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Methods of quantifying operational risk in Banks : Theoretical approaches

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***Abstract:* -** The definition of operational risk is a challenge. This risk has an atypical character as far as it concerns all the activities of the bank. It is also often difficult to estimate it independently of the other risks which characterizes the banking activity. Indeed, it is very difficult to determine the amount, the frequency, and the key factors behind this risk. Banks are still putting in place procedures of data collection and formalized approaches in this area. This is what we try to decipher. How then banks are they supposed to assess, predict and effectively manage operational risk, given the incredible diversity of dangers and threats now facing their business? How can they successfully respond to new constraints emanating from regulatory authorities while preserving their future profitability? These two questions are at the heart of the issues related to the measurement of operational risk, and are not without effect on the future ability of banks to manage this type of risk.

***Keywords*: -** *Banks, Basel II, Methods of quantification, Operational Risk, Regulatory measure.*

I. INTRODUCTION

During this last years, we see a growing interest of financial institutions to identify losses associated with operational risk, and that, due to regulatory considerations on the one hand, and upon the occurrence of huge operating losses in the financial sector on the other hand. Let us quote examples of huge operating losses incurred in the financial sector : $ 2.4 billion attributable to subsequent proceedings Enron and a loss of $ 690 million caused by an unauthorized transaction Allied Irish Bank.

Add the case of the oldest bank in the United Kingdom (233 years), Barings, which went bankrupt as a result of unauthorized activities causing losses of $ 1.3 billion. These examples show the extent of this risk. They also provide a signal to alert financial institutions that must define, measure and manage it, to avoid any huge losses that may arise.

In addition to these significant losses, operational risk affects all activities and operations of financial institutions in different ways. Indeed, we find operational events attribuable to persons, processes, systems and external events. However, the units are not affected in the same way by the operational risk. The impact varies depending on the nature of activities and the various stakeholders. Operational risk therefore becomes more and more large and its management becomes a necessity.

Aware of this big risk, regulators have launched a debate on the definition, identification, measurement and management of operational risk in June 1999. They thus introduce the pressure on banks to put in place a management framework specific to the operational risk management system (management system of risk, senior management). This framework allows, inter alia, the identification and measurement of the loss of an operational capital. One way to hedge exposure to operational risk is to hold capital to cover unexpected losses, as is the case for market risk and credit risk.

Several approaches of measures of operational risk capital have been proposed by the regulatory authorities, except that banks are encouraged to develop their own method, a method of measuring progress that will better reflect the level of operational risk. The development of such a method of measurement is in the center of this article. We study various aspects of the quantification of the operational risk of the banking institutions, in order to develop a measure that reflects the actual exposure of a bank.

Thus, the objective of this paper is to propose a robust method for calculating the value at operational risk, which will be the most realistic and the most representative of the level of operational risk of a bank.

One of the approaches proposed in the agreement of Basel II for the quantification of the operational risk is the advanced approach [1]. The development of such an approach requires a large database. The data can come from different sources. In fact, the internal data is of great value to reflect the actual degree of exposure in front of operational risk. However, the historical collection is short and operational losses observed are far from being representative of losses which a bank could suffer. Indeed, the internal data of a bank does not include enough of rares losses with a high severity, especially as the process of collection of losses is still in its infancy.

II. THE REGULATORY MEASURE OF THE OPERATIONAL RISK UNDER BASEL II

The operational risk measurement corresponds to a value at risk [2], similar in its principle to that calculated in the areas of market risk and credit risk. It should therefore cover both the « expected loss » and « unexpected loss ». Yet, in theory, regulatory capital only cover unexpected losses and not average losses, the latter being intended to be covered by provisions or charged to current income. The Basel Committee proposes three different approaches to determine the regulatory capital charge for operational risk [3] :

- *Basic Indicator Approach or BIA*
- *Standardised Approach or SA*)
- *Advanced Measurement Approach* or *AMA*

As highlighted in the Committee, regardless of the approach, an institution must demonstrate that its operational risk measure meets a soundness standard comparable to that of the IRB (Internal Ratings Based Approach) for risk credit (corresponding to a holding period of one year and a confidence interval of 99.9%). Banks have the option to choose the one that seems the most suitable to the specificity of their activity, but also to their overall capacity of action. They should indeed ensure that they have all the means necessary for the implementation of the solution. The degree of sophistication of each of these three methods is indeed increasing.

II.1. General principle of the available approaches

Under the BIA approach, the calculation of required capital is from an indicator of exposure. The Basel Committee[1] proposes to retain 15% of the average banking net income (Gross Income or IM) over the last three years. The required capital (or capital requirement) K_{BIA} is then equal to:

$$K_{BIA} = \alpha \times GI$$

The coefficient α is set at 15%.

This standard method is imperfect and concerns mainly the small local banks who can not do better. If no eligibility criterion is required, it does not matter as long as the regulator allows banks operating in the international financial scene to use this approach so unrefined.

Unlike the BIA, banks using the AMA methods are allowed to calculate themselves their own regulatory capital from their own internal models. These banks must meet many requirements to use the advanced approach. In particular, certain qualitative criteria concerning the politics of risk of the bank must be respected (daily management, capital allocation to major units, reporting losses, integrated system, etc.). AMA methods lead to a requirement for regulatory capital a priori lower than in the case of the BIA approach , which clearly favors the bank. At first sight, the cost of implementation of the AMA may seem high. However, the marginal cost is not. Most qualitative criteria required to implement an AMA are indeed already validated, because laws (such as Sarbanes-Oxley, for example) or other regulatory procedures (regarding governance in particular) impose to respect them.

The standardized approach is between the BIA approach and AMA measures [4]. The required quality criteria are very similar to those of AMA methods. The real difference lies in the calculation of regulatory capital. However, the standardized approach seems particularly attractive for traditional banks, as the activities of « retail banking » and « retail brokerage » weigh up to 12% in the calculation of regulatory capital against 15% with a BIA approach.

[1] Basel II considers a matrix division of the bank. It is divided into eight categories or lines of business: Corporate Finance, Sales & Trading, Retail Banking, Commercial Banking, Agency Services, Asset Management, Retail Brokerage.

The standardized approach is in fact a finest extension of the BIA, by declining this type of calculation by type of activity. The regulatory capital of the bank for the operational risk (K) corresponds then to the sum of the regulatory capital of every category of activity, namely :

$$K_{SA} = \sum_i \beta_i \times GI_i$$

Where GI_i is the net banking income (Gross Income or IM) of the i-th row of activity[2]**.** Facteur β_i values (12%, 15% and 18%) were calibrated by the Basel Committee.

II.2. Advanced Measurement Approach (AMA)

The Basel Committee proposes several alternatives within the AMA system : a method based on internal parameters (Internal Measurement Approach or IMA), the RDCA (Risk Drivers and Controls Approach) method, formerly Scorecard, scenario analysis or sbAMA (Scenario -based AMA), and finally, the LDA (Loss Distribution approach) method, the more sophisticated technically. The practice of each of these methods is subject to a set of qualitative criteria, particularly in terms of operational risk assessment and procedure for collecting data loss. This is their common denominator. On the fund, the difference concerns essentially the type of privileged information in the calculation of regulatory capital. The LDA method is based on historical data loss [5], while sbAMA seeks to define scenarios ('what- if' scenarios). The value at risk is then calculated by a Monte Carlo method [6].

As part of the IMA (Internal Measurement Approach), the « average or expected loss » is calculated separately for each class or line of business. For a category of activity *i* and a type of risk *j*, the capital charge K, is defined by example follows this way :

$$K_{ij} = \gamma_{ij} \times EL_{ij}$$

Where EL is the average loss and γ is a scaling factor. The average loss can be calculated as the product of three terms:

$$EL\ \boldsymbol{\gamma} = EI_{ij} \times PE_{ij} \times LGE_{ij}$$

Where EL is the exposure indicator, PE_{ij} is the probability of occurrence of an operational risk event, typifies j for the business line i (probability of event), and LGE_{ij} is the amount of loss associated (loss given event). The challenge is to calibrate the γ parameter. The assumption of this method is that there is a (linear or non-linear) relationship, via the gamma (γ), between the average loss and risk measurement.

The RDCA method (eg Scorecard approach) proceeds by a series of weighted questions, some of which may resemble to scenarios. A score is determined on the basis of the obtained answers, that will help to break the total regulatory capital between the different business lines. The Basel Committee [7] has provided no mathematical formulation for this approach. However, the working groups within banks have proposed formulas for calculating the regulatory capital (K) of the form:

$$K_{Scorecard} = EI_{ij} \times \omega_{ij} \times RS_{ij}$$

With EI the Exposure Indicator, RS the Risk Score (Risk Score) and ω a Scale Factor.

II.3. The Scenario analysis

Scenario analysis (sbAMA) is actually an extension of the RDCA. The risk is considered as a combination of the severity and frequency of potential losses over a given period [8]. The frequency and severity (potential) loss can be measured in monetary units and number of annual occurrences. The risk somehow reflects the vulnerability of the bank. The risk assessment should therefore focus on the vectors of this vulnerability. Now, this one comes for the underlying risk factors. Reduce the level of operational risk imposes a good readability of the portfolio of the bank exposure to various risk factors previously defined.

To be really useful for purposes of decision regarding risk, a scenario analysis must be able to answer to these two questions: With what frequency does the scenario X may occur? What is the amount of the loss if the scenario X occurs?

On operational risk, the scenarios are generally derived from the critical resources on which support various business lines of the bank.

These resources correspond actually to operational risk factors. Among the most common, we list the level of competence / qualifications of staff, internal organization / transfers of information, IT infrastructure (eg,

[2] The Basel Committee holds seven events of operational risk: Internal Fraud, External Fraud, Employment Practices & Workplace Safety, Clients, Products & Business practices, Damage to Physical assets, Business Disruption and System Failures, Execution, delivery & process Management.

system security), procedures for control of unauthorized activities /theft and fraud / unintentional errors (eg, seizure, execution and monitoring of transactions), protective measures against disasters and other disasters, or the compliance with legal requirements (eg, compliance, information dissemination and fiduciary duty). The challenge is to determine how we can extract useful information scenarios. For example:
- What is the probability that one or several of these resources or risk factors are lacking on a time interval considered critical for the bank?
- What negative impact results from it?
If the probability of failure of risk factors or the impact on the operation of the bank is low, it is understood that it is obviously exposed to any real operational risk.

II.4. Modeling LDA
The general idea of the LDA method (Loss Distribution Approach) is to model the loss of operational risk for a given period (eg, one year), and deduct the value at risk. Frachot et al. (2003) propose to proceed in five steps to implement this method [9] :

- Estimation of the severrity distribution ;
- Estimation of the frequency distribution ;
- Calculation of the Capital charge ;
- Calculation of confidence intervals ;
- Incorporation of expert opinion.

It is not about getting into the mathematical formulation of these several steps, but simply to understand the general idea of the LDA method. Like most models of operational risk measurement, the LDA is based on a very old actuarial approach (frequency / severity) widely used in the field of insurance to model similar problems. So that the LDA model can turn, it is necessary to provide two key elements: loss severity distribution, and loss frequency distribution. These two distributions, which form the historical losses are then combined by a Monte Carlo simulation to obtain the distribution of the total loss. This is the result of several successive losses, it is a loss aggregate (aggregate loss distribution). From the total loss, we divert then the expected or average loss, and unexpected loss, for a given confidence level. The Fig1 illustrates the principle of the LDA method [9].

All this seems very simple : build an internal loss history , use usual statistical techniques to adjust the data to a standard distribution of the frequency of the losses (eg , Poisson); adjust historical data processed on a standard distribution of the severity of the losses (eg, lognormal) by a Monte Carlo simulation, integrating the effects of the key indicators of risk so as to take into account the possibility that potential future losses differ materially from historical losses; consider insurance to reduce the amount of loss in case of occurrence , and finally derive the distribution of the aggregate loss from which is determined the capital charge or regulatory capital required to cover the expected loss and exceptional loss. Could we imagine a clearer process? In fact, the difficulty does not lie in the different stages of the LDA method, but in the notorious lack of credible data regarding operational risk.

To stick to the Poisson distribution, the most commonly used in practice, no less than 1,082 observations of individual losses are necessary to obtain an estimate of the average number of casualties, with an error margin of 5 % and a level of only 90 % confidence. With the exception of very frequent loss events whose amount is necessarily weak, it is unlikely that a bank may have an internal history long enough to estimate the frequency distribution with a degree of confidence acceptable[3] losses. The problem of lack of data (or the necessary number of data) are exponentially more complicated when it comes to estimating the distribution of severity.

Must then indeed reasonable estimates not only of the average severity but also its variance. For example, a simple simulation of the lognormal law shows that it will take more than a million points to produce an acceptable estimate of the distribution of severity, with a confidence level of only 90% . This simply means that the number of available data is still insufficient to obtain an estimate of the capital charge not too far from its true value. However, the uncertainty of capital charge is directly related to the calculation of the average loss and especially the exceptional losses, two quantities necessary for the implementation of the LDA method.

III. THE LOAD CALCULATION CAPITAL

The **own funds** are one of the liabilities of a bank. They can be calculated in the prescribed manner. In this case, it is called standard own funds or regulatory capital. They can also be calculated using internal models which take account of diversification effects, the nature of the bank's portfolio, etc. In this case, we speak of own funds

[3] The frequent losses (high-frequency) must necessarily be associated with small amounts (low-severity). Otherwise, the bank may go bankrupt pretty quickly, which makes no sense from the perspective of operational risk measurement.

or Economic capital. The idea of Basel II is to converge the regulatory capital - concern of regulators - and economic capital - concern for banks.

III.1. Definition of Capital-at-Risk

The capital charge (Capital-at-Risk or CaR) is the share of the own funds intended to preserve the bank of the insolvency in case of exceptional losses. This hedging is of course subject to a certain level of confidence or probability. The capital charge CaR expresses the amount of the total potential loss (or severity) for a specified occurrence probability a priori. Capital-at-Risk is actually the output of a risk model. This notion of capital charge is rather indistinct in the area of operational risk. Following Roncalli (2004, p.175), we can hold the following three definitions [10] :

– Definition 1 (Value at Risk or *OpVaR*) : The capital charge is the 99.9% quantile of the distribution of the total loss or aggregate (obtained once the distributions of frequency and severity sized). *N* is the number of random events, the total loss is $L = \sum_{n=0}^{N} \varsigma_n$

Which ς_n represents the amount of the loss *n*. The capital charge is then written :

$$\Pr\{L > OpVaR\} = 0.1\%$$

– Definition 2 (*OpVaR unexpected loss* only) : it is about the previous definition from which we shield the average total loss or expected loss. The capital charge becomes :

$$\Pr\{L > \text{UL} + \text{EL}\} = 0.1\%$$

or: UL = *OpVaR* − E[*L*].

– Definition 3 (*OpVaR* or Value at risk beyond a threshold) : In this case, the capital charge is the 99.9% quantile of the distribution of the aggregate loss defined as the loss of over a certain threshold *H*. We then have :

$$\Pr\{\sum_{n=0}^{N} \varsigma_n \times \mathbf{1}\{\varsigma_n \geq H\} > OpVaR\} = 0{,}1\%$$

Where the term 1 {ζn ≥ *H*} is equal to 1 if the loss exceeds the threshold H and equal to 0 otherwise.

The calculation of the capital charge CaR occurs in three cases with the Monte Carlo method, but produces significantly different results depending on the definition used. In the third consultative document, the Basel Committee uses the first definition. He stated that the bank must calculate its capital requirement by aggregating the Expected Loss (EL) and Unexpected Losses (UL), except for being able to demonstrate that its internal systems cover adequately EL.

III.2. Aggregation of capital charges and correlation

In the framework of the LDA (Loss Distribution Approach) method, the total or aggregate loss $L_{i,j}$ is the random sum of the individual losses. The probability distribution of the aggregate loss, denoted $G_{i,j}$, is a compound distribution. The capital charge for CaR business line *i* and the type of risk *j* (ie, the *ij* matrix element of operational risk) corresponds then to the α quantile of G_{ij} :

$$CaR_{ij}(\alpha) = G_{ij}^{-1}(\alpha) = \inf\{x \,|\, G_{ij}(x) \geq \alpha\}$$

Equivalently, we can write that the capital charge CaR for the ij element of the matrix of operational risk is equal to the sum of the Expected Loss (EL) and the unexpected loss (UL), namely:

$$CaR_{ij}(\alpha) = EL_{ij} + UL_{ij}(\alpha) = G_{ij}^{-1}(\alpha)$$

This expression, shown in a simplified manner in Fig 2**,** can be calculated easily by the Monte Carlo method. The Basel Committee suggests that the capital charge for bank corresponds to the sum of all capital charges CaR_{ij} (α) :

$$CaR_{ij}(\alpha) = \sum_{i=1}^{I}\sum_{j=1}^{J} CaR_{ij}(\alpha)$$

Naturally, it is about a model of allowance of own funds of bottom-up type. The principle is to consolidate operational risk in the banking portfolio from the finest level, until the unity of allowance. By its nature, the bottom-up approach allows to track the consumption of own funds.

This method of calculating the capital charge CaR is particularly attractive, but not quite as simple as it seems. Confidence interval for α equal 99.9% set by the Basel Committee [11], a considerable number of simulations is required (several million) to expect a realistic estimate of economic capital.

IV. PITFALLS TO AVOID DURING THE IMPLEMENTING OF A MODEL OF OPERATIONAL RISK

Once it is specified in its outline, the measurement model - regardless of its form and its degree of sophistication - must be anchored in an integrated operational risk management system. This allows to feel "comfortable" in two respects. As with the development of the measurement model, it is ensured that the different assumptions, modifications and fittings are considered consistent with the guideline set by the risk management (most likely, improve the management of operational risk). And it is also a guarantee that these adjustments align on management processes already in place in the institution.

Again, Basel II is a convenient starting point. An integrated operational risk management system consists of five steps [2] :

- ✓ Step 1: identification ;
- ✓ Step 2: measure ;
- ✓ Step 3: monitoring ;
- ✓ Step 4: capital requirement ;
- ✓ Step 5: control.

Fig3 shows the integrated system, and highlights three essential properties of the latter : (1) it applies to all business lines within the institution, that they are or are not included in the proposed classification Basel II ; and (2) it applies to all new banking products and new initiatives prior to their launch.

The Fig3 also illustrates the need to continuously improve the system. This principle of operational risk management also deserves to be elevated to the golden rule. Without this process of improvement with continuous cycle, the system shown in Figure 3 can quickly disintegrate. More precisely, it is easy to fall into an Endless spiral of pseudo-improvements - in the vain hope of fully define a "perfect" system - without ever get something really useful on a practical level. While it is tempting to specify at first a measurement model which is expected to offer all the risk factors that may affect the level of operational risk [12]. The problem is that it unnecessarily lengthens the period of availability of the model.

V. FIGURES AND TABLES

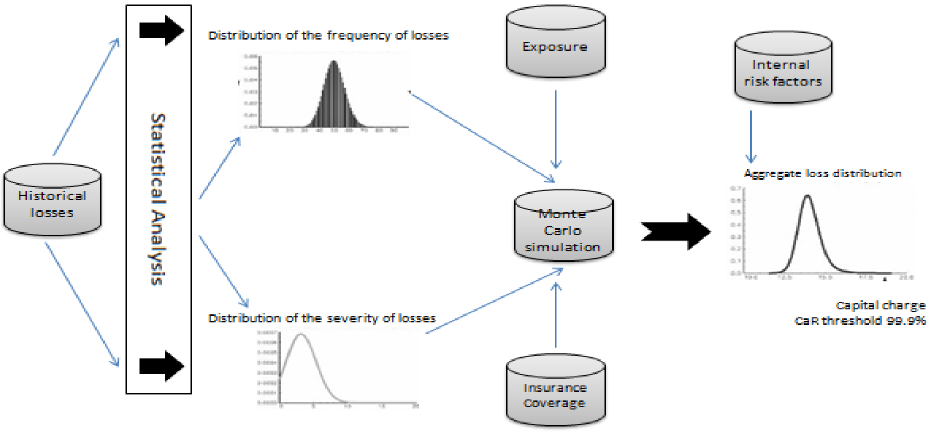

Fig1. Loss Distribution Approach (LDA)

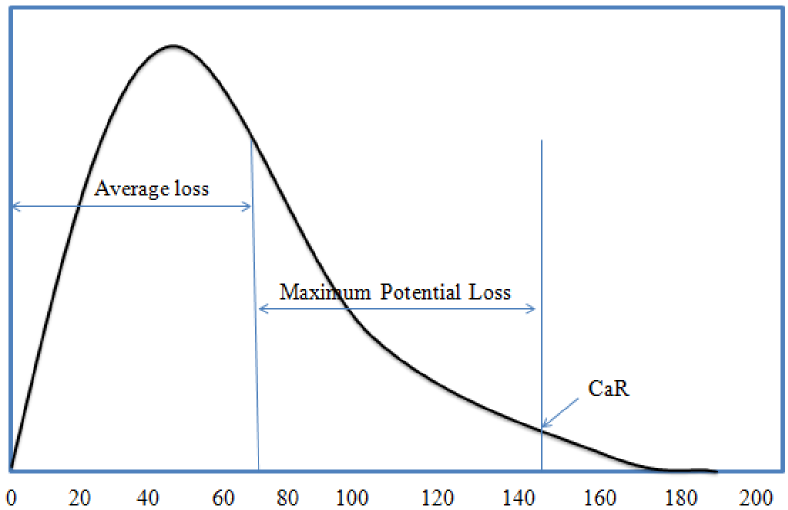

Fig2. Capital at Risk (CaR) and Operational Risk

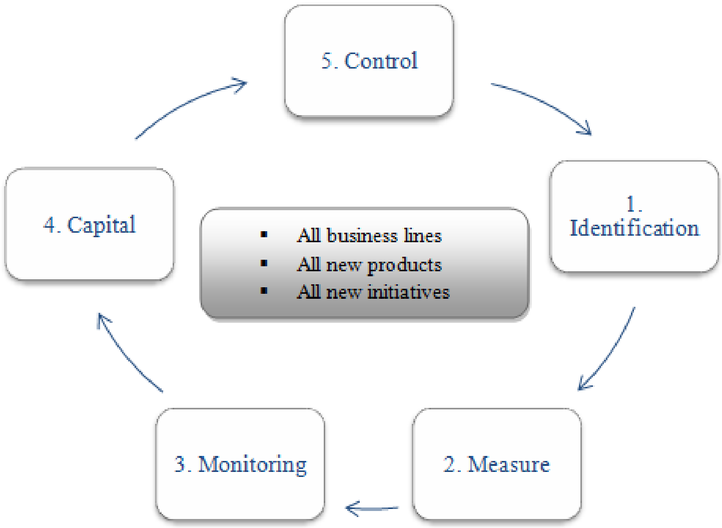

Fig3. Plan of an integrated management system of operational risk

VI. CONCLUSION

The operational risk management is relatively new in banks. In this article, we mainly approached the problem of the measure of this risk. It is necessary to wish that the models of operational risk in the near future provide the same level of transparency and accessibility as those used in market or credit risk. This is a must if we want to effectively integrate operational risk in a comprehensive system of risk management. Of course, it is always possible to improve a measurement model, whether or not operational risk. However, it is necessary to remain careful in front of the methodological arms race of these last years.

There is no denying that the level of technicality required from a risk manager sharply higher. Simply, it must be remembered that a "good" model is primarily a useful model in practice.

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