Volatility Trading Analysis with Python

Section 3: Futures Trading Strategies

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Futures Trading Strategies

- **Futures trading strategies** consist of implementing volatility hedge methodology by evaluating risk adjusted performance of associated benchmark indexes replicating investment vehicles such as exchange traded funds or exchange traded notes.
  - **Exchange traded funds ETFs** are collective schemes that follow certain asset allocation investment strategy with a structure similar to stocks in which owners have participation in underlying assets.
  - **Exchange traded notes ETNs** are collective schemes that follow certain asset allocation investment strategy with a structure similar to bonds in which owners don't have participation in underlying assets.

Futures

- **Futures** consist of exchange traded standardized contracts in which buyers and sellers agree forward price and delivery date of underlying asset.
- They are related to **forwards** contracts but have two relevant differences.
  - Futures consist of exchange traded standardized contracts while forwards consist of over the counter customized contracts.
  - Exchange requires futures have clearing margin as customer safeguard which lowers their credit risk.

$$f = se^{(r-q)t}$$

Futures Payoff

- **Futures payoff** consists of the difference between asset price at maturity and future agreed delivery price depending on whether position is long or short. This result then needs to be multiplied by contract size or multiplier.
  - **Return on investment** consists of dividing future payoff by amount originally invested. Amount originally invested consists of contract being partially or fully collateralized.

Futures Payoff

- It's calculated as follows.

$$long\ f_p = (s_t - f_k)f_m$$

$$short\ f_p = -[(s_t - f_k)f_m]$$

$$roi = \frac{f_p}{(f_k f_m)f_c}$$

Volatility and Asset Returns Correlation

- **Volatility and asset returns correlation** consists of measuring the degree to which they move together taking into account their standard deviation.

$$\rho(VIX_r, SPXTR_r) = \frac{\sum_{t=1}^{n}\left(VIX_{r,t} - E(VIX_{r,t})\right)\left(SPXTR_{r,t} - E(SPXTR_{r,t})\right)}{\sqrt{\sum_{t=1}^{n}\left(VIX_{r,t} - E(VIX_{r,t})\right)^2 \sum_{i=1}^{n}\left(SPXTR_{r,t} - E(SPXTR_{r,t})\right)^2}}$$

Volatility Risk Premium

- **Volatility risk premium** consists of the difference between implied and historical or realized volatility.

$$VRP_t = VIX_{t-21} - \sigma_t$$

Volatility Term Structure

- **Volatility term structure** consists of the difference between shorter and longer term implied volatility futures prices or between implied volatility spot and future prices.
- Term structure **contango** consists of longer term implied volatility future price being higher than shorter term one or implied volatility future price being higher than spot one while **backwardation** consists of the opposite.

$$VTS_t = VIX_t - f(VIX)_{t,i}$$

Volatility Skew

- **Volatility skew** consists of the difference between options implied volatilities at different strike prices.
  - **Volatility smile** is when both out of the money call and put options implied volatilities are increasingly higher than at the money ones.
  - **Volatility skew** or **smirk** is when out of the money put options implied volatilities are increasingly higher than at the money ones while out of the money call options ones remain similar.

- An estimation example includes **CBOE SKEW Index®** which measures 30 day annualized expected tail risk of S&P 500 index SPX.
- Chicago Board Options Exchange CBOE®. "*The CBOE Skew Index – SKEW®*". 2010.

Volatility Skew

- It has following interpretation.

$$\boldsymbol{SKEW = 100 = SPX\ Normal\ Log\ Returns}$$

- Find below estimated risk adjusted probability of S&P 500 30 day log returns two and three standard deviations above or below their historical mean.

$$\boldsymbol{SKEW = 100, 2\sigma = 2.30\%, 3\sigma = 0.15\%}$$

$$\boldsymbol{SKEW = 125, 2\sigma = 9.05\%, 3\sigma = 1.63\%}$$

$$\boldsymbol{SKEW = 145, 2\sigma = 14.45\%, 3\sigma = 2.81\%}$$

Volatility Risk Assessment

- **Volatility risk assessment** consists of evaluating implied volatility daily returns probability distribution against a normal probability distribution.
- **Normal Q-Q Plot** consists of comparing ranked standardized implied volatility daily returns sample quartiles to corresponding ranks inverse normal distribution theoretical quartiles.

$$z_t = \frac{r_t - \mu_r}{\sigma_r}$$

Strategies Performance Comparison

- **Strategies performance comparison** consists of evaluating volatility trading strategies historical risk adjusted performance by comparing it with asset buy and hold strategy. Annualized return, annualized standard deviation, annualized Sharpe ratio, returns skewness and returns excess kurtosis metrics are used for this assessment.
- **Annualized return** is a performance metric that consists of the number of observations root of annually scaled cumulative product of daily returns.

$$r_t = \frac{p_t}{p_{t-1}} - 1 \; or \; ln\left(\frac{p_t}{p_{t-1}}\right)$$

$$r_a = \left[\prod_{t=1}^{n}(r_t + 1)\right]^{252/n} - 1$$

Strategies Performance Comparison

- **Annualized standard deviation** is a risk metric that consists of daily standard deviation multiplied by square root of number of periods per year.

$$\sigma_a = \sigma\sqrt{252}$$

- **Annualized Sharpe ratio** is a risk-adjusted performance metric that consists of annualized excess return by unit of risk.

$$sr_a = \frac{r_a - rf_a}{\sigma_a}$$

Strategies Performance Comparison

- **Returns skewness** is a distribution shape metric that consists of measuring daily returns probability distribution asymmetry form their arithmetic mean.
  - **Positive skew** indicates daily returns probability distribution with asymmetric tail extending towards positive values.
  - **Negative skew** indicates daily returns probability distribution with asymmetric tail extending towards negative values.

$$s = \frac{\frac{1}{n}\sum_{t=1}^{n}(r_t - \mu_r)^3}{\left(\frac{1}{n}\sum_{t=1}^{n}(r_t - \mu_r)^2\right)^{3/2}}$$

Strategies Performance Comparison

- **Returns excess kurtosis** is a distribution shape metric that consists of measuring daily returns probability distribution peakedness or flatness compared with a normal probability distribution.
  - **Positive excess kurtosis** indicates daily returns probability distribution more peaked than normal probability distribution.
  - **Negative excess kurtosis** indicates daily returns probability distribution flatter than normal probability distribution.

$$k = \frac{\frac{1}{n}\sum_{t=1}^{n}(r_t - \mu_r)^4}{\left(\frac{1}{n}\sum_{t=1}^{n}(r_t - \mu_r)^2\right)^2} - 3$$

Volatility Hedge Futures Strategy

- **S&P 500 Dynamic VEQTOR Index Total Return – Short Term Index®** consists of hypothetically replicating volatility hedge futures strategy with long-only exposure to S&P 500 equity component, S&P 500 VIX Futures Index Total Return – Short Term Index® volatility component and cash component which are dynamically allocated on a daily frequency based on realized volatility and implied volatility trends.
- S&P Dow Jones. *"S&P 500 Dynamic VEQTOR Index Series Methodology"*. 2014

- Investment vehicle options include.
  - Invesco PowerShares® PHDG PowerShares S&P 500 Downside Hedged Portfolio ETF
  - Barclays VQT ETN+ S&P VEQTOR® ETN