TEACHERS' RETIREMENT BOARD

INVESTMENT COMMITTEE

SUBJECT: 2012 Asset Liability Study, Step 2 – Risk Exposure Allocation

ITEM NUMBER: 5

CONSENT: _____

ATTACHMENTS: 2

ACTION: ____

DATE OF MEETING: November 9, 2012 / *15 mins.*

INFORMATION: __X__

PRESENTERS: Allan Emkin and Neil Rue, PCA

POLICY

This item is covered by the CalSTRS Board Policy Manual, Section 1000, A: Investment Policy & Management Plan, (IPMP).

HISTORY OF THE ITEM

CalSTRS reviews our asset allocation targets once every three years through a full asset / liability (A/L) study. The 2012 study will transpire over several Investment Committee meetings in the next fiscal year:

Preliminary Agenda for 2012 Asset-Liability Project

September	Investment Return Objectives, Investment Objectives and Philosophy
November	Introduction of risk allocation across asset types
December	Continued discussion of risk allocation across asset types
January 2013	Debate concept of wide or narrow allocation ranges
February	Discussion / Review objectives - decision factors Discuss and approve asset classes, assumptions, and constraints
April	Presentation of CalSTRS A/L Model Interactive sensitivity analysis of objective / decision factors Approve factor weightings, select policy portfolio and set allowable ranges
June	Formally adopt the strategic asset class targets into the Investment Policy & Management Plan

PURPOSE OF THIS AGENDA ITEM

The purpose of this step in the process is to introduce the breakdown of risk exposures imbedded within various asset classes and study how risk varies in different economic regimes.

BACKGROUND

During the September 7, 2012, Investment Committee meeting, the 2012 Asset / Liability study started with a discussion of relative, real, and absolute return investments. This step builds on that discussion by looking at various investments across their risk exposure and how they perform in different economic regimes. For the past 20 years, CalSTRS and all other institutional investors have built their portfolios using Modern Portfolio Theory (MPT) and looking at the world through risk being defined by one term, standard deviation. This effort attempts to expand that thinking and looks at different forms of risk and different drivers of both an investment return and its risk exposures.

In the traditional method, the optimum portfolio may contain too much exposure to GDP growth and therefore be overly susceptible to prolonged periods of low growth. While it may achieve the desired results over a 20 year period, it will suffer more downside volatility during economic recessions. Since the return is linked year to year, geometrically, rather than just a simple average over time, starting in a low growth period will result in inferior compounded returns.

To be very clear, CalSTRS will continue to follow and use Modern Portfolio Theory, but we are attempting to expand our perspective and analyze investment risk in other perspectives.

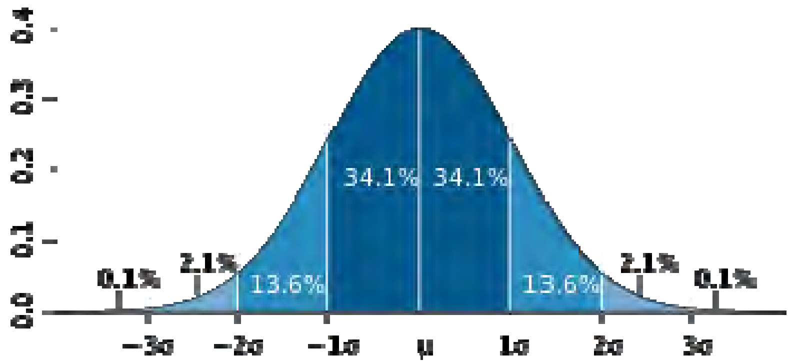
DISCUSSION

Pension Consulting Alliance (PCA) has developed the attached report taking some of our current investment areas and calculating their associated risk factors at June 30, 2012. Staff and PCA will explain the chart and the methodology at the Investment Committee meeting. The risk exposure highlights, as we have discussed before, that the majority of investments in the portfolio are exposed to GDP growth risk, followed by interest rate risk. This view of the portfolio provides a more powerful picture than just looking at risk as a standard deviation and correlation. Additionally, these risk exposures are based on the characteristics of these actual investment areas. This is in contrast to MPT, where the standard deviation and correlation are based on assumptions.

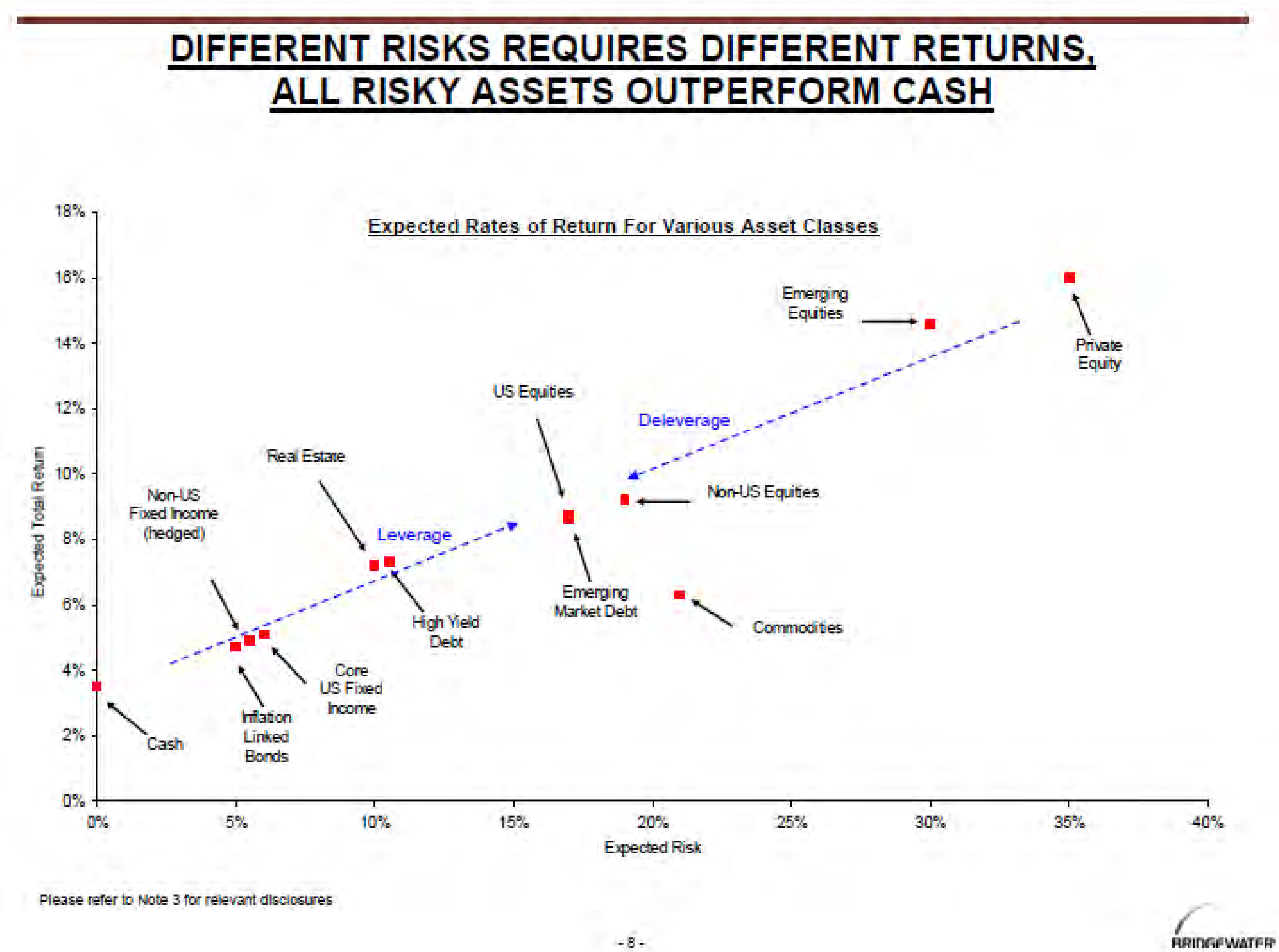
While the risk allocation method has positive attributes, the challenge and chief criticism of this method is that these risk exposures are not static over time. Since this is a picture of the risk attributes at June 30, it can and will change by December 31st. As a result, optimizing a long-term investment strategy using these risk exposures proves to be very difficult. Additionally, it requires us to make assumptions about the future risk exposures and is therefore, subject to the same human estimation risk as MPT. As additional background reading material, staff has attached a paper by Neuberger Berman, titled Risk Budgeting with Asset Class and Risk Class, critiquing this risk exposure concept (see Attachment 2). The conclusion is that while this risk effort is a worthwhile exercise, it is not likely to conclude with a very different portfolio. Since very few institutional investors have actually gone all the way through this exercise, it's too early to conclude that it won't result in a better portfolio. At the least, it will help us discuss, debate, and optimize the risk drivers and exposures of the portfolio, and that alone is a worthwhile end result.

MODERN PORTFOLIO THEORY

One of the biggest challenges in using MPT is that it assumes investment returns and risk will exhibit a normal distribution pattern" as displayed below:

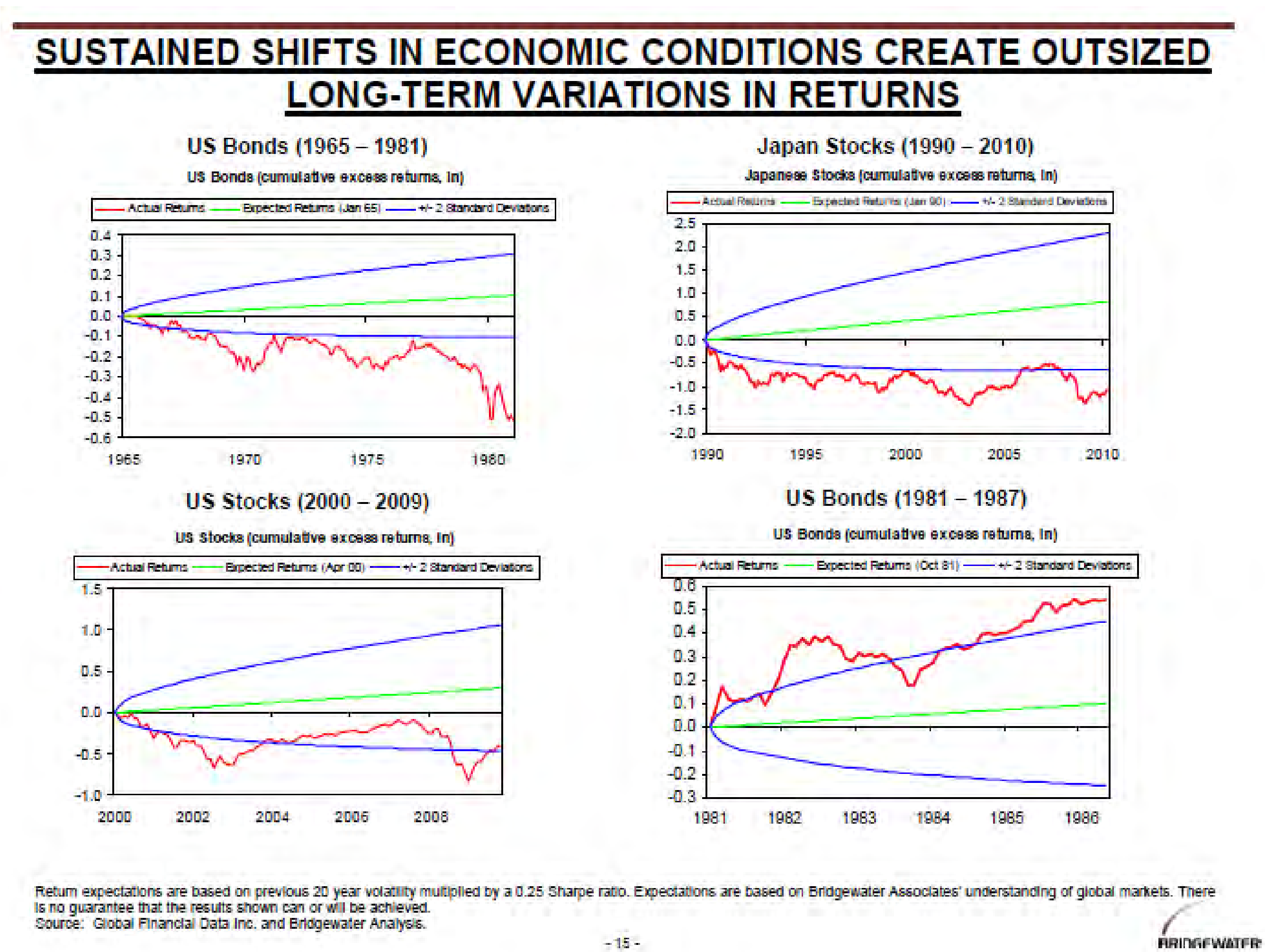


Looking at it another way, the following chart from [Bridgewater](), depicts the traditional "efficient frontier" of risk versus return. It also assumes a "normal" or ideal investment environment.



This world assumes life remains within one or two standard deviations of the "norm" or historic average. The trouble begins when real life happens out there between three and four standard deviations. In theory, that only occurs 4.4 percent of the time and half of those should be extreme positive outcomes, while 2.2 percent will be extreme negative outcomes like the global financial meltdown of 2008. We have argued in our 2010 risk study, that in the financial markets with non-stationary correlations, the downside risk maybe more than twice that size at 5.5 percent of the potential outcomes. Put another way, a negative 25 percent return can be expected to occur once each 20 years rather than once every 50 years.

The Bridgewater analysis below highlights the variation in investment return behavior in different economic conditions. We find, not surprisingly, that investments do not follow a normal distribution; in fact, anything but, as this shows investments can spend five to ten years well outside two standard deviations of the "expected / normal" distribution.



This leaves all long-term institutional and retail investors with a huge challenge, how do you construct a portfolio with the optimum risk and return balance. Modern Portfolio Theory has served as the core tool for over 35 years, but the examples above and the hard lesson of the decade of the 2000's require additional tools to navigate highly dynamic markets. Staff and PCA believe the risk allocation method is one potential additional tool along with MPT.

CALSTRS RISK STRUCTURE

In 2010, the Investment Committee heard several presentations on risk oriented asset allocation at the September and November meetings, (the hyperlinks connect to the past agenda items). This effort culminated in the adoption of the CalSTRS six risk factors and then incorporating them into the overall Investment Policy and Management Plan.

From 1913 to 1972 the CalSTRS Investment Portfolio was 100 percent exposed to interest rate risk. In ‘72, the Legislature expanded the list of authorized investments. The risk exposure in the mid ‘70’s and ‘80’s was predominately interest rate with a small exposure to GDP growth and leverage risk. The Actuarial Assumed Rate was only four percent. With the passage of Prop 21 in 1984 the portfolio became broadly diversified and the risk exposure shifted from interest rate to GDP growth. As noted above, the risk attribution of any particular investment is not static, so the risk exposure of the portfolio changes daily even if the traditional asset allocation does not. For example, inflation risk has been stagnant for several decades but if it increases, it would become a critical driver of risk in equities and real estate.

Since there is a strong linear relationship between risk and return within the investment world, the return objective drives the risk level and most of the exposures. With traditional investments, if an investor is seeking an income return with a low risk, the underlying portfolio will mostly be exposed to interest rate and market liquidity risk. If an investor, using traditional investments, is seeking capital appreciation and higher returns, then the underlying portfolio will usually have a large exposure to GDP and some residual exposure to leverage and inflation. With the creation of Hedge Funds and a variety of new investment vehicles, it is possible for the underlying risk exposure to come from multiple sources despite the overall return objective.

At the December and possibly January meeting, the Investment Committee will be given the option to consider different investments based on the estimated risk attribution rather than simply their expected return and standard deviation. These investments will include those that were described as “Absolute Return” at the September meeting, which PCA defined as investments that have a zero benchmark and whose goal is to "make money, but not lose money". While a lofty wonderful goal, as stated above, there is a tight linear relationship in the investment world between risk and return. Therefore, all investors, as well as CalSTRS, face the challenge of balancing these in a very difficult global financial market.

CONCLUSION

Given the limited time for this Investment Committee meeting, staff and PCA will just focus on our current asset exposures and the methodology of risk attribution. At the December Investment Committee meeting, PCA will try to provide the risk attribution of other investment areas, specifically the one presented under "absolute return" investments at the September meeting. This will allow the Committee to debate what types of investments to include and exclude from the full asset allocation study.

CALSTRS

…but periods of extended performance can be influenced by major macro themes…

Return & Risk Expectations, CalSTRS Investment Classes, Long-term and During Macroeconomic Regimes

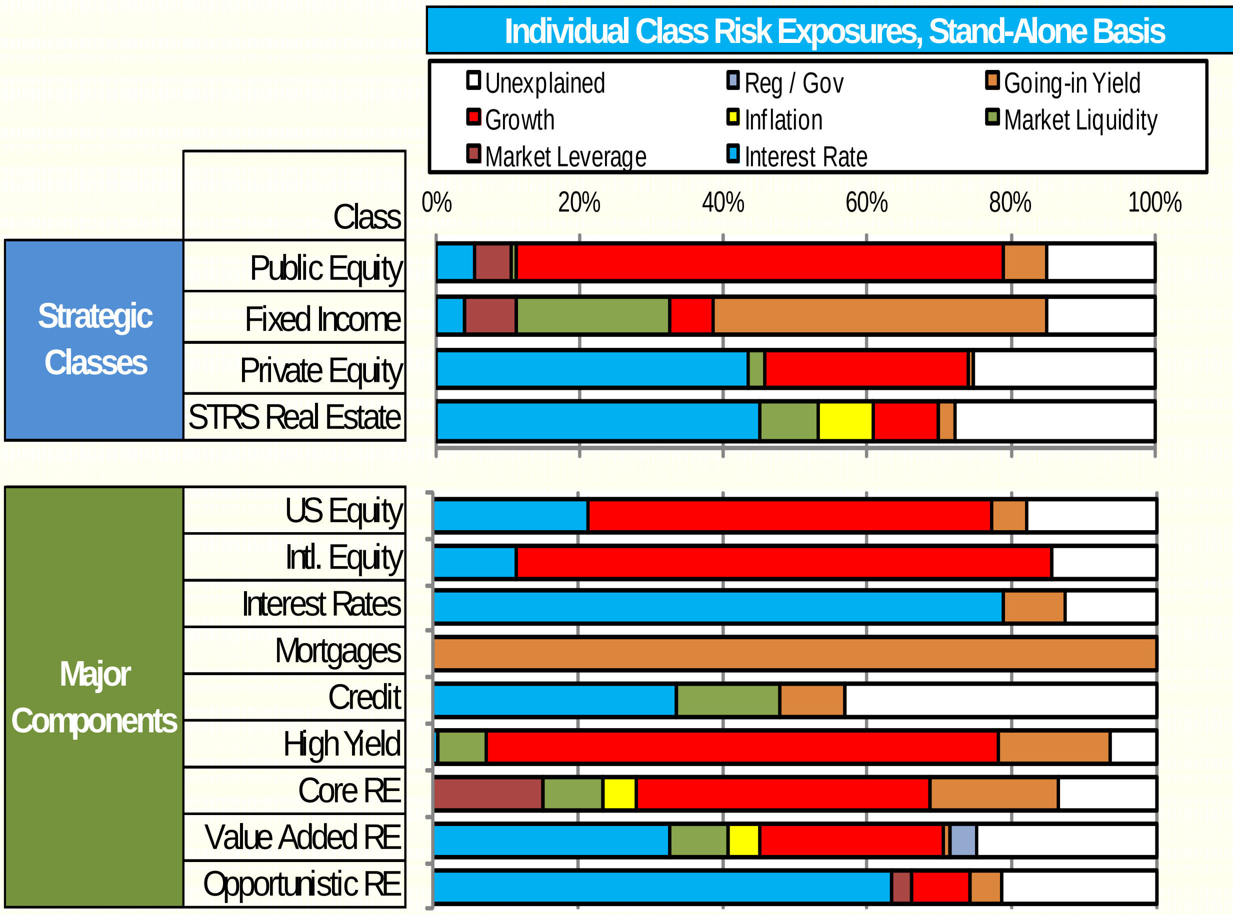
		Full Horizon Assumptions*			Inflation & Growth Regime Assumptions**							
					High Inflation High Growth*		High Inflation Low Growth*		Low Inflation Low Growth*		Low Inflation High Growth*	
	Class	Exp Geo	Expected Risk	History (years)	Exp Geo	Expected Risk	Exp Geo	Expected Risk	Exp Geo	Expected Risk	Exp Geo	Expected Risk
Strategic Classes	Public Equity	8.2%	18.5%	42	12.7%	14.9%	2.9%	19.2%	4.4%	23.6%	12.5%	15.2%
	Fixed Income	2.8%	4.5%	42	3.3%	4.8%	3.6%	6.8%	2.9%	3.3%	1.6%	3.4%
	Private Equity	10.0%	26.0%	42	13.7%	24.3%	7.7%	29.5%	5.4%	29.4%	12.9%	23.6%
	STRS Real Estate	7.8%	18.2%	42	11.8%	6.4%	13.0%	14.1%	-1.9%	24.0%	8.9%	12.3%
Major Components	US Equity	8.0%	18.0%	42	7.7%	16.9%	6.3%	20.5%	5.3%	23.2%	12.6%	11.1%
	Intl. Equity	8.1%	21.0%	42	15.3%	17.2%	0.0%	18.4%	4.0%	24.3%	12.7%	21.9%
	Interest Rates	1.5%	2.5%	42	1.7%	2.6%	2.9%	2.9%	1.0%	2.2%	0.6%	2.1%
	Mortgages	1.7%	3.7%	42	2.3%	3.6%	2.5%	6.4%	1.2%	2.1%	0.7%	2.0%
	Credit	4.0%	6.5%	42	4.9%	6.1%	3.8%	10.2%	4.8%	5.6%	2.5%	4.3%
	High Yield	4.2%	11.7%	42	3.1%	8.9%	2.3%	13.2%	7.4%	16.3%	3.3%	5.6%
	Core RE	6.9%	14.3%	42	10.6%	8.0%	10.0%	16.0%	0.7%	19.6%	7.7%	9.9%
	Value Added RE	7.1%	20.0%	42	12.7%	11.2%	11.5%	22.4%	-2.0%	27.4%	8.4%	13.9%
	Opportunistic RE	9.0%	20.8%	42	14.8%	15.3%	13.5%	23.2%	-0.5%	28.4%	10.4%	14.4%

- Expectations can vary dramatically based upon the macroeconomic environment

*Capital market assumptions are preliminary and subject to change after 12/31/2012.

**Regime assumptions determined by adjusting historical time series to forward looking assumptions and then arranging the modified time series into periods of high and low inflation/gdp growth with "high" meaning above-median of entire history and "low" meaning below-median of entire history.

…an asset's exposure to certain macro risks can really matter…



- Macro risks are like viruses: they don't care about the name of the host assets
- The "purest" asset, Interest Rates, models well

Risk Budgeting With Asset Class and Risk Class

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June 2011

One of the natural responses to the most recent financial crisis is to point out the failure of Modern Portfolio Theory and Mean-Variance Optimization in providing diversification when it was most needed. This has led some critics, including pensions, foundations and endowments to propose displacing "asset classes" with "risk classes" for the purpose of asset allocation. With this new Risk Class approach, investors determine an optimal mix of assets by achieving target exposures to different risks. From a conceptual standpoint, the Risk Class approach appears to be superior to an Asset Class approach as it recognizes that investable and tradable assets in a portfolio are merely vehicles for investors to gain exposures to a set of risks that are believed to be rewarded. However, practical application of the Risk Class approach presents its own set of challenges. If we consider that when the Risk Class approach is fully executed so that all risks are specified and idiosyncratic elements are almost negligible and uncorrelated, the approach converges with the Asset Class approach.

INTRODUCTION

In describing a portfolio, a set of portfolio weights that reflect capital allocation is the natural starting point because of its clear definition, timeliness, and the fact that it can be precisely measured. A description of a fund in Bloomberg, for example, typically includes asset class, regional, and sector allocation, followed by top ten and other portfolio holdings which are expressed as percentage weights of the total investment value.

By now, however, most investors realize that more analysis is required in order to understand the risks of the portfolio behind the set of measurable portfolio weights. This is where investors may have differing opinions. How will this portfolio perform if economic growth in the next quarter disappoints? What if inflation accelerates more than expected? How about oil prices reaching $125 a barrel? Unlike capital allocation, which is accounting driven, risk allocation is based on one's estimation of multiple parameters over potentially different time frames with different techniques, and may even begin with different definitions and interpretations of risks.

According to the Modern Portfolio Theory (MPT), investors seek balance between return and risk. While over time many alternative risk measures have been developed and better understood, the one proxy for risk that all investors continue to estimate and consider is the volatility of a portfolio, which takes into account the volatilities and correlations of all assets. Mean-Variance Optimization (MVO), whose required inputs include expected returns and a covariance matrix, is often used together with MPT. The theory and practice go hand in hand, so that an investor will seek to maximize portfolio return subject to his/her degree of risk aversion, which determines the level of portfolio volatility one may find appropriate. Although the theories provide a powerful and intuitive framework, they do not dictate how the required inputs should be determined. For instance, the investment horizon, estimates of expected returns, volatilities, and correlations among assets are all subject to an investor's approach.

Practitioners have offered some "next generation solutions" to what "went wrong" as their response to the most recent financial crisis. One of the most common refrains has been that MPT/MVO failed investors in providing diversification when it was most needed.[1] In particular, the failure of risk management points to the interpretation and the modeling of assets and portfolio risks. Some critics, for example, consider the use of a covariance matrix of assets as traditional and flawed. They point out that the traditional approach promotes seeing the world as defined by assets, such as stocks, bonds, commodities and the like. Their arguments go even further, emphasizing that the ways in which these assets responded during the financial crisis clearly indicated that asset classes, while different, could be exposed to the same risks. As such, some of these critics propose to displace "asset classes" by "risk classes" for the purpose of asset allocation. In this new Risk Class approach, the investor will determine the optimal mix of assets through which target exposures to different risks are achieved.

We think that this Risk Class approach makes a lot of sense conceptually, which should make the discussions and thought process of asset allocation more interesting and understandable. However, we do not believe that putting it into practice is any easier than the Asset Class approach. In the following sections, we discuss the motivation of the Risk Class approach through the most basic concept of asset pricing. We argue that the Risk Class approach is a more structural approach to modeling a covariance matrix of assets. However, our numerical examples illustrate that it comes with a price: more model misspecification risks and parameter uncertainties. We emphasize that when the specification of risks is complete and idiosyncratic elements are almost negligible and uncorrelated, the Risk Class approach converges with the Asset Class approach.

ASSET PRICES AND RISKS

Understanding the risks embedded in a portfolio is one of the most important steps in putting MPT to work. To establish a comparison of the asset class and the risk class perspectives, we went back to the drawing board using one of the most fundamental concepts in financial theory, namely, the present value of assets.

Financial assets are valued based on the stream of uncertain cash flows discounted by a risk-adjusted discount rate. In equation form, current price can be expressed as

$$(1) \qquad \text{Price}_0 = \frac{E_0[C_1]}{1+k_1} + \frac{E_0[C_2]}{(1+k_1)(1+k_2)} + \frac{E_0[C_3]}{(1+k_1)(1+k_2)(1+k_3)} + \ldots$$

where C_t is the uncertain cash flow at the end of period t, k_t is the discount rate for the period t, and $E_0[\bullet]$ denotes the expected value as of the current time. This equation is a mathematical identity that defines current price. In the simplified version, one may assume that the discount rate stays constant in all periods so that $k_t = k$. In the case of stocks, C_t are future dividends, while in the case of bonds, C_t are interests to be earned

[1] See Kritzman (2011) for different perspectives.

and the face value of the bond to be returned in the last time period. Risk modeling of an asset is thus rooted in our understanding of how prices move in accordance with this present value determination.

First, consider the volatility of a single asset. The causes behind an asset's price moving from one period to another must correspond to the changes in expectations of future cash flows and the perceived risk of the asset that is reflected by revisions to the discount rates used in calculating the present value. For instance, a "growth" factor can impact asset prices when business conditions are expected to deteriorate. In such a scenario, one may revise the expected future dividends of stocks to reflect slower growth, and revise the dividend discount rate up to reflect the higher expected risk premium, given higher perceived uncertainty. Both revisions will put a downward pressure on stock price. In the case of bonds, if coupons are fixed, then price change must be the result of changes in discount rates in response to a change in the growth factor. An "inflation" factor can work in a similar way. Suppose future inflation is expected to accelerate. Expected future dividends may be revised up if one believes that companies with pricing power will pass the nominal increase in goods price to their earnings and therefore dividends. Of course, the revision can also be downward in case one expects economic conditions to start to deteriorate in response to accelerating inflation, which ultimately has negative impact on growth and, therefore, propensity to consume. Inflation also tends to lead to upward revisions of future dividend discount rates not only as a nominal effect; but also a higher perceived risk as related to unstable prices. If coupons of bonds are fixed, then higher inflation has unambiguous negative impact on bond price through a higher discount rate.

Second, consider how assets are correlated with each other. Correlation measures how one asset moves with another. As a result, correlation between two assets must be determined by how their prices change over time, which is in turn driven by how their respective expected cash flows and discount rates are revised in response to changes in conditions. In the example above, correlation between stocks and bonds will be driven by how their prices move in response to changes in the "growth" and "inflation" factors. Needless to say, response to changes in factors of the same assets can be different at different times. Forecasting correlations precisely, therefore, requires a full understanding of how assets react to changes in different factors over time. In addition, at times, one asset may react to conditions that are unique to that particular asset, while other assets show no reactions whatsoever.

FROM ASSET CLASS TO RISK CLASS

The practice of asset allocation requires modeling risks of assets. For example, to determine the optimal allocation between stocks and bonds in a portfolio, we need a covariance matrix that includes the volatility of stocks, volatility of bonds, and correlation between the two assets. The Risk Class approach differs from the Asset Class approach by inserting an additional step in the process of modeling the covariance matrix. Instead of modeling the volatilities and correlations of assets directly as in the Asset Class approach, the Risk Class approach first imposes a factor structure on all assets so that volatility of an asset is driven by its exposures to these factors, the factor volatilities, as well as the idiosyncratic volatility of an asset that is unrelated to these factors. Since idiosyncratic volatilities are asset specific and do not overlap with other assets, by definition, correlation of assets are determined entirely through their relative exposures to the same set of factors.

In the earlier example with growth and inflation as the only two factors, we may specify the structure of stocks and bonds as follows:

(2) Stock Return = $\text{Constant}_S + \text{Beta}_{S,G}$ x Growth + $\text{Beta}_{S,I}$ x Inflation + Stock Specific

Bond Return = $\text{Constant}_B + \text{Beta}_{B,G}$ x Growth + $\text{Beta}_{B,I}$ x Inflation + Bond Specific

where Beta denotes exposure of an asset with respect to a factor, subscripts S, B, G, and I denote stock, bond, growth factor, and inflation factor, respectively. Assuming that the factor structure above is correct, volatilities of stocks and bonds can then be determined by their respective exposures to these factors, the factor volatilities, and the idiosyncratic volatilities of the assets. The correlation between stocks and bonds, given this factor structure, is entirely driven by how the stocks and bonds are exposed to these two factors. If both assets have positive exposures to the Growth factor, for the purpose of illustration, then a shock to the Growth factor will lead to a positive correlation, everything else being equal.

Obviously, the Risk Class approach has very intuitive appeal if the factor structure assumed is an accurate reflection of reality. With a factor structure such as the above, one can interpret, and even forecast, the correlation of stocks and bonds based on our understanding of how each asset responds to factor shocks, such as through the lens of the present value model discussed earlier, in an attempt to understand how the expected cash flows and the discount rates react.[2]

It is a big "if," however. First, what if our estimates of asset exposures to factors are off? If we get the signs of exposures correct but not the magnitudes, our correlation forecast is likely to have the correct sign, but is either too high or too low. And, if the signs of exposures are incorrect, our correlation forecast may be in the wrong direction as well, which would clearly affect our asset allocation decisions.

Second, what if there are missing factors? In this scenario, the assumed factor structure will not capture the correlation completely, therefore, diversification benefits will not be fully captured and forecasts of portfolio volatilities will be inaccurate. One simple diagnostic on the completeness of the Risk Class approach is to check the idiosyncratic components as defined by the factor structure. If the factor structure is complete so that the correlation of assets is fully captured, then by construction, the idiosyncratic components must be uncorrelated and have a relatively small contribution to asset variance when compared with factor related volatility. If the idiosyncratic components are found to be correlated, there must be some other factors that were missed by the current structure that still have an impact on asset correlations. Lastly, if the extent of asset volatility explained by the factors is insignificant, it may also indicate the possibility of missing factors.

Furthermore, details of model specifications, such as the definitions of factors, linear versus nonlinear, time horizons (e.g., monthly, quarterly, annual, or longer) and other considerations are all subject to debate. As a preview, the disappointing results of using the Risk Class approach in describing the realized risk characteristics of stocks and bonds in the following example could have been the result of model specifications to an extent.

[2] A relevant analogy is the structural macroeconometric modeling of the economy, particularly popular in the 1970s, such as the work by the Wharton Econometric Forecasting Associates (WEFA). Hundreds of structural equations were modeled and linked in order to understand and forecast economic variables. In contrast, the Vector Autoregression (VAR) introduced in the 1980s is often considered as the reduced-form approach to estimate economic relationships.

EXAMPLE

Recently, the Risk Class approach for asset allocation has caught the attention of the investment community.[3] However, there is generally no agreement on the methodology behind determining the factor structure. For illustrative purposes, we have estimated a factor structure for the S&P 500 and U.S. 10-Year government bond with a set of variables that can be related to growth and inflation factors. Given that our primary goal is to shed some light on the merits and challenges of the Risk Class approach rather than estimating the best factor structure, we simply followed a classical study by Chen, Roll, and Ross (1986) in selecting and defining the set of factors. For simplicity, we have grouped the factors into two broad categories—Growth and Inflation:

Growth:

- Monthly percentage change of the Industrial Production Index
- Credit spread, defined as the difference between the Moody's Baa yield and Aaa yield
- Slope of the yield curve, defined as the difference between the 10-year U.S. treasury and 1-year treasury yields

Inflation:[4]

- Monthly change in expected inflation rate
- Unexpected inflation

The factor structure in the risk class approach is estimated using the sample period of monthly data from April 1953 to December 2010.

It should be noted that if the factor structure is perfect, meaning that the Growth and Inflation factors (as defined) completely capture the risk characteristics of the assets as well as their correlation, then the volatilities and correlation as determined by the factors should match exactly the realized volatilities and correlation during this sample period. Recognizing the possibility that the factors alone may still miss some of the unaccounted variations of stock returns and bond returns, one may add back the stock- and bond-specific volatilities on top of the factor driven components. However, there is no guarantee that the second set of estimates, even taking into account risks specific to the assets that are unrelated to the factors, will match the realized risk statistics exactly. The reason is, if there are additional factors beyond Growth and Inflation that drove to an extent the correlation and volatilities of the assets, then what we consider as the specific risks of the assets will not be uncorrelated, as the missing factors are embedded there. Comparing these three cases, namely, (I) Factors Only, (II) Factors + Uncorrelated Specific Risks and (III) Factors + Correlated Specific Risks, where the last case should be identical to the Realized Sample statistics, will give us the extent of how well the factors captured the volatilities and co-movements of the assets, and how important the missing factors are, if there are any, in determining the risk characteristics of the assets.

Note that the empirical exercise here is not to forecast risks but, instead, merely to try to assess how successful a Risk Class approach, subject to the specification of factor structure, might have captured or described the realized risk characteristics of the assets. Table 1 reports the results, which are very interesting, if not alarming.

[3] See Rue (2009) and white paper of Meketa Investment Group (2010) on risk budgeting for examples.
[4] We follow the methodology of Fama and Gibbons (1984) in estimating expected and unexpected inflation.

TABLE 1: RISK CHARACTERISTICS OF S&P 500 AND U.S. 10-YEAR GOVERNMENT BOND: APRIL 1953 TO DECEMBER 2010

	(I) Factors Only	(II) Factors + Uncorrelated Specific Risks	(III) Realized Sample = Factors + Correlated Specific Risks
Volatility of S&P 500	2.04%	14.82%	14.77%
Volatility of Gov Bond	2.60%	9.43%	9.40%
Correlation	0.41	0.02	0.16

Source: Neuberger Berman Quantitative Investment Group.

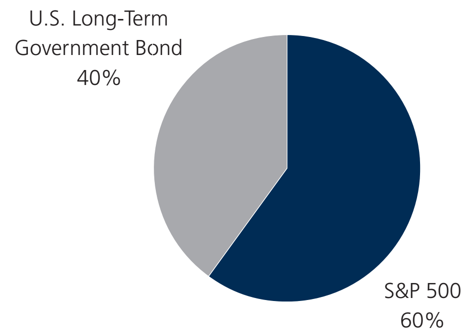
According to the estimated factor structure labeled Factors Only in the table, the volatilities of the S&P 500 and government bonds during this period, as driven by the Growth and Inflation factors, should have been 2.04% and 2.60%, respectively. Compared with their realized volatilities of 14.77% and 9.40%, these surprisingly low factor driven volatilities suggest that during this sample period, most of the volatilities of stocks and bonds were not driven by the Growth and Inflation factors together. Besides, the correlation between stocks and bonds in accordance to the factor structure alone should have been 0.41, compared with the realized correlation of 0.16.

Next, we add the Uncorrelated Specific Risks of stocks and bonds to the Factors Only, and the results are grouped under column (II) in the table. Note that volatilities of stocks, bonds and their correlation, after taking into account their specific risks, are now estimated to be 14.82%, 9.43%, and 0.02, respectively. These values are still different from, but much closer to, the realized sample values.

What could have been the missing factors beyond Growth and Inflation accounting for the gaps in asset volatilities and correlation during this period? Of course, the poor results could have been because of the way we specified the factors. As discussed earlier, a challenge of the Risk Class approach is that the true factor structure is unobservable. However, recent history may suggest that one such factor could have been related to risk aversion, or what some investors interpret as flight to safety. During the last decade or so, we have often observed that stocks and bonds moved in opposite directions during and around crisis, such as the 2008 global financial crisis. It may be helpful to refer back to the present value definition in Equation (1). Presumably, if investors attribute the risk aversion impact entirely on the assets through future growth and/or inflation, then the factor structure with Growth and Inflation factors should have captured the risk characteristics. However, if investors raise the discount rate for stocks and lower the discount rate for bonds in anticipation of higher risk aversion (having nothing to do with the future growth and inflation perspectives), then the Growth/Inflation factor structure is clearly miss-specified, and its degree of miss-estimation of assets risk characteristics will depend on the relative importance of the missing factors versus the included factors. In addition, even if the risk aversion is a factor that can be quantified, there is no guarantee that including it as the third factor could have perfectly captured the assets risk characteristics. There may be other unknown factors that were at work.

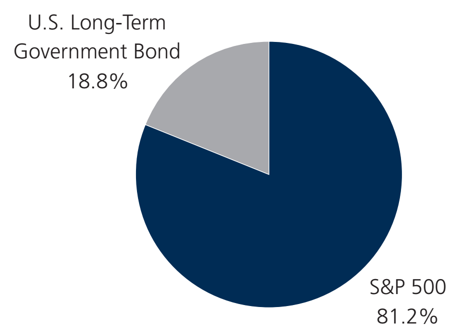
To make further comparison of the Asset Class and Risk Class approaches, we apply the results above denoted as Case (III) to analyze a 60/40 portfolio of the S&P 500 and the U.S. Long-Term Government Bond. The 60/40 portfolio volatility is calculated as 10.16% during this sample period. Figures 1, 2, and 3 represent three different descriptions of the same 60/40 portfolio.

FIGURE 1: PORTFOLIO WEIGHTS OF 60/40 PORTFOLIO



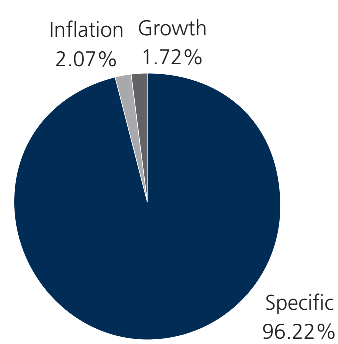
Source: Neuberger Berman Quantitative Investment Group.

FIGURE 2: RISK CONTRIBUTION OF 60/40 PORTFOLIO BY ASSET CLASSES (4/1953 – 12/2010)



Source: Neuberger Berman Quantitative Investment Group.

FIGURE 3: RISK CONTRIBUTION OF 60/40 PORTFOLIO BY RISK CLASSES (4/1953 – 12/2010)



Source: Neuberger Berman Quantitative Investment Group.

While Figure 1 is just the standard representation of a portfolio by portfolio weights, Figure 2 represents the percentage of risks of the 60/40 portfolio that can be attributed to each asset class.[5] Based on the historical, realized sample risk statistics of stocks and bonds during the sample period of April 1953 to December 2010, stocks accounted for over 80% of the 10.16% volatility of the 60/40 portfolio. This reaffirms the observation that portfolio weights of assets do not fully reflect risk contributions from the assets.

Figure 3 provides risk contributions by risk factors or classes.[6] Given the results we discussed earlier, it should not be a surprise to see that the volatility of the 60/40 portfolio that can be attributed to the risk factors is very low. Both the Growth and Inflation factors are shown to have accounted for about 2% of the total volatility of the 60/40 portfolio. In other words, about 96% of the volatility of the portfolio is the result of either missing factors and/or risks that are specific to the asset class stocks and bonds.[7]

DISCUSSIONS AND SUMMARY

From a conceptual standpoint, the Risk Class approach appears to be superior as it recognizes that investable and tradable assets in a portfolio are merely a vehicle for investors to gain exposures to a set of risks that are believed to be rewarded. Therefore, this approach provides a deeper understanding of what drives the risks and returns of a portfolio.

In practice, however, we believe that there is little magic behind the Risk Class approach and it doesn't necessarily offer a superior investment framework to the traditional Asset Class approach. As a matter of fact, when risk is measured by volatilities and correlations, we argue that, technically, the Risk Class approach is a structural, or factor approach of modeling the covariance matrix of the assets, using similar practices that can be dated back to the 1970s.[8] In addition, the success of such an approach depends on whether the investors can come up with a set of risk factors that not only are of interest and relevant to their strategic and/or tactical concerns, but also successful in capturing the exposures of the assets with respect to all of these factors. Besides, a majority of the risk characteristics of the assets that make up the portfolio should be driven by these factors rather than by the idiosyncratics. If the factors account for only a small portion of the assets' risks, then the Risk Class approach provides insignificant insights beyond the historical risk characteristics of the assets.

Finally, many, if not all, of the challenges in applying the Asset Class approach are equally, if not more, relevant to the Risk Class Approach. For instance, critics point out that the Asset Class approach relies on the assumption that correlation and volatilities of assets remain stable over a predetermined investment horizon. As discussed earlier, the Risk Class approach is a structural modeling of the covariance matrix of the assets.

[5] See Lee (2011) for details of risk decompositions by positions.
[6] See Grinold and Kahn (1999), Chapter 3, for details of risk decompositions by risk factors.
[7] This result may appear to be in sharp contrast to studies that report high R-squares of using factors or styles in explaining the portfolios' performance. One should note that style analysis of Sharpe (1992), for example, as well as recent literature of hedge funds replication typically use asset returns as factors or styles in capturing returns and risk characteristics of portfolios. Factors used in these studies such as small-size premium, value premium, credit premium and the like are all constructed using combinations of different asset returns, therefore bypassing the focus of our example, which is to use fundamental factors such as Growth and Inflation to capture risk characteristics of asset returns. As such, we believe that the style analysis used in the industry can be grouped into the Asset Class approach instead of Risk Class approach.
[8] For example, in equity, there are many specialized firms that offer their factor models of the covariance matrix of individual stocks. These factors can include industry, style, such as value or growth, characteristics such as liquidity, among others in the fundamental approach. Others may use a statistical approach such as principal component analysis to come up with a set of statistical factors, or combinations of both fundamental and statistical factors. Similarly, in the fixed income world, factor models of the covariance matrix is equally popular, such as using interest rate level, steepness and convexity of the yield curve as factors, among others.

Therefore, criticism of the Asset Class approach implies that implementation of the Risk Class approach would require stable factor structure, exposures of assets with respect to the risk factors, as well as stable correlations and volatilities of all the factors.

In short, we appreciate the deeper insights behind the Risk Class approach beyond the observable and investable assets in the portfolio. Its implementation, however, presents a new set of challenges.

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