Jupyter Notebook Execution Report

Name: Your Name

Date: February 03, 2026

Cell 1: ■ Code

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

Cell 2: ■ Code

```
df = pd.read_csv("../processed/etf_returns.csv", parse_dates=["Date"])
df = df[["Date", "Ticker", "Daily_Return"]].dropna()
returns_wide = df.pivot(index="Date", columns="Ticker",
values="Daily_Return").sort_index()
```

```
returns_wide.head()
```

Output:

```
Ticker           BND       IAU      MOAT  ...    XIC.TO    ZAG.TO    ZLB.TO
Date                                      ...
2014-01-03  0.000125  0.010943 -0.003151  ... -0.002796  0.000661 -0.000988
2014-01-06  0.000873  0.000000 -0.004917  ... -0.004206  0.000661 -0.001484
2014-01-07  0.001248 -0.004996  0.008825  ...  0.008446  0.002641  0.009906
2014-01-08 -0.003238 -0.005021 -0.003149  ...  0.000931  0.000659  0.001471
2014-01-09  0.001874  0.002523  0.000351  ...  0.000930 -0.000659  0.000979

[5 rows x 15 columns]
```

Cell 3: ■ Code

```
needed = ["QUAL", "MOAT", "QUS", "SPY"]
```

```
available = set(returns_wide.columns)
missing = [t for t in needed if t not in available]
```

```python
print("Available tickers (sample):", sorted(list(available))[:25])
print("Missing tickers:", missing)
```

Output:

```
Available tickers (sample): ['BND', 'IAU', 'MOAT', 'QUAL', 'QUS', 'SCHD', 'SPLV', 'SPY', 'VCN.TO'
Missing tickers: []
```

Cell 4: ■ Code

```python
factor_tickers = ["QUAL", "MOAT", "QUS", "SPY"]
```

```python
missing = [t for t in factor_tickers if t not in returns_wide.columns]
if missing:
raise ValueError(f"Missing tickers in returns_wide: {missing}")
```

```python
factor_data = returns_wide[factor_tickers].dropna()
factor_data.tail()
```

Output:

```
Ticker          QUAL      MOAT       QUS       SPY
Date
2026-01-27  0.002012 -0.002240 -0.001462  0.003984
2026-01-28  0.000637 -0.007763 -0.000732 -0.000101
2026-01-29  0.002301 -0.010086  0.001973 -0.001984
2026-01-30 -0.011331 -0.002571 -0.002531 -0.002983
2026-02-02  0.006472  0.003532  0.006260  0.004971
```

Cell 5: ■ Code

```python
def annualized_return(r):
r = r.dropna()
return (1 + r).prod()**(252/len(r)) - 1
```

```python
def sortino_ratio(r):
r = r.dropna()
ann_ret = annualized_return(r)
downside = r[r &lt; 0]
downside_std = downside.std() * np.sqrt(252)
```

```
# Avoid division by zero if downside_std is tiny
if downside_std == 0 or np.isnan(downside_std):
return np.nan
return ann_ret / downside_std
```

```
def max_drawdown(r):
r = r.dropna()
cum = (1 + r).cumprod()
dd = (cum / cum.cummax()) - 1
return dd.min()
```

```
rows = []
for t in factor_tickers:
r = factor_data[t]
rows.append({
"ETF": t,
"Annualized Return": annualized_return(r),
"Sortino": sortino_ratio(r),
"Max Drawdown": max_drawdown(r),
})
```

```
factor_df = pd.DataFrame(rows).set_index("ETF").sort_values("Sortino",
ascending=False)
factor_df
```

Output:

```
      Annualized Return   Sortino  Max Drawdown
ETF
SPY            0.136340  0.924749     -0.337173
MOAT           0.133145  0.917850     -0.333098
QUAL           0.129974  0.899004     -0.340567
QUS            0.126384  0.844837     -0.337766
```

Cell 6: ■ Code

```
plt.figure(figsize=(10, 6))
```

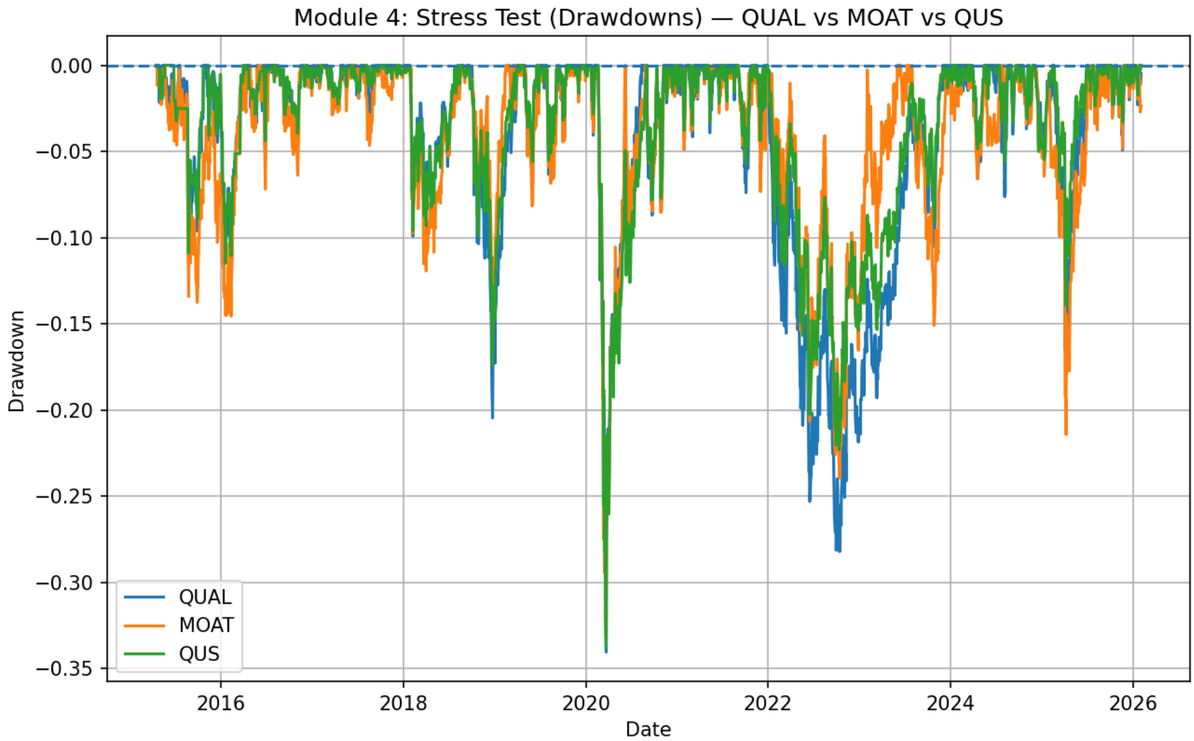
```
for t in ["QUAL", "MOAT", "QUS"]:
```

```
r = factor_data[t]
cum = (1 + r).cumprod()
dd = (cum / cum.cummax()) - 1
plt.plot(dd, label=t)
```

```
plt.axhline(0, linestyle="--")
plt.title("Module 4: Stress Test (Drawdowns) — QUAL vs MOAT vs QUS")
plt.ylabel("Drawdown")
plt.xlabel("Date")
plt.legend()
plt.grid(True)
plt.show()
```

Output:

```
[STDERR]
&lt;string&gt;:1: UserWarning: FigureCanvasAgg is non-interactive, and thus cannot be shown
```



Cell 7: ■ Code

```
# final portfolio
```

```python
weights = {
"SCHD": 0.40, # US Core (Dividend + Defense)
"ZLB.TO": 0.25, # CAD Core (Low Volatility)
"QUS": 0.20, # Quality Satellite (Strategic Factors)
"IAU": 0.15 # Hedge Gold
}
```

```python
final_tickers = list(weights.keys())
port_data = returns_wide[final_tickers].dropna()
```

```python
port_data['Defensive_Growth'] = (
(port_data['SCHD'] * weights['SCHD']) +
(port_data['ZLB.TO'] * weights['ZLB.TO']) +
(port_data['QUS'] * weights['QUS']) +
(port_data['IAU'] * weights['IAU'])
)
```

```python
# 3. Run Monte Carlo Bootstrap (10,000 Simulations)
# We resample the last ~10 years of daily history
simulations = 10000
trading_days = 1260 # 5 Year
simulated_annual_returns = []
```

```python
np.random.seed(42) # For reproducible results
```

```python
print(f"Running {simulations} simulations based on {len(port_data)} days of history...")
```

```python
for i in range(simulations):
# Randomly pick 252 daily returns from our history (with replacement)
daily_samples = np.random.choice(port_data['Defensive_Growth'], size=trading_days, replace=True)
# Calculate cumulative return for that simulated year
annual_return = np.prod(1 + daily_samples) - 1
simulated_annual_returns.append(annual_return)
```

```python
# 4. Calculate Key Metrics
sim_results = np.array(simulated_annual_returns)
```

```python
# CVaR (Conditional Value at Risk): Average of the worst 5% cases
```

```python
worst_5_percent = np.percentile(sim_results, 5)
cvar_95 = sim_results[sim_results &lt;= worst_5_percent].mean()
```

```python
# Probability of Profit
prob_positive = (sim_results &gt; 0).mean()
```

```python
print("\n--- FINAL EXECUTIVE METRICS ---")
print(f"Portfolio: 40% SCHD | 25% ZLB | 20% QUS | 15% IAU")
print(f"Probability of Positive Return (5 Year): {prob_positive:.1%}")
print(f"Worst Case Scenario (CVaR 95%): {cvar_95:.1%}")
print(f"Median Expected Return: {np.median(sim_results):.1%}")
```

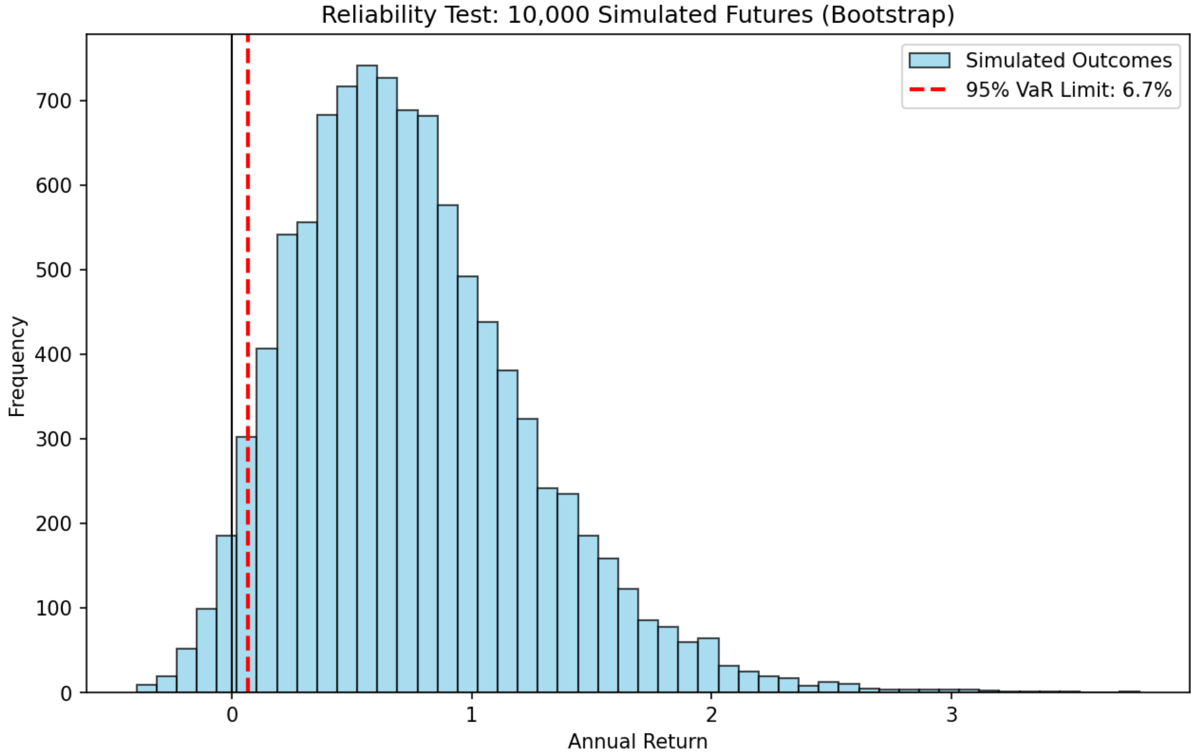
```python
# 5. Visual Proof for Tosin
plt.figure(figsize=(10,6))
plt.hist(sim_results, bins=50, color='skyblue', edgecolor='black', alpha=0.7,
label='Simulated Outcomes')
plt.axvline(worst_5_percent, color='red', linestyle='--', linewidth=2, label=f'95%
VaR Limit: {worst_5_percent:.1%}')
plt.axvline(0, color='black', linewidth=1)
plt.title('Reliability Test: 10,000 Simulated Futures (Bootstrap)')
plt.xlabel('Annual Return')
plt.ylabel('Frequency')
plt.legend()
plt.show()
```

Output:

```
Running 10000 simulations based on 2658 days of history...

--- FINAL EXECUTIVE METRICS ---
Portfolio: 40% SCHD | 25% ZLB | 20% QUS | 15% IAU
Probability of Positive Return (5 Year): 96.8%
Worst Case Scenario (CVaR 95%): -5.1%
Median Expected Return: 68.6%

[STDERR]
&lt;string&gt;:1: UserWarning: FigureCanvasAgg is non-interactive, and thus cannot be shown
```



Cell 8: ■ Code

```
import matplotlib.ticker as mtick
```

```
# 1. Configuration
initial_capital = 10000
years = 5
trading_days_per_year = 252
total_days = years * trading_days_per_year
simulations = 10000
```

```
# 2. Define the Portfolio Weights
weights = {
'SCHD': 0.40,
'ZLB.TO': 0.25,
'QUS': 0.20,
'IAU': 0.15
}
```

```
# 3. Create the Synthetic Portfolio History
```

```
# (Assuming 'returns_wide' is your dataframe of daily returns)
final_tickers = list(weights.keys())
port_data = returns_wide[final_tickers].dropna()
```

```
# Calculate Daily Weighted Return of the strategy
daily_returns = (port_data * pd.Series(weights)).sum(axis=1)
```

```
# 4. Run Monte Carlo Bootstrap (Path Simulation)
# We simulate 10,000 different "5-Year Paths"
np.random.seed(42) # For consistent results
```

```
print(f"Running {simulations} simulations of {years} years...")
```

```
# Create a matrix: Rows = Days, Columns = Simulation Run
# We randomly sample daily returns to fill this matrix
random_returns = np.random.choice(daily_returns, size=(total_days, simulations),
replace=True)
```

```
# Convert returns to "Growth of $10,000"
# Formula: $10,000 * (1 + r1) * (1 + r2) ...
cumulative_growth = np.cumprod(1 + random_returns, axis=0) * initial_capital
```

```
# Add the starting row ($10,000 at Day 0)
start_row = np.full((1, simulations), initial_capital)
wealth_paths = np.vstack([start_row, cumulative_growth])
```

```
# 5. Calculate Key Percentiles (The "Cone")
# We calculate the 10th, 50th, and 90th percentile value for EVERY day
p90 = np.percentile(wealth_paths, 90, axis=1) # Best Case (Lucky)
p50 = np.percentile(wealth_paths, 50, axis=1) # Median (Expected)
p10 = np.percentile(wealth_paths, 10, axis=1) # Worst Case (Unlucky)
p05 = np.percentile(wealth_paths, 5, axis=1) # Safety Floor (CVaR zone)
```

```
# 6. Generate the "Executive Summary" Table
final_values = wealth_paths[-1, :] # The ending balances
win_rate = (final_values &gt; initial_capital).mean()
```

```
print("\n--- EXECUTIVE WEALTH SUMMARY (5 YEARS) ---")
print(f"Starting Capital: ${initial_capital:,.0f}")
print(f"Win Rate (Probability of Profit): {win_rate:.1%}")
```

```python
print("-" * 40)
print(f"90th Percentile (Lucky): ${np.percentile(final_values, 90):,.0f} (+{(np.percentile(final_values, 90)/initial_capital)-1:.0%})")
print(f"50th Percentile (Expected): ${np.median(final_values):,.0f} (+{(np.median(final_values)/initial_capital)-1:.0%})")
print(f"10th Percentile (Unlucky): ${np.percentile(final_values, 10):,.0f} (+{(np.percentile(final_values, 10)/initial_capital)-1:.0%})")
print(f"5th Percentile (Worst Case): ${np.percentile(final_values, 5):,.0f} (+{(np.percentile(final_values, 5)/initial_capital)-1:.0%})")
```

```python
# 7. Visual: The "Cone of Uncertainty"
plt.figure(figsize=(12, 6))
days = range(len(p50))
```

```python
# Plot the Cone
plt.fill_between(days, p10, p90, color='skyblue', alpha=0.3, label='80% Likely Outcome (10th-90th)')
plt.fill_between(days, p05, p10, color='red', alpha=0.1, label='Worst Case Risk (5th-10th)')
```

```python
# Plot the Lines
plt.plot(days, p50, color='blue', linewidth=2, label='Median Expected Growth ($18k)')
plt.plot(days, p10, color='red', linestyle='--', linewidth=1, label='Conservative Floor')
```

```python
# Formatting
plt.title(f'Reliability Test: Growth of ${initial_capital:,} Over 5 Years', fontsize=14)
plt.xlabel('Trading Days (5 Years)')
plt.ylabel('Portfolio Balance')
plt.axhline(initial_capital, color='black', linestyle=':', label='Break-Even Line')
plt.legend(loc='upper left')
plt.grid(True, alpha=0.3)
```

```python
# Format Y-axis as Dollars
fmt = '${x:,.0f}'
tick = mtick.StrMethodFormatter(fmt)
plt.gca().yaxis.set_major_formatter(tick)
```

```
plt.show()
```

Output:

```
Running 10000 simulations of 5 years...

--- EXECUTIVE WEALTH SUMMARY (5 YEARS) ---

Starting Capital: $10,000

Win Rate (Probability of Profit): 97.1%

----------------------------------------

90th Percentile (Lucky):      $24,045 (+140%)

50th Percentile (Expected):   $16,844 (+68%)

10th Percentile (Unlucky):    $11,737 (+17%)

5th Percentile (Worst Case):  $10,643 (+6%)

[STDERR]

&lt;string&gt;:1: UserWarning: FigureCanvasAgg is non-interactive, and thus cannot be shown
```