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## SPECIAL REPRINT

**RAROC Comes Calling****Economic Capital and Risk-Adjusted Return on Capital for Energy and Commodity Trading Firms***By Carlos Blanco, Ph.D., risk management consultant*

Identifying, measuring, managing and pricing risk at a company-wide level involves designing appropriate policies and systems so different business units and risk-taking activities can be evaluated with a risk-adjusted return in mind. How can managers determine the most efficient generators of revenue on a risk-adjusted basis? What type of returns should be expected given the risk assumed to generate them? Risk-adjusted return on capital (RAROC) measures, which are widely used in the financial services industry, provide a common measurement unit for risk-

adjusted returns on allocated (ex-ante) and utilized (ex-post) risk capital.

The allocation of risk capital among different units is one of the key activities performed by senior management of trading firms, and also one of the building blocks of an integrated risk-management framework. Determining the economic capital allocated to each activity or business unit provides senior management with a mechanism to link risk and return, and therefore provide a risk/reward signal that can be used at different levels of the firm. An investment evaluation process based on economic capital considerations, where decisions are based on a risk-adjusted return basis, encourages corporate managers to become risk managers because they must take risk into consideration when allocating resources internally and making investment and divestment decisions.

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In this first article, we introduce economic capital and its role in risk-adjusted return on capital (RAROC) calculations by presenting some strategic uses for senior managers in energy trading firms. Economic capital lies at the heart of enterprise-wide risk management and optimizing it provides value for shareholders. Many energy firms are still using VaR as a proxy for economic capital. We will also argue that there are superior measures to VaR, particularly for economic capital and liquidity adequacy determination. In a second article, we will concentrate on capital adequacy assessment for energy trading firms from a regulatory, credit rating agency and internal firm perspective, analyzing recent proposals by the CCRO and Standard & Poors regarding financial liquidity adequacy to cover short-term unexpected events as well as economic capital to support medium and long-term business operations.

**Economic Capital for Energy Trading Firms**

The CCRO white paper defines economic capital as the “the capital a company is required to hold to support the risk of unexpected loss in the value of its physical and financial portfolio.” For energy companies, the primary sources of risk covered by economic capital are market, credit and operational risk. There are different ways to obtain an aggregate capital measure that range from a simple sum of the capital required to cover each of those risks to an integrated simulation framework adding multiple sources of risk.

Capital allocation decisions are made to share the costs to support the different risk-taking activities among the various constituents of a firm with the objective of achieving a “fair” allocation of capital and to provide a basis for performance comparisons among constituents in a risk-adjusted return basis.

The cost of capital for energy trading firms is considerably higher than the risk-free rate earned on the “risk capital” used as a buffer against large unexpected losses. Therefore holding a substantial amount of capital dormant, misallocating it to low risk-adjusted return activities or not fully utilizing it is a considerable burden for trading corporations. In the next article, we will analyze in more detail the capital adequacy proposals for energy trading firms from the point of view of regulators, credit rating agencies and internal and external stakeholders.

Due to the interdependencies between the risk-taking activities of an energy trading firm, the capital allocation process is particularly complex. If we just measure the economic capital of each unit in isolation, we would miss key portfolio effects and under-allocate capital at a substantial cost for shareholders. To the extent that the “risk capital” required by a firm is considerably lower than the sum of the capital to support each risk-taking activity, it is reasonable to expect each of the constituents to share those benefits. This can be achieved by calculating the risk capital of a constituent in isolation and subtracting its allocated share of the diversification advantage. This can be done by looking at the correlation between the different risk-taking activities and using historical performance and management’s judgment.

**Types of Economic Capital: Stand-Alone, Marginal and Diversified**

There are three main types of economic capital, depending on the scope of the measure and the extent to which

interdependencies between risks are introduced in the analysis. We will see how each measure can be very valuable as a decision-support tool in different business contexts.

◇ **Stand-alone economic capital** can be defined as the amount of capital an individual risk-taking activity would require if it were independent from the rest of the firm. Stand-alone economic capital is traditionally used to evaluate the performance of managers responsible for maximizing the risk-adjusted returns of that particular activity. If we use VaR to measure economic capital, we need to measure the VaR of that risk-taking activity in isolation. For example, once capital is allocated to each desk by management, trading managers can break down their own charges among their traders or books. The sum of the stand-alone economic capital assigned to each activity should always be greater than the capital necessary to support the firm. We will show that VaR does not always guarantee this.

◇ **Marginal economic capital** is the amount of capital that each business adds to the entire firm’s capital requirements. If we use VaR to measure “marginal” economic capital, we need to measure the VaR of the firm before and after removing a particular component corresponding to each risk-taking activity. Marginal economic capital can also be interpreted as the amount of capital that would be released if we decided to divest from a particular activity. Marginal economic capital can be used for acquisition and divestment decisions after taking into account the expected returns from those decisions.

◇ **Diversified economic capital** is the amount of capital allocated to each risk-taking activity as a part of the overall firm. Diversified economic capital is calculated by taking into account the interdependencies between different risk-taking activities within the firm, similar to a portfolio beta. If we used VaR to measure diversified economic capital, we would calculate it by taking into account the risk of each activity and subtracting the risk-reduction benefits at the portfolio level. Marginal economic capital can be used for measurement of contribution to risk from each risk-taking unit and for internal capital allocation within projects.

**RAROC and Risk-Adjusted Performance Measurement**

Risk-adjusted return on capital provides an indication to relate the return on capital provided by a risk-taking unit or transaction to the risk of the investment required to generate that return.

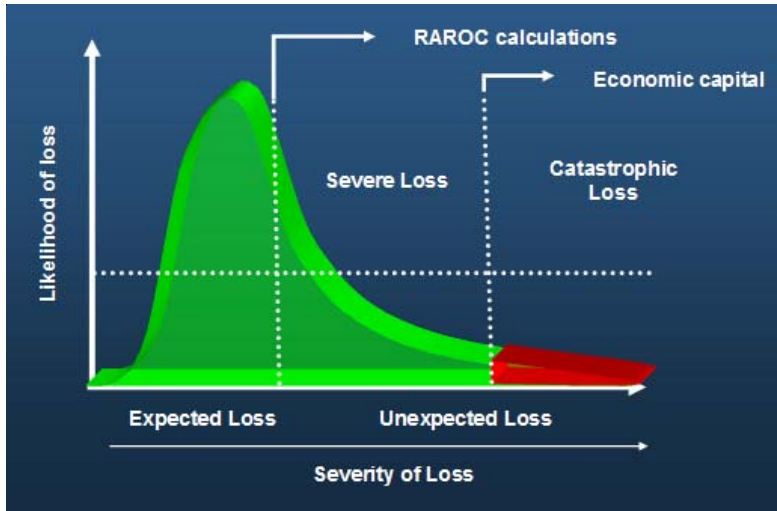


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The numerator is the adjusted income while the denominator is the capital at risk required to support the generation of that income. The expected losses refer to the credit risk component of a loan or transaction.

**Graph 1. Credit Loss Distribution, Expected and Unexpected Losses**



Although each business activity has different levels of risk and different capital requirements to sustain them, the (expected) return of economic capital for the firm should be homogenous for all activities.

It is important to point out that the capital in the denominator is not the capital in the balance sheet, which is clearly an incomplete measure to determine the capital used and required by different business activities, particularly energy trading. Economic capital is adjusted to cover credit, market, operational and other risks incurred in the normal course of business. Some people prefer to call it RARORAC (Risk-adjusted Return on Risk-adjusted Capital), but the capital used in the denominator is already risk-adjusted in most RAROC calculations.

Once we have an estimate of the expected returns (net of expenses) and the capital required to sustain each activity, we can produce ex-ante RAROC estimates to allocate capital across the firm. Once we know the actual results, we can use the actual profits or losses achieved by each risk-taking unit to determine the ex-post, risk-adjusted returns for performance measurement, evaluate the actual capital utilized by each risk-taking unit and set compensation levels.

Natural Gas Trading Desks	P&L(net)	Economic Capital Allocated	Economic Capital Used	Utilization Rate	RAROC	Hurdle Rate
Northwest	\$340,000	\$3,000,000	\$2,925,000	98%	12%	15%
Midwest	\$257,000	\$350,000	\$335,000	96%	77%	15%
Southwest	\$87,000	\$400,000	\$340,000	85%	26%	15%
Northeast	\$85,000	\$250,000	\$210,000	84%	40%	15%
Canada	\$120,000	\$2,500,000	\$2,400,000	96%	5%	15%
Firm-wide	\$565,500	\$5,000,000	\$4,657,500	93%	12%	15%

The Basle Accord capital adequacy standards (CAD) allow banks to use the results from internal VaR models to set capital requirements. In particular, VaR should be calculated for a horizon of 10 days and a confidence level of 99 percent, and multiplied by a factor of three in order to account for “extreme events” not captured by the models. In doing so, regulators assume that VaR models are unable to measure tail risks adequately, mistaking an implementation of a risk model with the model itself and penalizing “good” risk modelers.

From this point of view, choosing the right variables to model in the risk analysis (e.g. MtM vs. earnings vs. cash flows), the material risk factors (e.g. spot versus forward prices, implied volatilities, volume, counterparty risk...), trading strategy and liquidation period (e.g. stop-loss, delta-neutral, taking positions until expiration, etc.) and the right risk metric (VaR, expected tail loss, etc.) are key decisions that need to be made before setting short-term and long-term capital requirements. As Bucknall (2002) writes, “A common misunderstanding has been to simply run VaR calculations with extended holding periods and label the result as an ‘earnings-at-risk’ measure. This misses the key issue of using an accrual-based approach in risk management of asset-based business units. Where VaR is directly measuring the risks of previously achieved MtM earnings being lost over the next few trading days, PaR (profit-at-risk) is focused on risk to accrual based earnings over specific future operating periods.”

In our next article, we will explore the Basle capital adequacy (and inadequacies) when applied to energy trading firms and the key changes that should be taken into consideration when exploring capital adequacy for energy trading operations.

**RAROC Ten Commandments of Generally Accepted Capital Principles for Energy Trading Firms\***

1. Include all business activities and the global operations of the firm. An enterprise-wide portfolio approach, including physical assets and financial instruments, is necessary to provide clear signals in an integrated framework.
2. Strive to implement a RAROC system impervious to arbitrage (including tax differentials) and possible “gaming” by risk-takers. (Economic capital for each risk-generating activity should take liquidity and counterparty risks into account.)
3. Be explicit, consistent and goal-congruent with other policies (transfer pricing, price guidance, performance measurement, compensation, etc.).
4. Recognize different types of capital, but put the primary emphasis on economic capital. Financial liquidity adequacy is crucial for trading firms, but it should be analyzed separately.
5. Use a single risk-adjusted hurdle rate charged as a cost of capital, which should be broadly consistent with the firm’s long-term target return on capital.
6. Develop and implement an economic risk framework compris-

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ing credit risk, market risk (fixed assets, physical and financial trading) and operational risks. Add any other significant risks for the firm such as volumetric risks, liquidity risks, etc.

7. Recognize funding and time-to-close liquidity, particularly for long-term deals and physical assets.
8. Attribute capital as a function of risk and the authority to take risk (e.g. market risk limit). Trading managers should have enough economic capital to allocate among traders or desks in order to achieve profit goals.
9. Economic capital should be based on a confidence level deemed appropriate, based on the targeted solvency standard and the confidence in the output from the risk model. Regularly back-test and check the validity of the models used.
10. Promote matching of revenues and risk charges when risks are incurred. A “forensic” or ex-post analysis is important, but the key in RAROC analysis is to identify and measure risk and expected returns before decisions are made.

*\*Adapted and extended from Crouby, Galai and Mark (2000)*

**Economic Capital, VaR and Expected Tail Loss (ETL)**

Internal and external Capital requirement ratios are usually based on a risk measure that attempts to summarize the entire probability distribution of profit and losses with a single number. But you are always going to miss a considerable amount of useful information when you characterize the whole probability distribution with one number. Risk managers should identify the risk measures that best capture the risk of the portfolio and the firm’s risk tolerance. If VaR is the best possible measure, then there is no need to look further. But, just knowing that we are likely to lose *more* than a particular amount with a particular probability, without knowing how much we could lose on average in a worst-case scenarios, is not likely to be ignored by regulators, credit rating agencies, or most managers and board members.

There has been much debate on the strengths and weaknesses of the different ways to estimate VaR (e.g. Monte Carlo and historical simulation, variance-covariance, etc.), but relatively little debate on the inherent weaknesses of VaR itself as a risk measure. For example, in the *Valuation and Risk Metrics* white paper from CCRO, VaR is the risk metric more thoroughly discussed and recommended.

Academic work over the last few years has demonstrated that the VaR fails to satisfy a basic property – subadditivity – which means that the risk of a portfolio consisting of subportfolios A and B should always be equal to or smaller than the sum of the risks of subportfolios A and B in isolation.

This example illustrates the nonsubadditivity of VaR: Let’s assume we have a portfolio that contains short digital puts and calls on the same underlying, and we calculate VaR for a horizon equal to the expiration of the options. Each option has a notional amount of \$100 million, a 4 percent probability of ending in the money, and the current MtM for each option is \$4 million. The 95 percent VaR for each option in isolation is zero (the probability of loss is only 4 percent). However, the 95 percent VaR of the portfolio is \$100 million – 2 × \$4 million = \$92 million. The VaR

of the combined position is therefore greater than the sum of the VaRs of the individual positions, so the VaR is not subadditive. It is also interesting to note that the VaR of the portfolio composed of one-half of each position is  $(1/2) \times (\$100 \text{ million} - 2 \times \$4 \text{ million}) = \$46 \text{ million}$ . This means that VaR is not a homogeneous measure of risk.

Two consequences of using VaR for capital requirements:

- ◇ A firm could break itself up in order to reduce its economic capital.
- ◇ Margin requirements could be minimized by creating separate margin accounts. This could be exploited for exchange-traded contracts and OTC contracts through changes in netting agreements and margining provisions.

Expected tail loss (ETL), or conditional VaR (CVaR), is the loss we would expect in a “tail event” where the loss exceeds VaR. ETL numbers, other alternative complementary measures such as worst-case scenario and the standard deviation of the ETL also have the attractive property that they provide information about what happens beyond VaR, whereas the VaR tells us next to nothing about tail events. So why use VaR when there is a clearly superior alternative?

VaR proponents usually say that most market participants are familiar with VaR and its limitations, and it would be too complicated and possibly a setback to move to another risk measure. VaR proponents believe that after years of training and developing policies and processes around VaR, shifting to ETL or other measures would create confusion and undermine the use of quantitative risk measures in energy trading firms. But, as Dowd (2002) nicely states, “familiarity is hardly a decisive or long-lasting advantage,” and in our opinion, it is not enough to justify the use of VaR if it is not the most appropriate measure of risk and has clear limitations. For example, Reliant Resources made the decision to exit proprietary trading after experiencing a loss of \$80 million in a spread position after a weekend price increase of \$2.53/MMBtu for natural gas in February 2003. Even though the position was within VaR limits, the VaR did not indicate much about what could happen beyond VaR and the nature of “tail risk” for those positions. The CEO of the company indicated that “while this loss resulted from unprecedented market volatility, its magnitude is inconsistent with our desired risk profile and led to our decision to exit the proprietary trading business.” This means that either the VaR limits were not consistent with the risk appetite of the firm or that VaR was not a good proxy for the risk tolerance of the corporation.

**Conclusion**

Risk management and capital allocation decisions are clearly interlinked and should not be made in isolation. RAROC provides a bridge to tie risk/reward relationships through the different activities and balance sheet items of a firm and serves as a common analysis and communication tool.

Energy trading firms that successfully adopt and implement economic capital and RAROC models throughout the firm will have the competitive advantage of being able to run their businesses with less capital while also showing greater transparency and improving the confidence in their ability to manage risk

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for credit rating agencies, shareholders, regulators and creditors.

The implementation of a capital allocation model based on risk-adjusted returns for energy firms should be specifically tailored to the business activities of each firm, not take existing models from the financial services and insurance industries. As Hickman, Rich and Tange (2002) point out, “energy companies should also resist the urge to see every problem as a ‘nail’ simply because they possess a first-rate VaR analytics hammer.”

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