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METHODS OF MEASURING OPERATIONAL RISK AND THEIR INFLUENCE ON THE LEVEL OF BANK'S CAPITAL ADEQUACY

METODY POMIARU RYZYKA OPERACYJNEGO I ICH WPŁYW NA POZIOM ADEKWATNOŚCI KAPITAŁOWEJ BANKU

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Abstract: An increasing complication of the financial system with new products, international connections between institutions, the large scale of mergers and acquisitions and the process of globalization have a huge influence on the process of risk measurement and management in banks. Operational risk, which is one of the main financial risks in the bank (together with credit and market risk) differs from the others. Widely understood as the risk associated with a daily activity of the bank, it is defined as the risk of loss resulting from inadequate or failed internal processes, people and systems, or from external events. The purpose of this article is to compare the methods of measuring operational risk in relation to the amount of capital necessary to cover it.

Keywords: operational risk, risk measurement, capital adequacy.

Streszczenie: Rosnąca złożoność systemu finansowego z nowymi produktami, międzynarodowymi powiązaniami, dużą liczbą fuzji i przejęć, a także sam proces globalizacji mają ogromny wpływ na pomiar i zarządzanie ryzykiem w bankach. Ryzyko operacyjne, które jest jednym z głównych ryzyk finansowych w banku (wraz z ryzykiem kredytowym i rynkowym) różni się od pozostałych. Szeroko rozumiane jako ryzyko związane z codzienną działalnością banku, definiowane jest jako ryzyko straty wynikające z nieodpowiednich lub nieudanych procesów wewnętrznych, jako konsekwencja działań ludzi i systemów lub ze zdarzeń zewnętrznych. Celem tego artykułu jest porównanie metod pomiaru ryzyka operacyjnego w odniesieniu do kwoty kapitału niezbędnego do pokrycia ryzyka operacyjnego w bankach.

Słowa kluczowe: pomiar ryzyka, ryzyko operacyjne, adekwatność kapitałowa.

1. Introduction

An increasing complication of the financial system with new products, international connections between institutions, the large scale of mergers and acquisitions and the process of globalization have a huge influence on the process of risk measurement and management in banks. It has become more complicated and much more attention is required to identify, understand, calculate and to protect against it.

Operational risk, which is one of the main financial risks in the bank (together with credit and market risk) differs from the others. It is widely understood as the risk associated with a daily activity of the bank is defined as the risk of loss resulting from inadequate or failed internal processes, people and systems, or from external events (Basel II).

A classification of the operational risk is based on the nature of loss (internal versus external operational losses), expectancy (expected versus unexpected losses), association (direct versus indirect losses), and the magnitude (or severity) and the frequency of loss (low frequency and low severity, high frequency and low severity, low frequency and high severity, high frequency and high severity).

Basel Committee on Banking Supervision [BCBS 2001] defines seven distinct types of operational risk, often interlinked:

- internal fraud,
- external fraud,
- employment practices and workplace safety,
- clients, products, and business practices,
- damage to physical assets,
- business disruption and system failures,
- execution, delivery, and process management.

In spite of the fact that operational risk was quite early identified [Hussain 2000; King 2001; Cruz 2002; Chernobai et al. 2007], its importance has been widely recognized only after the crisis 2007-2009. Bank of International Settlements (BIS) provides also four major sources of the operational risk: systems, processes, people and external factors. New threats connected with higher geopolitical risk, technological advances – like e-banking and automated processes – are the challenges for the process of operational risk measurement and management.

Operational risk has also become a topic for the Basel Committee on Banking Supervision to calculate the required capital (both the regulatory capital, understood as a minimum amount needed to have a license; it corresponds to the expected risks, and the economic capital – the amount necessary to be and stay in business), for instance, providing a cushion at the 99% level of significance [Chorofas 2003].

Data collection which covers operational losses suggests to use a heavy tailed loss distribution which shows a probability of an extreme loss event (with high loss severity). Banks need to cover the expected losses (EL) that are a result of predictable failures, as well as the unexpected losses (UL) from large, one-time shocks.

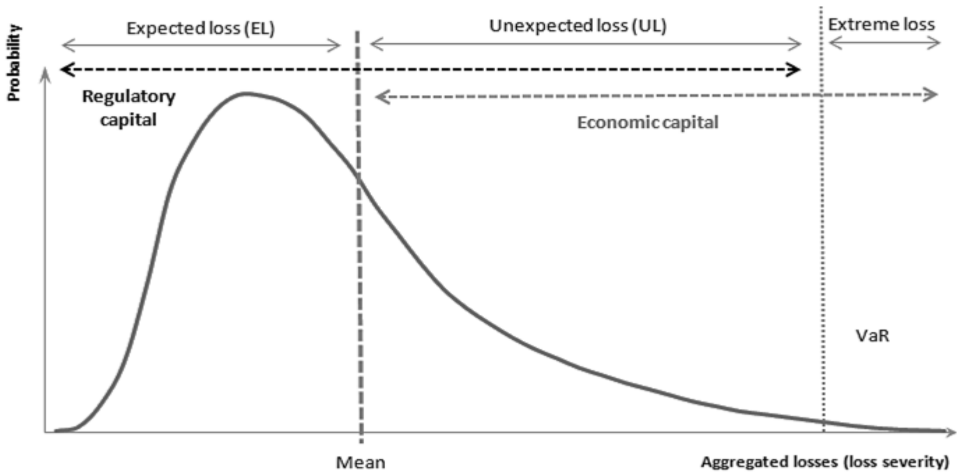

Fig. 1. Probability density function of operational losses

Source: own study.

2. Different aspects for operational risk measurement

Methods and tools that let us measure operational risk are significantly different from those dedicated to other types of risk. Lack of big data sources of extreme losses and their aberrant behaviour lead to lower predictability and difficulties in modelling of operational risk.

There is no one valid methodology used to calculate the capital needed for protection against the operational losses and those which are applied have both advantages and disadvantages. The most popular methods are [Haubenstock, Hause 2006]: basic indicator and standardized approach, loss distribution approach, structured scenario analysis based on the expert opinions, scorecard that uses various measures at a corporate business unit and a hybrid method – a combination of several approaches.

The way in which the risk is managed has a form of both top-down and bottom-up approaches [Chernobai 2007 et al.]. A top-down approach allows determining the probability and the magnitude of potential losses, as well as identifying threats that may prevent the institution from achieving its objectives. This approach allows to measure the risk for the whole bank quite easily, but it is very difficult to reformulate into the unit level. Top-down models include multifactor equity price models, capital asset pricing model, income-based models, expense-based models, operating leverage models, scenario analysis and stress testing and also risk indicator models.

A bottom-up approach focuses mainly on the risk sources that refer to the relationship between human actions, technology and procedures in an organization, as well as specific internal and external events. The risk is measured separately for each area of bank's activity (each business unit) and by summing it up – the result for the whole institution is obtained. Bottom-up models encompass three main subcategories: process-based models (causal models and Bayesian belief networks, reliability models, multifactor causal factors), actuarial models (empirical loss distribution-based models, parametric loss distribution-based models, models based on extreme value theory) and proprietary models.

Keeping in mind that there is no right approach, the institutions that face a need to choose a successful methodology must consider such factors as data availability, skills of staff responsible for the capital calculation, organizational culture and incentives to risk management and costs.

The Basel Committee on Banking Supervision [BCBS 2001, 2011] does not quantify operational risk directly, but it allows to designate the capital requirement for operational risk in the bank. In these documents there are three basic approaches for operational risk measurement: Basic Indicator Approach (BIA), Standard Approach (SA) and Advanced Measurement Approaches (AMA).

2.1. Basic indicator approach

As recommended by many authors [e.g. Akkizidis, Bouchereau 2005; Gregoriou 2009], according to the basic indicator approach the banks should maintain capital to cover operational risk equal to a fixed proportion of their gross income. The total capital value C_{BIA} is calculated as:

$$C_{BIA} = \alpha \cdot \frac{\sum_{i=1}^{n} GI_i}{n},$$

where: α – operational risk coverage ratio,
GI_i – positive gross income for i-th year,
n – number of the previous three years when GI is positive.

This method was generally intended for small or medium-size bank that does not operate in international markets. In addition, it does not need set of data, high qualified staff, is not time consuming and is easy to implement. On the other side it usually requires higher amount of capital as a consequence of the overestimation of operational risk.

2.2. The standardized approach

In this approach the business activities are divided into eight subdivisions (business lines) with individual beta factor which represents a relation between the operation risk loss and gross income for selected business line. The capital requirements for the operational risk C_{STA} are calculated as:

$$C_{STA} = \frac{\sum_{i=1}^{n}\left(\sum_{j=1}^{8} GI_{i,j} \cdot \beta_j\right)}{n},$$

where: β_j – beta factor for j-th business line,

$GI_{i,j}$ – positive gross income for i-th year and j-th business line,

n – number of the previous three years when GI is positive.

The capital required to cover the operating risk is determined by the methods for the bank in which it operates on the international markets. The standardized approach is better than the basic indicator method, because it considers the diversity of bank's activities (business lines), but on the other hand, the same beta parameters for all banks lead to the misspecification of a particular bank situation.

While both standard methods (BIA, TSA) have the tendency to overestimate the capital needed for the protection against the operational risk, Basel Committee suggests to adopt an alternative version of the standardized approach. Under the alternative standardized approach (ASA) for two business lines: retail banking and commercial banking the required capital is calculated as a beta factor multiplied by the total loans and advances (instead of the gross income) and this partial result is multiplied by 3.5%.

$$C_{RB} = \beta_{RB} \cdot 0.035 \cdot \frac{\sum_{i=1}^{n} LA_{RB,i}}{n},$$

$$C_{CB} = \beta_{CB} \cdot 0.035 \cdot \frac{\sum_{i=1}^{n} LA_{CB,i}}{n},$$

where: β_{RB}, β_{CB} – beta factors for retail banking and commercial banking respectively,

$LA_{RB,i}, LA_{CB,i}$ – total loans and advances for retail banking and commercial banking respectively for i-th year,

n – number of the previous three years when LA is positive.

2.3. Advanced measurement approach

In this approach the bank can use its own methodology as long as it allows to calculate operational risk for one-year period with high confidence interval. Despite the fact that at first BIS [BCBS 2001] suggested only three approaches:

the internal measurement approach (IMA), the scorecard approach (ScA) and the loss distribution approach (LDA), since 2006 it allows the banks to use their own internal methodology [BCBS 2006].

The advanced measurement approach, as the most complex and demanding, needs both qualitative and quantitative criteria to assess the regulatory capital charge. To assess the validity and reliability of the method, the banks must employ external databases, as well as stress-testing.

Among banks, the biggest attention was devoted to the loss distribution approach which considers the frequency and severity components of the loss distribution separately. The frequency shows numbers of events per time units while severity represents the monetary result (loss) of the event. Bank's activities were divided (by BIS) into eight business areas (business lines) among which seven types of events could emerge. In consequence a 56-cell matrix was created and for each cell the frequency and severity distribution must be modelled.

To determine the value of capital to cover operational risk, the VaR for the relevant level of significance in the specified risk area should be determined. The capital C_{LDA} needed to cover the operational risk is calculated as a simple sum of VaR measures (OpVaR).

$$C_{LDA} = \sum_{i=1}^{7} \sum_{j=1}^{8} VaR_{i,j},$$

where: $VaR_{i,j}$ – VaR measure for i-th event and j-th business line.

In order to determine the distribution of the operating losses, a database containing the operating losses must be created at the first stage. The loss function can be created on the basis of the historical data or random variables using the Monte Carlo method. The occurrence of each type of operational risk is accompanied by a probability that can be described by the Poisson distribution. As a result, operational risk is described by two random variables: loss frequency and loss size. The first is the number of events in a given period and the second is the measure of the amount of loss that arose from a given event.

The process of aggregating the frequency and severity distribution is not simple and could be done in different ways. One of the most popular method is to use Monte Carlo simulations. The procedure may be described as follows [Esterhuysen et al. 2008]:

- generate 10,000 Poisson random variables representing the number of events for the 10,000 simulated periods;
- for each period, the required number of severity random variables is generated (understood as a probability p) using exponential distribution with $\lambda = \frac{1}{\mu}$ where μ – is an average loss. The amount of severity loss is calculated using the generated uniform random number (described as p – probability) from the formula:

$$x = \frac{\ln(1-p)}{-1/100000},$$

where: x – the amount of severity loss;

- using the formula above for each created uniform random number (representing the probability) the summarized amount of loss for given period is calculated. Then by repeating this procedure many times (5,000; 10,000 or 100,000 times) one can sum up the amount of losses for each run (period) and get the total loss amount for each run (potential losses during the period);
- to obtain the aggregated distribution, the numbers that represent the total losses should be ordered from the highest (that represents highest quantile 99.99% or 1/10,000 for 10,000 runs respectively) and then the VaR for operational risk can be calculated.

3. Calculations

The example considers a chosen business line (retail banking) in one of the commercial banks. Risk identification – first step in the measurement process – allows recognizing the losses and then locating them into seven different loss categories. Then the process of risk management covers the risk assessment, mitigation and finally the control. The time horizon, which means the length of time over which the bank plans to calculate its VaR, is equal to one year (the period proposed by Basel Committee). The level of confidence at which the institution will make the estimate is 99.99 per cent.

Let us assume that for the last three years the bank has received gross income equal to $X_1=135$ *million,* $X_2=146$ *million,* $X_3=161$ *million* for a chosen business line. The data collected shows that there was on average 22 fraud events during the year with an average fraud amount equal to *90,000*, which gives the aggregated value of *1.98 million* per year.

Having the data available, the question arises how much capital is needed to cover the risk and maintain the bank in good financial condition. For this article two methods were applied – the standardized approach and the advanced measurement approach with the loss distribution approach.

3.1. The standardized approach

While beta for retail banking business line is equal to 12%, the minimum necessary capital is equal to:

$$C_{STA(Retail\_banking)} = 0.12 \cdot \frac{135+146+161}{3} = 17.68\,.$$

3.2. The advanced measurement approach

The frequency of data was generated through Poisson process with lambda parameter equal to 22. The process delivered 10,000 random variables that represent the frequency of events (number of potential losses during 10,000 hypothetical years).

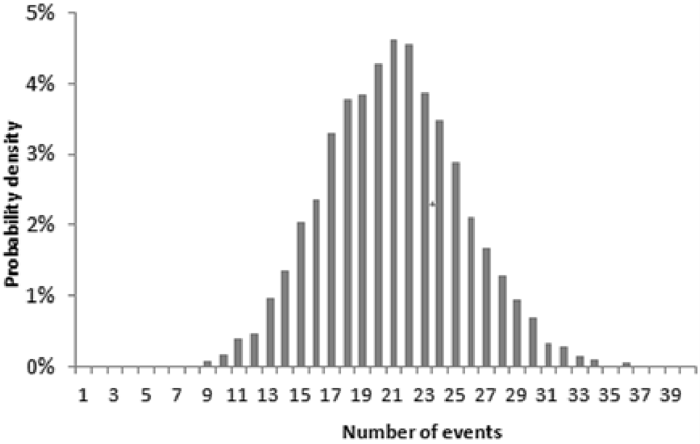

Fig. 2. Frequency of events distribution

Source: own study.

For each period (year), the required number (equal to frequency obtained above) of severity random variables was calculated with exponential distribution) and then summed up. By using Monte Carlo simulation, one can derive an aggregated loss distribution for a given frequency distribution and severity distribution (Fig. 3).

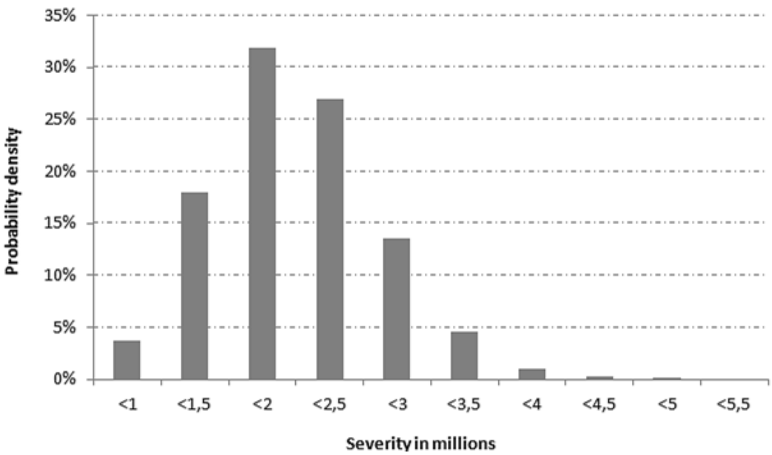

Fig. 3. Aggregated loss distribution

Source: own study.

Having the distribution of aggregated losses, one can calculate the required capital using VaR for several confidence levels.

Table 1. Capital requirements at different confidence level

Confidence level	Regulatory capital (VaR)	Expected Losses	Unexpected Losses
99.99%	4,733,677.06	1,986,817.75	2,746,859.30
99.00%	3,350,564.85	1,986,817.75	1,363,747.10
95.00%	2,803,534.45	1,986,817.75	816,716.70
90.00%	2,509,963.97	1,986,817.75	523,146.22

Source: own study.

The comparison of both methods shows that internal method allows for a significant decrease in the level of the required capital.

4. Conclusion

The application of different methods to the process of capital calculation allows achieving quite a wide range of possible results. It could be observed that the more sophisticated the process of capital calculation, the lower the level of required capital is obtained. Such result puts larger banks in more comfortable position, especially those with qualified staff capable to use the advanced analytical methods. In the opposite situation are the small banks for which the use of simple methods results in a higher level of capital requirements (proportionally to their size).

In consequence, in October 2014, the BCBS proposed revisions to its operational risk capital framework [BCBS 2014]. They state that all three simple operational risk approaches (basic indicator, standardized and alternative standardized) have little or no linkage to the operational risk they measure, except for the overall assessment of the bank's size. The proposal specified a new standardized approach (new SA) to substitute both the basic indicator approach (BIA) and the standardized approach (TSA) for calculating the operational risk capital. However, the proposed new SA itself was roughly criticized by the industry for lack of risk sensitivity.

At the same time, the large financial institutions were obliged to assess the operational risk regulatory capital via advanced internal models that were sensitive to the quality of risk management and fit to the institution's risk profile. However, in 2014 the BCBS concluded that for many banks the capital requirements for operational risk were not correctly calculated. The BCBS proposed to withdraw the internal modelling approaches for the calculation of the minimum capital requirement for operational risks, due to excessive complexity and lack of comparability arising from a variety of different modelling practices.

In March 2016 Basel Committee [BCBS 2016] has proposed a Standardized Measurement Approach, the SMA, as a single and non-model-based method which is the most suitable substitution for the gross income. It relies on a business indicator (based on the three main sources of income – interest component, services component and financial component) and the past performance of the financial institution.

European Commission reacted to the BCBS proposal by underlying its criticism for the plan to limit the flexibility of internal modelling. On 23 November 2016, the European Parliament adopted one resolution [European Parliament 2016] on the finalization of Basel III. The European Parliament underlined the need to carefully consider the impact of the proposed reforms, and to promote a level-playing field at the global level while paying attention to the peculiarities of the EU economy and of European banking models. In consequence, the issue of further use of internal models remains in the sphere of consultation.

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