RISK MANAGEMENT IN BANKS: NEW APPROACHES TO RISK ASSESSMENT AND INFORMATION SUPPORT

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Abstract. *This study is devoted to the problems of improving the banking risk management, taking into account the new regulatory and technological requirements based on the use of modern technology and combining the latest achievements in artificial intelligence, numerical mathematics, statistics and information technology.*

The paper analyzes the characteristics of banking risks, the main methods of assessment used in practice. The authors propose new prospective approaches to assessment, based on the most modern methods of data analysis, identify prospective directions for banking information system improvement and suggest the possibility of their implementation.

The example of Ukrainian banks shows the main problems of using new approaches to risk assessment and its information support. The article proposes the ways to overcome them.

Key words: *banking risk management, artificial intelligence, banking risks estimation, data analysis*

Introduction

Since a few years ago there was a financial crisis, the Basel Committee on Banking Supervision is developing new international regulations designed to minimize the possibility of the next large-scale financial crisis. The latest Committee "frame" (Basel III) includes strict capital rules which will force all banks to increase more than three times the capital amount in order to avoid the future rescue by taxpayers. It does not require significant capital growth: according to the Basel Committee studies, 100 largest banks worldwide need only about € 370 billion of additional reserves to meet the new rules in 2019 (Moshinsky, 2012). The main purpose of the Basel III is to improve the quality of risk management in the banking business, which in turn should enhance financial system stability as a whole.

In Ukraine, as well as around the world, the task of risk management is no longer considered separately from the problems of capital management and profitability. The

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rapid business development on the background of growing competition requires a more careful operation profitability assessment and customer service quality improvement. This resulted in the fact that, together with increasing business demands, new technological requirements reached a fundamentally new level: an integrated accounting operation profitability support with regard to risk; risk management specific features for bank departments; the rate of return and risk for individual agreement analytical accounting; the availability of a specialized payment for users from bank departments; increased data quality requirements.

All these problems occur on the background of the tendencies of international standards' implementation in financial accounting and risk management, which make a fundamentally new emphasis on management. Obviously, it is impossible to solve the new problems by using accounting schemes common for many banks.

Global financial institutions and international organizations, including the World Bank, the Bank for International Settlements, the Basel Committee on Banking Supervision, are paying more attention to resolving the issues of financial risk management and control. For example, the Core Principles for Effective Banking Supervision, developed by the Basel Committee, emphasize the need for the banks information systems that allow to accurately measure, monitor and adequately control the financial risks (Basel, 2011).

For years, the IT departments of Ukrainian banks had been solving the task of getting basic management reporting and data consolidation from various weakly interconnected operational automated banking systems (ABS). Increasing needs of business units led to the use of banking information systems for solving analytical problems, which require new methodological approaches. These tasks involve customer analytics implementation (client database segmentation, probability of loan repayment calculation, customer life cycle definition and profitability, etc.), transfer prices calculation, risk indicators calculation: expected and unexpected loss, instrument sensitivity to a change in the risk factors, and others.

It is important that these problems are correlated with regulatory requirements of capital adequacy calculation (according to the recommendations of the Basel Committee on Banking Supervision – Basel II and Basel III) and financial instruments' measurement according to the IFRS standards (based on market or model data). The implementation of considerable computing task requirements was nominated as a result of the banking information systems. It goes beyond the functionality of the ABS and is related to strategic management support, profitability management, financial management and consolidation, management accounting and budgeting, risk management.

The main objective of banking risk management is maintaining the acceptable profitability ratios of the safety and liquidity parameters in the management of assets and liabilities (minimize losses). An effective banking risk management must resolve a number of problems – from risk monitoring to its valuation. The risk level is associated

with a particular event and is changing together with the environmental dynamic nature. This makes a bank to specify its place in the market, to estimate the risk of events, to review client relations, and to estimate the quality of assets and liabilities, to adjust the risk management policy.

The process of banking risk management includes the risk forecast, determination of the probability, values and effects, the development and implementation of measures to prevent or minimize related losses.

This includes the development of the banking risk management strategy, the decision making policy allowing a timely and consistent use of all bank possibilities and keeping risk at the acceptable and controlled level.

A lot of scientific researches are devoted to developing the methodological basis of financial risk estimation and information support (Lobanov, Chugunov, 2003). Nevertheless, the latest technology, which combines the achievements of artificial intelligence, numerical mathematics, statistics, has enabled to suggest new promising approaches to risk assessment and information support. This will facilitate the implementation of an integrated approach to finance and risk management.

Risk management is a very important process for any bank. The methodical and informational risk management support significantly differs depending on the degree of bank development. This is so because, firstly, the banking risks – credit, market, operational – differ in their nature and require specific data for their evaluation, and secondly, risk management information support depends on the banking analytical system (Poliakov, 2011).

The main direction of banking risk management improvement is the methodological framework development for risk assessment and banking information systems. This process should take into account the new regulatory and technological requirements regarding the implementation of financial and risk management integrated approach. The study is devoted to these issues.

The task of the study was, first, to analyze the banking risks characteristics, the main methods of their assessment used in practice; to suggest new promising assessment approaches based on the most advanced methods of data analysis and, secondly, to identify the promising directions for improving the banking information systems and to offer the possibilities of their implementation.

Banking risks: features and evaluation methods

Integrated financial management and risk management create conditions for developing the technological base of the new pricing process: profitability is calculated taking into account the credit, market, operational risks (Fig. 1).

Credit risk is defined as the possibility of default by the borrower or counterparty obligations according to their terms (Basel, 2000). For its assessment, the bank must

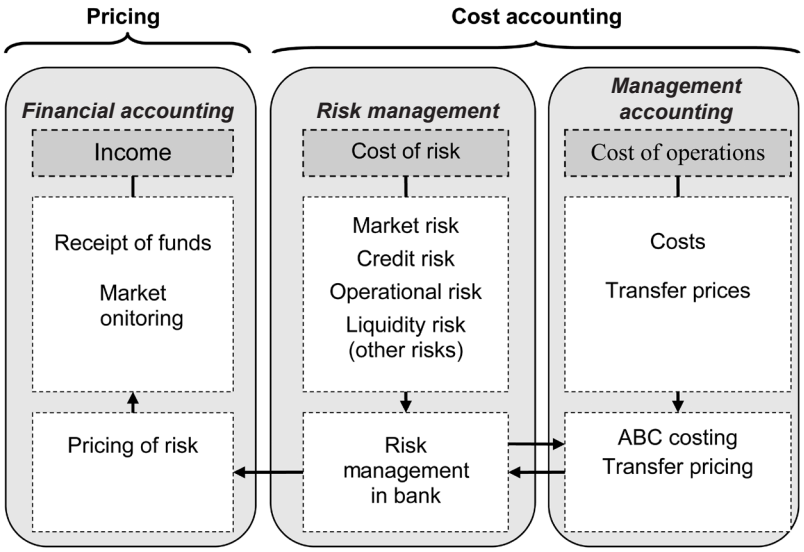

FIG. 1. **Banking risk management location in the calculation of financial instrument return**

Source: SAP, 2011.

have a strong client base over a long period. It can be used in the behavioral models that estimate the probability of the default of the client, based on his credit history and scoring models according to the application (client demographic information, information about his workplace, loan parameters, etc.). Statistical methods and data mining techniques are used to develop scoring models, including logistic and linear regression, decision trees, segmentation using K-means, neural network (Löffler, Prosch, Schöne, 2005). The set of scoring models according to the application, credit bureaus and information (obtained from systems to prevent fraud) can determine which customer segments can be approved automatically and which need further verification by credit analysts. Information about the most popular credit risks assessment models is systematized in Table 1. This table includes a few examples of the most often used methods and models for credit risk evaluation and input data. These are, for example, the Altman Z-Score model (Altman, 2008), Moody's KMV reduced form and the structural models of credit risk (Arora, Bohn, Zhu, 2005), the logistic regression model (Hilbe, 2009), hybrid models.

Market risk is a specific part of the financial risks caused by the emergence of investment and financial activities. Market risk is caused by the influence of the market factors that affect the value of assets, liabilities, and off-balance sheet items.

There are different methodologies for evaluating the losses of financial instruments. Most common is the method of quantifying the market risk value of trading positions (Value at Risk – VaR). The basis for the VaR evaluation is the price tools dynamics for a specified time period in the past. Classical methods of volatility estimation, such as the

parametric method, the Monte Carlo method, historical simulation, are used to assess the potential market risk level (Lobanov, Chugunov, 2003).

The tendency to operational risk is constantly growing with the increase in business and banking, as well as with the globalization of banking services. Operational risk is the risk of loss resulting from inadequate or failing internal processes, personnel actions or systems, or as a result of external factors (Basel, 2006). The concept of operational risk includes legal risk, but excludes strategic risk and the risk of reputation, contains a list of possible causes and problems (inadequate business processes, erroneous staff actions, information systems' failure, theft, fraud, etc.).

TABLE 1. **Models of credit risks evaluation, implemented in practice**

Input data	Evaluation method	Model type	The resulting parameter
Financial performance data	Data evaluation based on linear model	Analytical description model (Altman Z-Score model)	Creditability index – scoring variable
Data on liquid bonds, trades that taking place in the market	Data evaluation based on linear model	Market liabilities value models	Credit risk level
Data on borrower characteristics and macroeconomic factors	Data evaluation based on the Poisson process with the risk degree λ	Reduced form models	Probability of default (usually binary variable: 1 – default has occurred; 0 – default has not occurred)
Data on firm value at determined time	Data evaluation based on firm equity functions	Hybrid models	Probability of default; causes of default
The outstanding debt in the form of bonds (B) with zero coupon, nominal value (F) and maturity (T)	Debt estimation emitted by a firm. The cost of the firm is subordinated to a standard geometric Brownian motion	Market (structural) model (KMV, CUSP, Credit Grades)	Probability of default, the probability that firm value falls below the nominal value (F) of bonds
Annual financial statement data	Regression coefficient determination	Models based on statement data (KMV Portfolio Manager; logistic regression model)	Expected loss

Source: compiled by authors.

To manage the operational risk, it is necessary to understand its sources, causes, and the impact on the bank's activities. This can be achieved only by creating structured incident database over a long period (minimum 3–5 years). However, it is not enough to collect periodic reporting and use organizational methods. There is a need of the professional solution that provides a convenient user interface for incident registration, business processes support for operational risk management, analytics and operational risk level calculation employing complex mathematical methods and models (Table 2).

TABLE 2. **Models of operational risk evaluation, implemented in practice**

Input data	Evaluation method	Model type	The resulting parameter
An adequate amount of representative historical data on incidents	Unknown parameters' estimation from a set of observations	Statistical models (actuarial approaches, simulation-based stochastic differential equations)	Operational loss
Data collected from experts	Determination of expert evaluations, ranks	Expert model (Delphi technique, decision trees, impact diagrams)	Operational loss
Statistical data and expert evaluations	Expert evaluations, ranks, unknown parameters and coefficient estimation	Hybrid model (fuzzy logic, system dynamics simulation)	Operational loss

Source: compiled by authors.

For risk management purposes, we should use a qualitative and quantitative risk analysis. The qualitative risk analysis includes such tools and techniques as risk probability and impact assessment, the probability and impact matrix, risk data quality assessment, risk categorization, risk urgency assessment. On the other hand, quantitative risk analysis includes data gathering and representation techniques (interviewing, probability distribution), quantitative risk analysis and modeling techniques (sensitivity, decision tree). In fact, the resulting parameter for operational risk is operational loss which consists of the probability of a loss event and a loss given by that event. We can classify a loss event to internal loss data (history of system failures, process failures, external events and their impact on various business lines (value of operational loss), the frequency of occurrences) and reports from external rating agencies (list of defaulted clients, credit rating across clients/sectors, credit score for the clients).

There are a theoretical basis for applying actuarial techniques in operational risk modeling (Mango, 2006), stochastic differential equations' numerical simulation algorithm for financial problems (Larneback, 2006), the Delphi technique, decision trees, impact diagrams (Summerhayes, 2010). Nowadays, even the largest Ukrainian banks are small on the international scale. An obstacle to the Basel II (and so far Basel III) implementation for Ukrainian banks is the lack of operational risk management systems. It is also necessary to improve the system of corporate management and internal audit in banks.

The Basel II provides three methods for operational risks estimation: the method of basic indicators (Basic Indicator Approach), a standardized method (Standardized Approach), and an advanced method (Advanced Measurement Approach) (Basel, 2006). In the third method, a bank estimates its operational risks using its own internal models.

For this method, central banks require qualitative data in all areas of operational risk and permit to use the advanced method for regulatory reporting formation. Also, a bank must have a risk management scheme at the professional level and a profound statistical database of incidents.

Design operational risk management models using the Standardized Approach based on annual revenue / budget of each line of business / department; the Basic Indicator Approach based on the annual revenue / budget; the Advanced Measurement Approach (AMA) based on the internally developed risk measurement framework adhering to the prescribed standards (the methods include IMA, LDA, Scenario-based, Scorecard, etc.). The AMA includes developing internal empirical models to estimate the PD (Probability of Default) for individual clients or groups of clients; assistant risk management leadership teams with the design of quantitative models to estimate The PD, the EAD (Exposure at Default), the LGD (Loss Given Default) and other parameters required for calculating the RWA (Risk Weighted Asset), developing the analytical Value at Risk models.

While the AMA does not specify the use of any particular modeling technique, one common approach in the banking industry is the Loss Distribution Approach (LDA). With LDA, a bank first segments operational losses into homogeneous segments, called units of measure (UoMs). For each unit of measure, the bank then constructs a loss distribution that represents its expectation of total losses that can materialize on a one-year horizon. Given that data sufficiency is a major challenge for the industry, the annual loss distribution cannot be built directly using annual loss figures. Instead, a bank will develop a frequency distribution which describes the number of loss events in a given year, and a severity distribution whigh describes the loss amount of a single loss event. The frequency and severity distributions are assumed to be independent. The convolution of these two distributions then gives rise to the (annual) loss distribution.

New promising approaches to banking risks estimation

The modern technology combines the latest advances of artificial intelligence, numerical mathematics, statistics, heuristic approaches. It allows offering new promising approaches to risks estimation. These approaches give positive results even with small amounts of data. Table 3 gives information about the methods of estimating the probability of default (model types – Lobanov, Chugunov, 2003).

The probability of default (PD) is a financial term describing the likelihood of a default over a particular time horizon. It provides an estimate of the likelihood that a client of a financial institution will be unable to meet its debt obligations. The PD is a key parameter used in the calculation of economic capital or regulatory capital in the Basel II for a banking institution.

TABLE 3. **The newest approaches to VaR estimation**

Input data	Evaluation method	Model type
Credit risk		
Default data, public financial reporting data, regulators' reports data	Unknown parameters estimated from a set of observations	Bayesian model
Logarithmic share prices	Evaluation based on the binomial distribution	Structural model with noise (Monte Carlo simulation, Markov chains)
Logarithmic share prices	Regression coefficients estimated by the Gauss and Laplace methods	Statistical models (integrated Laplace approximation)
Market risk		
Data on financial instrument rate of return with covariance matrix	VaR estimation in analytic form	Parametric and nonparametric covariance model
Data on financial instrument rate of return in the form of time series with equal weights	Determination of unbiased and efficient covariance matrix estimation	Constant covariance models
Data on financial instrument rate of return in the form of non-stationary time series	Determination of unbiased and efficient covariance matrix estimation	Exponentially-weighted covariance models (J. P. Morgan RiskMetrics model)
Operational risk		
Data on losses from events, the amount of damages or annual loss from operating activities	Unknown parameters estimation from a set of observations	Bayesian model

Source: compiled by authors.

Models based on the extreme values theory can find VaR for market and operational risk with the level of reliability higher than 99%. The model parameters are determined for $(X_1, ..., X_n)$, which is a sample of independent identically distributed random variables from the distribution of the function extremum:

$$P\left(\frac{\min\{X_1,...,X_n\}-b_n}{a_n} \le x\right) \to G(x) \text{ with } n \to \infty, \text{ where } \{a_n\} \text{ and } \{b_n\} - \text{numerical}$$

sequences (Embrechts, 1997).

The advantages of new approaches to VaR evaluation are its accuracy and correctness assessments even for forecasting a period of one day and a 99% confidence level (for example, extreme values theory). It should be noted that the Basel Committee on Banking Supervision (within the approach based on internal models) does not allow banks to use models with a short-term (less than 250 days) period of observation for capital adequacy calculation. Based on the covariance method, the VaR calculation model (according to the criteria of the Basel Committee on Banking Supervision) is inadequate for assessing

the expected losses under a sustainable market development and in times of a crisis. Another advantage of the new approaches to risk assessment (especially operational risk) is their ability to give accurate probabilistic estimates even in the absence or lack of statistical data (for example, the Bayesian model).

The Basel II and Basel III provide additional regulatory requirements the fulfilment of which allows the banks to assess the risks and to manage them. They enable to optimize the regulatory capital in terms of the acceptable risk for a certain transaction.

The innovative aspect of regulatory requirements is that the basis for decisions justification should be statistics rather than individual practice and bank senior managers. So, quality and data structure requirements become the mainstream.

The task of the new approaches is not to learn the basic calculation methodology, but to achieve their implementation in a real management of decision making, and this is an extremely important task of the modern banking information systems.

Improvement of banking risk management information support: approaches and implementation

Risk management information support makes serious demands to analytical banking systems. The systematization of the key business objectives with regulatory and technological requirements allows submitting the banking management information system as a three-tiered solutions, which takes an important place in risk management (Fig. 2).

Each level provides the solution of certain business tasks. Various business tasks conditionally reproduce the "management vertical". This provides the maximum efficiency by a feedback between the management levels, creates a single information space, ensures the monitoring of implementation by business lines from the top management (strategic management) to the operators and client managers (operating activities) with a direct participation of economists, risk managers, and analysts (operational analysis and management).

The proposed architecture ensures a full data transparency and control over the achievement in the strategic and budgetary areas by comparing the "plan–fact" indicators and the performance factor variance analysis. The upper level is actually the remote banking management and the individual business lines that give the analyst convenient charts and indicators. A classical data warehouse is used for the top-level management realization.

The middle level (operational management and analysis) fulfils the main computer calculations (transfer price calculation, risk calculation, etc.). This level should be close to the transaction ABS lower level, as it provides the requirements for the analytical accounting rate of return and the individual transaction risk. Financial instruments measuring availability at this level are the first step towards creating a system of parallel

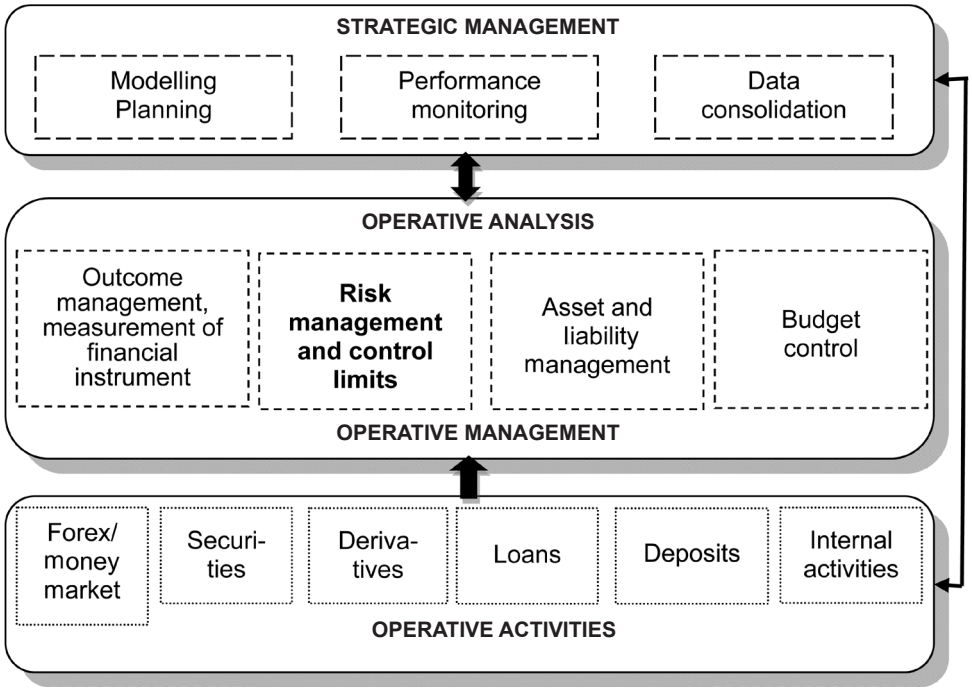

FIG. 2. **Three-tiered banking management information system**

Source: SAP, 2011.

accounting. A large number of computational problems that require the use of IT solutions different from the traditional data warehouse are performed at the middle level. The operational ABS with traditional functions is on the lower level.

It is not required to improve the existing ABS in architecture with separated functions of operational data, calculations, and analysis with the appearance of new management challenges. The issue of data availability somewhat complicates the situation due to the necessity of cross-communications, but this is not contrary to the general logic of the management structure and its division level. Accessibility calculation results of individual parameters are solved within the generally accepted approach "service on demand" in the service-oriented architecture.

The necessity of a powerful banking information management support explains the growing interest of Ukrainian banks to analytical information systems (SAP, 2011).

Most of the problems in banking information system analytics are solved by their developers or through the purchase of specialized components from suppliers. This leads to an uncontrolled growth of the number and complexity of subsystems, increasing the support cost and the deterioration of ROI (Return On Investment). This approach usually leads to an unpredictable banking information system development and brings additional risk factors. The recent studies of leading analytical companies evaluate this approach as

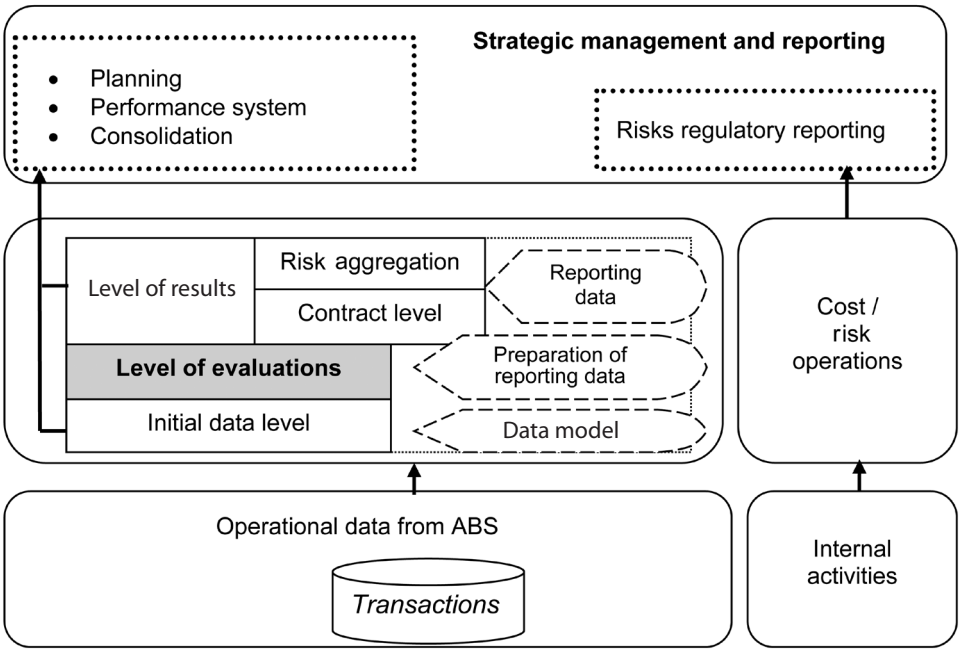

FIG. 3. **Integrated IT architecture for risk management**

Source: compiled by authors in accordance with (SAP, 2011).

a standstill in terms of the value and prospects of using it in a dynamically developing bank (Gartner, 2012).

The SAS Risk Management for Banking, Oracle Financial Services Liquidity Risk Management and SAP Bank Analyzer are the global market leaders in integrated systems of banking risk management (GRC, 2011).

An effective use of these products should be subject to the considered three-tiered bank management system (Fig. 2). In this sense, it is indicative that the structure of SAP solution "Integrated Finance and Risk Architecture" has made a fundamental step towards the further convergence of construction accounting, international accounting, and management (Fig. 3). The SAP company is one of the first providers of banking information systems that have implemented the concept of analytic risk management and return, as well as reflection financial data in different accounting standards. The IFRS accounting standards require various risk type estimates for financial instruments (deals).

The level that corresponds to the operational management and analysis in this architecture can be developed for risk management tools by the SAP Bank Analyzer (Volkov, 2010). There are built-in features: credit risk calculation (the Basel II methodology); scoring, calibration, and approval client ratings, limits management, asset / liability management (ALM); portfolio credit risk management, market risk

management, operational risk evaluation, cumulative risk reports. The possibility of modeling (PD, LGD, CCF and historical data) is an addition to the measurement of financial products. Consequently, the most modern techniques of credit, market, operational risks, and measurement of financial instruments based on the IFRS standards with regard to market or model data are used for the calculation.

It should be noted that the assessment level may be developed due to the new methods of evaluation (Table 3).

Conclusions

The article deals with the implementation possibilities of new approaches to risk evaluation and support on the example of Ukrainian banks.

The research on automating banking activities enables to distinguish the following tendencies: understanding the role of information technology (IT) as a significant factor which can strengthen the competitive advantages; bank automation, shifting the focus on the area of management due to the IT development and analytical decision support tool; rejection of their own development and switching to the use of standard solutions from leading banking software producers.

The relevant processes are accompanied by the development and implementation of the new risk evaluation models. This task is very complex and requires a lot of effort and considerable financial resources from banks.

The best calculation method selection depends on the data completeness and the banking portfolio specificity. The main difficulties in the use of new approaches are related to statistics: unavailable historical data, incomplete or inappropriate data on specific bank characteristics or credit policy. However, this should not interfere with banks in developing and applying new business models (such as Bayesian models which in the first phase may be based on information from open sources or expert opinion). The development of their own techniques is an extremely important step for the local banks that will further collect the necessary data for constructing and improving the risk evaluation models.

The Bayesian theory and the extreme values theory are quite effective tools in solving these problems, but the application of these methods often faces certain barriers associated with the imperfection of banks' information systems. An effective data analysis involves the creation of integrated information systems for risk management and finance, which are based on a modern analytical system.

The spot approach to the implementation of regulatory requirements costs much more than the integrated, comprehensive approach (Gartner, 2012). The desire to achieve compliance with the Basel requirements will create an effective system of integrated risk management. The next step is an integrated financial management and risk management which will significantly improve the function of individual banking institutions and strengthen the financial system as a whole.

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