The process of modeling and validating the CRM Model

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Disclaimer

• My own words, though work done while working at Morgan Stanley on Basel Op Risk/AMA and internal reg model review

• Great, collegial support from M.S. and E & Y

• Morgan engagement ends March 30th

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Outline

1. Historical Context
2. Regulatory Response: IRC and CRM
3. “Constant Level of Risk”
4. Liquidity Horizons
5. CRM as extension of IRC
6. Dodd Frank and Ratings
7. Current State of CRM Modeling
8. The Road Ahead
Historical Context

• Great Recession as prelude to regulation
  – Bear Stearns
  – Lehman
  – Shakeups at Merrill, Citi
It appears the mortgage crisis is having a fairy tale ending.
Historical Context, cont.

• Credit liquidity dried up
• Daily VaR (or 10 day VaR) a bad metric for credit holdings
  – Just a snapshot
  – Ignores large credit events (Lehman, Fannie/Freddie) that are relatively rare
  – Insensitive to long-term changes e.g. slow deterioration in positions over weeks/months
Historical Context, cont.

• CDO history
  – Issuance bubble
  – Increasing amounts of subprime
  – Tranche trading (esp. equity)
  – CDO^2, CDO^3, LSS

• CDO characteristics
  – Rampant speculation
  – Lucrative for IB’s, Moody’s, S&P... (“issuer pays”)

Historical Context, cont.

• CDO Misunderstandings
  – “high quality”
  – Gaussian copula always applicable

• Main copula deficiencies
  – Static correlation
  – Calibrated to periods of good credit, stable spreads
  – Blindsided by housing bubble
Historical Context, cont.

• Critique of the Gaussian copula
  – Linear correlation between obligors based on assets (equities)
  – Pairwise correlation only – sensitive to multiple defaults
  – No fat tails, could use t-Copula but DOF unknown, harder to compute
  – Known to be problematic in practice: correlation skew
Historical Context, cont.

• Failure to model/hedge
  – Volatility of spreads, correlations, recovery rates
  – Basis
    • Cash/synthetic
    • Index/single name
    • Bespoke/index
    • Between maturities of otherwise same security
  – Correlated defaults
Recipe for Disaster: The Formula That Killed Wall Street
By Felix Salmon 23 February, 2009
Wired Magazine

\[ \Pr[T_A < 1, T_B < 1] = \phi_2(\phi_{-1}(F_A(1)), \phi_{-1}(F_B(1), \gamma) \)
Regulatory Response

• Credit products (CDOs + flow)
  – 1 year capital horizon, 99.9%
  – patterned after current treatment of loans in banking book

  – Equates banking book and trading book treatment (closes loopholes)
  – Clearly is more punitive than 99% VaR
Regulatory Response, cont.

- IRC: liquid products (discussed later today)
  - Bonds, CDS (when used for investment/spec.)
  - Migration and default risks
  - Constant level of risk (roll over downgraded posns.)
  - Liquidity horizons, minimum 3 months.

  - Weekly computation
  - New internal bank models required

  - BIS survey estimated impact: IRC reg capital could go up by factor of 2 to 5 (model dependent)
Constant Level of Risk

• Regulatory thinking: mimic bank book, where loans held to maturity
• Constant risk $\iff$ constant credit rating
• Constant rating $\iff$ no migrations or defaults

• Where is the risk realized?
Liquidity Horizons

• Liquidity horizons – min. 3 months (“constant level of risk”)
• LH’s must ...
  – “be set according to the time required to sell the position ...
    ... in a stressed market, having particular regard to the size.”
  – “reflect ... experience during periods of both systematic
    and idiosyncratic stresses.”
  – Be long enough to avoid market impact
  – Be longer for concentrated positions
Liquidity Horizons, cont.

• LH issues
  – What if maturity/expiry occurs before LH?
    • Answer: LH = MIN(maturity/expiry, 3 months)
  – CDS’s are sometimes more liquid than the bonds they reference.
    – How do you handle the LH of an asset vs. its hedge?
Back to Constant Level of Risk

• Assign a liquidity horizon to a position
• Model the migration and default during the period of length corresponding to the LH (e.g., 3 months)

• Then rebalance: roll the position to another security of the same issuer with pre-event rating, maturity, security type, credit spread, and spread sensitivity.
Scope of CRM

• Correlation products
  – CDO’s
  – CDS’s used to hedge CDO, CDO^n, LSS
  – No product overlap with IRC
  – Measure all price risks, including those in IRC
  – Requires internal models (maybe extension of IRC)
  – Subject to 8% floor of “standardized charge” (SC)
The CRM 8% Floor

– Basel didn’t want to rely on bank modeling, so added the 8% floor driven only by the CDO’s credit rating (i.e., SC)

– But using SC inconsistent: punitive treatment of unrated tranches because doesn’t properly include risk hedges (no netting)

– “Banks would need to plough money into [CRM] model development, just to qualify for a standard 8% floor that is likely to be higher than the figure calculated by the model, dealers say, in which case, the model calculation would be ignored. “

Risk magazine article (Sep. 2010)
Will the floor deflate CRM?

- Example from Brunac presentation: mezz. (3%-7%) tranche, EUR 10 MM
### P&L DISTRIBUTION STATISTICS

<table>
<thead>
<tr>
<th>(EUR MM)</th>
<th>CDO only</th>
<th>CDO + spread hedge</th>
<th>CDO + spread &amp; corr hedge</th>
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<tbody>
<tr>
<td>Minimum</td>
<td>-4.2</td>
<td>-4.3</td>
<td>-2.1</td>
</tr>
<tr>
<td>Maximum</td>
<td>7.0</td>
<td>3.2</td>
<td>4.4</td>
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<tr>
<td>Mean</td>
<td>0.8</td>
<td>0.2</td>
<td>0.4</td>
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<tr>
<td>Std. deviation</td>
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<td>0.6</td>
<td>0.8</td>
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<tr>
<td>CRM charge</td>
<td>3.7</td>
<td>2.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Standard charge</td>
<td>1.9</td>
<td>56.0</td>
<td>69.1</td>
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<tr>
<td>Floor</td>
<td>0.2</td>
<td>4.5</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Un-hedged gives most capital relief!
State of IRC/CRM Modeling

• My understanding of where large banks are at
  – Started developing models last year
  – Got approval in some cases from FSA
  – Work for U.S. regulatory approval halted until Dodd-Frank issues resolved, rules issued
Downgrades and Defaults on Investment-Grade Subprime MBS Issued in 2005-07

Source: Author's calculations, based on Intex and ABSNet data.

Source: J. Vickery, blog
Dodd-Frank and Ratings

• Illustration: half of subprime CDO’s issued 2005-2007, and rated BBB- or above, have defaulted. Many others downgraded (40% of AA).

• Addressed in Subtitle C of DF
  – new Office of Credit Ratings to monitor NRSRO’s
  – OCR will be part of the SEC

  – Target conflicts of interest, make more indep.

  – Eliminate “look backs”
Dodd-Frank and Ratings, Cont.

– Annual examinations, or more frequently as needed

– Clear statement of methodologies used

– OCR can suspend or revoke NRSRO’s registration
DF and Ratings, cont.

• Main regulatory effects

  – Remove mentions of ratings in Security Exchange Act (of 1934), which created SEC

  – SEC, Fed, etc. must delete all references to ratings of NRSRO’s in regulations
DF and Ratings, cont.

• What do we use instead?
  – Credit spreads?
  – Internal bank models?
  – Most important: structured credit prods.

• Very recent NPR from SEC
  – Went into effect Feb. 14th
  – Describes alternative ways to express risk e.g. MBS, ABS
DF and Ratings, cont.

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State of IRC/CRM Modeling

• Discuss non-US IRC/CRM approval
• Ratings accepted in UK and rest of Europe

• What lessons can we draw from modeling that secured FSA approval?
CRM modeling

• Simulate
  – Risk factors
  – Migration (credit ratings matrix?)
  – Recovery rates
  – Index-name basis
  – Bespoke-index correlation mapping
  – Dynamic hedging, if used
Modeling Considerations

• How to simulate stochastic credit?
  – Monte Carlo of hazard rates?
  – Spreads e.g. BK process (exclude arb.)?

\[ d \ln S_t = \kappa_S (\theta_S - \beta - \ln S_t) \, dt + \sigma_S \sqrt{dt} Z_S \]

(per Wilkens et al.)

• Liquidity horizons: time required to sell or hedge
  – Everything at MIN(3 months, maturity) Basel floor?
  – 6 months for less liquid? 1 year?
  – What about dynamic hedging?
Modeling Considerations, cont.

• Recovery
  – Many names marked at 40% with zero vol.
  – Transition matrices can be created for recovery buckets e.g. from MarkIT
  – Dynamics (volatility needs to be modeled):
    • In the absence credit event, and
    • Following a credit event ("default-conditional recovery")
Modeling Considerations, cont.

• Resource issues
  – 99.9% VaR -> Many simulations (10K – 100K)
  – Can’t simulate every CDS -> factor models, bucketing (maturities, etc.)

• Could leverage:
  – Existing internal simulation engines
  – Firm’s VaR models and methodologies
  – Firm’s IRC models
IRC Modeling useful to CRM

• Use these directly, or extend:
  – Mark-to-market migration losses
  – Bond- CDS basis
  – Maturity basis on migration
  – Default conditional recovery (with volatility)
  – Exposure to sector, industry, region
  – Liquidity horizons
Default-conditional Recovery

• Example of how one might model:
  – Stochastic recovery as modeled in CDO’s
  – Used to help explain base correlation skew
  – Produces stylized fact: high recovery rates are accompanied by low default rates.
CRM Model Validation

• Measure sensitivities to inputs
• For example, to default and migration (also useful for IRC):
  – Use Moody’s ratings transition matrix from benign period => estimate how much CRM charge goes down relative to base case
  – Create “bad” matrix by reflection => CRM how much up?
Research Areas for CRM Models

• Liquidity
  – On the runs
  – Off the runs
  – Bespoke
  – Lehman-type junk
Research areas for CRM, cont.

• Corporate credit
  – CDS models: currently might be based on cash
  – Better to draw directly from CDS data
    • No need to model cash/synthetic basis
    • Isolate pure CDS effects
    • Other advantages such as constant maturity, standard expiries
    • But have to decide whether to model spreads or hazard rates
The Road Ahead

• Guidance from regulators soon to come?

• Meanwhile:
  – Continue developing the building blocks of IRC and CRM
  – Take advantages of new IT – solid state drives, etc.
  – Think of ways to calibrate and test.
Conclusions

• CRM models in U.S. are not in infancy
• But will remain in childhood until Fed gives clearer picture
• Impact of Dodd Frank yet to be fully felt – what are internally based ratings?
• Job security for regulatory quants!
References

- M. Pengelly, “Challenging Change: Banks struggle with Basel 2.5,” Risk, Sep. 2010
- R. Tops, “Copulas and Correlation in Credit Risk: who will pay the difference?,” University of Amsterdam, Aug. 2010