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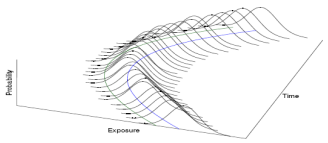
Integrating Market, Credit and Liquidity Risk to support trading and hedging decisions

PRMIA, Calgary Chapter, September 2010



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- Risk production vs. consumption
- Market Risk vs. Credit Risk models and metrics
- Long term vs. Short term simulations. Main issues for energy and commodity markets.
- Default Probabilities: Internal systems vs. Market-based assessments
- Counterparty Risk Mitigation and Impact on market and credit risk
- Credit Valuation Adjustments
- Charging for Credit Risk

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Consumers of Financial Risk Information in Energy/Commodity Firms

Organizational Level	Risk Management Information Gaps
Board of Directors	Transparency on material risks Understanding of high level risk/return tradeoffs
Senior Management	Knowledge of firm-wide exposures and interactions. – Impact of hedging on shareholder value maximization. Limit setting and metrics
CFO / Treasury	Potential cash flow implications & credit rating Hedge effectiveness / accounting impact (EPS) Risk-adjusted pricing for large transactions.
Procurement/Logistics Groups	Negotiation of critical contract price and volume related clauses. Performance benchmarks
Market Risk Managers	Interaction of risk dimensions before and after hedging at the portfolio level (market, collateral, liquidity, cash flow…).
Credit Risk Managers	Dynamic Counterparty risk assessments. Negotiation of netting and collateral clauses in OTC Master Agreements Integrated credit risk analysis at the counterparty level

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History of Market Risk Management

- **In late 1970s and 1980s,**
  - Firms with material exposures to financial and energy markets see increased volatility in earnings
  - As markets and instruments became more complex, it became critical to have a comprehensive view of firm-wide risks
- **Early 1990s**
  - Group of 30 report. *Derivatives: Practices and Principles.*
  - Oct-94: JP Morgan published RiskMetrics
- **1995-today**
  - Value at Risk (VaR) becomes a standard financial market risk measurement tool worldwide
  - Surprisingly, most firms still using original market methodologies and metrics with minor variations (despite significant advances in the field)
    - New metrics: ETL, Spectral Measures, Coherent Stress Tests
    - New Simulation-based approaches for long horizons

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Types of Credit Risk in Energy

- Physical Delivery Credit Exposure
  - Value of the physical product delivered to a counterparty prior to receiving payment for such product
- Current Mark-to-Market Credit Exposure
  - Current replacement value of a contract that could be lost if a counterparty defaults today.
- Counterparty Potential Future Exposure
  - Potential exposure with a counterparty over time as a result of fluctuations in market and other parameters.
- Settlement Credit Exposure
  - Settlement exposure is the risk that payment will not be made by a counterparty as of the contractual due date.

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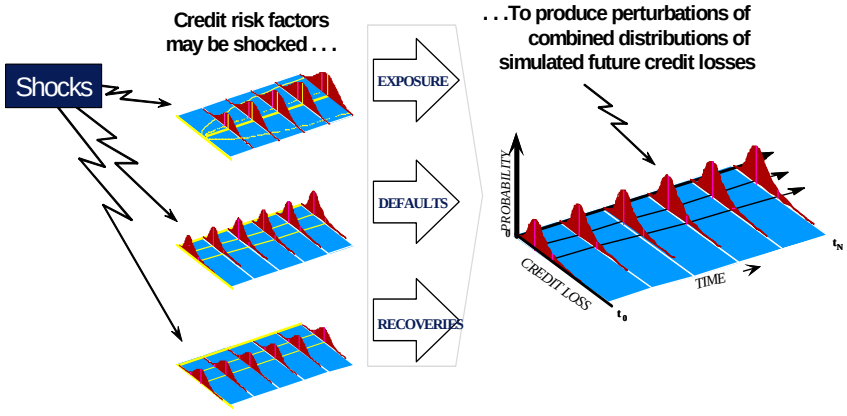
Credit Loss Distributions
Exposure, Default, Recoveries



Correlations to other factors

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Credit Risk Questions

- How could the exposure change over time based on existing forward prices as well as simulated scenarios of future states of the world?
- What is our expected and maximum potential losses change over a given horizon?
- What is the effect on our portfolio credit risk of that potential transaction?
- Should we adjust the price or the final profits of each transaction based on the credit risk taken by the firm?

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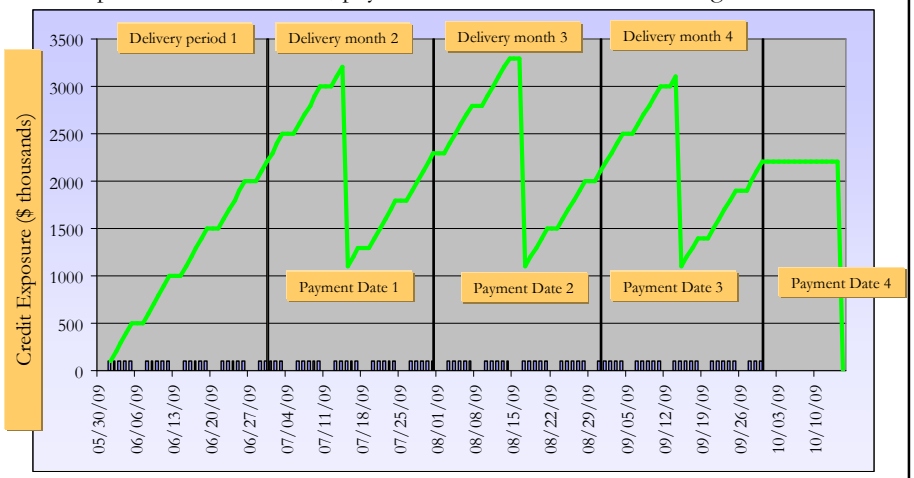
Modeling Credit Exposures of Physical Deliveries over Time

Gas Supply contract. June to September 2009; 10,000 MMBTUs/weekday @ fixed price of $10/MMBTU; payment on the 15th of the following month



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Credit Exposures

- Credit Exposure = Value of the claims to the counterparty at default
  - Current Exposure
    - **Net Exposure = Accounts Receivable - Accounts Payable + Mark to Market - Credit Mitigants**
  - Expected Exposure and (near) Worst-Case potential exposure Profiles (function of time horizon)
    - Sum of the "current exposure" (CE) plus:
      - The "expected exposure" (average) over the life of the transaction
      - The "potential future exposure" (PFE). The PFE is the projected worst case potential exposure over the life of the transaction with a given degree of statistical confidence

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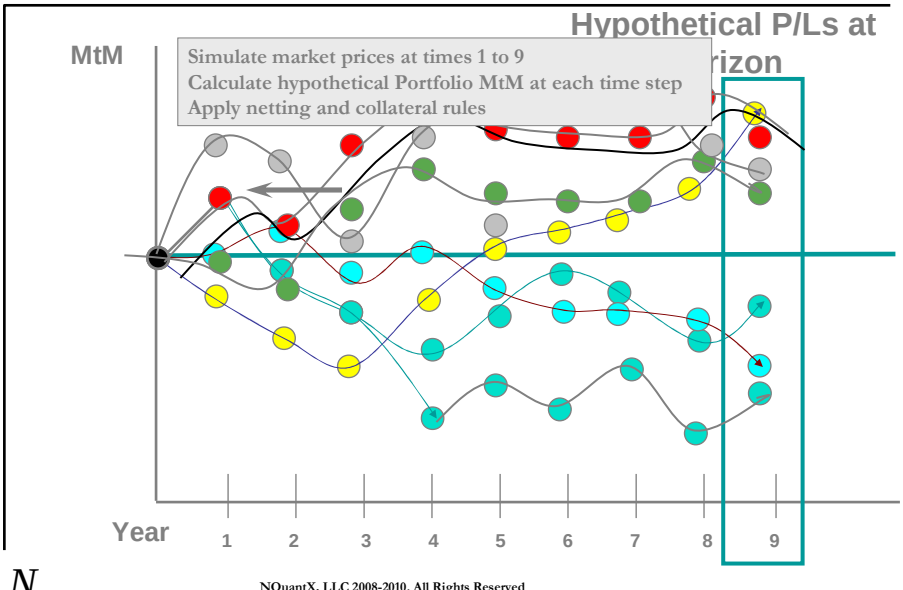
Dynamic Counterparty risk exposure simulation
General Simulation Framework



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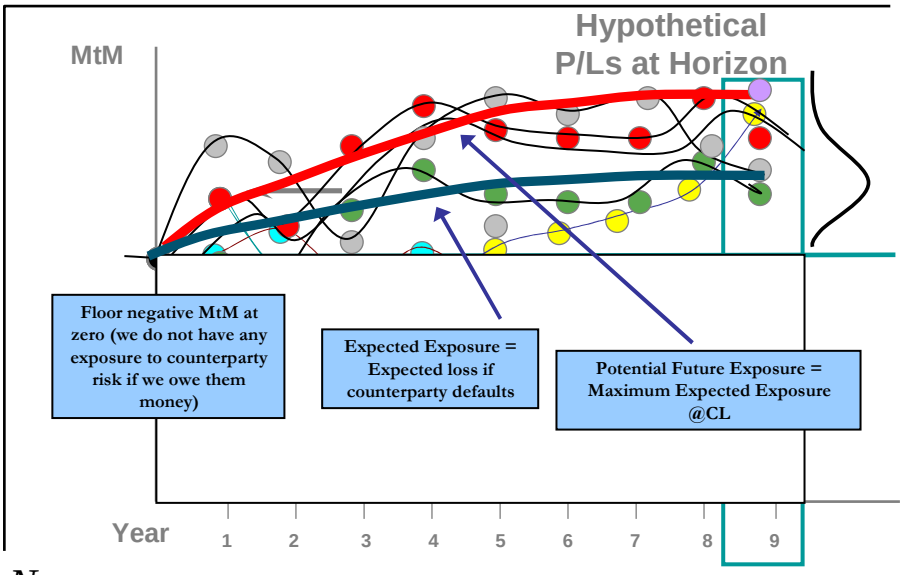
Expected Exposure and Potential Future Exposure



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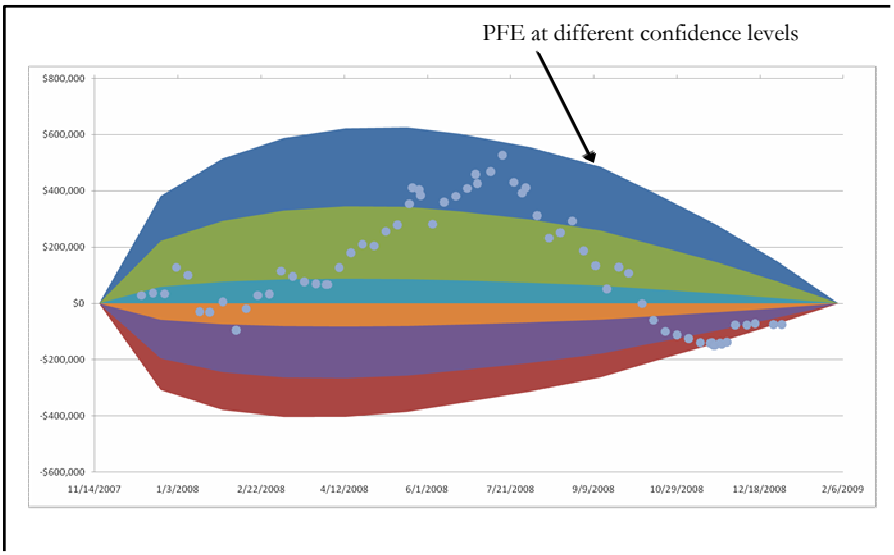
PFE and Mark to Market



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Spot price stochastic processes

- Geometric Brownian Motion (GBM):

  $$\frac{dS}{S} = \mu dt + \sigma dz$$

  μ is the growth rate ; σ is the volatility of changes in the spot price

- GBM w/ Mean Reversion
  Ornstein-Uhlenbeck (O-U) process:

  $$\frac{dS}{S} = \alpha(\mu - \ln S)dt + \sigma dz$$

  α is the mean reversion rate ; μ is the long term level to which *S* reverts ;
  σ is the volatility of changes in the spot price

- Jump-Diffusion (O-U with Jumps):

  $$\frac{dS}{S} = \alpha(\mu - \ln S)\ dt + \sigma\ dz + \kappa\ dq$$

  The process dq is a discrete time process. Jumps occur at specific points in time determined by the jump frequency.

where

$$\ln(1+\kappa) \sim N(\ln(1+\bar{\kappa}) - \frac{1}{2}\gamma^2, \gamma^2)$$

$\bar{\kappa}$ is the mean jump size and

γ is the standard deviation of the jump size (jump volatility)

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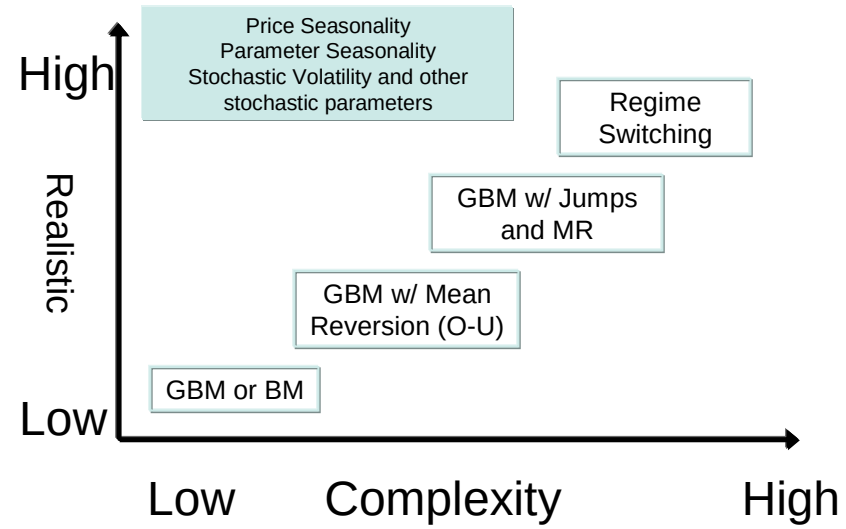
Model Complexity vs. Ability to Match Price Behavior



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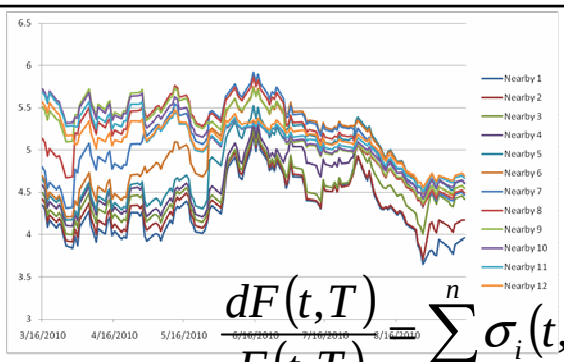
Forward Curve Behavior
Example: Natural Gas NYMEX Henry Hub



Source: Zema

$$\frac{dF(t,T)}{F(t,T)} = \sum_{i=1}^{n} \sigma_i(t,T)\,dz_i(t)$$

- Time to maturity effect
- Volatility of delivery period
- Correlation between contracts at different points of their lives
- Implied volatilities vs. Forward Volatilities
- Co-movement with other forward curves

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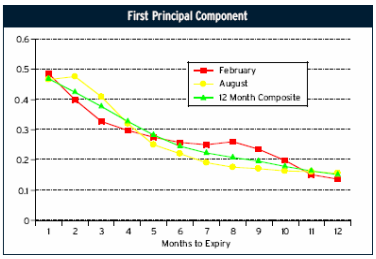
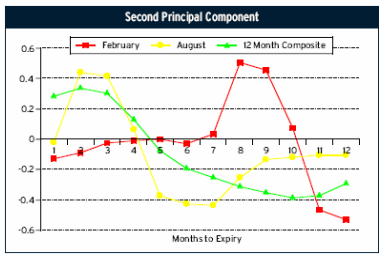
Seasonal PCA: Impact on different components
(Natural Gas Henry Hub example)

- The eigenvectors of the first component are relatively stable for different seasons vs. the average



- Eigenvectors of the second component (Curvature) are considerably different for different seasons vs. the average



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Liquidity Risk in Trading & Hedging

- Two types of liquidity risk
  - Trading liquidity risk – ability to exit positions
  - Funding liquidity risk – ability to meet margin/collateral calls payments
- Collateralization has two offsetting effects
  - Counterparty credit risk is mitigated
  - Liquidity risk is amplified (makes OTC derivatives more like exchange-traded futures)
- Increased disclosures on current and potential liquidity position of trading firms.
  - Constellation Energy – Collateral requirement errors
  - Enron, Semgroup, Amaranth – Misleading investors, debtors?

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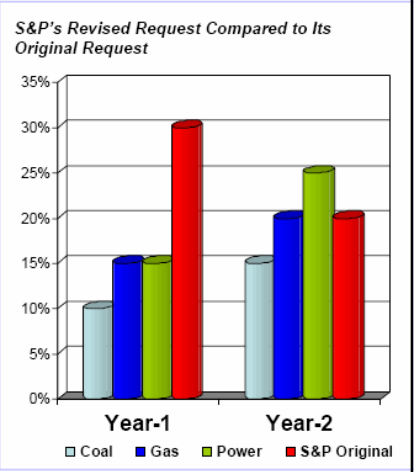
S&P (funding) Liquidity Risk Survey

- *To measure the sufficiency of liquidity under stress scenarios*
  - Market-related events
  - Downgrade triggering Credit-contingent collateral calls
- Credit event liquidity adequacy (CELA)
- Market and Credit event liquidity adequacy



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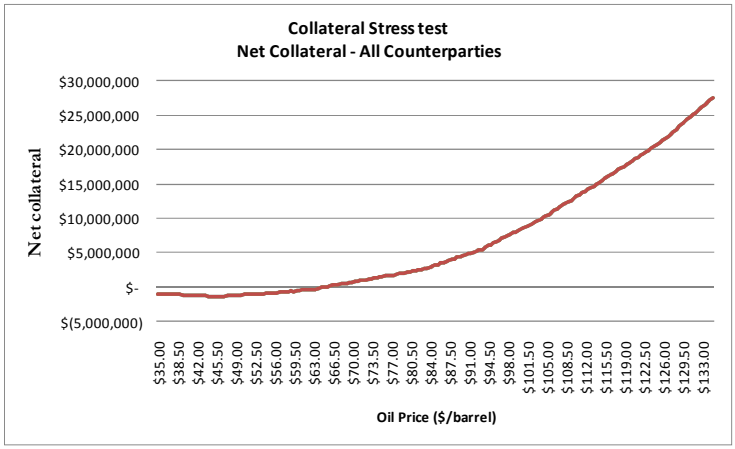
Funding Liquidity Stress Tests



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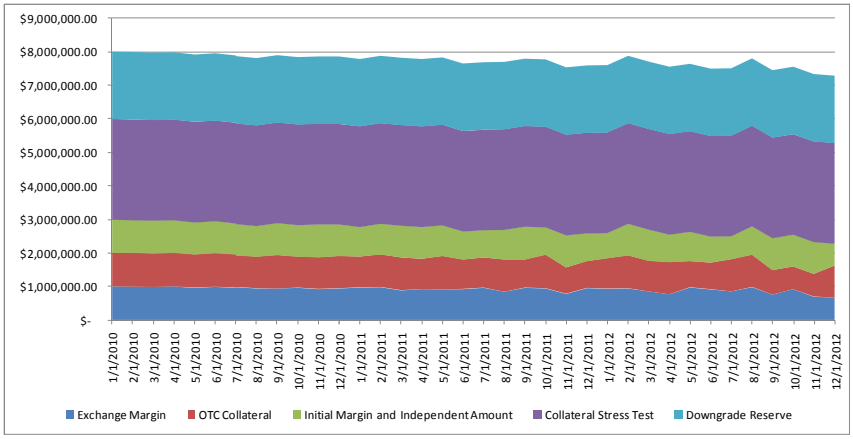
Projected Collateral Requirements based on Pre-defined Hedge Strategy



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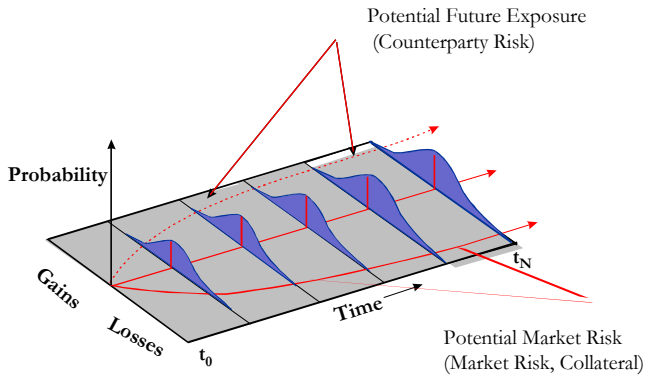
Market, Credit and Liquidity Risks are tightly linked



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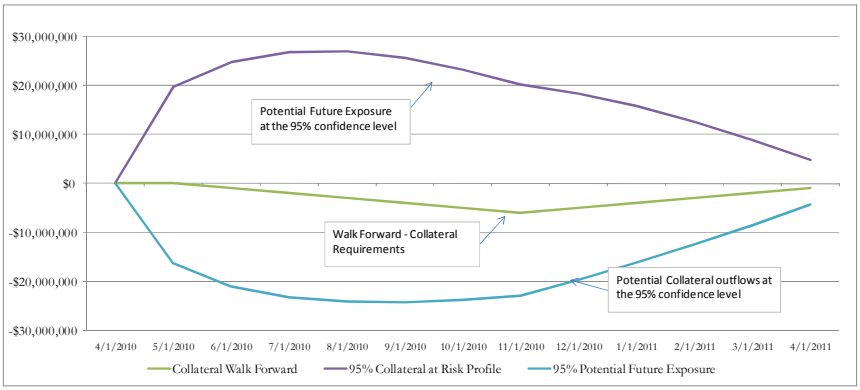
Collateral Walk Forward

Natural Gas Swap. Fixed Price Payer. Backwardated Curve



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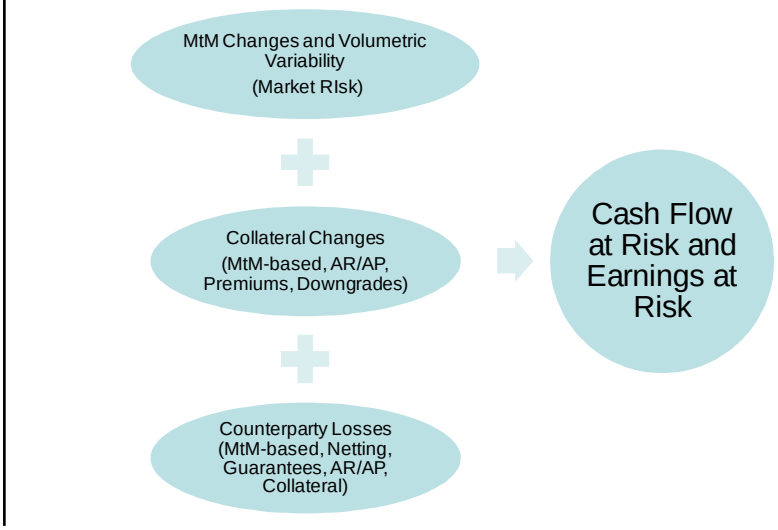
Cash Flow and Earnings at Risk



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Differences between 'at-Risk' methodologies

	Value at Risk (VaR)	Collateral at Risk (CaR) and CFaR	Potential Future Exposure (PFE)	Earnings at Risk (EaR)
Simulated Market Scenarios	YES	YES	YES	YES
Multiple Time Steps (periods)	NO	YES	YES	YES
Portfolio Ageing and Walk Forward Analysis	NO	YES	YES	YES
Netting Agreements	NO	YES	YES	YES
Collateral and Margin Clauses	NO	YES	YES	YES
Portfolio trading/hedging strategies	NO	YES	NO	YES
Counterparty Default	NO	YES	NO	YES
Hedge Effectiveness Rules	NO	NO	NO	YES
Rating Downgrade	NO	YES	YES	YES
Operational Risks	NO	YES	YES	YES
Dynamic Hedging Strategy	NO	YES	NO	YES
Volumetric Risks	NO	YES	NO	YES

Source: NQuantX, LLC

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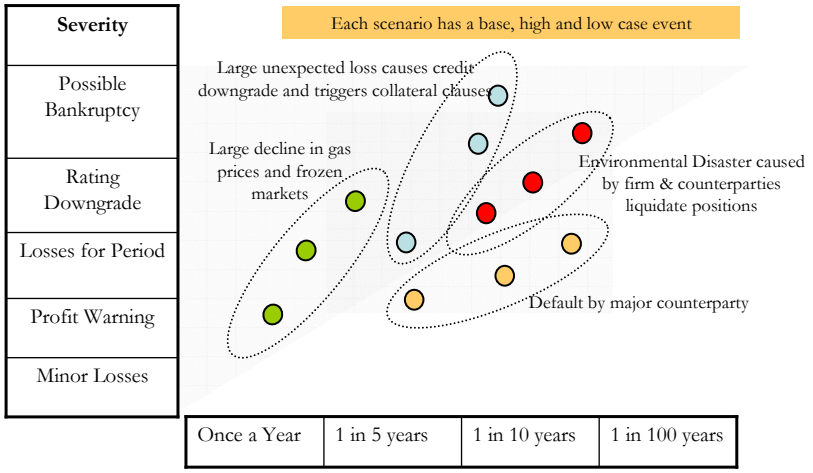
Sample Stress Tests for an Energy Trading Operation



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Hedging Programme

- Board policy must be clear
  - Connection to business strategy
  - Risks to maintain and to mitigate
  - Volumes, Terms
  - Available Instruments
  - Budgets
- Consider
  - Market risk
  - Credit risk
  - Liquidity risk (margin/collateral)
  - Hedger's regret
  - Economic vs. Accounting Impact

TABLE 3. HEDGE ADVISORY DASHBOARD IMPACT OF Q2 2009 HEDGE ALTERNATIVES

KRI (1 Quarter, 99% Level)	Physical Exposure	25% With Swaps	50% With Swaps	75% With Swaps	Zero Cost Collars	Call Options
Cost at Risk & Stress Tests	●	●	●	●	●	●
Potential Future Exposure	●	●	●	●	●	●
Margin/Collateral at Risk	●	●	●	●	●	●
Potential Rating Downgrade	●	●	●	●	●	●
Potential Regret	●	●	●	●	●	●
Hedge Ineffectiveness	●	●	●	●	●	●
Dollar Hedging Costs	●	●	●	●	●	●

Source: NquantX, LLC

● = HIGH ● = Medium ● = Low

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Estimating Creditworthiness of Counterparties

- Financial Statement Analysis
  - Cash flow statement
  - Balance Sheet
  - Income Statement
  - Disclosures
- Rating Agencies
  - Moody's
  - Standard & Poors
  - Fitch

- Market-Based Information
  - Bond Markets
    - Credit Spreads
  - Credit Default Swaps
  - Equity Markets
- Hybrid Models
  - Expected Default Frequencies (EDFs)

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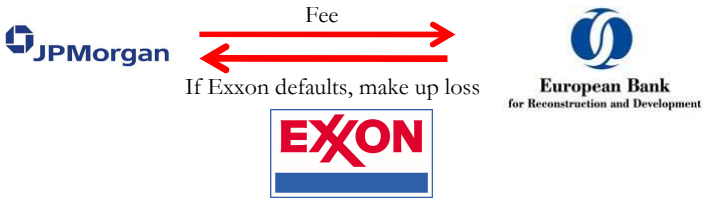
Origin of Credit Default Swaps

- Exxon fined $5 billion fine for Valdez tanker oil spill
- Asks for $4.8 billion credit line from J.P. Morgan
  - Exxon a long standing client, but….
    - would make little profit compared with risks taken
    - use up a lot of J.P. Morgan's capital
- Solution: JPMorgan approaches EBRD asking for protection in the event of Exxon's default (CDS)



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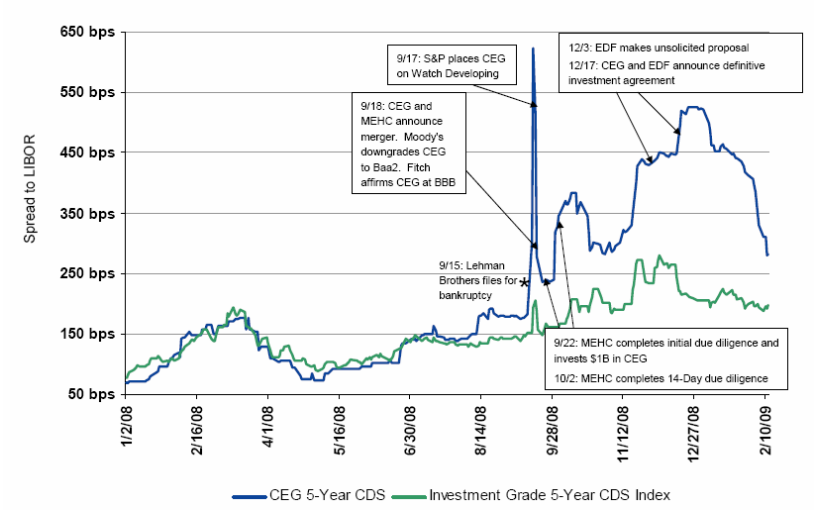
Constellation Energy and Investment Grade CDS index



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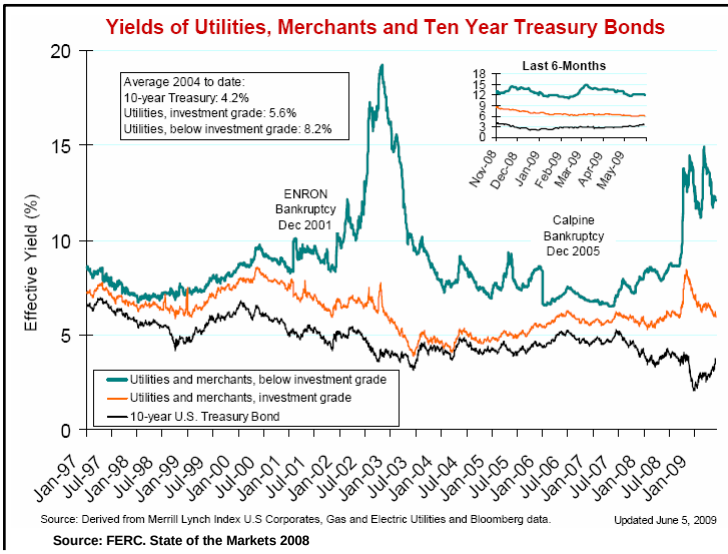
Yields for Utilities/Merchants Bonds



Source: FERC. State of the Markets 2008

Yields on bonds are a function of probability of return OF the investment

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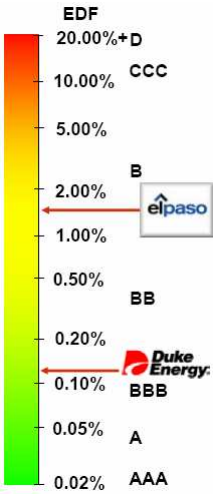
KMV's Expected Default Frequency

- Probability that a counterparty will default within a specified time horizon (1 year)
  - Numerical figure (in %)
  - Based on derivative pricing model
  - Empirically calibrated to extensive default database
  - Primary metric in managing credit portfolios in banks
- Allows direct comparison: a company with a 2% EDF is 10 times more likely to default than a firm with a 0.20% EDF



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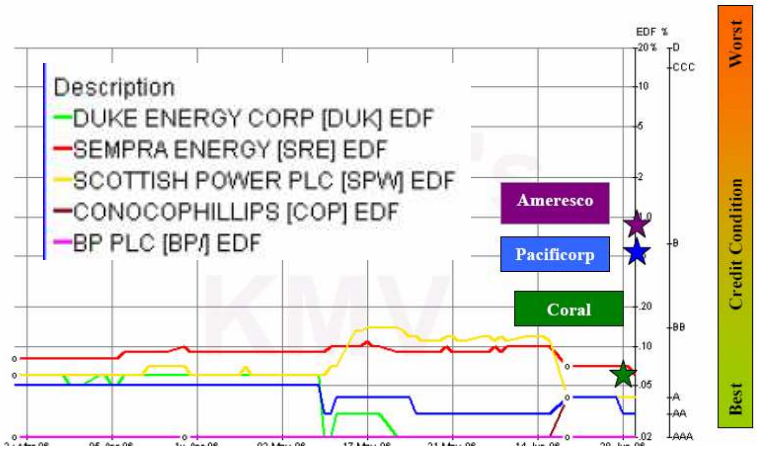
Sample Counterparty PD report

Evolution of ratings for top counterparties



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Counterparty Adjustment (CVA)

- Adjusting the discount rate
  - The counterparty adjustment is different for assets and liabilities.
    - For an asset, the non performance risk is based on the counterparty's probability of default.
    - For a liability, nonperformance risk is based on the own probability of default of the reporting entity.
- The method to perform NPV adjustments based on the credit spread is appropriate for most contracts with linear payoffs.
- However, there are non-trivial issues that need to be solved when calculating the CVA for non-linear contracts such as options.
  - Introducing Probability of Default via Monte Carlo Simulation
  - Dependency structure between default probabilities, market prices and recovery rates

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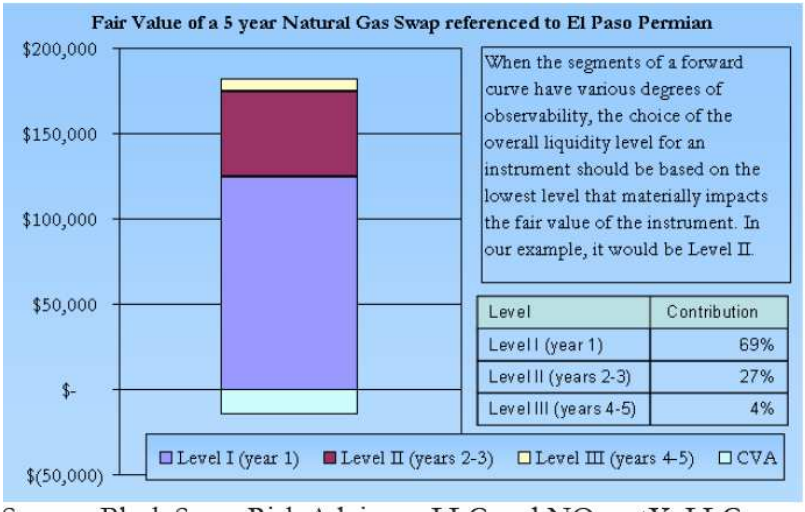
Fair Value Hierarchy for an Instrument referenced to a Forward Curve with multiple liquidity levels



Source: Black Swan Risk Advisors, LLC and NQuantX, LLC.

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Credit- and Market Risk: Differences and Mitigation Tools

	Risk Factors	Legal Considerations	Horizon
Credit Risk	Market Risk Factors, Probability of Default, Default Correlations, Recovery rates	Critical	Long
Market Risk	Market Prices, Volatilities	Largely Ignored	Short

	Original Risk	Mitigation Tools
Credit Risk	Default Risk	Guarantees, L/C, Netting, Covenants , Downgrade clauses, Prepayment, Collateral, Credit Default Swaps, Credit Insurance
Market Risk	Position Risk	Derivatives (options, swaps,..) Offsetting positions in correlated markets

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How to 'price' credit risk

- How can credit risk managers create the right incentives for traders and trading management to manage counterparty risk?
- How can traders be 'encouraged' to trade safely (from a credit point of view)?
  - Collateralized exposures
  - Stronger counterparties
  - Counterparty exposure reducing trades
- A credit charge based on expected losses sets a 'risk premium' from bringing credit risk in the firm. It can be thought as the 'cost' of doing business
- Two main types of charges.
  - Based on PFE. Charged at the beginning of the transaction.
  - Paying on a continuous basis while transaction is open

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Charging for credit risk on a continuous basis

Net of collateral

Based on internal rating and PD

	Current MtM	Current Exposure	Internal Rating	Annual Credit Spread	Daily Credit Penalty
Counterparty X	$ 875,000	$650,000	7	275 bp	$48.97
Counterparty Y	$ 2,928,000	$350,000	5	150 bp	$14.38

At what level should we institute the charges? Trading unit ; Trading desk ; Trader

What about marginal exposures?

- **Marginal Current Exposure**: Change in Current Exposure with a given counterparty as a result of adding a new transaction
- **Marginal PFE:** Change in PFE with a given counterparty as a result of adding a new transaction
- **Marginal CVaR**: Change in CVaR at the portfolio level as a result of adding a new transaction

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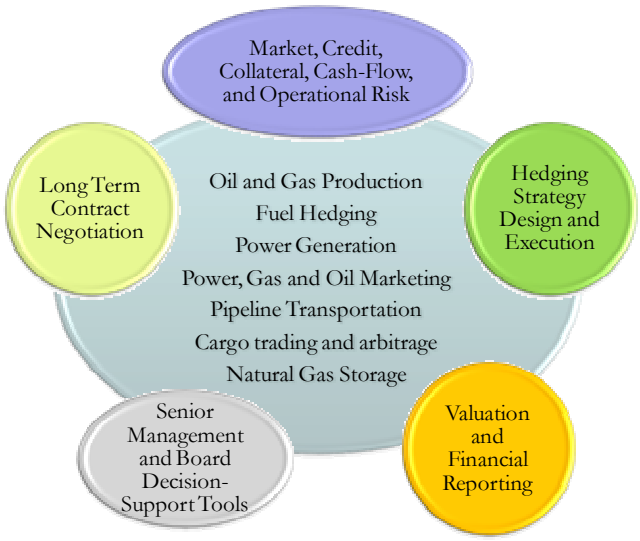
Integrated Risk Modeling as a Decision-Support Tool



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Summary

- Many exposure and loss metrics available for different types of risk could assist other groups make better informed decisions
- Production of risk information often in silos
- End users of Risk Information often need integrated view of risks
- Many risk groups moving towards compliance vs. strategic support to the business
- Explicitly bring interaction of material risks into risk policy
  - Limits
  - Reserves
  - Risk-adjusted Pricing
  - Risk-adjusted Valuation (CVA)

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- Thank you for your attention.
- Questions????

- For any additional questions in the future, please send me an email to: carlos@blackswanrisk.com

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NQuantX, LLC provides financial engineering solutions to support trading, hedging and risk management decisions. NQuantX is a spin-off of Black Swan Risk Advisors, LLC.

Our clients are firms active in energy and commodity physical and derivatives markets such as producers, consumers, utilities, marketers, traders, utilities, financial institutions, asset managers, and hedge funds.

We help clients solve their valuation and risk management needs with a wide range of services and solutions.

Financial Engineering Solutions

Portfolio risk measurement (market, credit, collateral, liquidity, volumetric, operational)
Physical asset and contract Valuation, Optimization and Hedging
Spot and forward curve simulation
Forward Curve Building and Shaping
Derivatives MtM, Greeks, hedge curves
Structured Product valuation and hedging
Trading and hedging strategy analysis and backtesting

Advisory and Outsourcing Services

Financial engineering outsourcing
Valuation and model development
Risk model review and assessment
Trading and hedging strategy design and execution
Trading and risk metrics, policies and procedures - Market, credit and ERM
Risk and trading strategy forensic analysis
M&A advisory work
Due diligence on derivatives and risk management

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Certificate in Energy Derivatives Pricing, Hedging, and RM

www.oxfordprinceton.com

Certificate in Derivatives Pricing, Hedging and Risk Management — **DPHC**

Candidates for this certification program need to successfully complete three courses in this order:

Energy Derivatives Markets, Instruments and Hedging (DPH1)
Energy Derivatives Pricing, Hedging and Risk Management (DPH2)
Advanced Energy Derivatives Pricing, Hedging and Risk Management (DPH3)

- Candidates have three (3) years to complete all three courses as well as accompanying exams. Each course is offered at least once a year.
- Once a course is completed, an exam paper will be mailed to the candidate and must be completed and submitted within three (3) months.
- A brief paper is to be completed at the end of the final course that will enable candidates to apply some of the concepts presented in an area that would benefit them in their day-to-day activities (final topic to be chosen in consultation with the Course Director) .
- Pre-testing is available for those who might be able to place out of DPH1 and/or DPH2.
- Delegates who have already successfully completed **Derivatives Pricing, Hedging and Risk Management** (TPD) in 2007 or 2008, are eligible to enroll into DPH3 (no need to take DPH1 or DPH2).

Upon successful completion, a certificate and accompanying token of achievement is presented to the recipient.

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Courses in Calgary: 2011

- Certificate in Derivatives Pricing, Hedging and Risk Management
  - DPH1: 2 - 3 May 2011 (2)
  - DPH2: 4 - 5 May 2011 (2)
  - DPH3: 20 - 21 June 2011 (2)
- Counterparty Risk Management (CCRM)
  - 22-23 June, 2011 (2)
- North American Gas and Power Trading and Risk Management
  - 14 - 16 March 2011 (3)

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- **"Integrated Risk Modeling for Trading and Hedging Decisions"**, Blanco, C. and M. Pierce, WorldPower. 2010
- **"Risk Governance and Stress Tests. Blanco"**, C. and J.R. Aragones. Commodities Now. September 2010
- **"Credit Risk Management: Time to review policies, metrics and systems"** Blanco, C. and W. Murdoch, NQuantX, LLC (to be published in Energy Metro Desk, September 2010)

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