Project E

Due November 28, 2018, 5:00 P.M.

1. Data model: Create a data model that supports the information provided by the first Bloomberg page for the description of corporate bonds (e.g., BA 4.7 10/27/2019 Corp DES). Provide the following diagrams:

a) Logical entity-relationship model with entity definitions
b) Logical entity-relationship model with attributes, primary key, and foreign key designations
c) Physical model with attributes, keys, relationships, and data types

Use of ERwin is encouraged but not required. See example models from lecture and on Canvas.

2. Indices and tradable proxies: Analyze these pairs of indices and tradable assets:

- S&P 500: SP1 Index vs. SPX Index ("Generic 1-month" future vs. S&P spot)
- S&P 500: SPY Equity vs. SPX Index (Index ETF vs. S&P spot)
- Gold: GLD Equity vs. GOLDS Cmdty (Gold ETF vs. spot metal)
- VIX: TVIX Equity vs. VIX Index (Volatility ETF vs. volatility index based on option implied volatilities)

For each pair, obtain the time series of 1-day prices and returns for the period 2010-2017. Note that dates may not match or be complete. The tradable security will always have the later start date (why?). Create a scatterplot of daily returns for each pair along with a trendline and its equation. Read the security description page (DES) for each tradable proxy and discuss on how well the returns on the paired entities behave in tandem. Note significant outliers, if any.

Data source: Bloomberg

3. Options and hedging: You are a market maker for DIA options, which are based on the ETF for the Dow Jones Industrial Average. On the first trading day of 2009, you sell **35 call option contracts expiring January 2010** and delta-hedge the position daily until expiration. Use historical daily market data to simulate trading for each of three different strikes. Assume the following:

- No transaction costs for trading.
- Option is initially sold **at the ask** price.
- Option is **marked** every day at the mid-market of closing bid/ask prices.
- Stock positions are **re-hedged** to delta-neutral position each day at the close.
- Cash earns **short-term risk-free** interest rate each day.
- Lend and borrow interest rates on cash are **equal**.
- **Dividends** are received on long stock, paid on short stock positions.
- Deltas are "**market deltas**," i.e., using current market implied volatility for each contract.
- Perform simulation **for three different strikes**: K=90, 95, and 100.

Data sources: the primary data source is the Option Metrics data set. You can access it from the location of your choice: OLAP server (Vol01 database, Vol cube), SQL Server (om database) or WRDS (flat files, SAS, .), using the client of your choice (Excel, OWC web pages, Access file twisty,…) and compute in the environment of your choice (R, Python, Matlab, Excel, SQL,…). You may also use more than one of the above.

a. Compute the mark-to-market value of the delta-hedged portfolio for each day. Plot market value vs. time over the lifetime of the trade.
b. Determine the expected P/L for the lifetime of the trade at the time it is opened.
c. *Optional, extra credit:* Estimate the standard deviation of the terminal P/L.
d. Determine the final realized P/L for the trade.
e. Determine the annualized standard deviation of P/L over the lifetime of the trade.
f. Determine the annualized Sharpe ratio for the trade.
g. Plot option delta over time for the lifetime of the trade.
h. Plot implied volatility over time for the lifetime of the trade and compare with realized 1-month volatility.
i. Create a scatterplot of daily P/L vs. return on the DIA. Are the results of the delta-hedged strategy in fact delta neutral?

Notes:

- Mind the gap: pay attention to potentially missing or inaccurate data. If you fill in or approximate missing values, be sure to explain what you did.
- For time series graphs, you should plot lines for each of the strikes on a single chart.

4. Butterfly: You sell 35 of the 90-95-100 Jan-10 butterfly on DIA. It uses the same call option contracts as the previous problem and the same simulation assumptions. On the first trading day of 2009, you sell (at the ask price) 35 contracts each of the 90 and 100 strike contracts, and you buy (at the bid price) 70 contracts of the central 95 strike. You close the trade **before expiration** on October 13, 2009. This time you buy the "wings" at the bid price and sell the 95's at the ask price.

a. Compute the mark-to-market portfolio value each day and the daily P/L. Plot the market value vs. time.
b. Determine the expected P/L for the lifetime of the trade at the time it is opened, assuming that the trade will be held until expiration.
c. *Optional, extra credit:* Estimate the standard deviation of the terminal P/L.
d. Determine the final realized P/L for the trade.
e. Determine the annualized standard deviation of P/L over the lifetime of the trade.
f. Determine the annualized Sharpe ratio for the trade.
g. Plot the aggregate option delta over time for the lifetime of the trade.
h. Plot aggregate vega over time for the lifetime of the trade.
i. Create a scatterplot of daily P/L vs. return on the DIA. Are the results of the delta-hedged strategy in fact delta-neutral?