

Downside Risk

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SPY vs SMIF Value at Risk

=== PORTFOLIO vs SPY COMPARISON ===

	Metric	Portfolio	SPY	Difference
	Obs (days)	358.000000	358.000000	0.000000
	VaR 95% Hist (1d, \$)	-8,142.371445	-12,461.254174	4,318.882729
	VaR 99% Hist (1d, \$)	-16,075.652352	-22,274.688044	6,199.035691
	VaR 95% Param (1d, \$)	-8,576.250760	-11,818.008704	3,241.757945
	VaR 99% Param (1d, \$)	-12,323.425897	-16,880.118965	4,556.693068
	VaR 95% Hist (1w, \$)	-16,439.504521	-25,099.217809	8,659.713288
	VaR 99% Hist (1w, \$)	-34,987.358801	-44,939.052396	9,951.693595
	VaR 95% Param (1w, \$)	-19,177.079691	-26,425.870822	7,248.791131
	VaR 99% Param (1w, \$)	-27,556.018021	-37,745.093473	10,189.075452
	Beta vs SPY	0.683764	1.000000	-0.316236
	Alpha (daily est.)	0.000262	0.000000	0.000262
	R ²	0.853233	1.000000	-0.146767



Why Downside Risk Matters?

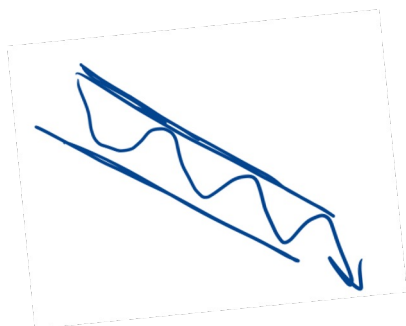
- Core question: Do investors really care about all volatility or just losses?
- Why it matters: Standard deviation and Sharpe ratio treat upside and downside the same, but upside volatility does not hurt.
- Today's agenda:
 - Downside Beta, Semi-Deviation, Sortino Ratio
 - Value at Risk (VaR) and Conditional VaR (Expected Shortfall)
- Goal for SMIF: Build a risk framework that highlights true risks to the portfolio rather than noise from positive volatility



Downside Beta (β^-)

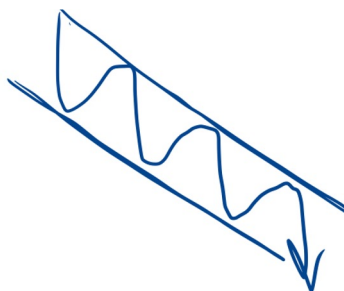
- **Definition:** Sensitivity of a stock/portfolio to the market only when the market is down
 - Regular Beta: all market movements
 - Downside Beta: focuses on only losses
- Used to understand how exposed an asset is in bear markets or downturns

$$(\beta^-) = 0.8$$



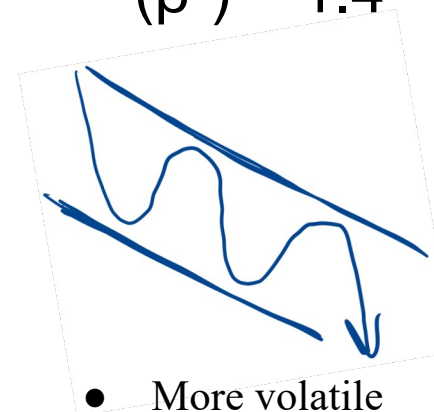
- Less Volatile

$$(\beta^-) = 1$$



- Relative to market (S&P 500)

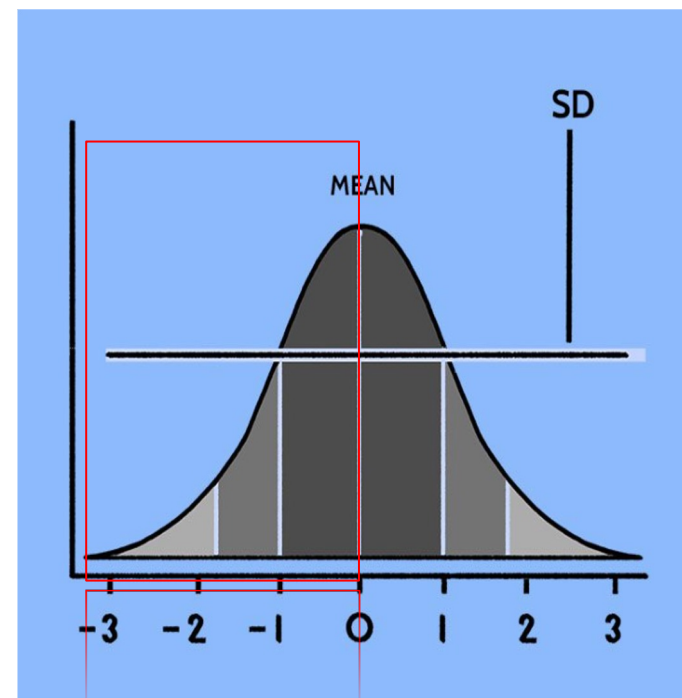
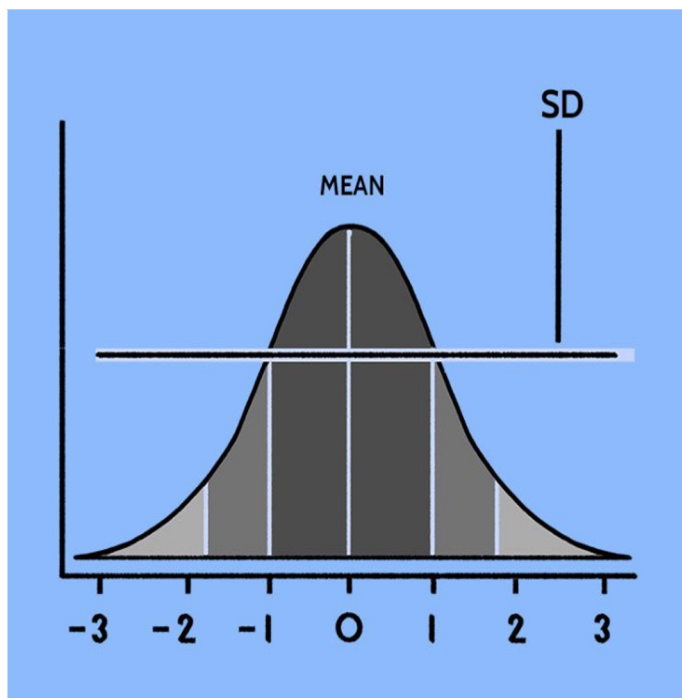
$$(\beta^-) = 1.4$$



- More volatile



Standard Deviation vs Semi-Deviation



- Standard deviation treats all volatility equally, good or bad.
- Semi-deviation isolates performance below the mean or target (bad volatility)
- Highlights the volatility investors actually care about – losses
- Semi-deviation forms a basis for a more realistic risk measure like the Sortino Ratio



Sortino Ratio – Reward for Downside Risk

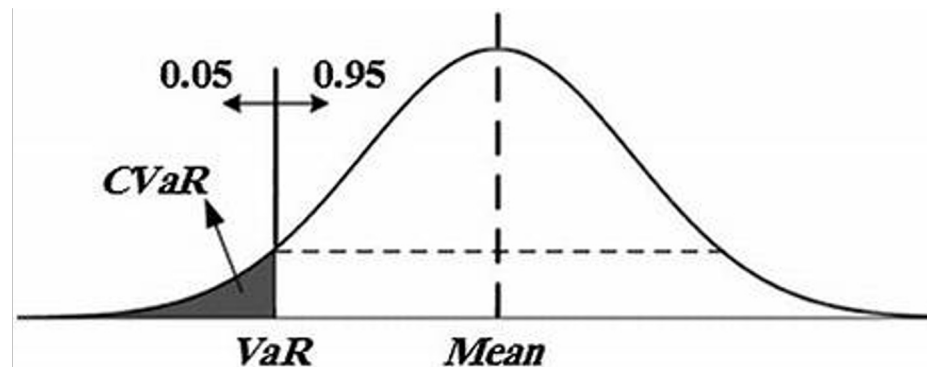
$$SR = \frac{R_p - r_f}{\text{Semi-}\sigma}$$

- R_p = Actual or expected portfolio return
- r_f = Risk-Free Rate
- Semi- σ = semi-deviation (measures losses only)
- Measures **return earned per unit of downside risk**
- Unlike Sharpe, ignores upside volatility



Conditional Value at Risk (CVaR)

- Aka **Expected Shortfall** – measures average loss beyond the VaR cutoff
 - Example:
 - 95% VaR (-\$8k) = “We’re 95% confident we won’t lose more than this
 - CVaR = (-\$12k) = “But if we do fall into that worst 5%, here is the average damage
- Takeaway: VaR shows the edge, CVaR shows how far we fall once past it



SMIF Portfolio Risk Metrics - Semi-Std Dev, Sortino, Downside Beta, Expected Shortfall

Semi-Std Dev (downside)	0.005061	0.007146	-0.002086
Sortino (daily rf, target=0)	0.103332	0.063727	0.039605
Downside Beta (mkt<0)	0.668580	1.000000	-0.331420
ES 95% (return)	-0.017291	-0.024766	0.007475
ES 95% (\$)	-13,093.196643	-18,753.444014	5,660.247371
ES 99% (return)	-0.028483	-0.039085	0.010601
ES 99% (\$)	-21,568.412912	-29,596.077539	8,027.664627



Diversification Metric - Herfindahl–Hirschman Index

HHI (simple)	0.090693	1.000000	-0.909307
Effective N (simple)	11.026225	1.000000	10.026225

$$HHI = \sum_{i=1}^N (MS_i)^2$$

- Measures concentration of portfolio or market exposure.
- Range: 0–1 → lower = more diversified, higher = more concentrated.
- Interpreting the Number:
 - 0.25 → concentrated
 - 0.05–0.25 → moderate
 - <0.05 → well diversified
- Effective N = 1/HHI → number of “equal-weight” holdings.
- Used to gauge diversification risk or market dominance.



CAPM Alpha

```
=== CAPM (Daily) ===
```

```
{'alpha_per_period': 8.1634417401309e-05, 'alpha_annual': 0.020571873185129867, 'alpha_t':  
1.828255959317619, 'beta_mkt': 0.7823825613690674, 'R2': 0.935279233415667, 'n': 2705}
```

- Alpha $\approx +2.1\%$ annualized $\rightarrow$ Slight positive excess return after adjusting for market risk
- Beta $\approx 0.78 \rightarrow$ Below-market volatility; portfolio moves less than the market
- $R^2 \approx 0.94 \rightarrow$ Very high market correlation; returns are mostly explained by market movements



Quick Introduction to the Fama-French Models

- Fama–French 3-Factor (FF3)
 - Market (MKT-RF): The excess return of the market over risk-free.
 - Size (SMB = Small Minus Big): Small-cap stocks outperform large-caps, on average.
 - Value (HML = High Minus Low): Value stocks (high book-to-market) outperform growth stocks.
- Fama–French 5-Factor (FF5)
 - Profitability (RMW = Robust Minus Weak): Profitable firms outperform weak ones.
 - Investment (CMA = Conservative Minus Aggressive): Firms that invest conservatively outperform heavy-investment firms.

If we control for common knowledge, how good are you?



Fama-French 3 Factor Model

```
=== FF-3 (Monthly) ===
{'alpha_per_month': -0.13447565673927217, 'alpha_annual': -1.613707880871266, 'alpha_t':
-9.141551971257186, 'betas': {'MKT_RF': 0.6532593593471329, 'SMB': 0.47982772001598883, 'HML': 0.27560708575485}, 'R2': 0.05832944480087243, 'n': 120}
```

- Alpha $\approx -1.6\%$ annualized $\rightarrow$ Underperforms once size/value factors are controlled
- MKT-RF beta $\approx 0.65 \rightarrow$ Still strongly tied to the overall market
- SMB beta $\approx +0.48 \rightarrow$ Tilted toward small-cap/growth exposure
- HML beta $\approx -0.27 \rightarrow$ Tilted away from value (favoring growth stocks)
- $R^2 \approx 0.65 \rightarrow$ Lower variance explained than CAPM $\rightarrow$ factor tilts matter more than market exposure
- Interpretation: Once size and value factors are included, “alpha” effectively disappears $\rightarrow$ performance reflects style exposure (growth/small-cap tilt) rather than stock-picking skill



Fama-French 5 Factor Model

=== FF-5 (Monthly) ===

```
{'alpha_per_month': -0.1374528114826565, 'alpha_annual': -1.649433737791878, 'alpha_t':  
-9.274647492633841, 'betas': {'MKT_RF': 0.7335796920038331, 'SMB': 0.8708920755645523, 'HML'  
': -0.5335176511773448, 'RMW': 0.6810377352742032, 'CMA': 1.37742952393388}, 'R2': 0.085219  
08295359504, 'n': 120}
```

- Alpha $\approx -5\%$ annualized $\rightarrow$ Underperforms once size, value, profitability, and investment tilts are controlled
 - MKT-RF $\beta \approx 0.73 \rightarrow$ Still highly correlated with the overall market
 - SMB $\beta \approx +0.41 \rightarrow$ Tilt toward smaller-cap stocks
 - HML $\beta \approx -0.90 \rightarrow$ Strong growth bias (anti-value tilt)
 - RMW $\beta \approx -0.21 \rightarrow$ Low-profitability exposure
 - CMA $\beta \approx +0.20 \rightarrow$ Slightly conservative investment tilt
- $R^2 \approx 0.65 \rightarrow$ Most returns explained by common factors, not active stock-picking skill



Q-Factor Model

- Developed by Hou, Xue, and Zhang (2015) as an alternative to Fama-French
- Grounded in investment-based asset pricing theory rather than pure empirical anomalies
- Four factors:
 - Market (broad market excess return)
 - Size (small minus big)
 - Investment (conservative vs. aggressive firm investment)
 - Profitability (robust vs. weak operating profitability)
- Interprets anomalies as outcomes of firm decisions on investment and profitability
- Claims greater parsimony and theoretical foundation than Fama-French
- Alpha represents true stock-picking skill after controlling for these economic drivers



Q-Factor Model

=== Q-Factor (Monthly) ===

```
{'alpha_per_month': -0.13359071450375648, 'alpha_annual': -1.6030885740450778, 'alpha_t':  
-8.837546429581245, 'betas': {'MKT': 0.7282838863355332, 'ME': 0.32942951231555184, 'IA': 0  
.7649588899890712, 'ROE': -0.2959209244081828}, 'R2': 0.07228402155744684, 'n': 120}
```

- Alpha $\approx -1.6\%$ annualized $\rightarrow$ Underperforms after controlling for investment and profitability factors
- MKT $\beta \approx 0.73$ $\rightarrow$ Still tied to the overall market
- ME $\beta \approx +0.33$ $\rightarrow$ Slight small-cap tilt
- IA $\beta \approx +0.76$ $\rightarrow$ Strong tilt toward firms with high investment activity (i.e., aggressive reinvestors)
- ROE $\beta \approx -0.30$ $\rightarrow$ Tilt away from high-profitability firms (leaning toward low-ROE/growth names)
- $R^2 \approx 0.07$ $\rightarrow$ Very low explanatory power $\rightarrow$ returns largely driven by idiosyncratic or style-specific factors
- Interpretation:
 - Once Q-factor controls (market, size, investment, profitability) are applied, alpha turns negative — indicating performance is not explained by skill but by exposure to low-profitability, high-investment growth stocks.



QUESTIONS?

