DOI: 10.15587/978-617-7319-37-4.CH4

# 4 ECONOMETRIC APPROACH TO JUSTIFICATION OF MANAGERIAL DECISIONS

N. Ivanova, T. Kozhukhova, V. Barabanova, V. Yankovsky

ABSTRACT

The analysis of existing approaches to making managerial decisions was carried out; their content and properties are determined. The author's understanding of the concept of «econometric approach to managerial decision-making» is proposed as a combination of the properties and principles of systemic (acceptance and understanding of the hierarchy of variables and their relationships, preservation of the principle of consistency) and situational approaches (accounting for system analysis, analysis of the content and dynamics of each individual situation) with an emphasis on application of econometric methods and models. The advantages and disadvantages of the econometric approach to managerial decision-making are determined. The general econometric methods of substantiating managerial decisions and their consequences are described.

A review of the practices of applying the econometric approach to substantiate managerial decisions has been carried out, as a result of which the expediency and effectiveness of using econometric models and methods at all stages of managerial decision-making have been determined, but they acquire special significance in the process of substantiating managerial decisions.

The methodological tools of the econometric approach to substantiating strategic decisions to ensure economic security, namely, taxonomic and canonical analyzes, have been determined. The statement about the existence of a connection between the standard of living of the population and the level of innovative development of the regions was proved, which made it possible to formulate strategic solutions for ensuring economic security. The matrix «economic security – standard of living – innovative development» is proposed to justify the decision to apply strategies to ensure economic security through changes in the level of innovative development and the standard of living of the region's population (transformation strategy, innovative development strategy, human development strategy and growth strategy).

KEYWORDS

Econometric approach, managerial decision making, econometrics, canonical analysis, taxonomic analysis, economic security, innovative development, living standards of the population.

## 4.1 ECONOMETRIC APPROACH: ADVANTAGES AND DISADVANTAGES

In the previous chapters, it has been proven that managerial decision making is a complex, multifaceted, uncertain and risky process. Decisions can be made either personally by managers

who are fully responsible for them, or with the participation of a large or small group. In the theory of managerial decision-making, two basic approaches are usually distinguished: systemic and situational approaches.

A systematic approach is a certain systematized way of thinking for decision-making, which is based on determining the overall goal of the system and consistent subordination of the activities of subsystems to it, plans for their development, indicators and labor standards [1]. The situational approach is based on system analysis, allows the manager to understand and take into account the specifics of the situation, the dynamics of its changes, and the like. The expediency of using systemic and situational approaches to decision-making in various fields and at different levels is described in the works of domestic and foreign scientists [1–9].

So Feldman, G., Shah, H., Chapman, C., Pärn, E. A., Edwards, D. J. [3], in contrast to others, emphasize the definition of the system of occurrence of problems, which consists of interacting parts; the authors propose to use the proposed approach for identifying problems, analyzing their boundaries, designing interventions, predicting and measuring the expected impact, their implementation and monitoring and assessing their success/failure.

In turn, Salhieh, S. M. [4] proposes a managerial decision model for concentrating organizational resources for maximum benefit, which is presented as a multi-criteria choice model and is built using the hierarchy analysis method.

The proposed econometric approach to managerial decision-making is a combination of the properties and principles of systemic (acceptance and understanding of the hierarchy of variables and their relationships, preservation of the principle of consistency) and situational approaches (accounting for system analysis, analysis of the content and dynamics of each individual situation) with an emphasis on the use of econometric methods and models (**Fig. 4.1**).

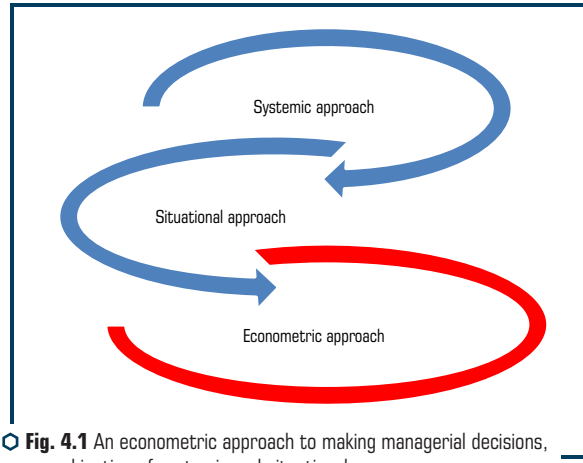


**Fig. 4.1** An econometric approach to making managerial decisions, as a combination of systemic and situational

The advantage of the mixed approach [10, 11] is the reduction of personal bias and the possibility of comparing dissimilar alternatives using quantitative analysis [12].

As noted in the previous chapters, the result of the activity (product) of management activity is a managerial decision. For a long time in domestic practice, the prevailing opinion about management as something more intuitive than analytical. The reason for highlighting and focusing on the econometric approach to managerial decision-making is the need for domestic managers to understand the importance of a quantitative justification for choosing a decision based on an analysis of the situation, identifying connections, assessing the risks and consequences of alternative decisions.

The main purpose of the econometric approach is to justify (argumentation) the choice of a specific managerial decision, taking into account the priorities and strategic goals of the organization's development using econometric methods.

Analysis of scientific developments on the application of econometric methods and models in management activities [13–23] made it possible to prove the feasibility of introducing an econometric approach to substantiate managerial decisions.

The application of generic econometrics to the general field of managerial decision making, where above all methods play a role in facilitating the overall data analysis process, was described in 1974 by Ball, R. J. and Burns, T. in their research study «Econometric analysis and managerial decision making» [11]. Econometric analysis describes quantitative relationships between economic variables and can provide important inputs to the decision-making process of managers. Usually, econometrics differs from other aspects of management science in that it considers problems primarily from an economic point of view, and not from other directions [18].

A supporter of quantitative methods for the study of economic processes, incl. in the field of management is Morris Altman, according to which «... the bounded rationality approach holds most promise, with its focus on methodology and related causal analysis and modeling, smart decision makers, capabilities, and institutional design» [19] and heuristics with given appropriate decision-making capabilities and institutional settings can produce better decision-making results.

That is why applied work in business requires a deep understanding of econometric decision-making methods. The combination of econometric methods with systemic and situational approaches provides the manager with an increase in the efficiency of the organization and contributes to being competitive.

Econometrics deals with the measurement of economic relationships, is the integration of economics, mathematical economics and statistics in order to provide numerical values for the parameters of economic relationships. The links of economic theories are usually expressed in mathematical forms and in combination with empirical economics. To obtain values, econometric methods are used, parameters, which are essentially the coefficients of the mathematical form of economic relations. Statistical methods that help explain an economic phenomenon, adapted like econometric methods [20].

The use of the econometric approach makes it possible to make decisions in the face of uncertainty, because the existence of ambiguity presents a challenge for those who make decisions,

since it makes it impossible to apply standard approaches to optimization (based on the calculation of objective expected values of alternative actions) [22]. The modern environment is characterized by a high level of uncertainty, which is exacerbated by the existing crisis phenomena. Arend, R. J. «… outline a multi-step, logical approach for addressing such problems in theory with the goal of providing an improved basis for practical decisions that should increase organizational performance» [22].

Modeling decisions is not so obviously expedient and straightforward, some of the models are very complex, but this does not mean that they are necessarily realistic. The modeling methods used by different people and in different situations can be different through individual schemes, personality, values, etc., as well as different internal and external environments [24].

Various econometric methods and their implications are presented in **Table 4.1**.

**Table 4.1** Application of econometrics to substantiate managerial decisions

| Applications | What it does |
|---|---|
| Linear model | Determination of independent drivers, degree of causality and preparation of forecasts with cross section data |
| Segmentation and Clustering Analysis | Identification of homogenous customer and product groups for strategic marketing and pricing initiatives |
| Time Series Modeling | Preparation of forecasts by building various time series models with a variety of distributional assumptions |
| Constrained Optimization | Creation of business rules by accounting for dynamic business constraints for an effective solution |
| GARCH (Generalized autoregressive conditional heteroscedasticity) | Identification of independent drivers, direction and degree of causality for parameter estimation in volatile environments |
| Neural Network Techniques | Development of machine learning based estimation techniques to help in pattern identification, sequence recognition and knowledge discovery in databases |
| Game Theoretic Applications | Identification of dominant and next-best strategies in a dynamic business environment with realistic asymmetric information assumptions |
| Non Linear Modeling | Key parameters estimations requiring high degree of precision |
| Response Modeling | Estimation of response probabilities to key marketing, pricing and operation strategies |

*Source:* [*18*]

Cooke, S. and Slack, N. [25] classifies quantitative models into two vectors [24] (**Table 4.2**):

1) according to the type of solution;

2) the degree of uncertainty of the model presented.

**Table 4.2** Classification of models in relation to the type of decision and the degree of uncertainty of the model

| Model | Deterministic | Probabilistic |
|---|---|---|
| Optimizing | Linear programming | Decision trees<br>Decision analysis |
| Satisficing | Corporate modeling<br>Heuristic models<br>Summary statistics | Queuing theory<br>Statistical analysis<br>Stochastic simulation<br>Risk analysis |

*Source:* [24]

So, among the advantages of the econometric approach are:

– unlike others, the econometric approach belongs to the mixed group, which gives it a wider range of methods and properties;

– econometric approach assumes that the problem can be described by a set of characteristics that are related by balance, functional or stochastic relationships, it allows to create a mathematical description (function) of the problem/solution and predict the result for various options;

– quantitative description of alternatives to managerial decisions allows to make a more informed choice, taking into account the priorities of a particular organization (for example, the risk-return ratio: for organizations with different goals – then reducing risk or increasing profitability – under the same conditions there will be different choices of decisions among the alternatives);

– are becoming more extensive and reliable, which can be processed thanks to new technologies and get a more accurate result of problem analysis and quantitative characteristics of solution alternatives.

Oddly enough, one of the main drawbacks of the econometric approach is the «human factor» – a decision-maker or analyst processes the databases.

The choice of modeling methods, the period of data sampling, the choice of variables and their number, the interpretation of the results, etc. carried out directly by the manager or analyst. Therefore, the econometric approach to managerial decision-making is the integration of not only mathematics, economics, statistics, management theory, but also the professionalism of a manager (decision-maker, analyst, etc.).

Existing examples of the application of the econometric approach in the theory of managerial decision making are presented in the next chapter.

## 4.2 REVIEW OF PRACTICES OF APPLYING THE ECONOMETRIC APPROACH TO JUSTIFY MANAGERIAL DECISIONS

The use of the econometric approach to making managerial decisions is possible at all its stages, but it acquires special significance in the process of substantiating managerial decisions.

Justification of management provides for the support of convincing evidence of the compliance of the proposed decision with the specified criteria and real-life restrictions.

The growing influence of uncertainty and risk factors has led to an interest in econometric methods that allow them to be taken into account and the application of which will allow the decision-maker to obtain information about the possible spheres of their occurrence, the likely degree of their influence, and the necessary measures to eliminate or mitigate the consequences of their action.

Unlike other approaches, within the framework of the econometric method of application does not depend on the competence, knowledge, skills and experience of the decision-maker, but on the content of the problem with all its characteristics.

In this chapter, an attempt is made to consider examples of the application of the econometric approach in making managerial decisions, to highlight the features.

It is appropriate to note scientific developments in decision-making in conditions of ambiguity, which is an insufficiently studied problem. Ambiguity is a more important type of context of uncertainty faced by managers making strategic decisions [25]. Arend, R. J. [22] proposes a new approach to solving the issues of strategic decision-making under ambiguity (SDMUA), which has not yet been practically tested, is a purely theoretical development. In the presented study, it is proposed to apply game theory when making investment decisions under conditions of ambiguity. «To maximize the payoff in an interdependent setting, the manager has to compare payoffs in each interdependent interaction. The simplest way to visualize this is as a normal form game where the interactions are the cells (i.e., the intersection of each row and column action choice in the table of possible actions by the players). Each cell contains a specific sub-set of the full investment choice set, where the sub-sets are mutually-exclusive and collectively-exhaustive. The full SDMUA then entails finding not only the best investment within each cell to fill out the game table, but it also entails identifying the Nash equilibrium choice for the competitive game as a whole» [22].

Thathsarani, U., Wei, J., Samaraweera, G. [23] investigate the problem of financial inclusion (the process of facilitating banking and financial services for individuals), as a result of which by analyzing the main components using an econometric approach to panel data with vector error correction models and a causality test Granger's Financial Inclusion Index was developed. Based on the information received, scientists have discovered the presence of a long-term impact on the development of human capital in South Asian countries, and a short-term positive impact on economic growth, is the basis for making managerial decisions at the state level.

Larsson, A.-S., Edwards, M. R. [16] carry out research in the field of personnel management and strategic personnel management, trying to identify the relationship between investments in HR and the performance of the firm. Research is conducted using Insider Econometrics «… an approach used in Personnel Economics to produce empirical estimates of the value of HR practices, to highlight longitudinal intra-firm research in economics that could provide insights to research exploring the HR investment-performance link (important in both SHRM and People Analytics fields)» [16].

Voloshyna, S., Provolotska, O., Lazaryshyna, I., Nieizviestna, O., Skliar, N. [26] in the process of researching the jewelry market determined that the development of effective managerial

decisions by all subjects of the jewelry market is hampered by ignorance the cause-and-effect relationship between its parameters is a consequence of the existence of systemic scientific gaps. Based on the econometric approach (regression analysis), it is determined that the price factor has a significant impact. The results of the regression analysis made it possible to formulate key solutions for the development of the Ukrainian jewelry market, which correlate with the systemic problems of its functioning.

When applying multivariate regression models, it is necessary to take into account multicollinearity and its negative impact. It is the study of multicollinearity in multifactorial regression economic and mathematical models of activity and the reduction of its negative impact based on the application of the parameterization method that the scientific work [27] is devoted to. For the first time, the application of the parameterization method is proposed, which makes it possible to simplify the construction of an economic and mathematical model in the form of regression equations. The use of the parameterization method makes it possible to reduce the uncertainty in the synthesis of multivariate regression equations, ensuring the appropriate adequacy, which increases the reliability of the information obtained for making managerial decisions.

Applying the methods of system-structural analysis and modeling of complex systems Barabanova, V. V., Bohatyryova, G. A. and Gorina, G. O. identified the potential opportunities for the development of industrial tourism at the city level, which are the basis for managerial decisions in the marketing strategy of the studied tourist region [27].

One of the guidelines for making managerial decisions is profit and its derivatives, from this point of view Chernega, O. B., Voloshyna, S. V., Kostakova, L. D. reveal the managerial significance of the profit of the enterprise [28], show the need to improve the methods of marginal analysis. The advantage of the presented results is the theoretical model of marginal analysis, which is formalized in the form of an industry methodology developed taking into account the specifics of the mining and processing plant for the extraction of iron ores. Classes of managerial decisions that can be implemented in structural divisions of an enterprise based on the method of margin analysis have been determined.

The use of the tools of the econometric approach allowed [29] to identify the main trends in the development of the European aviation network, a regression model for further improvement is presented, taking into account the results of the optimal placement of aviation hubs.

The development of additive and multiplicative models is characteristic of the econometric approach. Domestic scientists [30] for the first time used the apparatus of econometric modeling to study the influence of the components of production potential on the financial performance of an enterprise in the iron ore industry of the Kryvyi Rih region, taking into account the factor of scientific and technological progress, carried out a detailed economic and mathematical analysis of the results and made forecasts based on the obtained models. The results obtained are of practical value for the management of large industrial enterprises of the iron ore industry and can be used by them in the process of forming strategic plans for the management of financial and economic activities.

The econometric approach to substantiating managerial decisions takes place not only at the micro level; econometric tools are successfully used at the macro level as well. For example, using the regression analysis method Garbowski, M., Mironova, D., Perevozova, I., Khrushch, N., Gudz, I. [31], a relationship was established between macroeconomic stability and the economic development of IPO, which is described by mathematical regression models. The developed models make it possible to predict the level of macroeconomic stability as a result of IPO changes and timely adjust decisions at the state level.

A scientific study [32] proposed a methodological approach to assessing the regional level of human development, based on the improvement of mathematical tools for predicting the vectors of the country's development. It is based on the grouping of the country's regions according to certain demographic parameters. Common and peculiar issues of human development indifferent regions of Ukraine are systematized upon the basis of clusterization. The established regularities of demo-economic development of entire Ukraine and regional features, the levers of state regulation of human potential formation of Poland were taken into account and laid as the basis of scientific and practical recommendations for adjusting the Strategy of Sustainable Development of Ukraine [32].

## 4.3 METHODOLOGICAL TOOLS OF THE ECONOMETRIC APPROACH TO SUBSTANTIATE STRATEGIC DECISIONS TO ENSURE ECONOMIC SECURITY: TAXONOMIC AND CANONICAL ANALYZES

The analysis of theoretical sources on approaches to assessing and predicting the level of economic security of the national economy and regions made it possible to conclude that, in general, models for assessing the level of economic security have additive or multiplicative forms, qualitative and quantitative methods are used to assess the economic security of systems at various levels of hierarchy. However, despite the fact that qualitative methods are widely used to analyze economic security, their application will bring the greatest effect only in combination with quantitative methods [33].

The economic security of a system at any level of the hierarchy is characterized by a significant number of indicators that complicate its analysis and assessment. In order to fully take into account the influence of all indicators participating in the study, without significant loss of information, it is advisable to use the procedures of multivariate statistical analysis to assess the level of economic security.

This research is based on the methods of multivariate modeling and the matrix method.

Thus, based on the analysis of existing approaches and methods for assessing and predicting the economic security of systems at various levels of the hierarchy, it has been determined that the methods of multidimensional statistics are the most appropriate for research and modeling of the integral indicator of the economic security of regions. In this study, let's consider the application of taxonomic and canonical analysis.

*Taxonomic analysis* is used to assess and form the integral value of the level of economic security of regions according to certain indicators of the socio-economic development of regions, the forecast of which we have proposed using the method of regression modeling. The importance of the taxonomic method for economic sciences was separately noted by the Polish scientist Plyuta, V. in his work «Comparative multidimensional analysis in economic research. Methods of taxonomy and factor analysis» [34]. The author notes that most economic phenomena are actually characterized by a large number of different features, the number of which often reaches several dozen. In such conditions, the use of traditional methods becomes impossible. To solve such problems, the author suggests using the taxonomy method.

Kuz'minchuk, N. V., Dolya, D. G. formulated the advantages of the taxonomic method: «Based on the taxonomy method, which is able to organize multidimensional statistical material into a single quantitative characteristic, it is possible to build a generalized assessment of a complex object or process» [35].

The method is based on the definition of the so-called taxonomic distance, that is, the distance between points of a multidimensional space, the dimension of which is determined by the number of features that characterize the studied one. Determining these distances makes it possible to determine the location of each specific point relative to others, and, thus, structure the entire set of points. There are several objects of the same type with a certain set of essentially different features.

Data on these objects and their characteristics can be presented in the form of a matrix, in which objects form rows, and characteristics – columns.

This matrix is called the observation matrix, which, as a rule, has the form:

$$x = \begin{pmatrix} x_{11} & x_{12} & \dots x_{1j} \\ x_{21} & x_{22} & \dots x_{2j} \\ x_{i1} & x_{i2} & \dots x_{ij} \end{pmatrix}, \quad (4.1)$$

where $i$ – serial number of the investigated object from 1 to $n$;

$j$ – ordinal number of the investigated feature for each object from 1 to $p$.

For complex objects (such as the economic security of a region), indicators are indicators that characterize various properties of an object and, as a result, have different meanings, units of measurement, and sizes of quantitative indicators.

Combining such indicators into one is not possible without preliminary conversion procedures (reduction) to one measurement base.

For this, according to the rules of the taxonomy method, the standardization of features is carried out, in which the value of the indicator is replaced by a coefficient characterizing the ratio of the deviation of each specific feature from the average value of the feature for all objects in the root-mean-square (standard) deviation for this feature.

Mathematically, this transformation is:

$$Z_{ij} = \frac{x_{ij} - \overline{x_j}}{S_j}, \tag{4.2}$$

where $Z_{ij}$ – standardized value of feature $j$ for object $i$;

$x_{ij}$ – value of the feature $j$ for the $i$-th object;

$x_j$ – arithmetic mean of the feature $j$;

$S_j$ – standard deviation of features $j$.

The arithmetic mean value of the attribute $j$ is determined by the formula:

$$\overline{X_j} = \frac{1}{n}\sum_{i=1}^{n} x_{ij}, \tag{4.3}$$

where $n$ – the number of objects under study.

The standard deviation for each characteristic is calculated by the formula:

$$S_j = \left[\frac{1}{n}\sum_{i=1}^{n}\left(x_{ij} - \overline{x_j}\right)^2\right]^{1/2}. \tag{4.4}$$

The final procedure is the formation of a distance matrix, on the basis of which, subsequently, the location of each specific object in the entire set of objects under study is determined. The distance for each attribute of an object is determined as the difference between the standardized value of this attribute and the standardized value of this indicator for a neighboring or reference object (the object is selected based on the research objectives):

$$C_{ik} = \left|Z_{ij} - Z_{kj}\right|, \tag{4.5}$$

where $Z_{ij}$ – value of the standardized $j$-th feature for the $i$-th object;

$Z_{kj}$ – value of the standardized j-th feature for the object selected as the comparison base.

The elements of the distance matrix serve as the basis for the final calculations to determine the taxonomic indicator, which can be determined [36]:

– as the average absolute difference in feature values:

$$C_t = \frac{1}{p}\sum\left|Z_{ij} - Z_{kj}\right|, \tag{4.6}$$

where $p$ – the number of features by which objects are characterized;

– as the square root of the mean square of the difference in feature values:

$$C_t = \left[\frac{1}{p}\sum\left(Z_{ij} - Z_{kj}\right)^2\right]^{1/2}; \quad (4.7)$$

– as the sum of the absolute differences in characteristic values:

$$C_t = \sum\left|Z_{ij} - Z_{kj}\right|; \quad (4.8)$$

– as the square root of the sum of the squares of the differences in feature values:

$$C_t = \left[\sum\left(Z_{ij} - Z_{kj}\right)^2\right]^{1/2}. \quad (4.9)$$

The use of certain formulas in practice depends on the objectives of the study, and the requirements put forward by the researcher to the resulting taxonomic indicator.

The undoubted advantage of the taxonomic method, which allows its widespread use, is the process of the so-called standardization of indicators, as a result of which the properties of an object, described by various qualitative and quantitative indicators, are transformed into a single standardized measurement system.

The standardization of indicators (characteristics) is a necessary procedure, since it brings all indicators to a comparable form. However, as Plyuta, V. notes from the standpoint of mathematics, this procedure also has negative consequences, which are that each of the standardized values equally affects the distance between the objects under study [34]. To get rid of this negative influence of the process of standardization of features, allow the so-called coefficients of the hierarchy, in the economic literature better known as the coefficients of weighting of an indicator (feature).

The taxonomic indicator is calculated using the classical taxonomic analysis algorithm [37].

*Canonical analysis.* When analyzing the economic security of regions, an important task is to study the influence of many of these factors on the performance indicators of this process. One of the methods for solving this problem is canonical correlation analysis. The most acceptable in this case is the canonical correlation method, since it allows to establish the relationship between datasets. In addition, being a generalization of multiple linear regression, this method allows to determine in each set of variables those of them that most affect the opposite set of indicators, without breaking the latent relationships between the data sets.

Canonical correlation analysis is widely used to study the relationships between multiple socio-economic processes. One of the advantages of this method is the ability to determine the in-

fluence of many factors not into one indicator characterizing the phenomenon under study, but several at once.

With the help of canonical correlation analysis, the relationships between the indicators of both sets are simultaneously investigated and the closest ones, that is, with the highest correlation coefficient, are determined. On the basis of the results obtained, the main and secondary factors of influence are distinguished, and if the latter have weak connections between the canonical values, they can be discarded. Thus, the study of the economic process will not be overloaded with unnecessary factors.

In this study, the task is set to investigate such components of the economic security of regions as innovative development and the standard of living of the population.

According to the method of canonical analysis, the main indicators of socio-economic development are divided into 2 groups:

1) indicators $Y_j$, which are parameters of the living standards of the population of the region and refer to the metric scale, serve as the basis for assessing the level of the latent variable, is investigated. They form the first (small) group of performance indicators;

2) signs $X_i$ refer to the second (large) group of primary factors-symptoms of the economic security of the regions and characterize the innovative development of the regions of Ukraine.

Unlike traditional correlation-regression analysis, canonical analysis allows determining the influence of factors not in one effective indicator, but in several, which increases the practical significance of the calculations [38].

The result of the canonical analysis of two groups of variables – $Y_1$, $Y_2$, …, $Y_9$ and $X_1$, $X_2$,..., $X_7$ is a linear combination of features of the first group $Y_1$, $Y_2$, …, $Y_s$:

$$Z_Y = a_1 Z_{Y_1} + a_2 Z_{Y_2} + ... + a_S Z_{Y_s}. \quad (4.10)$$

The standardized $Z_Y$ value can be considered as one of the estimates of the latent indicator. In this case, the canonical coefficients $\alpha_1$, $\alpha_2$,…, $\alpha_s$ play the role of statistical weights of individual factor-symptoms $Y_j$.

In the process of research, the following tasks are solved:

– assess the tightness of the canonical correlation between the first ($Y_j$) and the second ($X_i$) groups of features;

– check the statistical reliability;

– reduce the number of indicators that affect the main criteria for changing the economic security of the regions.

Matrix methods are a set of methods for research and analysis of economic processes based on the construction of economic tables (matrices, scales). The result of the application of the matrix method for predicting the economic security of the region is a matrix of strategies for increasing the level of economic security, taking into account the living standards of the population and innovative development.

## 4.4 DESCRIPTION OF THE RELATIONSHIP BETWEEN THE STANDARD OF LIVING OF THE POPULATION AND THE INNOVATIVE DEVELOPMENT OF REGIONS IN THE CONTEXT OF ENSURING THEIR ECONOMIC SECURITY

Within the framework of this study, let's put forward a hypothesis about the existence of a connection between the standard of living of the population and the level of innovative development of the regions, which will make it possible to formulate strategic solutions for ensuring economic security.

To do this, it is necessary to complete the following tasks:

1) determine the level of economic security of the regions by the method of taxonomic analysis [37];

2) build canonical models of the living standards of the population and innovative development of regions (canonical analysis);

3) build a matrix «economic security – living standards – innovative development» (matrix method).

Analysis of the taxonomic indicator of the level of economic security of the regions. The results of calculating the taxonomy coefficients according to the indicators of the socio-economic development of the regions of Ukraine for the period 2008–2019 are shown in **Table 4.3**.

● **Table 4.3** Results of calculating the taxonomic indicator

| Region | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Vinnytsia | 0.28 | 0.27 | 0.26 | 0.29 | 0.28 | 0.30 | 0.31 | 0.33 | 0.32 | 0.31 | 0.34 | 0.35 |
| Volyn | 0.17 | 0.16 | 0.17 | 0.18 | 0.17 | 0.17 | 0.16 | 0.19 | 0.18 | 0.19 | 0.20 | 0.18 |
| Dnipropetrovsk | **0.67** | 0.58 | **0.70** | **0.72** | **0.67** | **0.67** | **0.59** | **0.65** | **0.51** | **0.65** | **0.72** | **0.71** |
| Donetsk | 0.66 | **0.62** | 0.64 | 0.70 | 0.58 | 0.59 | 0.52 | 0.28 | 0.33 | 0.26 | 0.29 | 0.27 |
| Zhytomyr | 0.19 | 0.19 | 0.20 | 0.21 | 0.20 | 0.20 | 0.19 | 0.20 | 0.18 | 0.21 | 0.23 | 0.23 |
| Zakarpattia | 0.18 | 0.16 | 0.17 | 0.17 | 0.15 | 0.16 | 0.14 | 0.17 | 0.16 | 0.18 | 0.17 | 0.18 |
| Zaporizhzhia | 0.37 | 0.36 | 0.37 | 0.37 | 0.36 | 0.37 | 0.36 | 0.40 | 0.36 | 0.38 | 0.38 | 0.36 |
| Ivano-Frankivsk | 0.19 | 0.21 | 0.22 | 0.22 | 0.21 | 0.21 | 0.22 | 0.23 | 0.20 | 0.23 | 0.22 | 0.21 |
| Kyiv | 0.38 | 0.49 | 0.46 | 0.49 | 0.53 | 0.54 | 0.53 | 0.52 | 0.55 | 0.57 | 0.56 | 0.55 |
| Kirovograd | 0.18 | 0.18 | 0.19 | 0.21 | 0.19 | 0.19 | 0.19 | 0.19 | 0.17 | 0.18 | 0.20 | 0.20 |
| Luhansk | 0.32 | 0.28 | 0.29 | 0.32 | 0.28 | 0.26 | 0.16 | **0.05** | **0.06** | **0.04** | **0.07** | **0.07** |
| Lviv | 0.34 | 0.36 | 0.38 | 0.40 | 0.40 | 0.39 | 0.37 | 0.41 | 0.42 | 0.42 | 0.45 | 0.43 |
| Mykolaiv | 0.23 | 0.24 | 0.25 | 0.26 | 0.23 | 0.24 | 0.23 | 0.26 | 0.25 | 0.27 | 0.25 | 0.26 |
| Odesa | 0.40 | 0.43 | 0.42 | 0.40 | 0.42 | 0.42 | 0.38 | 0.41 | 0.40 | 0.41 | 0.43 | 0.42 |
| Poltava | 0.32 | 0.34 | 0.36 | 0.38 | 0.37 | 0.37 | 0.37 | 0.35 | 0.32 | 0.40 | 0.39 | 0.37 |

● **Continuation of Table 4.3**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rivne | 0.17 | 0.16 | 0.19 | 0.19 | 0.17 | 0.18 | 0.15 | 0.18 | 0.16 | 0.17 | 0.19 | 0.18 |
| Sumy | 0.19 | 0.20 | 0.19 | 0.22 | 0.21 | 0.21 | 0.20 | 0.20 | 0.16 | 0.23 | 0.22 | 0.20 |
| Ternopil | 0.15 | 0.13 | 0.15 | 0.17 | 0.16 | 0.16 | 0.14 | 0.15 | 0.14 | 0.17 | 0.17 | 0.20 |
| Kharkiv | 0.42 | 0.47 | 0.42 | 0.46 | 0.48 | 0.48 | 0.47 | 0.46 | 0.43 | 0.46 | 0.46 | 0.42 |
| Kherson | 0.18 | 0.17 | 0.19 | 0.20 | 0.17 | 0.17 | 0.18 | 0.17 | 0.16 | 0.18 | 0.20 | 0.20 |
| Khmelnitskyi | 0.22 | 0.22 | 0.23 | 0.24 | 0.24 | 0.24 | 0.25 | 0.25 | 0.23 | 0.24 | 0.26 | 0.24 |
| Cherkasy | 0.26 | 0.27 | 0.27 | 0.27 | 0.26 | 0.25 | 0.25 | 0.25 | 0.24 | 0.25 | 0.28 | 0.29 |
| Chernivtsi | **0.14** | **0.12** | **0.13** | **0.13** | **0.12** | **0.11** | **0.10** | 0.12 | 0.09 | 0.12 | 0.12 | 0.12 |
| Chernihiv | 0.18 | 0.17 | 0.18 | 0.20 | 0.20 | 0.20 | 0.17 | 0.18 | 0.17 | 0.22 | 0.21 | 0.20 |
| Maximum | 0.67 | 0.62 | 0.70 | 0.72 | 0.67 | 0.67 | 0.59 | 0.65 | 0.55 | 0.65 | 0.72 | 0.71 |
| Minimum | 0.14 | 0.12 | 0.13 | 0.13 | 0.12 | 0.11 | 0.10 | 0.05 | 0.06 | 0.04 | 0.07 | 0.07 |
| Divergence | 0.53 | 0.50 | 0.56 | 0.59 | 0.55 | 0.55 | 0.49 | 0.60 | 0.49 | 0.61 | 0.65 | 0.64 |

*Source: calculated by the authors based on the data* [*39*]

For the entire period of the study, a high value of the integral indicator of economic security is observed in the Dnipropetrovsk region, the average value of which for 2008–2019 is 0.65; the next value in the Kyiv region is at the level of 0.51 points, that is, the gap is 0.14 points. The value of Donetsk region is lower by 0.03 points relative to the Kyiv region. The least value of the integral indicator of economic security was recorded in the Chernivtsi region – 0.12 points (**Fig. 4.2**).

The discrepancy between the maximum and minimum values of the integral indicator of economic security fluctuates on average at the level of 0.53 points from 0.49 (2014) to 0.64 (2019). This is a fairly significant deviation. At the same time, according to the results of the calculations, it can be argued that there is a tendency for an increase in disproportions to ensure the economic security of the regions after the reform of the decentralization of public administration.

Canonical models of living standards of the population and innovative development of regions. The list of indicators characterizing the standard of living of the population ($Y_j$) and innovative development ($X_j$) is presented in **Table 4.4**.

Indicators $Y_1$, $Y_2$, $Y_3$, $Y_4$, $Y_5$, $Y_6$, $Y_7$, $Y_8$, $Y_9$ are particular signs of the economic security of regions – the standard of living of the population related to the metric scale and serve as the basis for assessing the level of the latent variable is being investigated. They create the first (small) group of performance indicators in accordance with the definition of the economic security of the region. The signs $X_1$, $X_2$, $X_3$, $X_4$, $X_5$, $X_6$, $X_7$ belong to the second group of primary factors-symptoms of the economic security of the region and characterize the innovative development of the regions of Ukraine. In the process of practical solution of the set tasks, the STATISTICA 10.0 system was used, in particular, the Canonical Analysis module [40].

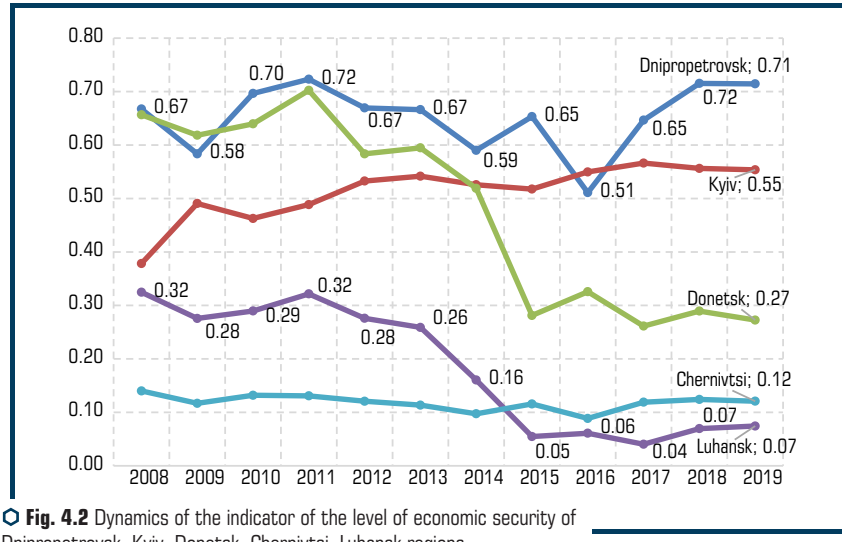


**Fig. 4.2** Dynamics of the indicator of the level of economic security of Dnipropetrovsk, Kyiv, Donetsk, Chernivtsi, Luhansk regions

**Table 4.4** Groups of indicators of private signs of the standard of living of the population of the regions ($Y_i$) and primary symptom factors ($X_i$)

| Private features group | | Group of primary symptom factors | |
|---|---|---|---|
| $Y_1$ | The volume of expenditures of local budgets (including interbudgetary transfers) per person, hryvnia | $X_1$ | The number of innovatively active enterprises for internal research and development |
| $Y_2$ | Expenses of the population per person, UAH | $X_2$ | The number of innovatively active enterprises for external research and development |
| $Y_3$ | Migration growth (reduction) of the population | $X_3$ | The number of innovatively active enterprises by purchased machines, equipment and software |
| $Y_4$ | Number of people employed in economic activity, thousand people | $X_4$ | The number of innovatively active enterprises based on acquired by other external knowledge |
| $Y_5$ | Disposable income of the population per person, UAH | $X_5$ | The number of other innovatively active enterprises |
| $Y_6$ | Average monthly salary, UAH | $X_6$ | Industrial innovation spending |
| $Y_7$ | Consumer price index, percent | $X_7$ | The volume of sold innovative products (goods, services) of industrial enterprises |
| $Y_8$ | Average assigned monthly pension for pensioners | | |
| $Y_9$ | Proportion of population with per capita equivalent total income | | |

The results of calculations of the canonical analysis of the factors of economic security of the regions – the standard of living of the population and innovative development – indicate a strong relationship between the canonical variables, confirmed by the value of the canonical correlation coefficient (Canonical R) – 0.883.The total excess for the variables of the first group ($X_1$–$X_7$) is 35.7 %, and the total excess for the variables of the second group ($Y_1$–$Y_9$) is 56.64 %.

This means that 88.23 % of the variation in effective living standards is explained by variations in seven symptom factors ($X_1$–$X_7$).

In turn, the effective indicators of regional economic security describe 56.64 % of variations in symptom factors. Such values of the indicators indicate the accuracy of the obtained canonical models, 43 % of the variance of the effective indicators of the standard of living of the population depends on other factors not taken into account in the model, which is quite true.

To construct a mathematical expression of models for assessing the standard of living of the population and the innovative development of regions, the coefficients of the canonical variables were determined, which made it possible to write down the mathematical expressions of the models. The obtained canonical models of regional economic security in a standardized form are written as follows (4.11), (4.12):

$$Z_Y = -0{,}28Y_1 + 0{,}278Y_2 + 0{,}6Y_3 + 0{,}76Y_4 + 0{,}115Y_5 - 0{,}21Y_6 + 0{,}37Y_7 + 0{,}004Y_8 - 0{,}021Y_9; \quad (4.11)$$

$$Z_X = 0{,}304X_1 + 0{,}348X_2 + 0{,}93X_3 + 0{,}65X_4 + 0{,}71X_5 + 0{,}03X_6 + 0{,}11X_7. \quad (4.12)$$

The practical implementation of the presented models is complicated by the standardized values of $Y$ and $X$ provided in it and, therefore, it is advisable to carry out the procedure of transition from standardized variables to ordinary ones according to formula (4.2).

The mathematical notation of the models takes the following form (4.13), (4.14):

$$Z_Y = -0{,}22Y_1 + 0{,}016Y_2 + 0{,}067Y_3 + 0{,}002Y_4 + 0{,}01Y_5 - 0{,}208Y_6 + 0{,}164Y_7 + 0{,}012Y_8 - 0{,}003Y_9; \quad (4.13)$$

$$Z_X = 0{,}06X_1 + 0{,}15X_2 + 0{,}079X_3 + 0{,}362X_4 + 0{,}154X_5 + 0{,}000043X_6 + 0{,}0001X_7. \quad (4.14)$$

The results of the implementation of the models (4.13, 4.14) according to the data of 2017–2019 are presented in **Table 4.5**.

Thus, the range of fluctuations of the calculated indicators of the level of investment development of the regions during the study period 2017–2019. It is characterized: according to 2017, a low value of the indicator is observed in the Luhansk region – 0.71; 2018 – Volyn region – 0.65; according to 2019 – Khmelnytskyi region – 0.58 points. The maximum value of the level of innovative development throughout the entire period of the study is observed in the Kharkiv

region – 13.23, 9.68 and 9.55, respectively. In addition, the calculation results indicate significant deviations between the minimum and maximum values – on average 94 % (**Fig. 4.3**).

● **Table 4.5** Implementation of models $Z_{Xi}$ (4.13), $Z_{Yi}$ (4.14) according to 2017–2019 data

| Region | $Z_{X2017}$ | $Z_{Y2017}$ | $Z_{X2018}$ | $Z_{Y2018}$ | $Z_{X2019}$ | $Z_{Y2019}$ |
|---|---|---|---|---|---|---|
| Vinnytsia | 3.50 | 17.24 | 3.34 | 16.19 | 3.64 | 15.34 |
| Volyn | 1.16 | 16.99 | **0.65** | 15.73 | 1.17 | 15.01 |
| Dnipropetrovsk | 6.97 | **21.24** | 3.89 | 18.74 | 8.99 | 17.70 |
| Donetsk | 4.24 | 15.54 | 3.50 | 15.29 | 5.74 | 14.95 |
| Zhytomyr | 1.85 | 17.21 | 1.96 | 16.17 | 1.96 | 15.43 |
| Zakarpattia | 1.27 | 17.41 | 0.67 | 16.68 | 1.32 | 15.34 |
| Zaporizhzhia | 6.74 | 17.86 | 5.27 | 16.71 | 7.35 | 15.89 |
| Ivano-Frankivsk | 2.17 | 17.67 | 3.16 | 16.37 | 1.69 | 15.69 |
| Kyiv | 5.27 | 19.85 | 5.24 | 18.66 | 6.21 | 17.99 |
| Kirovograd | 3.12 | 16.97 | 1.63 | 15.76 | 2.06 | 14.92 |
| Luhansk | **0.71** | **14.70** | 0.96 | **14.39** | 1.12 | **14.24** |
| Lviv | 7.96 | 18.91 | 8.70 | 18.14 | 7.18 | 17.37 |
| Mykolaiv | 3.49 | 17.26 | 1.42 | 16.31 | 3.28 | 15.20 |
| Odesa | 4.07 | 19.36 | 4.13 | 18.59 | 4.37 | 17.92 |
| Poltava | 4.24 | 17.01 | 3.23 | 16.09 | 4.42 | 15.66 |
| Rivne | 1.13 | 17.19 | 1.36 | 15.73 | 2.72 | 15.03 |
| Sumy | 4.27 | 17.21 | 3.29 | 16.12 | 3.73 | 15.69 |
| Ternopil | 2.85 | 16.98 | 2.29 | 16.08 | 2.59 | 15.31 |
| Kharkiv | **13.23** | 20.66 | **9.68** | **19.51** | **9.55** | **18.78** |
| Kherson | 1.96 | 17.48 | 1.84 | 16.38 | 1.71 | 15.56 |
| Khmelnitskyi | 0.85 | 17.15 | 0.87 | 16.29 | **0.58** | 15.67 |
| Cherkasy | 2.77 | 17.36 | 2.09 | 16.22 | 1.67 | 15.40 |
| Chernivtsi | 1.67 | 16.95 | 1.43 | 16.14 | 1.52 | 15.47 |
| Chernihiv | 1.18 | 17.05 | 3.05 | 15.99 | 1.27 | 15.35 |
| Maximum | 13.23 | 21.24 | 9.68 | 19.51 | 9.55 | 18.78 |
| Minimum | 0.71 | 14.70 | 0.65 | 14.39 | 0.58 | 14.24 |
| Divergence | 95 % | 31 % | 93 % | 26 % | 94 % | 24 % |
| Average value | 3.61 | 17.64 | 3.07 | 16.59 | 3.58 | 15.87 |

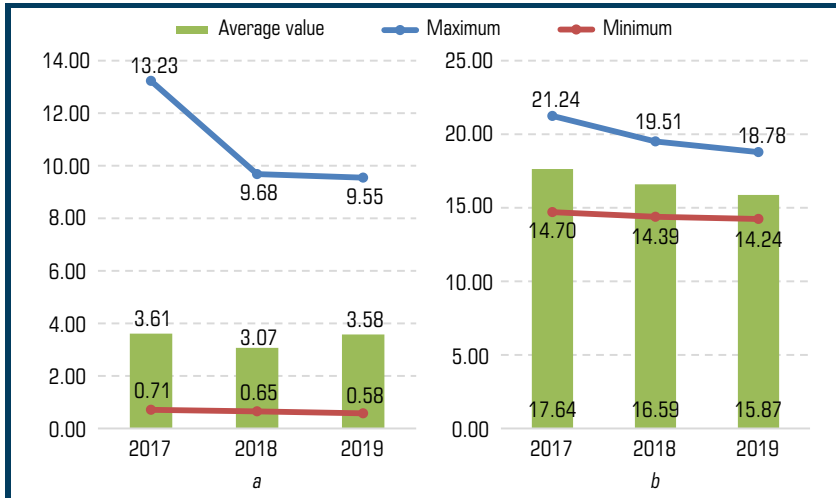


**Fig. 4.3** Dynamics of indicators: *a* – innovative development of regions $Z_{Xi}$: maximum, minimum and average values, 2017–2019; *b* – standard of living of the population $Z_{Yi}$

The applied application of models for assessing the living standards of the population $Z_{Yi}$ (*b*) and innovative development of regions $Z_{Xi}$ for 2019 is presented in **Fig. 4.4**.

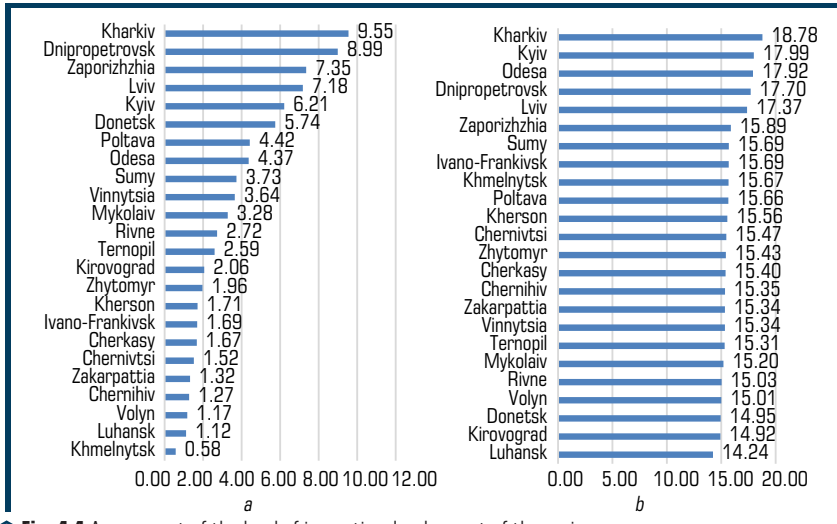


**Fig. 4.4** Assessment of the level of innovative development of the regions of Ukraine: *a* – model $Z_{Xi}$; *b* – model $Z_{Yi}$ (based on the results of 2019)

The results allow to assess the place of the region in the plane of economic security from the standpoint of the level of innovative development and the standard of living of the population, to determine the presence of disparities between regions. Based on the calculations and their visualization, it was established that the Dnipropetrovsk region occupies a leading position in terms of economic security, while in terms of the level of innovative development it is the second after the Kharkiv region and the fourth in the standard of living of the population (after Kharkiv, Kyiv and Odesa). The lowest level of innovative development was recorded according to the data of the Khmelnytskyi region and according to the standard of living of the population – the Luhansk region.

Thus, the obtained calculation results do not represent a comprehensive idea of the policy of ensuring the economic security of the regions by regulating innovative development and ensuring the standard of living of the population. The next chapter presents the results of a comprehensive econometrics for choosing a strategy for increasing the level of economic security of regions by constructing a matrix «economic security – standard of living – innovative development».

## 4.5 COMPREHENSIVE ECONOMETRICS FOR CHOOSING A STRATEGY FOR INCREASING THE LEVEL OF ECONOMIC SECURITY OF REGIONS: THE MATRIX "ECONOMIC SECURITY – STANDARD OF LIVING – INNOVATIVE DEVELOPMENT"

The use of economic and mathematical methods made it possible to comprehensively determine the level of economic security of the regions. The use of existing methods of system analysis and synthesis made it possible to monitor the level of economic security of the regions, the standard of living of the population and the innovative development of the regions.

It is proposed to determine strategies for increasing the level of economic security of regions using a matrix management strategy, which is based on the values of the level of economic security (taxonomic indicator), the model of the level of innovative development $Z_{Xi}$ and the standard of living of the population $Z_{Yi}$ . The matrix of the ratio of these indicators with the allocation of the corresponding zones is presented in **Fig. 4.5**.

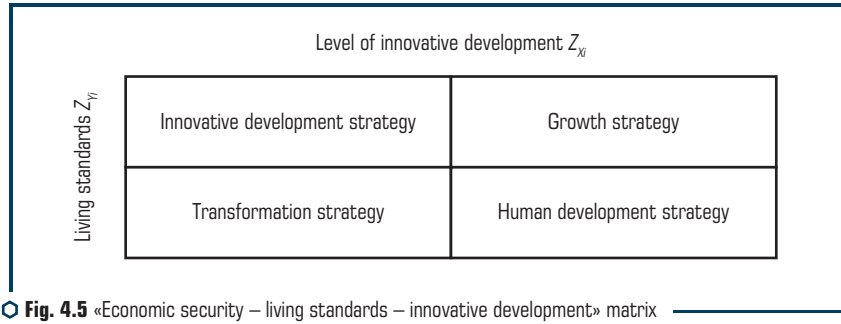


**Fig. 4.5** «Economic security – living standards – innovative development» matrix

*Transformation strategy*. The peculiarities of the transformation of regional economic systems in the context of innovative development include the following factors: entrepreneurship, informatization, new technologies, labor organization, structural transformations [41, 42], it should be noted that the transformation strategy is focused on the formation of the economic security of the region through transformation processes in the formation of potential innovative development of the region and/or the efficiency of using the existing potential. Taking into account the specificity of the factors of economic development of each region, it is advisable to form the directions of transformation processes based on the analysis of the main indicators of the socio-economic development of the region and monitoring the level of economic security. The spheres of transformation processes, again taking into account the specifics of the region, can be the following: industry, entrepreneurship, informatization, new technologies, labor organization, structural transformations. At the same time, the directions of transformation are determined at the regional level, and the spheres of transformation processes are determined at the national level.

The strategy is based on the principles of polarized development, support for regional initiatives, and synchronization of actions. The scope of application is determined in accordance with the specifics of the economic system of the region. One of the options is transformation processes in the sectoral structure of the region, involving the use of new technologies, the development of entrepreneurship, and the like. The programs of the proposed strategies are presented in **Table 4.6**.

*Growth strategy*. According to the proposed matrix, it is characterized by the development and implementation of a growth strategy. Economic security, in its essence, does not have a completed stage, the conditions and sphere of its occurrence provide for constant changes in the value of its level – any subject of the economic security system strives to a safe level of its functioning and development. The system for developing a strategy for the growth of the economic security of the region, in contrast to the previous strategies, is based on the existing strategy of economic development and ensuring the economic security of the region and provides for the implementation of preventive measures to prevent the possible negative impact of threats. The results of applying the proposed matrix are presented in **Fig. 4.6–4.8**. According to **Fig. 4.6–4.8** during 2017–2018 the best state in terms of innovative development and quality of life of the population to ensure the level of economic security is observed in two regions: Lviv and Kharkiv regions. According to the matrix «economic security – living standards – innovative development», built on the 2019 database, it was found that most regions of Ukraine require the use of a transformation strategy.

This necessitates the development and implementation of transformation strategies, taking into account such destabilizing factors:

– decrease in the level of human development;

– increase in the level of poverty of the population;

– determination of the spheres and directions of transformation processes within each separate region;

– formation of sources of investment funds for the implementation of innovations;

– reducing the level of control over corruption and the quality of regulation.

● **Table 4.6** Programs for the implementation of strategies for ensuring economic security: innovative development – living standards of the population

| **Strategy name** | **Transformation strategy** | **Innovative development strategy** | **Human development strategy** | **Growth strategy** |
|---|---|---|---|---|
| **Problem** | **Ensuring the economic security of the region** | | | |
| Strategy goal | Intensification of innovative activity in various fields with the implementation of structural transformations; improving the living standards of the population | Improving the efficiency of using the innovative potential of the region | Creation of conditions for the comprehensive development of a person throughout the life, expanding opportunities for the realization of individual freedom, business and civic activity in the harmonious, balanced and sustainable development of the country | Building up the margin of safety for the region's economic security |
| Strategy task | Structural transformation | Reconstruction transformations | Reconstruction transformations | Preventive measures, functioning on warning |
| Stages of strategy implementation | 1) design and research;<br>2) pilot projects;<br>3) systemic transformations | 1) research;<br>2) corrective actions;<br>3) reconstruction transformations | 1) research;<br>2) corrective actions;<br>3) reconstruction transformations | 1) monitoring;<br>2) corrective actions;<br>3) improvement (clarification) of the current Strategy |
| Main activities | – implementation of priority programs and projects;<br>– performance of research works;<br>– transfer of innovations;<br>– solving infrastructure problems and increasing infrastructure potential;<br>– formation of a positive investment image;<br>– development of measures to improve the system of attracting investment resources;<br>– training of specialists;<br>– increase in labor and intellectual potential;<br>– formation of a margin of safety to resist destabilizing factors of various types | – implementation of priority programs and projects;<br>– reconstruction of the existing investment image of the region;<br>– adjustment of the system of attracting investment resources for the introduction of innovations;<br>– using a margin of safety to resist destabilizing factors of various types | – implementation of priority programs and projects to ensure a high standard of living of the population;<br>– reforming the healthcare sector;<br>– development of educational space;<br>– improving the standard of living, enhancing employment and providing social support to citizens | – implementation of priority programs and projects;<br>– support for the existing investment image of the region;<br>– improving the system of attracting investment resources;<br>– increase in labor and intellectual potential;<br>– using a margin of safety to resist destabilizing factors of various types |
| Sources of funding for the strategy | Funds of the state, regional and local budgets, extrabudgetary funds | Mainly funds of regional and local budgets, extra-budgetary funds, state budget funds | Funds of the state and local budgets, funds of the Pension Fund of Ukraine and state social insurance funds, international technical assistance, loans from international financial organizations, from other sources not prohibited by law | Mainly funds of regional and local budgets, extra-budgetary funds, state budget funds |

*Source: compiled based on* [*33*]

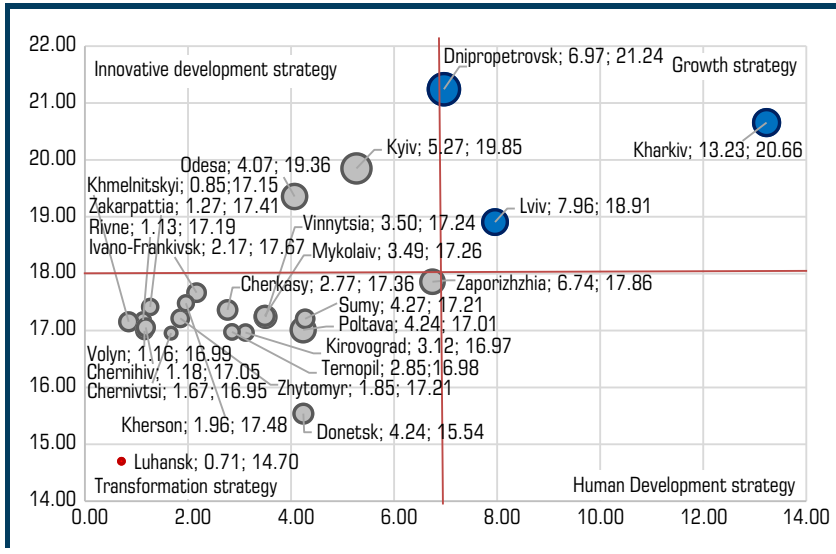


**Fig. 4.6** Strategies for ensuring the economic security of regions according to the matrix «economic security – standard of living – innovative development» in 2017

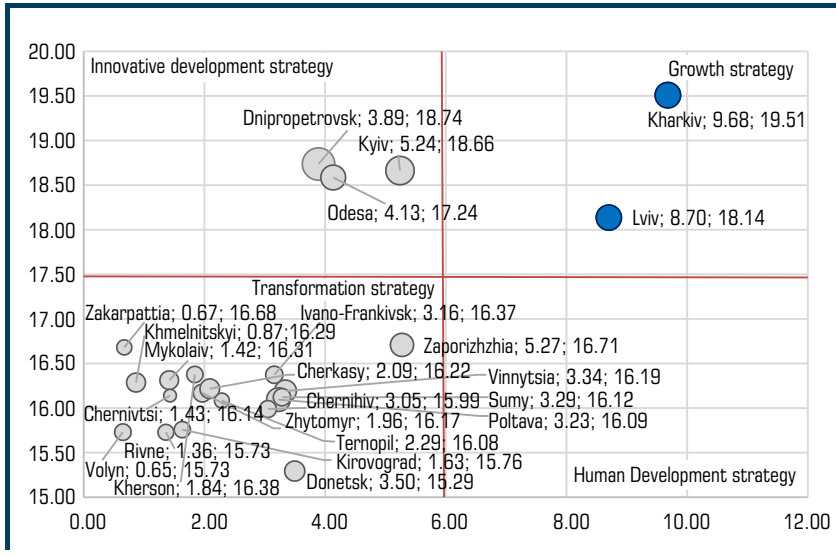


**Fig. 4.7** Strategies for ensuring the economic security of regions according to the matrix «economic security – standard of living – innovative development» in 2018

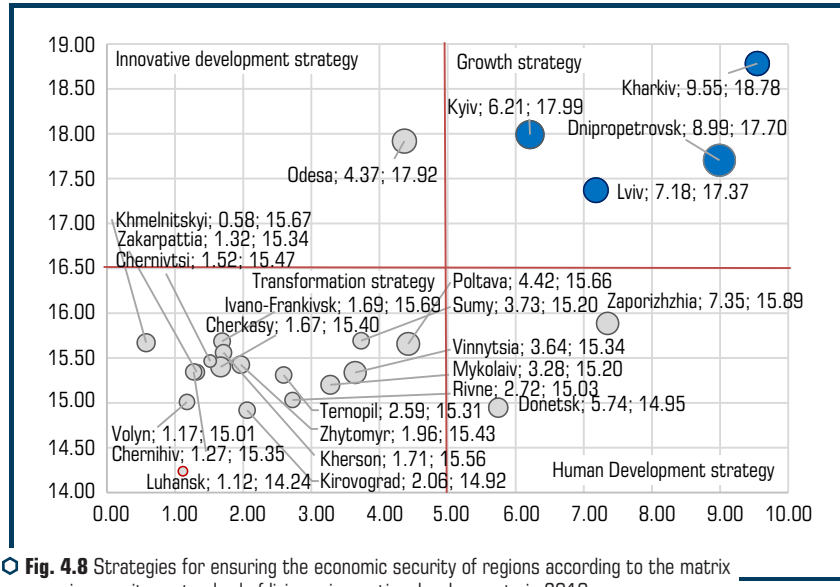


**Fig. 4.8** Strategies for ensuring the economic security of regions according to the matrix «economic security – standard of living – innovative development» in 2019

Analysis of the strategies of the regions [43, 44], for which it was recommended to implement the transformation strategy, made it possible to determine the strategic priorities:

1) development of small and medium-sized businesses on an innovative basis;

2) development and modernization of infrastructure, primarily transport communications and housing and communal services;

3) harmonious development of the leading sectors of the region's economy (industrial sector, agricultural sector, construction, high-tech services and forestry);

4) development of tourist (historical, cultural and natural and recreational) potential.

According to **Fig. 4.6–4.8** the exception is Kharkiv, Dnipropetrovsk, Lviv and Kyiv regions. It was found that the most acceptable is the growth strategy, the implementation of which ensures the preservation of the existing level of economic security and the prevention of possible threats. A significant factor at the regional level is the growth of the disposable income of the population of the regions per capita (wages, profits, mixed income, balance of property income, etc.) and the export of services.

Analysis of the existing strategies for the economic development of the regions, for which the growth strategy is recommended for use, made it possible to determine their strategic priorities:

1) development of human capital;

2) reduction of intraregional economic imbalances;

3) development of rural areas;

4) environmental and energy security.

The implementation of the Strategy will make it possible to transform the economy of regions with a rather slowly growing economy with a large asymmetry in the development of individual territories of the region into a more modern economy based on innovation, the activity of entrepreneurs, based on the optimal location of economic entities and the economical use of the region's natural resources. The implementation of the strategy contributes to an increase in the level of economic security of the region.

So, the econometric approach made it possible to determine the general dynamics of the level of economic security, life of the population and innovative development; identify links between various groups of economic security features and form a matrix that is quite applied in nature.

## REFERENCES

1. Petrunia, Yu. Ye., Litovchenko, B. V., Pasichnyk, T. O. et. al.; Petrunia, Yu. Ye. (Ed.) (2020). Pryiniattia upravlinskykh rishen. Dnipro: Universytet mytnoi spravy ta finansiv, 276. Available at: http://biblio.umsf.dp.ua/jspui/bitstream/123456789/4070/1/%D0%9F%D1%80%D0%B8%D0%B9%D0%BD%D1%8F%D1%82%D1%82%D1%8F%20%D1%83%D0%BF%D1%80%20%D1%80%D1%96%D1%88%D0%B5%D0%BD%D1%8C%202020.pdf
2. Grünig, R., Kühn, R. (2013). Successful decision-making: A systematic approach to complex problems. Springer, 200. doi: https://doi.org/10.1007/978-3-642-32307-2
3. Feldman, G., Shah, H., Chapman, C., Pärn, E. A., Edwards, D. J. (2017). A systematic approach for enterprise systems upgrade decision-making. Journal of Engineering, Design and Technology, 15 (6), 778–802. doi: https://doi.org/10.1108/jedt-08-2017-0076
4. Salhieh, S. M. (2007). A systematic approach for the selection of business processes for e-enablement. International Journal of Information Technology & Decision Making, 06 (04), 649–669. doi: https://doi.org/10.1142/s021962200700268x
5. Prezenski, S., Brechmann, A., Wolff, S., Russwinkel, N. (2017). A Cognitive Modeling Approach to Strategy Formation in Dynamic Decision Making. Frontiers in Psychology, 8. doi: https://doi.org/10.3389/fpsyg.2017.01335
6. Durman, O. L. (2020). Application of a systematic approach to decision making and the formation of the external course of the state. Visnyk Natsionalnoho universytetu tsyvilnoho zakhystu Ukrainy, 1 (12), 93–109. Available at: http://repositsc.nuczu.edu.ua/bitstream/123456789/10849/3/journalok.pdf
7. Ladanyuk, A., Ivashchuk, V., Boyko, R., Savchuk, O. (2016). Methods of situational control of multipurpose production. Naukovi pratsi Natsionalnoho universytetu kharchovykh tekhnolohiy, 22 (3), 25–30. Available at: http://nbuv.gov.ua/UJRN/Npnukht_2016_22_3_5

8. Tkachova, T. (2020). Neural network model for efficiency of management decisions at a machine-building enterprise. Visnyk of Sumy State University. Economy series, 3, 327–333. doi: https://doi.org/10.21272/1817-9215.2020.3-37
9. Olshanskiy, O., Tkachenko, O., Tkachova, S. (2021). Implementation of process management in theory of management decision making. Economic Scope, 166, 53–57. doi: https://doi.org/10.32782/2224-6282/166-9
10. Tamura, H. (2005). Behavioral models for complex decision analysis. European Journal of Operational Research, 166 (3), 655–665. doi: https://doi.org/10.1016/j.ejor.2004.03.038
11. Hämäläinen, R. P., Luoma, J., Saarinen, E. (2013). On the importance of behavioral operational research: The case of understanding and communicating about dynamic systems. European Journal of Operational Research, 228 (3), 623–634. doi: https://doi.org/10.1016/j.ejor.2013.02.001
12. Saaty, T. L. (2008). Decision making with the analytic hierarchy process. International Journal of Services Sciences, 1 (1), 83. doi: https://doi.org/10.1504/ijssci.2008.017590
13. Ball, R. (1974). Econometric analysis and managerial decision making. Omega, 2 (3), 295–311. doi: https://doi.org/10.1016/0305-0483(74)90024-3
14. Skouras, S. (2007). Decisionmetrics: A decision-based approach to econometric modelling. Journal of Econometrics, 137 (2), 414–440. doi: https://doi.org/10.1016/j.jeconom.2006.03.012
15. Manski, C. (2019). Econometrics For Decision Making: Building Foundations Sketched By Haavelmo And Wald. NBER Working Papers. doi: https://doi.org/10.3386/w26596
16. Larsson, A.-S., Edwards, M. R. (2021). Insider econometrics meets people analytics and strategic human resource management. The International Journal of Human Resource Management, 1–47. doi: https://doi.org/10.1080/09585192.2020.1847166
17. Silva, E., E. Stefanou, S., Oude Lansink, A. (2021). Dynamic Efficiency and Productivity Measurement. Oxford University Press. doi: https://doi.org/10.1093/oso/9780190919474.001.0001
18. Kolluru, S., Mishra, R. (2012). Relevance of Econometric Applications for Managers. In book: Econometric Applications for Managers. Chapter: 1. New Delhi. Available at: https://www.researchgate.net/publication/225376894_Relevance_of_Econometric_Applications_for_Managers
19. Altman, M. (2020). The evolution of decision-making: Why institutions and capabilities matters. Smart Economic Decision-Making in a Complex World, 17–37. doi: https://doi.org/10.1016/b978-0-12-811461-2.00002-x
20. Introduction to Econometrics (2020). Foundations of Modern Econometrics, 1–26. doi: https://doi.org/10.1142/9789811220197_0001
21. Flores-Garcia, E., Bruch, J., Wiktorsson, M., Jackson, M. (2020). Decision-making approaches in process innovations: an explorative case study. Journal of Manufacturing Technology Management, 32 (9), 1–25. doi: https://doi.org/10.1108/jmtm-03-2019-0087

22. Arend, R. J. (2020). Strategic decision-making under ambiguity: a new problem space and a proposed optimization approach. Business Research, 13 (3), 1231–1251. doi: https://doi.org/10.1007/s40685-020-00129-7
23. Thathsarani, U., Wei, J., Samaraweera, G. (2021). Financial Inclusion's Role in Economic Growth and Human Capital in South Asia: An Econometric Approach. Sustainability, 13 (8), 4303. doi: https://doi.org/10.3390/su13084303
24. Smith, G. (1989). Managerial problem identification. Omega, 17 (1), 27–36. doi: https://doi.org/10.1016/0305-0483(89)90017-0
25. Cooke, S., Slack, N. (1991). Making Management Decisions. Prentice Hall.
26. Voloshyna, S., Provolotska, O., Lazaryshyna, I., Nieizviestna, O., Skliar, N. (2019). Analytical assessment of the jewellery market in Ukraine. Economic Annals-XXI, 176 (3-4), 65–79. doi: https://doi.org/10.21003/ea.v176-07
27. Barabanova, V. V., Bohatyryova, G. A., Gorina, G. O. (2020). Marketing mechanisms of tourist industry development in an unstable environment. Journal of Geology, Geography and Geoecology, 29 (4), 625–636. doi: https://doi.org/10.15421/112056
28. Chernega, O. B., Voloshyna, S. V., Kostakova, L. D. (2018). Paradigm of marginal analysis of profits of enterprises with a multiple productive process. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, 6, 139–147. doi: https://doi.org/10.29202/nvngu/2018/17
29. Chernega, O. B., Dorofeyeva, K. M. (2015). Key features of formation and development of European aviation network. Actual Problems of Economics, 12 (174), 75–84. Available at: http://nbuv.gov.ua/UJRN/ape_2015_12_12
30. Cherep, A., Baranik, Z., Bondarenko, O., Khavrova, K., Kharabuga, S. (2020). Analysis and modeling of an iron ore enterprise's production potential in Kryvyi Rih region. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, 4, 130–139. doi: https://doi.org/10.33271/nvngu/2020-4/130
31. Garbowski, M., Mironova, D., Perevozova, I., Khrushch, N., Gudz, I. (2019). Influence of ipo on macroeconomic security of countries. Journal of Security and Sustainability Issues, 8 (4), 841–853. doi: https://doi.org/10.9770/jssi.2019.8.4(24)
32. Provolotska, O., Voloshyna, S., Nieizviestna, O., Holikova, K. (2019). Perfecting of mathematical tools for forecasting the country development vectors on the basis of economic and demographic parameters system analysis. Periodicals of Engineering and Natural Sciences (PEN), 7 (2), 509. doi: https://doi.org/10.21533/pen.v7i2.575
33. Ivanova, N. S. (2018). Prohnozuvannia zabezpechennia ekonomichnoi bezpeky natsionalnoi ekonomiky: rehionalnyi aspekt. Dnipro, 544. Available at: https://duan.edu.ua/images/head/Science/UA/Academic_Council/D_08_120_0/23871.pdf
34. Plyuta, V. (1980). Sravnitel'niy mnogomerniy analiz v ekonomicheskih issledovaniyah. Metody taksonomii i faktornogo analiza. Moscow: Statistika, 151.
35. Kuz'minchuk, N. V., Dolya, D. G. (2009). Metodicheskiy podhod k otsenke effektivnosti deyatel'nosti banka metodom taksonomicheskogo analiza. Biznesinform, 6, 66–69.

36. Council Directive 2009/50/EC «on the conditions of entry and residence of third-country nationals for the purposes of highly qualified employment» (2009). Official Journal of the European Union. Available at: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:155:0017:0029:EN:PDF
37. Ivanova, N. (2017). Formation of the integral indicator of economic security of the region by taxonomy method. Technology Audit and Production Reserves, 2 (5 (40)), 24–30. doi: https://doi.org/10.15587/2312-8372.2018.129861
38. Kanonicheskiy korrelyatsionniy analiz. Available at: http://statsoft.ru/products/STATISTICA_Advanced/canonical-correlation-analysis.php#%D0%92%D0%B2%D0%B5%D0%B4%D0%B5%D0%BD%D0%B8%D0%B5
39. Regional statistics. State Statistics Service of Ukraine. Available at: http://www.ukrstat.gov.ua/druk/publicat/kat_u/publ2_u.htm
40. Borovikov, V. P. (2003). Statistica. Iskusstvo analiza dannyh na komp'yutere. Sankt-Peterburg: Piter, 688.
41. Porter, M. E. (2005). Competitive Strategy: Techniques for Analyzing Industries and Competitors. Moscow: «Al'pina Biznes Buks», 454.
42. Konyuhov, Y. (2015). Strategy implementation mechanism sustainable socioeconomic development. Ahrosvit, 17, 64–68. Available at: http://nbuv.gov.ua/UJRN/agrosvit_2015_17_12
43. Stratehiya rozvytku Luhanskoi oblasti na 2021–2027 roky (2020). Sievierodonetsk, 117. Available at: http://loga.gov.ua/sites/default/files/collections/strategiya_lugansk_2027_last.pdf
44. Pro zatverdzhennia Derzhavnoi stratehiyi rehionalnoho rozvytku na 2021-2027 roky. Postanova Kabinetu Ministriv Ukrainy vid 05 serpnia 2020 roku No. 695. Available at: https://zakon.rada.gov.ua/laws/show/695-2020-%D0%BF#Text