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The Role of Statistics in Economic Research

The article reviews the establishment of economic statistics as an economic science rather than an auxiliary mathematical tool for economic research, as it was for a long time. Attention is paid to the applicative nature of statistical methods and indicators, which that allows for generating information necessary for the development of effective management decisions. References to studies of Nobel Prize laureates in Economics are given, which conclusions are based on the results obtained with use of statistical methods and approaches. The tasks of economic research are summed up, which solution requires use of descriptive and analytical statistics. Applications of statistical methods in assessing risks of bank activities are discussed in detail in view of the critical role of the banking system in today's global economy. A large part of the study is devoted to the history of risk management which methods are based on theoretical foundations of statistics; emphasis is made on VaR method used for risk assessment in most countries, but which has not yet commonly applied in Ukraine. Statistical approaches to refine the results of expert assessments of bank risk are proposed. Scheme and formulae for such assessment are given, which use allows for improving the validity of the ratings for both the national banking systems and individual banks.

Key words: *tasks of study, mathematics, applied statistics, statistical methods, risks of bank activities, banking statistics.*

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Роль статистики в економічних дослідженнях

У статті розглянуто місце і роль статистики в економічних дослідженнях. Поданий короткий огляд становлення економічної статистики та проблем, що вирішуються за її допомогою. Більш детально розглянуто застосування статистичних методів в оцінюванні ризику банківської діяльності.

Ключові слова: *завдання дослідження, математика, прикладна статистика, статистичні методи, ризику банківської діяльності, банківська статистика.*

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Роль статистики в экономических исследованиях

В статье рассмотрены место и роль статистики в экономических исследованиях. Представлен краткий обзор становления экономической статистики и решаемых с ее помощью проблем. Более детально рассмотрено применение статистических методов в оценивании риска банковской деятельности.

Ключевые слова: *задание исследования, математика, прикладная статистика, статистические методы, риски банковской деятельности, банковская статистика.*

The development of modern “economics of science” requires high rates of science development. The science of all areas must have in equal extent the above mentioned rates. This requires from the society the understanding of the importance of the development of each of them. But scientists-applicationists

used to divide the sciences into 2 groups – fundamental and applied ones. In the result of such approach:

1) the scientists-fundamentalists usually interpret applied sciences by the direct meaning of the term “applied”; as applications of fundamental sciences, but with their own specific object of research;

2) scientists-applicationists fill their works with propositions of fundamental sciences fearing that otherwise they will not be considered as scientific;

3) practitioners who use conclusions and recommendations of applied sciences for problem solution, because of the conglomeration of fundamental terminology can't find the propositions of applied sciences proper, and that is why they take the position of the scientists-fundamentalists (see [1, p. 1]).

And as a consequence:

1) the scientists doing applied research face the problems of financing their research when the received results don't have enough references on the fundamental sciences, though, as it is known, the suggestions which can be introduced in practice are made only according to the results of applied research;

2) with the development of computers, solutions of applied tasks are often substituted by making some calculations using a lot of mathematical methods and ways, but without explaining practical benefits of the produced results;

3) inability to determine the practical aim of scientific research by the most of scientists-fundamentalists (see [1, p. 216]).

In confirmation of the determined theses it is enough to look through the works of the best known scientists in the fields of the so-called “applied” science – economics. In our times the Nobel prizes laureates are considered to be such scientists. 65 prizes on economics were awarded, but going into details of all their works. A review of biographies of the authors and the form of their scientific publications allow us to make grounded conclusions about the continued “priority of fundamental sciences” (that is, mathematics) while determining the aims and tasks of economics researches.

The first and the main consequence of such approach is that the Nobel authors tend to substitute in their works economic terms and concepts by other ones. Very often these “new” terms are not understood even by their inventors. But the authority of the famous scientists causes the further usage of such inventions which meaning nobody tries to explain. An example of this can be the statement of R. A. K. Frisch, who, when being the chief editor of the “Econometrics” journal, wrote in 1933: “Econometrics is not the same as economic statistics. And it is not the same that is called economic theory, though the large part of this theory has quantitative character. It is not either the synonym of the usage of mathematics in economics. The experience shows, that each of these 3 points of view – the point of view of statistics, economic theory and mathematics – is the necessary condition for the

right understanding of quantitative relations in the modern economic life, but taken each in isolation is not enough. Only the unification of these 3 points of view can form the strong method of research” [2].

Such long citation is given here in order to show that it is possible to speak much and long, but say nothing if it is nothing to say. R. A. K. Frisch, who is considered to be the author of the main propositions of econometrics, as we see, couldn't give definition of the science. And T. M. Haavelmo, who is called “the father of the modern econometrics”, couldn't do it either. He only could write that in his research he used the approach which he called “the main law of econometrics: the economic theory can be considered viable only after being checked by mathematical and statistical methods”. He also writes about “statistical analysis of econometric models”, and that he developed “the statistical theory for analyzing dynamic model”.

As we can see, the above mentioned authors as many other Nobel laureates on economics, couldn't give the accurate definition and explanation of the aims, methods and results of their researches. In many cases they used different notions for describing the same events and phenomena. For example, for analyzing the economic processes they suggested to use methods of analysis as mathematical one, statistical one, economic-mathematical one, quantitative economic one, econometric one, and to build on their basis the models with the same name, without explaining the difference between them [3].

The reason of this terminological mess of such famous scientists is quite simple: the most of Nobel laureates in economics were mathematicians by university education and their first scientific interests! But among the laureates on physics and chemistry there were no economists!

Nobody doubts the compliance of works of the Nobel laureates on economics with the highest scientific demands. But their form is the main argument of the continued antagonism between the fundamentalists and applicationists: if there are few formulas then this research can't be considered as scientific. It is important to say that the same laureates paid attention to the change of role of the science and its results in the modern society. J. Stigler avoided using mathematics in his works, giving preference to simple literary style. That's why he gained general acceptance for accuracy and elegance of exposition and erudition. But he was an economist by education [4].

Where did the excessive mathematisation of economic and statistical research lead and continue to lead today? To the necessity double work, as it used and continues to be with the Noble laureates: the first – scientific (that is, mathematical) formatting of the results, and then – explaining the kernel of the problem (the role and the significance for practice) and showing the stages of the realization of these results to the practitioners at all levels.

Everything abovementioned concerns statistics, especially economic statistics. And the main reason why most of practitioners interpret statistics not as a science but as a method of analysis is in creating new “sciences” by way of extracting some elements from statistics.

First of all, the formulas were taken from statistics and the methods which can be used for constructing these formulas. They were called “mathematical statistics”. Having found out that interpretation of the results of the calculation has probabilistic character, the methods of the probability theory were added and the new “science” was called “the probability theory and mathematical statistics” [5].

The statisticians were upset, and in order not to loose the integral part of their science, they, in turn, sorted out for separate consideration and study of “the theory of statistics”. The further, the more: “the theory of statistics” was divided into “descriptive” and “analytical”. And, considering that economic phenomena and processes can be viewed both as functional and stochastic ones, “economic analysis” and “econometrics” was invented. But it was not the end: there appeared economic, demographic, social, sectoral, international statistics etc. Plus “simulation and forecasting”, also separated from “Statistics”.

As a result, “Economics” considers sectoral statistics as not a science but, rather, as mathematical methods for carrying out its economic calculations. In economic universities, instead of “Statistics” in broader scientific sense, the subject called “mathematical economics” is taught, although all the propositions of this subject are built on the usage of statistical indices and statistical methods.

Oversaturation of economic publications with mathematics was inherited by XXI century from XIX and XX centuries. In the previous times, universalism of knowledge, apart from science, was welcome everywhere. In XXI century, there is no necessity in this, as the specialization gives better effect than attempts to know everything and learn everything. For making efficient decisions, a manager (in all businesses, territories, economic activities or even countries), needs not only the calculation skills, but the skills to define tasks for those who can analyze, simulate and forecast. But if these three “sciences” both in universities and in scientific publications suggest considering the economic process from their own point of view, then it is very difficult for them to be favorably received by the practitioners [6].

It is impossible to change the situation of splitting statistics into parts, which has existed over the latest 80 years. But it can and must be changed, or otherwise the term “statistics” will go out of practitioners’ use in a future, and transferred from the category of “applied sciences” to the category of “fundamental sciences”. But “statistics” was once created as exclusively “applied science”.

We believe that the status of the basic science underpinning efficient management in the economy can be secured for statistics (and statisticians) as soon as statisticians build their research upon two basics for each science concepts – the aim and the tasks.

A single science which “branched off” the statistics never lays claim to the object to be researched. And the necessity of using just statistics while researching those “mass phenomena and processes” which system is presented by the modern economics of micro-, mezzo- and macro-level doesn’t demand special proof. Changes, as compared with the previous by generally accepted, demand to apprehend the aims of research of these phenomena and processes with help of statistics. Simply speaking, “What is the benefit from using statistics in management?” “The benefit”, in other words “the ultimate result” to which operation of an economic entity is directed, is increase of profit, gained by way of enhancing the efficiency of the operation. That means that the main task of the manager in an economic entity is to ensure attaining the indicated aim [7].

For that it is necessary:

- to estimate the results of the work in the past;
- to compare the influence of factors which caused the result;
- taking into account the investments, which the entity can use, to determine the strength of these factors in future;
- using the forecasted strength of the factors, to calculate the forecasted profit;
- to make this calculation in two versions – pessimistic and optimistic ones;
- all the estimations and calculations should be done by the persons assigned with responsibility for implementation of each solution.

It is impossible to make well-grounded decisions on each question without using statistics, which will:

- collect necessary data,
- prepare them for analysis,
- carry out the analysis,
- allow to draw conclusions about what happened in the past,
- make information base for building and correcting the models of the entity’s operation,
- make forecasting calculation.

Considering the aims and the tasks of the statistics users – managers of economic entities – the business aim and tasks of statistics should be defined:

- 1) the aim – constant up-date of the information base which ensures making efficient managerial decisions;
- 2) the tasks – giving answers for the questions:
 - “What happened to the entity?”
 - “Why has it happened?”
 - “What is the extent of participation of certain employees of the entity in what has happened?”

- “To what extent will financial resources be needed for changing the strength of factors?”

- “What change in the profit can be expected?”

The aim and the solution of the abovementioned tasks can be achieved by carrying out the well-known stages of statistic research – statistic observation, data processing and analysis, formulating the results, simulating and forecasting the process and phenomena. That’s why when applied economic terminology is used in statistical publications along with the statistics terminology, most of the users – managers and analysts – will easily understand the advantages of the integrated use of one science “Statistics” instead of dozens of its ramifications. These advantages will become apparent while formulating the tasks which solutions require special statistic calculations which results ensure making efficient managerial decisions [8, p. 293].

The complexity of bank system – multiplicity and diversity of bank institutions, and the functions which they perform – cause the occurrence of large information flow. The users of this information are bank institutions themselves, their customers and partners in the country and abroad, namely, the global financial and economic system.

The need in information is caused by the implicitness of risks in bank activities and the willingness of participants of the bank services market to lessen these risks for themselves. A lot of scientists and practitioners dedicated thousands of works to estimating risks including ones in bank activities. In all these works statistical methods are used. But as it is impossible to describe the bank institution, bank operation and the customers of the bank using only 1 or 2 indices, the proposed by the majority of the author’s methods of estimation of the risks are cumbersome and unreliable.

The results of the calculation of the ability of a bank to run across the risk are the determining of the limits as in whole for the portfolio so according to every position separately and the calculations of risk chances are the premium for risk.

In the global banking practice the calculation of risks is made from the two positions:

- 1) calculation of the bank’s ability to run across the risk without breaking its financial stableness and reliability;

- 2) calculation of the risk chances, which allows to have information on the expected income of the bank with accounting for the conditions of taking the risks.

The wave of bank failures in 90s of XX century caused the objective need for strengthening control over bank risks by bank supervision bodies. As the main tool of such control, Basel Committee for Bank Supervision in 1995 recommended the central banks of the world to use VaR methodology for calculating

the reserves necessary for covering the possible losses resulting from risk occurrence.

VaR methodology have diverse applications. It is used as a tool for:

- internal monitoring of risks within the bank;
- supervision by the central bank of the capital adequacy, necessary to cover risks (outward monitoring);

- making decisions on the expediency of hedging risk operations (the comparison is made by use of VaR before and after carrying out the hedge. If the difference between VaR before and after the hedge is not considerable, then the expediency of hedging is doubtful);

- determining the limits for bank dealers and control over observance of these limits;

- estimating different bank projects;

- determining the efficiency of the ways of using the bank capital with account for the risks;

- estimating the efficiency of bank activities on the whole and its divisions;

- motivating bank dealers, as their reward is conditional on the size of the income from bank transactions carried by them for one unit of VaR.

In comparison with other methods of risk calculation, VaR methodology has some advantages:

- wide range of applications, that means that it is possible to calculate risks for different markets including those for which the high changeability is the characteristic of them, namely the markets of CIS.

- universality meaning that the risk is calculated not only for one position, but in whole for the bank portfolio;

- simplicity of the methods that are based on VaR methodology.

- convenience of giving information. With the help of one number that has money expression it is possible to estimate the risk quantitatively in form of the maximum possible potential losses of the bank capital.

- consideration for volatility of securities of the market, the value of risk position and the period of its supporting.

Apart from the advantages VaR methodology has some disadvantages:

- it doesn’t secure the accuracy of the obtained result, that leads to the insufficiently correct estimation of the bank risks, as the calculations of VaR are based on the use of the law about the normal distribution of random variables. But in practice it is not always observed.

- it doesn’t give information on the exact size of bank losses related with the occurrence of risk;

- it involves rather big financial expenses, as it requires from the staff rather high level of qualification and computerization of calculation procedures in a bank.

As it is known, for calculating VaR, three main components need to be taken into account:

- 1) content and size of the bank portfolio (risk position);
- 2) time period for which it is calculated;
- 3) the function of the distribution of the parameters of risk (in case when VaR portfolio is determined – distribution of its current income)

The researches of the calculation procedures in some banks have revealed a number of problems:

a) calculation of VaR for the investing portfolio of bank is impossible due to lack of market prices for shares of a major part of companies;

b) technical difficulties involved in calculations, as bank portfolio contains more than ten different financial tools, which leads to the necessity to use the big correlation matrix. It is very difficult given partial computerization [9].

At present the Ukrainian banking system is at the formation phase. Lack of knowledge and experience as well as appropriate regulatory requirements from the National Bank of Ukraine are the main reasons why the majority of banks don't practice estimation and calculation of risks.

Our studies of the practice of bank risks calculation in Ukraine prove that in most cases calculations of the bank's capability to run across the risk are made by empiric way, whereas calculations of risk possibilities (chances) are not made at all.

It is caused by the following factors:

- the instable macroeconomic situation in Ukraine; this doesn't allow to create the objective information base for estimating and calculating the risks, forecasting their occurrence and determining the limits of their influence on the bank operation

- poor methodological and information support for calculating bank risks. By availability of methodological support and gained practical experiences in estimation and calculation of the risks, the Ukrainian banks can be divided into three groups:

1. The subsidiary institutions of the leasing foreign banks. It is necessary to stress that although these banks have certain experiences in risk calculation, they are not highlighted in mass media.

2. Big banks, which, however, are at the phase of establishing risk management system with use of modern tools for risk calculation. Of the whole set of advanced methods for risk calculation (historical simulation, method of Monte-Carlo, test simulation, analytical method and so on), only analytical method can sometimes be used.

3. Medium and small banks, which share is about 86% of their total number of banks. The specific feature of his group is lack of methodologies, information and personnel for carrying out risk calculation. It is the reason why quantitative estimation of risks and risk calculation by VaR methodology is not practiced by them.

- underdeveloped information technologies in banks, especially software; this doesn't allow for full computerization of the risk calculation procedure. This is a major barrier for use of advanced approach to risk calculation in Ukraine. The main reason for such situation, from our point of view, is very high cost of software for risk calculation compared with the profit rate of Ukrainian banks, and also insufficient economic advantage from introduction of calculation procedures compared with the cost for their elaboration [10].

The multiregression analysis in some cases allows for determining the influence of factors on the generalized estimation of risk. It offer participants of the bank services market the possibility to compare the risk and the profitableness of certain bank transactions, and to make well-grounded choice in favor of a concrete bank institution, to fix the grounded cost of the certain bank operation, to define the priority in making the decision concerning bank branch and so on.

That's why comparative analysis for estimation of the risks of bank activities or participants of the bank services market, and for choosing the ways of their lessening was widely spread. For modern banking the need in such comparisons is great for the following purposes:

- choice of investment object by investor;
- fixing individual credit rates by the bank;
- choice of cooperation bank by client;
- estimation of financial conditions in bank divisions, etc.

Comparison is made simultaneously by several indices. The main problem is to make up the list of appropriate indices for comparison purpose, but it is not dealt with in this article.

Once the list of the required indices is made, then the problem will be to determine the rank for certain elements of the totality by these indices. The difficulty is that more often the indices don't allow for drawing a simple conclusion: the values of some indices require inclusion of the element in the "best" group, while the values of others – in the "worst" group.

The common solution in this case can be to calculate multidimensional mean. The methods and peculiarities of its calculation are considered in many scientific publications. But one of the most important questions related with the grounds of the accuracy of the conclusions received by this way hasn't been described so far in the applied statistical research. It must be stressed that it cannot be found in applied research, because the theory of statistics contains the description of the answer to this question. The gap between theory and practice in this case shows, once and again, the distrust of economists-analysts to statistics and their inability (and very often unwillingness) to operate with accurate data [11].

In this article we consider the kernel of the problem of improving the accuracy of comparative analysis and its solution. The banker will say that the choice of the best (worst) branch must be made according to the profitableness of the assets, which is common. But he must also take into consideration other indices, the meaning of which form profitableness of the assets [10]. For example: profit per employee; profit rate on loans; number of clients per employee; proportion of interest-bearing income in the total sum.

For calculating multidimensional mean, the following formula will be used:

$$\bar{P}_i = \frac{\sum p_{ik} \cdot d_k}{k},$$

where p_{ik} – standardized values of original indices; d_k – the weights (the level of influence) of these indices; k – number of indices.

The accuracy of the result is defined first of all by the substantiation of the weights used while calculating \bar{P}_i . In practice, the expert opinion for this is commonly used. Insufficient accuracy in determining the weights by expert estimation method is caused by the following:

- 1) the concepts “opinion” and “expert” are not statistical, as there are no generally accepted definition of these concepts;
- 2) expert can determine the difference between the weights only in form of conditional “unity”, which has not got economic interpretation;
- 3) if conditions in which the event takes place change the new expert estimation is required.

At the same time, the theory of statistics offers a method, very simple and easily realised by computer, for proper measurement of the contribution of the share of every factor in the variation of the result. As it is known, the coefficient of multiple determination can be derived by the following formula:

$$R_{y.12}^2 = \frac{\sum (Y_i - \bar{y})^2}{\sum (y_i - \bar{y})^2}, \quad (1)$$

where Y_i – theoretical meanings of the indices derived from the equation of regression.

It is also known, that while learning the correlation, for example, between three variables:

$$Y_i - \bar{y} = b_1(x_1 - \bar{x}_1) + b_2(x_2 - \bar{x}_2), \quad (2)$$

where b_k – the coefficients of regression.

Taking into account the formulas for calculation of the variances s_1^2 and s_2^2 , and also s_{12} and by substituting (2) by (1), we will have:

$$R_{y.12}^2 = \frac{b_1^2 s_1^2 + 2b_1 b_2 s_{12} + b_2^2 s_2^2}{s_y^2}. \quad (3)$$

If the equation of regression is built not according to the original data but according to the standardized ones:

$$y' = \frac{y - \bar{y}}{S_y}, \quad x'_k = \frac{x_k - \bar{x}_k}{S_k},$$

where S_y and S_k – standardized deviations, then in such equation the regression coefficient b'_k will correlate with b_k in the following way:

$$b'_k = b_k \frac{S_k}{S_y}. \quad (4)$$

Then

$$R_{y.12}^2 = (b'_1)^2 + (b'_2)^2 + 2b'_1 b'_2 r_{12}, \quad (5)$$

from this

$$R_{y.12}^2 = r_{y1} b'_1 + r_{y2} b'_2 \quad (6)$$

and summarizing:

$$R_{y.12}^2 = r_{y1} b'_1 + r_{y2} b'_2 + \dots + r_{yk} b'_k, \quad (7)$$

where r_{yk} – bivariate correlation coefficient.

The meaning of (7) is the following: $R_{y.12\dots k}^2$ measures the influence of all x_k ; r_{yk} measures the influence of x_k on y including indirect influence of other variables, if these other variables influence x_k ; b'_k measures in standardized deviations of y' the “clean” influence of x_k on y .

So, by multiplying r_{yk} by b'_k influence of x_k on y is corrected (“is cleaned” from indirect influence of other factors). It means that $r_{yk} b'_k$ became similar to the partial coefficient of determination, but it has the advantages: it is much easier to calculate; it is always positive; it has the property of additivity.

The latter quality allows to use (7) for determining weights in calculation of :

$$d_k = \frac{r_{yk} b'_k}{R_{y.12\dots k}^2}.$$

By correlation and regression analysis the degree of estimation of the results of the activities of branches using each index separately was defined; by multidimensional mean their influence was taken into account in one multidimensional index; ranking of branches, made with the help allowed of correlation and regression analysis to give the objective comparative estimation of the risks of the activities of the branches and expose those, which in the first turn require the interference of bank top authorities for not allowing the worsening of the situation in the bank in whole.

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