Part 4: Hedging Strategy Implementation

Objective: Isolate alpha by removing market exposure using dynamic hedging based on beta.

Tasks: 1. Import required data (SPY, portfolio, betas) 2. Calculate daily hedge ratio and short SPY position 3. Simulate hedged returns 4. Update portfolio value with hedging logic

Deliverables: - Hedge ratio and short SPY position - Time series of hedged portfolio value and returns - Comparison with unhedged values

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import yfinance as yf
plt.style.use('default')
```

Task 1: Import Required Data

```
# Load SPY prices
spy = yf.download('SPY', start='2020-01-01', end='2025-07-31', progress=False)['Close']
spy_returns = spy.pct_change().dropna()
# Load portfolio value and returns
port = pd.read_csv('../Part 2: Initial Portfolio Construction/equal_weight_portfolio_results
portfolio_value = port['Portfolio_Value']
portfolio_returns = port['Portfolio_Return']
# Load betas
betas = pd.read_csv('../Part 3: Market Exposure Estimation/portfolio_beta_timeseries.csv', in
```

Task 2: Calculate Daily Hedge Ratio and Short SPY Position

```
# Align all data
dates = portfolio_value.index.intersection(spy.index).intersection(betas.index)
pv = portfolio_value.loc[dates]
spy_p = spy.loc[dates]
beta = betas.loc[dates]
pr = portfolio_returns.loc[dates]
mr = spy_returns.loc[dates]
# Hedge ratio: h_t = beta_t * (Portfolio Value / SPY Price)
hedge_ratio = beta * pv / spy_p
short_spy = -hedge_ratio
# Deliverable 1: Show first 5 hedge ratios and short SPY positions
pd.DataFrame({'Hedge_Ratio': hedge_ratio, 'Short_SPY': short_spy}).head()
```

Task 3: Simulate Hedged Returns

```
# Hedged return: r_hp,t = r_p,t - beta_t * r_mkt,t
hedged_returns = pr - beta * mr
# Deliverable 2: Show first 5 hedged returns
hedged_returns.head()
```

Task 4: Update Portfolio Value with Hedging Logic

```
initial = pv.iloc[0]
hedged_value = initial * (1 + hedged_returns).cumprod()
# Deliverable 2: Show first 5 hedged portfolio values
hedged_value.head()
```

Deliverable 3: Comparison with Unhedged Values

```
plt.figure(figsize=(12,6))
plt.plot(pv, label='Unhedged Portfolio')
plt.plot(hedged_value, label='Hedged Portfolio')
plt.title('Portfolio Value: Hedged vs Unhedged')
plt.xlabel('Date')
plt.ylabel('Portfolio Value ($)')
plt.legend()
```

```
plt.grid(True, alpha=0.3)
plt.tight_layout()
plt.show()
```