Basket Implied Correlation Analysis

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Objective

This project computes the **implied correlation** of an equity basket using options-market data from the Bloomberg Terminal. It extracts the market's forward-looking estimate of average pairwise correlation between large-cap equities for use in **dispersion trading** signal generation and **correlation risk premium** analysis.

Overview

Two Jupyter notebooks form the analytical core:

- `correl_matrix.ipynb`: Computes a 30-day rolling realized correlation matrix for the selected equity basket.
- `implied_correl.ipynb`: Calculates the basket-implied correlation time series using index and stock implied volatilities.

All data—including historical prices, implied volatilities, and basket weights—were extracted from the **Bloomberg Terminal**.

Methodology

1. Portfolio Variance Decomposition

The total variance of a basket can be expressed as:

$$\sigma_{\text{basket}}^2 = \sum_i w_i^2 \sigma_i^2 + \rho \Big[\Big(\sum_i w_i \sigma_i \Big)^2 - \sum_i w_i^2 \sigma_i^2 \Big]$$

where:

- σ_{basket}: index or basket volatility (proxied by VIX)
- σ_i: implied volatility of stock i
- w_i: weight of stock i in the basket
- ρ: average pairwise correlation among constituents

2. Implied Correlation Extraction

Rearranging yields:

$$\rho_{\text{implied}} = \frac{\sigma^2_{\text{basket}} - \sum_i w_i^2 \sigma_i^2}{\left(\sum_i w_i \sigma_i\right)^2 - \sum_i w_i^2 \sigma_i^2}$$

This isolates the implied correlation term from the variance equation, yielding the market's expectation of average pairwise correlation.

3. Realized Correlation

The realized correlation across N assets over a rolling window is given by:

$$\rho_{\text{realized}} = \frac{2}{N(N-1)} \sum_{i<j} Corr(r_i, r_j)$$

where r_i are the daily returns of each stock.

Data

- **Source:** Bloomberg Terminal
- **Fields:** 30-day implied volatilities for S&P 500 constituents and index (VIX)
- **Frequency:** Daily

Basket Composition

Top 10 S&P 500 constituents (approximately 38% index weight):

Ticker	Weight (%)
NVDA	7.38
AAPL	6.63
MSFT	6.13
AMZN	4.27
GOOGL	2.88
GOOG	2.70
META	2.55
TSLA	2.37
BRK.B	1.79
LLY	1.36

Note: Static weights used. Expanding to top 50 names would improve representativeness (80% of index coverage).

Outputs

- Implied correlation time series
- Realized correlation series (30-day rolling)
- Comparative plots of implied vs realized correlation
- Rolling correlation matrices

Applications

Area	Use Case
Dispersion Trading	Detect mispricing between index and basket options
Correlation Risk Premium	Measure implied–realized correlation spreads
Volatility Forecasting	Identify correlation regime shifts
Risk Management	Monitor systemic correlation clustering

Interpretation

Correlation Range	Market Regime
0.0–0.3	Low correlation (diversified)
0.3–0.5	Normal
0.5–0.7	Elevated
0.7–1.0	Crisis co-movement

Signal Interpretation:

- $\rho_{\text{implied}} > \rho_{\text{realized}}$: index options rich → sell correlation / long dispersion
- $\rho_{\text{implied}} < \rho_{\text{realized}}$: index options cheap → buy correlation / short dispersion

Requirements

```
pandas >= 1.5.0
numpy >= 1.24.0
openpyxl >= 3.0.0
matplotlib >= 3.7.0
```

Execution

1. Run `correl_matrix.ipynb` to compute realized correlations.

2. Run `implied_correl.ipynb` to calculate implied correlation.
3. Compare results for signal generation and visualization.

Limitations

- Static weights (no rebalancing)
- Limited universe (10 stocks, 38% index coverage)
- Requires Bloomberg data access
- No backtesting framework

License

Citation

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