On the Relative Pricing of Long Maturity S&P 500 Index Options and CDX Tranches

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Recent years witnessed an explosive growth of credit derivative markets. Capital structure arbitrage strategies try to exploit differences in credit and equity markets. Trading in these markets may lead to market integration. Structural model of market and firm-level dynamics to jointly price long-dated S&P 500 options and tranche spreads on the five-year CDX index.

Coval, Jurek, Stafford (2009) have found:
- observed spreads on equity tranche are too high,
- observed spreads on senior tranches are too low,
concluding that CDX traders are too fixated on $P$, instead of $Q$.

The CJS conclusions might be a consequence of their restrictive modeling approach, namely the use of a Gaussian copula.
Method

Basic Model Setup

- Fully dynamic model with market dynamics exhibiting
  - stochastic volatilities,
  - stochastic dividend yield,
  - jumps in return, dividend, and vol process.
- Individual dynamics are described by a CAPM-like equation.

Data

- Data spans the period from September 2004 to 2008.
- CDX index and tranche data with maturity 1 to 5 years.
- Equity option data ($\tau = 1, 2, 3$) from Optionmetrics.
- Options with 5 years maturity OTC.
- Weekly data is used. (206 weeks)
- Usual suspects for beta, idiosyncratic vol, and leverage calculations and risk-free rate.
Calibration Strategy

Calibration of Option Return Model

- First, dynamic model is fitted to 5-year (OTC) index options.
- In addition, to extrapolate from equity market, the model is also fitted to the super-senior tranche.
- Using data from Broadie, Chernov, Johannes (2009), correlation coefficient $\rho$ and $\sigma_v$ are fixed.
- Fitting exercise is based on RMSE criteria.

Calibration of Asset Value Process

- Calibration to whole term structure of CDX prices is used to identify idiosyncratic part of the return dynamics.
- Asset beta is estimated using weighted average of equity and debt beta. (looking backward on 5yrs daily returns).
- Recovery rate is set equal to 40% for individual defaults (market convention).
**Results I**

### Disentangling the Contributions from Jumps

- Model estimated average tranche spreads are close to historically observed spreads.
- The crucial role is played by the mix of systematic and idiosyncratic jumps.
- Idiosyncratic jumps are particularly important for the short end (1 to 2 yrs) of the CDX term structure.
- The mix between systematic jumps and idiosyncratic jumps helps to explain the spreads at different seniority.
- Hence, from the perspective from the formulated arbitrage-free model, credit risk and equity market seem to be well integrated – contrasting the result of CJS.
The authors provide an additional calibration exercise to derive the time series of spreads.

Option prices are used to identify $V_t$ and $\delta_t$.

By visual inspection, the model clearly outperforms CJS. Performance seems better in the pre-crisis period.
Discussion

Time Series Analysis

- As noted, model is recalibrated at each time instance. Hence, model is time-inconsistent.
- The choice of some parameters from other literature (Broadie et al.) is questionable, particularly $\rho$.
- How does one know whether results are not just driven by the large number of “state variables”?
- Why not implement a more elaborated estimation procedure for the time series analysis, e.g., filter approach using both $P$ and $Q$ dynamics.

The Stochastic Dividend Process

- Dynamics of the dividend yield (nonstationarity under $Q$) is justified by the need of violating the central limit theorem.
- The flattening of IV as $\tau \to \infty$ has been incorrectly attributed to the central limit theorem! (see, Rogers and Tehranchi, Finance and Stochastic, 2010).
Correlation Changes Dramatically

Figure 1: Realized Correlation of S&P 500 Stocks

Figure 2: Option-Implied Correlation Is Trading at a Steep Premium to Realized Correlation

Figure 3: High Volatility Regimes Coincide with High Correlation Regimes – Two Notable Exceptions: Tech Bubble Burst and Now

Figure 4: Over the Past Five Years, Correlation Has Increased More than Macro Volatility, Pointing to Additional Drivers of Correlation
Discrepancy Implied and Actual Div’s

Implied Dividend Dynamics

Actual Dividend Yields
and introducing new puzzles?

- Might it be the case that if one intends to fit one particular aspect of markets, the model will eventually fail in other aspects?
- One problem might be e.g. the pricing of shorter term options.
- Long term options (5y) are nicely fitted, but...
Calibration of Short-Term Options

- It is inherently difficult to fit a model to different maturities and moneyness simultaneously.
- How should we interpret the results, if the current calibration strategy would result in rather strange pricing results at the shorter end?
- Flexibility can be added by using stochastic correlation (see e.g. Leippold and Trojani, 2010).
Relation to Other Literature

- How compare the results with Kapadia and Pu, who find that
  - there is substantial mispricing, hence equity and credit markets are not integrated.
  - There are limits to arbitrage.
- Kapadia and Pu conjecture in their conclusion that differences in opinion also may play a role in explaining mispricing (see Buraschi, Trojani, Vedolin (2008)).
- Isn't it natural to think of the CDS market as driven by additional factors not priced in equity markets? E.g., if we think of estimation risk: historical data on credit default is sparse and less reliable. People feel more comfortable with equity data.
- What about liquidity issues, both for CDX tranches as well as equity options with 5yr maturity?
- Finally, capital structure arb is risky business: Deutsche Bank made $900mill in 2006, $600mill in 2007, and lost todo in 2008.
- Other literature on the link of credit and equity market: Zhang, Zhou, and Zhu (2006); Bedendo, Cathcart, and El-Jahel (2007); CJS (2009b).