Operational Risk Management: Optimal Incentive Contract

Financial services firms are subject to various types of risks, in particular credit risk, market risk and operational risk. Of these three types of risks, operational risk, commonly referred to as OpRisk, is a type that can cause substantial damage. In this paper, we study how a financial firm can offer incentive bonus contracts to its employees so as to incentivize them to exert efforts in reducing potential operational risk losses. We consider operational risk events as shocks characterized by a compound Poisson shock process to the financial firm’s payoff function, and then characterize the impact of efforts exerted by its employees on the shock process. The efforts exerted by the employees may help reduce the frequency of the operational risk events and/or lower the severity of a shock if an event occurs. The impact of such efforts would change therefore the stochastic nature of the compound Poisson process. The incentive bonus is based on how much effort each individual exerts. Each employee needs to balance the trade-off between the effort based wage and the cost of the efforts (in a non-monetary form) to him or her. The firm then has to decide (i) whether or not to pay out such incentive bonuses to its employees, (ii) which employees to award bonuses to, and (iii) how much of an incentive bonus to award. Each employee now needs to balance the trade-off between the effort based incentive bonus and the personal cost of his/her efforts.

We first characterize the equilibrium strategy between the firm and its $n$ employees, and show that the optimal incentive bonus for each individual is jointly determined by the expected operational risk losses and the risk reduction performances of all the other employees. We then show that the optimal incentive bonus may either increase or decrease in the total expected operational risk losses depending on the log-convexity or log-concavity of the risk reduction function of each employee. We proceed with a discussion on the conditions under which and to whom to award an incentive bonus, and we also provide an upper bound on the optimal incentive bonus. In addition, we find that if a sub-additivity property holds for the firm’s risk reduction function and the production efficiency of one employee dominates all others, then only this one particular employee receives a bonus. At the end of the discussion of our main model, we consider a special case with a homogeneous workforce of $n$ similar employees and we show
how the optimal incentive bonus depends on the number of employees $n$. We characterize the asymptotics of the optimal incentive bonus when the firm has a large number of employees. We show that the minimum total expected cost in the non-homogeneous case is always less than in the corresponding homogeneous case, which illustrates the advantage of workforce diversity.

We then extend our main model to three more general settings: (i) a general risk reduction function, (ii) a specific risk reduction function taking into account correlations between the efforts by non-homogeneous employees, and (iii) a specific risk reduction function taking into account correlations between the efforts by homogeneous employees. For all three cases we characterize the equilibrium strategy and discuss the conditions under which and to whom to award incentive bonuses. We find that with a positive (negative) correlation factor, the firm is more (less) likely to award bonuses than with no correlation. Moreover, when the correlation between employees is very high, regardless of its sign, the optimal bonus is always very small. Finally, the minimum total expected cost always goes down with a higher level of correlation. To be more specific, with a positive correlation factor, the minimum total expected cost is lower than in a setting with no correlation, which shows the positive effects of an effective collaboration. However, with a negative correlation factor, the minimum total expected cost is higher than in a setting with no correlation, which shows the negative effects of an unproductive collaboration.

At the end, we conduct numerical experiments to illustrate some of our main insights using an example from industry. We utilize a unique data set from a bank in China, which has 49 branches and a total of 675 employees. This data set covers 1441 operational risk events that occurred between August 22nd, 2013 and April 30th, 2015. We first show that both the optimal incentive bonus and the minimum expected cost go up with a higher risk frequency level and risk severity level. However, the increment decreases with the risk frequency level. This result always holds with or without correlation. Second, the minimum total expected cost in the non-homogeneous case is always less than in the homogeneous case, which shows the advantage of employee diversity. Third, both the optimal incentive bonus and the minimum total expected cost are higher under negative correlations than under positive correlations. In addition, under negative correlations both the optimal incentive bonus and the minimum total expected cost are higher than with no correlation, while under positive correlations both the bonus and the total
cost are lower.

The contributions of this paper are three-fold. The first contribution lies in the modeling framework. We establish a general modeling framework to characterize the relationship between a financial services firm and its employees for managing the operational risk the firm is exposed to. Such a framework is often used in the economics and operations management literature. We are able to obtain closed-form solutions for the equilibrium strategy within this general framework. Quantitative models in the operational risk literature tend to focus on the quantification of operational risk losses. Therefore, to the best of our knowledge, our work is the first to develop a moral hazard type setting specifically for operational risk management. We introduce this way a new type of operations-finance interface.

Our second contribution lies in the managerial insights we obtain through this modeling approach. We characterize the equilibrium strategy, and show how the optimal incentive bonus depends on the firm’s expected operational risk losses. We further characterize the conditions under which the firm would award incentive bonuses. In the special case when the employees are homogeneous, we show how the optimal incentive bonus depends on the number of employees. In the end, we are able to discuss the impact of both positive and negative correlation factors among the employees’ efforts. These managerial insights may help financial firms with the adoption of such incentive bonus systems and in the design of the underlying mechanisms. Furthermore, these insights also may help guide firms in considering the potential impact of the correlation between its employees’ efforts.

Finally, we are able to apply our modeling framework to industry practice using a unique data set from a commercial bank in China. We are able to further illustrate some of our main insights in real world practice. We show how our proposed optimal incentive bonus contracts can help a financial firm manage its operational risk losses. The experiments suggest that this particular bank should, in the management of its operational risk, award between 7.26% and 48% of its employees’ annual salaries as incentive bonuses. Our computations show that such an investment would help reduce the bank’s operational risk losses significantly.