Operational Risk modeling: A Review

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ABSTRACT

There are different types of risks: credit, fraud, market risk and so on. However, there is a special interest in operational risk. The reason that supports this idea is based in the international normatives like Basilea III and Solvency II. If there is a risk with the ability to affect the whole operation of a Company, is the operational because it's related with the business core. This must be managed with rigor and it's just an important as the others.

Having an operational risk administration system is a need and an obligation for every financial Company in Colombia. The Superintendencia Financiera, forces the financial entities under its vigilance to develop one. In addition, this system should be capable of identifying, measuring, controlling and monitoring all operational risks across all the business processes. This article is focused in methodologies to measure this risk.The principal quantitative models are presented, a comparison among them is made and the principal problems to develop this kind of models are mentioned.

Palabras Clave: **operational risk, aggregation problems, copulas.**

I. INTRODUCTION

The circular externa 041 – 2007 defines operational risk as "the likelihood of losses resulting from inadequate or failed internal processes, people and systems, or from external events (including legal risk)". For the characteristics of this risk, it's possible to minimize it but not eliminate it.

In Colombia, the Superintendencia Financiera forces the financial entities under its vigilance to develop an operational risk system called SARO for his Spanish initials (Sistema de Administración de Riesgo Operativo). It has four stages: identification, measurement, controlling and monitoring. The first one is the part which the risk administrators should begin to work in. Is in this part of the system where all the operational risks are known; it involves a deep analysis across all the business processes. A very common tool used in this stage, is creation of a matrix's risk.

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The second part of the system involves the qualitative and quantitative models. In this particular stage, the likelihood of every risk is measured and for that reason, it is the one that presents the biggest challenges across all the system.

On the other hand, the controlling stage is about the compilation of politics, procedures and standards created to minimize the risks.

Finally, the monitoring is the part where is possible to do a continuous examination of the whole system and of course, it brings the possibility of making changes.

II.THE PROBLEM

Even when the private companies could have many different goals, they share their biggest interest: increase net profits. If there's something that could lead an organization to the end is an insolvency issue. Operational risk is one of the principal insolvency's causes and that's because it is related to the business's heart.

As mentioned before, the SARO allows entities to understand this risk. Even when the four stages of the system are important, the measurement part involves biggest issues. For instance lack of useful data, etc. This is why is so much easy for the risk administrators to use qualitative modeling rather quantitative models. Even when the first methodology is accepted, it's subjective and as Ramona hassaid it's impregnate of the investigator's points of view[1].

As a result, the financial sector has the need to implement quantitative models gradually. The literature has shown different quantitative techniques applied to this risk. However, there is still a need for innovation. The most important thing to understand is that not only the academy should investigate or create the models, but also the companies.

In short, this article is focused on the following questions: What are the common techniques used to measure operational risk? What are the biggest problems presented when a company tries to develop a quantitative model? The dependency among risks should be study? It's necessary to study heavy - tail operational risk events?

III. QUANTITATIVE MODELLING

a. Common quantitative techniques.

Basically, Basilea II recommendations [2]are these three different techniques: Basic Indicator Approach – (BIA), Standarized Approach – (SA) and Advanced Measurement Approach – (AMA). The first and second ones are simple indicators, easily to implement. The AMA represents the advance recommendation. Bedoya [3]mentioned the AMA's classification: Internal measurement Approach (IMA), Loss Distribution Approach (LDA) and Scorecards.The LDA is the most common and accepted.

In general, the LDA comes from the actuary [4]and his propose is to find a loss distribution. This methodology has been applied in credit risk and market risk systems also. In operational risk terms, it's the most used. It's knownas the best way to find the Operational Value at risk also (OPVAR), which means the maximum losses, with a specific holding time period and using a confidence level. (It's similar to the market value risk VAR, introduced in 1989 by JP MORGAN).In this context, the Var represents the α *quantile*.

Feria, Jiménez & Martín (2007) have explained the LDA properly[5]. Firstly, the study of each intersection between risk j and process i should be made. For each one, it's necessary to model two independent variables: Frequency and Severity which are modeled separately. The $N(i,j)$ represents the j risk events for the business line i. The $X(i,j)$ represents the losses associated. S (i,j) is the aggregate loss. The next equation is taken for their research and accurately explains how it works.

$$S_{j=} \sum_{i=1}^{N_j} X_{ij} \quad (1)$$

In order to accomplish this first phase, different tests are required. The most common distribution used for Frequency are the poisson, the binomial and the negative binomial. For the severity, the Weibull, lognormal and gamma distributions are the most used.

Particularly, Piacenza (2012) has shown an alternative to the severity distribution whose body and tail could model separately as well, delimited by a high threshold value u[6].

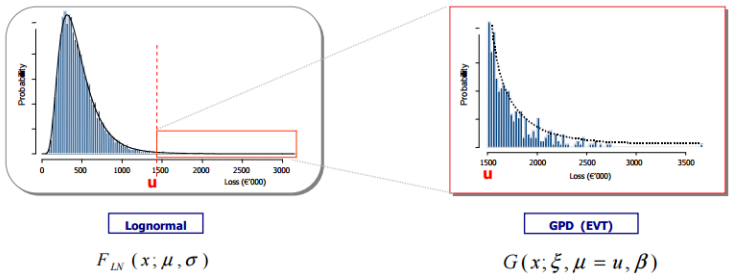

Fig.1. Piacenza (2012). This graphic belongs to Piacenza research and it's an example of constructing the severity distribution separating body and tail. The abscissa represents the value x of the function and the ordinate the probability.

The next step for the LDA consists in finding the aggregate distribution for each intersection between risk and business line. An analytical answer for this distribution, is not easy to find.

Alternatively, Franco shows that it may be found like the n-convolution of the severity, where the Frequency represents the weights [7]. This distribution could be obtained by different methods: the Montecarlo simulation, the Panjer procedure, and others. The most common way to get it is using Montecarlo simulation. G represents the distribution of S, P represents the Density function of N and F is the distribution of X. n* denotes the convolution. The next equation is taken for the Feria, Jiménez & Martín research and shows this idea[5].

$$G_{i,j}(X) = \begin{cases} \sum_{n=1}^{\infty} P_{i,j}(n) F_{i,j}^{n*}(X) & X > 0 \\ P_{i,j}(0) & X = 0 \end{cases} \quad (2)$$

When the aggregation distribution is found, it's possible to apply the concept of Value at risk which represents a percentile. The 95% confidence level is often used. The companies either apply it or the 99%. This must be done for every intersection. At that point, a question should be answered. How should the global Var be found? A common option and a used one, is to summarize all the Var.

b. Aggregation problem.

Even if summarizing the Value at risk of each intersection is an easy solution to find the Global Var, it has some issues. The problem it based in the next statement: this procedure assumes perfect dependency among the distributions.

As a matter of fact, Mora explains that it would be easy to overestimate the value at risk, if the subadditivity principle were accomplished[8]. And it would be even easier to

underestimate the VAR, if that principle were not applied. That implies that an aggregation problem exists.

A Statistical procedure that could be used to solve this issue is called Copulas Theory. Nelsen has explained how this procedure works[9]. A Copula is a multivariate distribution function C, with marginal functions distributed uniformly in [0,1]. A copula is a very useful technique because it allows seeing the dependency of the marginal functions, even when they have different forms and it is capable to find non-linear dependency as well.

$$F(x_{1\ldots\ldots}x_{n)} = C(F_1(x_1), \ldots, F_n(x_n))(3)$$

This is the Skar's theorem and F is a n-dimensional distribution function. C is the Copula and the individual F are the marginals. - Piacenza (2012)

There are different types of copulas. The common families are the Gaussians copulas and the Arquimedianas. Basically, in operational risk terms, an overall loss distribution can be obtained through a Copula.

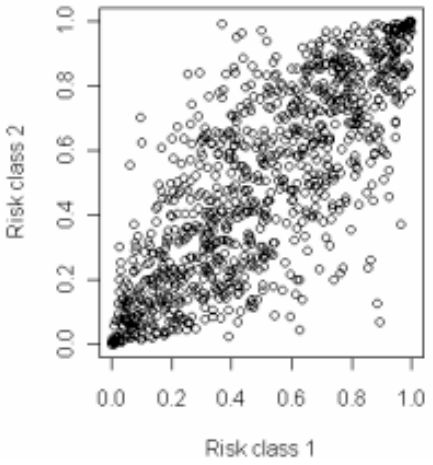

Fig.2. This graphic belongs to Piacenza research and it shows an example of a bivariate copula which represents the behavior and dependency between two types of risk.

This recommendation has also been made for Dalla Valle, Fantazzini & Giudici in their operational risk study[10]. Initially, they applied LDA to a database assuming perfect dependency. In contrast, used the same data but applied Normal Copula and a T-student Copula among severity distributions. After that, a comparison among the three scenarios was made and finally they found that the OPVAR was smaller when the copulas had been applied.

The Bank for International Settlements (2011) explains that currently the Gaussian copula is the most used in order to improve the LDA methods[11]. However, using this technique is not always simple because it's required to have good data, particular software and of course, human experts.

C.Another techniques.

Finally it's important to say that there are other statistical tools that can be used to solve this problem. The Bayesian networks are the perfect example. Posada dida different implementation focused on operational risk[12]. Even when it is a good technique, the disadvantage is the next: if the relationships among attributes were vague or incorrect, the risk measurement would have wrong results.

On the other hand, Allen & Balli[13], mentioned by Moosa [14] and Mora[15], worked with linear regressionsThey used an interest approach, combining market, credit and others risks as independent variables and they left operational risk as a dependent attribute. However, (depending on the researcher criteria) having all the assumptions of this approach would not be completely accurate at some point.

IV.CONCLUSSIONS

If there's something that could lead an organization to the end is an insolvency issue. Operational risk is one of the principal insolvency's causes and that's because it is related to the business's heart. Having an operational risk administration system is a need and an obligation for every financial Company in Colombia.

In addition, this system should be capable of identifying, measuring, controlling and monitoring all operational risks across all the business processes. Even when the four stages of the system are important, the measurement part involves biggest issues. For this reason, is so much easy for the risk administrators to use qualitative models. Even when this kind of models is accepted, it's subjective. For that reason, quantitative models should be used instead qualitative techniques.

In the literature, there are recommendations for applying quantitative models. The most common is the Loss distribution approach. However, there is the need to improve this technique and solve problems like aggregation and heavy tails - events. The Copulais believed to be a technique that might be implemented to solve this issue but more applications are needed to confirm this idea.

Even with this quantitative methods mentioned, measuring operational risk is not an easy thing to do. The biggest challenge are related with the poor data base that the companies have. Every organization should be committed

with the construction of an operational risk matrix event, in order to apply a quantitative model gradually.

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