Credit Exposure Measurement Applied to Reserving and Credit Capital for Derivative Portfolios

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Reserving and Credit Capital

- Reserve Defined: To a given horizon across a portfolio, what do I <u>expect</u> to lose due to counterparty defaults.
- Credit Capital Defined: To a given horizon across a portfolio, with <u>a specified level of confidence</u> what is the <u>most</u> I can lose due to counterparty defaults.

Reserving and Credit Capital

- What horizon should be used?
  - Budget cycle (1 year)
  - Time to return to capital markets to replenish capital (18 months to 3 years)
  - Portfolio life

Ideal Solution

- Loss Simulation
  - Generate path dependent economic scenarios to maximum horizon needed
  - Economic scenarios will drive market variables such as rates and levels (correlation)
  - Determine present value counterparty exposure paths resulting from future rates and levels considering
    - netting agreements
    - aggregation

Ideal Solution

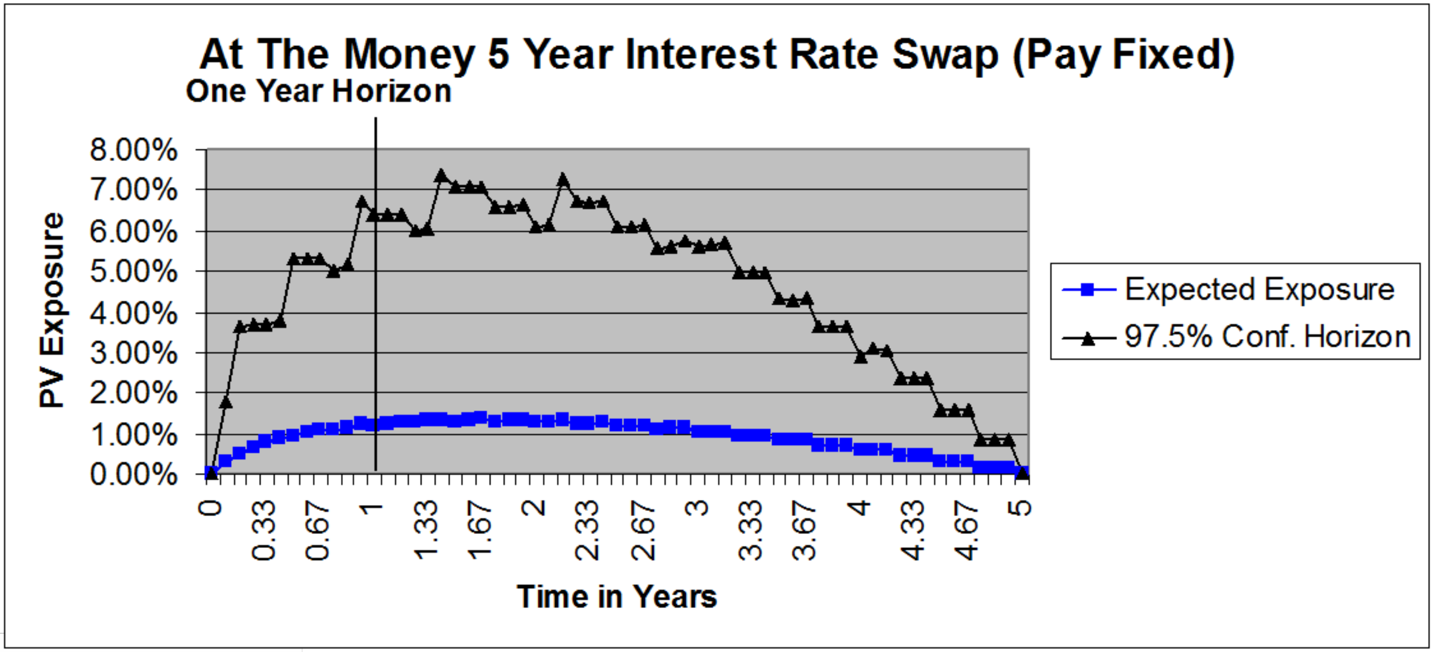
- Loss Simulation (cont.)
  - Economic scenarios will drive industry and individual obligor credit worthiness
  - Timing of defaults and recovery amounts
  - Across each simulation path will define total loss in present value terms
  - Expectation over paths is credit reserve
  - Confidence level measure (ex. 99.9%) or standard deviation multiple is credit capital

Reality

- Credit rationed via counterparty exposure limits (97.5% confidence) at a series of horizons (O/N to 10 years)
  - Counterparty horizon exposure measures determined independently of each other
- Combine counterparty exposure measurement with counterparty risk rating default likelihood and loss given default assumptions to measure reserve and capital

Reserving

- Need expected exposure <u>curve</u> in present value terms to target horizon
  - 97.5% confidence level exposure too high, even expected exposure measure at horizon will be inaccurate



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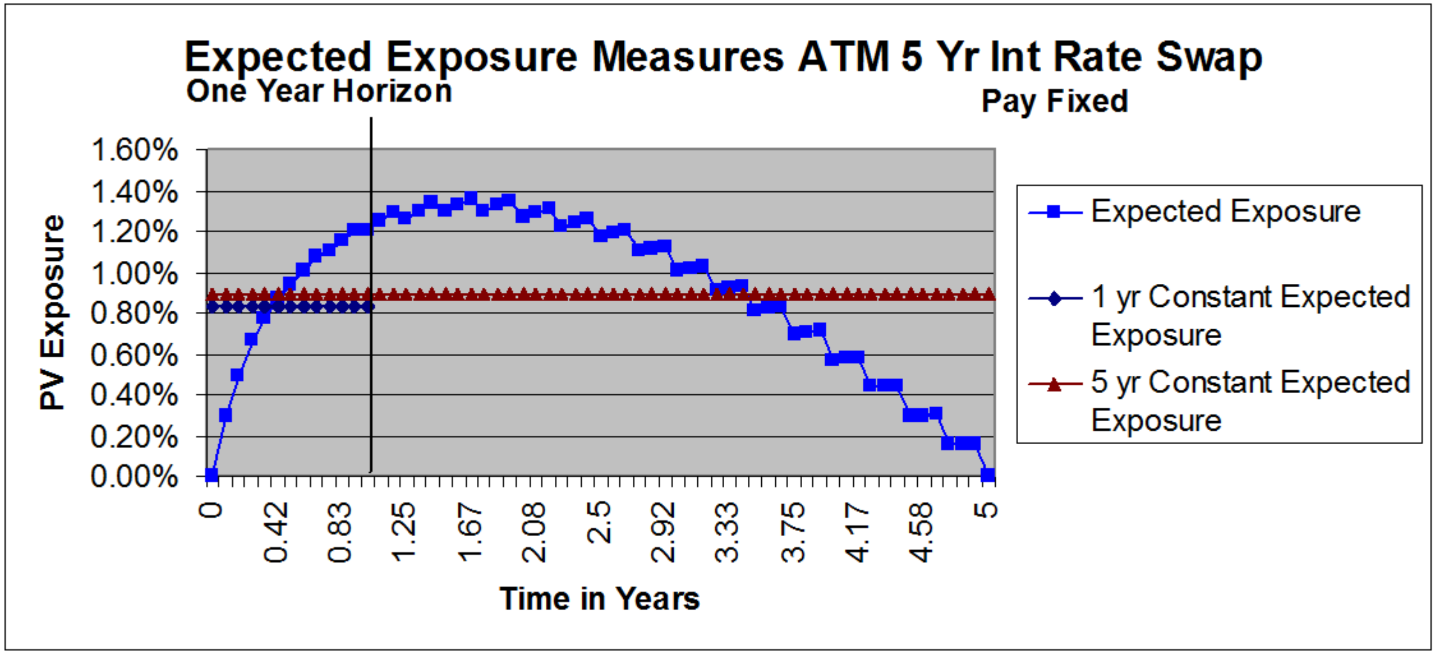
Reserving

- In addition to loss given default assumption, horizon specific expected loss measure will require either:
  - marginal default likelihoods for each expected exposure point
  - constant expected exposure measure accompanied by horizon cumulative default likelihood

Reserving

- Horizon in question will have both a different counterparty default likelihood & different constant exposure value



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Reserving and Credit Capital

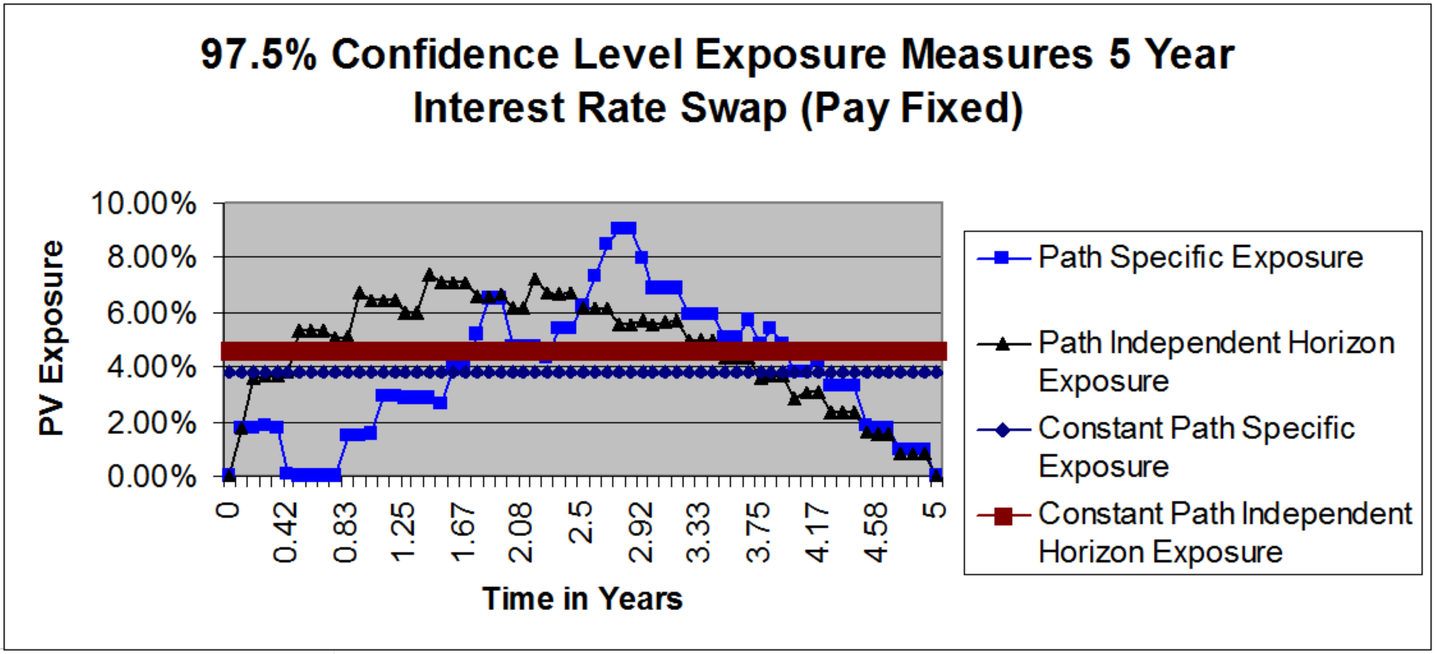
- For a given horizon, reserve is summation over n counterparties of expected loss
  - LGD is assumed constant over portfolio
  - EXP is counterparty constant expected exposure to horizon (t)
  - EDF is counterparty expected default frequency to horizon (t)

$$EL_{\text{portfolio}_t} = \sum_{i=1}^{n} EL_{i_t} = LGD \sum_{i=1}^{n} EXP_{i_t} EDF_{i_t}$$

- Credit capital requires a measure of variability

Credit Capital

- Where exposure methodology for risk management purposes need not be path dependent, measuring capital requires path dependency or will overstate exposure



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Credit Capital

- Although path specific confidence level exposure to horizon can be measured by counterparty, will not be able to aggregate and apply proper default likelihoods across portfolio of counterparties and still retain confidence level measure for portfolio loss
  - Counterparty A is S&P A pay fixed 2 year swap
  - Counterparty B is S&P BBB pay float 2 year swap
- Thus, will need to determine a standard deviation of loss approach and use n sigma estimate for default protection (credit capital)

Credit Capital

- Assuming independence of default and exposure across portfolio along with constant LGD, define loss variability across portfolio of n counterparties as follows:

$$UL = \sqrt{VAR(\sum loss)}$$

$$UL = \sqrt{VAR(\sum LGD * EDF * EXP)}$$

$$UL_{portfolio_t} = \sqrt{LGD^2 \sum_{i=1}^{n} \sum_{j=1}^{n} \left(E\left(EXP_{i_t}\right) E\left(EXP_{j_t}\right) COV\left(EDF_{i_t}, EDF_{j_t}\right) + E\left(EDF_{i_t}\right) E\left(EDF_{j_t}\right) COV\left(EXP_{i_t}, EXP_{j_t}\right) + COV\left(EDF_{i_t}, EDF_{j_t}\right) COV\left(EXP_{i_t}, EXP_{j_t}\right) \right)}$$

Credit Capital

- Covariability of default may be measured using either a counterparty or risk rating level default correlation along with a Bernoulli assumption for counterparty or risk rating specific default variability:

$$\mathrm{COV(X,Y)} = \rho_{\mathrm{xy}}\sigma_x\sigma_y = \rho_{\mathrm{xy}}\sqrt{\mathrm{VAR(X)VAR(Y)}}$$

$$\mathrm{VAR(X)} = \mathrm{EDF} * (1 - \mathrm{EDF})$$

Credit Capital

- Lacking a source for default correlations, bank risk rating joint default likelihoods can be determined as in Lucas' March 1995 Journal of Fixed Income article "Default Correlation and Credit Analysis."
  - Joint default likelihoods used to determine covariance of default

$$\mathrm{COV}(x, y) = E(xy) - E(x)E(y)$$

Credit Capital

- Covariability of exposure will require calculating a constant exposure measure to the desired horizon for each path by counterparty inclusive of netting and aggregation.
- Given expectation over all paths, counterparty i and j have a constant exposure covariability as follows for a time horizon of t:

$$\mathrm{COV}(\mathrm{EXP}_{it}, \mathrm{EXP}_{jt}) = \mathrm{E}(\mathrm{EXP}_{it} * \mathrm{EXP}_{jt}) - \mathrm{E}(\mathrm{EXP}_{it}) * \mathrm{E}(\mathrm{EXP}_{jt})$$

Weakness of Approach

- To the degree that default likelihood does not increase linearly over time, shorter maturity counterparty portfolios will have inaccurate default likelihoods applied to their constant average exposure at the desired horizon
  - 1 year swap examined at 5 year horizon
  - 5 year default likelihood not equal to 5 * 1 year default likelihood