FIN567 Final Project Methodology

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I. Introduction

Dispersion trading is basically a strategy that involving selling the options on an index against buying the options on a basket of individual stock components of the index. There are two dispersion trades we are discussing in this report: vega-neutral dispersion trade and theta-neutral dispersion trade. Historically in the financial markets, index volatility tends to be priced higher compared to volatility of its components. This can be explained because many traders tend to buy protection for the portfolio based on an index instead of a single stock. Dispersion trading can help profit from price differences in volatility markets using index options and options in individual stocks.

II. Methodology

1. Data Collection

a. We collected data from 12/31/2012 to 12/31/2017.

b. From WRDS, we downloaded the implied volatilities, delta, gamma, vega, and theta for the 62 options (1 index put, 1 index call, 30 component puts, and 30 component calls). Note that Dow Jones index options are in European style while the components stock options are in American style.

c. From Quandl, we downloaded the daily adjusted close price of each component stock in Dow Jones and calculated the historical returns of the underlying stocks.

d. We cleaned our downloaded data and gathered the relevant information into one data frame so we can access them conveniently.

2. Portfolio Construction

a. We reconstruct an index option using options on Dow Jones component stocks by assigning the weights for each option in the same way Dow Jones uses: the weight of each option is equal to the individual option price divided by the sum of all component stock prices, as shown in the following formula:

$$w_i = \frac{P_i}{P_I} = \frac{P_i}{\sum_{i=1}^{30} P_i}$$

b. The basic strategy we use is: writing the Dow Jones index straddles and buying the component stocks straddles. To achieve vega-neutral or theta-neutral, for each Dow Jones index straddle sold, we buy α options on the reconstructed index.

c. The portfolio consists of two parts: the Dow Jones index option and the reconstructed index option consisting of options on component stocks. In order to construct a vega-neutral or a theta-neutral portfolio, we need to keep the portfolio vega or theta as 0. We then use the following formulas to calculate the portfolio vega and theta and set both of them to 0:

$$\text{Vega}_p = (\text{Vega}_{\text{call, DJX}} + \text{Vega}_{\text{put, DJX}}) + \alpha \times w_i \times (\text{Vega}_{\text{call, component}_i} + \text{Vega}_{\text{put, component}_i}) = 0$$

$$\text{Theta}_p = (\text{Theta}_{\text{call, DJX}} + \text{Theta}_{\text{put, DJX}}) + \alpha \times w_i \times (\text{Theta}_{\text{call, component}_i} + \text{Theta}_{\text{put, component}_i}) = 0$$

3. Risk Measurement

a. We hold the options until the Friday of December 2017, which is 12/15/2017.

b. We calculate daily historical log returns of the index and component stocks, which are used to simulate index and component price path, then to calculate the next day stock and index option price using B-S formula and Binomial-tree. The next-day portfolio value is calculated based on its current value and the simulated option prices.

c. We evaluate VaR metrics using Filtered Historical Simulation, picking 5% quantile

- Calculation steps:
  - i. Estimate a GARCH(1,1) model using a sequence of past returns (in our case this could be the historical performance of our portfolio).
  - ii. Calculate past standardized returns based on observed returns and estimated standard deviations.
  - iii. Calculate 1-day VaR accordingly.
- The Benefit of this FHS:
  - i. Historical Simulation is relatively easy to implement
  - ii. Large losses in the forecast period without observing a large loss in the past returns.
  - iii. Automatically capture the correlations of volatility data
  - vi. Avoid making assumptions of simulations