

Merton's Model, Credit Risk & Volatility Skews

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Presentation to RMC

(joint work with John Hull & Alan
White)

Options on Equity

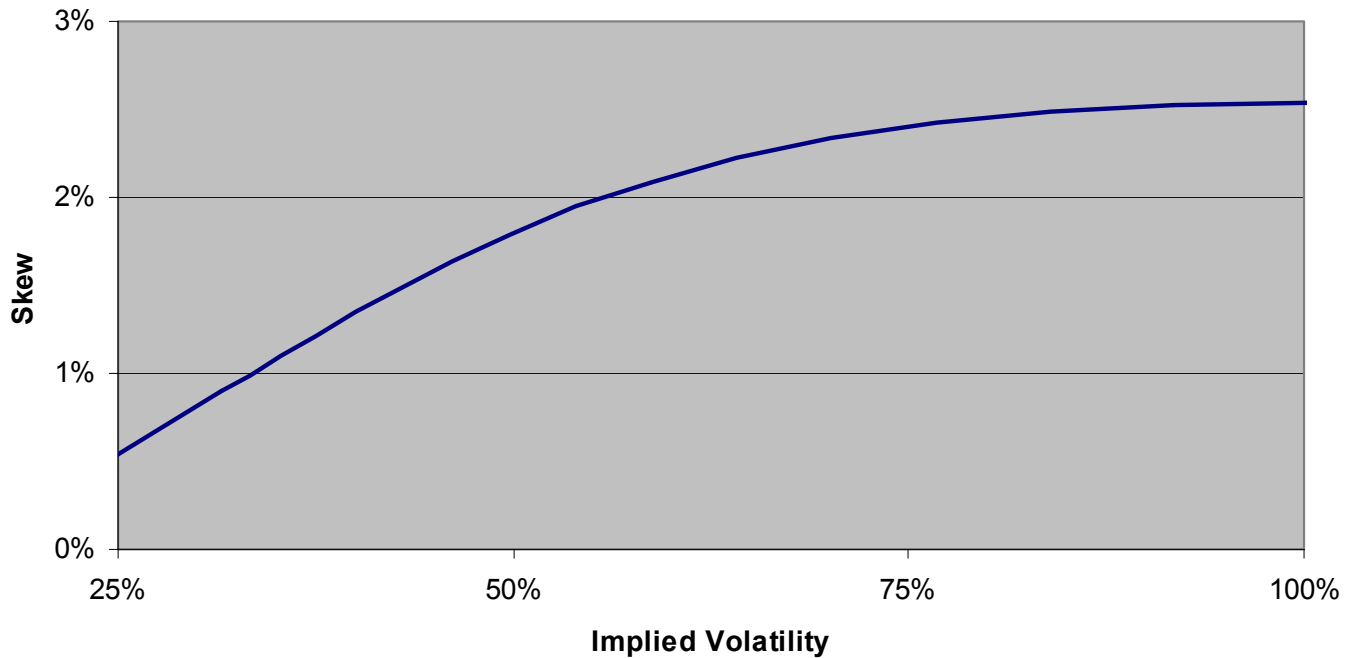
- In the Merton model equity is a call on the assets.
 - Options on the equity are options on options.
 - These can be valued using Geske's model
- Given A , σ , D , r , and T , and the option terms we can calculate the option price
- From the option price we can determine the implied volatility.
- The implieds exhibit a volatility skew

Implied Volatilities and Implied Credit Spread

- Both implied volatility and implied credit spread depend only on a leverage measure, L , σ and T
- By setting T and σ and allowing L to vary, or by setting T and L and allowing σ to vary
- We can explore the relation between volatility skews and
 - implied volatility, and
 - credit spreads
- The results are insensitive to the choice of T

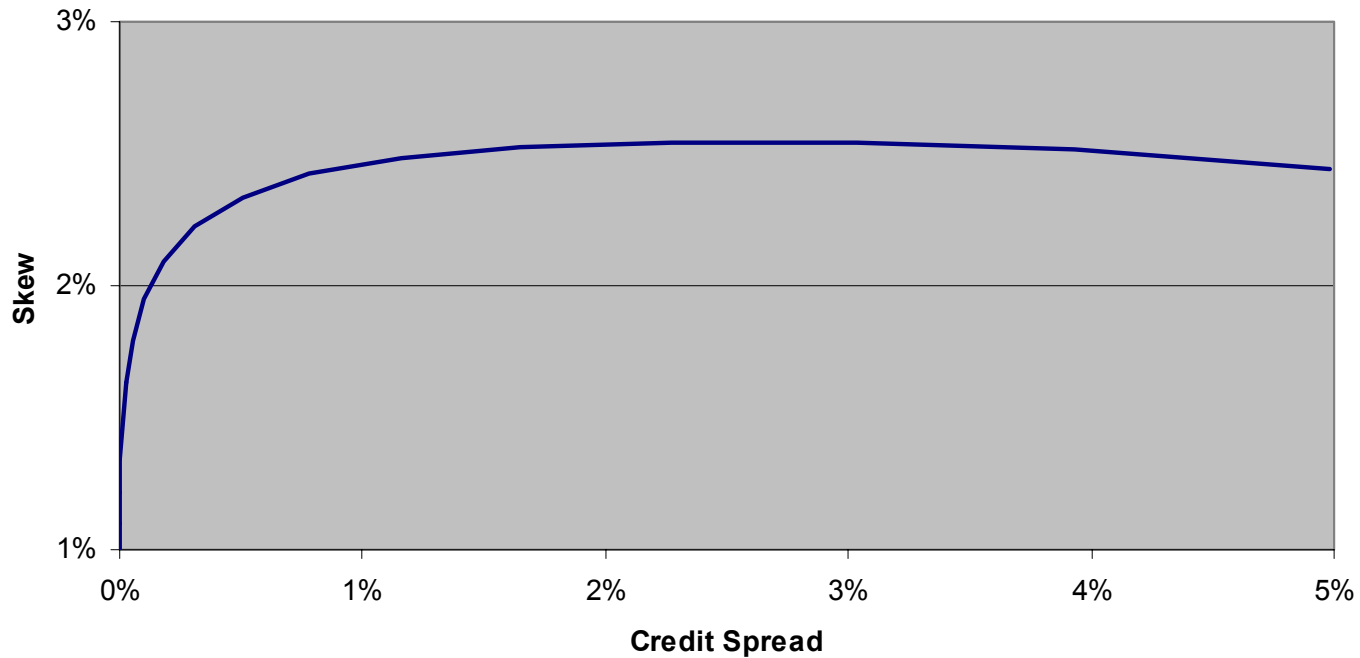
Vol Skew vs Volatility

Figure 3
Volatility Skew vs at-the-money Implied Volatility



Vol Skew vs Credit Spread

Figure 2
Volatility Skew vs Credit Spread



Empirical Sample

- A sample of 235 US firms with options and CDS quotes
- Calendar year 2002
- 6,887 matched observations of implied volatility (50-delta and 25-delta options) and 5-year CDS quote
- Regress volatility skew, $\sigma_{25} - \sigma_{50}$, against credit spread (CDS quote) or a-t-m volatility, or both

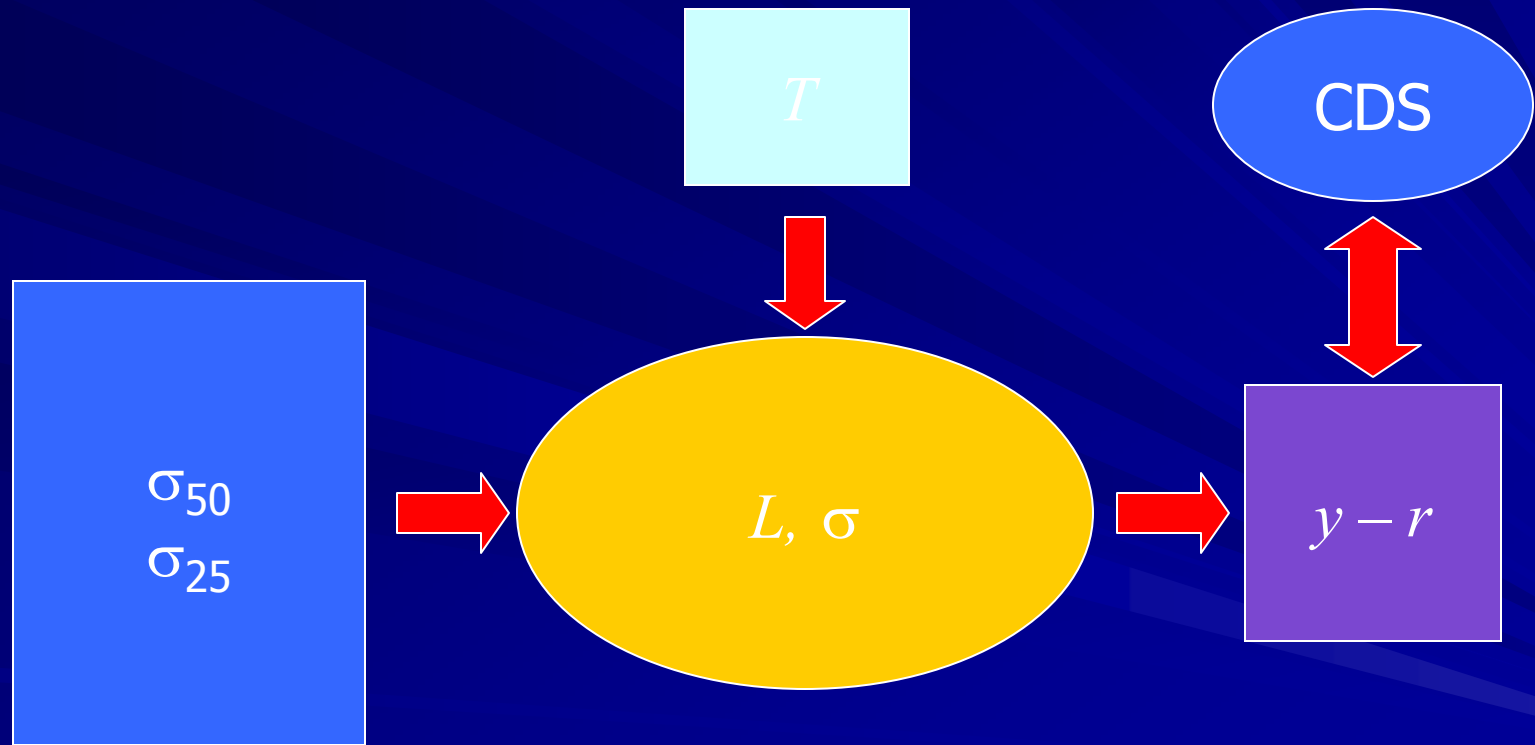
Empirical Evidence

- Regressions done across full sample and firm-by-firm.
- In full sample the skew is significantly positively related to all regressors
- In firm-by-firm regressions
 - 60% of estimates are significantly positive
 - 32% of estimates are not significant
 - 8% of estimates are significantly negative

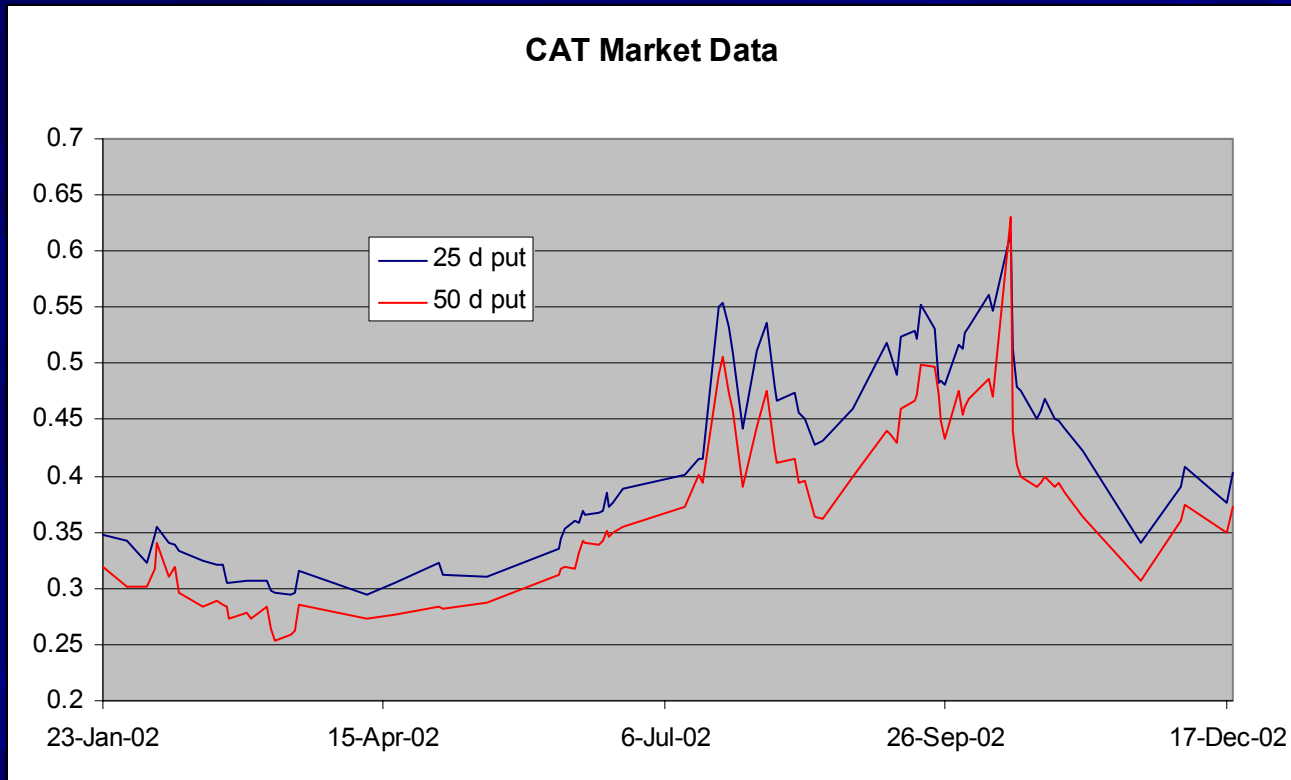
Predictive Power of Vol Skews

- Both implied volatility and implied credit spread depend only on a leverage measure, L , σ and T
- If T is assumed then L and σ can be implied from two implied volatilities
- The implied credit spread can be determined from this and compared with CDS quotes
- Results are insensitive to assumed T

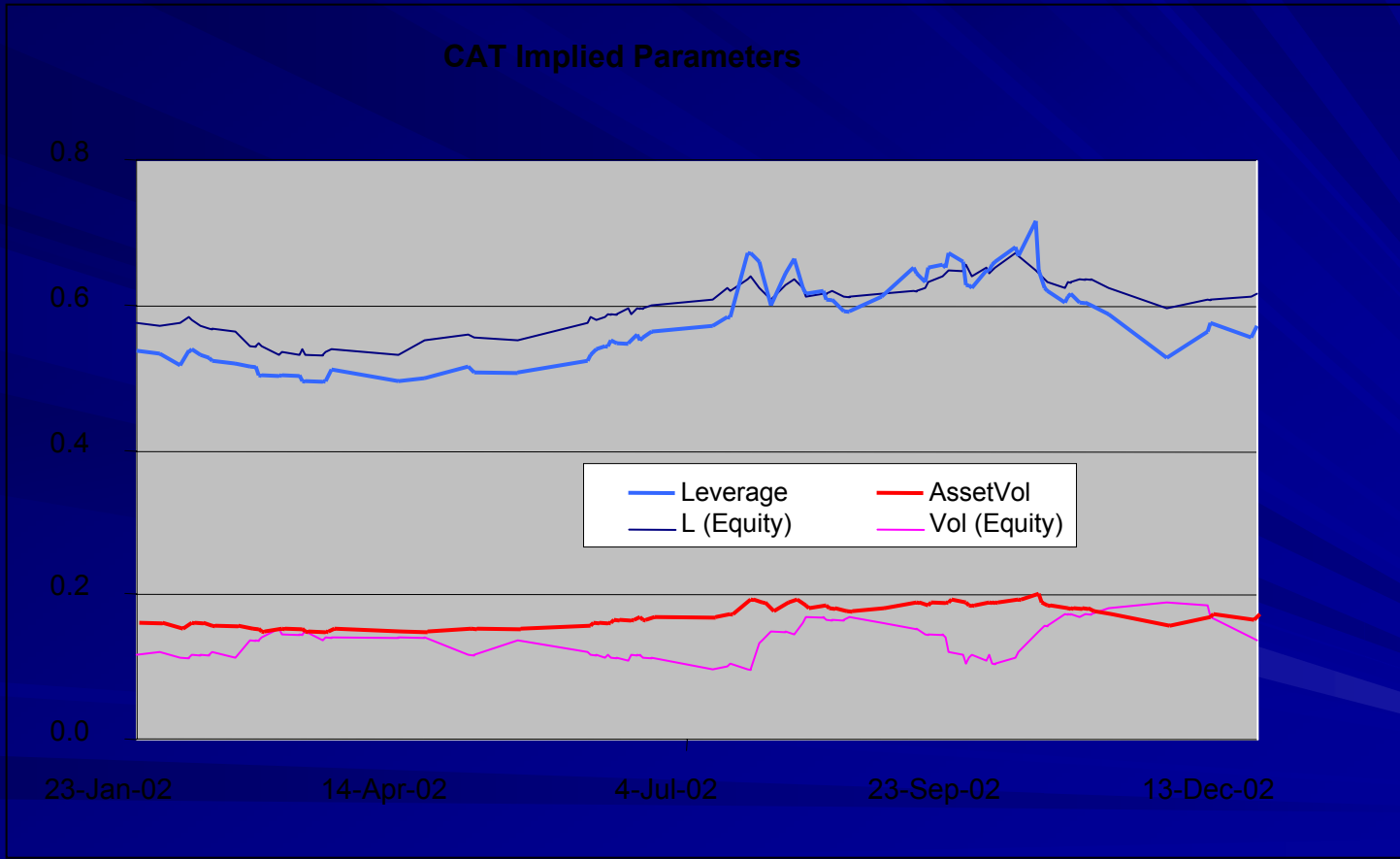
Mapping



CAT Example - Inputs



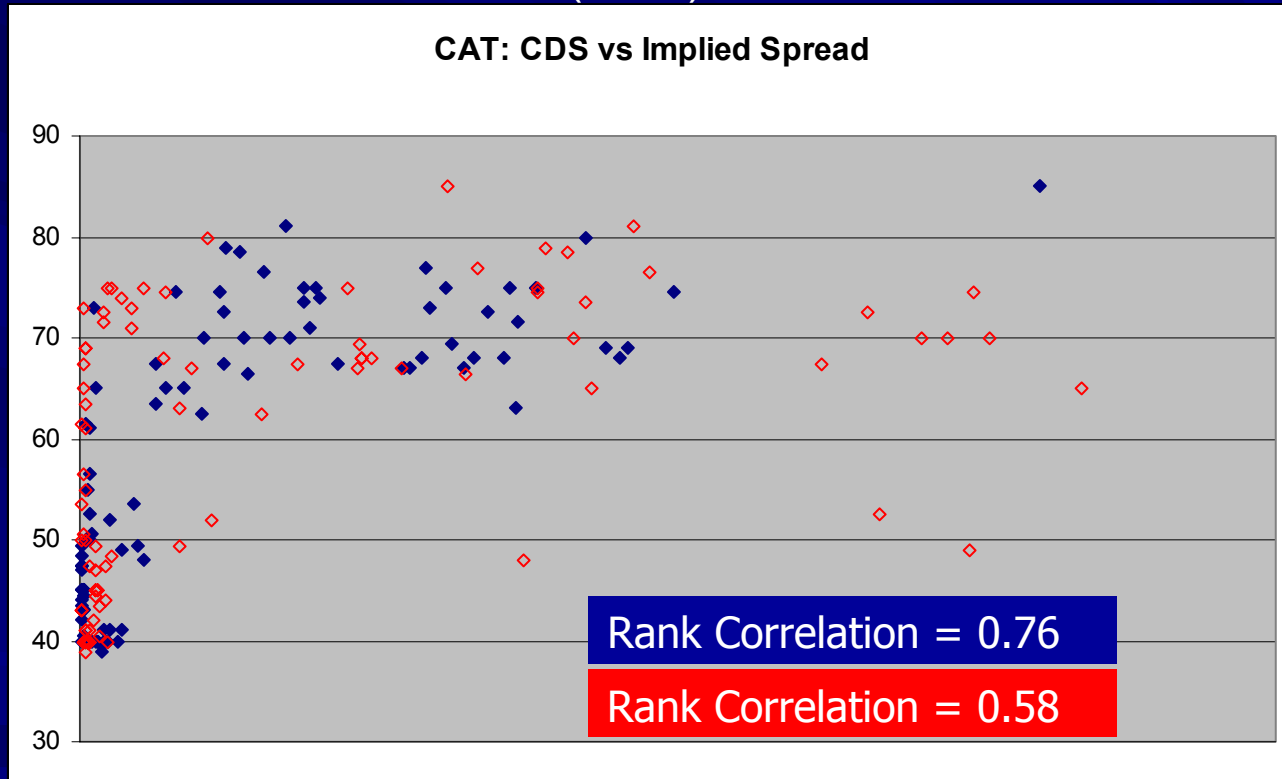
CAT Example – L, σ



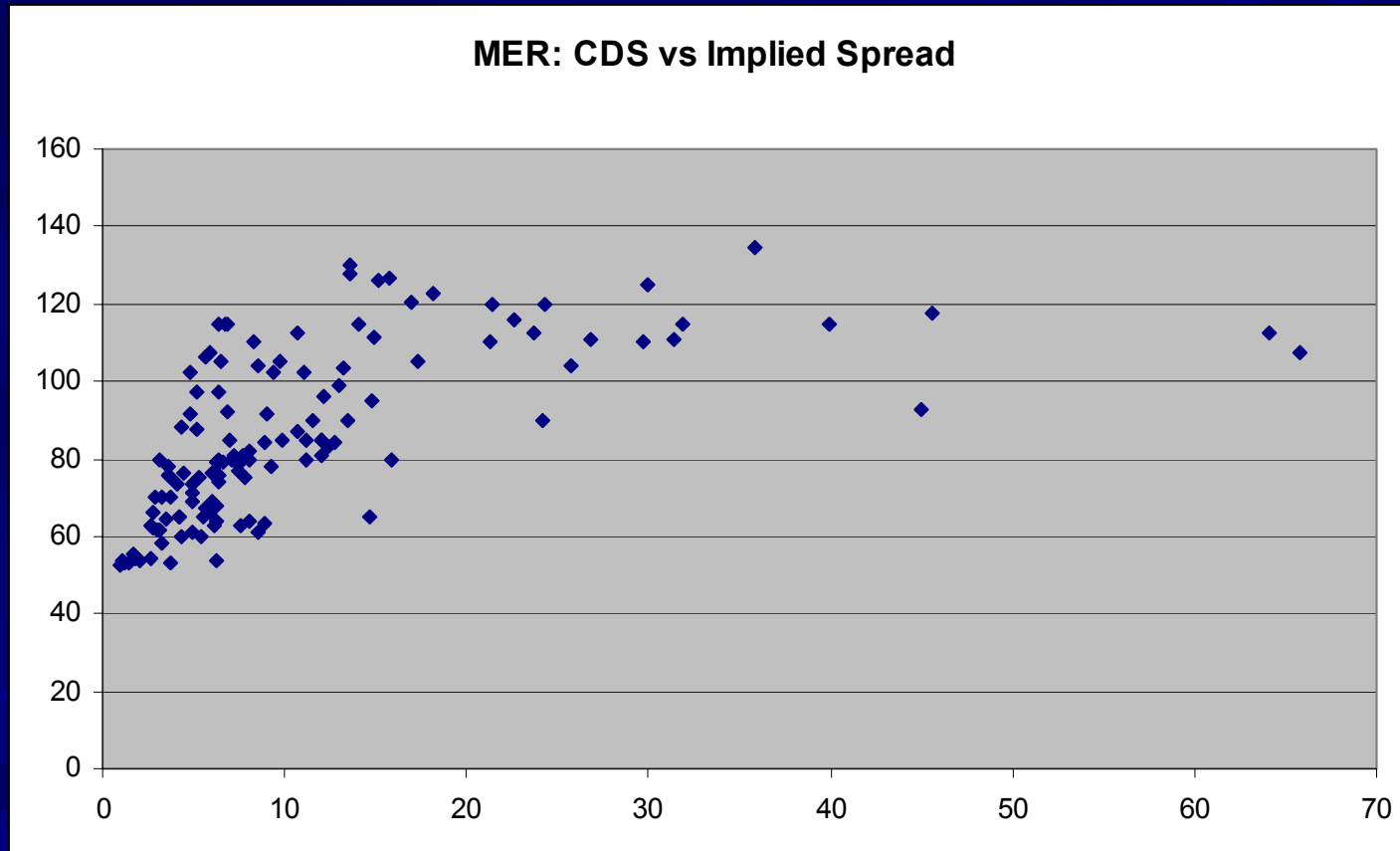
CAT Example - Spreads

Blue dots – Implied Vol (our method), rank=0.76

Red Dots – Historical Vol (KMV), rank=0.58

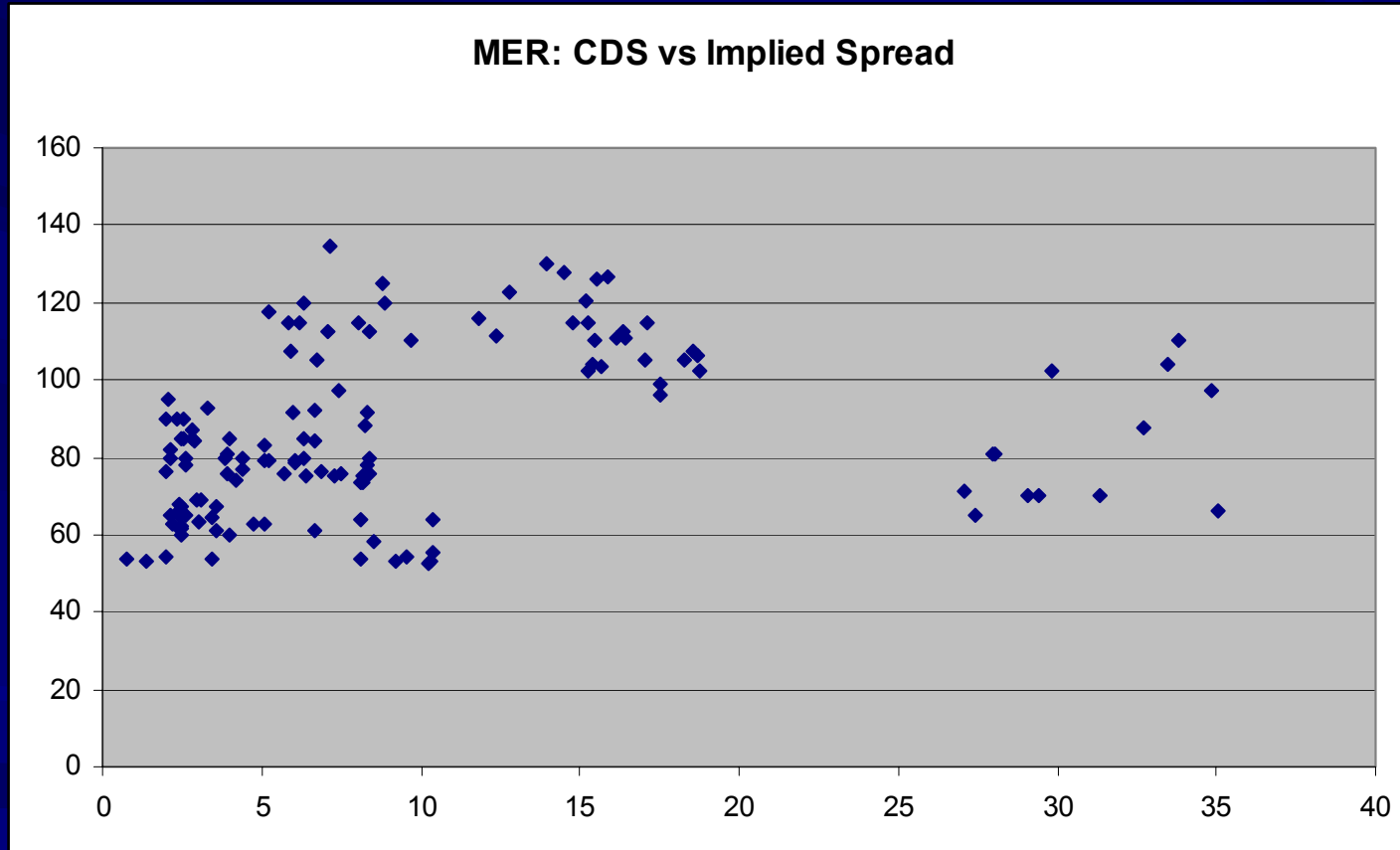


Merrill Lynch – Spreads from Vols



Rank Correlation = 0.83

Merrill Lynch – Spreads from Equity



Rank Correlation = 0.40

Super Computer Consulting, Inc.

Implied Spread vs CDS

Firm-by-Firm across Time

No. of Obs. per Firm	≥ 10	≥ 30
No. of Firms	149	86
Avg. Rank Correlation	0.48	0.57
Median Rank Correlation	0.62	0.71

Implied Spread vs CDS

Day-by-Day across Firms

Avg. Rank Correlation	0.40
Median Rank Correlation	0.42
First Quartile Rank Correlation	0.30
No. Greater Than Zero / Less Than Zero	218 / 4

Summary

Merton's model appears to have incredibly strong explanatory powers in relating actual credit spreads to observed volatility skews