An Appropriate Policy Allocation for Alternative Investments

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One of the biggest problems that institutional investors face in evaluating alternative investments such as venture capital, real estate, and hedge funds is determining the "normal" or policy allocation. The typical approach relies on single-period optimization programs, using historical data as key inputs. This is fraught with well-known problems, such as enormous allocations to private equity and other non-market-priced investments. Instead, we use a factor approach to build a consistent set of return and risk characteristics for conventional and alternative asset classes alike. Further, we use simulation techniques rather than optimization to provide better insight into the characteristics of the portfolio over time as market swings and liquidity constraints force deviations from the desired policy mix.

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Introduction

Pension plan sponsors, endowments, and other institutional investors have included non-traditional investments in their portfolios for many years. Larger, more aggressive funds, in particular those with longer investment horizons, have over time increased their allocations to venture capital, real estate, hedge funds and other assets that fall outside the realm of regularly priced and traded securities.

One of the biggest problems that institutional investors face in evaluating these alternative investments[1] is determining the policy allocation. At issue are which alternative investments to include and in what proportions. In this article we evaluate which are appropriate for investment by a typical institutional investor and suggest a policy mix based on long-term return and risk characteristics as well as other factors unique to alternative investments.

Typically, analysis of policy mix alternatives is based on historical data (e.g. Amin & Kat (2001)). Such an approach is acceptable for conventional assets, which are frequently traded and have market-observable prices, if the forward-looking period is proxied adequately by the historical dataset. For alternative investments, it is tempting to use historical data for policy analysis purposes simply because such data are available; however, there are a number of considerations that obviate their use for determining policy allocations.

It is imperative that the return and risk assumptions used for policy mix analysis across conventional and alternative investments be both forward-looking and consistent in reflecting the true underlying economic exposures of the assets. Historical data are biased on both counts. In this article, we consider the biases embedded in historical return data and demonstrate the impact that such data have on standard efficient frontier policy mix analysis. In a second step, we show how risk and return can be better estimated. And finally, we provide an alternative to standard portfolio optimization, which is seriously flawed when alternative investments are involved.

The Traditional Approach – Mean-Variance Optimization Based on Historical Returns and Covariances

For purposes of determining the policy allocation, whether to conventional or alternative investments, the use of *long-term* return and risk characteristics is appropriate. These estimates should not be conditional on the current or near-term market and business cycle situation, but instead focus on the characteristics relevant for the portfolio over a long horizon.

Often, policy studies are performed using risk and return inputs derived from long time series of historical data. Exhibit 1 shows historical returns, volatilities and correlations for asset classes as they are conventionally defined by U.S. institutional investors: U.S. and non-U.S. equities, U.S. and non-U.S. bonds, and alternative investments.[2]

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[1] Generally we distinguish between alternative assets and alternative strategies. The returns of alternative assets are primarily a function of passive or systematic market characteristics. Alternative strategies, on the other hand, have returns that are largely a function of active management, i.e. they are hedge funds. We use the term "alternative investments" to include both alternative assets and strategies.

[2] Internally, the domestic-foreign distinction has been superceded by global and bottom-up considerations. For instance, in equity risk assessment, a simultaneous sector-market approach is used to maintain consistency with the investment process. However, in the interest of providing analytical results consistent with most policy-setting practice and avoiding unrelated home-bias and risk discussions, we maintain the U.S./non-U.S. distinction in parts of this paper.

Exhibit 1: Conventional and Alternative Investments
Historical Return, Volatility and Correlation Characteristics*

		Return	Volatility	1	2	3	4	5	6	7	8
1	U.S. Equity	14.8%	12.8%	1.00	0.55	0.35	0.24	-0.46	-0.01	0.33	0.71
2	Ex-U.S. Equity	13.2	16.7	0.55	1.00	0.14	0.29	0.00	0.39	0.25	0.52
3	U.S. Fixed Income	10.5	7.0	0.35	0.14	1.00	0.73	-0.47	-0.05	0.17	0.31
4	Ex-U.S. Fixed Income	10.7	6.0	0.24	0.29	0.73	1.00	-0.10	0.23	-0.08	0.14
5	Private Equity	20.7	10.5	-0.46	0.00	-0.47	-0.10	1.00	0.47	-0.53	-0.30
6	Real Estate	7.8	5.9	-0.01	0.39	-0.05	0.23	0.47	1.00	-0.51	-0.18
7	Natural Resources	18.3	8.8	0.33	0.25	0.17	-0.08	-0.53	-0.51	1.00	0.23
8	Hedge Funds	18.2	9.4	0.71	0.52	0.31	0.14	-0.30	-0.18	0.23	1.00

*Based on annual logarithmic excess returns from 1981-2000 (Natural Resources from 1987-2000). Sources include: Wilshire, MSCI, Salomon, NCREIF, Venture Economics, Ibbotson Associates, Adams Street Partners, UBS Global Asset Management, hedgefund.net.

According to these numbers, the returns, volatilities and correlations for the alternatives appear to offer a "free lunch," i.e. disproportionately high return for their risk.[3] However, it is well known that the risks of alternative investments are understated as we do not have frequent observable market prices. In the absence of traded market prices, various methodologies are used to infer periodic returns; these lead to an understatement of the risk characteristics of alternative investments. This can be illustrated for two major alternative investment types, real estate and venture capital:

- Appraisal processes, such as those used in real estate, introduce a smoothing of returns. The infrequent nature of price updates in the alternative world induces a significant downward bias to the measured risks and correlations of the assets.
- Because committed venture capital is drawn down over time, investors only observe returns upon realization of a sale; thus, there is little in the way of shorter-term volatility to be measured. Internal rate of return computation, typically used for venture capital, tend to masks asset return volatility.[4]

When both conventional and alternative investments are included in an unconstrained optimization, the efficient portfolio with the same volatility as a 60% US equity/40% US bond portfolio *only* includes alternative investments. Although this domestic portfolio is close to the benchmark or normal policy for many US investors, we will employ a globally diversified analog for the remainder of this paper. A portfolio with 65% global equity and 35% global fixed income has very similar volatility as the domestic-only, but a moderately higher Sharpe ratio due to the increased diversification.[5] Discomfort with this "all alternatives" result leads investors to impose artificial or ad hoc constraints on the maximum allocation to alternative investments in the optimization. However, such constraints in most cases simply predetermine the resultant policy allocation to the alternatives.[6] This type of analysis, therefore, does not provide a satisfactory solution to the question of the appropriate allocation to alternative investments.

[3] Attractive return expectations are often derived from analysis of historical data. Since performance data for alternative investments are limited, they are skewed by self-selection and survivorship biases.
[4] Clearly, we are dealing here with the time series characteristics of IRR computations. The enormous dispersion *across managers or funds* within a given period of time is another matter.
[5] In addition, we do not want to mislead readers who may be inclined to view results later in this paper as applying only to US investors.
[6] Another alternative to straight mean-variance optimization is to include another constraint in the objective function – mean-variance-tracking error optimization. Because the purpose here is to

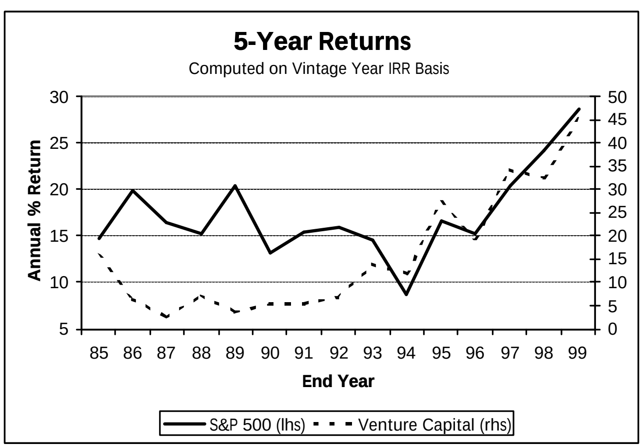
It is a fact that institutional investors do not hold the overwhelming share of their portfolios in alternative investments as would be recommended by optimizations based on historical data. This observation is by no means new. Numerous authors, such as Swensen (2000); Asness, Krail and Liew (2001); and Brown, Goetzmann, and Park (1999) have criticized the historical return and risk parameters used in such analyses. Nonetheless, the availability of historical data and the difficulty of creating forward-looking risk estimates that are intuitively correct and consistent are strong incentives to employ constrained optimizations and historical data in policy mix analyses.

Estimating "True" Risk Exposures

Swensen (2000) suggests that assets with the same fundamental and economic drivers have similar risk characteristics which reflect underlying economic risk exposures. To make our risk estimates for conventional assets and alternative investments consistent, we thus want to put both investment types on an equal footing. One way to do this is to consider the long-term risk characteristics of each asset. This risk can be thought of as the uncertainty of the ending wealth level produced by that asset. In similar fashion, the long-term correlation between two assets can be viewed as the correspondence between their respective ending wealth levels.

In Exhibit 2, we construct a venture capital analog from publicly traded equity. The S&P 500 Index was "bought" in each vintage year, then held for a 5-year period whereupon its terminal value was used, with interim cash flows, to compute the IRR. These returns to the "private" S&P are calculated in the same manner as venture capital returns and are compared to the corresponding 5-year venture capital vintage returns.

Exhibit 2: Venture Capital and U.S. Equity—a Simple Comparison



A simple indication of volatilities can be obtained by looking at the range of returns. In fact, the venture capital volatility may be on the order of two times that of the U.S. equity market. Further, there has been a relatively close relationship between these two series since 1980; any assumption that the correlation between the S&P 500 and venture capital is zero or only slightly positive is probably highly suspect. Clearly, the higher-frequency historical data would be significantly misleading for policy allocation analysis.

determine the policy, i.e. the benchmark, optimizing with the additional tracking error variable does not solve this problem, as it requires presupposition of the benchmark itself.

Any *individual* alternative investment may have a low correlation with the other assets in the portfolio. But when investors build *well-diversified* alternative investment programs, the systematic influences – underlying economic and fundamental drivers – become more significant and the residual noise diminishes.[7] Hence, the more diversified the private equity, real estate, natural resource or hedge fund portfolio, the more correlated it is likely to be with public markets.

The Factor Approach to Generate the Covariance Matrix

The process for setting the consistent, forward-looking equilibrium covariance matrix must address two issues. First, it needs to reflect the fact that true covariances are understated in historical data. The previous section provided some ways of thinking about this problem. Second, it must provide a means to easily integrate these fundamental views into the covariances and returns. The approach we use is based on factor modeling.

We have chosen 12 primary factors that capture systematic risk characteristics and provide the foundation for building a correlation matrix of all assets. [8] The factors are aggregates of traded asset markets (equity, fixed income and currency) and a real estate factor to properly account for the various real estate subcategories. The pairwise correlations are generated from the assets' sensitivities to these 12 factors or risk drivers.[9] Consistency in the factor matrix then ensures consistency in the full asset risk matrix.

After defining the factor matrix, the sensitivities of each individual asset category – alternative or conventional – are set in relation to the risk factors. Key to this process is the determination of factor influences on the asset classes in a way that is consistent with their common underlying risk exposures. Finally, all volatilities and the entire alternative investment correlation matrix, shown in Exhibit 3, are generated from the primary factor covariance properties and the asset class sensitivities. The aggregate asset class risks and correlations are shown in Exhibit 4.

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[7] This is why we come to a conclusion different from Peng, Baierl and Kaplan (2002). They conclude that the correlation between U.S. venture capital and the U.S. equity market is low, as they investigate it on an *individual fund* basis, whereas we use *aggregated* venture capital.
[8] Given the potentially huge size of a correlation matrix, it becomes impossible to maintain consistency – either mathematically or in terms of forward-looking views – by considering pairwise correlations individually.
[9] More precisely, $V = L \cdot F \cdot L' + R^2$, where F is the factor covariance matrix, L the matrix of all markets' factor exposure and R is the diagonal matrix of all markets' idiosyncratic risks, i.e. the portion of the markets' risks not attributable to the factors.

Exhibit 3: Equilibrium Risks and Correlations

		U.S. Equity	U.S. Bonds	Ex-U.S. Equity	Ex-U.S. Bonds	Venture Early	Venture Late	LBO	Mezzanine	Distressed Debt	Distressed Securi...	Event-Driven	Fund of Funds	Emerging	Growth	Value	Macro	Market-Neutral	Risk-Arbitrage	Convertible Arbitrage	Fixed-Income Arbitrage	Income	Sector Technology	Short Sellers	REITS (unleveraged)	RE Apartment	RE Industrial	RE Office	RE Retail	REITS Apartment	REITS Industrial	REITS Office	REITS Retail	Timber	Farmland (row crop)	Farmland (perm. crop)
U.S. Equity	15.8%	1.00	0.30	0.71	0.25	0.58	0.62	0.90	0.55	0.58	0.31	0.35	0.28	0.29	0.36	0.51	0.00	0.11	0.10	0.11	-0.05	0.12	0.38	-0.41	0.40	0.33	0.36	0.37	0.34	0.32	0.34	0.34	0.32	0.35	0.22	0.26
U.S. Bonds	4.6%	0.30	1.00	0.22	0.67	0.24	0.26	0.18	0.35	0.38	0.16	0.11	0.13	-0.02	0.08	0.20	0.00	0.03	0.03	0.03	-0.02	0.39	0.09	-0.11	0.22	0.14	0.18	0.20	0.16	0.02	0.08	0.04	0.01	0.10	0.07	0.08
Ex-U.S. Equity	14.3%	0.71	0.22	1.00	0.28	0.33	0.36	0.66	0.40	0.42	0.23	0.26	0.21	0.32	0.20	0.37	0.00	0.08	0.08	0.08	-0.04	0.09	0.23	-0.26	0.29	0.24	0.26	0.27	0.25	0.23	0.25	0.24	0.23	0.25	0.17	0.20
Ex-U.S. Bonds	4.0%	0.25	0.67	0.28	1.00	0.19	0.20	0.17	0.26	0.28	0.12	0.09	0.10	0.02	0.07	0.16	0.00	0.03	0.03	0.03	-0.01	0.26	0.08	-0.09	0.16	0.11	0.14	0.15	0.13	0.03	0.07	0.05	0.03	0.09	0.06	0.07
Venture Early	44.8%	0.58	0.24	0.33	0.19	1.00	0.71	0.53	0.34	0.36	0.19	0.21	0.17	0.13	0.42	0.31	0.00	0.06	0.06	0.06	-0.03	0.09	0.40	-0.36	0.25	0.20	0.22	0.22	0.21	0.18	0.20	0.20	0.19	0.21	0.13	0.15
Venture Late	35.1%	0.62	0.26	0.36	0.20	0.71	1.00	0.57	0.37	0.38	0.20	0.22	0.18	0.14	0.45	0.33	0.00	0.07	0.06	0.07	-0.03	0.10	0.43	-0.39	0.26	0.21	0.23	0.24	0.22	0.20	0.21	0.21	0.20	0.22	0.14	0.16
LBO	36.6%	0.90	0.18	0.66	0.17	0.53	0.57	1.00	0.49	0.51	0.28	0.32	0.26	0.27	0.34	0.47	0.00	0.10	0.09	0.10	-0.05	0.07	0.36	-0.38	0.36	0.30	0.32	0.33	0.31	0.30	0.31	0.32	0.31	0.32	0.20	0.24
Mezzanine	18.0%	0.55	0.35	0.40	0.26	0.34	0.37	0.49	1.00	0.37	0.19	0.20	0.17	0.14	0.20	0.30	0.00	0.06	0.06	0.06	-0.03	0.14	0.21	-0.23	0.25	0.19	0.22	0.22	0.21	0.17	0.19	0.18	0.17	0.20	0.12	0.14
Distressed Debt	20.4%	0.58	0.38	0.42	0.28	0.36	0.38	0.51	0.37	1.00	0.20	0.21	0.18	0.14	0.21	0.31	0.00	0.06	0.06	0.06	-0.03	0.15	0.22	-0.24	0.26	0.20	0.23	0.23	0.21	0.17	0.19	0.18	0.17	0.20	0.13	0.15
Distressed Securities	14.0%	0.31	0.16	0.23	0.12	0.19	0.20	0.28	0.19	0.20	1.00	0.11	0.09	0.08	0.11	0.16	0.00	0.03	0.03	0.03	-0.02	0.06	0.12	-0.13	0.13	0.11	0.12	0.12	0.11	0.10	0.11	0.10	0.10	0.11	0.07	0.08
Event-Driven	16.0%	0.35	0.11	0.26	0.09	0.21	0.22	0.32	0.20	0.21	0.11	1.00	0.10	0.10	0.13	0.18	0.00	0.04	0.04	0.04	-0.02	0.04	0.14	-0.15	0.14	0.12	0.13	0.13	0.12	0.11	0.12	0.12	0.12	0.12	0.08	0.09
Fund of Funds	11.0%	0.28	0.13	0.21	0.10	0.17	0.18	0.26	0.17	0.18	0.09	0.10	1.00	0.08	0.10	0.15	0.00	0.03	0.03	0.03	-0.02	0.05	0.11	-0.12	0.12	0.10	0.11	0.11	0.10	0.09	0.10	0.09	0.09	0.10	0.06	0.07
Emerging	25.1%	0.29	-0.02	0.32	0.02	0.13	0.14	0.27	0.14	0.14	0.08	0.10	0.08	1.00	0.09	0.14	0.00	0.03	0.03	0.03	-0.02	-0.01	0.10	-0.11	0.11	0.09	0.10	0.10	0.09	0.10	0.10	0.10	0.10	0.10	0.07	0.08
Growth	39.9%	0.36	0.08	0.20	0.07	0.42	0.45	0.34	0.20	0.21	0.11	0.13	0.10	0.09	1.00	0.19	0.00	0.04	0.04	0.04	-0.02	0.03	0.26	-0.23	0.15	0.12	0.13	0.13	0.12	0.12	0.13	0.13	0.12	0.13	0.08	0.09
Value	22.3%	0.51	0.20	0.37	0.16	0.31	0.33	0.47	0.30	0.31	0.16	0.18	0.15	0.14	0.19	1.00	0.00	0.06	0.05	0.06	-0.03	0.08	0.20	-0.21	0.22	0.17	0.19	0.20	0.18	0.16	0.18	0.17	0.17	0.18	0.12	0.13
Macro	20.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Market-Neutral	11.1%	0.11	0.03	0.08	0.03	0.06	0.07	0.10	0.06	0.06	0.03	0.04	0.03	0.03	0.04	0.06	0.00	1.00	0.01	0.01	-0.01	0.01	0.04	-0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0.03
Risk-Arbitrage	11.1%	0.10	0.03	0.08	0.03	0.06	0.06	0.09	0.06	0.06	0.03	0.04	0.03	0.03	0.04	0.05	0.00	0.01	1.00	0.01	-0.01	0.01	0.04	-0.04	0.04	0.03	0.04	0.04	0.04	0.03	0.04	0.04	0.03	0.04	0.02	0.03
Convertible Arbitrage	11.1%	0.11	0.03	0.08	0.03	0.06	0.07	0.10	0.06	0.06	0.03	0.04	0.03	0.03	0.04	0.06	0.00	0.01	0.01	1.00	-0.01	0.01	0.04	-0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0.03
Fixed-Income Arbitrage	11.0%	-0.05	-0.02	-0.04	-0.01	-0.03	-0.03	-0.05	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	0.00	-0.01	-0.01	-0.01	1.00	-0.01	-0.02	0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
Income	11.1%	0.12	0.39	0.09	0.26	0.09	0.10	0.07	0.14	0.15	0.06	0.04	0.05	-0.01	0.03	0.08	0.00	0.01	0.01	0.01	-0.01	1.00	0.04	-0.04	0.08	0.05	0.07	0.08	0.06	0.01	0.03	0.02	0.01	0.04	0.03	0.03
Sector Technology	35.7%	0.38	0.09	0.23	0.08	0.40	0.43	0.36	0.21	0.22	0.12	0.14	0.11	0.10	0.26	0.20	0.00	0.04	0.04	0.04	-0.02	0.04	1.00	-0.23	0.15	0.13	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.14	0.08	0.10
Short Sellers	22.0%	-0.41	-0.11	-0.26	-0.09	-0.36	-0.39	-0.38	-0.23	-0.24	-0.13	-0.15	-0.12	-0.11	-0.23	-0.21	0.00	-0.04	-0.04	-0.04	0.02	-0.04	-0.23	1.00	-0.17	-0.14	-0.15	-0.15	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.09	-0.11
REITS (unleveraged)	8.8%	0.40	0.22	0.29	0.16	0.25	0.26	0.36	0.25	0.26	0.13	0.14	0.12	0.11	0.15	0.22	0.00	0.04	0.04	0.04	-0.02	0.08	0.15	-0.17	1.00	0.84	0.90	0.91	0.87	0.89	0.91	0.92	0.90	0.14	0.09	0.10
RE Apartment	10.3%	0.33	0.14	0.24	0.11	0.20	0.21	0.30	0.19	0.20	0.11	0.12	0.10	0.09	0.12	0.17	0.00	0.04	0.03	0.04	-0.02	0.05	0.13	-0.14	0.84	1.00	0.75	0.76	0.73	0.75	0.77	0.78	0.77	0.12	0.07	0.09
RE Industrial	10.4%	0.36	0.18	0.26	0.14	0.22	0.23	0.32	0.22	0.23	0.12	0.13	0.11	0.10	0.13	0.19	0.00	0.04	0.04	0.04	-0.02	0.07	0.14	-0.15	0.90	0.75	1.00	0.82	0.78	0.80	0.81	0.83	0.81	0.13	0.08	0.09
RE Office	11.2%	0.37	0.20	0.27	0.15	0.22	0.24	0.33	0.22	0.23	0.12	0.13	0.11	0.10	0.13	0.20	0.00	0.04	0.04	0.04	-0.02	0.08	0.14	-0.15	0.91	0.76	0.82	1.00	0.79	0.81	0.83	0.84	0.82	0.13	0.08	0.10
RE Retail	11.1%	0.34	0.16	0.25	0.13	0.21	0.22	0.31	0.21	0.21	0.11	0.12	0.10	0.09	0.12	0.18	0.00	0.04	0.04	0.04	-0.02	0.06	0.13	-0.14	0.87	0.73	0.78	0.79	1.00	0.77	0.79	0.80	0.79	0.12	0.08	0.09
REITS Apartment	14.1%	0.32	0.02	0.23	0.03	0.18	0.20	0.30	0.17	0.17	0.10	0.11	0.09	0.10	0.12	0.16	0.00	0.04	0.03	0.04	-0.02	0.01	0.13	-0.14	0.89	0.75	0.80	0.81	0.77	1.00	0.83	0.85	0.83	0.11	0.07	0.08
REITS Industrial	14.5%	0.34	0.08	0.25	0.07	0.20	0.21	0.31	0.19	0.19	0.11	0.12	0.10	0.10	0.13	0.18	0.00	0.04	0.04	0.04	-0.02	0.03	0.13	-0.14	0.91	0.77	0.81	0.83	0.79	0.83	1.00	0.86	0.84	0.12	0.08	0.09
REITS Office	16.0%	0.34	0.04	0.24	0.05	0.20	0.21	0.32	0.18	0.18	0.10	0.12	0.09	0.10	0.13	0.17	0.00	0.04	0.04	0.04	-0.02	0.02	0.13	-0.14	0.92	0.78	0.83	0.84	0.80	0.85	0.86	1.00	0.86	0.12	0.08	0.09
REITS Retail	15.9%	0.32	0.01	0.23	0.03	0.19	0.20	0.31	0.17	0.17	0.10	0.12	0.09	0.10	0.12	0.17	0.00	0.04	0.03	0.04	-0.02	0.01	0.13	-0.14	0.90	0.77	0.81	0.82	0.79	0.83	0.84	0.86	1.00	0.11	0.07	0.08
Timber	14.0%	0.35	0.10	0.25	0.09	0.21	0.22	0.32	0.20	0.20	0.11	0.12	0.10	0.10	0.13	0.18	0.00	0.04	0.04	0.04	-0.02	0.04	0.14	-0.14	0.14	0.12	0.13	0.13	0.12	0.11	0.12	0.12	0.11	1.00	0.17	0.29
Farmland (row crop)	13.5%	0.22	0.07	0.17	0.06	0.13	0.14	0.20	0.12	0.13	0.07	0.08	0.06	0.07	0.08	0.12	0.00	0.02	0.02	0.02	-0.01	0.03	0.08	-0.09	0.09	0.07	0.08	0.08	0.08	0.07	0.08	0.08	0.07	0.17	1.00	0.87
Farmland (perm. crop)	18.2%	0.26	0.08	0.20	0.07	0.15	0.16	0.24	0.14	0.15	0.08	0.09	0.07	0.08	0.09	0.13	0.00	0.03	0.03	0.03	-0.01	0.03	0.10	-0.11	0.10	0.09	0.09	0.10	0.09	0.08	0.09	0.09	0.08	0.29	0.87	1.00

Exhibit 4: Asset Class Level Equilibrium Risks and Correlations

	U.S. Equity	Ex-U.S. Equity	U.S. Bonds	Ex-U.S. Bonds	Private Equity	Real Estate	Natural Resources	Hedge Funds	Risk
U.S. Equity	1.00	0.71	0.30	0.25	0.91	0.38	0.35	0.58	15.8%
Ex-U.S. Equity	0.71	1.00	0.22	0.28	0.62	0.28	0.25	0.42	14.3%
U.S. Bonds	0.30	0.22	1.00	0.67	0.25	0.19	0.10	0.19	4.6%
Ex-U.S. Bonds	0.25	0.28	0.67	1.00	0.21	0.15	0.09	0.16	4.0%
Private Equity	0.91	0.62	0.25	0.21	1.00	0.35	0.32	0.59	31.1%
Real Estate	0.38	0.28	0.19	0.15	0.35	1.00	0.14	0.23	10.0%
Natural Resources	0.35	0.25	0.10	0.09	0.32	0.14	1.00	0.21	14.0%
Hedge Funds	0.58	0.42	0.19	0.16	0.59	0.23	0.21	1.00	6.9%

Risks and Returns under Equilibrium Conditions

Looking ahead, it is easily imaginable that the financial landscape may differ markedly from events found in past periods. Reflecting unique assessments of economic environment and capital market structures in a small number of primary factors is straightforward compared to trying to ensure the consistent application of these views across a large number of assets.

For example, in the U.S. fixed income market, we may not feel that the inflationary period of the late 1970s-early 1980s and the subsequent disinflationary period of the middle and latter 1980s are in any way representative of the future environment. Because we do not believe that this sort of environment is likely to recur, we will not want to base our risk assessment strictly on historical volatility.

The equilibrium risk and correlation matrix allows us to tackle the first and most difficult dimension of alternative investments that renders most policy mix analysis useless – the misrepresentation of risk through the analysis of historical data.

Before we can conduct a policy analysis using the equilibrium risk data, we must build a consistent set of forward-looking risk premiums. We employ a procedure developed for conventional asset classes by Singer and Terhaar (1997). They provide a procedure that enables us to generate risk premiums from a consistent, forward-looking covariance matrix. The framework is similar to the Capital Asset Pricing Model (CAPM), but allows for varying degrees of world capital market integration to be priced into risk premiums. At one end of the spectrum we assume that assets are fully integrated and each risk premium is solely determined relative to a world market portfolio – the Global Investment Market (GIM) portfolio – of conventional and alternative assets.[10]

In order to determine the fully integrated risk premiums, the beta of each asset with respect to the GIM is derived from the equilibrium covariance matrix. These betas indicate the systematic risk that would be compensated in a fully integrated, equilibrium capital market. It is only the contribution of the asset's risk to the world market portfolio that is compensated.

[10] The capitalization-weighted global market portfolio is composed of: 44% traded equities, 50% fixed income, and 6% alternativeassets.

At the other end of the spectrum, a market could be fully segmented from the rest of the world. Local assets are then priced relative to their local market; hence the risk that is compensated is the total risk of the local market, not its contribution to world risk.

The assumption that assets are priced in a fully integrated, global context is probably too strong, not only for alternative investments but also for many conventional assets as well. In fact, the assumption that alternative investments are priced in a fully integrated manner seems at odds with the boutique nature of private equity, real estate, natural resources and hedge fund teams.[11]

Yet, it would be too restrictive to assume complete segmentation. In between full integration and full segmentation, we consider a world in which the marginal investor is one who requires compensation for systematic risk relative to a "home-biased" portfolio (HBP), skewed to the investor's country of domicile. Assets in a country or region would be priced relative to a home-biased "market" portfolio.[12]

Risk premiums would generally be lower in a fully integrated world than in a partially or fully segmented world. The greater the integration of the global capital market, the more of a typical asset's risk will be diversified away by other assets in the broader market portfolio. Using the equilibrium covariance matrix with a CAPM-like, single-factor model, we can derive risk premiums that reflect various degrees of integration.

Exhibit 5 shows the formulas used to derive risk premiums from the equilibrium covariance matrix given varying degrees of assumed segmentation.[13]

Exhibit 5: Risk Premiums for Varying Degrees of Segmentation

	Compensated Risk	*Risk Premium*
Fully Integrated	$\rho_{i,GIM}\ \sigma_i$	$\rho_{i,GIM}\sigma_i(SR)$
Home Biased	$\rho_{i,HBP}\ \sigma_i$	$\rho_{i,HBP}\ \sigma_i(SR)$
Fully Segmented	$\rho_{i,i}\ \sigma_i = \sigma_i$	$\sigma_i(SR)$

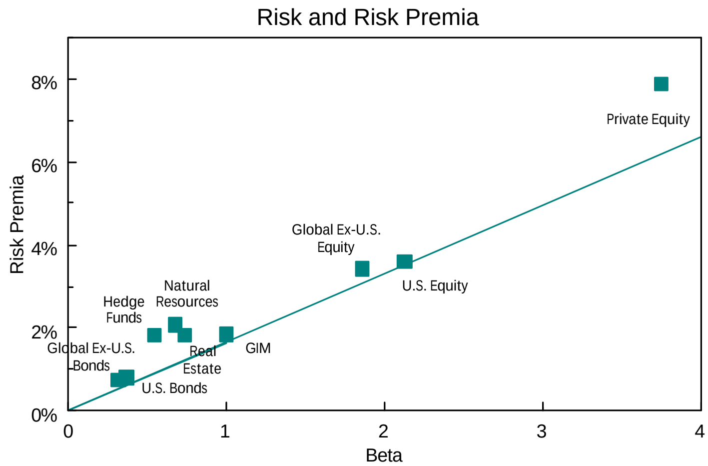
An asset's correlation with itself ($\rho_{i,i}$) is one, so the fully segmented risk premium would be the highest. The correlation of an asset with the GIM ($\rho_{i,GIM}$) tends to be lower than with a home-biased portfolio ($\rho_{i,HBP}$), so the fully integrated risk premium is generally the lowest. Usually, the home-biased risk premium falls between the fully integrated and fully segmented cases.[14]

We can use this relationship to set bounds on the equilibrium risk premium for each alternative investment. In general, the equilibrium risk premiums are set nearer to the home-biased risk premiums and reflect greater segmentation for alternative investments than for conventional asset classes. These risk premium estimates based on the equilibrium covariance matrix are provided in the *Risk Premium* column in Exhibit 7.

[11] Limited integration of alternative investments in the investment process also arises from lack of transparency, investments in blind private equity pools and limited availability of investment alternatives.
[12] See Bekaert & Harvey (1995).
[13] The derivation of the risk premium is straightforward algebraic manipulation of the CAPM formula.
[14] We assume in these derivations that the price of risk, or conversely the marginal investor's risk aversion, is the same in both integrated and segmented pricing.

Exhibit 6 displays the equilibrium risk premiums of conventional and alternative asset classes relative to their betas. Plotting the integrated risk premiums versus the betas would result in all the points lying on the straight line shown on the chart. The extent to which an asset's pricing is segmented determines the additional segmentation premium and thus its vertical positioning above the line. Based on our analysis, private equity provides the greatest segmentation premium and is the furthest above the line. The segmentation premium offers more return for a given level of systematic or beta risk.

Exhibit 6: The Reward for Risk from Conventional and Alternative Investments



The Liquidity Premium

The integration/segmentation distinction characterizes liquid assets fairly well, but for alternative investments, we need to model illiquidity compensation as well. Compensation for illiquidity can be derived from recognizing that a one-period Sharpe Ratio is an inappropriate measure of the compensation for risk when assets cannot be liquidated after one period. [15] Consequently, the liquidity premium is a function of an asset's time horizon and the corresponding multi-period Sharpe Ratio (MPSR). It can be shown that the MPSR of an asset, i.e. the asset's multi-period wealth in excess of the wealth generated by the risk-free investment (i.e. compounded return over compounded cash return), is a non-linear function of time.[16]

Exhibit 7 shows the equilibrium excess returns for conventional and alternative investments, including consideration of equilibrium risks and correlations, differential segmentation and illiquidity:

Exhibit 7: Excess Returns of Conventional and Alternative Investments

	Risk Premium	**Excess Return** (Risk Premium + Liquidity Premium)
GIM	1.84%	1.97%
U.S. Equity	3.59	3.59
Ex-U.S. Equity	3.42	3.42

[15] See Staub (2002)
[16] See also Hodges, Taylor and Yoder (1997).

U.S. Bonds	0.80	0.80
Ex-U.S. Bonds	0.75	0.75
Private Equity	7.88	9.92
Real Estate	1.82	3.06
Natural Resources	2.07	3.88
Hedge Funds	1.82	2.57

Although considered unbiased, it is still not appropriate to run these numbers through a mean-variance optimization. Since the risk premiums can reflect compensation for more than just systematic risk, due to varying levels of segmentation and illiquidity, one would expect a simple mean/variance optimization to result in a disproportionately large allocation to the more-segmented and illiquid alternative investments. Indeed that is precisely what occurs.

The real issue, however, is the fact that simple optimization is typically a single-period approach. Conventional and alternative investments should not be evaluated with a single period model due to extreme differences in availability of liquidity. The single period assumption forces the evaluation of illiquid assets into a shorter investment horizon, implicitly assuming liquidity similar to conventional assets. But this contrasts with the fact that the real portfolio rarely matches policy because of the impossibility of rebalancing.

Employing a Simulation Approach

For these reasons, we approach the policy-setting exercise with a simulation framework. The objective in the simulation that follows is to identify a high-return, middle-risk, middle-liquidity policy portfolio suitable for a typical institutional investor. By "middle risk" we mean a portfolio that is approximately the same risk level as the 65/35 global balanced policy, i.e. just over 10% risk.

Simulations permit the inclusion of both the cost of illiquidity (allowing rebalancing only to the extent possible in practice) and the benefit of illiquidity (the liquidity premium). The multi-period simulation is constructed with a standard Monte Carlo return generating process, with a number of standard, albeit "arbitrary," assumptions.[17]

We began the simulation with a relatively low alternative allocation. This allocation was increased in subsequent simulation runs (a "run" consisted of 1000 20-year iterations) until we arrived at a policy portfolio with a volatility level similar to that of the global balanced policy; the volatility of the balanced, traded securities-only portfolio is 10.1% per annum. Also, the moderate tolerance for illiquidity was translated into an upper limit on the realized or actual alternative investment allocation. This limit was set at 30% of the total portfolio.[18]

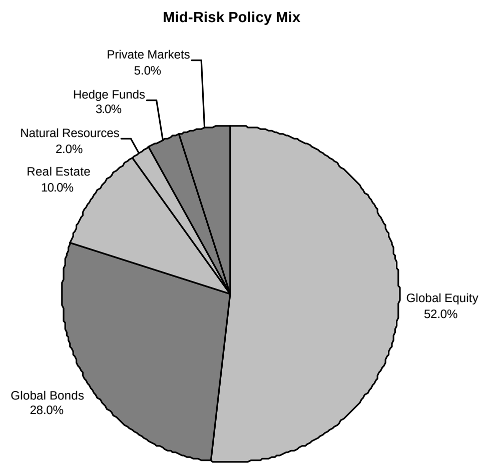
The policy mix that fulfilled these volatility and liquidity objectives includes a 20% allocation to alternative investments, with the remaining 80% of the portfolio held in a diversified global securities portfolio as shown in Exhibit 8. The alternative investment portion of the

[17] These assumptions include: (i) Annual (one-year) periods were modeled. (ii) There is a one-year lag between the decision to change any alternative investment position and the start of actual execution of that change. (iii) Alternatives can be rebalanced over time by redeployment of their cash distributions (liquidation) or through new contributions. (iv) A dual volatility regime exists. During the high volatility state, which occurs 15% of the time on average and in which the market return is below its equilibrium return, we assume that alternative investment liquidity dries up, so rebalancing decisions are essentially impossible to execute. This results in return distributions that exhibit real-world characteristics, such as fat tails.

[18] Given the probabilistic nature of the simulation returns, the 30% maximum was expressed as the level which we did not want breached more than 5% of the time.

policy mix is 10% in real estate, 5% in private equity, 3% in hedge funds, and 2% in natural resources. We refer to this policy portfolio as an "appropriate" mix rather than as an "optimal" mix. First, we want to avoid any misleading impression that the policy is the result of any mathematical optimization. And second, there are any number of portfolios that satisfy the objectives; hence many policies may be appropriate.

Exhibit 8: Policy Mix for a Mid-Risk Institutional Investor



Simulations run on the 65/35 global balanced policy portfolio, with no alternatives, produce an average volatility of 10.3%, consistent with the covariance matrix estimate.[19] Since the

[19] Note that the simulations discussed here include the dual volatility regime discussed earlier. As a result, the average volatility level of 10.3% differs slightly from the 10.1% risk forecast using the policy allocation and the covariance matrix.

policy comprises only traded securities, we can safely assume that the asset class weights can be rebalanced each period to the target weights. Therefore, at the end of any given period the forecast risk, based on policy weights and the covariance matrix, remains at 10.1% after rebalancing.

Rebalancing certain types of alternative investments is not always possible. Therefore, the actual allocation to each of the alternative investments and the aggregate share of the alternatives in the portfolio can differ considerably from the policy target. At those times, the forecasted risk characteristics can deviate substantially from the target risk level of 10.1%. So even over many years, the alternative investment allocation and the portfolio's expected risk can fluctuate considerably.

In examining the results of 1,000 10-year periods, these effects are patently obvious. While the target policy risk is 10.1%, the expected or forecast risk is above 11.5% in 5% of the periods. This increase in expected risk occurs because the actual allocation to riskier alternative investments varies over time, due to the constrained ability to rebalance. The actual alternatives weight is greater than 28%, compared to the target of 20%, in 5% of the periods. This considerable difference is driven in large part by the huge swings in the private equity allocation; whereas the target allocation is 5%, the actual weight exceeds 14% of the portfolio in 5% of the simulation periods.

Overall, because the returns and risks of some alternative investment classes are large and liquidity is low, the "swings" in their policy allocations can be pronounced. This increases the uncertainty of risk for the total portfolio. The investor must have a tolerance for risk that is high enough to encompass the periodically elevated risk levels. In addition, he or she needs to have a sufficiently long investment horizon to allow for the benefits to offset the costs of illiquid investments.

Using our equilibrium return and covariance assumptions for each asset class, the 65/35 global balanced and global-including-alternatives policy mixes exhibit the characteristics shown in Exhibit 9. This indicates that the improvement in return from adding alternatives is about 50 basis points, at the same risk level as the global policy mix (excluding alternatives). This results from broadening the portfolio – improving diversification – to include alternative investments and from the additional liquidity premium obtained from holding illiquid alternative investments. The Sharpe ratio increases by 25%, from 0.26 to 0.31.

Exhibit 9: Global Balanced Portfolios with and without Alternatives

	Return	*Average Risk*	*Sharpe Ratio*
Global Balanced Portfolio – Traded Securities Only	7.2%	10.3%	0.26
Global Balanced Portfolio – Including Alternative Investments	7.7	10.1	0.31

It is important to note we are not claiming that adding alternatives to a portfolio provides a substantial "free lunch" to the investor. The improvement in the Sharpe ratio comes from two sources: first, the increased diversification of the portfolio and the allocation to more-segmented investments does indeed lead to a better risk-return condition; second, a good deal of the return improvement is due to the liquidity premium portion of the newly added alternatives. Since the liquidity premium is essentially a compensation for relinquishing the ability to rebalance, there is no free lunch from this component – the compensation is commensurate with the risk. It's simply that illiquidity is not reflected in the volatility risk in the denominator of the Sharpe ratio.

It is also important to note that the policy portfolio highlighted here is just one of many that fulfill the objectives. Varying many of the allocations by small amounts has little effect on the overall outcome.

Conclusion

Traditionally, investors have relied on rules of thumb and artificial constraints in setting policy weights for alternative investments. Optimizations using historical data series in the alternatives area cannot be relied upon to provide sensible policy mixes. Unconstrained optimized portfolios contain absurdly large allocations to these "low-risk, high-return" investments.

We have proposed a framework for considering alternative investments that circumvents these data problems and is consistent with fundamental economic notions of risk and return. The resulting policy mix is grounded in classical theory rather than simply being a "best guess" effort.

The framework is based on a factor model, which permits us to set risks and sensitivities in a straightforward and intuitive fashion; all the risks and returns will reflect forward-looking assessments of the underlying economic and fundamental drivers of financial markets. Additionally, by using this approach, mathematical consistency of the full covariance matrix is assured. Once risk characteristics are set, appropriate returns are developed. Additionally, the liquidity characteristics are taken into account. All these facets of the analysis are brought together in a simulation environment to evaluate portfolio policy allocations.

A recommended portfolio allocation was then developed for a typical institutional investor with moderate liquidity needs and a moderately long investment horizon. Other investors, with different risk tolerances, investment horizons and liquidity needs, would hold different allocations to the portfolio of alternative investments and have different allocations within the portfolio of alternatives. For instance, the longer the investor's horizon and the lower the need for liquidity, the greater will be the allocation to the illiquid alternative investments.

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