

ENNISKNUPP CAPITAL MARKETS MODELING ASSUMPTIONS – Updated January 2006

Asset allocation modeling requires three types of inputs: estimates of expected return; volatility (standard deviation); and correlation among asset classes. The most critical inputs are the estimates of expected return. EnnisKnupp's capital markets model uses a theoretical, Global Capital Asset Pricing Model (Global CAPM) methodology to obtain expected returns for individual asset classes, rather than relying on historical results or arbitrary estimates. With the exception of U.S. fixed income (described later), estimates of volatility (risk) and correlation are obtained directly from historical data—a standard practice, as these variables tend to be more stable over time than the level of returns.

The Global CAPM methodology requires two “anchors” that describe the tradeoff between risk and expected return. In our approach, these two anchors are the return estimates for U.S. equity and fixed income, from which all other asset class return estimates are derived.

Anchor #1: U.S. Equity

The expected annual return for the U.S. equity market is 9.0%. The historical record shows great variation in the premium of equities over bonds, depending on the period of time used. However, analysis indicates that the historical average at any point in time is a very poor predictor of future experience. Our assumption is therefore based on the economic premise that the total return over time for stocks can be divided into three components:

Dividend income: The current dividend yield on the broad market is about 1.7%.¹

Nominal growth in corporate earnings: The estimate for expected real (after-inflation) growth in

earnings is based upon the current forecast of real gross domestic product (GDP) growth from a survey of leading economists (Blue Chip Economic Indicators).² Over long periods of time, GDP and corporate earnings should grow at similar rates. The forecast for inflation, which is 2.6%, is also obtained from the same survey in order to arrive at the expected rate of nominal growth in earnings. The expected nominal growth in corporate earnings is 7.3%.

Change in valuation levels: Historical evidence indicates that valuation levels (e.g. price/earnings [P/E] ratios, etc.) at any point in time have an impact on the expected return of stocks over the succeeding years. Adjustments for valuation will be made if P/E (as defined by current price over trailing 10-year operating earnings) is above the 90th percentile (the “upper bound”) or below the 10th percentile (the “lower bound”) of historical experience. If required, an adjustment will be made so that the P/E will converge to the upper/lower bound within 15 years. Using current statistics, the lower and upper bounds for P/E are 9 and 26, respectively. Based on current market P/E level, there is currently no adjustment for valuation.

The long-term expected growth rate of the U.S. equity market, therefore, is the sum of 1.7% and 7.3%.

The standard deviation for U.S. equity is 16.7%, which reflects the historical volatility of equity returns over the 1978-2005 period. The standard deviation is a measure of the deviation from the expected return in a given year. For example, a 16.7% standard deviation means that, in two out of three years, one should expect to experience a U.S. equity return between -7.7% (9.0%-16.7%) and +25.7%

(9.0%+16.7%), or one standard deviation around the expected return. In nine out of ten years, one should expect a U.S. equity return that is within two standard deviations of the expected return, or between -24.4% and +42.4%.

Anchor #2: U.S. Fixed Income

The expected return for U.S. fixed income (represented by the Lehman Brothers Aggregate Bond Index [LB Aggregate]) is based on the current yield, and a simulation of future changes in yield. The consensus results of a semiannual survey of leading economists for the forward-looking expectations on 10-year Treasury yields is used as a baseline for developing yield simulations.

At the end of 2005, the yield for the LB Aggregate was 5.1% and the yield for the 10-year Treasury was 4.4%. In our model, the spread of the LB Aggregate yield over 10-year treasury is expected to decline gradually to the historical average of 0.4% from the current 0.7%.

A simulation of 10-year Treasury yields over a 15-year period is developed based on separate

simulations of its components: expected inflation, inflation risk premium and real yields. LB Aggregate yields are then simulated based on the 10-year Treasury yields. Finally, the average annual expected returns for LB Aggregate are 5.6% over 15 years with a standard deviation of 6.6%.

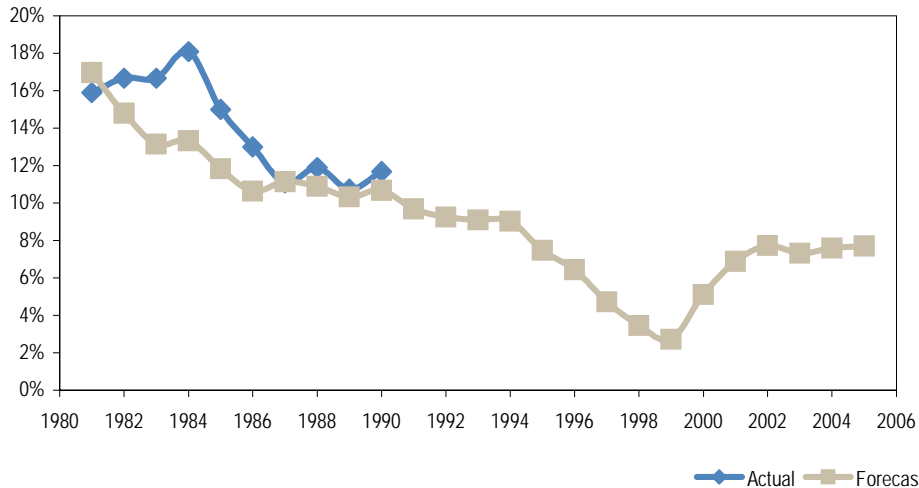
Comparison of Forecasts For the Anchors With Actual Historical Returns

The major inputs for determining expected returns for U.S. equity and fixed income are mainly derived from surveys of leading economists (Blue Chip Economic Indicators and Blue Chip Financial Forecasts). The long-term forecasts have been available since 1981. The methodology described above for determining forecasts of 15-year return expectations for U.S. Stocks and U.S. Bonds is applied retrospectively since 1981. The actual 15-year return historical results are then compared to the forecast results.

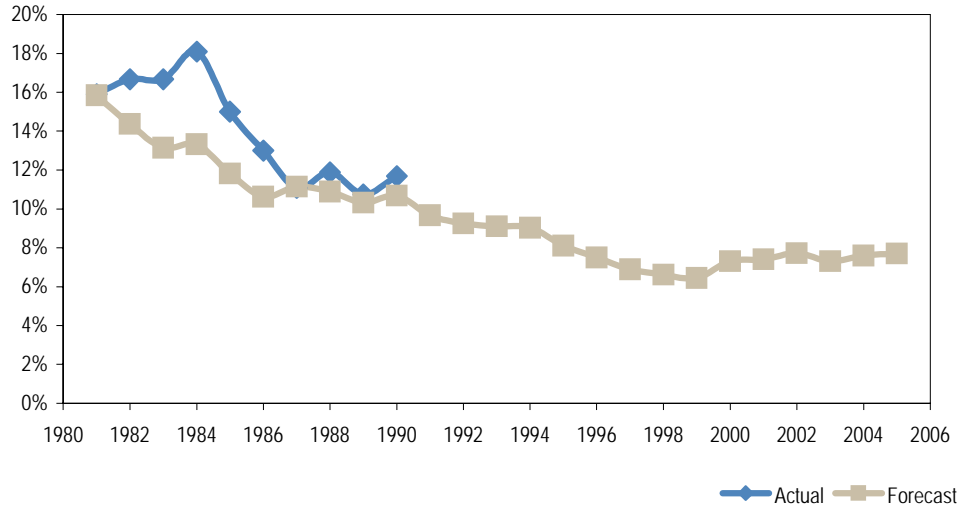
The following graphs illustrate the actual and forecasted results.

Exhibit 1

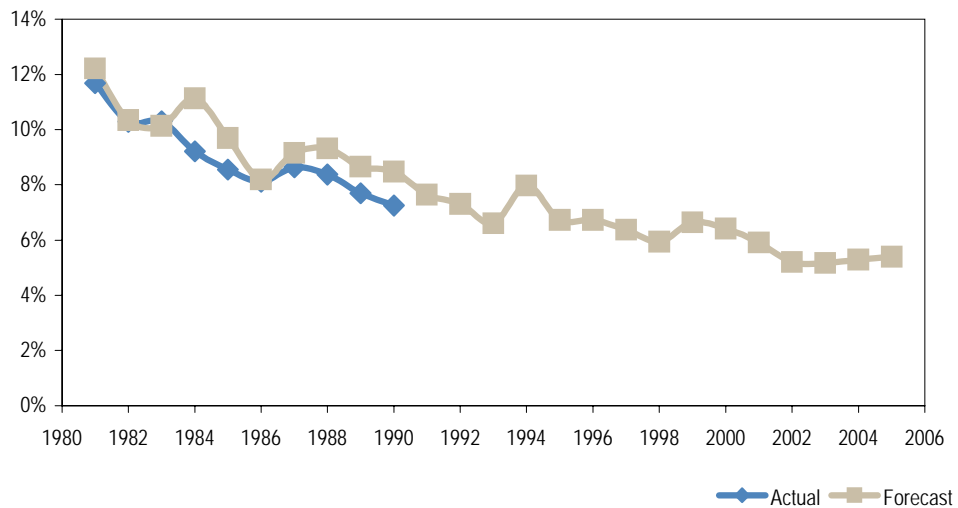
U.S. Equity Returns Over 15 years



U.S. Equity Returns Over 15 years (Without Valuation Adjustment)



Fixed Income Returns Over 15 years

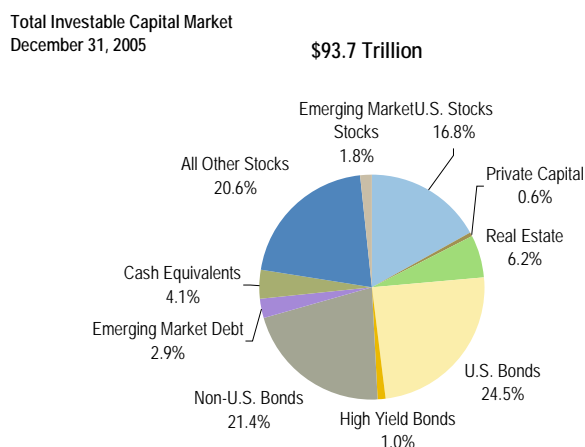


Other Asset Classes

A Global CAPM process is used to arrive at the expected returns for these asset classes. Expected returns on the various asset classes are proportional to their systematic (market) risk relative to the market

portfolio, defined in this context as the collection of all investable assets in the global marketplace. The current composition of the market portfolio is shown on the following page.

Exhibit 2



Source: UBS Global Asset Management, Venture Economics, EnnisKnupp

The return histories of indexes representing each asset class are combined at their historical market proportions in the total investable world capital market, creating a return stream that represents the market portfolio. (See the Appendix for a partial list of the representative indexes.) Betas for each asset class are calculated relative to the market portfolio over the 1978-2005 period. Beta is a measure of an asset's sensitivity to overall market movements, sometimes also called "market risk" or "systematic risk." The beta of the market, here defined as the total world investable capital market, is by definition 1.0. An asset with a beta of 2.0, for example, has twice as much market risk, and we would expect it to experience about double the gain of the market in a period of positive returns—and double the loss of the market in a period of negative returns.

Additionally, the ratio of each asset class's beta to that of U.S. equity is calculated. This ratio for each asset class should be identical to the ratio of the of the asset class's risk premium to U.S. equity's risk

premium. For instance, the ratio of U.S. fixed income's beta (0.40) to that of U.S. equity (1.71) is 23%, or 0.23. This implies that the ratio of U.S. fixed income's risk premium to U.S. equity's risk premium should also be 0.23 (i.e., $(5.6 - r_f)/(9.0 - r_f) = 0.23$). This results to an implied risk free rate (r_f) of 4.6%. The risk premium of each asset class is then calculated so that it is directly proportional to its systematic risk, with the expected U.S. equity return and the expected U.S. bond return serving as the links between the Global CAPM model and current market yields and economic variables.

The full set of betas and expected asset class returns is shown in Exhibit 3 on the following page.

Exhibit 3

Betas, Risk Premiums and Expected Returns

Asset Class	Beta With Respect to World Market	Expected Nominal/Arithmetic Return ¹	Standard Deviation	<i>Expected Compounded/Geometric Return</i>
U.S. Equity	1.71	9.0	16.7	<i>7.7</i>
Non-U.S. Equity	1.73	9.1	18.7	<i>7.3</i>
U.S. Bonds (LB Aggregate)	0.40	5.6	6.6	<i>5.4</i>
Real Estate	0.98	7.1	11.3	<i>6.5</i>
Private Equity	2.74	14.7 ²	31.1	<i>9.9</i>

¹ Arithmetic, or single-year, expected returns.

² Total expected return for private equity is 14.7% to reflect an extra 3% liquidity premium.

The expected compounded/geometric return is the relevant assumption from the point of view of a long-term investor. It is the return that the asset will experience over the long-term. The geometric average return is lower than the arithmetic average return whenever there is uncertainty (which is measured by standard deviation) in annual returns. For instance, earning +50% in the first year and -50% in the second year produces an arithmetic average return of 0.0%. However, the average geometric return over the two-year period is -13.4%. The geometric average is equivalent to earning -13.4% for both the first and second years. To illustrate the math, suppose \$100 is invested at the beginning of year 1. At the end of year 1, the asset would have grown to \$150 (earn +50%). After earning -50% in the second year, the asset balance would be \$75. This result is equivalent to earning -13.4% in the first year (ending with \$86.6 after 1 year) and the second year (i.e., $\$86.6 * (1 - .134) = \75).

Additionally, to account for the illiquid nature of private equity investments, their nominal arithmetic expected return is adjusted upward from 11.7% (based on the Global CAPM) to 14.7%. The 3% represents common industry expectation for the

additional return provided by private equity investments over public equity.

The standard deviation for U.S. fixed income is based on a simulation of expected returns where the historical volatility of real yield changes is taken into account. The standard deviations of all other asset classes and correlations, shown in Exhibit 4, reflect the historical annualized volatility experienced over the 1978-2005 period. Correlation coefficients measure the degree to which two asset classes' returns experience good or bad returns in the same period. A correlation coefficient of +1.0 between two asset classes means that they move together perfectly in lockstep. A correlation of -1.0 means that the two asset classes move in opposite directions, and a correlation of zero means that there is no relation between their returns. Asset classes that are less correlated with others provide greater opportunity for risk reduction through diversification.

Exhibit 4
Standard Deviations and Correlations

Asset Class	Standard Deviation	Correlation				
		U.S. Equity	Non-U.S. Equity	U.S. Bonds	Real Estate	Private Equity
U.S. Equity	16.7	1.00				
Non-U.S.	18.7	0.71	1.00			
U.S. Bonds	6.6	0.20	0.20	1.00		
Real Estate	11.3	0.60	0.45	0.58	1.00	
Private Equity	31.1	0.90	0.63	0.06	0.44	1.00

APPENDIX

The market indexes used to represent each asset class are as follows:

U.S. Equity	DJ Wilshire 5000 Stock Index
International Equity	1988-2005 MSCI All -Country World Ex -U.S. Index 1978-1987 MSCI EAFE Index
Real Estate	DJ Wilshire Real Estate Securities Index (Unlevered)
Private Equity	Credit Suisse Warburg Pincus Global Post-Venture Capital Index
Fixed Income	Lehman Brothers Aggregate Bond Index

An analytical framework such as Global CAPM that directly links expected returns with risk (volatility or standard deviation, and correlations between assets) requires, as inputs, returns based on prices determined in an open, publicly traded market. Traditional indexes for illiquid investments such as real estate and private equity suffer from disadvantages such as appraisal-based pricing, which tend to distort (generally understate) the risks of these asset classes, and artificially reduce their correlations with other assets. For this reason, EnnisKnupp uses indexes of publicly traded securities as proxies for such investments.

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GLOSSARY

Appraisal-based pricing: Determining the market value of an asset based on estimates given by analysts or experts. Since appraisals are done only periodically (not continuously), the fluctuation in value of an appraisal-priced asset may be understated.

Beta: A measure of an asset class' relative volatility. The beta is the covariance (a measure that combines correlation and volatility) of an asset class in relation to the rest of the market portfolio. The market portfolio has a beta coefficient of 1. Any asset class with a higher beta is more volatile than the market, and any with a lower beta can be expected to rise and fall more slowly than the market.

Capital Asset Pricing Model (CAPM): Model of the relationship between expected risk and expected return. The model is grounded in the theory that investors demand higher returns for higher risks. It says that the return on an asset or a security is equal to the risk-free return plus a risk premium that is proportional to its relative risk (beta). Global CAPM extends the analysis to all investment opportunities worldwide.

Correlation: A measurement of the degree of mutual variation between two random variables. The correlation coefficient is bounded by the values +1 and -1. A correlation close to +1 indicates that the two random variables tend to move in the same direction (i.e., a higher value for one variable increases the chances for a higher value for the other variable). A correlation close to -1 indicates that the two random variables tend to move in the opposite direction. A correlation close to 0 indicates that the two variables tend to change independently of each other.

Gross Domestic Product (GDP): Market value of the goods and services produced by labor and property in a country. GDP is made up of consumer and government purchases, private domestic investments, and net exports of goods and services. Figures for GDP are released by the Commerce Department on a quarterly basis. Growth of the U.S. economy is measured by the change in inflation-adjusted GDP, or real GDP.

Nominal return: The percentage change in the value of a financial asset, where the beginning and ending values of the asset are not adjusted for inflation over the time of the investment.

Price/earnings ratio (P/E ratio): Price of a stock divided by the company's earnings per share. The P/E ratio gives investors an idea of how much they are paying for a company's earning power.

Risk premium: The additional return, above that offered by cash equivalents, on a risky investment in compensation for its risk. In the Capital Asset Pricing Model, the risk premium reflects market-related risk as measured by beta.

Standard deviation: Statistical measure of the degree to which an individual value in a probability distribution (such as the returns on an asset class) tends to vary from the average.

Valuation: Placing a value or worth on an asset. Stock analysts determine the value of a company's stock based on the outlook for earnings and the market value of assets on the balance sheet. Stock valuation is normally expressed in terms of price/earnings ratios. A company with a high P/E is said to have a high valuation, and a low P/E stock has a low valuation.

ENDNOTES

¹ As measured by the Wilshire 5000 Stock Index.

EnnisKnupp does not make an explicit adjustment to the dividend yield to account for the possible impact of future net share repurchases on equity prices. Although share repurchase programs have been popular in recent years, the future effect of such corporate actions on the income return of the broad market is difficult to predict. In particular, much share repurchase activity is related to firms' need for funding employee stock options, rather than a mechanism for distributing earnings to shareholders.

² Blue Chip Economic Indicators, and its companion publication Blue Chip Financial Forecasts, are monthly surveys of more than 50 economists from manufacturing firms, banks, insurance companies, brokerage firms and other institutions on a wide range of economic variables. They are published by Aspen Publishers.

Capital Market Assumptions Review Ohio Public Employees Retirement System

April 2006

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Background

- Review of Asset Policy requires modeling of future portfolio returns.
- Three key inputs required to model portfolio returns:
 - Expected asset class returns
 - Expected risk or volatility of returns (standard deviation)
 - Expected correlation among asset classes
- For the last two inputs (risk and correlation), historical data has proven relatively stable and therefore good future estimate.
- Historical asset class returns, however, have proven ineffective in predicting future performance so we use financial theory to estimate returns.

Basic Methodology

- Assume that risk and return are related.
- Develop an expected return for U.S. stocks using a building-block approach.
- Develop an expected return for U.S. bonds using current yields and consensus estimates for future yields.
- Calibrate the expected returns of the other asset classes based on their risk relative to the risk of U.S. stocks and bonds.

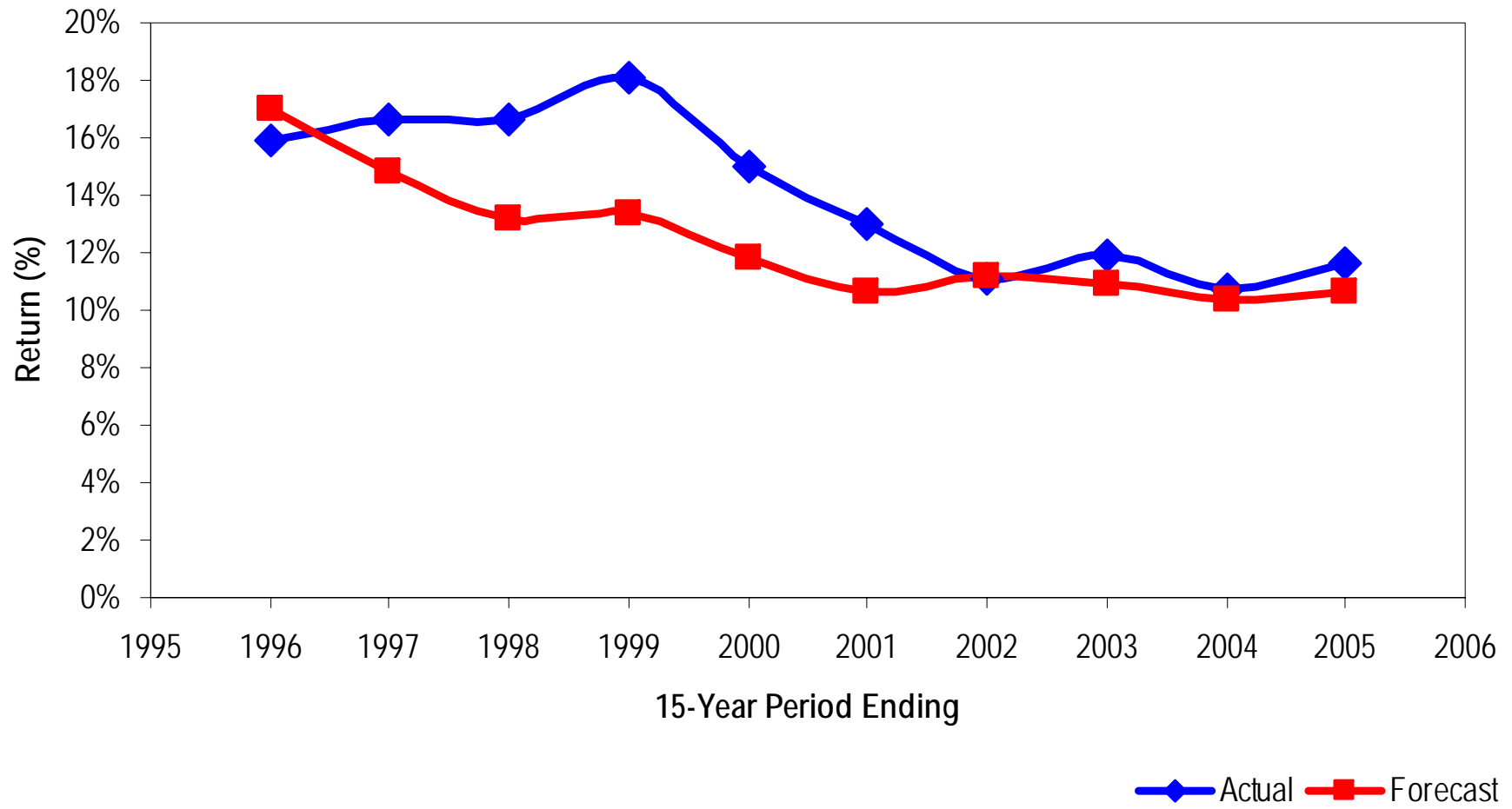
Development of the U.S. Stock Assumption

■ Dividend Income	1.7%
■ Growth in Corporate Earnings*	7.3
■ Change in Valuation	<u>0.0</u>
■ TOTAL EXPECTED RETURN	9.0%

* Using the current forecast for gross domestic product (GDP) growth from a survey of leading economists (Blue Chip Economic Indicators)

Reasonableness Test

U.S. Equity Returns Over 15 years



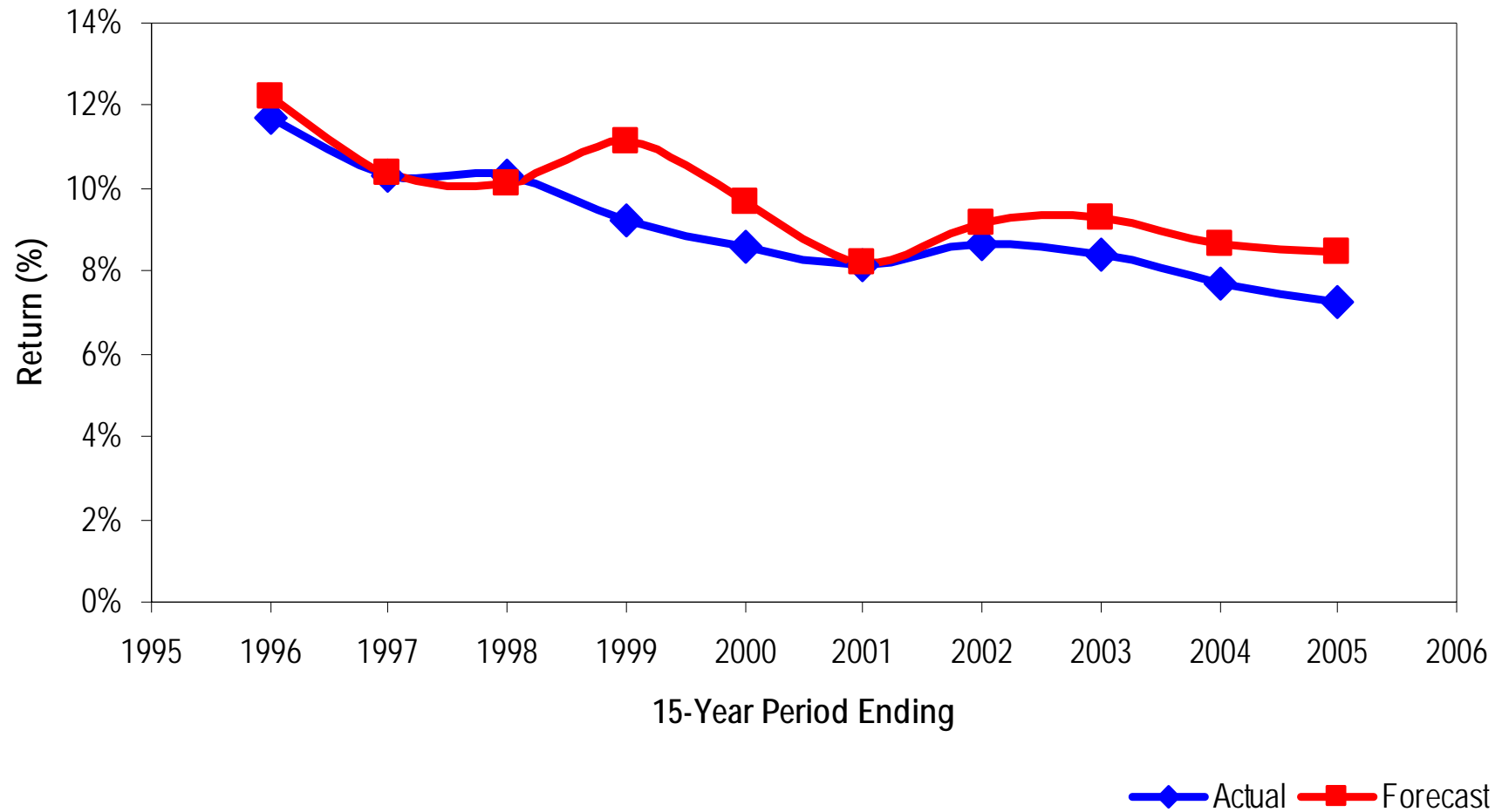
Development of the U.S. Bond Assumption

■ Current Yield to Maturity	5.1%
■ Impact of Expected Change in Yields*	<u>0.5</u>
■ TOTAL EXPECTED RETURN	5.6%

* Based on expected future yields from a survey of leading economists (Blue Chip Economic Indicators)

Reasonableness Test

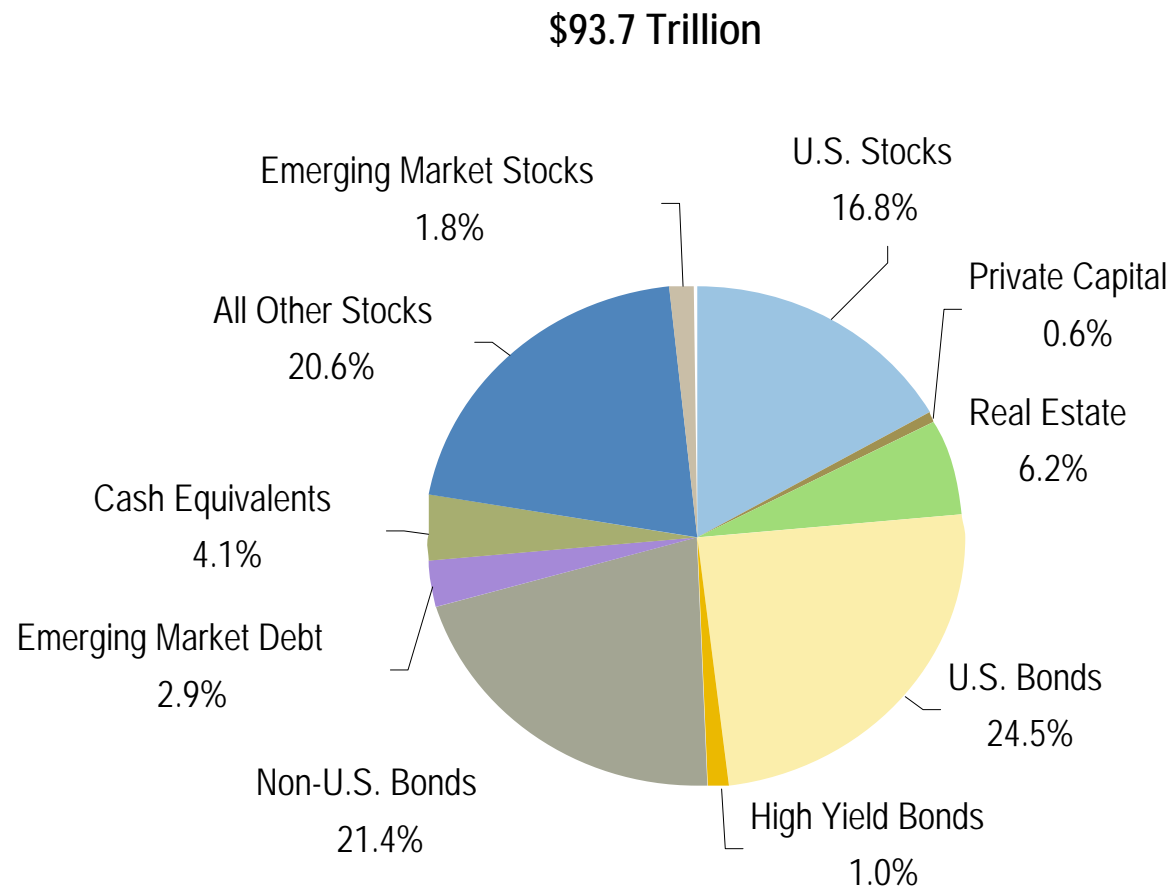
Fixed Income Returns Over 15 years



Market Risk (Beta)

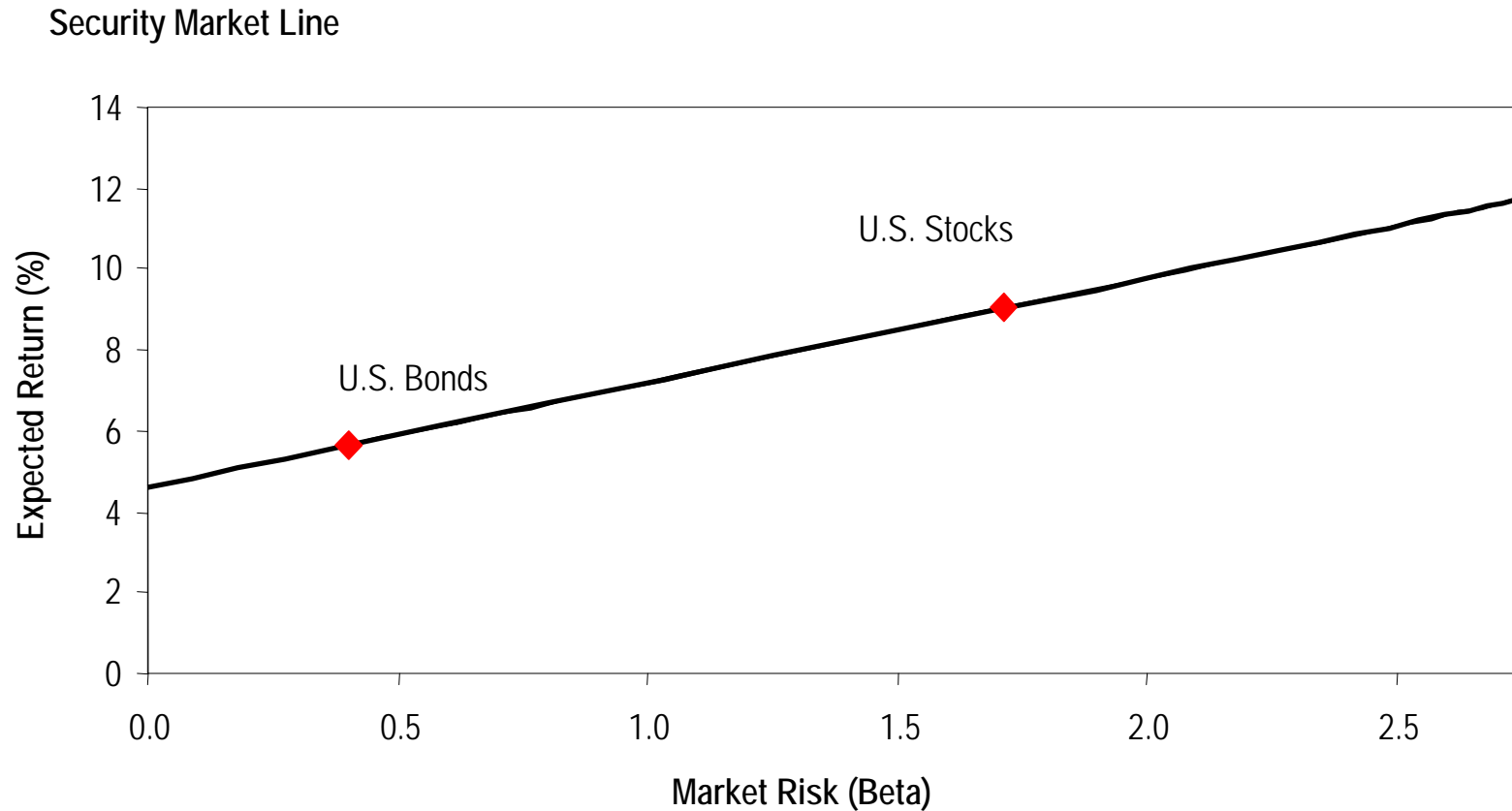
- Market risk is measured by *beta*.
- The beta of the market is 1.0.
- An asset class with beta of 2.0 has twice the risk of the market.
- An asset class with beta of 0.5 has half the risk of the market.

Defining The Market (As of December 31, 2005)



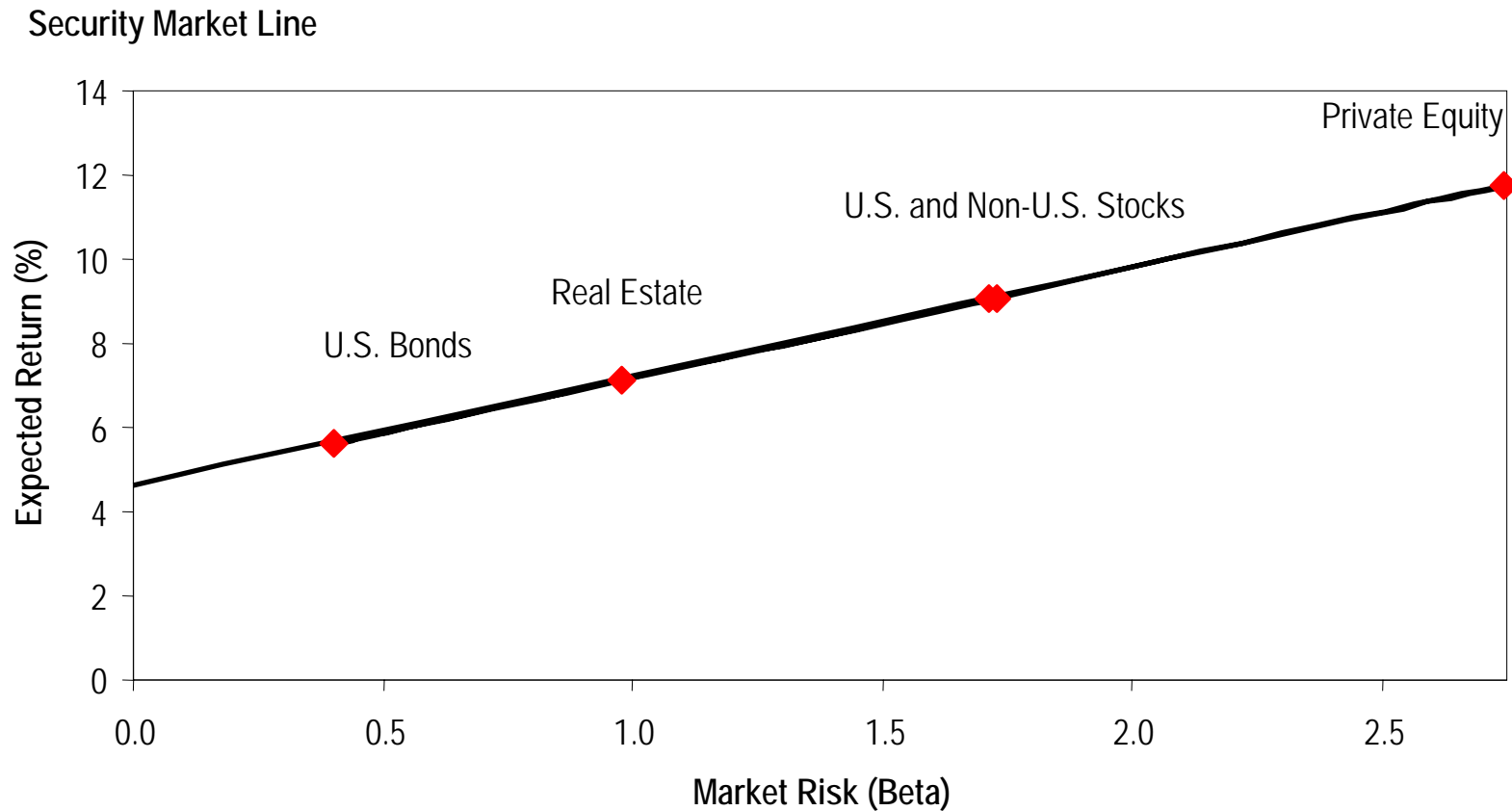
Source: UBS Global Asset Management, Venture Economics, EnnisKnupp

Tradeoff Between Risk and Return



- U.S. stock and bonds are the “anchors” that define the expected risk/return tradeoff.

Tradeoff Between Risk and Return



- Asset class expected returns are proportional to risk

Volatility Drain

- Variability in year-to-year returns causes a cumulative average return to shrink
- Example:

	Returns			
	Year 1	Year 2	Year 3	3-Year Annual
Investment #1	5%	5%	5%	5.0%
Investment #2	5%	15%	-5%	4.7%

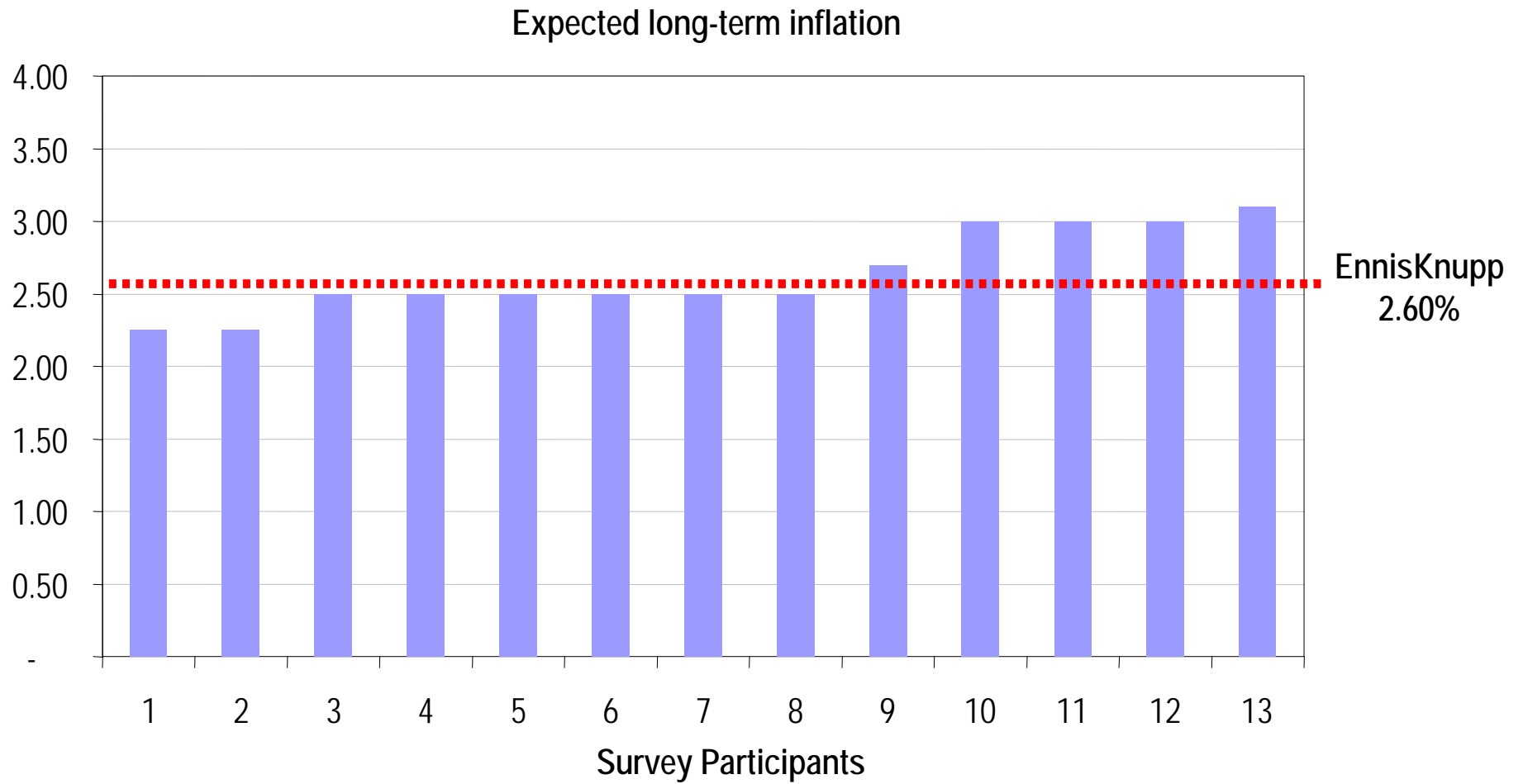
- Given stock market volatility, our 9.0% return assumption equates to approximately 7.7% compounded annually.

Long-Term Assumptions

	Single-Year Return	Volatility	Compounded Return
U.S. Stocks	9.0%	16.7%	7.7%
Non-U.S. Stocks	9.1	18.7	7.3
U.S. Bonds	5.6	6.6	5.4
Real Estate	7.1	11.3	6.5
Private Equity	14.7*	31.1	9.9

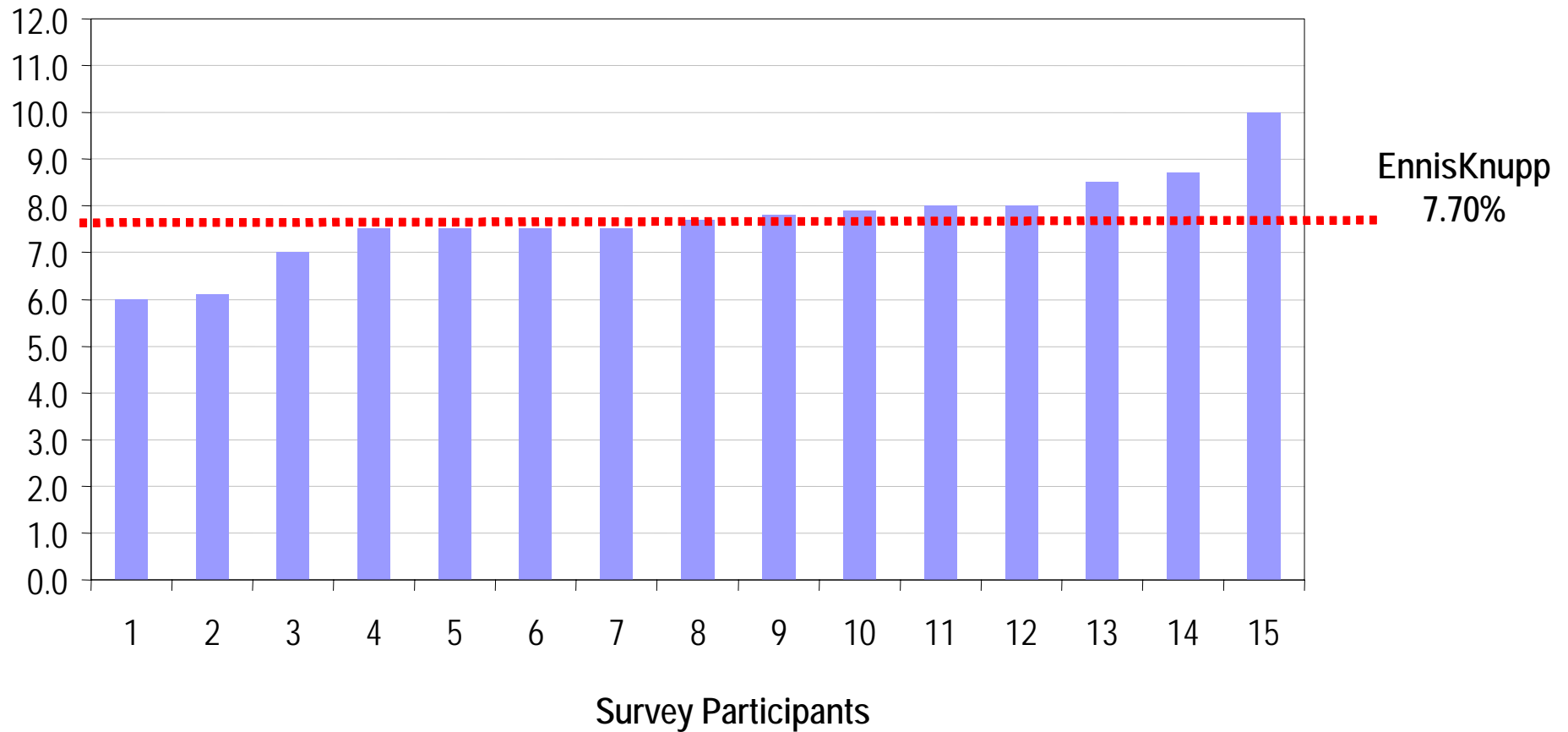
* Includes a 3.0% premium for the illiquid nature of private equity investments

Survey Results – Long-Term Expected Inflation

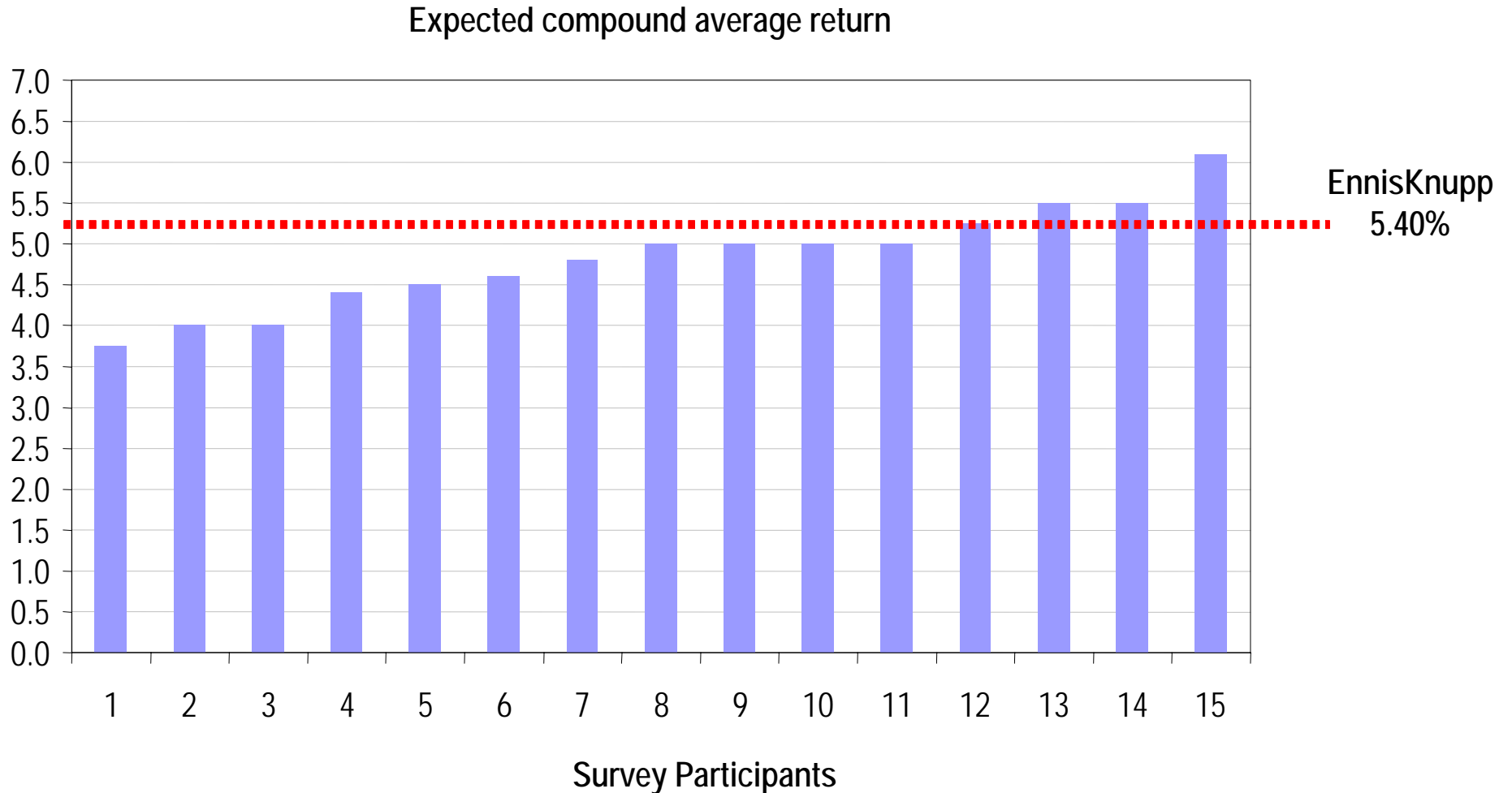


Survey Results – Long-Term U.S. Stock Return Expectations

Expected compound average return

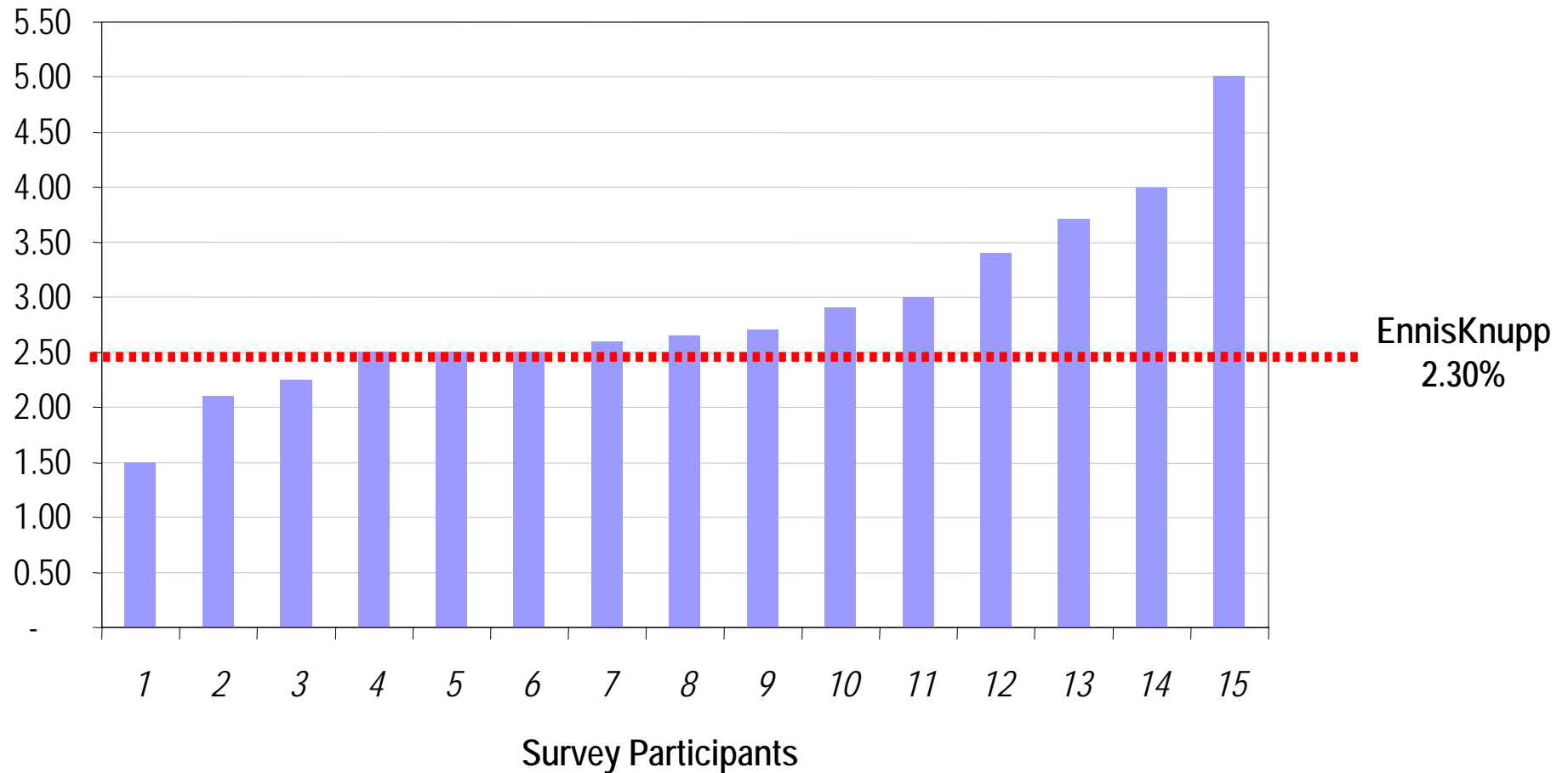


Survey Results – Long-Term U.S. Bond Return Expectations



Survey Results – Equity Risk Premium Expectations

Expected compound average return spread of US stocks over US bonds



How To Use The Capital Market Assumptions

- Not an indication of next year's returns.
- Not intended as a perpetual forecast.
- Intended as an indication of what level of returns might be expected within an intermediate horizon (15 years), or until we enter into a substantially different economic environment.

Implications of the Capital Market Assumptions

- Expect lower returns for the next 15 years than experienced in the past 15 years.
- Expect the difference between stock and bond returns to be less than in the past 15 to 20 years.

Asset Class	OPERS Target Allocation	Historical Return (past 15 years)	Forecast Return (next 15 years)
U.S. Stocks	43%	11.8%	7.7%
Non-U.S. Stocks	20	7.4	7.3
Bonds	24	7.4	5.5
Real Estate	8	10.1	6.5
REITS	1	13.9	7.4
Private Equity	4	12.0	9.9
Total	100%	10.3%	7.5%

Implications of the Capital Market Assumptions

- It still makes sense for investors to have equity-oriented policies, as common stocks are expected to earn greater returns than bonds.
 - Expected return for the OPERS's target asset allocation policy is 7.5%, which is lower than the actuarial asset return assumption of 8.0%.
 - Using the target asset allocation and our capital market expectations, there is a 42% chance that the actuarial return assumption of 8.0% will be exceeded during the next 15 years.
- But this may not be the environment in which to push common stock exposure to the highest tolerable level, as the additional reward is expected to be modest, while the risks are significant.

Next Steps

- May – Discussion of preliminary results of modeling assets with liabilities
- July – Investment policy proposal
- August – Finalize investment policy (including rebalancing policy)