



RiskMetrics Group
The Center of the Financial Community

Lessons in risk modeling: What works and what's missing

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Agenda

- ◆ Not too bad...
 - ◆ Short-term risk forecasting in liquid markets
- ◆ Still troublesome ...
 - ◆ Acceptance of flawed models
 - ◆ Modeling the basis, or correlation by another name
- ◆ Not nearly enough work ...
 - ◆ Proxies for difficult to value assets
 - ◆ Liquidity
- ◆ A technique in search of a purpose ...
 - ◆ Stress testing



The Senior Supervisors Group (SSG) Report

- ◆ Released 6 March 2008, a joint report of regulators from entities in France, Germany, Switzerland, United Kingdom and United States
- ◆ Result of conversations with sixteen internationally active banks
- ◆ What practices differentiated those institutions that fared best through the recent market turbulence?
- ◆ Four key practices:
 - ◆ Firm-wide risk identification and analysis
 - ◆ Consistent, independent and rigorous valuation across the firm
 - ◆ Effective management of funding liquidity, capital and balance sheet
 - ◆ Informative and responsive risk reporting
- ◆ <http://www.newyorkfed.org/newsevents/news/banking/2008/rp080306.html>



Statistical risk measures

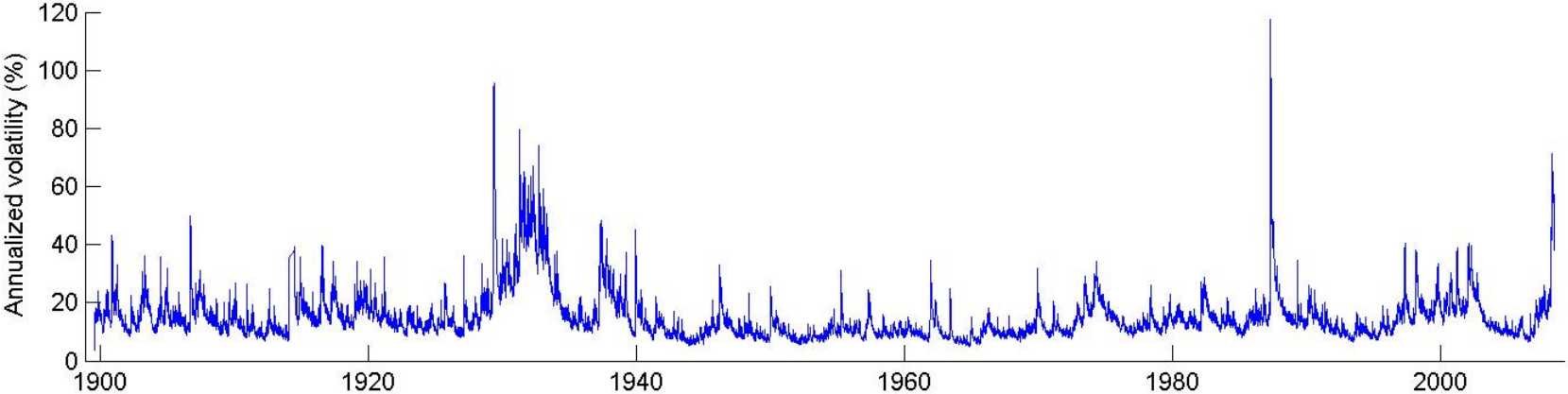
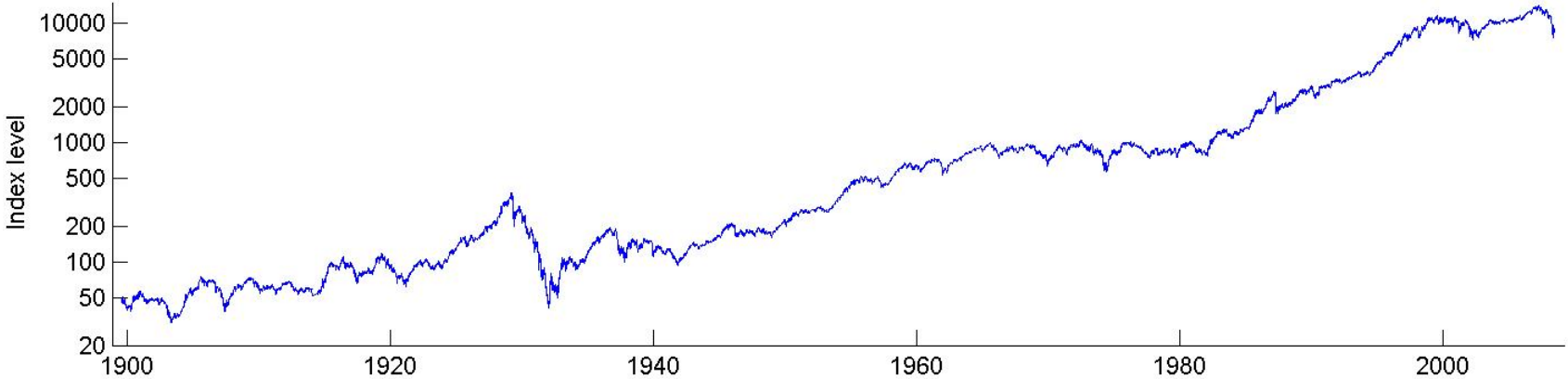
SSG Report, Section V

... many firms are planning to change the volatility estimates ... firms may give greater weight to more recent observations, and they may update the volatility estimates more frequently.

Most firms' VaR measures did not properly capture the basis risk between bonds and credit default swaps.

Simple measures of the sensitivity of super-senior subprime CDO tranches to the AAA spread were not sufficient to capture the credit risk in the product.

Dow Jones Industrial Average, 1900-2008



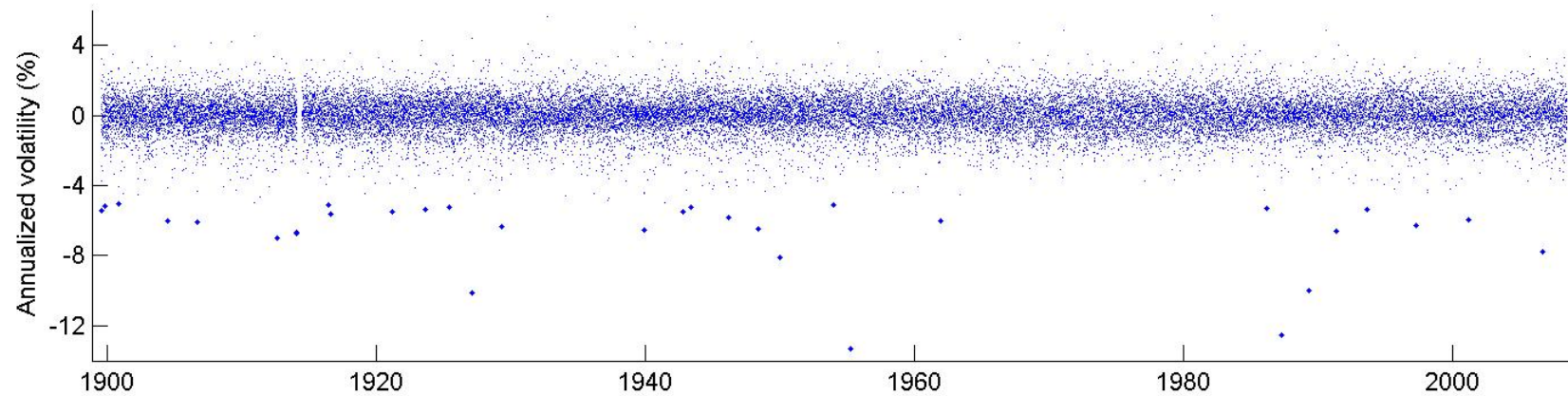
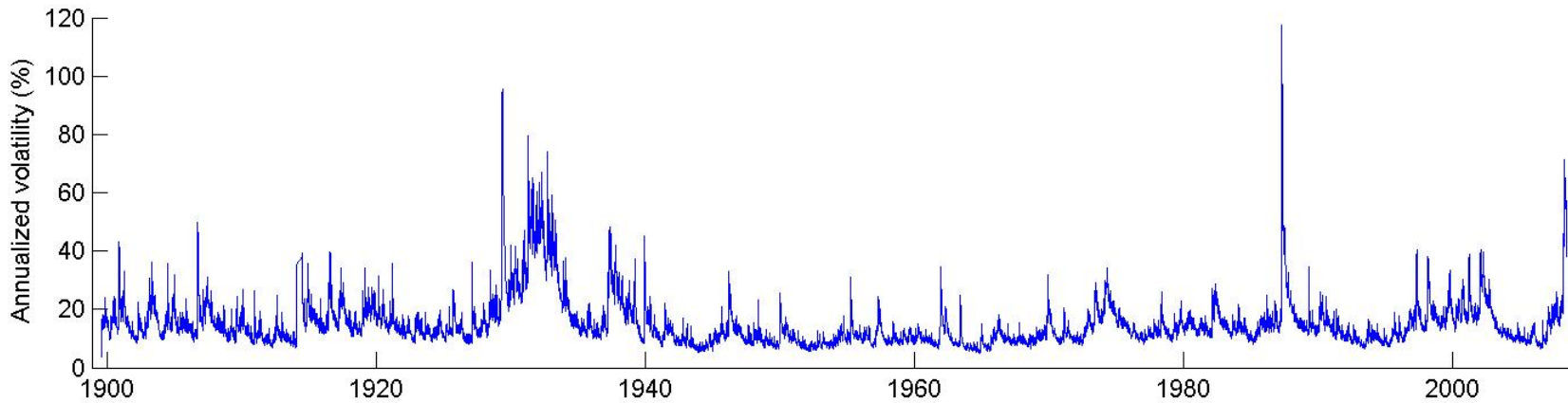


Testing the model empirically

- Basic risk measure states that the future return is equal to the product of:
 - Volatility, which we think we can forecast, and
 - Residual (or surprise), of which we claim ignorance.
- If our volatility forecasts are good, then residuals should look like (a form of) white noise.
- If our model is good, then a single, constant statistical distribution should fit the residuals throughout history.
- If our model is good, then surprises should occur, but with a frequency we can forecast, and should come with a story, at least after the fact.



DJIA volatility and residuals, 1900-2008





Not Gaussian, but not so bad

- How many residuals over 5?
 - Data (about 30,000 points) – 32
 - Gaussian – none
 - T-distribution (df=4) – expect 31 ± 9

- How many residuals over 9?
 - Data – 4
 - Gaussian – none
 - T-distribution (df=4) – expect 3.5 ± 2.5

- A standard statistical distribution fits the data well through all periods, even the tails.



Top ten surprises

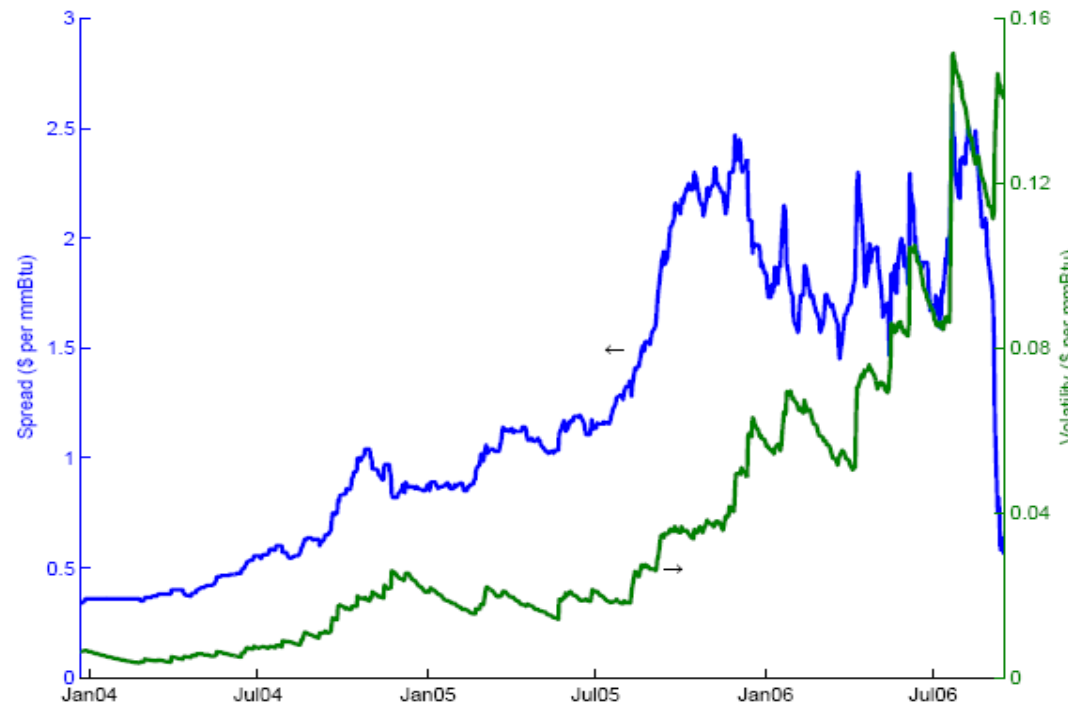
<u>Date</u>	<u>Residual</u>	<u>Return (%)</u>	<u>Volatility (%)</u>	<u>Comment</u>
26-Sep-1955	-13.3	-6.5	8.1	Eisenhower heart attack
19-Oct-1987	-12.6	-22.6	32.4	Black Monday
29-Jul-1927	-10.1	-5.2	8.3	
13-Oct-1989	-10.0	-6.9	11.4	Collapse of junk bond market
26-Jun-1950	-8.1	-4.7	9.3	Start of Korean War
27-Feb-2007	-7.8	-3.3	6.8	Beginning of subprime, China worries
20-Jan-1913	-7.0	-4.9	11.4	
30-Jul-1914	-6.7	-6.9	16.9	NYSE about to close, WW1
28-Jul-1914	-6.7	-3.5	8.5	
15-Nov-1991	-6.6	-3.9	9.6	



Amaranth Case: How Good Were The Risk Models?

- Knee jerk reaction was to claim that the 2006 Amaranth Blowup was an exceptional “nine standard deviation event”, and to throw out the models. But in fact, risk models gave plenty of early warning...

Chart of April/March 07 Natural Gas Spreads vs Volatility (EWMA)



Amaranth's losses were well within VaR and ES bands



- Simple EWMA based risk models performed adequately, and gave early warning

	Residual	<i>p</i> value	Loss/VaR	Loss/ES
September 15				
EWMA, Gaussian	-3.54	0.02%	1.52	1.33
EWMA, <i>t</i>	-3.54	0.30%	1.36	1.03
Equal, Gaussian	-4.63	0.00%	1.99	1.74
Equal, <i>t</i>	-4.63	0.09%	1.78	1.34
September 11–15				
EWMA, Gaussian	-2.93	0.17%	1.26	1.10
EWMA, <i>t</i>	-2.93	0.65%	1.12	0.85
Equal, Gaussian	-8.75	0.00%	3.76	3.28
Equal, <i>t</i>	-8.75	0.00%	3.36	2.54

- Residual—the actual loss divided by the volatility we would have forecast using information available at the time,
- p* value—the probability, according to our model, of observing a return as bad or worse than what actually occurred,
- Ratio of the actual loss to the VaR (at 99% confidence) forecast, and
- Ratio of the actual loss to the Expected Short-fall (also at 99% confidence) forecast.⁶

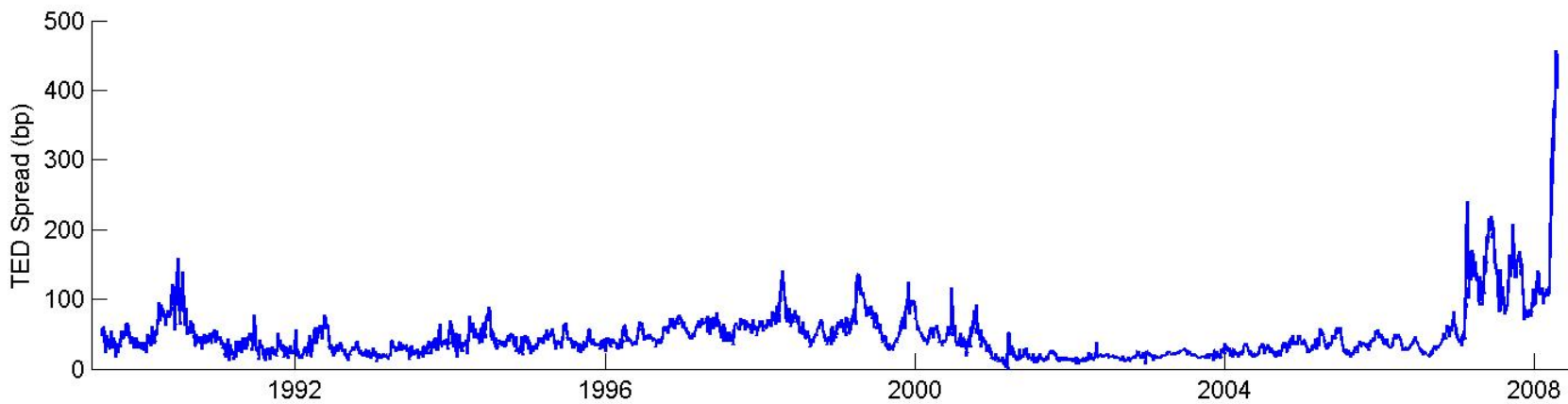
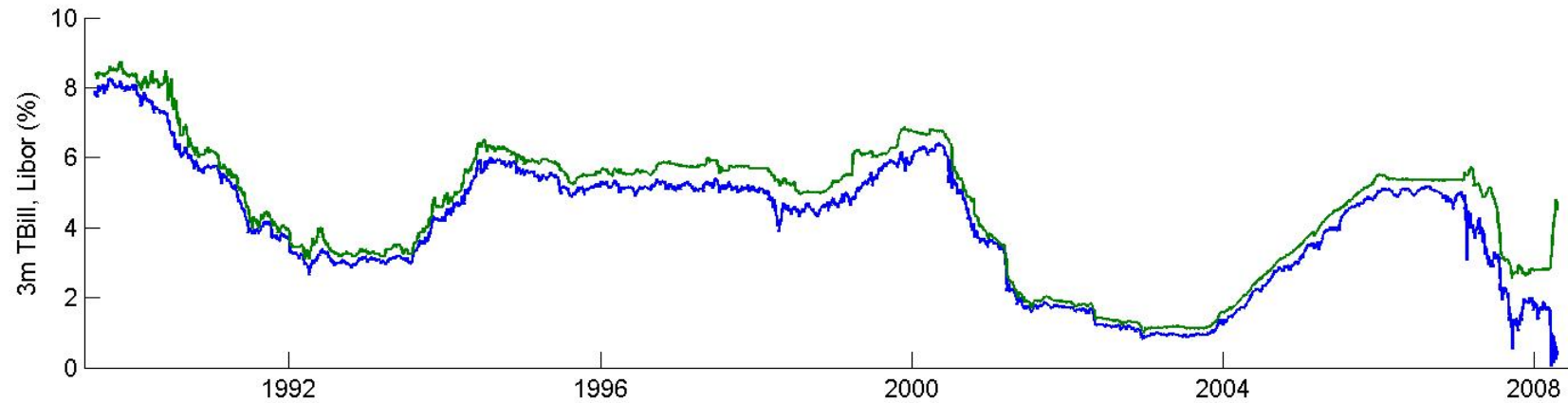


Signs of a bad model

In the case of UBS, 2007 saw its first exceptions since 1998... In the third quarter of 2007, UBS reported 9 exceedances at 99%. Risk, February 2008.

- Nine years (1998-2007) without an exception, including Sep11 and tech bubble.
- What is a bigger surprise, nine years without an excession or a quarter with nine?
- P-value ($9 \times 250 = 2250$ trading days) = 1.5×10^{-10} ... 6 sigma event ... same as chance of flipping 33 heads in a row
- $P(9 \text{ or more excessions in a quarter}) = 1.5 \times 10^{-8}$
- The period without excessions was 100 times less likely *assuming a good model*.
- In truth, UBS had 16 excessions in 3Q 2007. (My literary license, not Risk's)

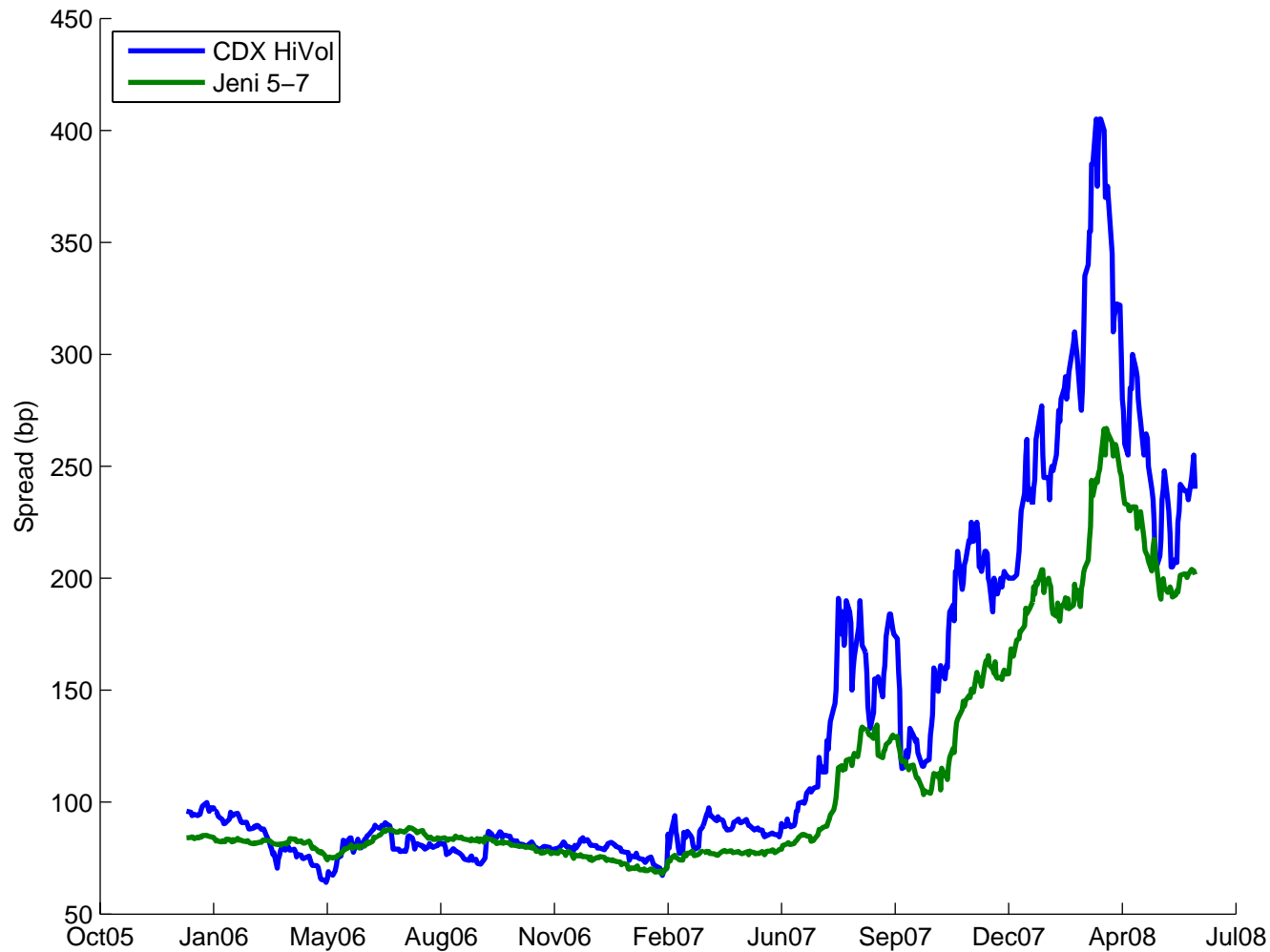
Modeling basis risk ... the scourge of statistics





Bond-CDS basis ... investment grade

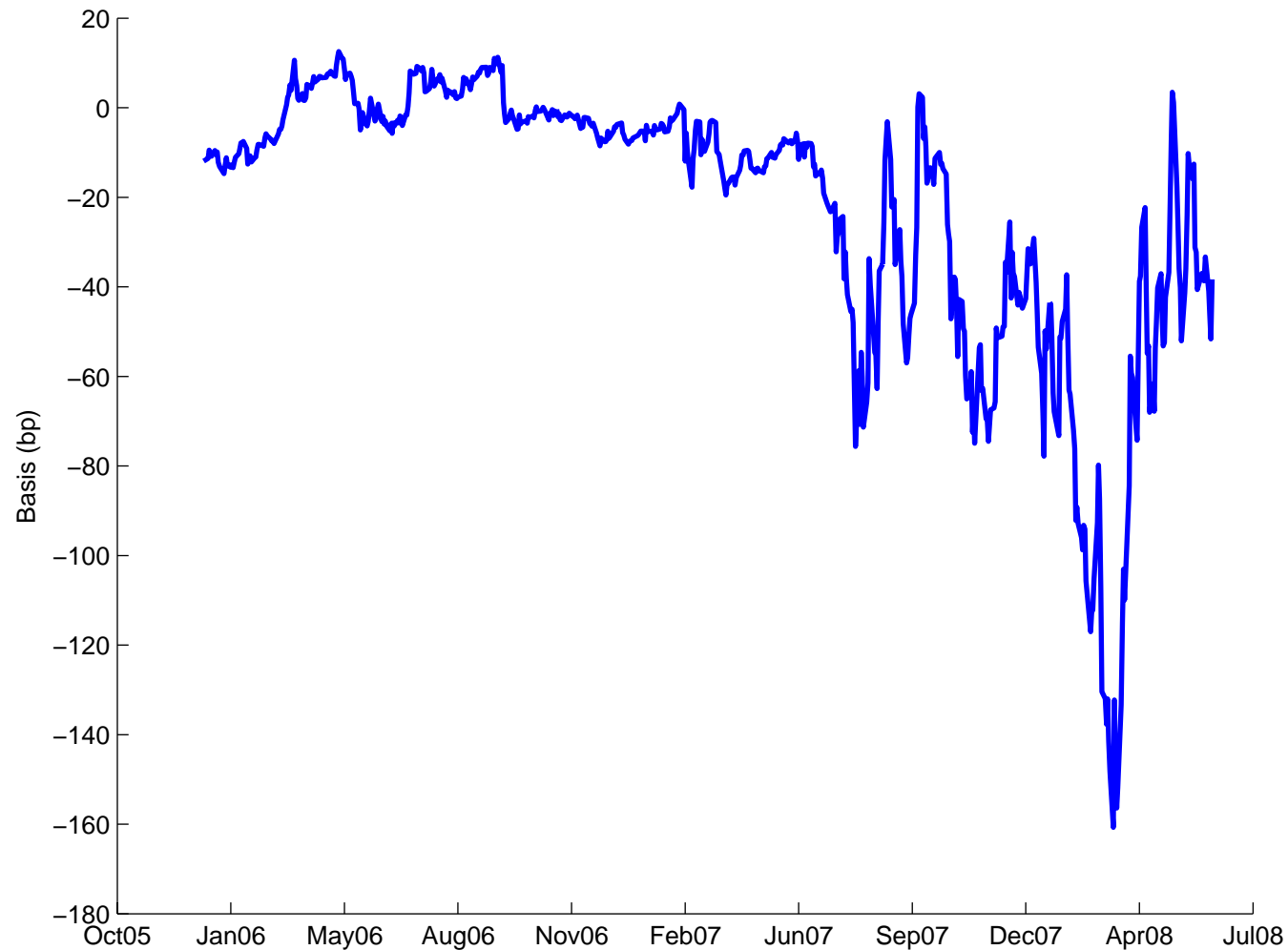
Derivatives are a reasonable proxy for valuation and risk for a substitute position...





Bond-CDS basis ... investment grade

... but the basis exists and moves, sometimes wildly.





Bond-CDS basis ... high yield

Relationship is tighter ...





Bond-CDS basis ... high yield

... but basis risks remain.





Proxies – the bass player in the risk band

Volatility and distributions get the attention, but it all comes down to data.

- Beyond overall model comments, the SSG focused on what data was chosen to model risk in specific cases
 - CDS-Bond basis ... is there any risk at all?
 - AAA-rated subprime CDOs ... is there information in other AAA curves?

- When it's not obvious, use proxy data to ...
 - Perform mark-to-model valuation,
 - Provide risk sensitivities for a position substitute,
 - Analyze a basis trade.

- These are all assumptions, though not ones that get as much attention as volatility models.



What is the subprime market?

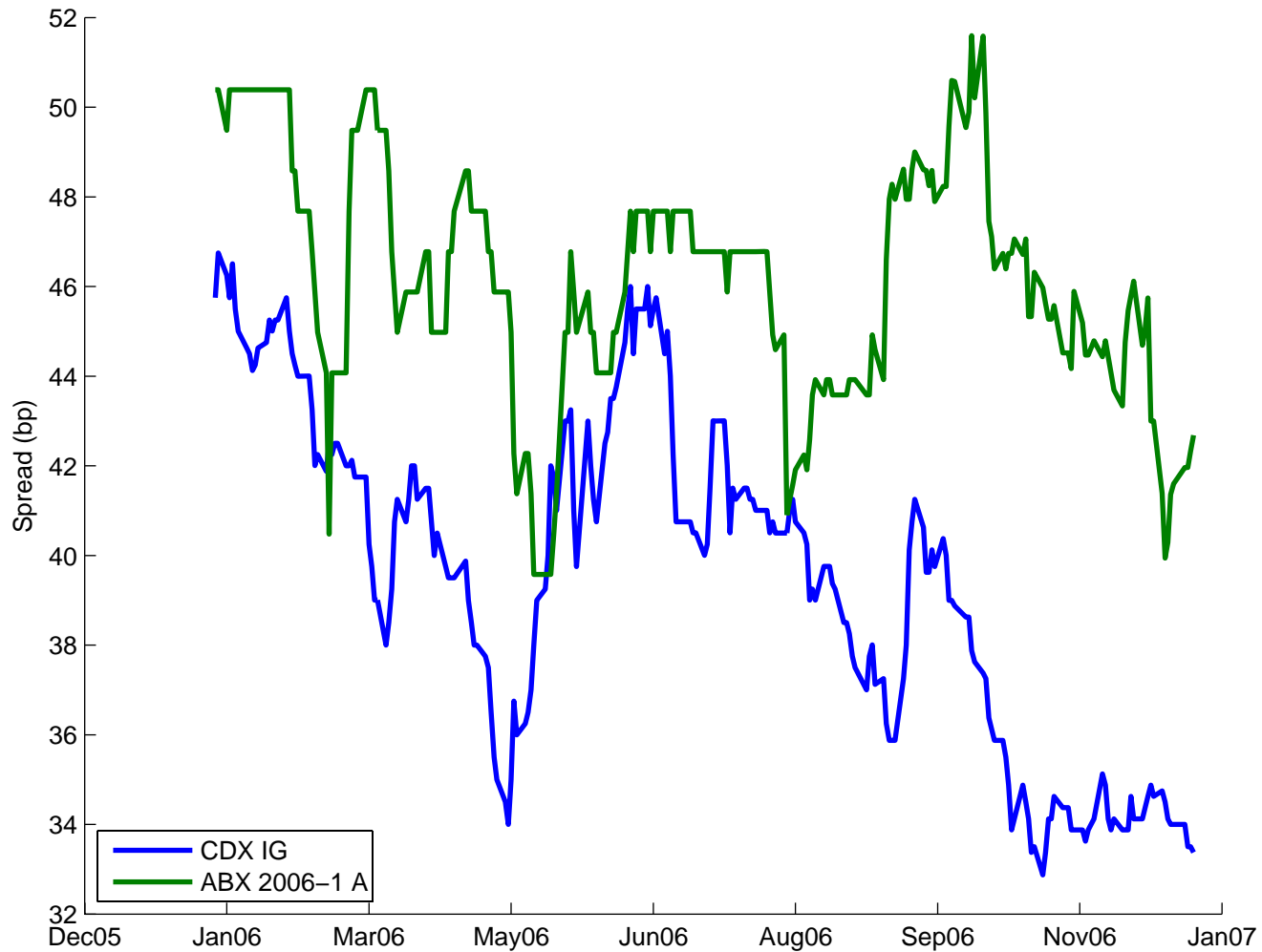
Poor quality, heterogeneity, and lots of structuring

- ◆ Subprime mortgages
 - ◆ Poor credit, but that is just the beginning.
 - ◆ Heterogeneity in mortgage products --- adjustable rates, negative amortization, light (no) documentation, definition of subprime credit
- ◆ Subprime-backed ABS
 - ◆ Assets are a pool of subprime mortgages from a single source.
 - ◆ Liabilities are a set of tranches, differentiated by seniority and other structural features.
- ◆ Subprime ABS-backed CDOs
 - ◆ Further structuring, with assets being like rated tranches of ABS deals
- ◆ Not surprisingly, the market has little secondary activity and is highly dependent on the rating agencies.
- ◆ Valuation and risk are thus dependent on proxies to “similar” risks.



Corporate proxy for subprime ... A-rated

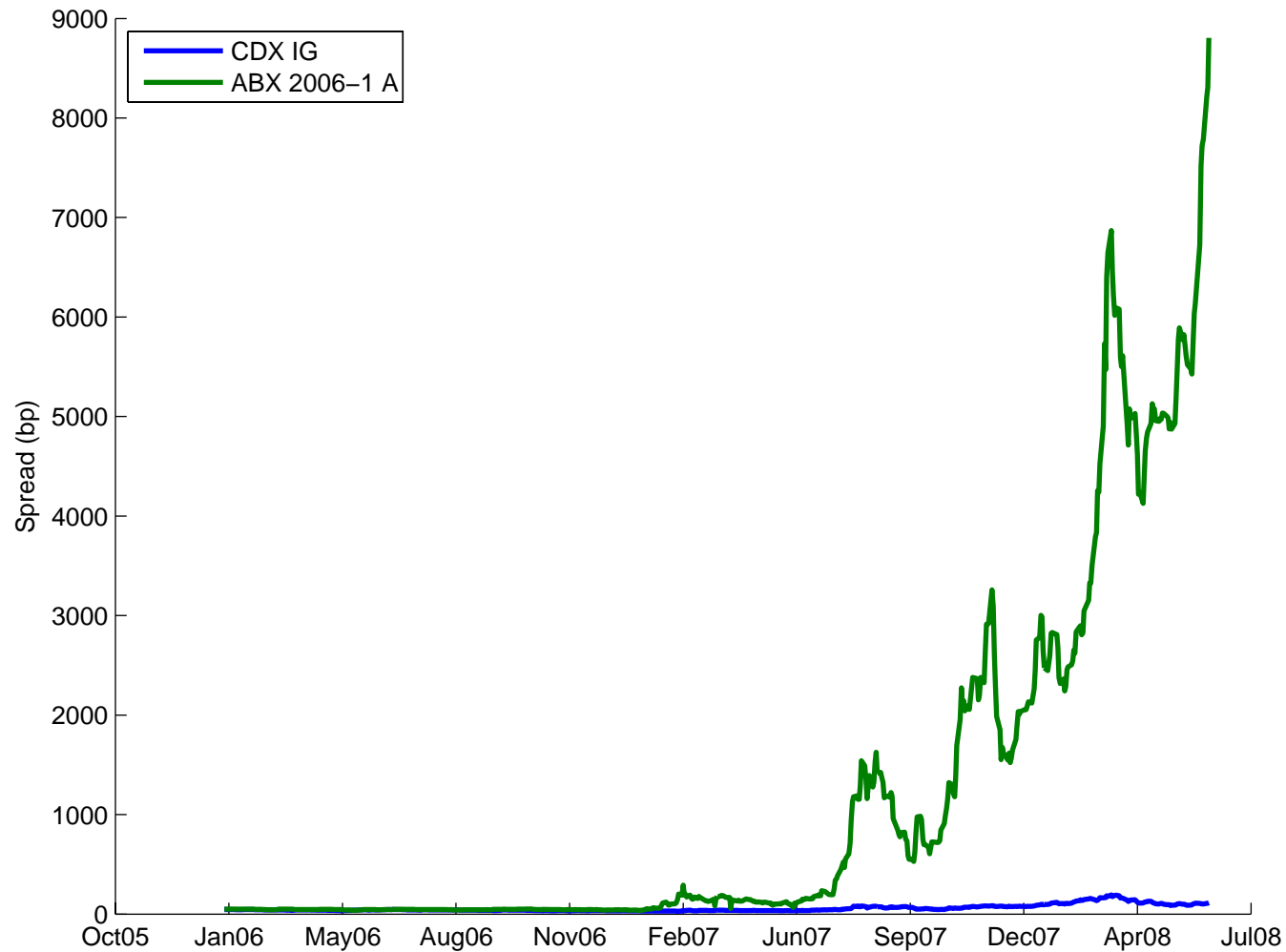
Reasonable match, as long as we aren't trading the basis ...





Corporate proxy for subprime ... A-rated

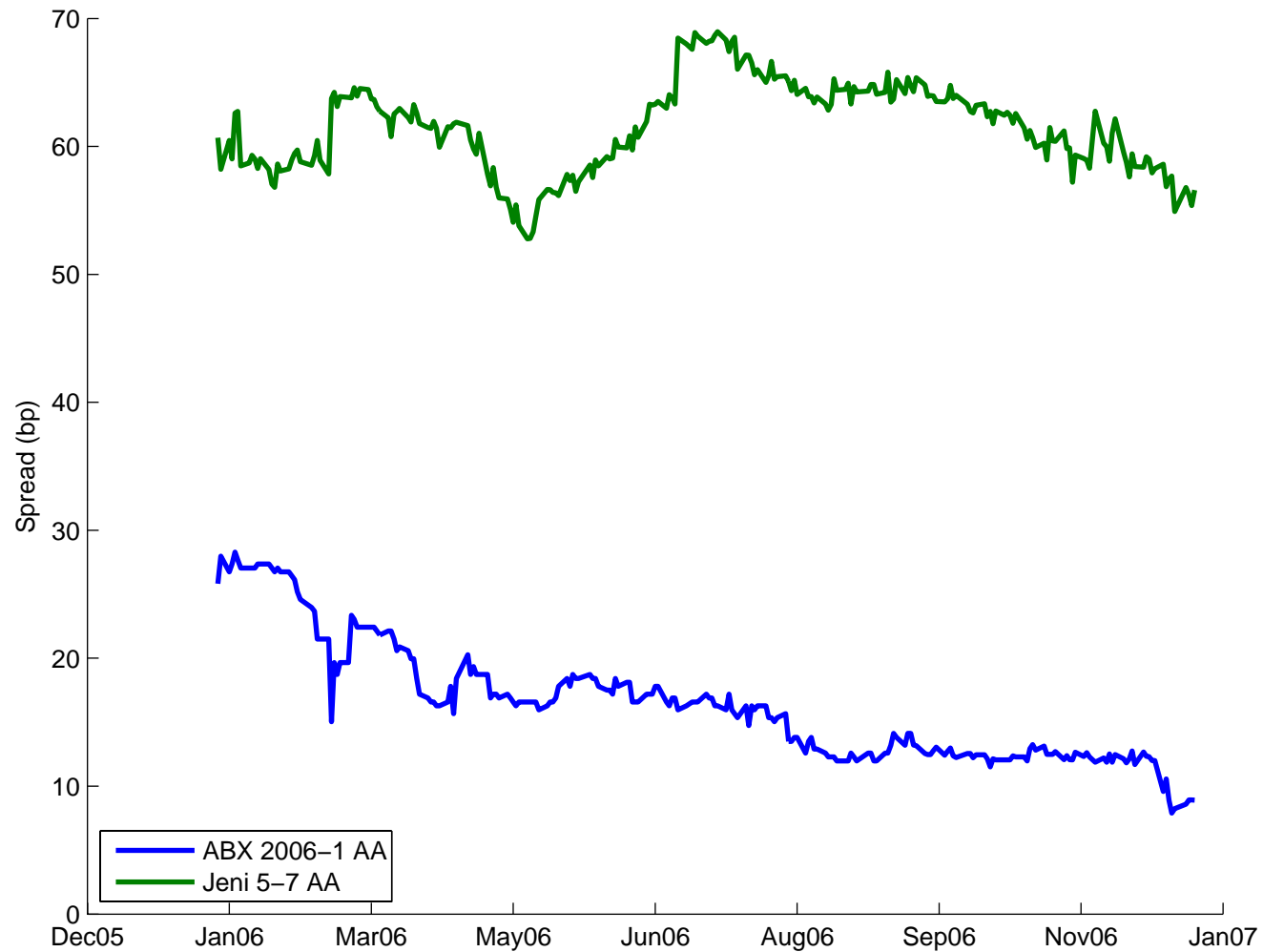
... but things get bad in 2007.



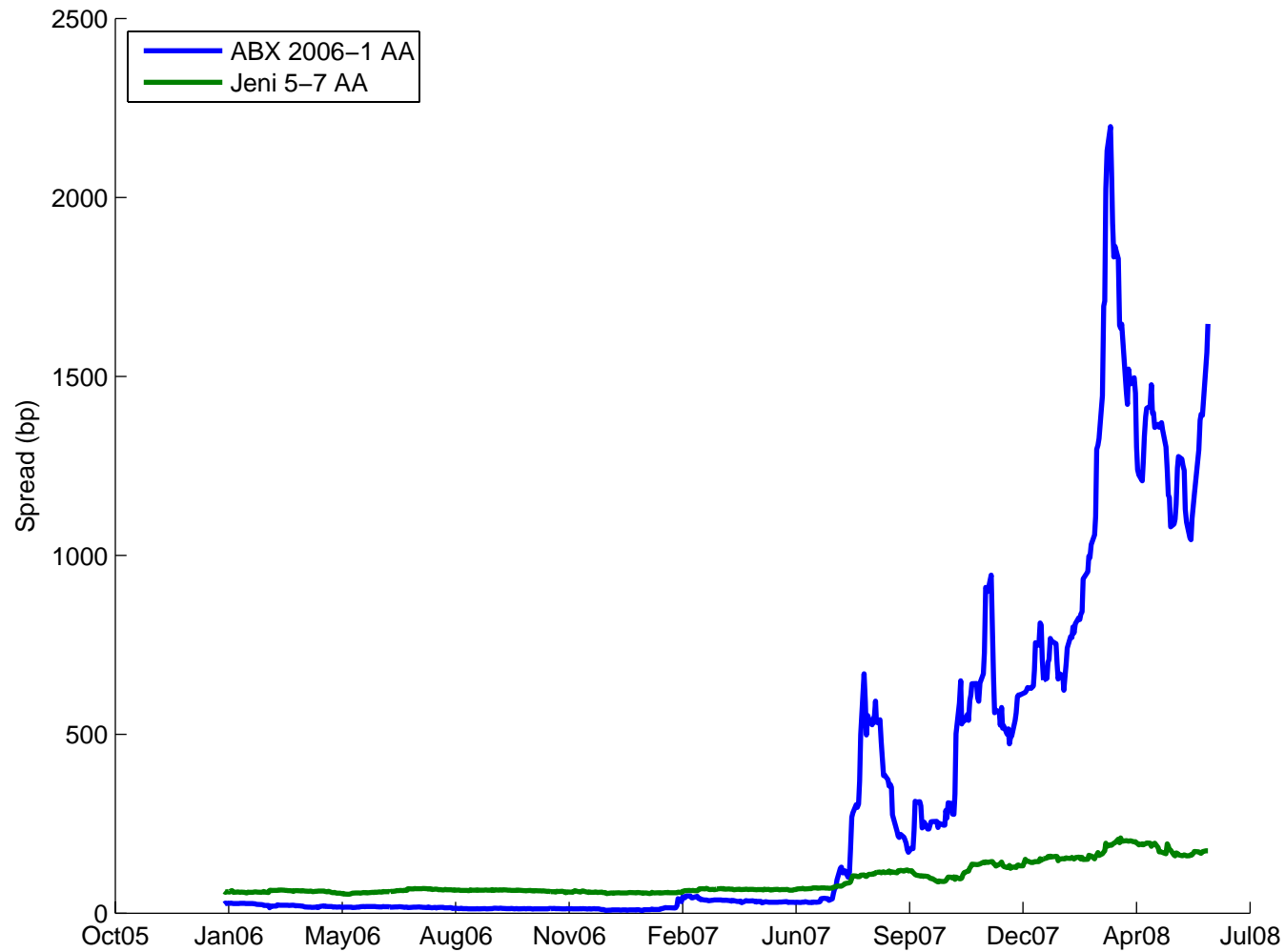


Corporate proxy for subprime ... AA-rated

Corporates look cheap (and uncorrelated) in 2006 ...



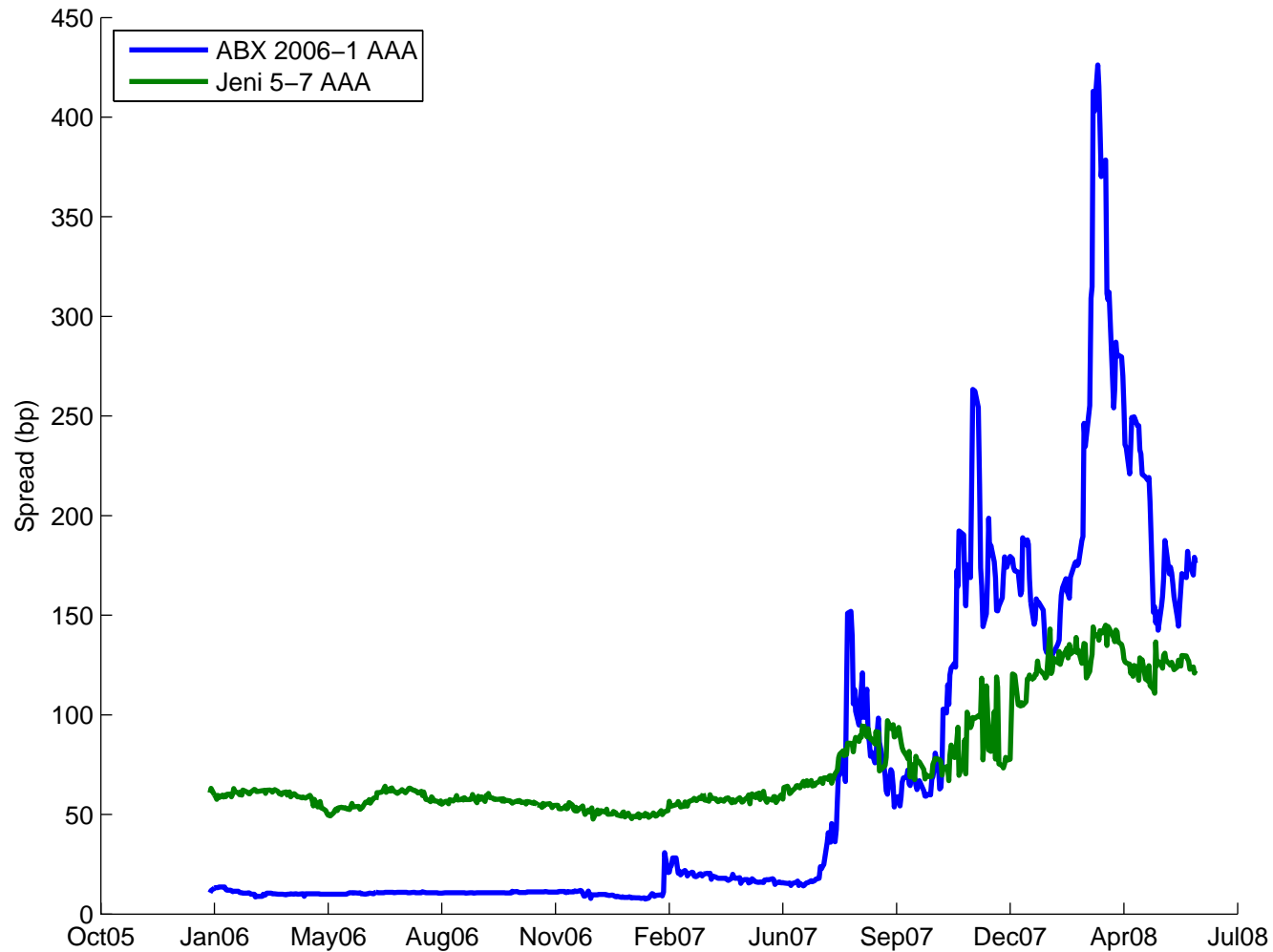
Corporate proxy for subprime ... AA-rated





Corporate proxy for subprime ... AAA-rated

The best of the lot, still poor, and who would have used the valuations in 2006?





Subprime proxy

- ◆ The subprime proxy relies heavily on consistent ratings.
- ◆ How can we compare AAA-rated corporates and AAA-rated structured finance?
 - ◆ Long-term likelihood of full principal and interest repayment,
 - ◆ Mark-to-model valuation,
 - ◆ Short-term price volatility,
 - ◆ Relationship with other asset classes.
- ◆ Who is to blame if we rely on all of these being comparable?
- ◆ Alternate approach for CDOs
 - ◆ Focus on the underlying collateral ... select useful proxies here (e.g. use the ABX).
 - ◆ Approximate the structure, that is, the relationship between collateral and CDO.
 - ◆ A better choice to represent relationships across CDOs and collateral

Liquidity

SSG Report, Section IV

Many firms had not expected that asset market liquidity would be impaired.

... had not assumed their balance sheet would increase during a stress event.

... had not expected difficulty in obtaining funding in major currencies.

... had not planned for a funding disruption lasting as long as the current one.



First, distinguish two problems.

- ◆ Funding liquidity
 - ◆ Are my assets and funding arrangements sufficient to meet obligations and to continue normal operations?

- ◆ Asset liquidity
 - ◆ How effectively can I transform an asset I own into cash?
 - ◆ Specific components
 - ◆ Size of position, amount desired to trade
 - ◆ How much will I move the market if I trade all at once?
 - ◆ How long do I have to space the trade to not move the market?
 - ◆ Market components
 - ◆ Liquidity issues that can hit me even if I don't trade
 - ◆ Other large positions being liquidated?
 - ◆ Reduction in typical volumes?

Liquidity horizon is a framework to tackle both asset liquidity flavors.



- ◆ Liquidity horizon
 - ◆ Horizon over which I can trade out of a position without impacting its price
 - ◆ Part of new Incremental Risk Charge (IRC) capital standards
- ◆ Proposal: track two statistical risk measures
 - ◆ Mark-to-market risk over a fixed horizon
 - ◆ Full liquidation risk
- ◆ Full liquidation risk is defined as potential losses stemming from liquidating the portfolio, assuming we sell each security slowly enough to not materially impact the market.
- ◆ Each security needs its own liquidity horizon.
- ◆ Questions:
 - ◆ How to estimate liquidity horizon?
 - ◆ How to think about risk with mixed horizons?



Volume – unused risk information

- ◆ If we know volume, we can compute liquidity horizon assuming we can sell a fixed proportion of this volume per day without impacting the market.
- ◆ So liquidity horizon is influenced by: our position (specific) and trading volume (market).
- ◆ Where can we get volume information?
 - ◆ Exchanges
 - ◆ Market aggregators, e.g. TRACE
 - ◆ ISDA, BIS surveys
 - ◆ Rumors
 - ◆ Clearing institutions, interdealer brokers, etc ... need pressure for transparency

In any case, thinking through the definition of liquidity horizon is an important step toward managing liquidity risk.



Liquidity VaR – simulate liquidation of all positions

- ◆ How to make sense of mixed horizons?
- ◆ Purist – correlation applies only for shorter liquidity horizon, after which the liquid market movements do not impact the illiquid ones.
- ◆ Pragmatist – just scale volatilities according to liquidity horizons.

- ◆ Liquidity VaR will increase relative to standard VaR if
 - ◆ Volumes shrink, or liquidity horizons rise
 - ◆ Asset mix shifts to less liquid securities

The answers are not perfect, but we need to debate them and gain experience with this type of modeling.

Stress testing



SSG Report, Section V

Several firms that experienced losses used VaR and static single-factor stress tests calibrated using the same historical data series. As a result, the stress tests provided no new information.

... a particular challenge was obtaining senior management and business line acceptance of stress tests...

Knowledge of how business areas made money helped risk managers identify relevant stress scenarios ...

... some managers have stressed the importance of considering how market shocks appear to counterparties.

Stress testing should come from the other side of our modeling brain.



- ◆ Stress testing should not be an excuse to not fix a bad model. Yes, risk is an art and science, but let's be sure to get the science part right.
- ◆ Stress tests cannot validate a statistical model.
- ◆ Stress testing should probe the things our model cannot tell us:
 - ◆ Exposure to unmodeled factors
 - ◆ Quality of data proxies
 - ◆ Liquidity implications of business surprises (absorbing an SIV)
 - ◆ Changes in funding arrangements with counterparties
- ◆ The conversation (not confined to the risk area) is as important as the results.



Things to come...

- A move away from static short-term risk forecasting models (I hope)
- More education of risk managers on the business of the institution
- More scrutiny on pricing models, risk factor choices and proxies
- Incorporation of default into market risk models
- Stress testing in reverse



To read more ...

- ◆ SSG report
 - ◆ Finger (2008). The SSG and My Two Brains. RiskMetrics Research Monthly. March.
- ◆ Amaranth
 - ◆ Finger (2005). The Lights Are On. RiskMetrics Research Monthly. October.
- ◆ Subprime and ABX
 - ◆ Finger (2007). A Subprimer On Risk. RiskMetrics Research Monthly. August.
- ◆ Stress testing
 - ◆ Finger (2008). Fishing for Complements. RiskMetrics Research Monthly. September.
- ◆ Volatility modeling
 - ◆ Finger (2008). Doomed to Repeat It? RiskMetrics Research Monthly. November.
- ◆ Liquidity risk
 - ◆ Malz (2003). Liquidity Risk: Current Research and Practice. *RiskMetrics Journal*, 4(1): 35-72.
- ◆ All available at www.riskmetrics.com under Risk Management Publications.