Risk Management Lessons from the Credit Crisis

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Spain shows the way in better handling of risk management

A report calls for lenders to consider full-time expert non-executive directors.

Peter Thal Larsen

Every Wednesday morning at 9:30 AM, BBVA's board members gather at the Spanish bank's head office in Madrid.

For the following three hours, they review new loans and discuss broader risks that might affect the bank's operations. When necessary, they reconvene the next day.

In 2003, they met a total of 76 times.

These meetings are similar to those that are held regularly by banks around the world. But in the case of the Madrid-based BBVA, it's not enough. There is one important difference: just one of its members, Jose Maria Casanova, is a full-time bank executive. The other four are non-executive directors of the bank.

Other Spanish banks take a similar approach. Santander, BBVA's main domestic rival, has a five-member risk committee, including three non-executive directors, which met three times last year.

Managers believe that this intense board-level focus on risk is one reason why Spain's large banks have so far weathered the credit crunch in better shape than many of their European rivals.

This approach is now winning admirers elsewhere. Lord Turner, chairman of Britain's Financial Services Authority, recently argued that banks might benefit from non-executive board members who have been plucked from their top five or 10 institutions.

Sir David Walker, the new head of the Financial Services Authority, has encouraged the board to consider this question in his review of banks' corporate governance.

The notion of full-time non-executive directors is one of the main suggestions to emerge from a report on European bank governance released by Neuer Associates.

"Banks will need people to come to their boards in a very dedicated fashion, and though they are non-executive, become more hands-on in terms of the way risk is run," says Sil pinch Nester, the corporate governance consultancy's founder.

For some directors, many of whom have full-time jobs elsewhere, the notion of a weekly meeting is unmanageable. Some boards fear that a move in this direction would scare off potential board members who are already committed to the workload and public scrutiny associated with being the director of a large financial institution.

Institutional investors fret that full-time directors would have less independence than their part-time counterparts.

"We do not believe in a system of full-time independent directors: this would lead to a loss of independence and would rule out our being able to attract non-executive directors from other companies and sectors to become non-executive directors on our board," Marcial Agil, chairman of Barclays, told shareholders at the bank's annual meeting.

The board of BBVA, for example, delegated many of its risk management decisions to a small committee of former executives who failed to spot that the bank was fairly rated by Moody's and had a better balance sheet.

Mr. Nester points out that all of the committee members have a financial background, have been involved in the industry for many years, are not only independent but also very experienced in the field.

Boards urged to develop more commitment from independent directors

BBVA has a board that focuses on more than just the bottom line. The bank's board is made up of experienced financial professionals who serve as executive directors while taking on their board responsibilities. The board's approach is to have directors who understand the bank's business and can make informed decisions.

The board's focus on risk management is not just about compliance. It's about understanding the bank's business and making sure that it's aligned with the bank's overall strategy.

"If we do not have a clear understanding of the risks that are facing the bank, then we cannot make informed decisions," says Mr. Nester. "This is why we have opted for independent directors who have a clear understanding of the bank's business and can make informed decisions."
Risk Mismanagement…

“The best Wall Street minds and their best risk-management tools failed to see the crash coming.”
“A large loss is not evidence of a risk management failure because a large loss can happen even if risk management is flawless.”

» René Stulz (2008), “Risk Management Failures”
(1)
Risk Measurement Systems
Components of a Risk Measurement System

**Positions**
- Global Repository
- Mapping
- Positions

**Risk Factors**
- Historical Market Data
- Model
- Distribution of Risk Factors

**Risk Engine**
- Portfolio Distribution
- Value at Risk Reports

**Data Warehouse**

**Risk Warehouse**

- Trades from front office
- Data feed with current prices

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Market Risk Measurement: Returns-Based

- **Advantages:**
  - easy and cheap to implement
  - account for dynamic trading

- **Drawbacks:**
  - no data for new markets and managers
  - will not capture style drift (e.g. Amaranth)
  - may not reveal hidden risks, e.g. short options
  - give no structural insight into risk drivers

Market Risk Measurement: Positions-Based

● Advantages:
  » use the most current position information
  » can be applied to new products and managers
  » can be used for stress tests, with factor scenarios

● Drawbacks:
  » expensive to implement: several million positions for large bank or full transparency for fund of funds
  » assume that the portfolio is frozen over the horizon and do not account for dynamic trading
  » susceptible to errors in data and models

References: Jorion, 2008, “Risk management for event-driven funds,” FAJ
   Jorion, 2007, “Risk management for hedge funds with position information,” JPM
Conclusions: Returns- vs. Positions-Based

- Modern risk measurement systems are based on position information.
- Positions-based risk measures are more informative than returns-based risk measures and can be used for forward-looking VAR reports and stress tests.
- Returns information should be used to calibrate risk models: “backtesting” counts the number of exceptions, or losses worse than VAR.
Risk Management Lessons

(2)

Taxonomy of Risks
- Known knowns
- Known unknowns
- Unknown unknowns
Known Knowns

- Flawless risk measurement:
  1. The risk manager correctly identifies and measures the distribution for the risk factors
  2. All the positions are correctly mapped
  3. The distribution of P&L is correct
- Top Management and the Board decide on a risk/return profile for the business
- Big losses can still occur:
  1. Bad luck
  2. Management took too much risk
Distribution of S&P Returns: 1871-2008

Total Annual Return

(-37%)
Example

- Suppose a long/short equity portfolio has a beta of 0.5; the distribution of equity returns is based on 1871-2007 data
  - in 2008, the S&P lost 38%
  - the portfolio should have lost around 19%
- VAR is not a worst-loss measure, however: it should be exceeded with some regularity
- VAR does not describe the distribution of losses beyond the quantile (conditional VAR)
Known Unknowns: Model Risk

(1) The risk manager ignores important known risk factors
• Example: many banks lost money on “basis” trades, which involve buying corporate bond and buying CDS protection
  » arbitrage trade if can be held to maturity
  » in the meantime, there is mark-to-market risk
  » typical risk systems map both positions on the same yield curve, and do not capture this risk
Known Unknowns: Model Risk

(2) The distribution of risk factors is incorrect, e.g. volatilities and/or correlations

- Example: volatility is measured over a recent window, not representative (“euphoria”)  
  » risk models experienced many exceptions in 2007
- Example: credit risk model used to build tranches of CDOs is inappropriate  
  » credit rating agencies underestimated default correlations, calibrated to rising home prices  
  » normal copula cannot explain default clustering

Jorion and Zhang, “Credit contagion from counterparty risk,” JF, 2009
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Daily Volatility Forecast for the S&P Index

Volatility (% per day)

- EWMA
- MA

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Ex_GARCHSP.xls
## Structured Credit Models: Default Probabilities

### Standard & Poor's Cumulative Default Rates (%)

**Global Corporates, 1981 to 2006**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Y1</th>
<th>Y2</th>
<th>Y3</th>
<th>Y4</th>
<th>Y5</th>
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<tbody>
<tr>
<td>AAA</td>
<td>0.00</td>
<td>0.00</td>
<td>0.09</td>
<td>0.19</td>
<td>0.29</td>
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<tr>
<td>AA</td>
<td>0.01</td>
<td>0.05</td>
<td>0.10</td>
<td>0.20</td>
<td>0.32</td>
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<td>A</td>
<td>0.06</td>
<td>0.17</td>
<td>0.31</td>
<td>0.47</td>
<td>0.68</td>
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<td>BBB</td>
<td>0.24</td>
<td>0.71</td>
<td>1.23</td>
<td>1.92</td>
<td>2.61</td>
</tr>
<tr>
<td>BB</td>
<td>1.07</td>
<td>3.14</td>
<td>5.61</td>
<td>7.97</td>
<td>10.10</td>
</tr>
<tr>
<td>B</td>
<td>4.99</td>
<td>10.92</td>
<td>15.90</td>
<td>19.76</td>
<td>22.55</td>
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<tr>
<td>CCC/C</td>
<td>26.29</td>
<td>34.73</td>
<td>39.96</td>
<td>43.19</td>
<td>46.22</td>
</tr>
</tbody>
</table>

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Building the Tranche

Frequency

Required width of junior tranches

Fix target default probability: 0.29%

Number of defaults

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Distribution of Defaults: 125 BBB Credits

Default probability = 2.5%
Asset correlation = 0.20

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Default correlation = 0.04
Cumulative Distribution of Defaults

Target: 0.29%

27 defaults

22% subordination

78% of the structure is rated AAA

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Distribution of Defaults: 125 BBB Credits

Default probability = 2.5%
Asset correlation = 0.50

With default correlation of 1, 97.5% at 0, 2.5% at 1
Default correlation = 0.16
Distribution of Defaults: Effect of Correlation

- Correlation = 0.20
- Correlation = 0.50

Number of defaults vs. Risk of Default

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Fixed PD
Cumulative Distribution of Defaults

Number of defaults

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Actual: 2.4%

27 defaults

Actual rating should be BBB, not AAA
Known Unknowns: Model Risk

(3) The mapping process is incorrect

- Example: UBS mapped AAA-rated ABS tranches on AAA corporate yield curves
  - this ignored nonlinearities in super senior tranches, which are similar to out-of-the-money short positions in options
  - credit tranches are nor comparable to corporate credits because they result from an optimization
  - because they were viewed as riskless, these structures found their way in all business units

- This is particularly an issue for new products

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Known Unknowns: Liquidity Risk

- Asset liquidity risk, or price impact of large asset sales
- Funding liquidity risk, when the firm cannot meet cash flow or collateral needs
- BCBS: “Liquidity is crucial to the ongoing viability of any banking organization”
- However, this risk is complex and difficult to reduce to simple quantitative rules
Unknown Unknowns
(Knightian Uncertainty)

- Regulatory risk, such as sudden restriction on short sales
- Structural changes, such as conversion of investment banks to commercial banks and deleveraging
- Counterparty risk with contagion: it is not enough to know your counterparty--you need to know your counterparty’s counterparties too
- Difficult to handle
- No solution: need higher capital cushion
Many institutions have developed “economic capital” analysis, which is a measure of the worst loss from all risk factors at a high confidence level over a long horizon.

Example: DB reports an EC of €13,611 for 2008 at the 99.98% confidence level.

Such numbers are unreliable: unlike typical applications of VAR, (1) the horizon is long, (2) confidence level is very high, and (3) economic cycles are over 5-10 years.

Risk Management Lessons

(3)

- Lessons for risk managers
- Lessons from regulators
(Known) Pitfalls in Risk Management

- Traditional risk measures are backward-looking and assume stable distributions that are relevant for the future.
- Historical risk measures rely on market-clearing prices, which requires trading activity.
- Institution is assumed to be a price taker.
- With VAR limits, traders could try to game the risk measure, deliberately moving into positions that appear to have low risk but big losses when they occur.
How to Detect Flaws in Risk Measurement System

- Perform “backtests”: compare daily VAR numbers with next-day (hypothetical) P&L.
- The percent of exceptions should be in line with the confidence level, e.g. approximately 1 percent for 99% VAR: 1 day out of 100.
- The decision rule concludes that the model is biased if there are too many exceptions.
- However:
  » rule is not powerful if confidence level too high
  » this ignores the size of losses beyond VAR.
Our trading units achieved a positive actual income for over 96% of the trading days in 2006 (over 93% in 2005). On no trading day in either year did they incur an actual loss that exceeded the value-at-risk estimate for that day.

In our regulatory back-testing in 2006, we observed three outliers, which are hypothetical buy-and-hold losses that exceeded our value-at-risk estimate for the trading units as a whole. This is in line with the two to three outliers a year that are statistically expected when using a 99% confidence level…
Our trading units achieved a positive actual income for over 87% of the trading days in 2007 (over 96% in 2006). On 10 trading days in 2007 we recognized a loss that exceeded the value-at-risk estimate.

In our regulatory back-testing, we observed 12 outliers (hypothetical buy-and-hold losses)... While we believe that the majority of these outliers were related to extreme events outside standard market conditions, we are also re-evaluating our modeling assumptions and parameters...
Examples of Backtesting: VAR Exceptions

- At the 95%/99% confidence level, we should expect $n=13/2.5$ exceptions per year

<table>
<thead>
<tr>
<th></th>
<th>E(n)</th>
<th>2006</th>
<th>2007</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldman (95%)</td>
<td>13</td>
<td>3</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Bear Stearns (95%)</td>
<td>13</td>
<td>0</td>
<td>27</td>
<td>1</td>
<td>0</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>JPM Chase (99%)</td>
<td>3</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Credit Suisse (99%)</td>
<td>3</td>
<td>2</td>
<td>9</td>
<td>2</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>UBS (99%)</td>
<td>3</td>
<td>0</td>
<td>29</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>13</td>
</tr>
</tbody>
</table>
Lessons for Risk Managers

- Risk models can overweight recent data:
  - AAA securities backed by subprime debt started to experience unusual moves in March 2007
- Scenarios should be used to complement the limited vision of VAR windows
  - longer-term, through-the-cycle perspective
- Models should be stress tested
  - top ABS tranches were overrated because models underestimated correlation between defaults
  - basis risk ignored in many models

⇒ Risk of loss can be assessed using position-based mapping, and with scenarios
Risk Forecast: ABX-HE Tranche Rated AAA

Volatility
Returns

HSBC

Source: ABXhistory.xls

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## Differences in Risk Management Practices

<table>
<thead>
<tr>
<th>Practice</th>
<th>Winners</th>
<th>Losers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Org. structures</td>
<td>-Cooperative</td>
<td>-Hierarchical</td>
</tr>
<tr>
<td>Firm analysis</td>
<td>-Shared info across firm</td>
<td>-No prompt discussion</td>
</tr>
<tr>
<td>Valuations</td>
<td>-In-house expertise</td>
<td>-Relied on credit ratings</td>
</tr>
<tr>
<td>Mgt. of balance sheet, liquidity</td>
<td>-Charged bus. lines for contingent liquidity risk -Avoided CDO, SIV</td>
<td>-Did not consider contingent exposures -Exposed to CDO, SIV</td>
</tr>
<tr>
<td>Risk measurement</td>
<td>-Used qualitative and quantitative analysis -Varied assumptions -Tested correlations</td>
<td>-Strict model application -Used historical Aaa spreads -No test of correlations</td>
</tr>
</tbody>
</table>


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Lessons from Regulators

- Banks failed the stress test because of misaligned incentives: large banks did not perform meaningful stress tests because they knew that they were too big to fail and that regulators would step in.
- Regulators are now defining stress scenarios:
  - Fed is now requiring banks to perform stress tests, reflecting severe downturn.
  - FSA advises “reverse stress tests,” which start from a known stress outcome (insolvency) and work backward.
OFHEO House Price Index (Real)

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Range of Forecasts and Actual Home Price Index

Source: From Loffler, 2008, Caught in the Housing Crash: Model Failure or Management Failure?

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Conclusions (1)

- Many institutions (banks, hedge funds) have experienced very large losses.
- There have been flaws in risk management, in particular in models and mapping process for new products, particularly in 2007 for some banks.
- Losses in 2008 are largely due to unknown unknowns: types of risks are not amenable to formal measurement, such as liquidity risk, regulatory risk, and contagion risk.
Conclusions (2)

- Risk management, however, will not go away as a core function of financial institutions
- Regulators will put more emphasis on pre-defined stress tests
- Such tests can only be assessed with position-level information
- Regulators will require more transparency in financial markets
I could blame the herd effect, the Basel Accord or the over-use of the Value at Risk technique, but I won't. The bottom line is, we've lost your money.