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## PROCEDURE OF FORMALIZATION OF THE INDICES OF BANKS' STABLE FUNCTIONING IN COMPARATIVE ESTIMATES OF THEIR DEVELOPMENT

Alexander Kuzemin, Vyacheslav Lyashenko

*Abstract: The advisability of analyzing the banks liquidity and profitability as the key factor when building the comparative estimate of their functioning is considered. The procedure of formal description of the bank stable functioning indices is substantiated. Fuzzy interpretation of the bank management efficiency estimation is offered. The possibility to formalize the bank functioning estimates on the basis of the corresponding fuzzy set levels hierarchy is analyzed. The comparative estimate of different bank systems functioning is given.*

*Keywords: bank system, liquidity profitability, fuzzy numbers, ownership function management.*

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### Introduction

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Analysis of the financial flows of both a banking system as a whole, and separate banks specifically, is one of the key components for building of the adequate economical security system for any subject of management acting in the market economy. The reason is that it is precisely due to banks and their activity that movement and redistribution of cash and financial resources are realized. Because of this, a consideration of the problems of functioning and development of the banking system are constantly the focus of attention. This fact makes the given direction the currently central one.

The comparison estimate of different banking systems deserves particular attention. On the whole, this is favorable not only to revealing acceptable approaches to solution of different problems but the possibility of the forestalling estimates in the decision-making referring to the corresponding development of the banking system. At the same time, actually emerging difficulties in different stages of development or transformation of social-economic systems, first and foremost, call for an appropriate support of the banks stable activity basic condition which, in the general case, is expressed through establishment of the acceptable relation of liquidity and profitability. In other words, liquidity and profitability should be considered as the main components of the unified system for estimation of the financial stability and reliability of the whole bank management system. Thus, an adequate description of the liquidity and profitability interrelation is one of the key sub-problems demanding a solution.

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### Substantiation of the Object of the Research

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The foundation for the chosen direction of researches is based as a rule on the statistical derivations or models, whose origin being in the approaches of the theory of games. But in both cases the mathematical basis of researches forms generally the probabilistic methods of data analysis. The works of E. Berglof, G. Roland, G.J. Mailath, L.J. Mester, T. Hellmann, K. C. Murdock, J.E. Stiglitz [1, 2, 3] can exemplify such a consideration of the bank activity. Nevertheless, the main problem emerging when building an adequate system of an economic

process or an object management is associated with that the economic development laws assume the presence of such interaction between different subjects of the market as well as control of the action on this interaction of different environment manifestations not having definite statistical nature in the classical sense. Therefore construction of the system for some economic process or object management requires a particular formalization taking into account not only the available statistical uncertainty but the subjective probability objectively present when making economic decisions. Solution of the given problem, in a way, is obtained through introduction of the considered bank activity indices into examination of different aspects of the information saturation. It is precisely this direction which has been chosen as the main one in the work of M. Malyutina and S. Parilova [4]. Nevertheless, the given direction contributes to solution of the set problem not in full measure as a new problem emerges which is associated with the necessity to consider ranging of different manifestations of one or other banking activity indices information saturation. Hence, the use of fuzzy sets theory approaches making it possible to describe the emerging subjective probabilities in the study of economical processes as a whole and banking activity in particular is a natural one. At the same time despite a considerable body of work in the indicated subject field of investigation [5, 6, 7, 8] the question is still open concerning the choice of the procedures relating to construction and substantiation of the type of belonging functions of fuzzy variables which are used henceforward in the appropriate models. The main reason for the given question openness is associated, first of all, with multivectorial nature of directions of the fuzzy sets theory methods use. The majority of these methods are still in the initial stage of their development. On this basis formalization of the stages of the economical parameters interrelation fuzzy description procedure characterizing parameters of the banking activity liquidity and profitability is considered as one of the goals of the given investigation. The validity of the given investigation goal choice is also associated with that in the general case the schemes and diagrams uniting the data for financial-economical activity indices of any economy subject contain a discrepant information. Therefore, the additional processing of such data should be, first of all, directed to the transformation of the financial data into information which will be useful in the process of decision-making, revealing and interpretation of the hidden tendencies.

When facing such a problem as efficiency of different economical systems comparative estimate analysis, the following should be set off:

- relative generalization of the corresponding macro indices dynamics based on the descriptive statistical data [9, 10] ,
- construction of cluster models making it possible to range the degree of development of the systems being compared. Investigations carried out by A.M. Karmisky, A.A. Peresetsky, S.V. Golovan, A.V. Kopylov [11, 12], V. Snityuk [13] can exemplify this approach.

Nevertheless, the use of the above approaches, first of all, assumes in any case the choice of the definite indices used in further comparative analysis. In this case it is necessary to define meaningful facts, to perform their ranging and only then carry out the comparative analysis, this is rather complicated problem by itself. Thus, in our opinion, it is expedient to use somewhat different approach as a preliminary analysis based on the comparative estimate of a definite index defined in terms of the fuzzy sets theory. Such an interpretation makes it possible not only to eliminate the procedure of the agreed data ranging but to perform a corresponding comparative analysis which can complete classical approaches significantly.

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### **Classical Interpretation of the Estimate of the Bank Management Efficient with Respect to Interaction of its Liquidity and Profitability**

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In the commonly accepted sense the interrelation between the bank liquidity and profitability can be expressed as an inverse relationship. This fact has a very simple economical explanation. So, with an increase in the degree of the banks assets liquidity the possibility of obtaining higher profits from such assets decreases and, vice versa, less liquid assets of the bank are capable a priori of brining higher profits. Classical example of such a manifestation of liquidity and profitability in the banking activity interconnection shows that more risky credit operations can bring higher profits.

Yet, the liquidity parameters are controlled externally as a whole (from the concrete bank standpoint) and are appointed generally according to the banking system. In this case the bank profitability in many instances is associated with conducting of active-passive bank operations and in general can be characterized with a spread between its credit and deposit rates. On the one hand, the given rates in turn are governed by the classical law of

supply and demand conformity and, on the other hand, they are subject to the concurrent effect on the side of other banks.

Thus, when considering the probabilistic interpretation of banking activity management starting from a definite liquidity level one should take into account the fact that the bank tends to support the liquid assets volume at the level sufficient to ensure meeting previously taken commitments. At the same time the bank defines the probability of the need for loan resources to meet its commitments [14].

In other words, the essences of the bank management efficiency estimate in terms of its liquidity and profitability parameters can be interpreted as a probability of finding in some specified region defined with the corresponding indices of the considered parameters (Fig. 1a).

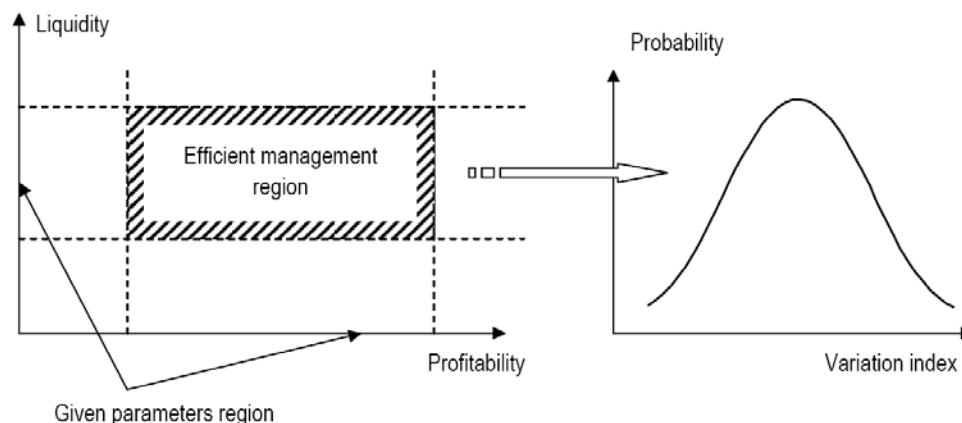


Fig.1. Essence of the bank management efficiency estimate

In this case when specifying different values for variation of the admissible liquidity and profitability values intended parameters it is possible to obtain the curve (Fig. 1b) which characterizes the bank management efficiency in terms of the possible variations of the parameters being analyzed.

At the same time the interpretation of the banking system development based on the liquidity analysis can be considered as a probability for a random two-dimensional value to penetrate into some specified field where acceptable and admissible liquidity and profitability levels parameters manifest themselves as boundaries of such a field. Just this model is applied for further analysis of different banking systems.

### Fuzzy Formalization of the Bank Management Efficiency in Terms of its Liquidity and Profitability Interrelation

At the same time the classical interpretation of the bank management efficiency can be considered in terms of the fuzzy sets theory. The given approach becomes possible through introduction into consideration of the ownership function of some set of the bank liquidity and profitability indices corresponding to a subset of efficient managing actions of the given indices.

Then the fuzzy interpretation of the bank management efficiency in the specified phase space is limited to building and estimation of the corresponding ownership functions characterizing the degree of reaching the bank efficient management in the specified variation intervals of the banking activity being analyzed. In this case it is expedient to choose a fuzzy interpretation of the intended parameters variations in the limits of the admissible values of liquidity and profitability indices presented in the probabilistic model by the corresponding probabilistic curve as a formal description of such functions (Fig. 1b). The advisability of such a transition is motivated by that the fuzzy formalization of the corresponding probabilistic curve is possible on the basis of the concept of the fuzzy number of L-R type [15] which in the given case can be regarded as a trapezoidal fuzzy number (Fig. 2a).

Such an interpretation of the ownership function makes it possible not only to describe the processes under investigation formally but to take into account existing economical aspects in their development. Hence, in the given case the edges of trapezoidal representation of the ownership function for estimation of the banking activity efficiency characterize the liquidity and profitability management in terms of their boundary values. At the same time the upper base of the trapezoidal representation of the ownership function can be regarded in terms of such liquidity and profitability values which are in the center of the efficient management field (Fig. 2b).

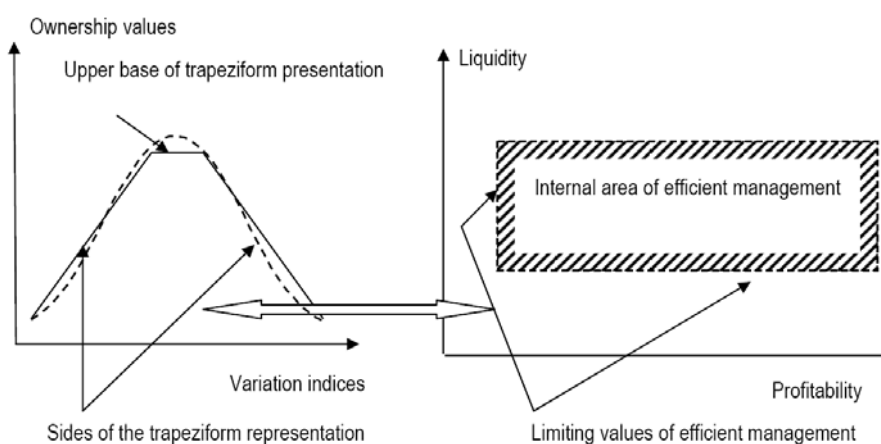


Fig.2. Interrelation between the trapeziform representation of the membership function of the bank activity and bank efficient management area indices

### Levels of Bank Efficient Management Fuzzy Representation

The given approach was approved on the analysis of the real data of the banking activity liquidity and profitability indices interrelation for the banking system of Ukraine as a whole during 2003-2005. Due to such analysis different ownership functions characterizing the banking activity efficiency with regard to variations of the liquidity acceptable values for different intervals of the spread between the credit and deposit rates were built (Fig. 3, in this case the current liquidity values were analyzed).

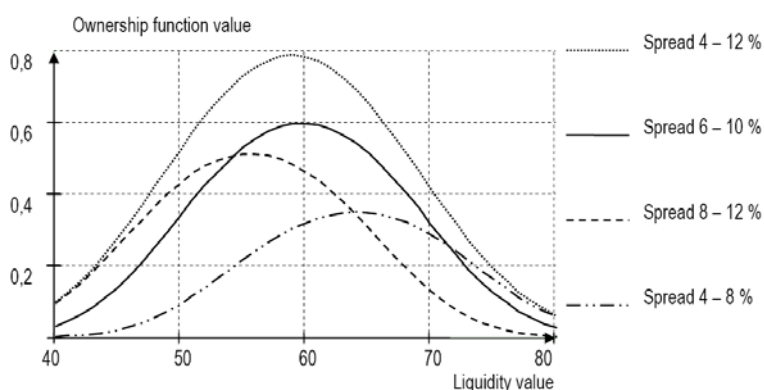


Fig.3. Ownership functions characterizing the degree of reaching the banking system efficient management on the specified intervals of the banking activity indices variations being analyzed

As may be seen from Fig. 3, the offered representation of the bank stable functioning indices formalization makes it possible to analyze informally different combinations of the considered parameters and substantiate the most acceptable ones. In the given case the spread variation between the credit and deposit rates within 4-12% and sufficient level of the current liquidity within 55-65% may be considered the most acceptable in terms of efficient functioning of the banking system of Ukraine as a whole.

At the same time the considered example led to the idea of the necessity to treat different functional representations characterizing the degree of attainment of the bank efficient management for definite values of one of the investigated parameters depending on the interval of variation of the other one. Solution of such a problem is possible on the basis of introduction of the efficient management field fuzzy set levels into consideration. In the given example it is possible to consider functional dependences of the ownership functions of the liquidity values for definite intervals of the spread variation as such levels. Then the bank management efficiency estimate can be defined on the basis of consideration of different conditions of the corresponding level subsets generalization. In this case the essential aspect of such process formalization is defined by the bank

functioning concrete conditions at different temporal stages of its activity; this can be presented as separate operations on fuzzy sets and fuzzy numbers.

### Comparative Estimate of the Ukrainian and Russian Banking Systems Functioning

The corresponding similar periods' indices of Ukrainian and Russian banking systems are considered as an example of the use of the banking systems comparison probabilistic estimate based on the account of the liquidity and profitability levels interrelation. In this case the corresponding characteristics of the investigated parameters were analyzed in the assumption of the hypothesis for the presented data normal distribution. So, in the first case the probability of the optimal feasible level of the banking system profitability depending on the possible current liquidity level variation interval (Fig. 4) was considered where the value of spread between the credit and deposit rates act as the profitability. In other words, in the given case the establishment of an acceptable relation between the level of different interest rates is important, which also can be an indicator of the banking system stable development.

As can be seen from Fig. 4, the Russian banking system demonstrates the most stable state of development in terms of the possible admissible current liquidity interval. This is evident both from great values of the corresponding probability, and lesser value of spread between different interest rates level. In this case the fact is taken into account that the profitability over the banking system as a whole is defined not only by the maximum value of the interest rate spread, but the possibility to get more accessible resources and, respectively, the turnover of the value of resources passing through the banking system.

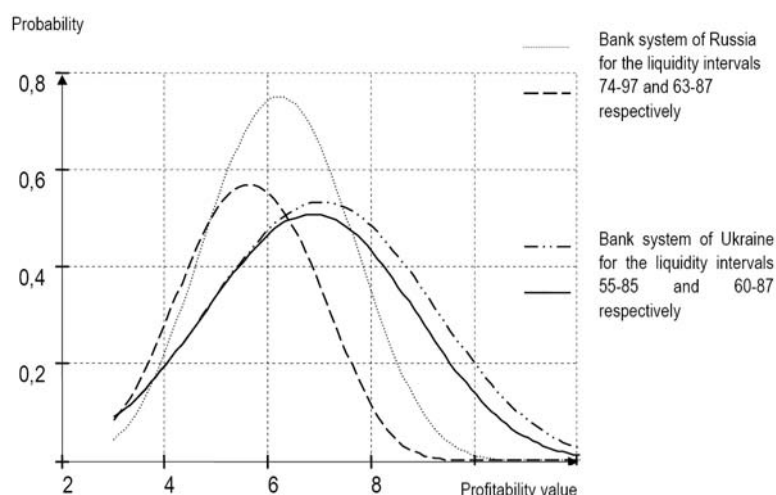


Fig. 4. Probabilistic estimate of profitability of the analyzed banking systems for different possible admissible current liquidity intervals

In the second case, Fig. 5, the probability of advisability to increase the spread between deposit and credit rates taking into account possible admissible variations of the current liquidity intervals is shown.

As can be seen from Fig. 5, the corresponding borderline values of spreads for different banking systems correlate with the data from Fig.4. At the same time the probabilistic estimate of the advisability to increase the spread for the banking system of Ukraine in some instances is greater than for the banking system of Russia. This fact can be interpreted as a great tendency of the banking system of Ukraine to the increase in spread between the credit and deposit rates. In other words, in the given aspect one can speak about less stable development of the banking system which is associated either with the risk of formation or distribution of the corresponding banking activity resource base.

At the same time, the consideration of the probabilistic and fuzzy model of interpretation of such indices of the banks functioning as liquidity and profitability leaves room for some generalization. First of all, this concerns the advisability of considering different probabilistic comparative estimates as levels of some fuzzy set. This is associated with the fact that the estimate of the banking systems functioning is more precise when considering the liquidity and profitability different levels as a single whole, their indices can be modified in the course of time under the action of internal and external factors of such economical systems development.

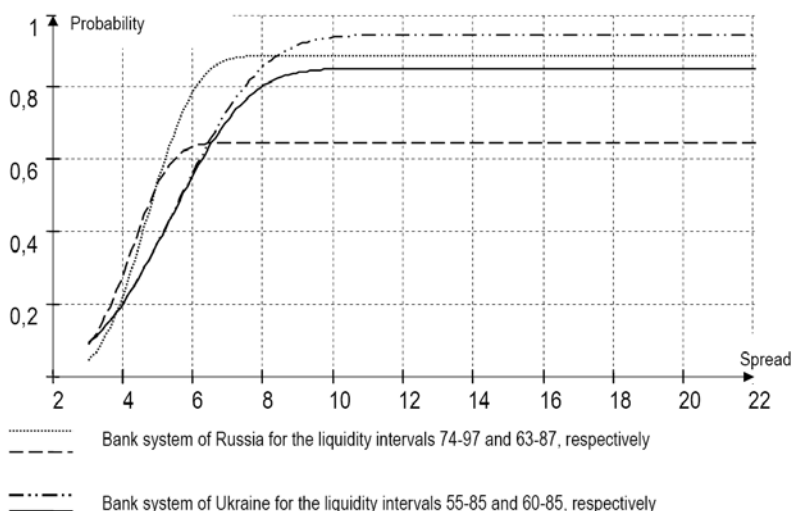


Fig. 5. Probabilistic estimate of the advisability to increase the spread between deposit and credit rates taking into account possible admissible variations of the current liquidity intervals

## Conclusion

Thus, the procedure of transition from the probabilistic interpretation of the bank efficient management to its fuzzy model is considered in this work. At the same time the essence characteristics of the problem under consideration is obeyed. This makes it possible to perform the bank management efficiency analysis taking into account possible variation of its different parameters defining the bank functioning stability. At the same time the probabilistic approach of the comparative estimate of the banking system functioning makes it possible to analyze a relative functioning of different banking systems, to reveal definite features of their development, this is rather significant in terms of building an adequate system of economical safety.

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## AN ALGORITHM FOR FRESNEL DIFFRACTION COMPUTING BASED ON FRACTIONAL FOURIER TRANSFORM

Georgi Stoilov

**Abstract:** The fractional Fourier transform (FrFT) is used for the solution of the diffraction integral in optics. A scanning approach is proposed for finding the optimal FrFT order. In this way, the process of diffraction computing is speeded up. The basic algorithm and the intermediate results at each stage are demonstrated.

**Key words:** Fresnel diffraction, fractional Fourier-transform

**ACM Classification Keywords:** G.1.2 Fast Fourier transforms (FFT)

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### Introduction

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The analysis of a great number of optical systems and devices requires diffraction computing under various conditions. This task can be solved through the implementation of modern methods of optical and digital image processing. Precise computing of the diffraction pattern obtained by illuminating complex transmitting objects or reflecting surfaces is a problem requiring huge computing resources. Thus, the necessity becomes obvious of introducing fast computing algorithms and of reducing the computational volume by simplifying the solution of the wave equation [1]

$$\nabla^2 v - \frac{1}{c^2} \frac{\partial^2 v}{\partial t^2} = -s, \quad (1)$$

where  $c$  – speed of light,  $v$  – a scalar quantity, describing the wave in an arbitrary point in space,  $s(x,y,z,t)$  – a known function of the irradiating surface.

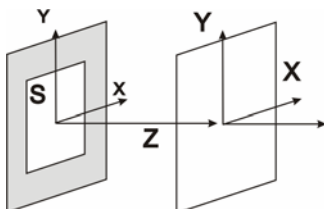


Fig.1. Irradiating and recording surface

In some cases the irradiating and the recording surface (Fig.1) can be presented as parallel planes. Most of the used approximations are based on the solution of Eq.(1) using Kirchoff's integral [2]: