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An application of capital allocation principles to operational risk and the cost of fraud

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ABSTRACT

The costs of operational risk refer to the capital needed to cover the losses generated by a firm's ordinary activities. In this paper several capital allocation principles are examined to demonstrate how such principles can be used to distribute aggregated capital across the various constituents that generate operational risk. Proportional allocation, for example, allows a cost per unit to be calculated. An application to fraud risk in the banking sector is presented and correlation scenarios between business lines are compared.

1. Introduction and motivation

Risk management in business concerns itself with anticipating the potential losses a firm might suffer and with designing methods that can either mitigate such losses or compensate for them. It is a field of intense research given that security and protection are essential elements of quality control.

In ordinary business operations, risks of malfunction or operational risks - including, software failures, electricity cuts, human errors, internal and external fraud, etc. – are almost inevitable and as such are a constant burden on expected profits. Expected operational losses can be integrated as a fixed cost component of production, while it is necessary to reserve a capital sum to offset any unexpected operational losses and, thus, respond to exceptional operational risk events.

Here, we address the costs of operational risk and calculate the proportion that each unit of production should contribute to the total capital held to cover this risk. A *constant* allocation involves dividing the total capital by the number of production units regardless of the contribution each unit makes to aggregate operational risk; a *proportional* allocation increases the contribution of those units that represent a greater risk; and, an *optimal* allocation considers the contribution of each unit in relation to the dependence between risks within a firm.

We examine an example concerning the risk of fraud in banking. Our simplified scenario centers on a bank with just two lines of business: credit cards and savings accounts. Losses attributable to fraud occur in these two services and, as such, represent a key area of research. Managers can predict the annual average loss due to fraud in these two services independently and, thus, include the expected loss as part of the general management costs of credit cards and savings accounts, respectively. However, additional capital needs to be held to offset exceptional exposure to risk from fraud in either of the two lines and, here, there are various methods for determining how much capital should be provided by the credit card business and how much by the savings account business. Yet, assuming independence between lines of business is unrealistic. It has been widely documented that the propensity for fraud fluctuates with exogenous factors that create spurious correlations between business units (Viaene, Ayuso, Guillén, Van Gheel, & Dedene, 2007). Factors such as economic recession; social networking, where people share information about the *modus operandi* of successful fraudulent activities; and periods of the year when consumers are more prone to defraud affect all business lines at the same time (see, for instance, Caudill, Ayuso, & Guillén (2005)). We address how to deal with this dependence between fraud risks in the two-dimensional setting of credit card and savings account fraud (see Fig. 1). It is worth noting that similar applications have been examined in the context of the automobile insurance (Ai, Brockett, Golden, & Guillén, 2013; Artis, Ayuso, & Guillén, 1999, 2002; Viaene, Van Gheel, Ayuso, & Guillén, 2004).

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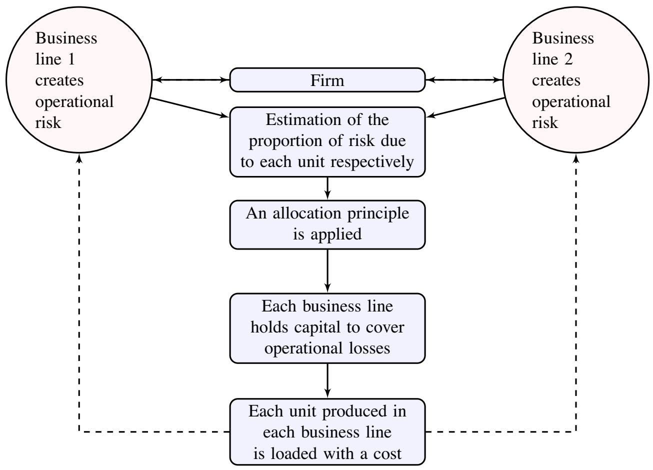

Fig. 1. Operational risk assessment system in a firm with two business lines.

In general, companies seek to allocate capital to their business units for reasons of solvency. Moreover, banks and insurance companies are legally required to set aside an amount of capital so as to guarantee their solvency and so they seek to associate this capital, and hence the loss of returns, to each single unit as a price loading or *risk premium*. The mere existence of operational risk means firms are advised to retain some capital, unless they prefer to purchase an insurance policy to cover operations failures. In this latter case, rather than capital, firms are required to take out an insurance policy, which in the terms described here can be considered an equivalent problem (see, Guillén, Gustafsson, & Nielsen, 2008).

The use of economic capital and its decomposition into a sum of single contributions of sub-businesses has become a standard approach in many banks (see, Rosen & Saunders, 2010) and insurance companies. Myers and Read (2001) and Das and Kratz (2012) propose alarm systems that signals possible ruin based on pattern of premium collection and demands for claim settlement.

The problem of operational risk arising from several risk sources is increasingly present in many areas. Buch, Dorfleitner, and Wimmer (2011) develop a procedure concerning capital allocation that is designed to maximize the Return On Risk-Adjusted Capital (RORAC) of a company. They consider conditions that are required for capital allocation to be a useful tool for obtaining the optimal value of a return function of a decentralized financial firm. They regard the maximization problem as a managerial control problem and embed it into a general systems framework. Zaks and Tsanakas (2014) extend the optimal capital allocation framework of Dhaene, Tsanakas, Valdez, and Vanduffel (2012) and they achieve a compromise between conflicting views of risk within the organization. They allow potentially diverging risk preferences in a hierarchical structure. where stakeholders at two organizational levels (e.g., board members vs line managers) may have conflicting objectives, preferences, and beliefs about risk.

Additionally, capital allocation for operational risk can be a useful tool or indicator for measuring performance and serve as the basis for management incentive schemes (Bolancé, Ayuso, & Guillén, 2012; Bolance, Guillén, Gustafsson, & Nielsen, 2013). Indeed, managerial performance can be assessed by the amount of capital allocated to a firm's respective business units.

Note that while capital allocation is the focus of this study, we do not seek to establish how a firm should determine the capital sum to be allocated, since this is dependent on other characteristics, such as risk aversion and regulatory rules. Thus, we assume the capital to be held for operational losses as given. The main problem we concern ourselves with is the so-called *allocation problem*. Based on the general framework proposed by Dhaene et al. (2012), we provide explicit formulations for different sources of risk of the proportion of capital a manager should allocate.

Our specific contribution is to provide an exact functional form of each allocation principle. In addition, we study the role of correlation. In this context, the correlation effect refers to changes in allocated capital resulting from the correlation between the losses arising in different sources of risk. We show that, in practice, these correlations influence capital allocation (Boucher & Guillén, 2011; Buch-Kromann, Guillén, Linton, & Nielsen, 2011; Englund, Guillén, Gustafsson, Nielsen, & Nielsen, 2008; Sarabia & Guillén, 2008).

Chavez-Demoulin, Embrechts, and Nešlehová (2006) assume that there is some dependence between segments of a firm. Cossette, Mailhot, and Marceau (2012) focus on the computation of the tail value at risk (TVaR) and the TVaR-based allocation for multivariate compound distributions, so they also consider dependence. They provide general formulas for the cumulative distribution function of total cost and the contribution to each risk and they only obtain closed-form expressions for these quantities for multivariate compound distributions in some particular cases, for instance, with gamma and mixed Erlang claim amounts.

In all those approaches the existence of dependence between segments is admitted but its consequences remain rather unexplored.

Many recent contribution propose fraud detection systems in a variety of situations. Jha, Guillén, and Westland (2012) explore fraud in credit cards. Ngai, Hu, Wong, Chen, and Sun (2011) present a comprehensive academic literature review of the data mining techniques that have been applied to financial fraud detection. However, the cost aggregate cost of fraud is usually neglected and how should customer cover this potential loss has not been addressed literature because it is generally assumed that the cost if part of the general budget of a company.

Our research is about the cost of operational risk and how this capital is assigned to each business segment, so we shown an implementation of capital allocation in firms where dependence between segments exists. In our contribution we provide explicit expressions to compute the allocation for some simple cases of risk measure and allocation criterion. We also show how to solve a problem where there are two sources of fraud that produce losses to a bank. We design a system to calculate how much proportion of the capital to cover operational risk arising from fraud should be reserved in each segment and we show that if dependence is taken into account then allocation is not strictly proportional to volume.

The remainder of this article is organized as follows. Section 2 discusses formally what the allocation problem is. The allocation principles are presented in Section 3 while the general framework for capital allocation, based on Dhaene et al. (2012), is also discussed there. An application to fraud is reported in Section 4 and some concluding remarks are provided in Section 5.

2. The general capital allocation problem in risk management

Capital allocation refers to the subdivision of aggregate capital held by a firm across its various constituents, which might be business lines, types of exposure, territories, or even individual products in a portfolio of insurance policies.

Consider a portfolio of n individual random losses $X_1, X_2, \ldots, X_n$ arising from different business lines, materializing at a fixed future date T. Assume that random vector $(X_1, X_2, \ldots, X_n)$ is defined on the probability space $(\Omega, \mathcal{F}, \mathbb{P})$. We assume that any loss X_i has a finite mean. The distribution function $\mathbb{P}(X_i \leqslant x)$ of X_i can be denoted by $F_{X_i}(x)$. The aggregate loss is formally defined as:

$$S = \sum_{i=1}^{n} X_i \quad i = 1, \ldots, n. \tag{1}$$