Jumps and the Correlation Risk Premium: Evidence from Equity Options

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Theoretical Motivation

Summary

This paper breaks the correlation risk premium down into two components: a premium related to the correlation of continuous stock price movements and a premium for bearing the risk of co-jumps. We propose a novel way to identify both premiums based on dispersion trading strategies that go long an index option portfolio and short a basket of option portfolios on the constituents. The option portfolios are constructed to only load on either diffusive volatility or jump risk. We document that both risk premiums are economically and statistically significant for the S&P 100 index. In particular, selling insurance against co-jumps generates a similarly annualized Sharpe ratio of 8.25.

Index Variance Risk Premium

Investors dislike tails of stock market turbulence:
- Premiums for four stock market volatilities:
  - Pay variance risk premium (VRP) to hedge against states of high market volatility.
  - Stock correlations go up when markets are volatile.
- Pay correlation risk premium (CRP) to eliminate the risk of high correlations.

There is a close theoretical link between the two risk premiums:
- Index variance is the sum of individual stocks' variances and covariances.

\[ VRP_i = \sum_{j=1}^{N} \omega_{ij} VRP_j + \text{Cov}(VRP) \]

Literature shows that index VRP is largely driven by CRP (e.g., Driessen et al., 2009; Carr and Wu, 2009; Biais et al., 2018).

Research question: What are the drivers of the CRP?

Stock correlations may stem from:
1. Continuous movements in the same direction.
2. Common discontinuous movements on rare occasions (co-jumps).

Continuous and Discontinuous Co-Movements

The index comprises constituents \( i = 1, \ldots, N \) whose stock prices follow jump-diffusions:

\[ dS_i \sim \mu_i dt + \sigma_i dW_i \]

\[ dV_i \sim \mu_{V_i} dt + \sigma_{V_i} dW_{V_i} \]

The index is the weighted sum of all constituents:

\[ j \sum_{i=1}^{N} \omega_{ij} S_i \] and \( V \sum_{i=1}^{N} \omega_{ij} V_i \)

The index variance risk premium can be decomposed into:

\[ VRP_i = \sum_{j=1}^{N} \omega_{ij} \left( E \left[ V_{ij} | V_j \right] \right) - E \left[ V_i | V_j \right] dV_i + \sum_{j=1}^{N} \omega_{ij} \left( E \left[ V_{ij} | V_j \right] \right) - E \left[ V_i | V_j \right] \left( E \left[ V_j | V_j \right] \right) \]

\[ \text{jump correlation risk premium}\]

\[ \text{jump covariance risk premium}\]

Investors pay the index VRP for very different reasons:
- How large are the risk premiums for continuous correlation and co-jumps?
- Empirically identifying these risk premiums is challenging.
- Option returns contain rich information about several risk premiums.
- Specifically constructed option portfolios provide a simple and legitimate way to solve the identification problem.

Empirical Strategy

Option Returns

The price of any option follows:

\[ dO_{t} = rS_{t}dt + \sigma_{V_{t}} dW_{V_{t}} \]

\[ dV_{t} = \mu_{V_{t}} dt + \sigma_{V_{t}} dW_{V_{t}} \]

where \( dV_{t} = \sum_{j=1}^{N} \omega_{ij} dV_{j} \)

\[ dJUMP_{t} = \text{JUMP}_{t} dt + \sigma_{JUMP_{t}} dW_{JUMP_{t}} \]

where \( \text{JUMP}_{t} = \sum_{j=1}^{N} \omega_{ij} \text{JUMP}_{j} \)

The portfolios are only exposed to volatility or jump risks:
- VRP returns depend on individual volatility and continuous correlation risk premiums.
- JUMP returns depend on individual jump and co-jump risk premiums.

To isolate the correlation risk premiums, we implement dispersion trades:
- VRP returns on the S&P 100 index,
- JUMP returns on the S&P 100 index.

\[ dCRP_{VRP} = rS_{t}dt + \sigma_{V_{t}} dW_{V_{t}} \]

\[ dCRP_{JUMP} = \text{JUMP}_{t} dt + \sigma_{JUMP_{t}} dW_{JUMP_{t}} \]

\[ \Rightarrow \text{portfolios pay the risk premiums for continuous correlation and co-jumps, respectively.} \]

Data

- Sample: S&P 100 index constituents, 01/1996 - 12/2017, daily frequency.
- Data sources: Optimax Ltd., CRSP, Computrade.
- Filters: similar to Goyal and Saretto (2009).
- Additional complications: American-style options.
- Strip off early exercise feature in CRM trees.
- Compute European option prices and Black-Scholes greeks.

Every day, we construct VRP and JUMP portfolios for the S&P 100 index and all constituents:
- Set up strategies with different times to maturity between 1 and 365 days.
- Select the two strategies that are nearest-to-the-money.
- Take positions in these 4 options while:
- Restricting delta, vega, and gamma.
- Aiming for balanced allocation of wealth across options.

\[ \min \left| \omega \cdot O \right| \quad \text{subject to:} \quad \omega \cdot \Omega = 0 \]

\[ \text{VRP} = \sum_{j=1}^{N} \omega_{ij} V_{j} \]

\[ \text{JUMP} = \sum_{j=1}^{N} \omega_{ij} \text{JUMP}_{j} \]

We hold the positions for 1 trading day and calculate excess returns at recorded closing prices:
- If necessary, we interpolate using a kernel smoother (maturity, moneyness, put-call identical).

Correlation Risk Premium

Summary Statistics

- Mean CRPVRP: 0.1321
- Mean CRPJUMP: 0.3067
- Median CRPVRP: 0.3082
- Median CRPJUMP: 0.1361
- Sharpe ratio CRPVRP: 0.6046
- Sharpe ratio CRPJUMP: 0.8480

Time Series

- CRPVRP: negative on 55% of days; no sudden changes during crash periods.
- CRPJUMP: negative on 61% of days; occasional extreme positive returns coincide with extreme index returns.
- Co-jumps materialize in crash periods.

Dispersions, Trade Components

- CRPVRP: slow-moving, prolonged gradual increase after burst of dot-com bubbles.
- CRPJUMP: short leg is less volatile.
- CRPJUMP: both legs are of same magnitude; short leg is less volatile.
- Index jumps almost exclusively come from co-jumps.

Detrended Cumulative Excess Returns

- CRPVRP: shows moving, prolonged gradual increase after burst of dot-com bubbles.
- CRPJUMP: insures against the long-term risk of worsening investment opportunities.
- CRPJUMP: prompt reactions to major events; large positive payoff around default of Lehman Brothers.
- Insures against the short-term risk of simultaneous crashes.

Predictive Power

Predictive Regressions

- Investors pay premium of 11.21% p.a. to hedge against high continuous correlation.
- Investors pay large premium of 36.67% p.a. to hedge against co-jumps.
- Returns are scaled by greek; Sharpe ratios are more informative (0.82 vs. 0.60).
- Risk premium for co-jumps is larger than for continuous correlation.

\[ \text{CRPVRP:} \text{CRPJUMP:} \]