Cash-Flow-at-Risk and Debt Capacity

Jankensgård, Håkan

2008

Lund Institute of Economic Research

Working Paper Series

Cash Flow-at-Risk and Debt Capacity

2008/2

Håkan Jankensgård

Håkan Jankensgård, Department of Business Administration, Lund University, P.O. Box 7080, 220 07 Lund, Sweden, Phone + 46-46-222 7830, hakan.jankensgard@fek.lu.se

Abstract

Cash Flow-at-Risk (CFaR) is a risk measure that conveys information on the shortfall in cash flow, associated with a certain probability, a firm could experience over a certain time period. However, to provide information on outcomes that are identified as costly by the risk management literature, in particular underinvestment due to financing constraints, a risk measure needs to make explicit reference to the firm's presumed access to external sources of funding. What is called for is thus a framework in which cash flow-based measures of risk are conditional on the firm's debt capacity. The group of risk measures presented in this paper incorporates this information. They render hedgeable magnitudes that can inform risk management strategies by indicating if a hedge is likely to mitigate costly consequences of volatility by acting as a substitute for equity capital.

Keywords: Risk management, Liquidity, Debt capacity, Shortfall risk

Jel-codes: G30, G32

ISSN 1103-3010
ISRN LUSADG/IFEF/WPS-008/2-SE

The author wishes to thank, in particular, Niclas Andrén, Lund University, for valuable comments. I am also grateful to Lars Oxelheim, Hans Landström, and Göran Andersson, all of Lund University, and Claes Wihlborg, Copenhagen Business School for their comments.

At one point the managers of Norsk Hydro ASA, an integrated aluminium company headquartered in Oslo, Norway, posed the question: "Is a hedge desirable to accompany a strategy involving a substantially increased investment-budget"? Presumably, the managers would be willing to implement such a hedge if the benefit from doing so outweighed the cost. Such a benefit would be at hand if there was a sufficient reduction in the overall risk profile of the company, provided that the risk was perceived to be unacceptably high under the new investment strategy. But how should this risk be defined and measured? How could the company obtain a tangible indication that the risk profile had been shifted in a meaningful way?

In search of such information, the managers of the company could opt to evaluate its risk profile using the widely used Value-at-Risk measure, or, being an industrial company, Cash Flow-at-Risk (CFaR). The CFaR measure provides a summary statistic of the risk inherent in the firm's portfolio of cash flows.[1] It essentially represents the shortfall of cash flow, associated with a certain probability, a company could experience over a certain time period. Such a modelling effort can be helpful in managing the firm's operating cash flow and provide a sense of the firm's overall liquidity risk over a certain time period.

Framing a firm's risk tolerance in terms of an amount that is 'at risk' is potentially misguided, however, because this magnitude may correspond poorly with outcomes that are truly costly to the firm's shareholders. Suppose a risk manager wants to manage risks to reduce the costs of liquidity shortfalls (as suggested by Froot, Scharfstein, and Stein, 1993, 1994). It is unclear whether a corporate manager who hedges to reduce her firm's CFaR really has shifted the firm's profile in a way that is of benefit to the company's owners. If CFaR is construed, as in Stein et al (2001), as the fifth percentile in the firm's distribution of operating cash flow ("EBITDA"), then it is clear that this measure leaves some important questions unaddressed. For example, how does the CFaR measure relate to the risk of default? Or how does it relate to the risk of underinvesting relative to an optimal level, or other 'costly states of nature'?[2]

The CFaR measure cannot, as it stands, be easily connected with outcomes that are perceived as costly because it does not incorporate information on the firm's balance sheet. For the managers of a corporation, with its largely fixed portfolio of fairly illiquid assets, the state of the balance sheet is an important piece of information as it will indicate the firm's ability to deal with short- to medium term fluctuations in cash flow The need to consider debt capacity reflects the fact that costly 'states of nature' are typically a function of both weak liquidity *and* a weak balance sheet (Mello and Parsons, 1999). Indeed, the risk management literature often emphasizes the endogenous relationship between risk management, understood as cash flow hedging, and the capital structure. Stulz (1996), for example, views risk management as a direct substitute to equity capital.

This paper's main argument is that a truly useful summary risk statistic concerning corporate liquidity risk management needs to make reference to the firm's debt capacity. By making explicit the role of debt capacity in obtaining interpretable risk measures one

[1] Approaches to CFaR-modelling can be found in Risk Metrics (1999), Stein et al (2001) and Andrén et al (2005).

[2] Benefits of risk management include avoiding the deadweight costs of costly bankruptcy (Smith and Stulz, 1985); reducing expected taxes when tax rate is progressive (Ibid); reducing stakeholder risk compensation (Shapiro and Titman, 1986); reducing underinvestment due to external financing costs (Froot, Stein and Scharfstein, 1993)

improves on CFaR, where debt capacity is at best implicitly part of the analysis. The framework advanced here also recognizes that the cost of shortfalls depends on the consequences they entail, which leads to interpretations that are more aligned with theories of risk management. One obtains hedgeable magnitudes that indicate if and by how much a hedge mitigates costly states of nature by acting as a substitute for equity. Second, by adjusting the parameters in the model a great deal of flexibility is achieved in terms of adapting the risk definition according to circumstances, improving the interpretability of the measures.

The article is outlined as follows. The next section discusses debt capacity as it relates to cash flow risk measures. After that follows a section on the need to consider the cost of risk. The section after that looks at the Lower Partial Moments (LPM)-framework for creating risk measures. In the section thereafter I discuss how to obtain more relevant risk measures by conditioning cash flow-based risk measures on the firm's debt capacity. The section after that discusses various ways to approach the debt-capacity parameter, followed by an illustrative application using the case of Norsk Hydro. A final section concludes.

1. On the need to consider debt capacity when measuring corporate risk

Value-at-Risk[3] (VaR) has had a huge impact on risk measurement practice in the financial industry. A survey published in 2007 by Deloitte indicates that over 60% of global financial institutions use VaR in managing their risk exposures. Bank regulators even use VaR when determining the amount of capital a bank is required hold. So as far as risk measures go, VaR can be considered 'successful'. Its rise to stardom can be attributed to its ability to aggregate a large number of exposures into a single summary of overall risk, which greatly facilitates risk monitoring and communication (Andrén et al, 2005). VaR also makes the risk of different types of financial instruments directly comparable. Furthermore, by viewing only shortfalls relative target ("downside") as risk, VaR achieves greater intuitive appeal than the symmetric standard deviation.

Due to a growing interest among non-financial firms about the at-Risk methodology, the same principles were eventually applied in other contexts, usually with cash flow or earnings replacing value as the target variable[4]. Cash Flow-at-Risk (CFaR) is thus the cash flow-equivalent of the Value-at-Risk-measure. As such, it shares many of its advantages. Compared with the traditional 'silo', or departmentalised, approach to risk management, it sums up the firm's various risk exposures into a single measure of risk. To an extent, the analogy between a portfolio of financial assets and the non-financial firm holds up well. In the latter case we are dealing with a portfolio of cash-flow generating real assets rather than traded financial claims. The combined volatility of this portfolio of assets is more relevant for management purposes than the volatility of any particular asset in that portfolio.

The objections raised in this paper do not concern the analogy between financial and real assets as such. Rather, I wish to address the *interpretability* of risk measures at the corporate level. What characterizes a risk measure that has an intuitive and economically relevant

[3] According to RiskMetrics, a leading authority on VaR, VaR is defined as "*the predicted worst-case loss with a specific confidence level (for example, 95%) over a period of time (for example, 1 day).*"

[4] See Corporate Metrics (1999). Other approaches to CFaR are found in Stein et al (2001) and Andrén et al (2005)

interpretation? Jeffrey (1984) argues that variability as such is not necessarily very informative unless coupled with information on potential (costly) consequences. Arnott and Bernstein (1989) argue that the proper perspective on risk management is that it refers not to the elimination of variability, but the elimination of exposures to scenarios that involve a failure to meet obligations as they come due. What these arguments seem to suggest is that, to make risk measures meaningful, we should identify scenarios that involve some costly consequence and measure risk with reference to these. Costly should here be understood as a cost seen from the perspective of the firm's owners, not according to the risk-aversion of the managers running the firm. This follows if we accept that risk management, like any other major corporate activity, is subject to the shareholder-wealth maximization criterion.

An attractive measure of corporate risk, therefore, has the property that it conveys information on the likelihood of outcomes that are genuinely costly to the firm's shareholders. The corporate risk management literature has indeed identified a number of costly consequences of volatility that can serve as reference points for constructing risk measures. Smith and Stulz (1985) argue that bankruptcy involve direct costs (legal fees, management time spent on administrative issues, etc). Lessard (1990) argue that risk management should protect the firm's ability to pay out a dividend. Froot, Scharfstein and Stein (1993) argue that risk management can increase the likelihood that the firm is able to carry out value enhancing investments. Schleifer and Vishny (1992) argue that liquidity shortfalls can force a firm to make asset fire sales. In the literature these sorts of consequences are referred to as "deadweight costs".

It is clear that CFaR, if defined as the 5th percentile of the probability distribution of operating cash flows (Stein et al, 2001), do not convey any precise information as to the likelihood of shortfalls that could lead to any of these deadweight costs materializing. Mello and Parsons (1999) suggest that we can obtain more informative, and theory-consistent, cash flow risk measures by conditioning them on information on the firm's spare debt capacity. A focus on the operating side alone is, according to these authors, bound to be misleading because it tells nothing about whether or not the company is at risk of not being able to carry out its business plan. Indeed, the challenge to measure the risk of a company is made difficult by the fact that costly 'states of nature' are typically a function of both weak liquidity *and* a weak balance sheet. Consider first a firm whose conservative financial policy has landed its Debt-to-Equity ratio at 0.3. It may find the prospect of a funding need to be less than frightening, because its low leverage indicates it would have ample refinancing opportunities. An otherwise similar firm whose aggressive use of debt has put its Debt-to-Equity ratio at 2 may not be as keen to exposure to refinancing risk.

By making cash flow risk measures conditional on debt capacity we acknowledge that some cash flow shortfalls may entail negative consequences – i.e. they are 'risky' – whereas others do not, because the firm's debt capacity is such that the shortfalls can be covered by external financing. This necessitates a modelling of the firm's debt capacity, which may itself be a stochastic, state-dependent variable itself (Froot, Scharfstein, and Stein, 1993). If, say, the firm's ability to borrow is constrained by a covenant in one of its existing loans, then the terms of that covenant will be important in determining if and how much additional borrowing the firm can take on in any given scenario. If, as is typically the case, the covenant is expressed as a financial ratio then the stochastic behaviour of this ratio is a relevant input for imputing the debt capacity in each scenario. Correlation will matter too. Assume that the covenant is written in terms of its ratio of debt to equity. If the firm

generates most of its revenues in a particular currency and has debt denominated in this currency, both the firm's cash flow *and* the proxy for debt capacity will respond to changes in the exchange rate in question.

2. Incorporating the cost of risk

In the previous section it was argued that the CFaR measure, due to its inattention to debt capacity, fails to provide meaningful information on the likelihood of outcomes that are costly to the firm's shareholders. A response to this could be to redefine CFaR to represent the loss *relative a particular target* level of cash flow at which, say, the firm would be unable to execute its investment program. Then it follows that this threshold level would have to be a function of the firm's debt capacity, for the reasons outlined in the previous section. While technically equivalent, it is nevertheless less preferable because it is less transparent to have a stochastic target level that is a function of debt capacity. Modelling the firm's liquidity and debt capacity separately and deriving risk measures from the interaction between these two variables is a more straightforward exercise.

A stronger argument against re-formulating the CFaR-measure comes from the fact that this measure would nonetheless be deficient in explicitly incorporating any notion of the *cost* of risk. A recurring critique of at-Risk measures is that they ignore what the outcome distribution looks like *below* the identified target level (Acerbi et al, 2008). That is, a shortfall of $10 million is treated no differently than a shortfall of $100 million, which is against intuition. Baltzer (2001) argues that a realistic risk measure should recognize that larger shortfalls ones are more undesired and should be penalized more heavily.

Corporate policy should depend not only on probabilities of certain scenarios, but also on their cost if they do in fact materialize. We deduce from this that an attractive measure of corporate risk has the property of incorporating information on the cost implied by the outcomes defined as 'risky'. To appreciate this point, consider the following sequence of events. A firm's first response to insufficient liquidity might be to cut down the investment spending with the lowest expected return. It may then choose to cancel its dividend payment, sending clear distress signals to the investor community. For even larger uncovered shortfalls, the firm may have to scale back its strategic investments where the expected profitability is the highest. If a firm's interest payments are threatened, a variety of financial distress related costs might set in, as stakeholders demand a higher risk premium for doing business with the firm.

As the above sequence of events illustrate, the first set of cash commitments that the firm would scale back on can be assumed to be less important than the next set.[5] This non-linear feature of corporate risk is a very subtle but important point, suggesting that the implicit assumption of an at-Risk measure regarding the cost of risk may be inappropriate. What CFaR lacks, in short, is *a mechanism for applying some sort of penalty* to the shortfalls in a way that reflects their perceived cost.

[5] This non-linear feature of the consequences of liquidity shortfalls is in fact analogous with some leading theoretical models of corporate risk management, notably Froot, Scharfstein, and Stein (1993). In these models the cost of external financing increases exponentially with the size of the funding need. In much the same way, cutting back cash commitments will tend to get increasingly costly the larger the shortfalls.

3. Moving beyond Cash Flow-at-Risk

Are there any alternatives to the at-Risk framework? Culp et al (1998) discuss measures of risk associated with a specified target level below which the variable in question must never fall – the Below-Target Probability and the Below-Target Risk. This "doomsday level" is a level of performance that would have truly dramatic consequences to the organisation if not met. For example, it could be the level at which bankruptcy occurs, or at which some covenant is breached. Management can ask itself "at what level of performance do we really feel the pain?" and use this level as reference point when constructing risk measures. Such shortfall risk measures convey information about risk that is potentially more meaningful to a wide array of decision-makers.

The measures proposed by Culp et al are actually part of a more general framework concerned with downside risk. The general framework is the LPM (a, t)-model (Fishburn, 1977), in which risk is measured relative to a benchmark level.[6] The basic idea behind the LPM is that a penalty is applied to shortfalls to reflect the risk tolerance of the decision-maker(s) and the perceived costs of the shortfall. That is, a penalty is applied to outcomes that are *worse* than the benchmark, but not those in which the target level is met or outperformed. Risk tolerance is described by selecting a value for *a*, the penalty applied to shortfalls below target, and *t*, the threshold level of performance. The general principle is that the higher the value of *a*, the higher the penalty placed on a given shortfall (and by extension the higher the perceived cost of risk).

In the LPM risk is defined by the following function.

$$F_a(t) = \int_{-\infty}^{t} (t - x)^a \, dF(x) \qquad a > 0 \qquad \text{(A)}$$

Assuming that the variable of interest x is the firm's cash holdings at some future point in time we obtain the following group of risk measures.[7]

$LPM_0 = P\ (x < t)$ (B)

$LPM_1 = E\ \{(x), \text{ for all } x < t\}$ (C)

$LPM_2 = E\ \{(x)^2 \text{ for all } x < t\}$ (D)

LPM_0 is the probability that cash falls below a certain target level.[8] It can be interpreted as the probability of an external funding need.[9] LPM_1 weighs each of these potential funding needs with its respective probability of occurrence.[10] Compared to LPM_0, this measure takes into account the *magnitude* of shortfalls below the target. It can therefore be interpreted as the *expected,* or probability-weighted, funding need (not to be confused with the *most likely*

[6] The LPM framework has been applied to the portfolio optimization problem by many authors, see for example Harlow (1991)

[7] By analysing the cash balance (pre external funding) we incorporate information on any existing financial slack in the form of readily available liquidity. A flow-based measure will not tell the whole story if the company holds significant cash reserves.

[8] This could be zero, but also some positive number that reflects the fact that a firm may want a minimum buffer of cash at all times for working capital needs

[9] LPM_0 is closely related to the at-Risk measure. The former refers to the probability of reaching a certain level, whereas the latter is concerned with the level, or size of the loss, associated with a certain probability.

[10] LPM_1 is also sometimes referred to as Below-Target Risk, Expected Shortfall, or Conditional Value-at-Risk.

funding need). LPM_2 applies a heavier penalty to potential funding needs, which reflects that these funding needs may be more problematic and expensive the larger they get.[11] Note that these three measures with risk aversion coefficients of 0, 1, and 2 are not the only ones possible. In fact, the coefficient can take any value depending on risk preferences (for a useful introduction to the LPM-framework, see Nawrocki, 1999).

While quite possibly informative in their own right, these risk measures suffer from not having a clear-cut interpretation. Do such funding needs pose a problem or not? Do they mean that the firm's strategic plan could be derailed, or whether the firm risks having insufficient funds to meet debt obligations? It is hard to tell without additional information regarding the firm's debt capacity.

4. Conditioning liquidity risk measures on debt capacity

Taking the perspective of a non-financial firm, this paper suggests a Conditional Lower Partial Moments (CLPM)-framework for measurement of corporate level liquidity risk. The idea of this framework is to make liquidity risk conditional on the firm's debt capacity to obtain risk measures that can be given meaningful interpretations. In particular, they allow interpretations more attuned to existing theories of how risk management creates value.

The CLPM (a_1, t_1, t_2)-framework is a generalization of Fishburn's LPM (a, t)-framework (1977) to include the debt capacity-parameter t_2. The debt capacity-parameter concerns the identification and description of a liability overhang in the firm's balance sheet that could lead the firm to conduct its business sub-optimally in some states of the world. That is, we complement our analysis of cash holdings by looking at whether current levels of leverage, bond covenants, or other balance sheet constraints could impair the firm's ability to carry out its strategic plan or meet other important cash commitments, such as dividends or interest expenses. An integral part of this analysis is to establish benchmark levels of performance where these constraints would become operative (more on this in the following section). That is, we use information on such constrains to filter out outcomes that are considered 'non-risk' from those that are truly 'risk' in the sense that they imply some negative consequence.

In the CLPM risk measures are defined by:

$$F_a(t_1 t_2) \;=\; \int_{-\infty}^{t_1} (t_1 - x)^a \, dF(x) \quad (t_1 - x\,) = 0 \;\; for\ all \;\; (y \le t_2) \quad a > 0 \;\text{(E)}$$

Again, the unit of analysis x is the firm's cash holdings. Again, t_1 refers to the critical, or threshold, level for the firm's cash balance. t_2, in turn, refers to the critical, or threshold, level for the proxy for the firm's debt capacity, which is denoted y (more on this later). a_1, finally, is the risk coefficient as applied to the shortfalls below the target level for cash that are *not covered within the firm's remaining debt capacity*. The difference between the LPM and CLPM resides in the debt capacity parameter t_2.

[11] This assumption is common in the risk management literature. See, for example, Froot, Scharfstein and Stein (1993)

Risk measures in this framework are derived from the interaction between the firm's cash balance and its debt capacity. In the CLPM a risk event can be thought of as an indicator variable that takes the value one if both the cash balance and the proxy for debt capacity breach their respective target levels *simultaneously*. We obtain the following set of risk measures.

$$CLPM_0 = P\ (x < t_1 \bullet y > t_2) \qquad (F)$$

$$CLPM_1 = E\ \{(x) \text{ for all } x < t_1 \bullet y > t_2\} \qquad (G)$$

$$CLPM_2 = E\ \{(x)^2 \text{ for all } x < t_1 \bullet y > t_2\} \qquad (H)$$

How can we interpret these measures? $CLPM_0$ is the probability that a funding need occurs at the same time that a firm's debt capacity is presumed to be exhausted. It can be interpreted as the probability of the firm having to cut back its investment spending, or some other planned cash outlay. The interpretation will depend on the circumstances. It could be interpreted as the probability of default if the firm's financial condition is already very weak and it is approaching the level where default is a realistic outcome.

$CLPM_1$ can, in many cases, be viewed as the expected, or probability-weighted, underinvestment since we have filtered out those external funding needs which are considered unproblematic, or "business-as-usual". By weighting each uncovered shortfall with its probability of occurrence we obtain a measure of by how much, in a statistical sense, the firm is *expected* to underinvest (or cut some other cash commitments) due to weaknesses in the balance sheet.

The difference between the LPM and CLPM-measures has appealing interpretations that can inform risk management strategies. If LPM_1 is estimated to 10bn and $CLPM_1$ to 10bn then this signals that the balance sheet is exhausted and will not provide a buffer – no funding need, however small, can be covered externally. A hedge in this situation may make a lot of sense because it stands a significant chance of acting as a substitute for the equity base the company is lacking. If, on the other hand, LPM_1 is estimated to 10bn and $CLPM_1$ to 0 then this is a clear indication that the firm's balance sheet is strong enough to absorb practically any funding need that might arise. A hedge may then may less sense because the firm's access to external funding is virtually ensured. Finally, if LPM_1 is estimated to 10bn and $CLPM_1$ to 2bn, then the firm "expects" the balance sheet to absorb 80% of the liquidity shortfalls. Likewise, it "expects" to underinvest by 2bn due to a liability overhang in the balance sheet. A firm can then evaluate which hedge strategy is most effective in bringing this number down.

We conclude from this that the difference between LPM_1 and $CLPM_1$ is a hedgeable magnitude with a meaningful interpretation: it indicates the size of the underinvestment problem caused by a weak balance sheet. If positive, it indicates that a hedge stands a chance of acting as a substitute for equity capital. A hedge can then be evaluated according to its ability to reduce this magnitude.

$CLPM_2$, or any value of the coefficient larger than one, captures the notion that the consequences of a liquidity shortfall may be increasing non-linearly with the size of the shortfall. As argued previously, the first set of cash outlays the firm would cut back on can be assumed to have less costly consequences than the next. The extent to which one ex-ante should penalize shortfalls is firm-specific and depends on the perceived damage to the

firm's value as a function of such shortfalls. Since the coefficient is related to the cost of risk it determines the size of any benefit from risk transfer (i.e. hedging). The firm's hedge ratio should therefore, in principle, increase in the size of the coefficient.

It is important to note that in this framework the proxy for debt capacity could either be a constant amount (say the size of an existing credit facility) *or* be described as a stochastic process, which very well might co-vary with the cash holdings. An alternative approach to formulate risk measures that would render the same type of information as the measures in CLPM is to write the target level, the t_1 parameter, as a function of debt capacity. Then the critical level for cash holdings would vary according to the variable which proxies for the firm's debt capacity. Under this approach the C drops out and we are dealing with a LPM framework in which the target level is itself a stochastic variable (see, for example, Balzer, 2001). While admittedly this provides the same type of information, it is less intuitive than thinking of the firm's balance sheet as a 'filter' with which to qualify the firm's potential funding needs – are they problematic or not? Indeed, the very *difference* between LPM and CLPM is a very attractive variable for analysis, in particular when it comes to the usefulness and effectiveness of a hedge strategy. Table 1 summarizes the main approaches to corporate risk measurement.

Table 1. Main approaches to corporate risk measurement

Risk measure / framework	Concept	Comments
Standard deviation	Measures the degree of dispersion around the mean	• Symmetric perception of risk • Relies on normal distribution
Cash Flow at Risk	Measures the maximum loss associated with a certain statistical confidence level	• Asymmetric, ie treats losses different than gains • Based on operating cash flow
Lower Partial Moments	Measures risk as the deviations below a target level penalized by a risk aversion coefficient a	• Adopts easily to varying levels of risk aversion • Makes no explicit reference to debt capacity
Conditional Lower Partial Moments	Makes reference to a second probability distribution to separate risky from non-risky shortfalls	• Incorporates information on debt capacity

5. Debt capacity

What distinguishes the CPLM framework from the other frameworks mentioned in this paper is that it explicitly tries to incorporate information on the firm's debt capacity. This is done in order to separate 'non-risky' outcomes – those where liquidity shortfalls can be assumed to be covered with external funding – from the 'risky' outcomes – those where liquidity shortfalls can be assumed to lead to negative consequences for lack of spare debt capacity.

This requires the ability to describe the circumstances under which further borrowing externally would not be possible, or exceedingly costly, due to the weakness of the firm's balance sheet. The debt capacity parameter t_2 in the CLPM-framework thus concerns the identification of a liability overhang in the firm's balance sheet that could lead it to conduct its business sub-optimally in some states of the world. One needs to identify a financial ratio, or some other variable, that as closely as possible correlates with the firm's refinancing opportunities. How could this parameter be obtained?

One way of approaching this issue is to look at the firm's initial leverage. The literature on capital structure has long recognized that contracting problems in the financial markets increase in the level of debt (see, for example, Myers, 1977). As a firm's leverage increases, so does the potential for information and agency problems with respect to the investor community, thus making attracting new funding more difficult. The firm's Debt-to-Equity-ratio (or Debt-to-Total Assets) would therefore appear like a natural candidate to proxy for the firm's capital market access. For risk calculations one would therefore have to identify a critical level for the Debt-to-Equity-ratio at which the firm's balance sheet constraints become operative. Mello and Parsons (1999) suggest that the industry average could be a useful indicator.

Another possible proxy for the debt capacity is existing debt covenants. A debt covenant is a provision included in debt contracts that restricts the firm's activities after the bond is sold, the purpose of which is to mitigate the bondholder-stockholder conflict (Smith and Warner, 1979). A covenant targeting subsequent financial policy may state that the firm is restricted from issuing additional debt, for example by subjecting it to aggregate dollar limitations (Ibid). Covenants in existing debt contracts may constitute a very real constraint on a firm's borrowing, so it might sometimes be possible to rely on clearly formulated debt covenants to impute the circumstances under which a firm would cease to have access to external funding in a meaningful way.

A third approach is to assess if there is a financial ratio on which the firm's credit rating depends to a high degree. Credit rating agencies may choose to downgrade a company if it fails to meet the target levels associated with a particular rating. This approach presumes that it is highly likely that the firm would be downgraded if it fails to meet the rating agencies' target level, and that this event would materially impair its capital market access. Yet another, and somewhat more tangible constraint, may be derived from the size of a firm's existing credit facility. It may be reasonable to assume that a firm can expect to draw credits under existing arrangements but fail to attract new funding beyond that.

6. An illustrative example

Norsk Hydro ASA is an integrated aluminium company headquartered in Oslo, Norway. At one point its managers posed the question: "Is a hedge desirable to accompany a strategy involving a substantially increased investment-budget"? To help answer such questions, the company operates a risk model that simulates the product prices, exchange rates, and interest rates the company is exposed to. The model simulates a complete set of interrelated financial statements five years into the future. Based on these statements the company is able to evaluate its liquidity and financial strength under a large number of scenarios. The firm defines and communicates its financial capacity in terms of two key financial ratios: the Net Interest-bearing Debt-to Equity and the Funds-from-Operations to Net Interest-

bearing Debt. The maximum amount of borrowing, in each simulated scenario, is imputed by the position of these ratios relative the company's targets.

To enlighten the issue at hand, Cash flow-at Risk was found insufficient. This measure could not inform sufficiently about the interplay between the firm's operating cash flow, its planned investment strategy, and the strength of the firm's balance sheet. Running 10 000 simulations assuming the new investment strategy both LPM_0 and LPM_1 rose substantially. From this it was clear that exposure to significant borrowing needs would increase compared to the base case if the new plan were to be implemented. However, $CLPM_0$ and $CLPM_1$ remained close to zero. This was an indication that the balance sheet would be able to absorb practically all funding needs that might arise. Since the difference between the LPM and CLPM measures was extremely small, there was no sign that a hedge would work as an effective substitute to equity capital. The main reason was that the company, following a de-merger of one of its major operating units, had lower-than-usual debt. Spare debt capacity was correspondingly high. The company concluded that, at the time being, a hedge was not worthwhile even if the firm were to implement a high growth strategy.

7. Summary

This paper's main argument is that a truly useful summary risk statistic concerning corporate liquidity risk management needs to make reference to the firm's debt capacity. This is based on the intuitive idea that a liquidity shortfall entails some truly negative consequence only to the extent the firm also has an impaired access to financial markets due to a weak balance sheet. By making explicit the role of debt capacity in obtaining interpretable risk measures one improves on Cash Flow-at-Risk, where debt capacity is at best implicitly part of the analysis.

The contribution of this paper is a set of risk measures that qualifies cash flow-based risk measures with a reference to the firm's debt capacity, and as a result can be given interpretations that are aligned with existing theories about risk management (i.e., costly financial distress, underinvestment). Debt capacity can be imputed by, for example, current levels of leverage, bond covenants, or credit facilities. The risk measures in the framework presented will indicate if a hedge is likely to mitigate costly consequences of volatility by acting as a substitute for equity capital.

References

Acerbi,C., C. Nordio, and C. Sirtori (2008) “Expected Shortfall as a Tool for Financial Risk Management”, Working paper, Abaxbank

Andren, N., H. Jankensgård, and L. Oxelheim (2005), “Exposure-based Cash-Flow-at-Risk: An Alternative to Value-at-Risk for Industrial Companies”, Journal of Applied Corporate Finance, 17(3), pp. 76-87

Artzner, P., F. Delbaen, J.M. Eber, abd D. Heath (1999), ”Coherent Measures of Risk”, Mathematical Finance 9(3), pp.203-228

Arnott, R.D. and P. Bernstein (1989), “The Right Way to Manage Pension Fund Risk”, Harvard Business Review, January/February

Balzer, L A (2001), “Investment Risk: a Unified Approach to Upside and Downside Returns”, in F Sortino and S Satchell (eds), *Managing Downside Risk in Financial Markets*, Butterworth-Heinemann

Deloitte (2007), “Global Risk Management Survey; 5th Edition”

Culp C.L. and M. Merton and A. Neves (1998) “Value at Risk: Uses and Abuses”, Journal of Applied Corporate Finance, 10(4), pp.26-38

Fishburn, P.C. (1977), “Mean-risk Analysis with Risk Associated with Below Target Returns”, American Economic Review, March

Froot, K.A., D.S. Scharfstein and J.C. Stein (1993), “Risk Management: Coordinating Corporate Investment and Financing Policies”, Journal of Finance, 48(5), pp.1629-1658

Froot, K.A., D.S. Scharfstein and J.C. Stein (1994), “A Framework for Risk Management”, Harvard Business review, 72(6), pp.91-102

Harlow, W.V. (1991), “Asset Allocation in a Downside-risk Framework”, Financial Analysts Journal, 47(5), pp.28-40

Jeffrey, R.H (1984), “A New Paradigm for Portfolio Risk”, Journal of Portfolio Management, 11(1), pp.33-40

Kahneman, D. and A. Tversky (1979), “Prospect Theory: An analysis of Decisions under Risk”, Econometrica, March

Lessard, D. (1990), “Global Competition and Corporate Finance in the 1990s", Continental Bank Journal of Applied Corporate Finance, pp. 19-28.

Mello, A. and J. Parsons (1999), “Strategic Hedging”, Journal of Applied Corporate Finance, 12(3), pp.43-54

Myers, S.C. (1977), “The Determinants of Corporate Borrowing”, Journal of Financial Economics, 5, pp.147-175

Nawrocki D. (1999), "A Brief History of Downside Risk Measures", Journal of Investing, Fall, pp.9-26

RiskMetrics (1999), CorporateMetricsTM Technical Document, New York: RiskMetrics Group.

Schleifer, A. and R.Vishny (1992), “Liquidation Values and Debt Capacity: A Market Equilibrium Approach”, Journal of Finance, 47, pp. 1343-66

Shapiro, A.C. amd Titman, S. (1986), “An Integrated Approach to Corporate Risk Management”, in: J.M. Stern and D.H. Chew (eds.), *The Revolution in Corporate Finance,* Basil Blackwell, Oxford

Smith, S.W. (1996), “Corporate Risk Management”, Journal of Derivatives, Summer, pp.21-30

Smith, S.W. and J.Warner (1979), "On Financial Contracting: An Analysis of Bond Covenants", Journal of Financial and Quantitative Analysis 7, pp.117-161

Smith, C.W., and R.Stulz (1985), "The Determinants of Firms' Hedging Policies", Journal of Financial and Quantitative Analysis, 20 (4), pp.391-405

Stein J. and S.Usher and D.LaGatutta and J.Youngen (2001) "A Comparables Approach to Measuring Cashflow-at-Risk for Non-financial Firms", Journal of Applied Corporate Finance, 13(4), pp.100-109

Stulz, R.M., (1996) "Rethinking Risk Management", Journal of Applied Corporate Finance (Fall), pp.8-24

School of Economics and Management
Lund University

Working Paper Series

Editors: Hans Landström & Ulf Elg

Year	No	Author	Title
2008	2	Jankensgård, Håkan	Cash Flow-at-Risk and Debt Capacity
2008	1	Nylinder, Pia Anell, Anders	Mesuring 'Tight Budgetary Control' in Swedish Public Hospitals
2007	3	Cederström, Carl Willmott, Hugh	Desiring Agency
2007	2	Jonsson, Anna	Knowledge Sharing at Micro Level: A Participant Observation at IKEA in Japan
2007	1	Anselmsson, Johan Johansson, Ulf	Are the retailer motives of private label brands fulfilled? – Creation of brand value, brand loyalty and the affect on store image and store loyalty
2006	10	Anselmsson, Johan Johansson, Ulf	Innovation in the competition between retailer and manufacturer brands – An examination of new-product releases in the Swedish grocery sector
2006	9	Jonsson, Anna Kalling, Thomas	Challenges to knowledge sharing across national and intra-organizational boundaries: A comparison of IKEA and SCA Packaging
2006	8	Macheridis, Nikos Nilsson, Carl-Henric	Managing Project Complexity – a managerial view
2006	7	Macheridis, Nichos	Project selection from an ethical point of view
2006	6	Alvesson, Mats Kärreman, Dan Sturdy, Andres Handley, Karen	Unpacking the Client(s): Constructions, Positions and Client-Consultant Dynamics
2006	5	Politis, Diamanto Gabrielsson, Jonas	Entrepreneurial Decision Making: Examining Preferences for Causal and Effectual Reasoning in the New Creation Process.
2006	4	Anselmsson, Johan Johansson, Ulf Persson, Niklas	A conceptual framework for understanding Customer-based brand equity and price premium in grocery categories
2006	3	Alvesson, Mats Empson, Laura	The Construction of Organizational Identity: Comparative Case Studies of Consulting Firms
2006	2	Fougère, Martin Moulettes, Agneta	Development and Modernity in Hofstede´s *Culture´s Consequences*: A Postcolonial Reading
2006	1	Anselmsson, Johan	Customer perceived service quality in the supermarket and the discount store – Examination of a service quality measurement scale in a Swedish context

2005	9	Sveningsson, Stefan Larsson, Magnus	Fantasies of leadership - identity work
2005	8	Norén, Catharina	The Social Construction of Successful Practical Selling - A study of how sales persons at CR Ltd construct selling as successful
2005	7	El-Ansary, Adel Cerne, Annette	An Integrative Framework for Evolving A Socially Responsible Marketing Strategy
2005	6	Elg, Ulf	A study of inter-firm market orientation dimensions in Swedish, British and Italian supplier-retailer relationships
2005	5	Svensson, Peter	The Survival of the Unfittest: Delinquent corporations and the production of organisational legitimacy through symbolic-discursive fit.
2005	4	Erlingsdottír, Gudbjörg Lindberg, Kajsa	Isomorphism, Isopraxism and Isonymism - Complementary or Competing Processes?
2005	3	Sanchez, Ron	Knowledge Management and Organizational Learning: Fundamental Concepts for Theory and Practice
2005	2	Tarnovskaya, Veronika Elg, Ulf Burt, Steve	The Role of Corporate Branding in a Market Driving Strategy
2005	1	Politis, Diamanto Gabrielsson, Jonas	Exploring the Role of Experience in The Process of Entrepreneurial Learning
2004	10	Braunerhjelm, Pontus Oxelheim, Lars Thulin, Per	The Relationship Between Domestic and Outward Foreign Direct Investment: The Role of Industry-Specific Effects
2004	9	Alvesson, Mats Hardy, Cynthia Harley, Bill	Reflecting on Reflexive Practices in Organization and Management Theory
2004	8	Andrén, Niclas Jankensgård, Håkan Oxelheim, Lars	Exposure-Based Cash-Flow-at-Risk under Macroeconomic Uncertainty
2004	7	Macheridis, Nikos Nilsson, Carl-Henric	Managing Project Complexity - a managerial view
2004	6	Stafsudd, Anna	The (Non-)Significance of Quantitative Management Research: The Demise of Popper in View of a Hypothesis-Verifying Publication Norm.
2004	5	Elg, Ulf Jonnergård, Karin	Societal, Organizational and Individual Factors Influencing Women´s Entry to Professional Organizations
2004	4	Bengtsson, Anders	Exploring the Symbolic Dimension of Co-Branding: When Hershey Met Betty
2004	3	Elg, Ulf Ghauri, Pervez Sinkovics, Rudolf R.	A market and network based model for retailers´ foreign entry strategies
2004	2	Macheridis, Nikos	The Specific Costing Problems of Project Form – How those can be managed with activity based costing
2004	1	Holmqvist, Mikael Larsson, Rikard	Interlevel Learning Dynamics: Balancing Exploitation and Exploration Within and Between Organizations
2003	10	Dedijer, Stevan	Development & Intelligence 2003-2053

2003	9	Jonnergård, Karin Kärreman, Mats Svensson, Claes	The impact of changes in the corporate governance system on the boards of directors – experiences from Swedish companies
2003	8	Alvesson, Mats Kärreman, Dan	Collectivity –a cultural and processual view
2003	7	Forsbæck, Jens Oxelheim, Lars	Do Exchange-Rate Regimes Matter for Monetary-Policy Autonomy? The Experiences of 11 Small, Open European Economies in the 1980s and 1990s
2003	6	Kärreman, Dan Alvesson, Mats	Understanding ethical closure in organizational settings - the case of media organizations
2003	5	Alvesson, Mats Sveningsson, Stefan	Managers Doing Leadership: The extra-ordinarization of the Mundane
2003	4	Oxelheim, Lars Rafferty, Michael	The quality of bond markets. The dynamic efficiency issue
2003	3	Schewe, Charles Carlson, Benny	Age Matters. Segmenting Swedish Markets by Generational Cohorts
2003	2	Noble, Stephanie M. Schewe, Charles D.	The Globalization of Values. A Comparison of the United States and the Kingdom of Jordan
2003	1	Sveningsson, Stefan Alvesson, Mats	Managing Managerial Identities. Organizational Fragmentation Discourse and Identity Struggle
2002	5	Landström, Hans	Why do European Venture Capital Companies Syndicate?
2002	4	Oxelheim, Lars Randøy, Trond	The Effect of Internationalization on CEO-Compensation
2002	3	Kalling, Thomas	Enterprise Resource Planning Systems: Strategic and Organisational Processes.
2002	2	Alvesson, Mats	'Up-or-out' versus 'Fun-and-profit': A Study of Personnel Concepts and HR Themes in two IT/Management Consulting Firms.
2002	1	Johansson, Ulf	Information Technology in Supplier-Retailer Relationships. Some Possible Consequences
2001	9	Hedman, Jonas Kalling, Thomas	The Business Model: A Means to Understand the Business Context of Information and Communication Technology
2001	8	Andrén, Niclas Oxelheim, Lars	Exchange-Rate and Interest-Rate Driven Competitive Advantages in the EMU.
2001	7	Oxelheim, Lars Rafferty, Michael	On the Static Efficiency of Secondary Bond Markets.
2001	6	Elg, Ulf	Market Orientation in Retailing: An Approach Based on Inter- and Intra-Firm Activities
2001	5	Stavsudd, Anna	Managers in the Context of Strategic Content – Industrial Organization Theory and Resource-Based view Predictions for the Selection of Managers
2001	4	Johansson, Ulf	Food Retail Buying Processes. A Study of UK, Italy and Sweden
2001	3	Johansson, Ulf	Retail Buying; Process, Information and IT use. A Conceptual Framework
2001	2	Alvesson, Mats Willmott, Hugh	Identity Regulation as Organizational Control: Producing the Appropriate Individual (published in Journal of Management Studies, Vol 39 (5): pp 619-644, 2002)

2001	1	Oxelheim, Lars Randøy, Trond	The Impact of Foreign Board Membership on Firm Value: A Study of Corporate Governance in Scandinavia. (Forthcoming in Journal of Banking and Finance
2000	9	Oxelheim, Lars Wihlborg, Claes	Recognizing Macroeconomic Fluctuations in Value Based Management. (Forthcoming in Journal of Applied Corporate Finance.)
2000	8	Elg, Ulf	The Meaning and Antecedents of Market Orientation in a Distribution Network
2000	7	Alvesson, Mats Due-Billing, Yvonne	Beyond Body-counting - a Discussion of the Social Construction of Gender at Work, with the Scandinavian Public Sector as an Example.
2000	6	Alvesson, Mats	Knowledge Work: Ambiguity, Image and Identity (Published in Human Relations,vol 54 (7): pp 863-886, 2001)
2000	5	Sveningsson, Stefan	Strategy as a Disciplinary Technology. Discursive Engineering in the Newspaper World
2000	4	Larsson, R Lubatkin, M	Achieving Acculturation in Mergers and Acquisitions: A Case Survey Study
2000	3	Henriksson, K	When Communities of Practice Came to Town. On Culture and Contradiction in Emerging Theories of Organizational Learning.
2000	2	Eneroth, K Malm, Allan, T	Strategic Identity. Visions as Catalysts for Competence Dynamics (published in Advances in Applied Business Strategy, vol 6A (2000) pp: 121-146)
2000	1	Alvesson, Mats Johansson, Anders W	Professionalism and Politics in Management Consultancy Work (forthcoming in T Clark & R Fincham (eds): Critical Consulting: Perspectives on the Management Advice Industry. Oxford: Blackwell)
1999	5	Elg, Ulf Johansson, Ulf	The Contributions of International Alliances when Managing the Firm's Set of Interorganizational Dependencies. (Published in the Journal of Strategic Marketing, 9 pp 93-110 2001)
1999	4	Alvesson, Mats	Methodology for Close up Studies. Struggling with Closeness and Closure
1999	3	Alvesson, Mats	Beyond Neo-Positivists, Romantics and Localists. A Reflexive Approach to Interviews in Organization Research
1999	2	Pushkala, Prasad, Birdsell, Judith M Zerbe, Wilfred	Translated Myths: The Mirroring of Institutional Expectations in the Formal Structure of the Canadian Breast Cancer Research Initiative (CBCRI)
1999	1	Oxelheim, Lars, Stonehill, Arthur Randøy, Trond	Finance-Specific Factors and Theories of Foreign Direct Investment (Published in International Business Review, Vol. 10, (4), 2001)

Working papers are published and distributed as a professional service of the Institute of Economic Research. Direct inquiries to:

Elsbeth Andersson
Institute of Economic Research
P.O. Box 7080
SE-220 07 Lund, Sweden
Tel: +46 46-222 7824,
Fax +46 46-222 44 37

E-mail: Elsbeth.Andersson@fek.lu.se
http://www.lri.lu.se