6 On the (Ir)Relevancy of Value-at-Risk Regulation

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6.1 Introduction

The measurement and practical implementation of the Value–at–Risk (VaR) criterion is an active and exciting area of research, with numerous recent contributions. This research has almost exclusively been concerned with the accuracy of various estimation techniques and risk measures. Compared to the statistical approach, the financial economic analysis of VaR has been relatively neglected. Guthoff, Pfingsten and Wolf (1996) consider the ranking of projects and traditional performance criteria, while Kupiec and O'Brien (1997) and Steinherr (1998) discuss incentive compatible regulation schemes. The wider issue of the benefits for society of VaR based risk management and supervision has hardly been addressed, see however Danielsson, Jorgensen and de Vries (1999b) and Danielsson, Jorgensen and de Vries (1999a). They consider the implications of externally imposed VaR constraints, the public relevance of the VaR based management and regulation schemes, and incentives for quality improvement. This paper summarizes the public policy aspects of this broader line of reasoning.

It is, first of all, important to understand the relation of the VaR measure to other risk measures. The VaR measure is reasonable if interpreted according to its stated intensions, i.e. when it is evaluated truly in the tail area. As demonstrated by Jorion (1998) account of the Long Term Capital Management crisis, VaR risk management is about the tail events. Evaluating VaR deep in the tail area yields good information about infrequent but extreme events about which one should not stay ignorant. Note the emphasis on extreme tail events is counter to most stated industry practice. In addition, the VaR criterion and related alternatives like expected shortfall, have their limitations due to presence of securities with nonlinear payoffs. VaR, as the sole risk objective, may distort bank actions towards excessive risk taking if it permits mangers to become overly focused on expected returns, as noted by Jorion (1998). Since a single minded focus on VaR and expected returns appears too simple minded, we feel that VaR should be modelled as a side constraint on expected utility maximization when structuring portfolios. This has the added benefit that the public relevance of VaR regulation and supervision is better captured by such an interpretation of risk management. When modelled as a side constraint, the VaR restriction can be viewed as a means to internalize externalities of individual risk taking to the financial system at large. To address this issue Danielsson et al. (1999a) discuss how the VaR side constraint affects the equilibrium allocation in a complete markets setting.

The complete markets setting necessarily results in VaR management by financial intermediaries being of limited relevance. We therefore investigate the signals of the VaR measure in incomplete markets. If security markets are incomplete, VaR requirements may correct for market failures. The VaR measure in an incomplete markets setting is unfortunately a double edged sword. Due to the second best nature, the imposition of a crude and sub-optimal VaR constraint may perversely increase the risk in the financial system. From the related literature on solvency regulation we know that crude regulation can enhance risk taking rather than reducing it, see Kim and Santomero (1988) and Rochet (1992). Danielsson et al. (1999b) discuss two cases of incomplete markets and VaR constraints, and demonstrate the possibility of adverse outcomes due to moral hazard and differences in attitudes towards risk taking in combination with limited knowledge on part of the regulators. Taking the limited information of supervisory agencies as given, the potential negative effects of crude VaR based regulation should ideally be minor in comparison to an easily identifiable overriding and glaring market failure to warrant the centralized regulation. We are, however, not aware of such an important market failure and suspect other motives play a role as well.

Using a public choice framework, we suggest that the drive for VaR regulation derives from the regulatory capture by the financial industry to safeguard its monopoly power and the preference of regulators for silent action instead of overt actions like bail outs. We also discuss decentralized alternatives to system wide regulation that may be better at coping with the market imperfections, and are such that these provide positive incentives for quality improvements in the risk management of market participants.

This paper is organized as follows. In section 2 we identify sufficient conditions under which minimizing VaR provides the same unambiguous signal as expected utility maximization and as Expected Shortfall, an alternative risk measure. Further, we discuss the implementation of expected utility maximization subject to attaining a VaR criterion. Section 3 analyzes the effects of introducing regulation based on VaR constraints in an incomplete markets setting. VaR regulation can have an effect even if the confidence level is not binding in the absence of VaR regulation. In section 4, we take a public choice perspective on the drive for VaR regulation. Section 5 summarizes the paper.

6.2 VaR and other Risk Measures

The VaR criterion has three distinct users: internal risk management, external supervisory agencies, and financial statement users (VaR as a performance measure). Although financial institutions are the most common users of VaR, a few non–financial corporations have started to use VaR and provide voluntary disclosures. We investigate conditions under which a VaR objective rank orders projects analogous to other risk criteria. The VaR measure computes the loss quantile q, such that the probability of a loss on the portfolio return R equal to or larger than q is below a prespecified low confidence level, δ:

$$P\{R \leq q\} \leq \delta. \tag{6.1}$$

If the confidence level, δ, is chosen sufficiently low, the VaR measure explicitly focuses risk managers and regulators attention to infrequent but potentially catastrophic extreme losses. An advantage of the VaR measure is that it may be computed without full knowledge of the distribution of returns R. That is, semi–parametric or fully non–parametric simulation methods may suffice.

In this section, we focus on the relation between the VaR concept and other risk measures in complete markets. We first discuss the established relation between VaR and utility theory. Danielsson et al. (1999a) consider risky projects that can be ranked by Second Order Stochastic Dominance (SOSD). They demonstrate that at sufficiently low quantiles, minimization of VaR provides the same ranking of projects as other risk measures, e.g. the First Lower Partial Moment, the Sharpe Ratio, and Expected Shortfall if the distributions are heavy tailed. Here we provide an alternative argument.

We start by ranking projects by expected utility. Under some conditions on the stochastic nature of projects, projects can be ranked regardless the specific form of the utility functions. To this end, we now introduce the SOSD concept as is standard in financial economics, see Ingersoll

(1987), p. 123, or Huang and Litzenberger (1988).

Definition 6.2.1 *Consider two portfolios i and j whose random returns R_i and R_j are described by cumulative distribution functions F_i and F_j respectively. Portfolio i dominates j in the sense of Second Order Stochastic Dominance (SOSD) if and only if*

$$\int_{-\infty}^{t} F_j(x)dx \geqslant \int_{-\infty}^{t} F_i(x)dx \ \forall t \tag{6.2}$$

or, equivalently,

$$E\left[U(R_i)\right] \geq E\left[U(R_j)\right], \forall U \in \mathcal{U}$$

where

$$\mathcal{U} = \{U : \mathbb{R} \to \mathbb{R} | U \in C^2, U'(.) > 0, U''(.) < 0\}.$$

Suppose the relevant risky prospects can be ordered by the SOSD criterion, and assume that R_i strictly SOSD the other prospects. Define the first crossing quantile q_c as the quantile for which $F_i(q_c) = F_j(q_c)$, for $x \leq q_c : F_i(x) \leq F_j(x)$, and for some $\varepsilon > 0$, $x\epsilon(q_c - \varepsilon, q_c) : F_i(x) < F_j(x)$. By the definition of SOSD, such a crossing quantile q_c exists, if it is unbounded First Order Stochastic Dominance applies as well. From the definition of the VaR measure (6.1) it is clear that for any $\delta \leq F_i(q_c)$ the VaR quantile q_j from $P\{R_j \leq q_j\} \leq \delta$ is such that $q_j \leq q_i$. Hence at or below the probability level $F_i(q_c)$, the VaR loss level for the expected utility higher ranked portfolio is below the VaR of the inferior portfolio. Minimization of VaR leads to the same hedging decision as maximizing arbitrary utility functions. The important proviso is that the confidence level, δ, is chosen sufficiently conservative in the VaR computations, but this comes naturally with the concept of VaR.

6.2.1 VaR and Other Risk Measures

First Lower Partial Moment

There are other measures that explicitly focus on the risk of loss, we consider two closely related alternatives. The First Lower Partial Moment (FLPM) is defined as:

$$\int_{-\infty}^{t} (t - x)f(x)dx. \tag{6.3}$$

The FLPM preserves the SOSD ranking regardless the choice of the threshold t since, if the first moment is bounded,

$$\int_{-\infty}^{t}(t-x)f(x)dx=\int_{-\infty}^{t}F(x)dx.$$

As was pointed out by Guthoff et al. (1996), it immediately follows that the FLPM and VaR measures provide the same ranking given that δ is chosen sufficiently conservative. Furthermore, they note that the VaR is just the inverse of the zero'th lower partial moment.

Expected Shortfall

Closely related to the FLPM is the Expected Shortfall (ES) measure discussed in Artzner, Delbaen, Eber and Heath (1998) and Artzner, Delbaen, Eber and Heath (1999). The ES measure is defined as

$$ES=\int_{-\infty}^{t}x\frac{f(x)}{F(t)}dx. \tag{6.4}$$

If the definition of SOSD applies, we now show that at conservatively low risk levels, the ES and the VaR measures also coincide.

Proposition 6.2.1 *Suppose the first moment is bounded and that distribution functions are continuous and can be rank ordered by SOSD. Below the first crossing quantile q_c, as defined above, $ES_i \geq ES_j$.*

Proof: If the first moment is bounded, from Danielsson et al. (1999a)

$$ES=t-\frac{FLPM(t)}{F(t)}.$$

At $\delta=F_j(t_{\delta,j})=F_i(t_{\delta,i})\leq F_i(q_c)$,we can thus rewrite $ES_i \gtreqless ES_j$ as

$$t_{\delta,i}-\frac{1}{\delta}\int_{-\infty}^{t_{\delta,i}}F_i(x)dx\gtreqless t_{\delta,j}-\frac{1}{\delta}\int_{-\infty}^{t_{\delta,j}}F_j(x)dx$$

where $q_c \geq t_{\delta,i} \geq t_{\delta,j}$. Rearrange the terms as follows

$$\delta(t_{\delta,i}-t_{\delta,j})\gtreqless\int_{-\infty}^{t_{\delta,i}}F_i(x)dx-\int_{-\infty}^{t_{\delta,j}}F_j(x)dx.$$

Consider the RHS with F_j fixed, but F_i variable. Given $t_{\delta,i}$ and $t_{\delta,j}$, find

$$\sup_{F_i}\left(\int_{-\infty}^{t_{\delta,i}}F_i(x)dx-\int_{-\infty}^{t_{\delta,j}}F_j(x)dx\right).$$

Under the Definition 6.2.1 and the definition of q_c, the admissable F_i are

$$F_j(x) \geq F_i(x) \ \forall x \leq q_c, \text{ and } F_i(t_{\delta,i}) = \delta.$$

Define the following $\widetilde{F}_i(x)$

$$\widetilde{F}_i(x) = \left\{ \begin{array}{l} F_j(x) \text{ for } x \in \ (-\infty, t_{\delta,j}] \\ \delta \text{ for } x \in \ [t_{\delta,j}, t_{\delta,i}] \\ F_i(x) \text{ on } [t_{\delta,i}, \infty), \end{array} \right.$$

Note that $\sup F_i(x) = \ \widetilde{F}_i(x)$, for $x \in (-\infty, t_{\delta,i}]$. From integration

$$\begin{aligned} \int_{-\infty}^{t_{\delta,i}} \widetilde{F}_i(x)dx &= \int_{-\infty}^{t_{\delta,j}} \widetilde{F}_i(x)dx + \int_{t_{\delta,j}}^{t_{\delta,i}} \widetilde{F}_i(x)dx \\ &= \int_{-\infty}^{t_{\delta,j}} F_j(x)dx + \delta(t_{\delta,i} - t_{\delta,j}). \end{aligned}$$

Thus

$$\sup_{F_i} \left(\int_{-\infty}^{t_{\delta,i}} F_i(x)dx - \int_{-\infty}^{t_{\delta,j}} F_j(x)dx \right) = \delta(t_{\delta,i} - t_{\delta,j}).$$

Hence the RHS at most equals the LHS, since for any other admissable F_i the RHS will be smaller. □

Artzner et al. (1998) and Artzner et al. (1999) have leveled a critique against the VaR concept on the grounds that it fails to be subadditive. Subadditivity of a risk measure might be considered a desirable property for a risk measure, since otherwise different departments within a bank would not be able to cancel offsetting positions. However, this criticism may not be applicable in the area where VaR is relevant since the above theorem demonstrates that sufficiently far in the tail of the distribution (below the quantile q_c) Expected Shortfall and VaR provide the same ranking of projects. Although, the criticism is applicable if current industry practice of choosing confidence levels at 95 to 99 percent, which is insufficiently conservative. The criticism does not apply when very conservative confidence levels are chosen.

Nevertheless downside risk measures have their problems as well. If an organization becomes too focused on meeting a downside risk objective in combination with large bonuses for traders, it may lead to the following. Initially dealers ensure that the downside risk objective is met through buying the appropriate hedges. Subsequently, dealers use the remaining capital to maximize expected returns, say by buying call options which are far out of the money (which supposedly have the highest expected returns). The resulting kinked payoff function imitates a gambling policy such that a high return occurs with small probability, whereas a low return has a very high probability of occurrence. Dert and Oldenkamp (1997) have dubbed this the casino effect. This effect stems from the implicit objective function within the organization that applies loss aversion as the concept of risk, but displays risk neutrality above the loss threshold. A remedy for this casino effect explored in the next subsection is to view the dealers' problem as maximizing expected utility subject to a side constraint that a given VaR level must be maintained.

6.2.2 VaR as a Side Constraint

In this subsection, we model VaR regulation as a side constraint, where the VaR restriction can be viewed as a means to internalize externalities of individual risk taking to the financial system at large. Regulatory bodies often cite the stability of the payment system as the prime motive for requiring commercial banks to satisfy certain VaR criteria. Hence it seems that the public relevance of VaR regulation and supervision would be better captured by this interpretation.

Grossman and Vila (1989) find that optimal portfolio insurance can be implemented by a simple put option strategy, whereby puts with the strike at the desired insurance level are added to the portfolio, and the remaining budget is allocated as in the unconstrained problem solved at the lower wealth level. Similarly, at the very lowest risk level, the optimal VaR–risk management involves buying a single put option with exercise price equal to the VaR level. But for higher δ–levels, Danielsson et al. (1999a) demonstrate that the optimal VaR strategy generally requires a cocktail of options. Consider a complete market of contingent claims in discrete space. States can then be ordered in keeping with marginal utilities. Suppose the VaR constraint is just binding for the m–th ordered state. The optimal policy then requires an marginal increase in the consumption of the m–th state, at the expense of all other states. Thus optimal VaR management typically, lowers the payoffs of the lowest states, in contrast to the portfolio insurance strategy. The VaR strategy can be effected through buying supershares[1] of that state and to allocate the remaining budget to the solution of the VaR unconstrained problem. In a somewhat different setting Ahn, Boudoukh, Richardson and Whitelaw (1999) consider risk management when op-

[1]Supershares are a combination of short and long positions in call options with strikes at the neighboring states

tion prices follow from the Black–Scholes formula. In their model, a firm minimizes VaR with a single options contract subject to a cash constraint for hedging. They derive the optimal options contract for VaR manipulation, and show that a change in funds allocated to the hedging activity only affects the quantity purchased of the put with that particular exercise price.

A benefit of considering complete or dynamically complete capital markets is that no–arbitrage arguments specify the price of all possible hedging instruments independent of risk preferences. The flip side is that risk management is relatively unimportant.[2] A firm can affect its VaR by implementing a hedging strategy; but its capital structure decision as well as its hedging decisions do not affect the Value of the Firm (VoF) in utility terms. Since private agents in a complete markets world can undo any financial structuring of the firm, VaR management by financial intermediaries has only limited relevance, and financial regulation appears superfluous.

6.3 Economic Motives for VaR Management

Incomplete markets are interesting because in such a setting VaR requirements might correct for market failures. To explore this issue, we initially present two examples of market failures from Danielsson et al. (1999b). We then proceed to produce an example of how VaR regulation, that is never binding in the absence of regulation, can still have negative impact on the economy.

Relative to complete markets, incomplete market environments are obviously more complex; hedging can no longer be viewed as a separate activity from security pricing since hedging activities influence the pricing of the underlying securities. For the financial industry and supervisors this became reality during the 1987 market crash. In the Example (6.3.1) below we construct a simple case of feedback between secondary markets and primary markets, i.e. where the price of a put option affects the stock price. In this section at several places we consider two agents labelled A and B, who have the following mean–variance utility functions

$$\begin{aligned} EU_A &= M - \alpha V, \\ EU_B &= M - \beta V, \end{aligned} \tag{6.5}$$

where M denotes the mean and V the variance.

[2] See, among others, Modigliani and Miller (1958), Stiglitz (1969b), Stiglitz (1969a), Stiglitz (1974), DeMarzo (1988), Grossman and Vila (1989), and Leland (1998)

Example 6.3.1 *For the two agents A and B with utility functions as given in Equation (6.5), let the risk aversion parameter for A be $\alpha = 1/8$, and suppose that agent B is risk neutral so that $\beta = 0$. Let A own a risky project with payoffs $(6, 4, 2, 0, -2)$ depending on the state of nature, and where each state has equal probability $1/5$. Since for this project, the mean is $M = 2$, and variance $V = 8$, it follows that $EU_A = 1$. Agent A is considering selling a 50% limited liability stake in the project. The value of this share is equal to writing a call C with strike at 0. The payoff vector for him changes into*

$$(3 + C, 2 + C, 1 + C, 0 + C, -2 + C),$$

with mean $M = 0.8 + C$ and variance $V = 74/25$. He is willing to write the call if he at least makes $0.8 + C - \frac{1}{8}\frac{74}{25} \geqslant 1$, i.e. if $C \geqslant 57/100$. So the minimum price for the stock is 0.57. The risk neutral agent, B, considers this a good deal since she is willing to pay $(3 + 2 + 1)/5 = 1.2$ at the most. Now suppose that B offers to sell a put on the issued stock with strike at 3. She requires at the minimum an option premium of: $(0 + 1 + 2 + 3 + 3)/5 = 1.8$. Buying the put as well as selling the stock yields A a payoff vector of

$$(3 + C - P, 2 + C - P + 1, 1 + C - P + 2, 0 + C - P + 3, -2 + C - P + 3).$$

The mean payoff is $M = C - P + 13/5$, and the variance $V = 16/25$. Hence, assuming that $P = 1.8$, we find that A is willing to sell the stock if

$$\frac{13}{5} + C - \frac{9}{5} - \frac{1}{8}\frac{16}{25} = \frac{18}{25} + C \geqslant 1,$$

thus $C \geqslant 0.28$. The introduction of the put with strike at 3 lowers the minimum acceptable price of the stock from 57 cents to 28 cents. It can also be shown that the introduction of a put with strike at 1 would lower the minimum desired stock price from 57 cents to 42 cents, assuming that the put trades at 40 cents, the minimum premium requested by B.

The Example shows that the share price is related to the type of the put being sold. Typically, in incomplete markets the pricing of primary and derivative securities occur simultaneously, see Detemple and Selden (1991). As a consequence, hedging and utility maximization are not independent activities. This joint valuation of all securities is driven by the general equilibrium structure of the economy, i.e. individual marginal utilities, the production structure, and the nature of shocks. These structures are likely far from easily analyzed in concert. In view of this example, an important question for future research appears to be the effect of VaR regulation on the valuation of primary securities. Within the limited scope of this paper we will develop two further examples as a proof of the following second best type proposition from Danielsson et al. (1999b).

Proposition 6.3.1 *If markets are incomplete, VaR based regulation may either increase or decrease welfare.*

In incomplete markets the effects of risk regulation follows from the relation between the VaR criterion and the expected utility, EU, via the value–of–the–firm, henceforth VoF. A negative association between the VaR and VoF measures is less interesting since regulators can sit idle as the firm management has an incentive to capture the gains from VaR management. An example of this is the costly state verification setting considered by Froot, Scharfstein and Stein (1993), and the complete markets environment considered in Leland (1998). In the case below, if the association is positive, VaR management has to be imposed, but ipso facto implies Pareto deterioration, see Danielsson et al. (1999b).

Example 6.3.2 *Let the risk aversion parameter of agent A be* $\alpha = 4$, *and suppose agent B is risk averse with parameter* β *to be determined below. Agent A owns a risky project with payoff vector* $(1/15, -1/15)$ *and state probabilities* $(1/2, 1/2)$. *This project yields A the expected utility*

$$EU_A = 0 - 4/225 = -8/450.$$

Suppose A can buy a put from B with strike at 0 *and premium* P. *This changes the mean return to* $M = \frac{1}{2}\frac{1}{15} - P$, *while the variance becomes* $1/900$. *Hence*

$$EU_A(P) = 13/450 - P.$$

Thus A is better off as long as $P < 21/450$. *Let the benchmark utility for B be* $EU_2 = 0$. *Clearly, she is willing to sell the put as long as*

$$P \geqslant (15 + \beta/2)/450.$$

Suppose she is willing to sell at fair value: $P = (15 + \beta/2)/450$. *Three cases emerge depending how risk averse B is:*

1. $0 \leq \beta \leq 12$: *A and B are both better off by trading the put. Hence, in this case the VoF and VaR of agent A are negatively correlated and the VaR does not have to imposed.*

2. $12 < \beta \leq 30$: *A does not want to buy the put since this lowers his expected utility, but buying the put would still reduce his VaR at the 50% probability level. In this case the VoF and VaR correlate positively and VaR regulation has to be imposed.*

3. $\beta > 30$: *B is extremely risk averse, so imposing the purchase of a put on A would not only lower his expected utility, but also increase the VaR.*

The table below summarizes the three possible outcomes from the external imposition of VaR regulation from Example 6.3.2. The lesson is that in incomplete markets agents may often have a positive incentive for risk management themselves. Legislature may therefore think twice before imposing risk constraints. Rather, attention should first be given to provide incentives for better risk management activities, rather than constraining the industry.

Level of Risk Aversion	Impact of VaR regulation
low	Not necessary
medium	Decreases both risk and VoF
high	Increases risk and decreases VoF

Differences in risk attitudes may be viewed as a rather strained basis for analyzing the essential features of risk management in financial markets. Asymmetric information among agents and between agents and regulators is more characteristic. In such a setting moral hazard can have important macro effects as we know for example from the S&L crisis in the United States. In such a setting risk regulation may correct for certain externalities, but can also produce adverse outcomes, again due to the second best solution. As is shown below, adverse effects may arise even when the VaR constraint is *never* binding in the unregulated case. The example builds on Baye (1992) analysis of Stackelberg leadership and trade quota.

Example 6.3.3 *Suppose A and B are banks who have to decide over investing abroad. Bank A is the lead bank and B follows. The investment decisions are interdependent. The decision trees in payoff space and utility space are given in Figures 1 and 2. Bank A has to decide between strategy U and D respectively. After observing this action chosen by bank A, bank B decides on its investment strategy through choosing L or S. Nature plays a role in determining the chances and the outcomes in two states of the world, labelled G and B; positive returns occur with probability* 0.8, *and negative returns have probability of* 0.2.

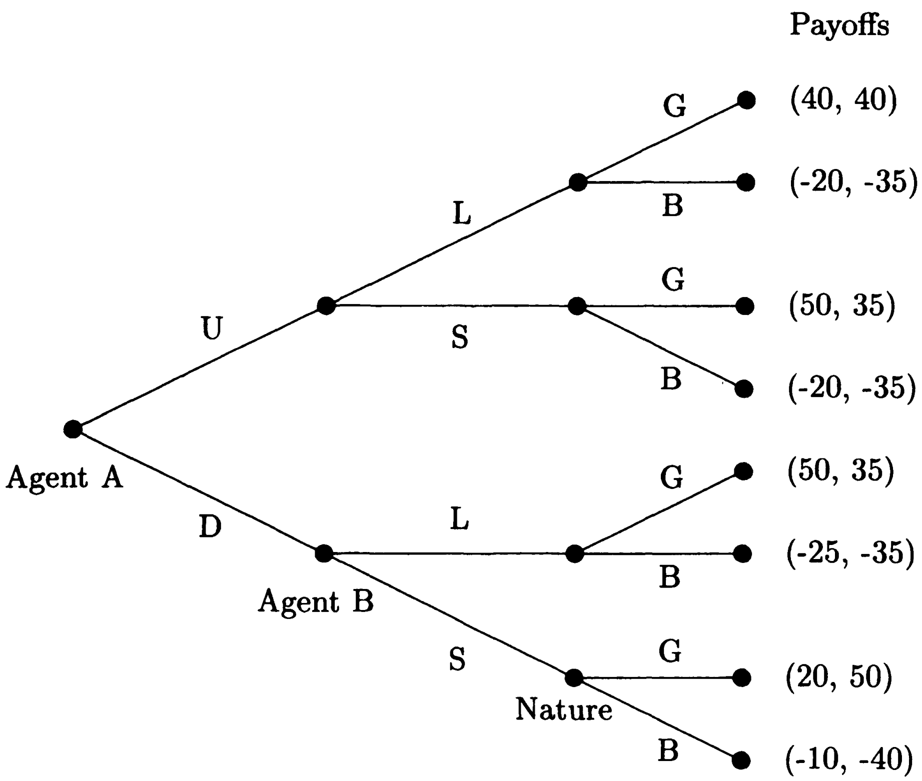

Figure 6.1: Decision tree in payoff space

Assume further that the binomial distributions of returns and the risk aversion parameters are common knowledge among the banks but not to the regulators. In this example we assume that banks have a mean-standard deviation utility function instead of a mean–variance utility function. So replace V in (6.5) by $\sqrt{V}$. *The risk aversion parameters are respectively* $\alpha = 0.5$ *and* $\beta = 1.0$. *Expected utilities corresponding to each strategy profile are represented in Figure 2.*

By backward induction, the strategy combination (U, L) *is the only subgame perfect Nash equilibrium in the unregulated case. Suppose, however, that risk regulation bars banks from losing more than* 35. *Note such a loss may only occur if the banks would select* (D, S), *which however is not selected. Nevertheless, such a seemingly innocuous VaR restriction has the effect of changing the equilibrium to* (D, L). *Since, if bank A selects D, bank B can no longer respond by choosing S. It is then optimal for the lead bank A to switch to D.*

Although it is not an intention of the regulators to influence the unregulated Nash equilibrium, since the restriction is non–binding in that particular equilibrium, it can nevertheless alter the equilibrium. In the

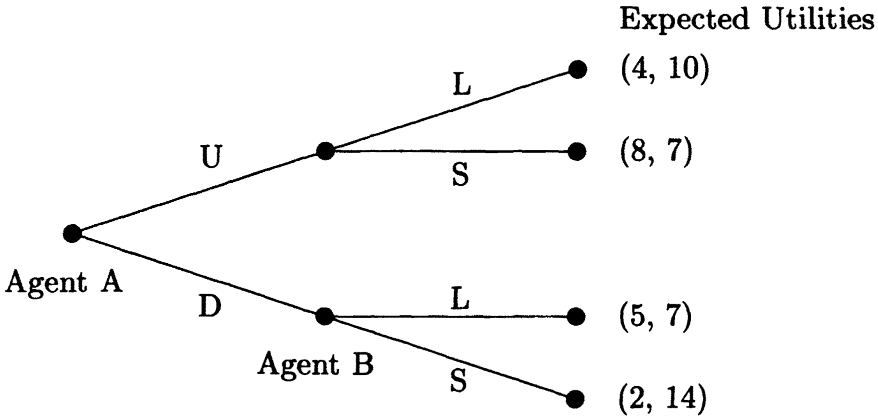

Figure 6.2: Decision tree in utility space

example, regulation obviously induces moral hazard: It provides bank A a chance to achieve higher expected utility by bearing the higher risk and meanwhile forcing bank B to end up at lower utility. While the VaR of bank B is fixed in both equilibria, an increase in the VaR of bank A raises social risk and deteriorates social welfare. In fact, the summation of the maximum likely loss of the two banks is minimized in (D, S) and maximized in (D, L). The new equilibrium maximizes systemic risk. Paying too much attention to individual parties' risk, may lead to ignoring the social aspect and consequently systemic risk. Of course we could also have the apparent non-binding VaR regulation produce a reduction in risk in the regulated equilibrium. Suppose that the payoff to bank A in the bad state of (D, L) is raised from -25 to -15, then the out off equilibrium VaR constraint barring (D, S) unambiguously reduces the risk in society. This leads to the following result strengthening Proposition 6.3.1.

Proposition 6.3.2 *Even though VaR-based regulation is introduced at a confidence level where it is not binding in the absence of regulation, the introduction of VaR-based regulation may increase overall risk.*

Hence, regulators cannot infer that introducing seemingly non-binding VaR could not be harmful. There are, off course, additional sources of externalities. For example, Danielsson et al. (1999b) also demonstrate that, alternatively, these market failures could be due to a moral hazard with regards to risk management.

6.4 Policy Implications

The previous two sections illustrate that the case for externally imposed risk management rests on strong assumptions about the financial system and that poorly thought out risk control may lead to the perverse outcome of increasing systemic risk. Therefore, any argument in favor of external risk management ought to depend on genuine financial economic arguments. Typically, the case for externally imposed risk management and bank supervision is based on a perceived fear of a systemic failure in the banking industry, in particular the breakdown of the payment clearing system. While it is clear that such failure would be catastrophic, it is less clear that the present regulatory environment is conducive for containment of such a failure. Indeed, as seen above, the current regulatory system may perversely promote systemic risk.

There are numerous episodes of financial crises with sizable failures in the banking sector. Nevertheless, modern history contains few episodes where the clearing system broke down, the classic definition of systemic failure, due to imprudent banking activities. As in many of the bank panics during the era of free banking in the USA, fiscal problems at the state level were the root cause. Free banks were required to hold state bonds on the asset side of their balance sheets, but states often defaulted. The fact that we do not have a large record of systemic failures may also be due to preventive regulatory action and other policy measures, like large scale credit provision by monetary authorities in times of crisis. But since the notion of market risk regulation is a very recent phenomena, it is difficult to imagine how VaR regulation may reduce the chance of an event that has hardly ever been realized. In addition financial history contains many episodes where privately led consortia provided the necessary liquidity to troubled institutions. Thus, even without considering the impact of VaR regulations, it is clear that there are private alternatives to traditional systemic risk containment regulations.

The fundamental protection of the clearing system available to most monetary authorities in a world with fiat currencies is the provision of central bank credit in times of crisis. For obvious reasons of moral hazard, monetary authorities only reluctantly assume the Lender-of-Last-Resort (LOLR) role, but we note that some monetary authorities have an explicit policy of providing liquidity when needed, witness the Federal Reserve System actions after the 1987 market crash.

The alternative to the LOLR role is explicit regulation. Such regulation can take multiple forms. It can be preventive as the tier I and tier II capital adequacy requirements and VaR limits. Second it can consist of ex post intervention, such as the government take-over of banks in Scandinavia and the Korean government intervention forcing the take-overs of five illiquid banks by other banks in 1998. In either case, moral hazard plays an obvious role. First, regulation based on selected variables creates a demand for financial instruments that circumvent or relax these restrictions. Second, if the government policy of bailing out financially distressed financial institutions is correctly anticipated, there is an incentive for excessive risk taking.

There are two avenues open to the authorities, LOLR and preventive regulations, and the trade–offs between them have yet to be investigated. Without knowing the balance between these alternative instruments, we suspect the authorities display a preference for regulation over the LOLR instrument. The use of the latter instrument always implies failure on part of the public authorities and this has real political costs to the authorities. Moreover, the LOLR makes public the costs of the bail out. In contrast regulation, even though costly, goes largely undetected by the public. A desire to keep the cost of systemic failure prevention hidden from the public also tilts political preference in favor of regulation. The preference for hidden actions shows up in may other aspects of public life, e.g. in the prevalence of voluntary export restraints over tariffs in the area of foreign trade, in spite of the costs to society. In addition, institutional economics points out that self preservation and accumulation of power may be the primary objective of bureaucracy.[3] Since regulatory prevention depends on the existence of a sizable administration, while the LOLR role can be executed by a small unit within the monetary authority, the authorities may have a preference for the regulatory approach. Finally, it is possible that financial institutions have willingly embraced regulation, if regulation affects industry structure by deterring entry and expediting exit, or if it facilitates collusion.

There are other more market oriented alternatives to VaR based system wide regulation: The precommitment approach advocated by Kupiec and O'Brien (1997) and the use of rating agencies. In the market oriented proposals more attention is given to incentives for information provision, without the necessity for the regulator to have detailed knowledge of the internal risk management systems. Indeed, the market based regulation adopted by New Zealand in 1986 is combined with more extensive *public* disclosure, see Moran (1997) and Parker (1997). One critique of the current set of Basel rules is that these provide adverse incentives to improve internal risk measurement systems. The market oriented approach would provide the positive incentives. On the other

[3]See, among many others, Machiavelli (1977), Hall (1986), and Carpenter (1996) and Carpenter (1998) .

hand such systems leave more room for undetected excessive leverage building. Steinherr (1998) proposes to raise capital requirements for OTC positions, so as to stimulate the migration to organized exchanges, where the mark–to–market principle reduces the risk of systemic meltdown, and individual market participants have a strong incentive for proper risk management. Inevitably, VaR based risk management is likely to stay with us, hopefully it will improve due to a regulatory environment that places more emphasis on individual responsibility.

6.5 Conclusion

When investors are risk averse and their investment opportunities can be ranked through the second order stochastic dominance (SOSD) criterion, Danielsson et al. (1999a) show that if the probability of extreme loss is chosen sufficiently low, the VaR concept attains the same ranking as standard risk measures and other loss criteria. This paper extends this result by showing that without the SOSD ranking, the rankings of investment opportunities based on VaR and Expected Shortfall coincide sufficiently far out in the tail. In our view, however, the VaR criterion is best understood as a side constraint to the expected utility maximization problem of a risk averse investor or portfolio manager. This also has the advantage that we can view the VaR constraint as internalizing the externalities from individual risk taking to the financial system at large. At the margin the VaR side constraint affects the equilibrium allocation within the complete markets setting by increasing the payoff in the state where the constraint is just binding, and by lowering the payoffs to all other states. Within complete markets, however, VaR management by financial intermediaries has only limited relevance, since private agents can undo any financial structuring of the firm. Therefore we shifted attention to incomplete market settings.

When security markets are incomplete, VaR requirements may correct for market failures. Due to the second best nature, however, the regulated outcome may be Pareto inferior to the unregulated case. We present a case where VaR regulation while being non–binding at the prevailing optimal portfolios, can still have real effects since it alters the range for strategic manoeuvering; the off–equilibrium nodes are affected by the seemingly innocuous regulation and this in turn changes the playing field. In contrast to the intended effect, the regulation adversely affects societal risk taking.[4] Of course full knowledge of the

[4]This increase in risk is not necessarily a bad thing, if society at large receives non–marketable gains from the high risk, and supposedly innovative, projects. But such a stimulus is an unforeseen outcome of the VaR regulation.

specific situation at hand on part of the regulator would generate a different policy prescription. But the difficulty with incomplete markets is that it places an enormous informational burden on the supervisory agencies to be able to implement the correct policies. The usefulness of regulation is conditional on the information available to the regulation designers. Absent a detailed pool of information to the supervisors, it seems that regulatory intervention can be warranted only if we can identify an overriding unidirectional negative externality which, when corrected, swamps the costs of regulation.

As a result, one can not present an unambiguous case for regulation over lending of last resort as a mechanism for containing systemic failure. By using public choice arguments to analyze the preference for regulation, we surmise that this preference has more to do with political optimization and preservation of market power than systemic risk minimization.

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