RUTGERS

Quantifying Investment Risk: A Multi-Method VaR Framework for Personalized Portfolios

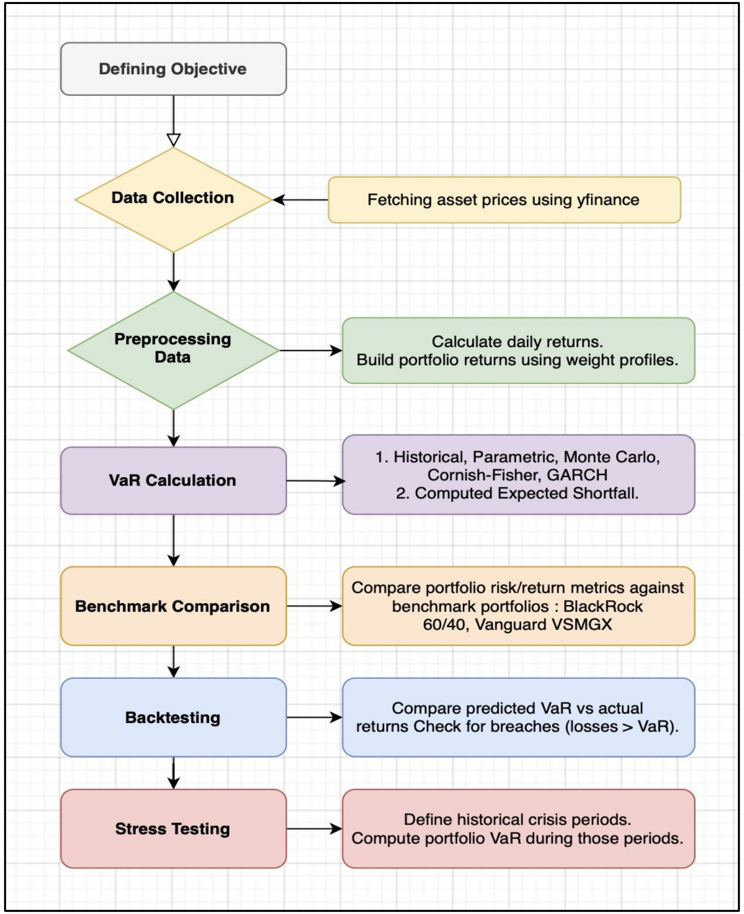
By

Annshu G Prajapati

Workflow & Methodology

```python
# === 2. Portfolio Configuration (Constants) ===
tickers = [
    'SPY',       # SPDR S&P 500 ETF – U.S. Large Cap Equities
    'AGG',       # iShares Core U.S. Aggregate Bond ETF – Broad Bond Exposure
    'QQQ',       # Invesco QQQ ETF – Nasdaq 100 (Tech-heavy Equities)
    'GLD',       # SPDR Gold Shares – Exposure to Gold (Commodities)
    'BTC-USD',   # Bitcoin (USD) – Leading Cryptocurrency
    'ETH-USD',   # Ethereum (USD) – Smart Contracts & Altcoins
    'IVV',       # iShares S&P 500 ETF – U.S. Large Cap Equities (BlackRock Portfolio)
    'IEFA',      # iShares MSCI EAFE ETF – International Equities (BlackRock Portfolio)
    'VTI',       # Vanguard Total Stock Market ETF (Vanguard Portfolio)
    'VXUS',      # Vanguard Total International Stock ETF (Vanguard Portfolio)
    'BND',       # Vanguard Total Bond Market ETF (Vanguard Portfolio)
    'VWOB'       # Vanguard Emerging Market Bond ETF (Vanguard Portfolio)
]

start_date = '2015-01-01'
end_date = '2024-12-31'
confidence_level = 0.95
rolling_window = 60  # Days for rolling VaR calculation
```

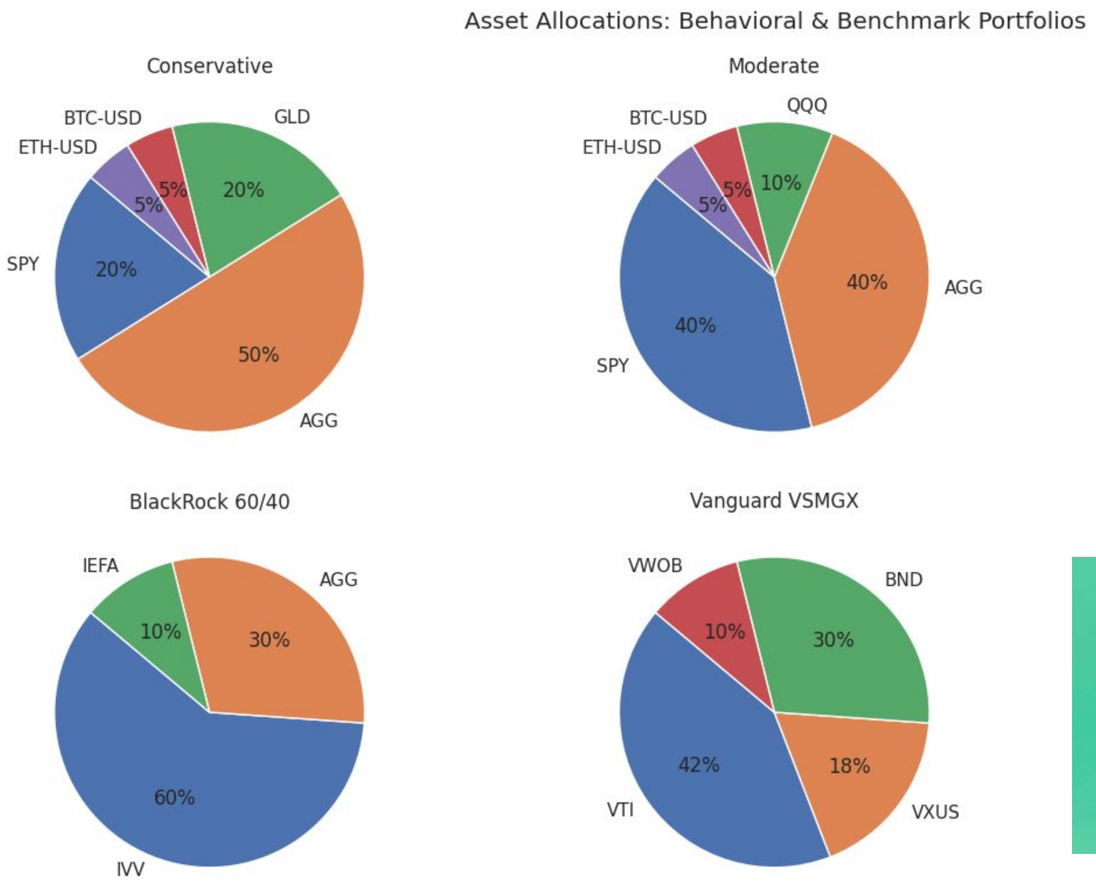
```python
# === 2.1 Behavioral Risk Profiles ===
risk_profiles = {
    "Conservative":   {'SPY': 0.2,  'AGG': 0.5, 'GLD': 0.2,  'BTC-USD': 0.05, 'ETH-USD': 0.05},
    "Moderate":       {'SPY': 0.4,  'AGG': 0.4, 'QQQ': 0.1,  'BTC-USD': 0.05, 'ETH-USD': 0.05},
    "Aggressive":     {'SPY': 0.25, 'QQQ': 0.25,'GLD': 0.1,  'BTC-USD': 0.2,  'ETH-USD': 0.2},
}

benchmark_profiles = {
    "BlackRock 60/40": {'IVV': 0.60, 'AGG': 0.30, 'IEFA': 0.10},
    "Vanguard VSMGX": {'VTI': 0.42, 'VXUS': 0.18, 'BND': 0.30, 'VWOB': 0.10}
}
```



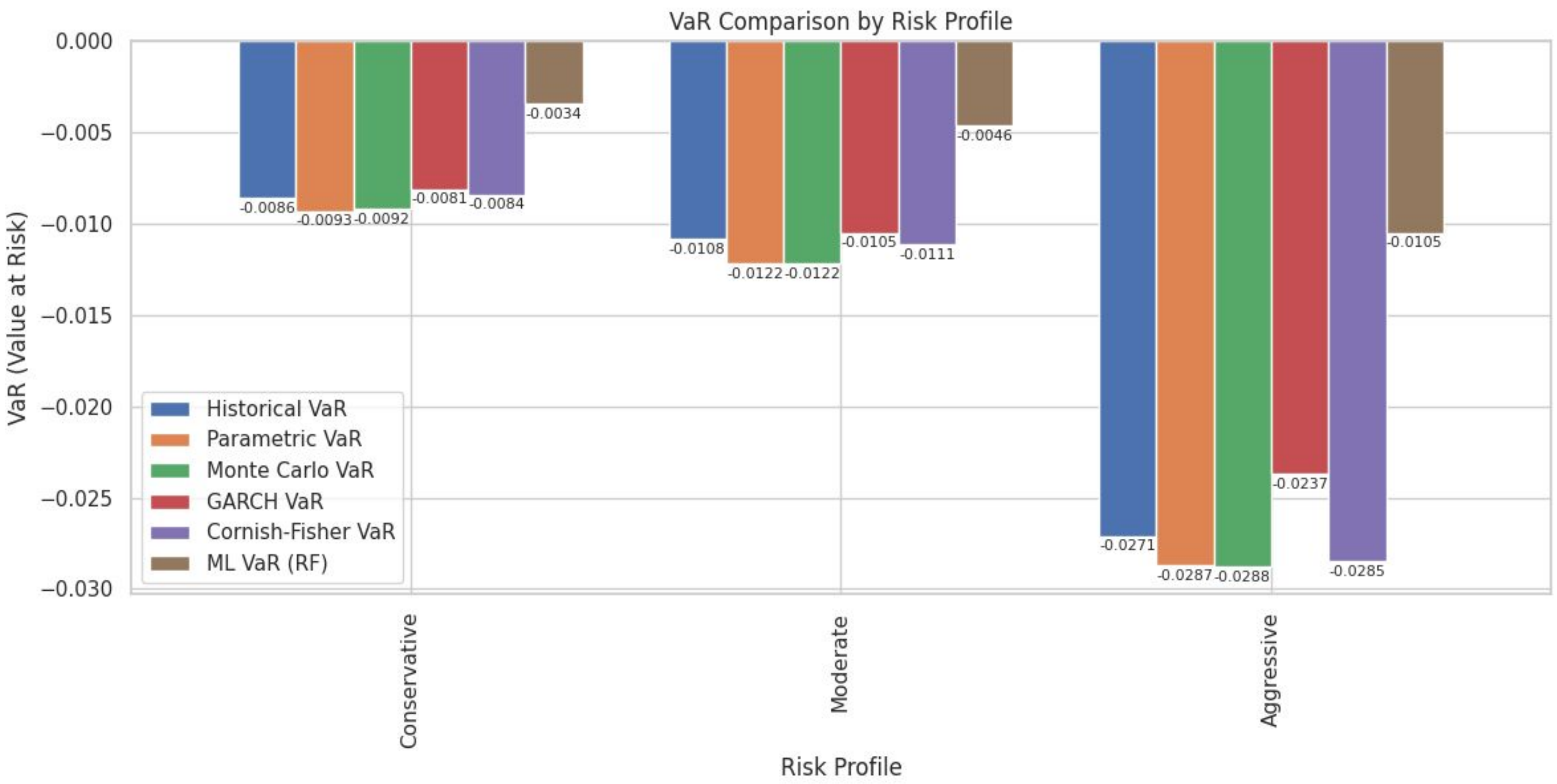
VaR Calculation Methods

VaR Calculation Methods

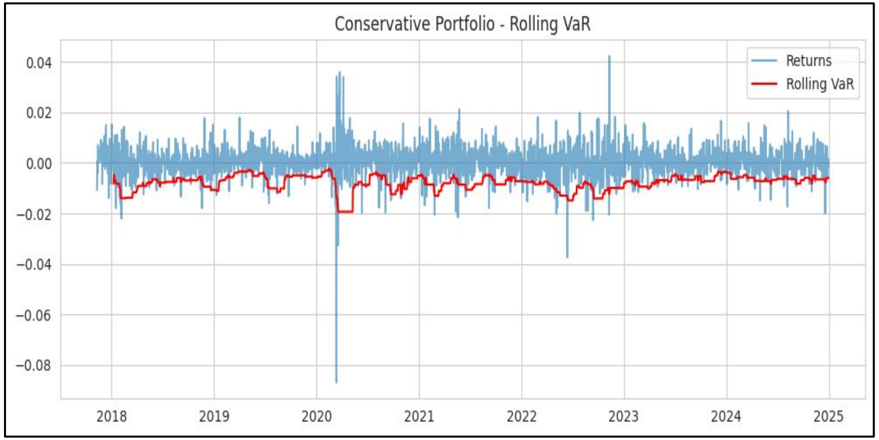
- **Historical VaR**
  - Based on past returns.
- **Parametric VaR**
  - Uses mean and standard deviation
- **Monte Carlo VaR:**
  - Simulates many return scenarios.
- **Cornish-Fisher VaR**
  - Adjusts for skew and kurtosis
- **GARCH VaR**
  - Uses time-varying volatility.
- **Expected Shortfall**
  - Average loss beyond VaR.

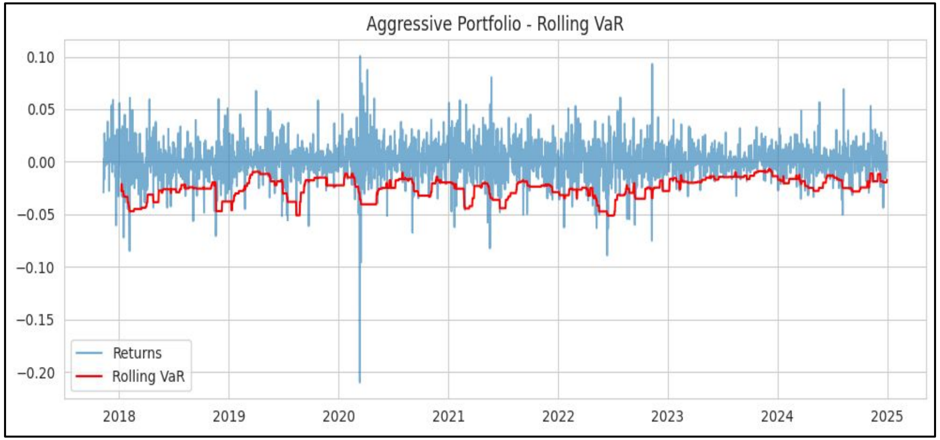

Asset Allocations: Behavioral & Benchmark Portfolios
Conservative
BTC-USD
GLD
ETH-USD
5%
5%
20%
SPY
20%
50%
AGG
Moderate
BTC-USD
QQQ
ETH-USD
5%
5%
10%
40%
AGG
40%
SPY
Aggressive
ETH-USD
20%
BTC-USD
20%
SPY
25%
10%
GLD
25%
QQQ
BlackRock 60/40
IEFA
AGG
10%
30%
60%
IVV
Vanguard VSMGX
VWOB
BND
10%
30%
42%
18%
VTI
VXUS

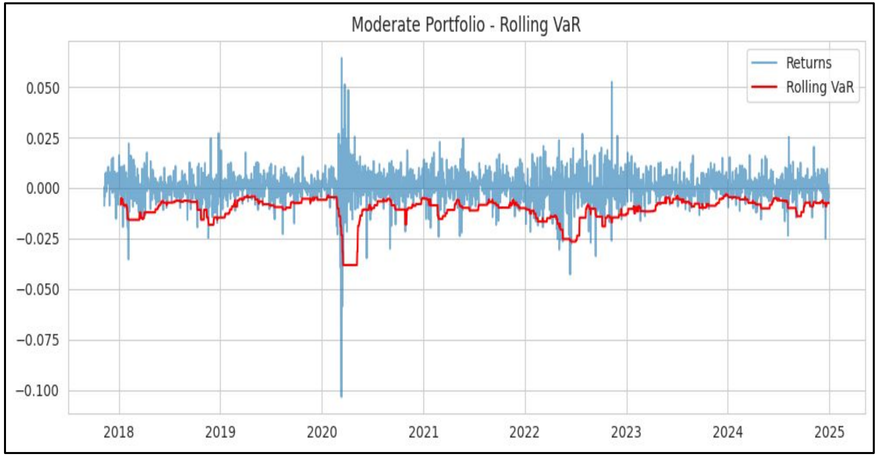

ISK
RETURN

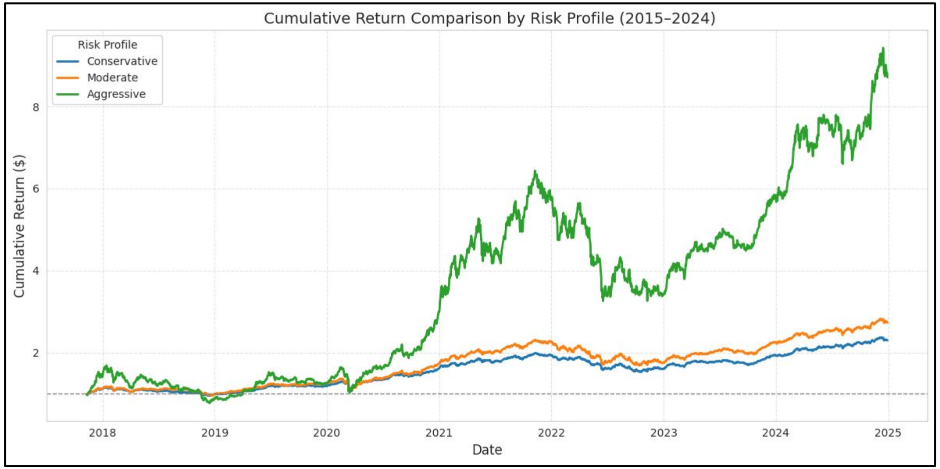

VaR Comparison by Risk Profile
VaR (Value at Risk)
0.000
−0.005
−0.010
−0.015
−0.020
−0.025
−0.030
Historical VaR
Parametric VaR
Monte Carlo VaR
GARCH VaR
Cornish-Fisher VaR
ML VaR (RF)
-0.0086
-0.0093
-0.0092
-0.0081
-0.0084
-0.0034
-0.0108
-0.0122
-0.0122
-0.0105
-0.0111
-0.0046
-0.0271
-0.0287
-0.0288
-0.0237
-0.0285
-0.0105
Conservative
Moderate
Aggressive
Risk Profile

Rolling VaR across the Behavioral Portfolios

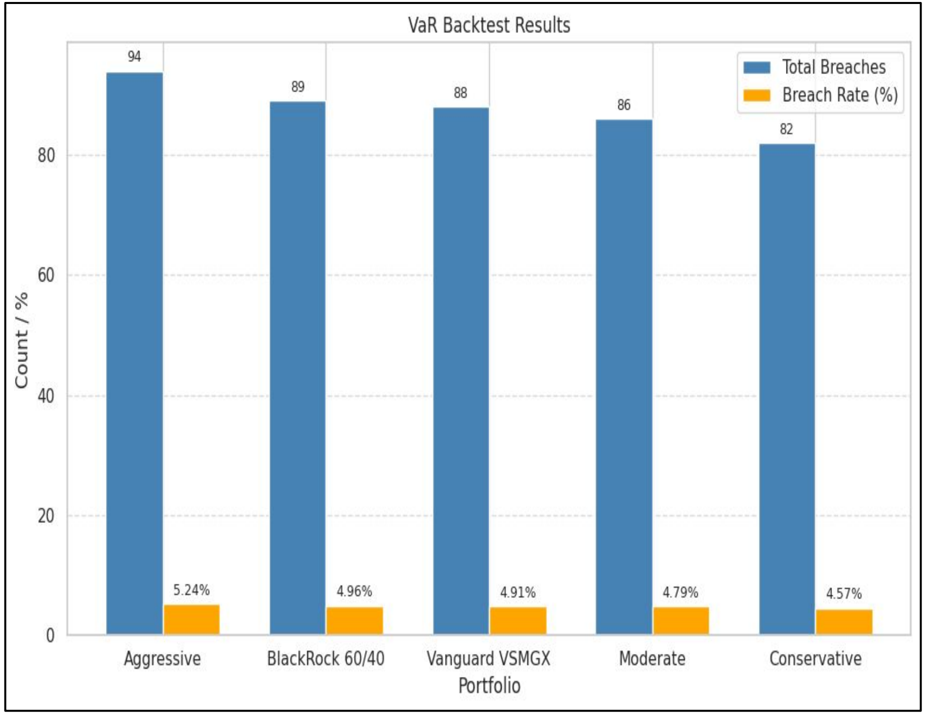


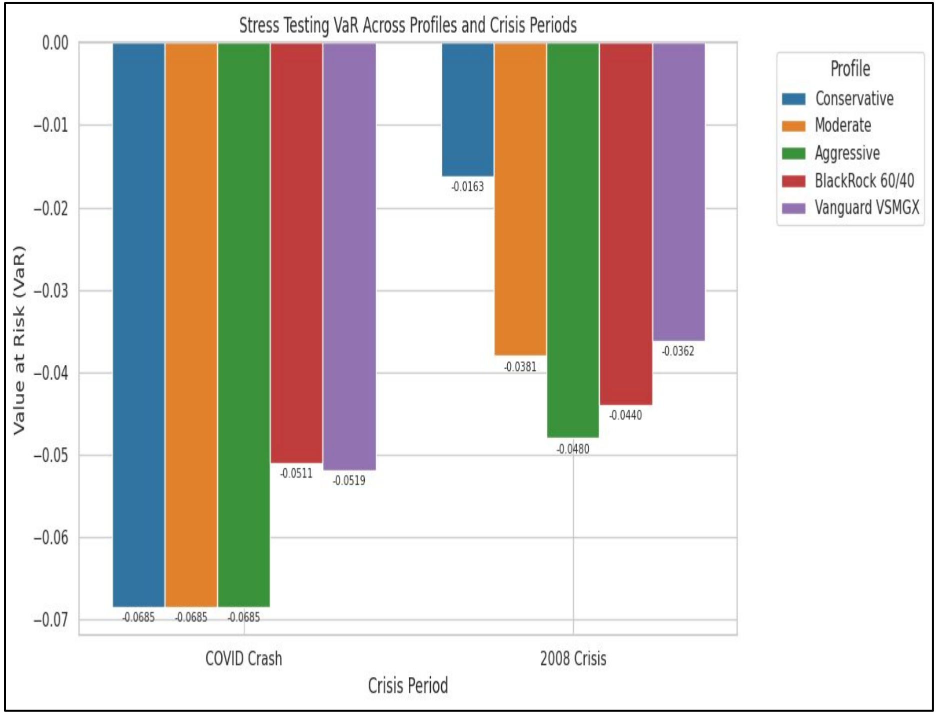






Backtesting & Stress Testing





Portfolio Risk & Performance Summary

- **Aggressive**: Highest return (36.6%) but also highest risk and breach rate.
- **Conservative**: Lowest risk with stable return (12.4%) and lowest breaches.
- **Moderate**: Best balance of return and risk.
- **VaR Methods**: Consistent across models — reliable results.
- **Backtesting**: Breach rates ~5% → models are well-calibrated.
- **Expected Shortfall**: Always higher than VaR — correct tail-risk capture.

Portfolio	Ann Return	Ann Vol	VaR 95%	Param VaR	MC VaR	CF VaR	ES	GARCH VaR	Breaches	Breach Rate
Conservative	0.1236	0.1122	0.0101	0.0111	0.0110	0.0110	0.0159	0.0103	82	0.0457
Moderate	0.1521	0.1469	0.0135	0.0146	0.0147	0.0145	0.0218	0.0132	86	0.0479
Aggressive	0.3657	0.3470	0.0320	0.0345	0.0342	0.0353	0.0511	0.0294	94	0.0524
BlackRock 60/40	0.1006	0.1369	0.0125	0.0138	0.0138	0.0128	0.0207	0.0119	89	0.0496
Vanguard VSMGX	0.0775	0.1244	0.0111	0.0126	0.0126	0.0116	0.0185	0.0105	88	0.0491

Risk vs Return: Behavioral vs Benchmark