Buy Side Risk Management

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Outline

Part 1

Buy side/sell side - objectives

- Buy side/sell side definitions
- Sell side Sharpe ratios
- Risk definitions
- Risk management implications
- Basis risks

Definitions

Sell side: firms (or sections of large diversified firms) that effect financial transactions ordered by clients. These firms put firm capital at risk to (1) facilitate the completion of transactions; and/or (2) make a direct profit.

Buy side: firms hired by clients to exercise discretion as to how to put the client's capital at risk in order to attain a financial goal or reward for the client. Includes pension funds and endowments.

Sell side statistics

Sales&Trading Revenue (2005) vs. Trading VaR (99% 1-day)		
Company	Sales&Trading Revenue	Trading VaR
Goldman Sachs	15,927	113
JP Morgan	9,041	93
Citigroup	12,673	90
UBS	12,009	85
Deutsche Bank	13,251	84
Morgan Stanley	11,586	81
Merrill Lynch	10,705	70
Credit Suisse	8,195	53
Lehman	9,807	48
Source: Company filings, Morgan Stanley compilation. Figures in $MM.		

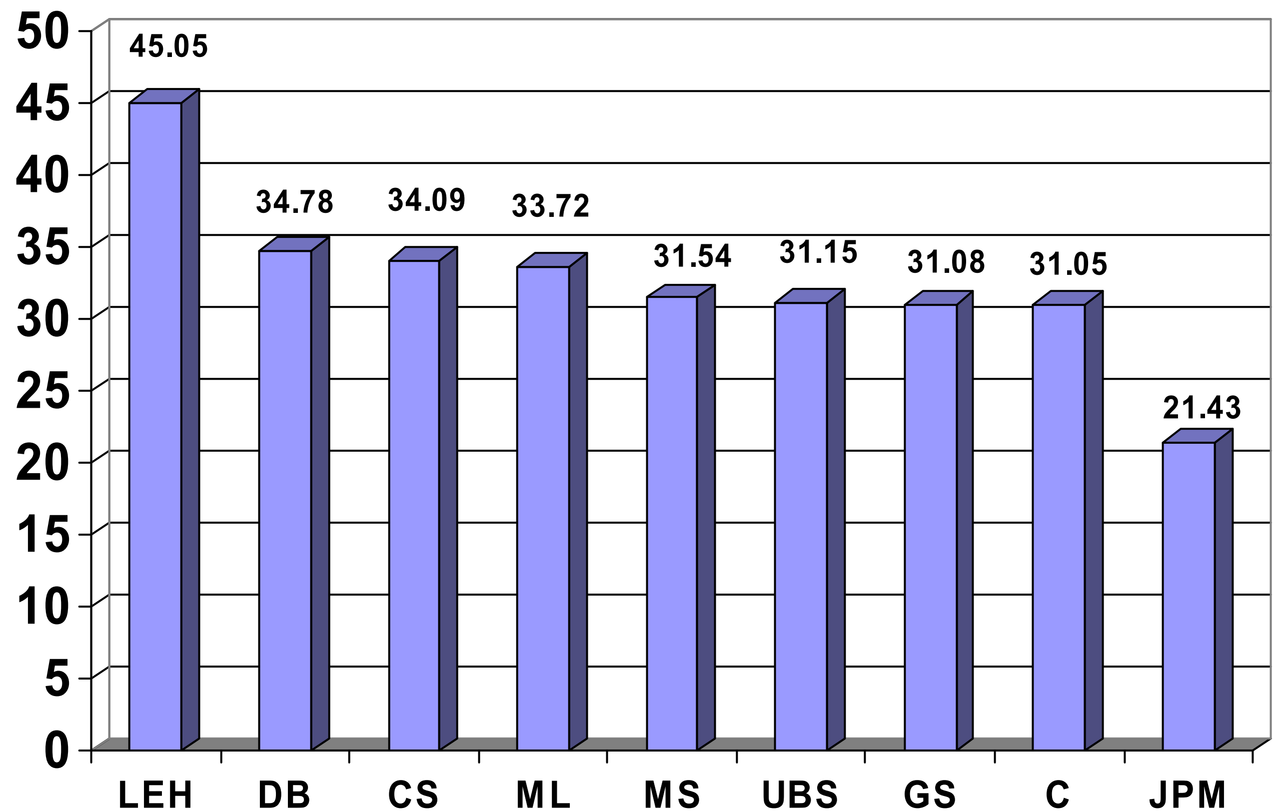
Sell Side Sharpe Ratios

•Inverse cumulative normal $N^{-1}(.99)=2.33$. Thus in a normal distribution 99% 1-day VaR is 2.33σ.

•But daily tails are fat – rough rule of thumb is to bump this up to 3.5 (see e.g. [Litterman 1996]).

•VaR/3.5 is a daily σ, so we multiply by $\sqrt{252}$ to annualize – this gives σ~4.54VaR

•Put annual sales in numerator



Risk definition

Risk is imperfect knowledge about the outcomes of an action.

•Managing what we know is straightforward (or impossible): a vampire knows the sun will come up and he will die if exposed to it. There is no risk of death if the vampire is exposed to the sun – there is the certainty of death.

•Risk management consists of characterizing and dealing with the imperfection in our knowledge of the future.

Knightian Risk vs. Uncertainty

Knight (1921):

•**<u>Risk</u>** involves a set of known outcomes with known probabilities.

•**<u>Uncertainty</u>** involves more imperfect knowledge of the future where all the outcomes and probabilities may not be specified; in fact none may be known.

•(Note our definition of risk covers both.)

Keynes (1937):

•By `uncertain' knowledge, let me explain, I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty...The sense in which I am using the term is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence...About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know.

Why are sell side Sharpe ratios so high?

- Sell side says*:
  - We are skilled risk takers who expose firm capital to variable outcomes in order to keep the capital markets functioning.
  - Functioning capital markets are the foundations of modern civilization.
  - The money we collect is fair compensation (a pittance, really) due to the fact that we are the ones keeping modern civilization running.

- Another possibility:
  - The numerator is dominated by franchise rents that are not directly rewards for risk-taking activity

*I don't know anyone who actually has said this. These statements are completely fabricated.

Risk management implications

The buy side's business model is to profit from successfully taking risk, while the sell side's business model is to profit from avoiding risk.*

•***Buy side risk management*** analyzes outcomes and probabilities and takes actions to

- •Profit from anticipated outcomes; and
- •Limit the cost of unanticipated outcomes.

•***Sell side risk management*** analyzes outcomes and probabilities and takes actions to

- •Avoid uncertain outcomes; and
- •Lock in a certain or near-certain spread.

*A deliberate oversimplification that allows us to delineate two extremes of a spectrum

Basis risks

No arbitrage	Convergence	Model parity	Correlation
(conversion)	(on/off run)	(delta hedging)	

Basis risks in hedging activities

Basis risks, continued

Long	Short	Basis risk
Single equity security	long call plus short put	5bps
10 year on-the-run	10 year off-the-run	5-7bps
MSCI World index fund	MSCI World index	20bps
Vanguard S&P 500 Index Fund (VFINX)	S&P 500 Index	72bps
MS SICAV Emerging Markets Debt Fund	JP Morgan EMBI Global Index	90bps
SPDRs S&P 500 ETFs	S&P 500 Index	130bps
Actively managed US credit portfolio (569bps absolute std dev)	US Treasury futures	213bps
Diversified group of US equity seed capital investments (1249bps abs std dev)	S&P 500, Midcap, Russell 2000, and NASDAQ futures	277bps
Van Kampen Comstock Fund (US equity)	Russell 1000 Value	359bps
Vanguard Small-Cap VIPERS	MSCI US 1750 Small-Cap Index	482bps
MS Japan Small Cap Fund	MSCI Japan Small Cap Index	1058bps

Basis risks are in annualized tracking error terms, except OTR Treasurys which give the quarter 1 annualized yield spread. This table is provided for illustrative purposes only and should not be deemed a recommendation.

Part 2

Some current methods – practical considerations

- Separation of duties
- Theory/practice: predicting market risk
- Theory/practice: risk budgeting
- Value at Risk
- Scenario analysis
- Prediction breakdowns and control mechanisms

Separation of duties

A turf-grabbing view from a risk manager's perspective

Portfolio managers →	•Direction and magnitude of asset price movements
Risk managers →	•Overall market volatility •Relative volatility (portfolio or security to benchmark or market) •Correlations •Responses to changes in environment (e.g. durations, Greeks) •Higher moments (skew, kurtosis) •Shapes of distributions of returns

Separation of duties - rationale

Theory	Practice
Risk factors are return factors	Over finite time periods, estimating risk and estimating return can involve very different considerations
Portfolios are constructed by an optimization process in which an objective function involving risk and return is maximized	A range of portfolio construction techniques exists ranging from none (stock picking) to completely integrated quantitative strategies
Quantitative portfolio managers estimate risk and return	Quantitative portfolio managers may spend most of their time estimating return

Risk transparency: In the current regulatory environment, asset managers are expected to communicate clearly and ex ante what risks a portfolio is taking. A risk management group independent of the portfolio management group can fulfill this function to the satisfaction of clients, regulators, mutual fund/SICAV boards, and others with fiduciary responsibility.

Theory: standard equity models

Rosenberg and Marathe, 1976

$C=L'FL+D$

- C=nxn equity covariance matrix
- L=kxn factor loading matrix ($k \ll n$)
- F=kxk factor covariance matrix
- D=nxn diagonal specific risk matrix

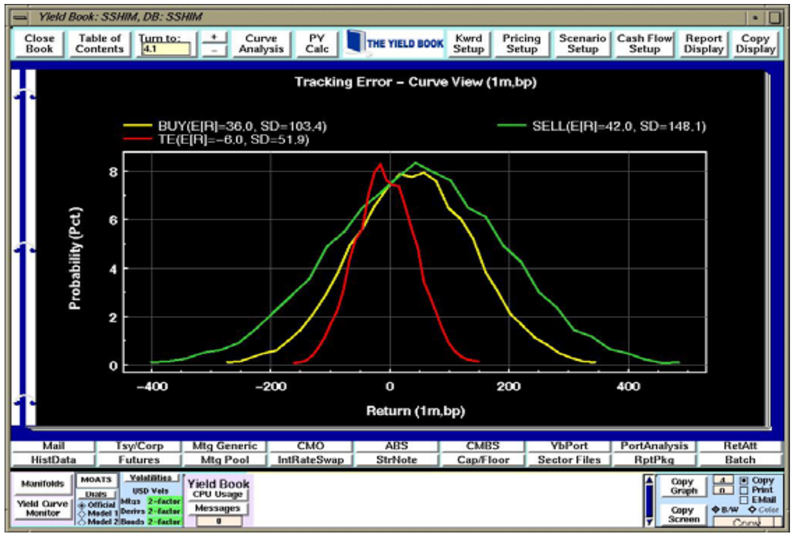
Principal components (eigen decomposition)

$C=EVE'$, where $E'E=EE'=I$ and V is diagonal with descending non-negative entries;

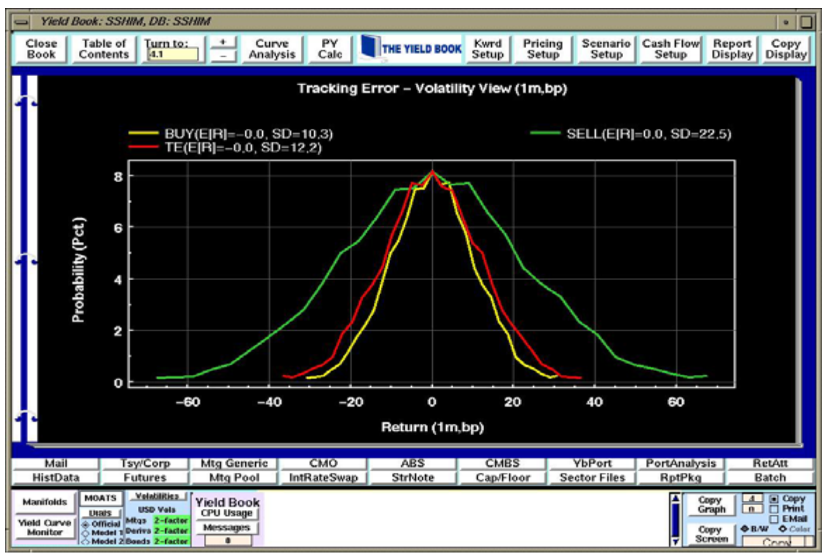
Find $k \ll n$ and estimate $\tilde{C}=E_k V_k E_k'$ where E_k is the first k columns of E and V_k is the upper left kxk diagonal of V

Theory: fixed income model

- Citigroup Yield Book
  - 10,000 Monte Carlo simulations of shocks to 800 variables (reduced to 300 principal components)
  - Assess P&L of each simulation with scenario analysis – 3 PC for curve, volatility term structure model, etc.
  - Develop distribution of returns and extract statistics



Distributions of returns due to curve shocks

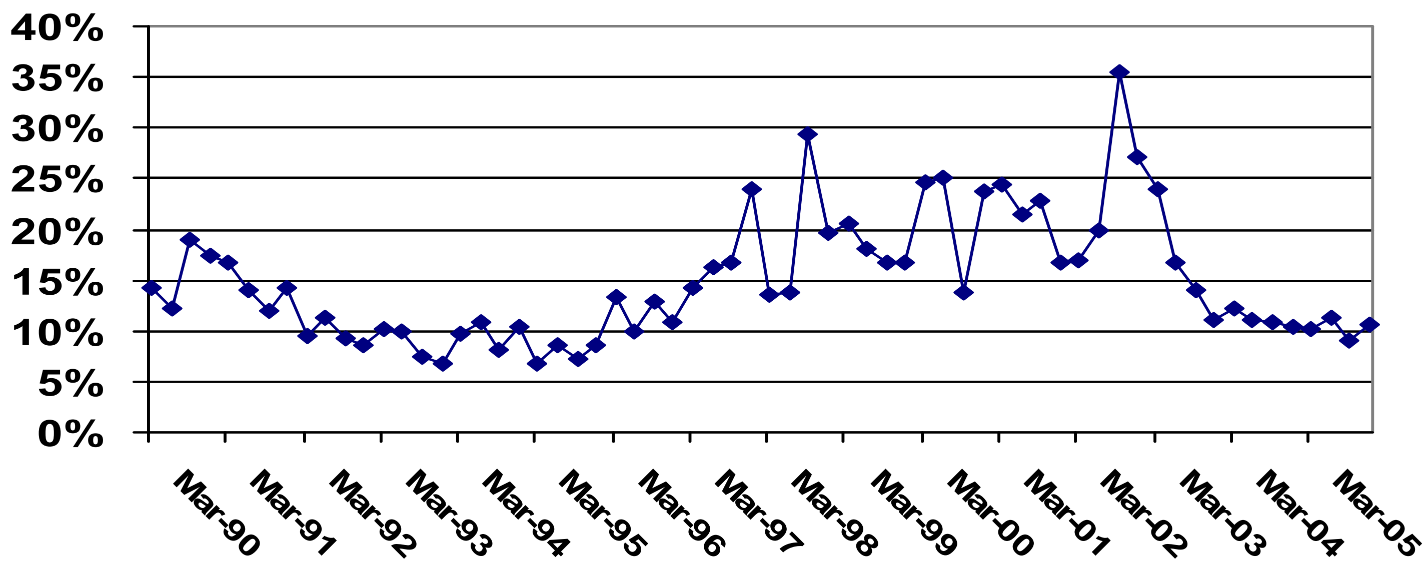


Distributions of returns due to volatility shocks

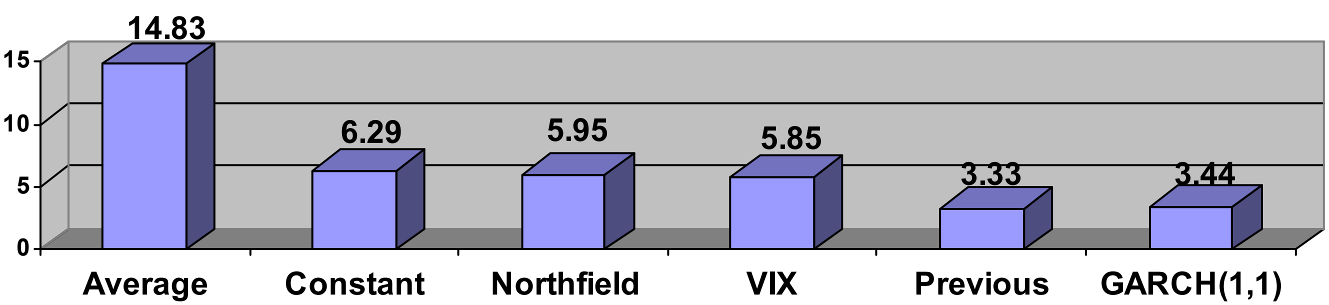
Source: Citigroup Yield Book

Practice: Rosenberg-Marathe-type model

S&P 500 volatilities from quarters of daily data



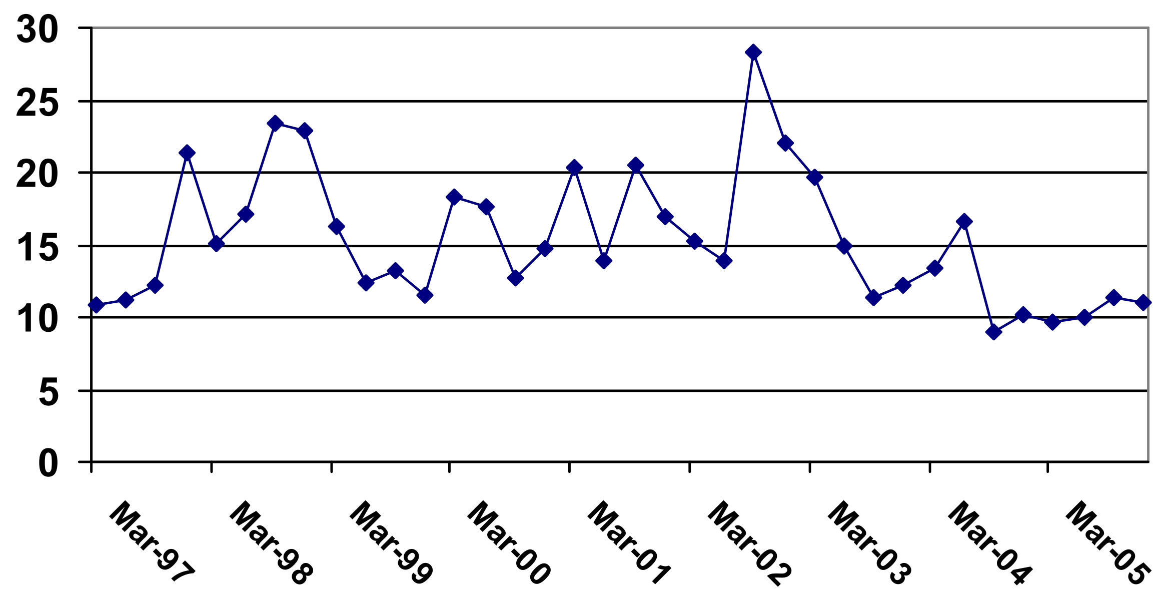
S&P 500 standard deviations and predictions



Average followed by mean absolute deviations

Practice – Principal components model

MSCI EAFE volatilities from quarters of daily data



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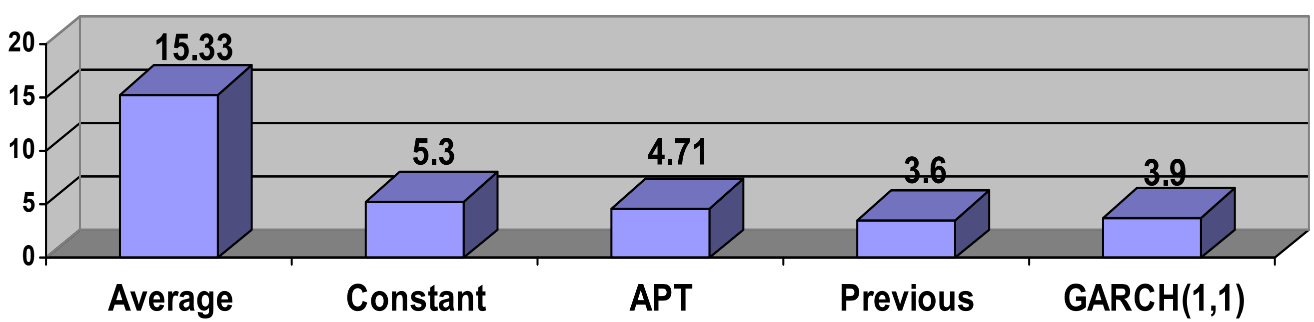
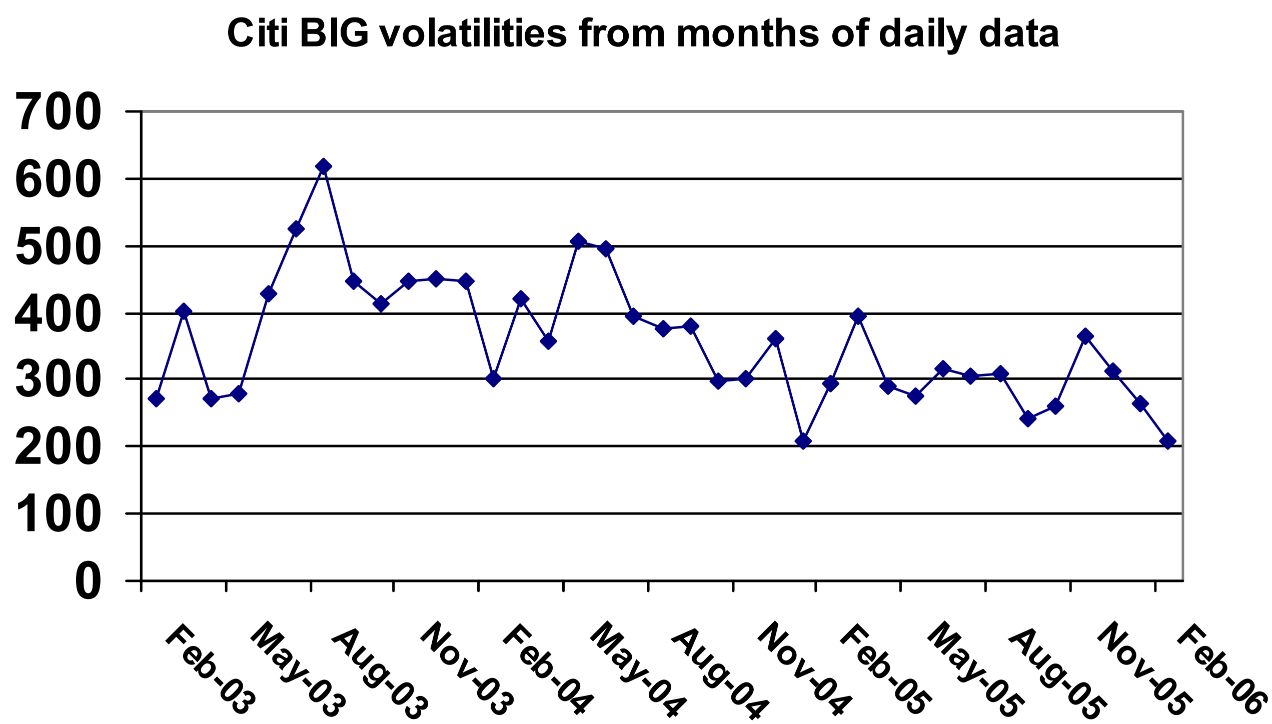
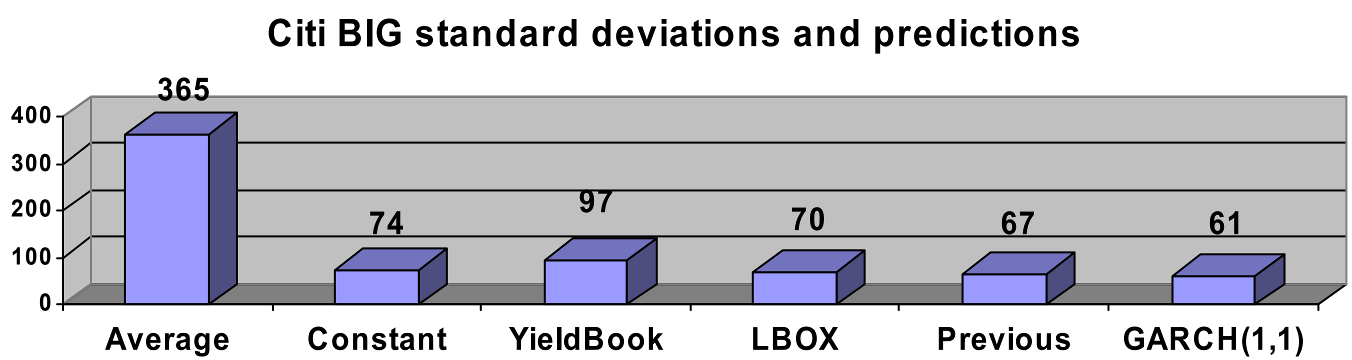


Average followed by mean absolute deviations

Practice – Fixed income model



Average followed by mean absolute deviations



Absolute and relative risk

- Beyond the obvious, absolute levels of market risk are hard to predict
- Dividing predictions into an absolute level and a relative-to-market multiplier can be helpful

$$Variance\ (Portfolio) = Variance\ (Market)\ \frac{Variance\ (Portfolio)}{Variance\ (Market)}$$

$$Variance\ (Portfolio - Benchmark) =$$

$$Variance\ (Benchmark)\left(\frac{Variance\ (Portfolio)}{Variance\ (Market)} + (1-2\beta)\right)$$

Risk decomposition

If a statistic (e.g. variance, standard deviation, VaR) is k-homogeneous, we can write

$$f(x) = \sum_i \left(\frac{1}{k} \frac{\partial f(x)}{\partial x_i} \right) x_i = g' x$$

where g is the gradient. For example, combining this with the previous absolute/relative breakdown, we can write tracking variance as

$$TrkVariance(x) = Variance(Benchmark)\left(1 + (h - 2\beta)' x\right)$$

where h is the gradient divided by benchmark variance. The dot product of (h-2β) with x provides a component-by-component breakdown of relative risk.

Optimization: theory

We try to maximize an objective function

$$\alpha - \lambda\sigma^2 / 2$$

where α is expected return, λ is risk tolerance, and σ is standard deviation – or these terms can be benchmark-relative. Response of this objective function to changes in i^{th} parameter is

$$\frac{\partial(\alpha - \lambda\sigma^2 / 2)}{\partial x_i} = \alpha_i - \lambda\sigma g_i$$

Optimization: practice

•A spectrum of knowledge about α is found:

•Trinary (I like/don't like/don't know that)

•Range (I don't like it that much)

•α_i =3.273025±.002315

•λ is usually not known and not easily estimated.

•Can use a decision tree in trinary case

•If $\alpha_i>0$ and $g_i<0$, portfolio moves to efficiency on the margin if we increase exposure to i. Start with biggest outliers and move toward the middle.

•If $\alpha_i<0$ and $g_i>0$, portfolio moves to efficiency on the margin if we decrease exposure to i.

•If $\alpha_i \sim 0$ and contribution to risk $x_i g_i$ is large, consider neutralizing the tilt.

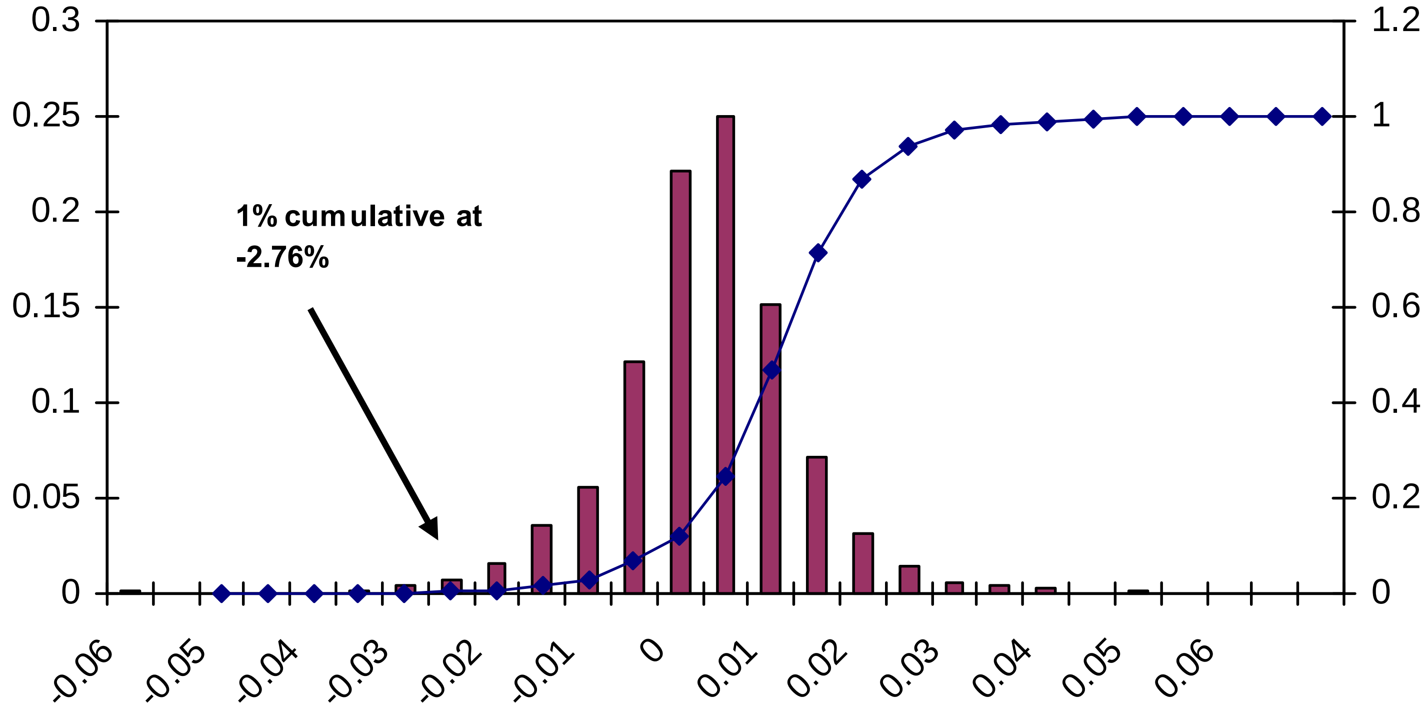
•As we gain more information about parameters, we can move toward more sophisticated optimization techniques, up to and including robust optimization. Thus at each level we can apply quantitative techniques to the extent they are applicable.

Risk decomposition table

Factor Name	Active Factor Senstv's	Factor Volatility	Contrib to TE	Marginal Contrib to TE
MSIM World Momentum	0.007	13.563	0.019	2.920
MSIM World Size	0.079	8.783	0.184	2.326
MSIM World Value (PE)	0.023	8.249	0.005	0.223
MSCI IG Household & Personal Products	0.016	10.327	-0.046	-2.874
MSIM World Value (PCF)	-0.014	8.453	0.048	-3.358
MSCI IG Food, Beverage & Tobacco	0.005	10.658	-0.021	-3.791
MSCI IG Pharmaceuticals & Biotechnology	0.010	13.429	-0.048	-4.839
MSCI IG Health Care Equipment & Services	-0.007	12.617	0.037	-5.567
MSCI IG Utilities	0.025	13.066	-0.159	-6.428
MSCI IG Energy	-0.022	17.370	0.157	-7.150

Return of the sell side: Value at Risk

- Histogram of S&P 500 daily returns, 1993-2005 in red bars (left scale); cumulative frequency shown in blue line (right scale).
- 99% 1-day VaR is shown (2.76%). Daily standard deviation is σ=1.047%. Multiplying by inverse normal $N^{-1}(.01)=-2.33$ gives -2.44%, but "fat tails" means the multiple is actually -2.64.



$$If\ \Pr(X(t) \geq v) = p,\ \ then\ VaR(p,t) = v.$$

Morgan Stanley

Is VaR right for the buy side?

- The VaR conundrum:
- If distribution is normal, then VaR is just a multiple of standard deviation
- If distribution is not normal, we need to understand the shape of the whole distribution. Why restrict attention to a single point?

- Depends on the client's objectives
  - Outcome-oriented portfolios may use VaR or a complete description of outcome distribution
  - Endowments and pensions may use surplus-at-risk
  - Hedge funds use VaR because many people at hedge funds come from the sell side and don't know any better. For long/short portfolios the distribution of outcomes is very different from long-only (see Part 3).
- If objective is long-term wealth maximization, focus on VaR can lead to excessive risk aversion. Buy side profits from taking risk and thus needs to assess the full distribution. VaR can be minimized by buying a put – doesn't help us meet our clients' objectives.
- In practice, despite Bernstein the policy portfolio is alive and well and many clients specify tracking error.

Excess Kurtosis

S&P 500

Start Date	End Date	Daily	Weekly	Month	Quarter	Year
12/31/1949	12/31/1959	7.58	0.79	-0.51	-0.49	-0.50
12/31/1959	12/31/1969	10.36	1.64	0.25	3.67	-1.72
12/31/1969	12/31/1979	2.57	0.76	0.97	2.08	0.06
12/31/1979	12/31/1989	81.87	6.39	6.03	2.63	0.08
12/31/1989	12/31/1999	5.52	1.73	2.40	1.42	-1.22
12/31/1999	2/16/2006	2.49	1.93	0.08	-0.02	-0.61
12/31/1949	2/16/2006	36.83	3.38	2.46	2.17	-0.14

Start Date	End Date	Daily	Weekly	Month	Quarter	Year
12/31/1949	12/31/1959	13.60	4.25	1.05	-0.02	0.95
12/31/1959	12/31/1969	2.90	2.05	0.68	-0.52	-1.53
12/31/1969	12/31/1979	13.71	4.88	1.21	-0.32	3.78
12/31/1979	12/31/1989	48.61	3.88	2.02	1.56	0.69
12/31/1989	12/31/1999	5.12	2.43	0.69	-0.06	2.93
12/31/1999	2/16/2006	2.04	0.57	-0.67	0.00	-1.52
12/31/1949	2/16/2006	11.28	3.13	1.20	0.39	1.86

TOPIX

Why use Value at Risk

1. Based on market values – use of trading book captures real time risk (0)
2. Defining risk as volatility-related (1952)
3. Ability to express risk in common, simple terms (1952-1970's)
4. Ability to aggregate different asset classes (1952)
5. Forward-looking estimates (1970's)
6. Estimation techniques
7. Focus on tail behavior – attention to extreme value theory
8. Valuation methodologies

Scenario Analysis

- Designed to help avoid model risk
- Actually still involves modeling, but removes task of assigning a probability to a particular outcome
- Only seeks to assess what will happen in a particular outcome or set of outcomes
- For complex portfolios of complex instruments, it may not be obvious if the portfolio will react as desired
- Manager or client may wish to shield portfolio from adverse reaction to extreme circumstances like replays of historical disasters like October 1987, Russian debt crisis, LTCM meltdown

Scenario Analysis

Parallel yield curve shifts, instantaneous, Citi BIG (2/28/2003)					
Effective Duration	**3.986**				
Effective Convexity	**0.096**				
Instantaneous Parallel Shift (bps)	**-100**	**-50**	**0**	**50**	**100**
Rate of Return % (1-month scenario)	**4.02%**	**2.12%**	**0.32%**	**-1.53%**	**-3.54%**
Rate of Return % (duration/convexity/carry)	**4.31%**	**2.31%**	**0.32%**	**-1.67%**	**-3.67%**

Derivatives Policy Group, 1995, standard scenarios:

- Parallel yield curve shift of ±100bps
- Yield curve twist of ±25bps
- Equity index changes of ±10%
- Currency changes of ±6%
- Volatility changes of ±20%

Scenario Analysis – economists' narratives

Narrative Iraq war scenarios, March 10, 2003 (source Citigroup Yield Book)	
Short War No Recovery	Plus - short war; Minus - economy cannot shake off the problems, dismal corporate earnings, high oil price, layoffs. No correction in yields. No rate cut from Fed feeding enough stimulus to turn econ around. 2s settle in the 1.6% and 5s to underperform w/yields closer to 3%. 10s and 30s follow suit, backing up 30 bps and 10 bps as curve flattens. No change in swap spread and vol will decline in response to resolution of the biggest near-term uncertainty
Short War Recovery	Short war with confidence going through the roof, biz spending, Tsy sell off and vol falls like a rock, 2s jump past 2% and 5s crushed to 3.5%. Curve flattened from 5s on out. 10s shoot to 4.25%, bonds just shy 5%, Not much change in spread with widening pressure countered by upswing in Tsy issuance.
Long War Equity Crash	Skyrocketed oil price, no confidence, no biz expansion, the bottom falls out of equity. Fed cuts rates by 50bps, the relentless Tsy rally , curve steepens across all spectrum. no econ turnaround, 2s dip below 1%, 5s to 2% 10 to 3.3%, bond in mid 4%. 10-yr swap sprd blow out to 80bps, yield vol spikes reflecting declining yld and high bp vol
Long War Malaise	High oil price, biz gun shy, but equity does not fall out. Fed cautious w/ 1cut. Tsy bull flatten to intermediate as investors reach out longer, 5s and 10s yields decline by 30 bps and outperform the rest of curve. Sprds tightens as war costs fuel the prospects of ever-rising Tsy supply further. Yld Vol climbs due to decline in rates.
Forward	Ongoing UN inspection with no war, yields stay at the same levels implied for forwards.
No Change	

Scenario Analysis – quantification

Iraq war scenarios quantified (March 10, 2003)

		Short War		Long War		
	Mar 10	No Recov	Recovery	Eq Crsh	Malaise	Fwd
Fed funds	1.25	1.25	1.25	0.75	1.00	1.25
2-Yr Treasury Yield	1.33	1.63	2.04	0.89	1.08	1.48
5-Yr Treasury Yield	2.48	2.87	3.36	2.10	2.19	2.65
10-Yr Treasury Yield	3.58	3.89	4.26	3.30	3.32	3.71
30-Yr Treasury Yield	4.65	4.75	4.93	4.49	4.50	4.71
Fed funds/2s	0.08	0.38	0.79	0.14	0.08	0.23
2s/5s slope	1.15	1.24	1.32	1.21	1.11	1.17
5s/10s slope	1.10	1.02	0.90	1.20	1.21	1.11
2s/10s slope	2.25	2.26	2.22	2.41	2.24	2.23
10s/30s slope	1.07	0.86	0.67	1.19	1.18	1.00
1x10yr swaption yield vol	29.14	25.81	22.44	33.62	32.36	27.56
10-Yr Swap spread (bp)	43	42.5	43.5	80	38	43.6
5-Yr Swap spread (bp)	42	41.5	42.5	79	37	42.6

Scenario Analysis – simulation

Iraq war scenarios applied to Citi BIG index						
3-month Iraq War Scenario (as of Mar 2003)	Short War No Recovery	Short War Recovery	Long War Equity Crash	Long War Malaise	Forward	0bps
Rate of Return % (1-month)	-0.21%	-1.37%	1.69%	1.48%	0.28%	0.70%
Rate of Return % (3-month)	-0.61%	-4.06%	5.16%	4.49%	0.83%	2.12%

What actually happened – variables as of June 10, 2003													
Fed funds	2-Yr Tsy Yield	5-Yr Tsy Yield	10-Yr Tsy Yield	30-Yr Tsy Yield	Fed funds/ 2s	2s/5s slope	5s/10s slope	2s/10s slope	10s/30s slope	1x10 swptn yield vol	10-Yr Swap spread	5-Yr Swap spread
1.22	1.121	2.087	3.196	4.263	-0.099	0.966	1.109	2.075	1.067	29.383	32.8	32

- S&P 500 rose from 807 on March 10 to 985 June 10; no crash, no malaise.
- Quantification of yield curve responses was wrong. Citi BIG actually rose 2.90%. Closest scenarios to what actually happened: between long war malaise and no change (0bps).
- Human analysts didn't do so well in projecting the key variables. But if they had been projected correctly, the return on the scenario would have been close.

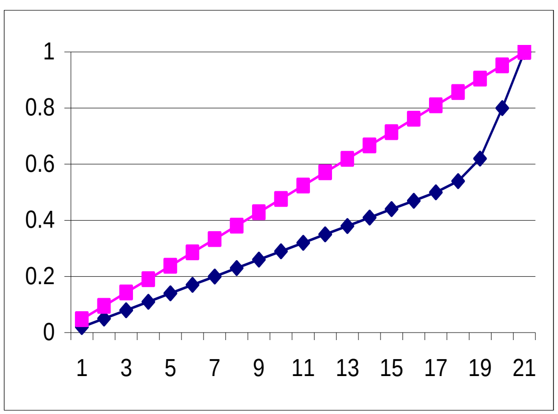
Control mechanisms

- **Gini index**
  - **Order weights so that $x_1 \leq x_2 \leq \ldots \leq x_n$**
  - **Define**

$$Q_i = \sum_{j=1}^{i} x_j$$

  - **Set**

$$Gini \equiv \sum_{i=1}^{n} 2\left(i/n - Q_i\right)/n$$



- **Weight control**
  - **$\max(b_i - \delta, 0) \leq x_i \leq \min(b_i + \delta, 0)$**
- **Characteristics ranges**

	0-1	1-3	3-5	5-7	7-10	10-20	20+	Sum
AAA	2.37	-1.41	1.25	0.65	1.33	-2.11	-0.41	1.68
AA+	1.94	-0.94	0.34	0.34	-1.48	-1.17	-0.37	-1.33
AA-	0.93	-1.98	-2.32	-0.81	-1.11	-0.97	-1.13	-7.40
A+	-0.48	-1.52	-2.36	2.48	-0.97	0.81	2.05	0.02
A-	-1.27	1.41	1.43	1.52	-2.39	2.36	1.91	4.98
BBB	1.27	0.60	1.15	0.15	-0.10	-0.42	-0.60	2.06
Sum	4.76	-3.83	-0.51	4.34	-4.72	-1.49	1.45	0.00

- **Concentration control.**
  - **Set ranges for Gini index (either absolute or relative)**

Part 3

Long-short portfolios

This part is excerpted from Hewett and Winston, 2006

Why long-short portfolios are different

•Even if long side and short side are each lognormal, the difference is not.

•For one thing, the difference can go negative. This can't happen in a long-only portfolio.

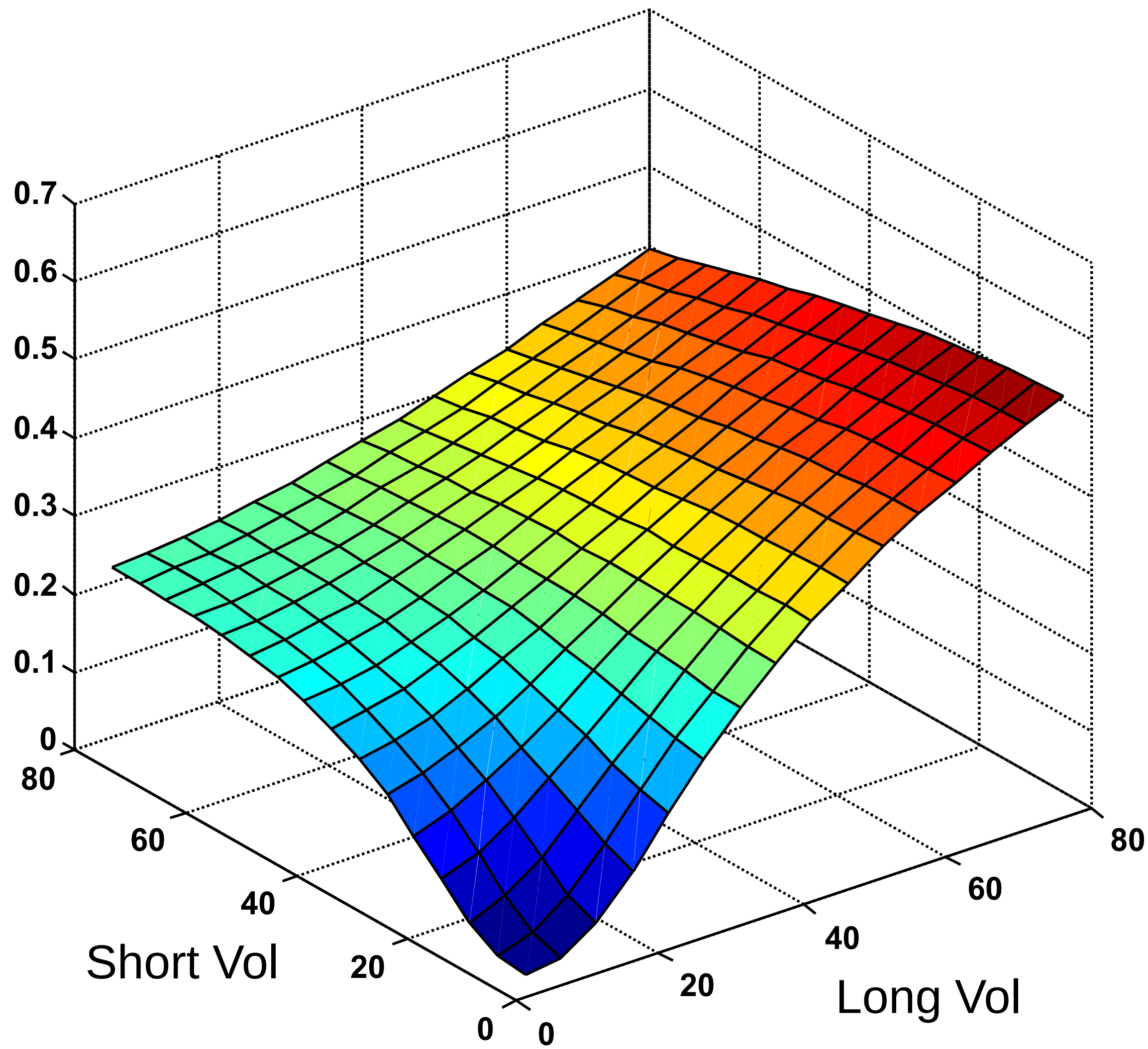
•The difference of two lognormal distributions is not a tractable distribution.

•To start, we assume a long portfolio L and a short portfolio S that follow correlated geometric Brownian motion:

$$\frac{dL}{L}=\alpha_L dt+\sigma_L dZ_L \quad \frac{dS}{S}=\alpha_S dt+\sigma_S dZ_S \quad dZ_L dZ_S = \rho dt$$

Terminal probability of bankruptcy

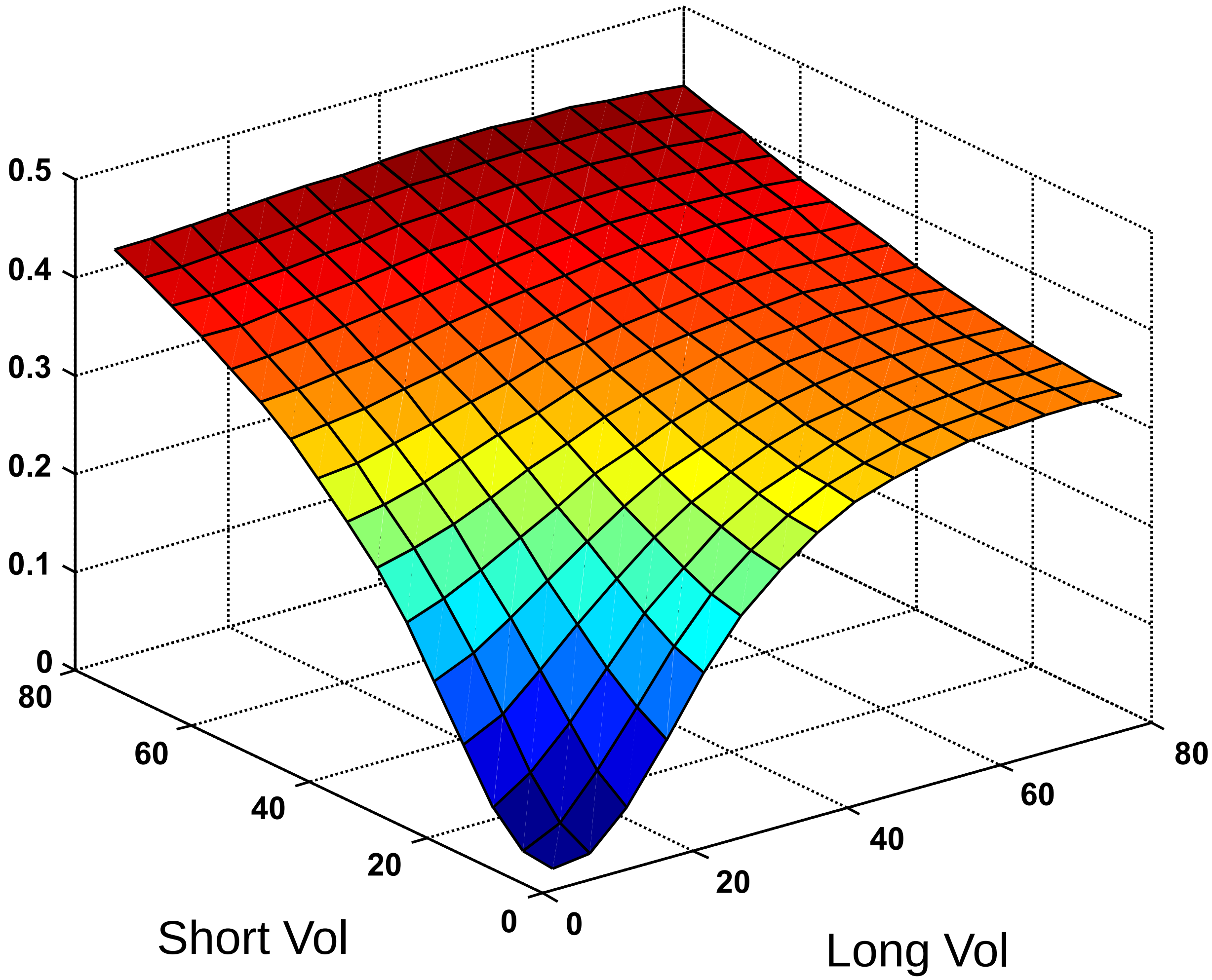
- Initial leverage=8 (long=4.5, short=3.5)
- 1 year
- 300bps skill on long side, 200bps skill on short side
- 0 correlation



Additional probability w/interim stopping barrier

Probability (above previous graph) when interim (t between 0 and 1) bankruptcy included

- Initial leverage=8 (long=4.5, short=3.5)
- 1 year
- 300bps skill on long side, 200bps skill on short side
- 0 correlation



Probability of hitting a drawdown stopping barrier

τ_k is the first time the portfolio value goes below k.

$$\tau_k = Inf\{t : t > 0, L(t) - S(t) \le k\}$$

$P(\tau_k \le t)$ is the probability the portfolio value drops to k or below before time t.

$$P(\tau_k \le t) \approx N(\hat{D}_1) + \left(\frac{L(0)}{S(0)+k}\right)^{1-\frac{2\hat{A}}{\hat{\Sigma}^2}} N(\hat{D}_2)$$

$$\hat{D}_1 = \frac{\ln\left(\frac{S(0)+k}{L(0)}\right) - (\hat{A} - \hat{\Sigma}^2/2)T}{\hat{\Sigma}\sqrt{T}} \qquad \hat{D}_2 = \hat{D}_1 + 2\frac{(\hat{A} - \hat{\Sigma}^2/2)\sqrt{T}}{\hat{\Sigma}}$$

$$\hat{A} = \alpha_L - SF\alpha_S + SF^2\sigma_S{}^2 - \rho\sigma_L\sigma_S SF$$

$$\hat{\Sigma}^2 = \sigma_L{}^2 + SF^2\sigma_S{}^2 - 2\sigma_L\sigma_S\rho SF$$

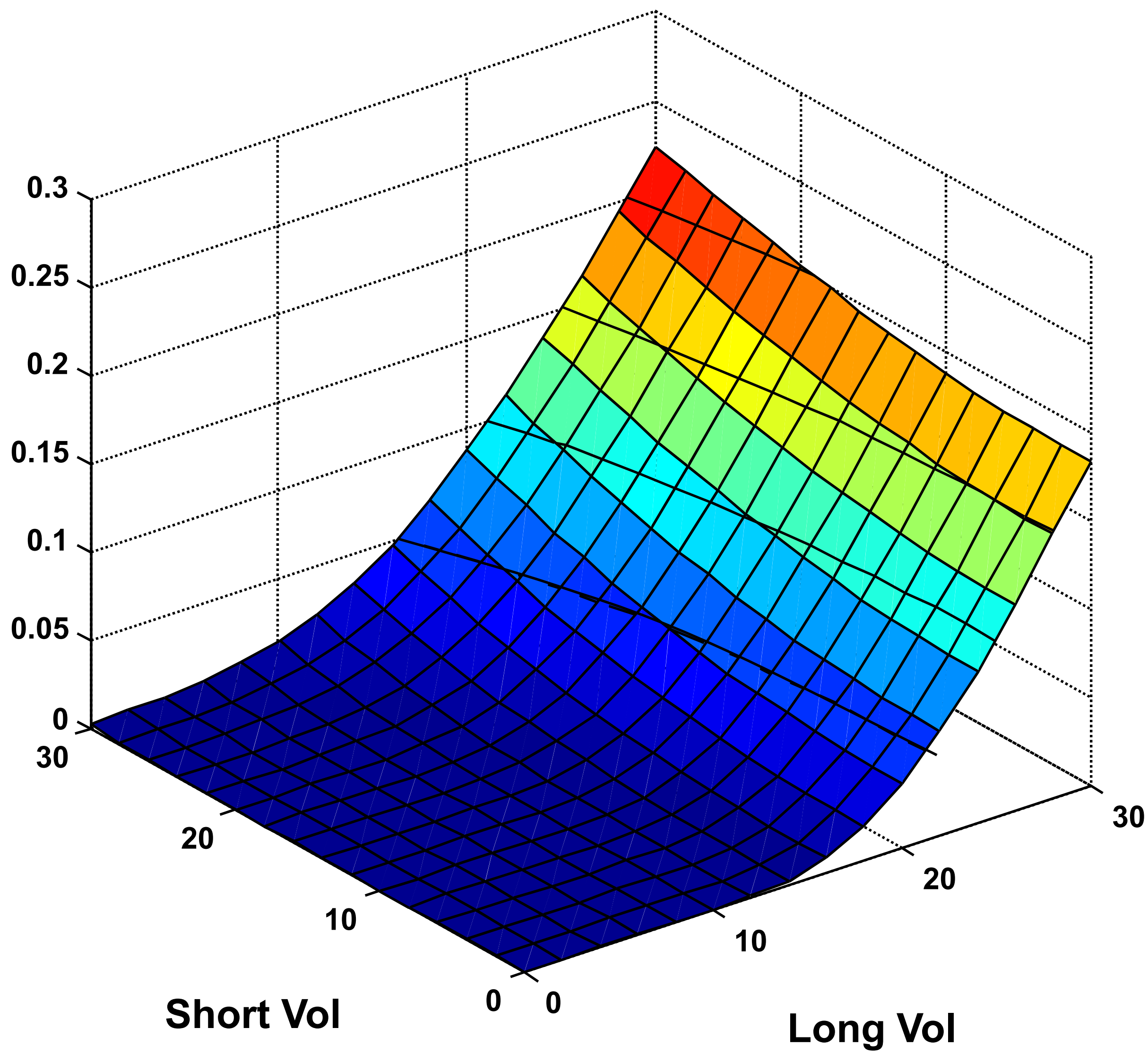
$$SF = \frac{S(0)}{S(0)+k}$$

Morgan Stanley

Probability of stopping at 50% drawdown

Taking into account interim stopping barrier between t=0 and t=T

- Initial leverage=2 (long=1.5, short=.5)
- 1 year
- 300bps skill on long side, 200bps skill on short side
- 0 correlation



Combining success metric with failure avoidance

•We compute the joint probability of success (portfolio value reaches K) given that we avoid any interim failure (portfolio value below k). Based on [Lee 2004] barrier option pricing formula.

$$P(K,k) = P(L(T) - S(T) \le K, \forall t \in [0,T] : L(t) - S(t) > k)$$

$$P(K,k) \approx \Phi_2\left(\hat{D}_1(K), -\hat{D}_1(k), -\hat{R}\right) - \left(\frac{L(0)}{S(0)+k}\right)^{1-\frac{2\hat{A}(k)}{\hat{\Sigma}(k)^2}} \Phi_2\left(\hat{D}_1(K) + \frac{2\hat{R}\ln\left(\frac{L(0)}{S(0)+k}\right)}{\hat{\Sigma}(k)\sqrt{T}}, \hat{D}_2(k), -\hat{R}\right)$$

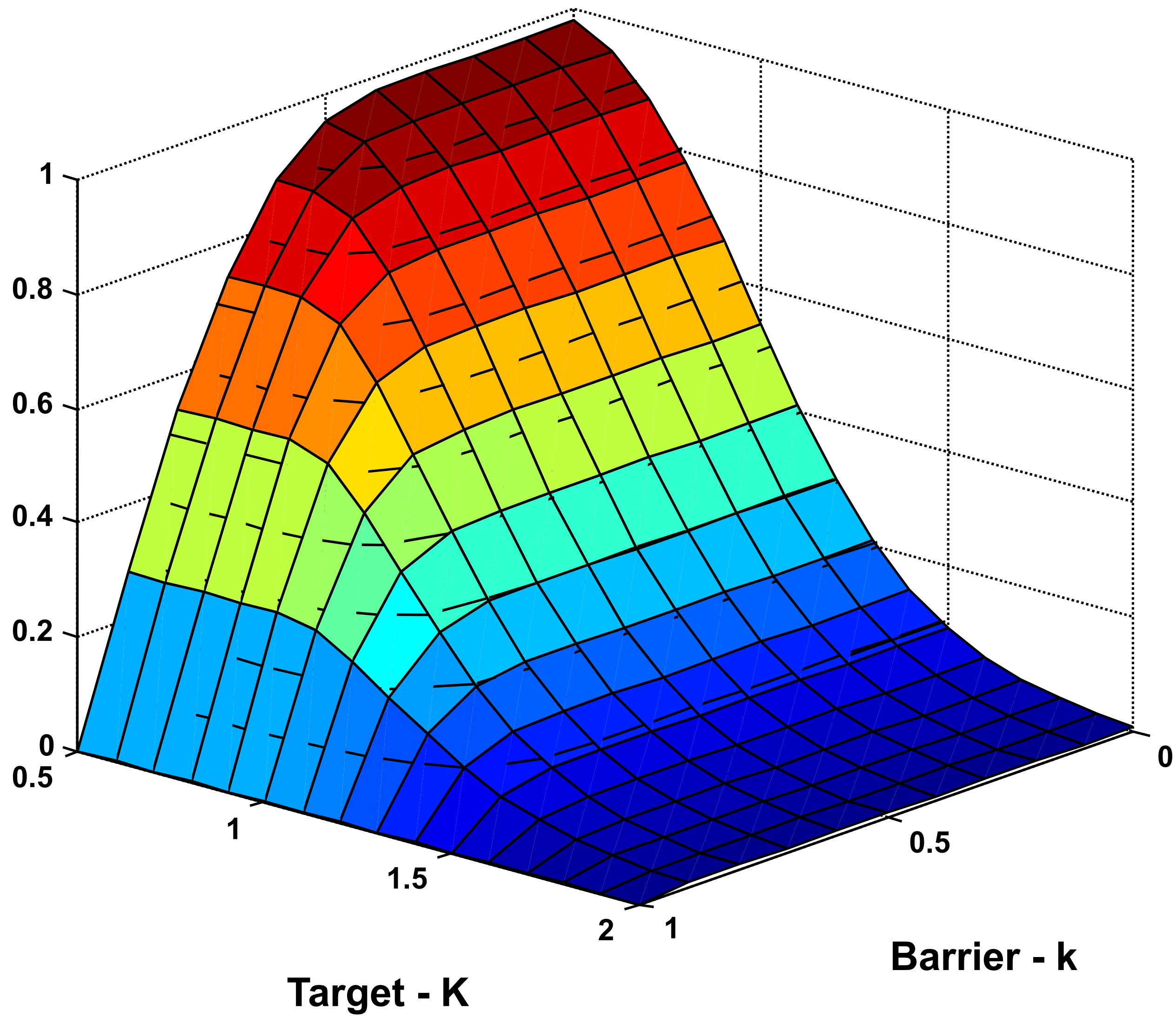
$\Phi_2(a,b,R) = P(Z_1 \le a, Z_2 \le b)$ is the standard bivariate cumulative normal distribution function where the correlation is R.

$$\hat{R} \equiv \frac{1}{\hat{\Sigma}(K)\hat{\Sigma}(k)}\left[\sigma_L^2 - \rho\sigma_L\sigma_S S(0)\left(\frac{1}{S(0)+K} + \frac{1}{S(0)+k}\right) + \frac{\sigma_S^2 S(0)^2}{(S(0)+K)(S(0)+k)}\right]$$

Success surface

1-P(K,k)

where we have 300bps skill on long side (α_L=3%), 200bps skill on short side (α_S=-2%), long vol σ_L=20%, short vol σ_S=15%, no correlation (ρ=0), initial leverage 2 (L(0)=1.5, S(0)=.5), 1 year.



Long/short conclusions

- Unmanaged long/short portfolios have large chances of unacceptable drawdowns
- Skill can be ineffective when leverage, volatility, and correlation are not properly managed
- Higher levels of leverage, volatility, and drawdown constraints force more frequent risk management