i = S_i / S_{max} \qquad (2.1)$$

3. To calculate the ratio of insurance reserves to insurance amounts according to the equation:

$$K_i = z_i / R_i \qquad (2.2)$$

4. The choice of strategy is made at the final stage.

To select a strategy, the analysis of the calculated indicators is carried out and substituted in our table. Our competitive strategy model of reinsurance market participants considers five characteristics of the choice of strategies:

− The first characteristic is the number of reinsurance. If the number of reinsurance ≤ 1 then the score is given to the following strategies external expectation, internal expectation, passive introvert, introvert leader, if ≥ 2 the score is given to such strategies active extrovert and extrovert-adaptation.

–   The second characteristic is the ratio of net premiums of the company in question and net premiums of the market leader. If the ratio of net premiums of the company > 50%, the score is given to the following strategies active extrovert, extrovert-adaptation, external expectation, internal expectation, if ≤ 50% then the score is given to such strategies passive introvert, introvert leader.

–   The third characteristic is the ratio of the level of payments, if more than 50% the score is given to such strategies internal expectation, passive introvert, introvert leader, if less than or equal to 50%, it is given to such strategies active extrovert, extrovert-adaptation, external expectation [36, 37].

–   The fourth characteristic is the ratio of insurance reserves to insurance amounts, depending on the interval. If the ratio of insurance reserves to the sum insured in the company is from 1 to 5%, the score is given to the following strategies active extrovert, extrovert-adaptation; if from 5 to 10%, the score is given to the following strategies external expectation, internal expectation; if more than 10% the score is given to the following strategies passive introvert, introvert leader [38].

2.3. Implementation of the strategy choice model of insurance companies

The data for 5 insurance companies were collected for our model.

Table 2.2 – Assets of insurance companies for 3 years

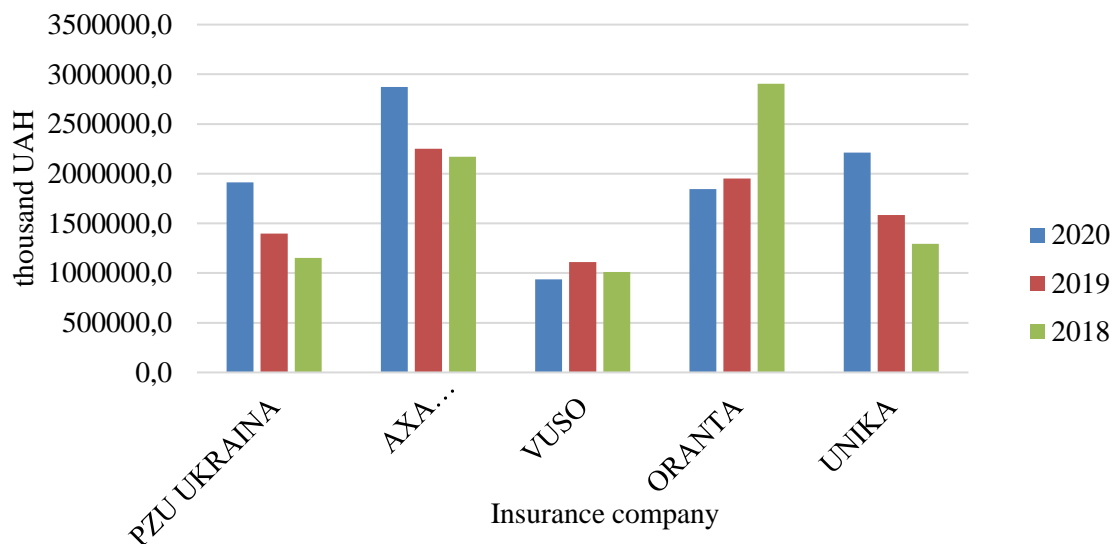| №	Insurance companies	Assets, thousand UAH		
		2020	2019	2018
1	PZU UKRAINA	1913385,5	1397913,8	1153625,9
2	AXA STRAKHUVANNIA	2871421,9	2250594,8	2169596,1
3	VUSO	938146,0	1111298,0	1009799,5
4	ORANTA	1843951,8	1952262,8	2905424,0
5	UNIKA	2211267,5	1584912,6	1294393,6

Figure 2.1 - Assets of insurance companies for 3 years

From Figure 2.1 we can see that AXA STRAKHUVANNIA and ORANTA are the leaders in terms of assets over the last 3 years.

Data on net premiums are presented in table B.1.

In terms of net premiums, we see that the first place is occupied by the insurance company AXA STRAKHUVANNIA (Figure B.1).

Data on payments of insurance sums and insurance indemnities under contracts are presented in Table B.2 and Figure B.2.

The following insurance companies take the first places AXA STRAKHUVANNIA and UNIKA according to the payments' indicator of insurance sums and insurance indemnities under contracts.

There are three leading insurance companies AXA STRAKHUVANNIA, PZU UKRAINA and UNIKA according to the costs of servicing the insurance process. Here AXA STRAKHUVANNIA takes the lead too.

Data on maintenance costs of insurance companies are presented in Table B.4 and Figure B.4.

Leading insurance companies AXA STRAKHUVANNIA and UNIKA are also allocated for the costs of maintaining insurance companies.

Data on insurance reserves of insurance companies are presented in Table B.5 and Figure B.5.

The insurance companies AXA STRAKHUVANNIA, UNIKA and PZU UKRAINA stand out the most regarding insurance reserves.

Data on the level of insurance companies payments are presented in Table B.6 and Figure B.6.

Regarding the level of payments, the insurance company PZU UKRAINA stands out the most, followed by all others distributed between 35 and 70%.

When analyzing the input data, we see that the insurance company AXA STRAKHUVANNIA is a leader among insurance companies in Ukraine.

Going directly to the actual implementation of the division, we find the number of reinsurance risks for each insurance company based on information about five companies.

Table 2.3 – The number of found risk reinsurance

Insurance company	Number of reinsurance	Value
PZU UKRAINA	0	0.419
AXA STRAKHUVANNIA	0	0.329
VUSO	1	0.744
ORANTA	1	0.523
UNIKA	0	0.330

The next step in the development of our model is to calculate the following indicators:

− the ratio of net premiums for the i-th insurance company, we use equation 2.1 for it;

− the ratio of insurance reserves to insurance amounts according to the equation 2.2;

Table 2.4 – Found values

Insurance companies	The ratio of net premiums	The ratio of insurance reserves to insurance amounts
PZU UKRAINA	0.422	0.468
AXA STRAKHUVANNIA	1,017	0.784
VUSO	0.152	0.435
ORANTA	0.421	0.304
UNIKA	0.797	0.736

The choice of strategy is made at the final stage. So we put one for each insurance company, when the figure corresponds to the specified. Thus, each insurance company is checked for all the characteristics listed in table 2.5. after the insurance company has checked for compliance with the indicator, if it is correct then put one and and if it is not correct we put zero. Then another unit is added to it, if another characteristic is suitable for insurance. When all the indicators are added, we can see which strategy is chosen by one or another insurance company with the help of the maximum indicator.

Table 2.5 – Choice of strategy

| Characteristic | Competitive strategy | | | | | |
| | extrovert | | neutral position | | introvert | |
	active extrovert	extrovert-adaptation	external expectation	internal expectation	passive introvert	introvert leader
$q_i \leq 1$	0	0	1	1	1	1
$q_i \geq 2$	1	1	0	0	0	0
$P_i \leq 50\%$	0	0	0	0	1	1
$P_i \geq 50\%$	1	1	1	1	0	0
$1\% \leq K_i \leq 5\%$	1	1	0	0	0	0
$5\% \leq K_i \leq 10\%$	0	0	1	1	0	0
$K_i > 10\%$	0	0	0	0	1	1

Findings data are presented in table 2.6.

Table 2.6 – The choice of strategies

| Insurance companies | extrovert | | neutral position | | introvert | |
	active extrovert	extrovert-adaptation	external expectation	internal expectation	passive introvert	introvert leader
PZU UKRAINA	0	1	1	1	4	4
AXA STRAKHUVANNIA	2	2	2	1	2	3
VUSO	1	1	2	0	4	3
ORANTA	0	0	1	1	4	5
UNIKA	2	2	4	1	2	2

As a result of competitive strategies modeling of insurance companies based on nonlinear programming, we see that it is proposed to choose the strategy of external expectation for insurance company UNIKA. This strategy is used by insurance companies in much stronger positions to adapt to the conditions of a particular environment than to dictate their own through innovation.

Our model offers to choose the strategy introvert leader for insurance companies such as AXA STRAKHUVANNIA and ORANTA, it is typical for insurance companies that meet a significant share of effective demand in the insurance market and monitor any opportunity to develop and use innovative insurance services in a competitive environment in the insurance market to gain additional competitive advantages constantly.

The VUSO model recommends the insurance company to choose the strategy of passive introvert, the application of this strategy is typical for insurance companies that meet a significant share of effective demand in the insurance market, has stable positions and accumulate internal reserves mainly to maintain their financial condition at a constant level.

You should choose one of introvert strategies for PZU UKRAINA.

CONCLUSIONS

A competitive strategies model of insurance companies behavior based on nonlinear programming was developed during the thesis. The purpose of the work was solved, namely, a structural and logical model for choosing competitive strategies for the insurance companies behavior based on nonlinear programming was developed. In turn, to achieve the goal of modeling, the following tasks were solved:

- the most important parameters of the object of study are identified;

- an overview of the current state of modeling of the object of study is made;

- the mathematical model of a competitive strategies choice of insurance companies behavior based on nonlinear programming is constructed;

- the practical implementation of the model of choosing competitive strategies of insurance companies behavior is made;

- a model for adequacy is tested.

One of the prospects for further research is to write a software application that would focus on the web platform and client-server architecture.

Since the model we built is a tool for analyzing competitive strategies in the insurance market, the insurance companies are the clients of our application.

REFERENCES

1. Азоев Г. Л. Конкуренция: анализ, стратегия и практика / Г. Л. Азоев. – М. : Центр экономики и маркетинга, 1996. – 108 с.

2. Максимов И. Оценка конкурентоспособности промышленного предприятия / И. Максимов // Маркетинг. – 1996. – № 3. – С. 33–39.

3. Родионова Л. Н. Оценка конкурентоспособности продукции / Л. Н. Родионова, О. Г. Кантор, Ю. Р. Хакимова // Маркетинг в России и за рубежом. – 2000. – № 1. – С. 63–77.

4. Шкардун В. Д. Методика исследования конкуренции на рынке / В. Д. Шкардун, Т. М. Яхтямов // Маркетинг в России и за рубежом. – 2000. – № 4. – С. 44–54.

5. Про захист економічної конкуренції : закон України від 11 січня 2001 року № 2210-ІІІ [Електронний ресурс]. – Режим доступу : http://zakon.rada.gov.ua.

6. Про Антимонопольний комітет України : закон України № 3659-ХІІ від 26 листопада 1993 року [Електронний ресурс]. – Режим доступу : http://zakon.rada.gov.ua.

7. Про захист від недобросовісної конкуренції : закон України № 236/96-ВР від 7 червня 1996 року [Електронний ресурс]. – Режим доступу : http://zakon.rada.gov.ua.

8. Долан Є. Дж. Рынок: микроэкономическая модель ; пер. с англ. В. Лукашевича и др.; под общ. ред. Б. Лисовика и В. Лукашевича / Долан Є. Дж., Линдсей Д. – С.-Пб, 1992. – С. 223–224.

9. Chandler J Rapson. Problems of health care system still exist / Chandler J Rapson // Business Insurance, 2009 [Електронний ресурс]. – Режим доступу : http://www.businessinsurance.com/article/20091018/ISSUE0401/ 310189969.

10. Peter Harbage. Competitive Health Care / Peter Harbage, Karen Davenport // A Public Health Insurance Plan that Delivers Market Discipline, 2009.

11. Брызгалов Д. Стратегии конкурентного поведения компаний на страховом рынке России / Д. Брызгалов // Экономические стратегии. – 2005. – № 3. – С. 88–93.

12. Полунєєв Ю. Конкурентоспроможність країни як національна ідея / Ю. Полунєєв // Дзеркало тижня. – 2005. – № 10 (538).

13. Гончарук Т. І. Конкурентоспроможність національної економіки: критерії визначення та динаміка розвитку / Т. І. Гончарук // Проблеми і перспективи розвитку банківської системи України : зб. наук. праць. Т. 10. – Суми : Мрія-1 ЛТД; УАБС, 2004.

14. Соколова Л. В. Конкурентоспособность предприятия и критерии её оценки / Л. В. Соколова [Электронный ресурс]. – Режим доступа : http://masters.donntu.edu.ua/2004/fem/ustimenko/library/literatura10.htm.

15. Галанцева И. В. Обеспечение конкурентоспособности предпринимательской структуры на основе антикризисной финансовой политики : автореферат на соискание ученой степени кандидата экономических наук / И. В. Галанцева. – Санкт-Петербург, 2009.

16. Визначення конкурентоспроможності підприємства [Електронний ресурс]. – Режим доступу : http://www.vuzlib.net/strat_upr/25.htm.

17. Должанський І. З. Конкурентоспроможність підприємства : навчальний посібник / І. З. Должанський, Т. О. Загорна. – Київ : Центр навчальної літератури, 2006. – 384 с.

18. Економіко-математичне забеспечення функціонування перестрахового ринку: монографія / О.В.Кузьменко. - Суми: Університетська книга, 2014. - 430 с.

19. Горбашко Е. А. Конкурентоспособность промышленной продукции : учеб. пособие / Е. А. Горбашко. – СПб. : Университет экономики и финансов, 1991;

20. Игольников Г. Что понимать под конкурентоспособностью, инвестиционной привлекательностью и экономичностью производства / Г. Игольников, Е. Патрушева // Рос. экон. журн. – 1995. – № 11. – С. 108–111.

21. Экономическая стратегия фирмы / под ред. Градова А. П. – СПб. : Спец. лит., 1995.

22. Вютрих Ганс А. Конкурентоспособность глобальных предприятий / Вютрих Ганс А., Винтер Вольфганг Б. // Проблемы теории и практики упр. – 1995. – № 3. – С. 96–102.

23. Шварц Г. «Мягкие» составляющие конкурентоспособности / Г. Шварц // Проблемы теории и практики упр. – 1995. – № 4. – С. 96–99.

24. Кравчук Г. В. Методологічні засади управління конкурентоспроможністю страхових компаній: дисертація на здобуття наукового ступеня доктора економічних наук / Кравчук Ганна Вікторівна - Суми 2010.

25. Конкурентоспроможність підприємства [Електронний ресурс]. – Режим доступу : http://www.library.if.ua/books/14.html.

26. Гридчина А. В. Теория и методология разработки стратегий конкурентоспособности организации: автореферат диссертации на соискание ученой степени доктора экономических наук / А. В. Гридчина. – Белгород,

27. Alghamdi S., Bach C. Technological Factors to Improve Performance of Marketing Strategy. *ASEE.* 2014. P.1-4

28. Analyzing the Influence of Ethical Sales Behavior on Customers Loyalty through Customer Satisfaction and Trust in Insurance Company. Pezhman RJavadi MShahin A International Journal of Academic Research in Business and Social Sciences. 2013.Vol. 3(9).

29. Peter Harbage. Competitive Health Care / Peter Harbage, Karen Davenport. *A Public Health Insurance Plan that Delivers Market Discipline*, 2009.

30. Rabelo L., Helal M., Jones A. A study of the impact of production scheduling using enterprise simulation.. *IIE Annual Conference and Exhibition*. 2004. P. 839-840

31. Hansen M. Competition among Life and Pension Insurance Companies: The Driving Force of High Policy Rates? *SSRN Electronic Journal.* 2005.

32. Global Insurance Industry Insights: An In-depth Perspective. Mckinsey & Company. *Global Insurance Pools.* 2014. Vol. 04. P. 32.

33. Hilli P., Koivu M., Pennanen T. A stochastic programming model for asset liability management of a Finnish pension company. *Annals of Operations Research.* 2007. Vol. 152(1). P. 115-139.

34. Kibicho P.Determinants of Strategy Implementation Success in the Insurance Industry: A Survey of Insurance Companies in Kenya. *International Journal of Business and Social Science.* 2015. Vol. 6(4). P. 74-91

35. Scawthorn C., Kunreuther H., Roth R. Insurance and financial risk transfer. *CRC Press,* 2002, Vol. 32-1-32-34.

36. Globalization, political institutions, financial liberalization, and performance of the insurance industry. Lee CLin C. North American Journal of Economics and Finance (2016) 36 244-266.

37. Bader M. Managing intellectual property in the financial services industry sector: Learning from Swiss Re. *Technovation.* 2008. Vol. 28(4). P. 196-207.

38. Albert R. Attack and error tolerance of complex networks / Albert R., Jeong H., Barab´asi A. *Nature*. 2000. Vol. 406. P.378–382. 351. Berkshire Hathaway Inc. Annual Report 2015. URL: http://www.berkshirehathaway.com/2011ar/ 2015ar.pdf .

39. Berkshire   Hathaway   Inc.   Annual   Report   2016   URL: http://www.berkshirehathaway.com/2016ar/ 2016ar.pdf. Castells

40. Forecasting of principal directions of Ukrainian insurance market development based on German insurance market indices / O. Kozmenko, O. Merencova, A. Boyko, H. Kravchuk. *Innovative Marketing*. Vol. 5, issue 4. 2009. P. 51−54.

41. Gale D. College Admissions and the Stability of Marriage. American Mathematical   Monthly   69.   1962.   P.   9–14.   URL: http://jmvidal.cse.sc.edu/library/gale62a.pdf.

APPENDICIES

Appendix A
Summary

Chernets V.S. Economic and mathematical modeling of insurance companies. Qualifying work of the bachelor. Sumy State University, Sumy, 2021.

The work at the theoretical level identifies the features of insurance companies, identifies practical aspects of assessing the competitive strategies of insurance companies, as well as the existing approaches to modeling the choice of competitive strategies of insurance companies. Having studied the theoretical features of the choice of strategy of insurance companies formalized requirements for its modeling. The author of the work developed and implemented a mathematical model for choosing the strategy of insurance companies in Ukraine.

Key words: modeling, insurance company, competition, strategy.

Анотація

Чернець В. С. Економіко-математичне моделювання діяльності страхових компаній. Кваліфікаційна робота бакалавра. Сумський державний університет, Суми, 2021 р.

В роботі на теоретичному рівні визначені особливості діяльності страхових компаній, визначені практичні аспекти оцінювання конкурентних стратегій страхових компаній, а також досліджені існуючі підходи до моделювання вибору конкурентних стратегій поведінки страхових компаній. Дослідивши теоретичні особливості вибору стратегії діяльності страхових компаній формалізовані вимоги до його моделювання. Автором роботи розроблена та реалізована математична модель вибору стратегії діяльності страхових компаній в Україні.

Ключові слова: моделювання, страхова компанія, конкуренція, стратегія.

Appendix B

Table B.1 – Net premiums of insurance companies for 3 years

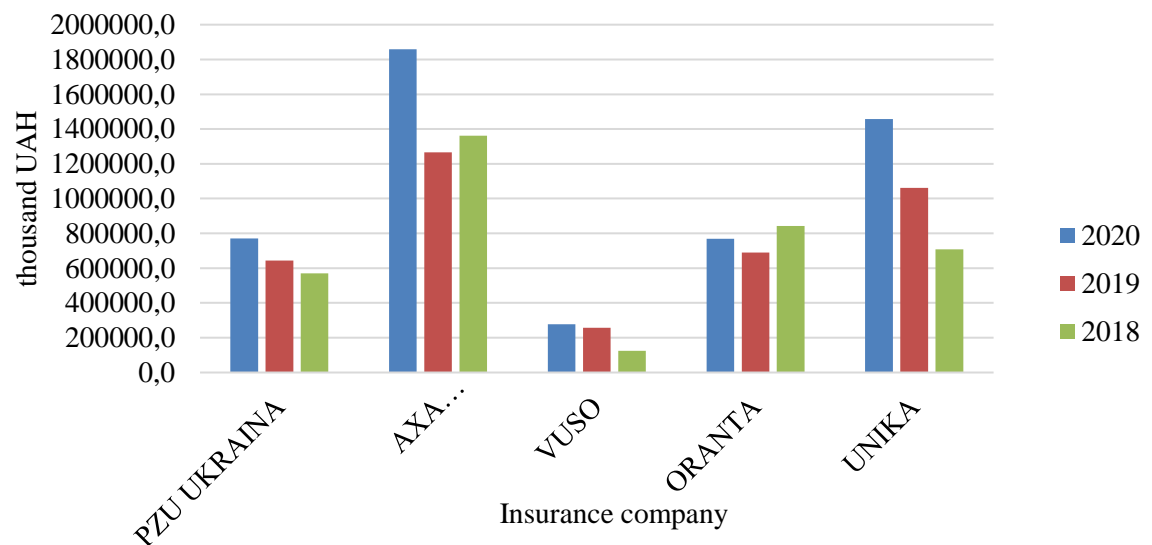| Insurance companies	Net premiums, thousand UAH		
	2020	2019	2018
PZU UKRAINA	771415,3	644184,4	570892,6
AXA STRAKHUVANNIA	1858171,1	1265492,2	1361046,6
VUSO	277410,1	257299,7	124833,3
ORANTA	768686,2	689872,2	842829,9
UNIKA	1457263,0	1062230,9	707635,2

Figure B.1 – Net premiums of insurance companies for 3 years

Table B.2 – Payments of insurance sums and insurance indemnities under contracts for 3 years

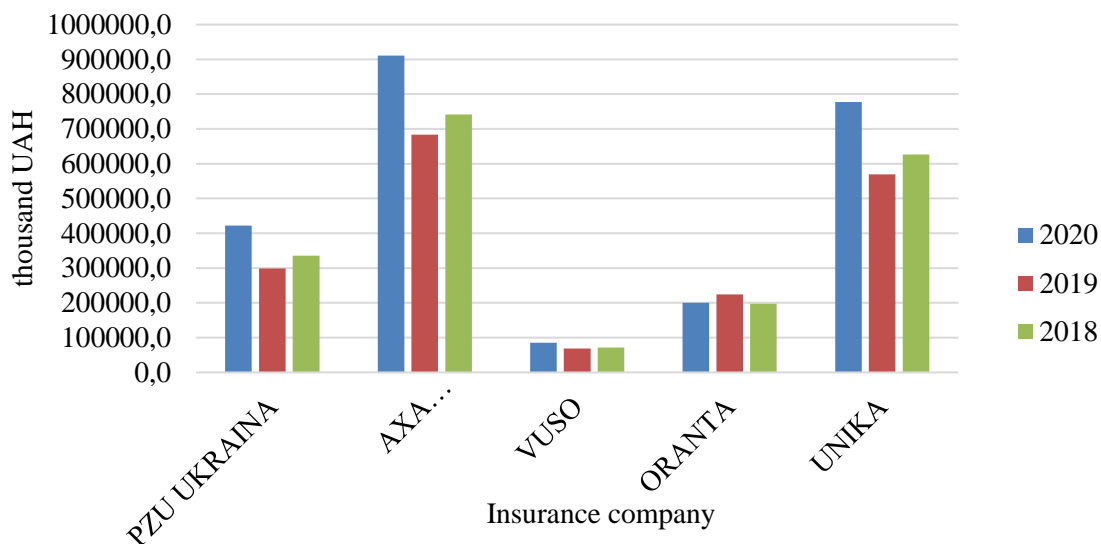| №	Insurance companies	Payments of insurance sums and insurance indemnities under contracts, thousand UAH		
		2020	2019	2018
1	PZU UKRAINA	422475,0	298968,3	335471,1
2	AXA STRAKHUVANNIA	911259,6	683389,7	741511,9
3	VUSO	85056,9	68900,7	71590,3
4	ORANTA	200594,1	224506,5	197671,8
5	UNIKA	777565,9	569386,9	626333,0

Figure B.2 – Payments of insurance sums and insurance indemnities under

contracts for 3 years

Table B.3 – Costs of servicing the insurance process for 3 years

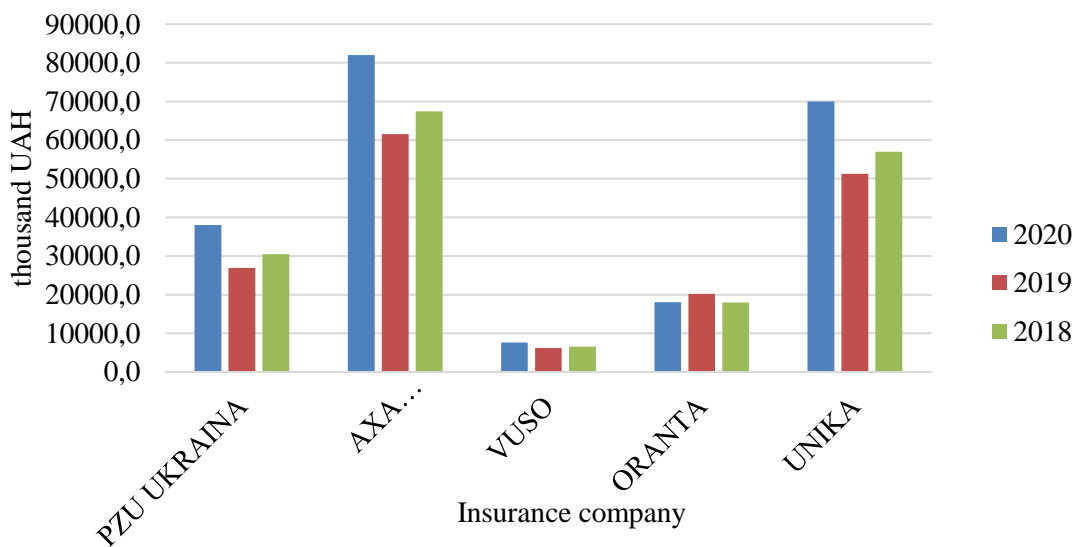| №	Insurance companies	Costs of servicing the insurance process, thousand UAH		
		2020	2019	2018
1	PZU UKRAINA	38022,7	26907,2	30517,1
2	AXA STRAKHUVANNIA	82013,4	61505,0	67453,7
3	VUSO	7655,0	6201,2	6512,4
4	ORANTA	18053,5	20205,6	17981,8
5	UNIKA	69981,0	51244,8	56976,2

Figure B.3 – Costs of servicing the insurance process for 3 years

Table B.4 – Maintenance costs of insurance companies for 3 years

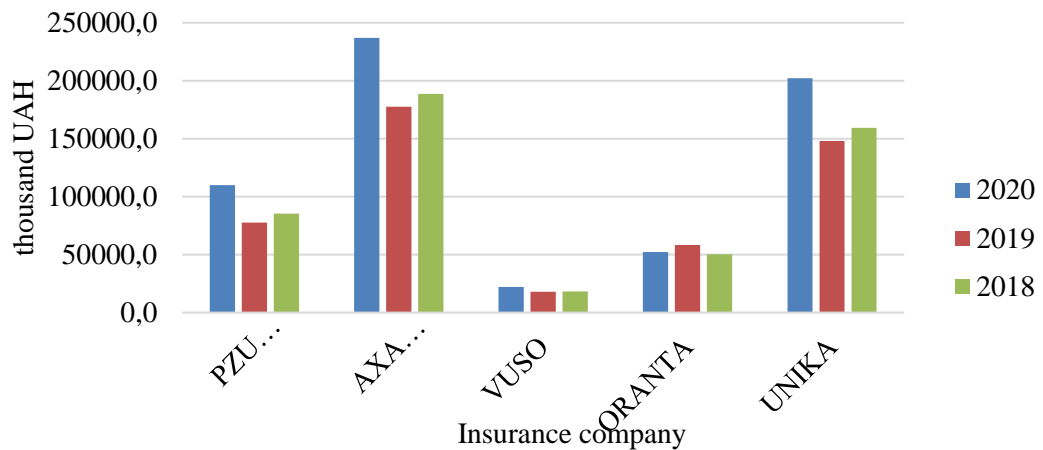| №	Insurance companies	Maintenance costs of insurance companies, thousand UAH		
		2020	2019	2018
1	PZU UKRAINA	109843,6	77731,6	85346,7
2	AXA STRAKHUVANNIA	236927,6	177681,4	188647,1
3	VUSO	22114,9	17914,2	18213,2
4	ORANTA	52154,5	58371,8	50289,5
5	UNIKA	202167,0	148040,7	159344,5

Figure B.4 – Costs of maintaining insurance companies for 3 years

Table B.5 – Insurance reserves of insurance companies for 3 years

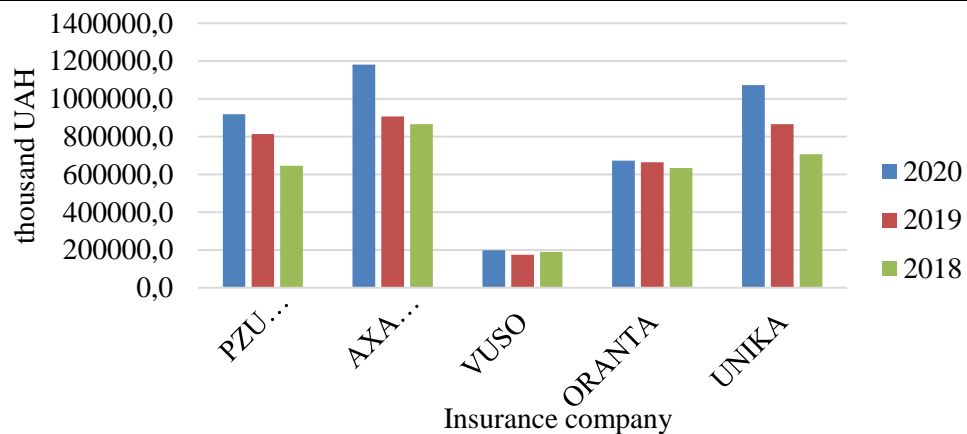| №	Insurance companies	Insurance reserves, thousand UAH		
		2020	2019	2018
1	PZU UKRAINA	919045,0	813267,3	644773,7
2	AXA STRAKHUVANNIA	1181551,7	905771,2	866182,1
3	VUSO	198563,1	174796,0	189685,6
4	ORANTA	671932,4	664757,8	633866,2
5	UNIKA	1073247,1	865085,4	707220,3

Figure B.5 – Insurance reserves of insurance companies for 3 years

Table B.6 – The level of insurance companies payments for 3 years

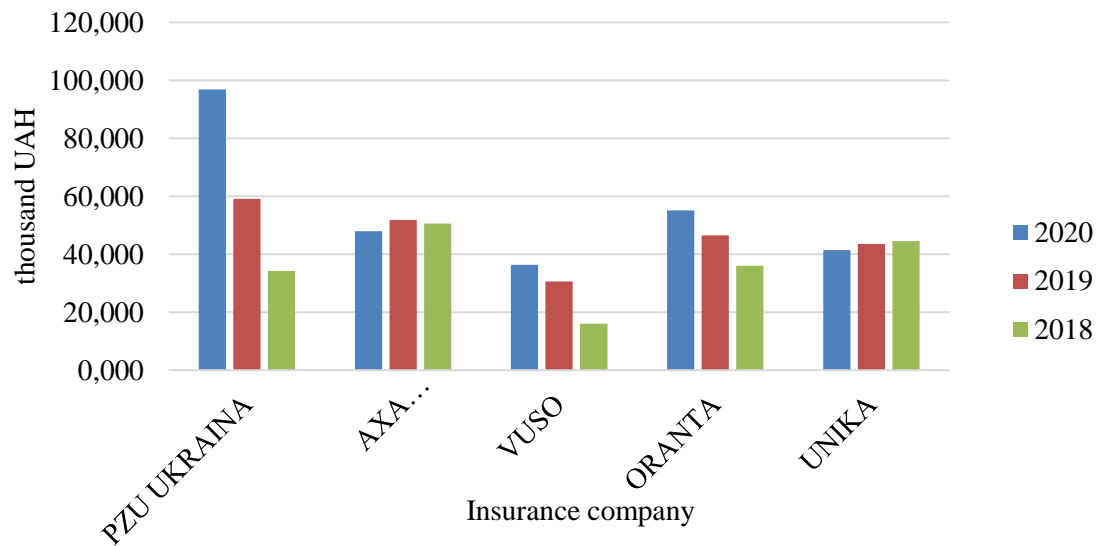| №	Insurance companies	The level of payments, %		
		2020	2019	2018
1	PZU UKRAINA	96,933	59,073	34,307
2	AXA STRAKHUVANNIA	47,908	51,867	50,649
3	VUSO	36,337	30,653	16,037
4	ORANTA	55,115	46,487	36,033
5	UNIKA	41,412	43,544	44,559

Figure B.6 – The level of insurance companies payments for 3 years