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Risk Appetite
Reaching for the Efficient Frontier

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Context

Internal Audit provides independent assurance over the design and effectiveness of an organization's risk appetite framework (Deloitte, 2014) and supports management in monitoring that activities are consistent with its risk appetite (Rittenberg & Martens, 2012, p.2). Risk appetite is defined by COSO (2004) as the 'the broad-based amount of risk an entity is willing to accept in pursuit of its mission/vision' (p.110).

There exist several normative criteria for the design of a quantitative risk appetite. Risk appetite can be based on the expected value criterion of risk neutrality (Huygens, 1657). This criterion supports the idea of a single optimal risk appetite. Another criterion is the mean-variance criterion of risk aversion (Markowitz, 1952). This criterion allows for a set of optima, located along what is called an 'efficient frontier', on which higher expected costs are traded-off against lower variances and hence lower risk.

In risk management risks that are outside an organization's risk appetite can be treated by either reducing the risk's impact or its probability of occurrence. Both risk reduction strategies lower the expected cost of risk and thus are each other's substitute. The impact reduction strategy is, however, superior to the probability reduction strategy in lowering variance. It is consistent with a risk averse attitude and, given identical marginal costs of impact and probability reduction strategies, the only risk reduction strategy that leads to optima for risk appetite along the efficient frontier. This characteristic of the impact reduction strategy is not described in risk management literature.

Principal-agent theory (Laffont & Martimort, 2002) suggests that financial incentives can be used to stimulate or discourage risk averse behavior. Financial incentives could thus be used to stimulate movements along the efficient frontier towards risk aversion using fixed incentives and towards risk neutrality using variable incentives.

Hypotheses

To assess whether laymen and risk professionals act in line with known criteria for risk appetite and can be stimulated by financial incentives the following hypotheses were tested in an experimental setting:
H1a: The risk appetite of risk professionals results more frequently than laymen in optimal choices that are located close to the efficient frontier.
H1b: Risk professionals apply the combination of expected value calculation and impact reduction more frequently than laymen.
H2: A fixed incentive stimulates risk aversion in participants.

Methods

To test these hypotheses an experimental game was designed that was based on the risk matrix, a popular tool is risk management. The game is programmed in VBA for MS Excel. The screenshot in figure 1 (a) shows the two risk matrices that are used to elicit choices from the participants and the screenshot in figure 1 (b) shows bar-charts and a box with summary information on selected risks.
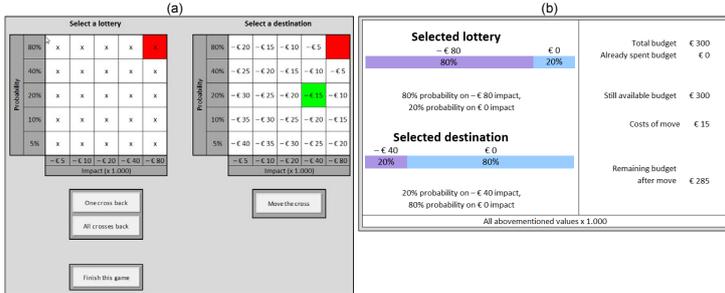
Figure 1. Left side (a) and right side (b) screenshot of the computer programme used to elicit choices.

Participants were given a matrix containing 25 risks (lotteries), each signified by the symbol "x" and a budget that could either be spent on risk mitigation or be used as a buffer to protect against losses. Risk mitigation entails moving a risk in the risk matrix, by reducing either impact or probability or both. The remaining buffer after risk mitigation is used to protect against the losses of a random draw for all of the 25 risks.

To stimulate participants to employ a variety of strategies, separate groups were exposed to two incentive conditions:
- A fixed fee condition that stimulates participants to act risk averse, avoid a ruinous loss and survive the game.
- A variable fee condition that stimulates participants both to avoid a ruinous loss and to minimize expenditures on risk reduction.

Details of the experiment
Lecturers of a Dutch business school (n=34) were chosen to represent the laymen. Among large companies risk professionals were recruited to participate in the experiment (n=56). The mean age of laymen was 42 and that of risk professionals 46, this is not a significant difference (T-test, p = .081). The distribution of sexes was 29% female in the laymen group and 20% in the group risk professionals. There is no significant relation between the variables group and sex (Chi-Square test, p = .288).

Results

H1a: The risk appetite of risk professionals results more frequently in optimal choices that are located close to the efficient frontier.
The median (mean) expected outlay of risk professionals was -173K (-186K) compared to -180K (-195K) in the laymen group. This is not significantly different (Mann-Whitney U test, 1-sided p = .053). The median (mean) probability or ruin for risk professionals was 1.2% (3.5%) and for laymen 1.8% (6.2%). This is not significantly different (Mann-Whitney U test, 1-sided p = .484). Figure 2 shows the simulated performance of laymen and professionals. The difference in normalised distance to the efficient frontier between laymen and risk professionals groups were, however, not significant (Mann-Whitney U test, p = .330).
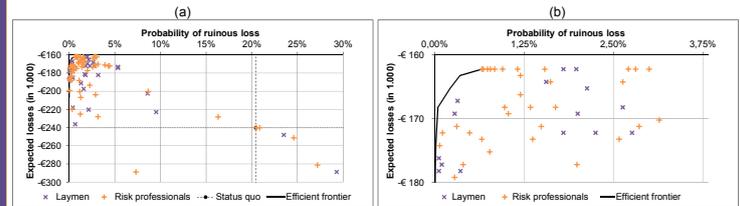

Figure 2. Simulated performance of laymen and risk professionals with all participants (a) and zoomed in on the section close to the efficient frontier (b).

H1b: Risk professionals apply the combination of expected value calculation and impact reduction more frequently than laymen.
In the group of risk professionals 6 out of 56 participants employed expected value calculation in combination with only impact reduction. None of the laymen employed this strategy. There is no significant relationship between the groups and the use of expected value calculation (Fisher's Exact test, 1-sided p = .052).

H2: A fixed incentive stimulates risk aversion in participants.
Figure 3 shows a summary of the decisions made by laymen and risk professionals in the experiment.

(a)	Total moves	Impact reducing moves (median fraction)	Probability reducing moves (median fraction)	(b)	Total moves	Impact reducing moves (median fraction)	Probability reducing moves (median fraction)
Variable incentive	11.5	5.5 (0.50)	5 (0.50)	Variable incentive	15	7 (0.47)	9 (0.53)
Fixed incentive	21.5	8 (0.43)	12 (0.57)	Fixed incentive	11	5 (0.27)	7 (0.53)
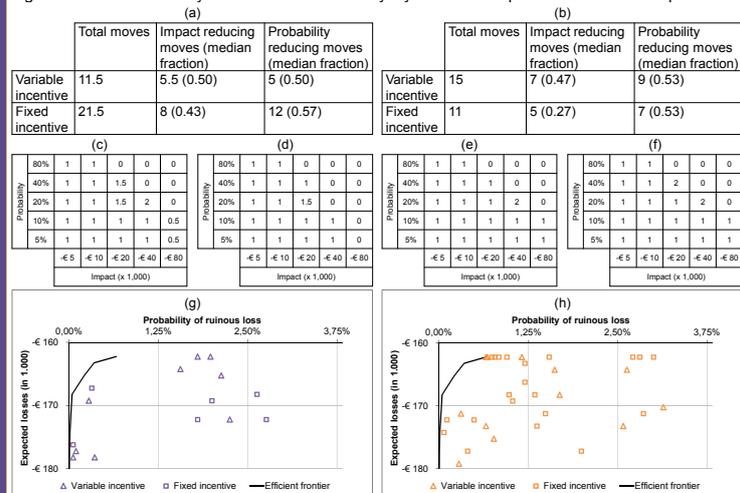
Figure 3. Summary of the decisions made by laymen and risk professionals in the two incentive conditions, with the total moves and distribution over impact and probability for laymen (a) and professionals (b), the median number of lotteries in each cell after mitigation for laymen with variable (c) and fixed incentive (d), and professionals with variable (e) and fixed incentive (f), and a plot of the simulated performance near the efficient frontier of laymen (g) and professionals (h).

In the laymen, there is a significant difference between the total moved lotteries between the two incentive conditions (Mann-Whitney U test, p = .010), though there is no significant difference between the fraction of impact reducing moves (Mann-Whitney U test, p = .484). The median of cell (.20 : -40K, 0) is significantly different in the incentive conditions (Mann-Whitney U test, p = .025). There is also no significant difference between expected outlay and probability of ruin or distance to the efficient frontier in the two conditions for laymen.

In the risk professionals there is a significant difference between the diagonally mirrored cells with identical expected value (.40 : -10K, 0) and (.10 : -40K, 0) in the variable condition (Wilcoxon signed rank test, p = .039), which implies risk aversion. There is also no significant difference between expected outlay and probability of ruin or distance to the efficient frontier in the two conditions.

Conclusions

In the experiment risk professionals and laymen did not differ in their application of known criteria for designing risk appetite. The extent to which these criteria were used is very limited. Financial incentives do not consistently influence risk appetite in the direction that was predicted by principal-agent theory. This suggests a need for creating more awareness among risk professionals of both the merits of expected value calculation and impact reduction.

References

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