The Effect of Credit Risk on Derivative Pricing

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Market Risk vs. Credit Risk

- Tradable assets
  “ready for sale” → daily mark to market → standard VaR
  assets are usually limited liability assets, with no negative payoff
  (e.g., stocks, currencies, etc)
  → market risk is relevant
- Non-tradable assets (e.g., loans)
  “long term book” → no mark to market
  → credit risk is relevant
- …hence, there is usually a clear separation
- Except for the case of derivatives
  (think of the payoff function of swaps, forwards, options)
Systemic Risk of OTC derivatives: A Decade-Old Problem

...Since Merrill’s loss on CMOs in the early 90s, to Nick Leeson at Barings to LTCM, OTC derivatives have been a matter of great concern:

- Greenspan
  We must all guard against a situation in which traders lack the expertise to evaluate the attendant risks, and ... senoir managers are too embarrassed to admit they don’t understand them

- Corrigan
  ...the growth and complexity of derivatives ... and the nature of the credit risk they entail should give us all a case for concern

The Interest Rate Sensitivity of a Swap: a short review

- How do we MTM a Swap?
  SWAP == (long floater) + (short fixed bond)
- The interest rate sensitivity is driven primarily by the short fixed bond component.
- For our purposes, note that the critical relevant characteristic is that the IRS has no principal amount at stake
Credit Risk Issues Arise

- The swap curve indicates how much a dealer would pay / receive in a swap with an investment grade counterparty
- Interesting to note: Spreads does not seem to be rating sensitive!

DOES IT MAKE SENSE?

- Some argue that credit risk is underpriced in the swaps market, since swap spreads are much lower than corporate credit spreads.
- However, swaps have many special features, which substantially reduce their credit risk.

<table>
<thead>
<tr>
<th>Loans</th>
<th>Swaps</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Full principal at risk</td>
<td>• No principal at risk</td>
</tr>
<tr>
<td>• Full interest payments at risk</td>
<td>• Only a spread payment at risk</td>
</tr>
<tr>
<td>• Defaults always matter</td>
<td>• Default matters only if in the money</td>
</tr>
<tr>
<td>• Covenants apply</td>
<td>• Contracts often have rating-related unwind/settlement triggers and advanced credit enhancement and collateralization features</td>
</tr>
</tbody>
</table>
Credit Enhancement

- The most "matured" setting can be found on organized exchanges
- The OTC market provides a variety of standard (ISDA master agreement) and new (asset/counterparty-specific) additions

Credit Enhancement: the Case of Exchanges

- Options and futures margin requirements
  » margin serves as a collateral
- Daily mark-to-market and possible liquidation of a position
  » margin is proportional to avg. vol
  » margin may be related to the nature of the trade (hedging or speculative)
- Position limits vis-a-vis each counterparty helps diversify default risk
- Cross-clearing agreements

The system is, however, not fool-proof
(e.g., the case of Barings)
Credit Enhancement: OTC Derivatives

- Netting Arrangements
  » bilateral close-out is now standard in the ISDA master swap agreement
- Position Limits
  » RM group monitors the "exposure profile" for each counterparty
  » each trade is considered for its portfolio effect
- Margins and Collateral
  » common to require dynamic margining

Credit Enhancement: OTC Derivatives
Continued

- Derivative Product Companies (SPVs)
  » Dynamically capitalized to maintain AA / AAA -rating
  » Often a requirement of sovereigns
- Re-couponing
  » MTM-triggered payment and recouponing brings transaction to market
- Credit Triggers
  » If a counterparty falls below investment grade, the other counterparty may require an immediate cash settlement (of questionable effectiveness)
  » Common for long-dated swaps
Credit Exposure

…So, what are the key factors affecting the exposure of derivatives?
- Current fair value
- Potential exposure
  - Time to maturity
  - The time series properties of the underlying
  - …
- Effect of netting, collateral and margin
- Probability of default
- Priority of claimants upon default
- (± the effect of deviations from absolute priority?)
- Recovery rate

Capital Adequacy Rules

The rules account for time to expiration and the degree of moneyness of the default option.
### Capital Ratios
The 88 Basel Accord

<table>
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<th>&lt;1yr</th>
<th>1-5 Yr</th>
<th>&gt; 5yr</th>
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<tbody>
<tr>
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<tr>
<td>Ex Rates</td>
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</tr>
<tr>
<td>Commodity</td>
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</tr>
</tbody>
</table>

### Exposure Through Time

- **The amortization effect**
  - as time goes by, there are less outstanding exchanges of money outstanding, and the potential loss relative to the notional amount decline

- **The diffusion (volatility) effect**
  - a function of “how far things can get”
  - for interest rates, important to account for mean-reversion and lower volatility
  - also, there is no exchange of principal
Combining the Effects: *interest rate swap*

- Expected
- Average

Combining the Effects: *currency swap*

- Expected
Average vs. Worst Case

- So far we discussed the **expected path**
- Regulators and management also ask: How much capital is needed under “adverse conditions” -- **Maximum Exposure**
- Loans: Maximum=Expected= Face
- IR Swaps: Maximum can be capped
  
  *Suppose short rates go to zero -- pay fix side loses X% every period*
- FX Swaps: only prob statement

Analysis critically depends on the stochastic model for the underlying
Netting

- Addresses multiple contracts between two counterparties
- Key: defaulting counterparty cannot sell/reassign ITM contracts and “walk away” from OTM contracts
- Implications
  - w/o netting, loss is
    \[ \Sigma_i \text{Max} [0, V_i] \]
  - w/ netting
    \[ \text{Max} [0, \Sigma_i V_i] \]
  - ...a much lower number
The Credit Risk of a Portfolio of Derivatives

- Exposure to a major counterparty should account for netting
  example  pay LIBOR receive 7% on $100MM
  pay 8% receive 7.5% on $90MM
- Net exposure is much smaller than the sum of replacement costs
- Netting can be generalized (in a portfolio sense)
  » Layer 1: correlation of FX, Diff, IR swaps
  » Layer 2: correlation of def prob across counterparties