

NEUBERGER	BERMAN
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Keys To Asset Allocation



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Presentation to the PAPERS Spring 2011 Forum

NB Quantitative Investment Group

We put our work to practice

Selected Publications

Demystifying Risk-Parity

- Neuberger Berman white paper, forthcoming

Risk Budgeting With Asset Class and Risk Class

- Neuberger Berman white paper, forthcoming

Risk-Based Asset Allocation: A New Answer To An Old Question?

- Forthcoming in *The Journal Of Portfolio Management*

Implementable Tail Risk Management and Optimization

- Forthcoming in *Journal of Derivatives and Hedge Funds*

Regimes: Non-Parametric Identification and Forecasting

- The Journal of Portfolio Management*, Winter 2010

The Black-Litterman Model For Active Portfolio Management

- Winner of Bernstein Fabozzi/Jacobs Levy Award for Outstanding Article; published in *The Journal of Portfolio Management*, Winter 2009

Risk Budgeting

- Handbook of Finance: Investment Management and Financial Management*, 2008

Implementing Optimal Risk Budgeting

- The Journal of Portfolio Management*, Fall 2001

Modeling and Forecasting Interest Rate Volatility with GARCH

- Advances in Fixed Income Valuation Modeling & Risk Management* 1997

Theory and Methodology of Tactical Asset Allocation

- Wai Lee, 2000.

Challenges of Traditional Asset Allocation

Asset Allocation Drawing Board

Balancing act between returns and risks

◆ The Goal:

Maximize Return – Penalty for Risk

Subject to Constraints

◆ Three key elements:

- Return
- Risk (and Risk Aversion)
- Constraints

The Equation And The Picture

The Step-By-Step Guide from textbook

$$\max \sum_{i=1}^N w_i E[R_i] - \lambda \sum_{i=1}^N \sum_{j=1}^N w_i w_j \text{Cov}(R_i, R_j)$$



Economics of Matrix Algebra

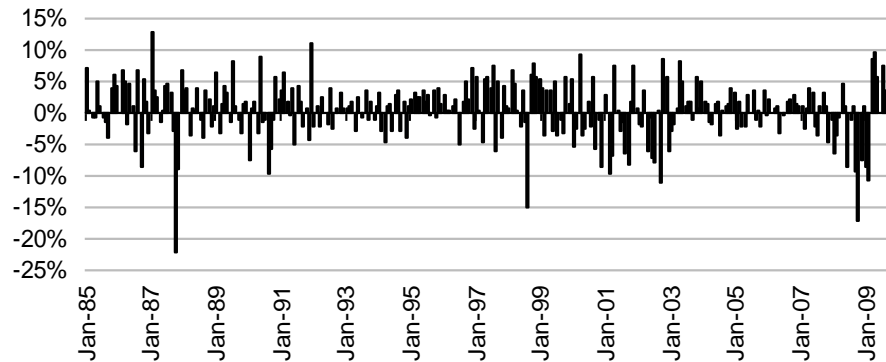
Lee (2000): Equations (2.28), (2.34), (2.35), (2.36)

- ◆ The optimal portfolio is the sum of three component portfolios:
 - (2.34): $\text{Optimal} = \text{GMV} + \text{Strategic} + \text{Tactical}$
- ◆ GMV: Global Minimum Variance Portfolio
- ◆ Strategic: determined by the risk-adjusted equilibrium (long-term) returns of all assets
- ◆ Tactical: determined by the risk-adjusted deviations from equilibrium (long-term) returns of all assets

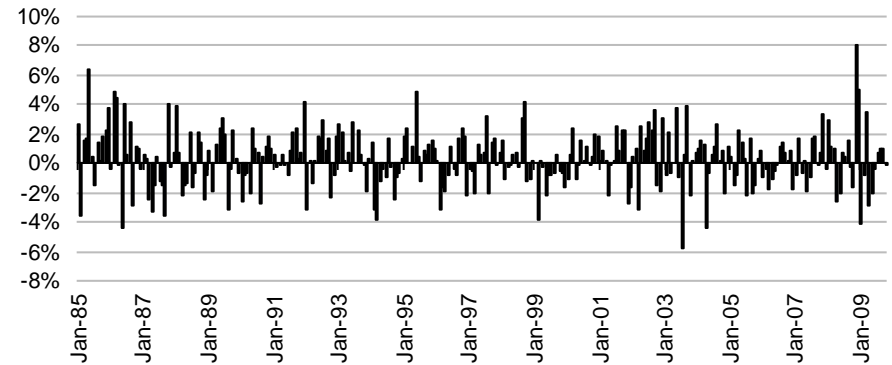
Challenge #1: Return Forecasts

What are historical equilibrium? And Future?

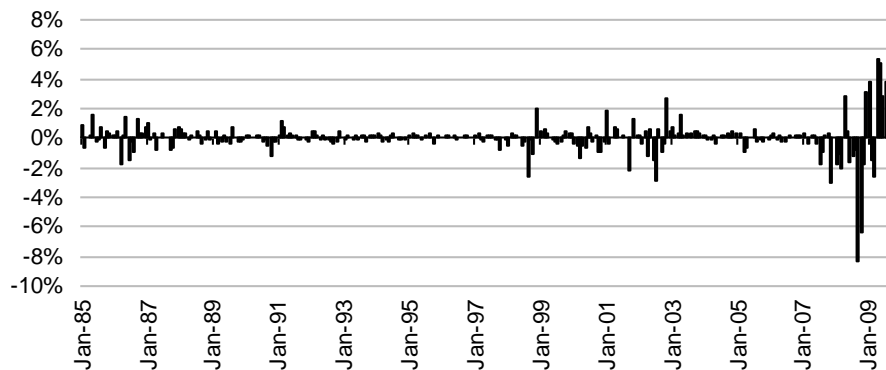
U.S. Stocks (Excess Returns)



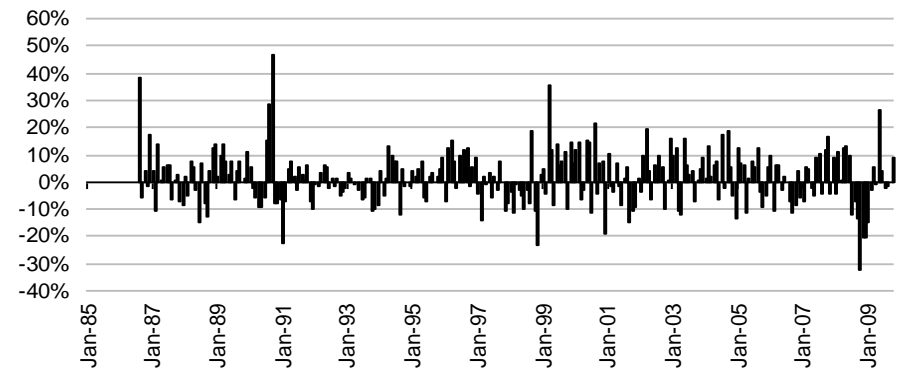
U.S. Bonds (Excess Returns)



U.S. Investment Grade (Excess Returns)



Crude Oil (Excess Returns)

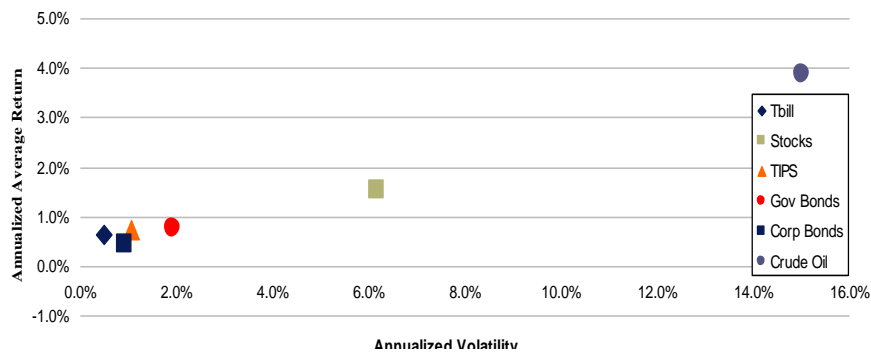


Challenge #2: Risk Forecasts¹

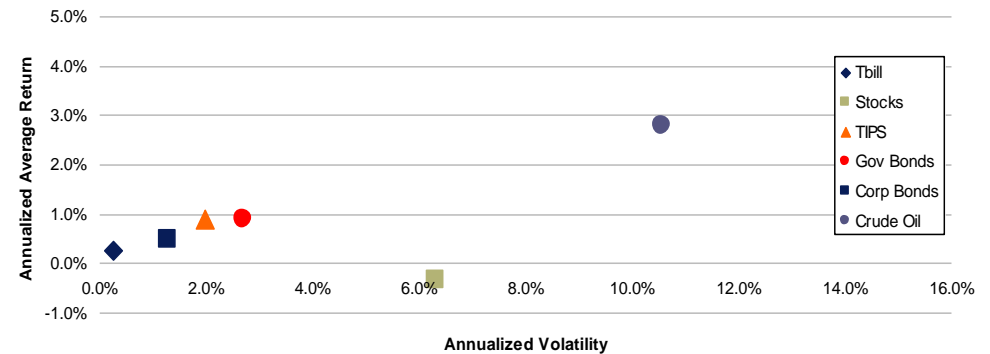
Work Harder

- ◆ Merton (1990): the more frequently we sample the data, the more precise the estimates of volatilities and correlations will be.

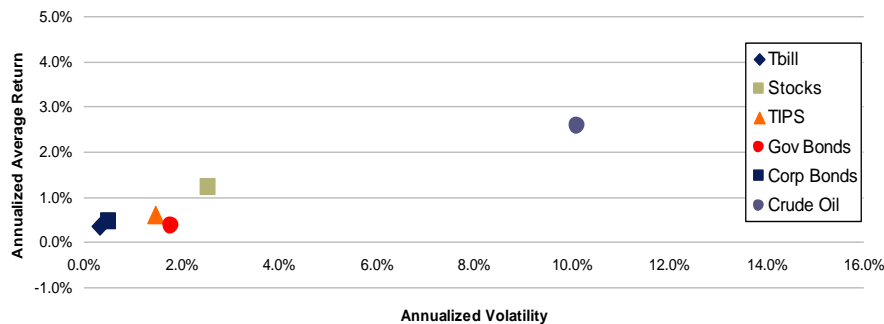
Risk Return Profile Between 1998 and 2000



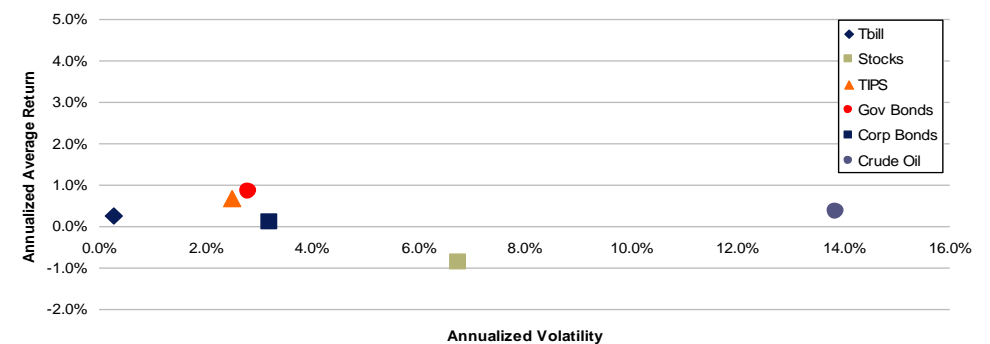
Risk Return Profile Between 2001 and 2003



Risk Return Profile Between 2004 and 2006



Risk Return Profile Between 2007 and 2009

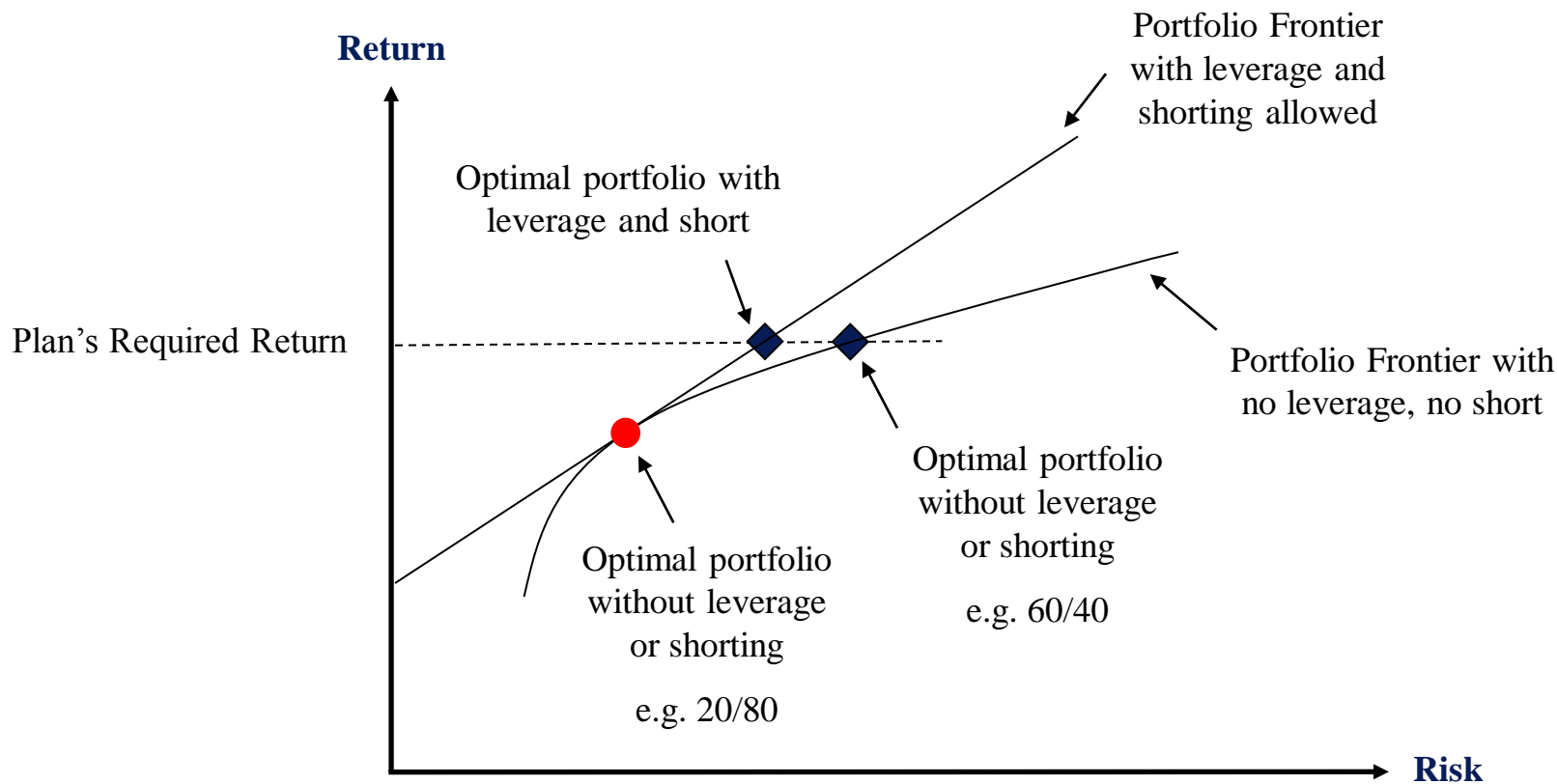


1. Merton, Robert C., *Continuous-Time Finance* (1990, Chapter 3)

Challenge #3: Constraints

Constraints such as no leverage and/or no shorting can lead to risk concentration

- ◆ A 60/40 of stocks/bonds would be optimal in an unconstrained world if Sharpe ratio of stocks is 3-5 times as high as Sharpe ratio of bonds

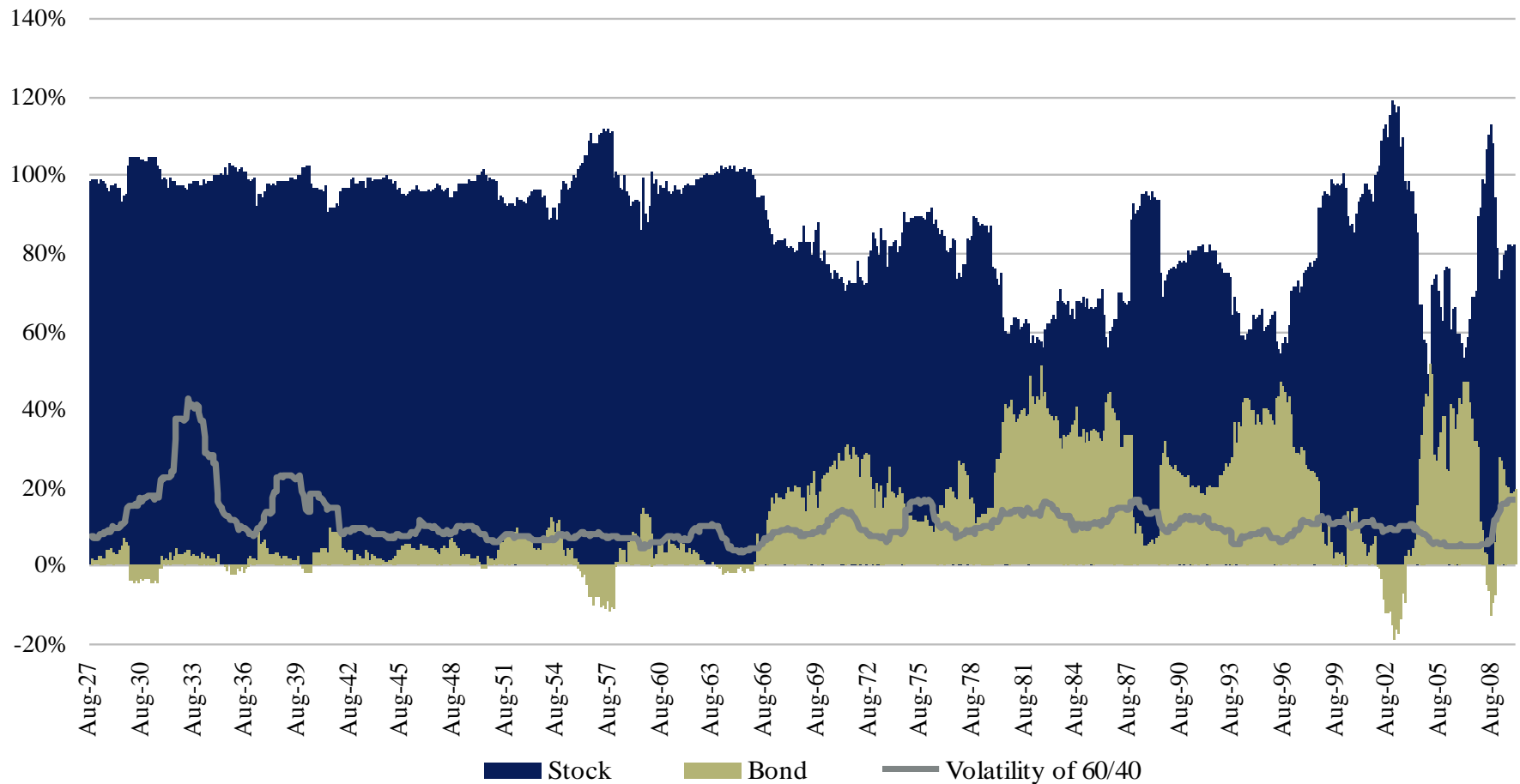


Note and Considerations

Note 1: Risk Concentration Of 60/40

No leverage, no shorts, required return 7.5%–8.5%

Percentage Contribution to Risk and Volatility of 60/40

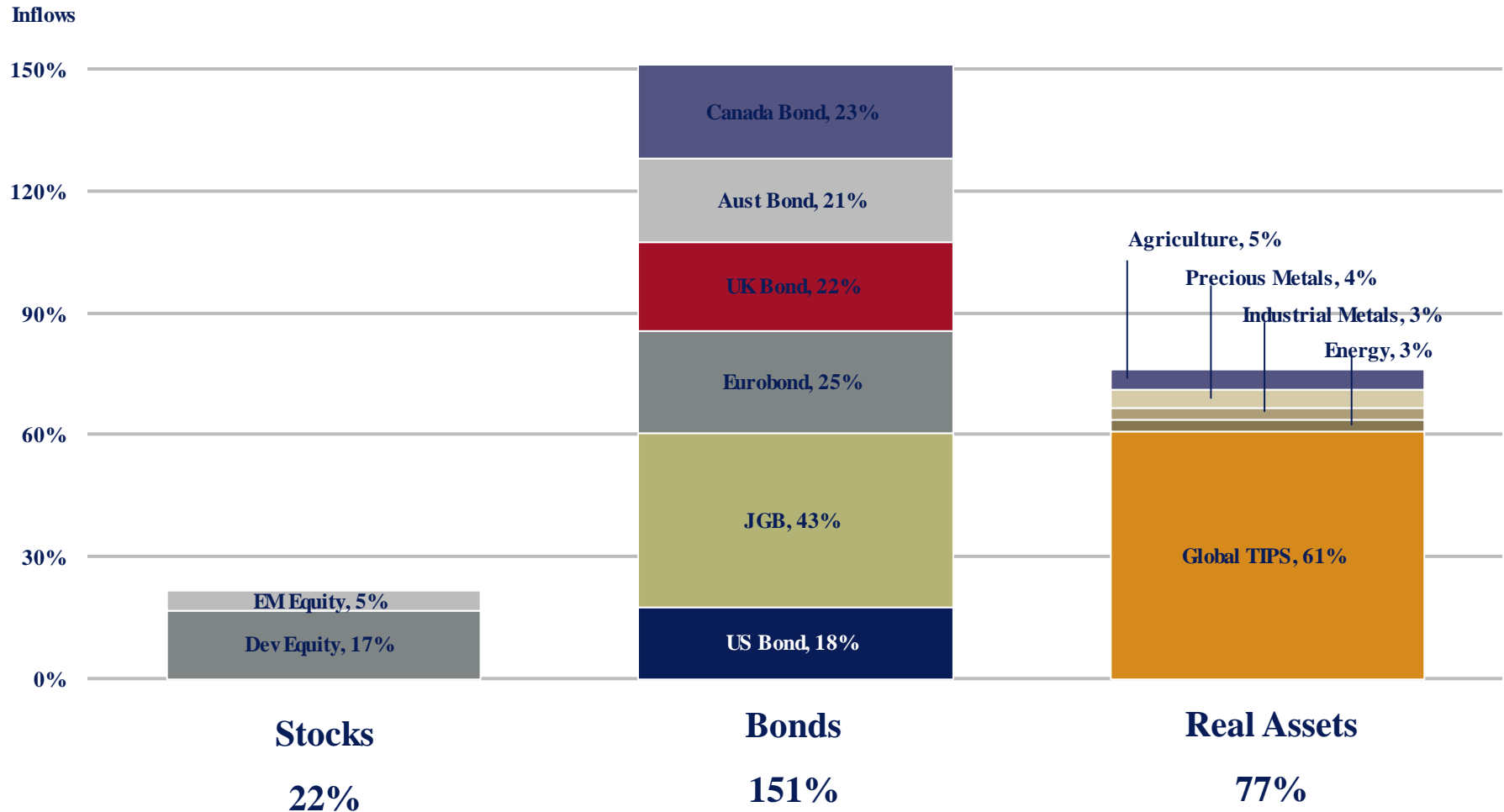


1. Source: Neuberger Berman Quantitative Investment Group

Is Risk Parity A Solution? ¹

Need leverage to deliver required return

NB Dynamic Beta Navigator Portfolio Weights (hypothetical weights)

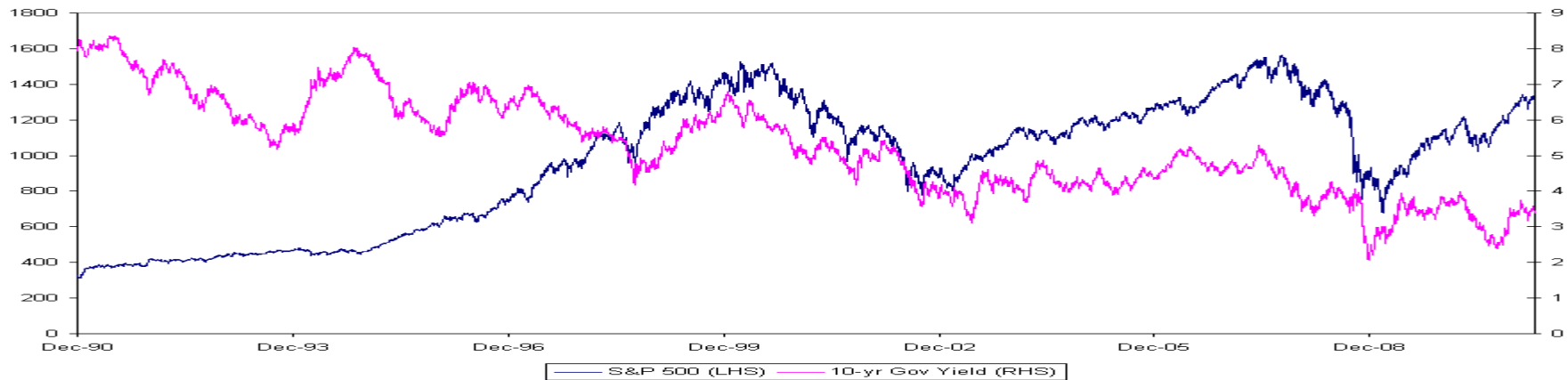


1. Lee (2011): risk-parity is optimal when Sharpe ratios and correlations of all assets are identical

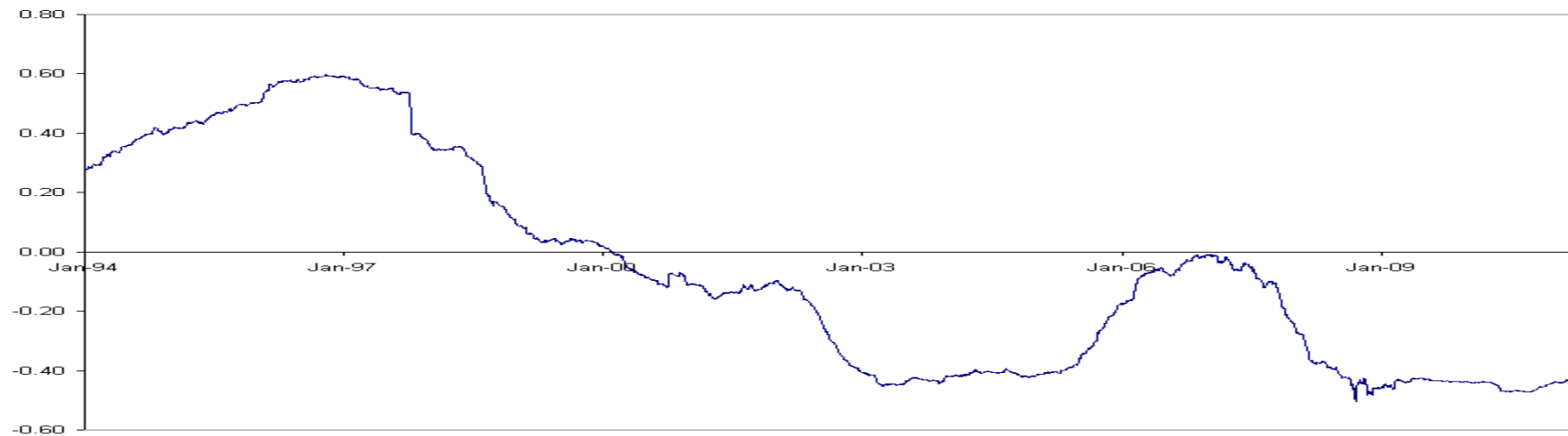
Note 2: Stock/Bond Correlation

60/40 today is very different from 20 years ago

S&P 500 Index and US 10-Year Treasury Yield



Rolling 3-Year Correlation Between S&P 500 and 10-Year Gov Bond Returns



1. Source: Neuberger Berman Quantitative Investment Group

Overweight and Underweight, Still?

Or is there a better way to reflect our views?

- ◆ Hypothetical investment views:

Exp Ret	Stock	Bond
	7.0%	3.5%
Volatility	18%	6%
- ◆ Hypothetical tactical trades:

No Leverage: Traditional Overlay

CASE 1: Correlation = -0.3			
Tactical Trades 1			
Stock	Bond	Exp Alpha	Exp TE
5%	-5%	0.17%	1%
Tactical Trades 2			
Stock	Bond	Exp Alpha	Exp TE
4%	15%	0.83%	1%

CASE 2: Correlation = +0.3			
Tactical Trades 1			
Stock	Bond	Exp Alpha	Exp TE
6%	-6%	0.20%	1%
Tactical Trades 2			
Stock	Bond	Exp Alpha	Exp TE
2%	14%	0.62%	1%

Leverage: Hedge Fund Version

Note 3: Investment Views

Once upon a time, there lived 3 strategists, FX, FI, and EQ ...

- ◆FX: “We expect the rebound of stocks to continue, we are bearish on USD ...”
- ◆FI: “We expect the rebound of stocks to continue, lowering the flee-to-safety demands of bonds, ...we are bearish on bonds ...”
- ◆EQ: “We expect treasury yield to stay in a range, or even go down a bit as the current real yield seems to be attractive, providing support for equities ...”

What Are We Forecasting?

Forecasting Y through first Forecasting X

	FX Strategist	FI Strategist	EQ Strategist
Need to forecast (Y)	FX	Bond	Equity
Is forecasting (X)	Equity	Equity	Bond
Hypothesis	$\text{Corr}(X, Y) < 0$	$\text{Corr}(X, Y) < 0$	$\text{Corr}(X, Y) > 0$

◆ May add value if

- can predict future realizations of X; AND
- the contemporaneous correlation (positive or negative) between X and Y, as hypothesized, is correct; OR
- Luck! predict future realizations of X incorrectly AND have the hypothesized correlation wrong

Information Leakage is Significant

% of Time That We Forecast Y Correctly

Corr (X, Y)	% of Time That We Forecast X Correctly										
	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	99%
0.0	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
0.1	50%	51%	51%	52%	52%	53%	53%	54%	55%	57%	59%
0.2	50%	51%	52%	53%	54%	55%	57%	58%	60%	63%	68%
0.3	50%	52%	53%	55%	56%	58%	60%	62%	65%	69%	76%
0.4	50%	52%	54%	56%	58%	61%	63%	66%	70%	74%	82%
0.5	50%	53%	55%	58%	60%	63%	66%	70%	74%	79%	88%
0.6	50%	53%	56%	59%	62%	66%	69%	73%	78%	84%	92%
0.7	50%	54%	57%	61%	64%	68%	72%	77%	82%	88%	95%
0.8	50%	54%	58%	62%	66%	71%	75%	80%	85%	91%	97%
0.9	50%	55%	59%	64%	68%	73%	78%	82%	88%	93%	98%
0.99	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	99%

1. Source: Neuberger Berman Quantitative Investment Group

And Many More Examples

To forecast stocks, bonds, and currencies, we forecast:

- ◆ GDP growth
- ◆ capacity utilization
- ◆ inflation
- ◆ Fed's action
- ◆ earnings growth
- ◆ weather
- ◆

Example: Hirshleifer, David, and Tyler Shumway, "Good Day Sunshine: Stock Returns and the Weather," Journal of Finance, June 2003, pp. 1009-1032: Sunshine is strongly significantly correlated with stock returns (sample of 26 countries with daily returns data from 1982 to 1997).

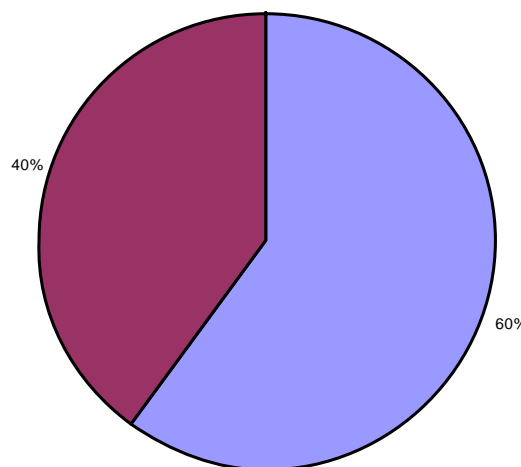
Note 4: Assets As Exposures To Risks

“Risk Budgeting with Asset Class and Risk Class” Conceptually sound, but ...

Capital Allocation:

60/40

Stock/Bond

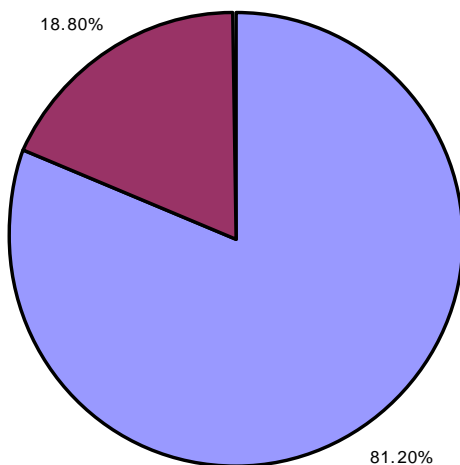


■ SP 500 ■ US. LT Govt Bond

Risk Allocation:

81/19

Stock/Bond

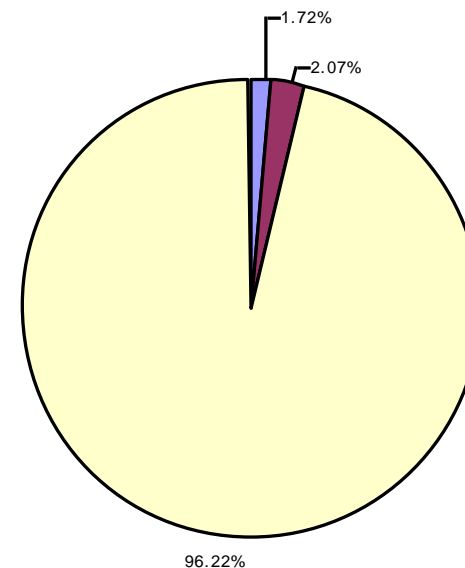


■ SP 500 ■ US. LT Govt Bond

Risk Allocation:¹

2/2/96

Growth/Inflation/Others



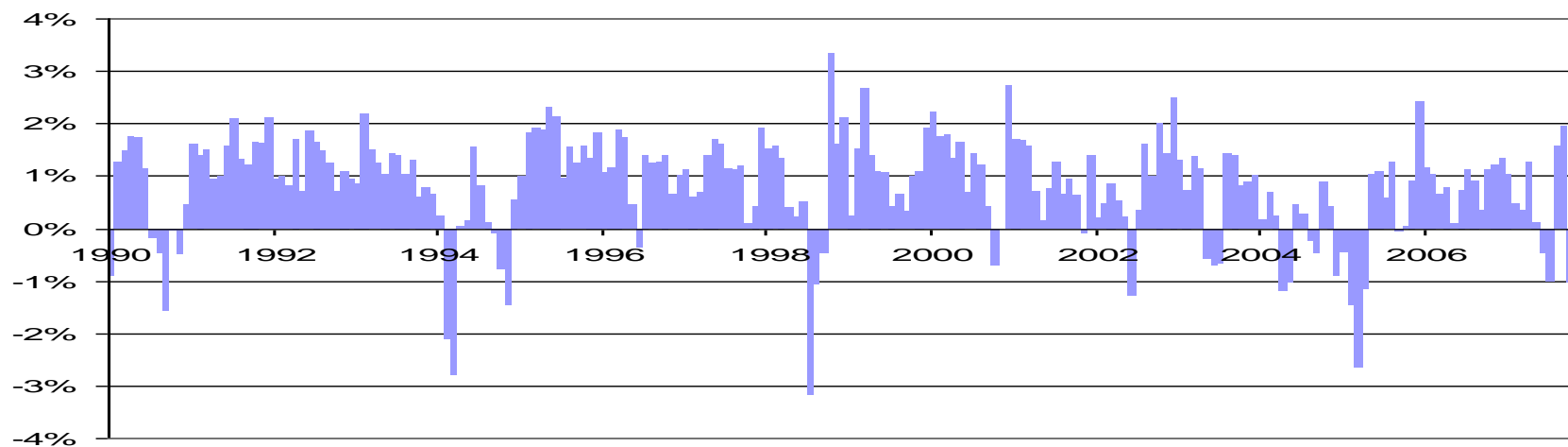
■ Growth ■ Inflation ■ Specific

1. We follow the approach in Chen, N., R. Roll, and S. Ross, “Economic Forces and the Stock Market,” *Journal of Business*, Vol.59, No.3 (July 1986), pp. 343-403, in estimating the risk-class model for stocks and bonds for the purpose of illustration.

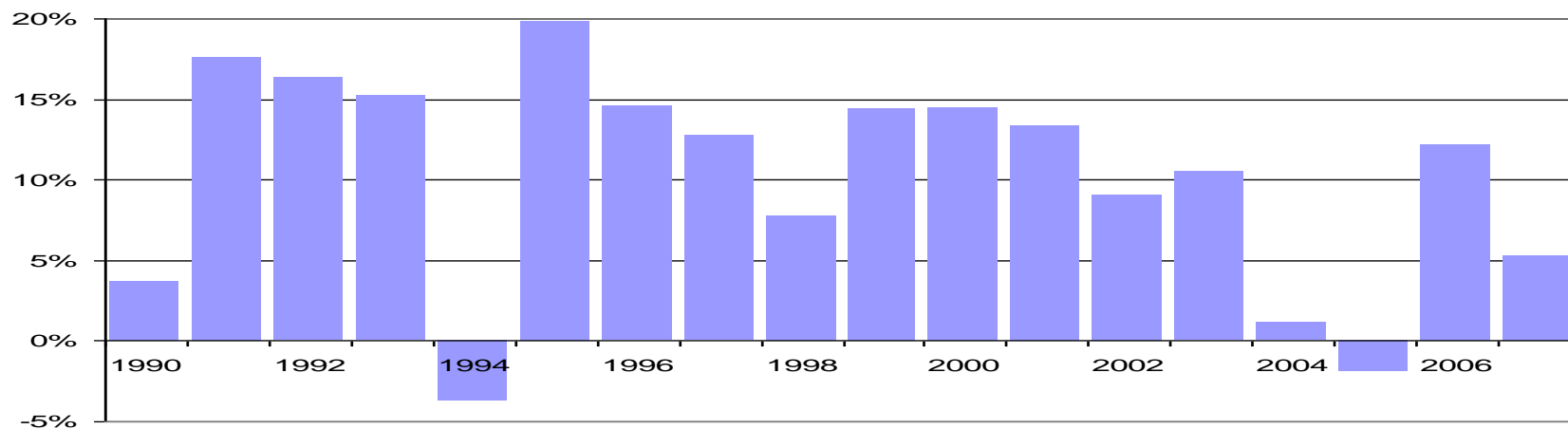
Note 5: Volatility Estimates

Is calculating realized volatility easy?

Monthly Returns of a Hedge Fund Strategy



Annual Returns of A Hedge Fund Strategy



1. Source: Hedge Fund Research

Risks of Illiquid Assets Understated

Positive serial correlations of returns generally lead to understated volatility

	1990 - 2007	1990 - 2010
Annualized Volatility (Monthly Returns)	3.4%	9.6%
Annual Volatility (Annual Returns)	6.8%	16.1%

◆ For a Normal distribution

- 67% of the annual returns would be typically in a range of $\pm 1\sigma$
- 90 % of the annual returns would be typically in a range of $\pm 1.65\sigma$

◆ Is volatility of this hedge fund strategy 3.4%, 6.8%, or something else?

Disclosures

This article reflects the views of the author and does not reflect the official views of the author's employer, Neuberger Berman.

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