Study Guide on the Value of Risk Reduction for the Casualty Actuarial Society (CAS) Exam 7

(Based on "Value of Risk Reduction" by Gary Venter and Alice Underwood)

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Source: Venter, G.G.; and Underwood, A., "Value of Risk Reduction," CAS Study Note, 2010.

This is an open-source study guide and may be revised pursuant to suggestions.

Problem S7-VRR-1.
(a) What does the Modigliani-Miller theory suggest regarding the undertaking of risk mitigation by a firm owned by diversified investors?
(b) What simplifying assumption does Modigliani-Miller theory have (as mentioned by Venter and Underwood), which does not correspond to reality?
(c) In the model of de Fineti, how are the assumptions "almost exactly opposite" to those of Modigliani and Miller?
(d) How do the assumptions of de Fineti compare to the real world?
(Venter and Underwood, p. 2)

Solution S7-VRR-1.
(a) The Modigliani-Miller theory suggests that any risk can be diversified against broader holdings of the owners, so it is not worthwhile for a firm to incur costs to mitigate risks.
(b) One simplifying assumption of the Modigliani-Miller theory that does not correspond to reality is that distressed firms have access to unlimited new capital with no extra costs or conditions.
(c) The model of de Fineti assumes that a firm has no means to raise capital except for retained earnings. This is the opposite of the Modigliani-Miller of unlimited external capital at no extra cost.
(d) The assumptions of de Fineti are fairly representative of distressed firms, though they generally do not apply to healthy firms.

Problem S7-VRR-2. Briefly describe four general motivations for firm-specific risk reduction (Venter and Underwood, pp. 3-5).

Solution S7-VRR-2. 1. *Financial distress can be costly.* → Difficulties for distressed firms in raising new capital.
2. *Agency issues*: Potential conflict between principals (owners) and agents (managers) and incentives to minimize such conflicts by engaging in risk mitigation that satisfies shareholders, debtholders, and other stakeholders on whose behalf management is supposed to make decisions. Also, risk mitigation prevents situations of financial distress where shareholders and management become less risk-averse than debtholders.
3. *Regulation and taxation* provide motivations for hedging risk.
4. *Relationships with stakeholders* can be damaged by excessive risk and financial distress.

Problem S7-VRR-3. Briefly describe three insurance-specific issues that enhance the desirability of using risk management to avoid financial distress (Venter and Underwood, pp. 5-7).

Solution S7-VRR-3.
1. *Agency theory complications*: Policyholders are the principal debtholders and sometimes the owners of the insurance company. Policyholders typically have more influence over the insurer than typical debtholders, because they are also the customers, and the insurer's relationship with its customers may be damaged in cases of financial distress.
2. *Insurers are particularly vulnerable to financial distress*. The insurer's promise of making a future payment becomes much less valuable if the insurer is in a vulnerable financial condition.
3. *Reinsurance as the dominant means of hedging risk* → Greater transparency with regard to an insurer's use of risk transfer.

Problem S7-VRR-4.
(a) Describe the conceptual essence of the model of de Fineti (1957) regarding the value of a firm.
(b) Conceptually, how do Gerber and Shiu (2006) refine de Fineti's model? (Venter and Underwood, p. 8)

Solution S7-VRR-4.
(a) The model of de Fineti expresses the value of the firm as the present value of all future dividends paid to shareholders.
(b) Gerber and Shiu use a general severity distribution that could approximate many actual distributions. They focus on dividend-paying strategy to optimize the value of the firm and conclude that the optimal strategy is to pay no dividends if capital is below a certain level, and to pay out any capital beyond that level.

Problem S7-VRR-5. List the four approaches discussed by Venter and Underwood for quantifying the value of risk transfer for insurers (Venter and Underwood, pp. 8-9).

Solution S7-VRR-5.
1. Simple multiplier methods
2. Efficient-frontier comparison
3. Cost of allocated risk capital
4. Estimates of firm value under different strategies

Problem S7-VRR-6. Describe the conceptual essence of the simple multiplier approach to estimating the costs of financial distress. (Venter and Underwood, p. 9).

Solution S7-VRR-6. Simple multiplier approach: Look at the historical costs of distress and estimate loss of future earnings capacity by applying a multiplier to the actual financial loss.

Problem S7-VRR-7.
(a) Describe the conceptual essence of using efficient-frontier comparisons for estimating the costs of financial distress when comparing reinsurance programs.
(b) What is one challenge in using efficient-frontier comparisons?
(Venter and Underwood, pp. 9-10).

Solution S7-VRR-7. For each proposed reinsurance program, estimate probabilities of various levels of distress. Measure the cost of each reinsurance alternative as expected payments to the reinsurers, minus expected recoveries. For each distress threshold, do an "efficient-frontier" comparison, selecting the program where no other program or linear combination of programs gives a more favorable result at the selected distress threshold.
(b) For a particular distress threshold, there may be multiple "efficient" alternatives, and the method provides no definitive guidance as to how to select among those alternatives.

Problem S7-VRR-8. (a) Briefly describe the essence of the approach involving the *cost of allocated risk capital*.
(b) What two questions does this approach raise? (Venter and Underwood, p. 10).

Solution S7-VRR-8.
(a) Apply an economic-capital model to the simulated results, net of reinsurance alternatives. Compare the difference in the cost of the reinsurance programs to the difference in the cost of risk capital.
(b) 1. Which capital measure is most appropriate (e.g., VaR, TVaR)?
2. What threshold probability should be selected to define the tail of the probability distribution? (Or should one even use a tail-based measure?)

Problem S7-VRR-9. Suppose the risk-capital estimate for a 2-in-250 value at risk (VaR) without reinsurance is 150 million. The cost of a reinsurance program is 40 million, and the risk-capital estimate for a 2-in-250 VaR with that program in place is 30 million.
(a) What is the capital cost for each alternative, assuming that it is 8% of the risk capital?
(b) What is the gross savings in capital cost if the reinsurance program is selected, not considering the cost of the reinsurance program?
(c) What is the net savings in capital cost if the reinsurance program is selected?
(d) Based on this analysis, is it worthwhile for the firm to engage in this reinsurance program? Why or why not? (Venter and Underwood, p. 14)

Solution S7-VRR-9.
(a) With no reinsurance: Capital cost = 8%*150 million = **12 million.**
With reinsurance: Capital cost = 8%*30 million = **2.4 million.**
(b) Gross savings in capital cost = (Cost without reinsurance) – (Cost with reinsurance) = 12 million – 2.4 million = **9.6 million.**
(c) Net savings in capital cost = (Gross savings) – (Cost of reinsurance program) = 9.6 million – 40 million = **-30.4 million.**
(d) It is **not** worthwhile for the firm to engage in this reinsurance program, because the net savings in capital cost from the program are negative.

Problem S7-VRR-10. In the simple model of firm value described by Venter and Underwood on page 15, let E = expected annual earnings; let d = probability of distress; let r = the risk-free interest rate.
(a) What is the formula for D, the one-year discount factor?
(b) What is the formula for V, the value of the firm?
(c) What is the formula for M, the perpetuity-value multiplier?
(d) How does M relate E to V? Give the mathematical relationship.

Solution S7-VRR-10.
(a) D = (1-d)/(1+r).
(b) V = E*[D/(1-D)].
(c) M = D/(1-D).
(d) V = E*M.

Problem S7-VRR-11. Suppose that a company can either have no reinsurance or engage in a particular reinsurance program. Without the reinsurance program, its expected annual earnings will be $300 million. With the reinsurance program, the expected annual earnings will be $250 million. Without the reinsurance program, the annual probability of distress will be 2%. With the reinsurance program, the annual probability of distress will be 0.5%. The annual risk-free interest rate is 3%. We use the

(a) What is D, the one-year discount (i) without reinsurance and (ii) with reinsurance?
(b) What is M, the perpetuity-value multiplier (i) without reinsurance and (ii) with reinsurance?
(c) What is V, the value of the firm (i) without reinsurance and (ii) with reinsurance?
(d) According to this analysis, should the reinsurance program be selected? Why or why not?

Solution S7-VRR-11.
(a) (i) Without reinsurance: D = (1-d)/(1+r) = (1 – 0.02)/(1+0.03) = **D = 0.9514563107**.
(ii) With reinsurance: D = (1-d)/(1+r) = (1 – 0.005)/(1+0.03) = **D = 0.9660194175**.

(b)
(i) Without reinsurance: M = D/(1-D) = 0.9514563107/(1-0.9514563107) = **M = 19.6.**
(ii) With reinsurance: M = D/(1-D) = 0.9660194175/(1-0.9660194175) = **M = 28.42857143.**

(c) (i) Without reinsurance: V = E*M = 300 mln * 19.6 = **5.88 billion.**
(ii) With reinsurance: V = E*M = 250 mln * 28.42857143 = **7,107,142.86**.

(d) The reinsurance program **should be selected**. The estimated value of the firm is higher with reinsurance than without.