

Discussion of “Explaining Credit Default Swap Spreads with the Equity Volatility and Jump Risks of Individual Firms”  
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- Summary of the paper
- Motivation
- Comments
- Suggestions



## Regression analysis

- ▶ Construct various measures of volatility and jumps for equity returns:
  - ▶ Realized diffusion volatility using 1-month high frequency (5 mn) TAQ data
  - ▶ Realized jump intensity and jump size (mean and variance) using 1-year high frequency data (Barndorff-Nielsen and Shephard)
  - ▶ Historical volatility, skewness and kurtosis using 1 year daily CRSP returns.
- ▶ Panel data regression of average monthly CDS spread levels from Jan 2001 to Dec 2003 on various volatility and jump measures give  $R^2 \approx 45\%$ .
- ▶ Adding ratings and firm specific variables (equity return, leverage...), and macro variables (S&P 500 return, interest rate...) find  $R^2$  as high as 77%.
- ▶ For credit spread changes explanatory power only 14%.
- ▶ Document non-linear impact of volatility (both historical and realized) on credit spreads.



## Model calibration exercise

- ▶ Propose an affine jump-diffusion stochastic volatility model for underlying firm value in a standard Merton (1974) structural model.
- ▶ Price risky debt using Merton approach as risk-free debt minus put option.
- ▶ Parameters are either calibrated (leverage, default barrier, risk-premia) or estimated (asset volatility, jump coefficients).
- ▶ Find calibrated JDSV model better able to fit credit spreads than models without jumps and/or stochastic volatility:  
*"The additional flexibility introduced by the volatility and jump parameters are critical for such model to be able to match empirically both credit spreads and default probabilities better relative to other candidate models."*

## Structural Models Literature I

- ▶ Classical framework for modeling credit risk: Structural Models
  - ▶ Specify firm value and default boundary dynamics.
  - ▶ Default occurs if firm value falls below default boundary.
  - ▶ Equity and debt values/dynamics determined jointly and self-consistently using contingent claim valuation.
  - ▶ Risky debt is valued as risk-free debt minus a put option written on asset value. Merton (1974), Black and Cox (1976), Leland (1994), Longstaff and Schwartz (1996)
- ▶ Unfortunately, early empirical examinations found structural models don't work well
  - ▶ Only very small proportion of spread can be attributed to default risk. Jones, Mason and Rosenfeld (1984)
  - ▶ Calibration of various structural models are in poor agreement with each other. Eom, Helwege and Huang (2004)
  - ▶ Changes in spreads not well predicted by structural models. Collin-Dufresne, Goldstein and Martin (2001)

## Structural Models Literature II

- ▶ Subsequent literature argues structural models work well at capturing credit component of spreads. However, latter is only a small fraction of observed spread. Residual might be due to other factors (liquidity, taxes. . . )
    - ▶ Structural models are in agreement once they are calibrated to match historical default rates, which are low! (Huang and Huang (2003))
 

Baa-Treas. $\approx$ 32bp	vs.	actual 158 bp
Aaa-Treas. $\approx$ 1bp	vs.	actual 55 bp.
    - ▶ Even simple structural models generate hedge ratios similar to empirical values (Schaefer and Strebulaev (2005))
    - ▶ Most of (Aaa - Treasury) may not be due to credit risk, and hence should not be explained by structural models (CDS premia  $\neq$  Aaa - Treasury) Grinblatt (1995), Collin Dufresne and Solnik (2001), Hull, Predescu and White (2005), Elton, Gruber, Aggrawal, Mann (2001), Blanco, Brennan, Marsh (2005)
- ⇒ Credit spread puzzle: observed Baa-Aaa spread seems too large relative to model predicted spreads given historical default rates on typical Baa bonds (Chen, Collin-Dufresne, Goldstein (2005)).

## Structural Models Literature III

- ▶ Recent literature actually finds that almost all of the spread can 'easily' be explained within structural model even without liquidity or tax component!
  - ▶ Spreads are consistent with predictions of a jump diffusion model calibrated to fit equity index options. (Cremers, Driessen, Maenhout and Weinbaum (2006))
  - ▶ Spreads are consistent with a regime switching model where hidden states, which can be inferred from inflation data, affect growth rate of dividends. (David (2006))
  - ▶ Using panel data, structural models perform better than suggested by CGM at explaining changes in spreads (if use different data and more explanatory variables). (Avramov, Jostova, Philipov (2004), Ericsson, Jacobs and Oviedo (2005))
- ▶ This paper also finds support for predictions of structural framework:
  - ▶ If we have better measure of individual firm volatility (obtained via High Frequency data and better econometric techniques) then we get high  $R^2$  in regressions.
  - ▶ Further, as long as we add jumps and stochastic volatility to the asset value process, we can predict more sizable spreads.

⇒ N.B.: This literature seems to contradict findings of HH!

## Regression analysis

- ▶ Do high  $R^2$  in regressions of average monthly spread levels offer strong support for structural models?
    - ▶ Very low explanatory power for regression in *changes*.
    - ▶ Strong explanatory power of Ratings and SP500 returns *after* controlling for firm specific variables (return, volatility, leverage).
    - ▶ Both components of volatility remain significant (HV and RV).
- ⇒ Is that consistent with predictions of the structural model?
- ⇒ If one were to simulate structural model and replicate regression analysis, would results be similar?



## Model Calibration Exercise

- ▶ Does added flexibility of jump-diffusion-stochastic volatility really help in better fitting credit spread levels?
  - ▶ Consider simple Merton (1974) model

$$\frac{dV}{V} + \delta dt = (r + \theta\sigma) dt + \sigma dz$$

where  $\theta$  is the asset value Sharpe ratio.

- ▶ Default occurs at  $T$  if  $V(T)$  falls below  $B$ . in that case recover  $1 - L$ .
- ▶ Spread  $(y - r)$  on a date- $T$  zero coupon bond is:

$$(y - r) = - \left( \frac{1}{T} \right) \log \left\{ 1 - L N \left[ N^{-1} \left( \pi^P \right) + \theta \sqrt{T} \right] \right\}.$$

- ⇒ Even though the model is specified by 7 parameters  $\{r, \mu, \sigma, \delta, V(0), B, L\}$ , credit spreads only depend on historical default probability, recovery and asset sharpe ratio  $\{\pi^P, L, \theta\}$ .

(Similar intuition holds in jump-diffusion case (CCG (2005)).)

## Model Calibration Exercise

Sharpe	T = 4Y			T = 10Y		
	Baa	Aaa	Baa-Aaa	Baa	Aaa	Baa-Aaa
0.15	44.0	1.6	42.4	67.7	12.0	55.7
0.20	54.9	2.2	52.7	88.1	17.4	70.7
0.25	68.1	3.0	65.1	112.8	24.6	88.2
0.30	83.7	4.1	79.6	141.7	34.2	107.5
0.35	102.0	5.5	96.5	175.1	46.6	128.5
0.40	123.4	7.4	116.0	212.9	62.2	150.7

**Table:** (Baa - Aaa) spreads as a function of Sharpe ratio. 4Y Baa default rate = 1.55%. 4Y Aaa default rate = 0.04%. 10Y Baa default rate = 4.89%. 10Y Aaa default rate = 0.63%. Recovery rate = 0.449.

- ▶ Typical Baa firm asset value Sharpe ratio estimated around 0.22.
- ▶ HH only calibrate their models to match historical estimates of  $\{\pi^P, L\}$ !
- ⇒ The credit spread puzzle only difficult to explain if models are calibrated to (i) historical expected loss rates, **and** (ii) Sharpe ratios (or ratio of idiosyncratic to systematic volatility).
- ▶ In that case, time variation in risk-premia seems essential ingredient to explain the puzzle (Chen, Collin-Dufresne and Goldstein (2005)).

## Suggestions

### ▶ Regression analysis

- ▶ Why use monthly averaged credit spreads? High frequency realized volatility measures allow to work at higher frequency and exploit longer time series.
- ▶ Can we be more formal about testing the implications of the structural model and consistency with regression analysis? For example, replicate regression analysis on simulated model data.
- ▶ Can we build profitable trading strategy based on out of sample forecasting with realized volatility?
- ▶ Why not use state of the art GARCH forecasting model instead of trailing daily historical volatility?
- ▶ VIX?

### ▶ Model Calibration

- ▶ Calibration of various models should insure consistent default rates and sharpe ratios. Else comparisons across models difficult to interpret.
- ▶ Discuss calibration of jump risk-premia? (estimated values are all historical measure parameters).
- ▶ Why do spreads converge to zero in Jump-diffusion model?