

Efficient Frontiers and the Optimally Risky Portfolio (Updated)



SINCE WE HAVE not materially changed our three-to-five-year capital market return expectations, our update of the optimally risky portfolio in this issue will be devoted to showing the results of including commodities as an asset class. The type of commodity investment we include is a passively managed, fully collateralized, commodities future index fund as described in the article in this issue on commodities. It is not a leveraged commodities futures account, which can make or break fortunes.

The table in figure ORP.1 recaps our return and risk expectations for the seventeen asset classes under consideration, including commodities.

Correlations among asset class returns are as indicated in the table in figure ORP.4.

Commodity return correlations are based on a comparison of historical total returns on the Goldman Sachs Commodities Index (GSCI) with returns for other classes. Commodity returns are not strongly correlated to returns on any other asset class. They are, however, negatively correlated to both stock and bond returns, albeit weakly. This negative correlation makes commodities a good risk hedge and a valuable portfolio component. A more detailed description of how expected correlations were developed for other asset classes is contained in the previous issue, available on-line at www.aametrics.com.

The modestly weak negative correlations of commodity returns to most other asset class returns make commodities a valuable portfolio component. Figures ORP.2 and ORP.3 show the impact of commodities on the efficient frontier—those combinations of assets that provide for the maximum return for a given level of risk or the minimum level of risk for a given level of return. Figure ORP.2 shows the impact on portfolios that include venture capital as an alternative. Figure ORP.3 shows the impact on portfolios that do not have access to venture capital. In both cases, including commodities shifts the efficient frontier to the northwest—making it possible to achieve higher rates of return for a given risk level and lower levels of risk for a given return.

How much of an exposure to commodities is included in these efficient frontiers? Figures ORP.5 and ORP.6 show the compositions of the efficient frontiers for portfolios including and excluding venture capital, respectively. The maximum allocation to commodities in figure ORP.5 is approximately 25% in the portfolio with 11% standard deviation. The maximum allocation in figure ORP.6 is approximately 26% also in the

ASSET CLASS EXPECTED RETURN AND RISK

Asset Class	Expected Return (Total Return Per Year)	Expected Risk (Standard Deviation of Annual Returns)
U.S. large-cap stocks	8.9%	20.0%
U.S. small-cap stocks	11.1%	28.0%
UK stocks	13.3%	24.0%
Euro area stocks	12.5%	27.0%
Japan stocks	13.0%	32.0%
Emerging-market stocks	15.0%	34.0%
Venture capital	16.0%	36.0%
Real estate	7.5%	17.0%
Commodities	8.8%	23.0%
Intermediate-term Treasuries	5.0%	6.0%
Long-term Treasuries	5.1%	10.0%
TIPS (inflation-indexed)	5.0%	6.0%
Long-term corporate bonds	5.9%	9.0%
High-yield bonds	8.8%	12.0%
Mortgage-backed bonds	6.1%	5.0%
Foreign investment-grade bonds	4.5%	13.0%
Emerging-market sovereign debt	7.5%	20.0%
Treasury bills	4.8%	
Inflation	2.5%	

Figure ORP.1: Asset Class Expected Return and Risk
Source: Asset Allocation Advisor

portfolio with 11% standard deviation. It should be noted that the efficient frontier allocations in both cases have been constrained to force a broader diversification than would be the case without the constraints. Readers of the last issue, and of the article on the Art and Science of asset allocation in this issue, will understand that minimum constraints are necessary in a standard Markowitz optimization to account for the uncertainty of projections and to avoid placing too big of a bet on single asset classes. Nevertheless, even without constraints, the maximum asset allocation to commodities never exceeds 21% for portfolios with venture capital, and 27% for portfolios excluding venture capital.

Figures ORP.5 and ORP.6 may require some study, for they contain a great deal of information. A vertical slice through the graph at any point shows the asset allocation for a portfolio along the efficient frontier with the return and risk characteristics as labeled on the x axis, return numbers on top, and risk numbers (in the form of expected standard deviation) on the bottom in parentheses. The minimum risk portfolio is on the left and the maximum return portfolio is on the right. Points in between correspond to points along the efficient frontier. Readers should note that the graphs do not show continuous calculations but the discrete results of allocations measured at every whole percentage of standard deviation between the minimum risk and maximum return portfolios.

What's the best asset allocation for our portfolio? Which point along the efficient frontier do we choose? The answer depends on several issues: the expected return on short-term Treasury bills (the riskless asset); your institution's risk tolerance; and the policies and practices governing the management of your endowment assets.

EFFICIENT FRONTIERS WITH AND WITHOUT COMMODITIES (INCLUDING VENTURE CAPITAL)

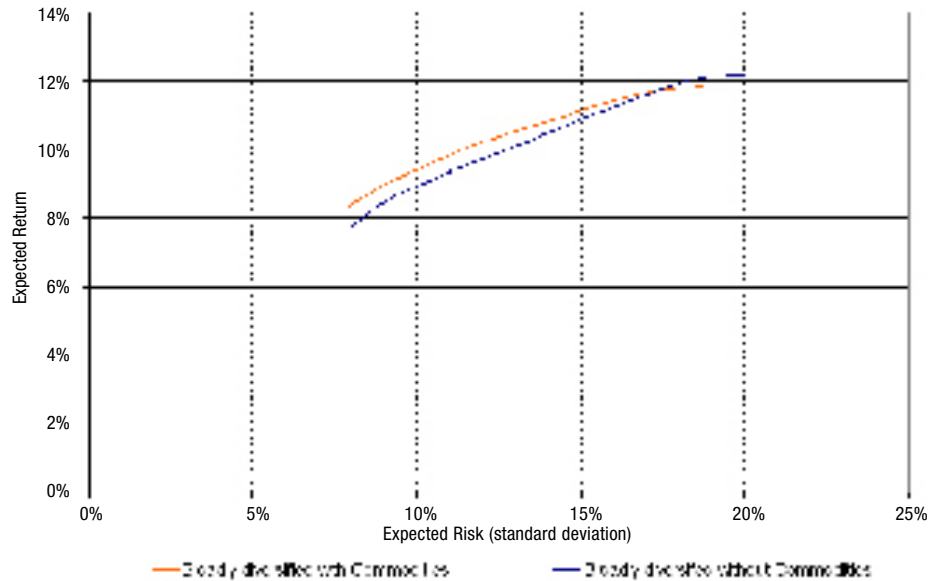


Figure ORP2: Efficient Frontiers with and without Commodities and Including Venture Capital
Source: Advisor calculations

EFFICIENT FRONTIERS WITH AND WITHOUT COMMODITIES (EXCLUDING VENTURE CAPITAL)

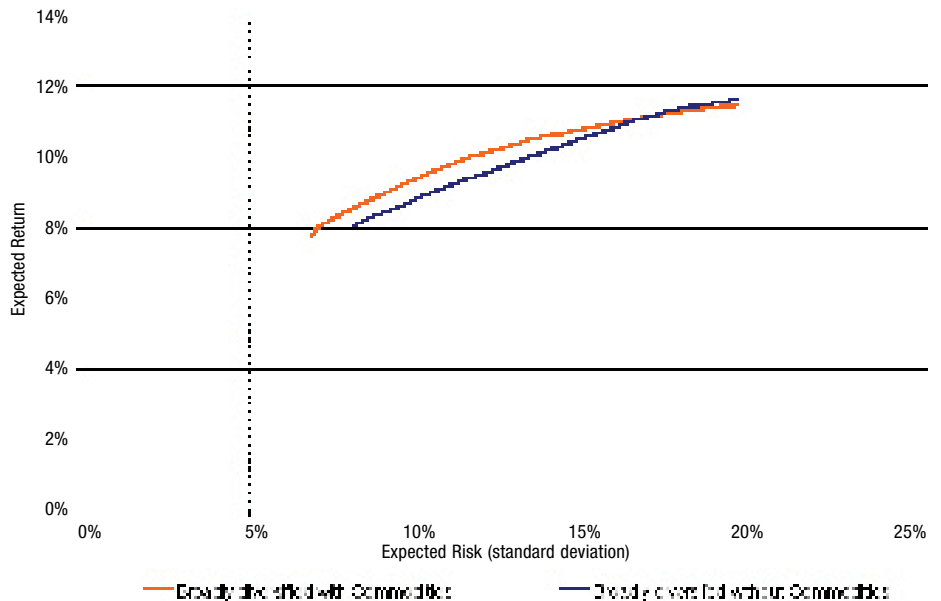


Figure ORP3: Efficient Frontiers with and without Commodities and Excluding Venture Capital
Source: Advisor calculations

The weakly negative correlations of commodity returns with stock and bond returns make commodities a good risk hedge and valuable portfolio component.

We expect the return on short-term Treasury bills to average 4.8% over the next three to five years. If we add the riskless asset to our mix of other assets, we get an efficient frontier as pictured in ORP.7. This is for a broadly diversified portfolio without venture capital.

Although it is impossible to construct a portfolio from our sixteen asset categories (in this case, excluding venture capital) with a standard deviation of less than 6.8%, by adding Treasury bills to the mix, we can construct a portfolio with standard deviations down to 0.0%. We do this by adding Treasury bills to a portfolio that otherwise has the mix of assets as the optimally risky portfolio—which is just that portfolio where the line to the riskless asset touches or is tangent to the efficient frontier (see the point indicated by the arrow on figure ORP.7). As we reduce the portion of the portfolio invested in the optimally risk portfolio and increase the portion invested in Treasury bills, we travel down the blue line in figure ORP.7 from the optimally risky portfolio towards the 100% Treasury bill portfolio yielding 4.8% with no risk.

What if we are willing to assume more risk? We have two options. We can assume more risk by adjusting our asset allocation consistent with those portfolios along the efficient

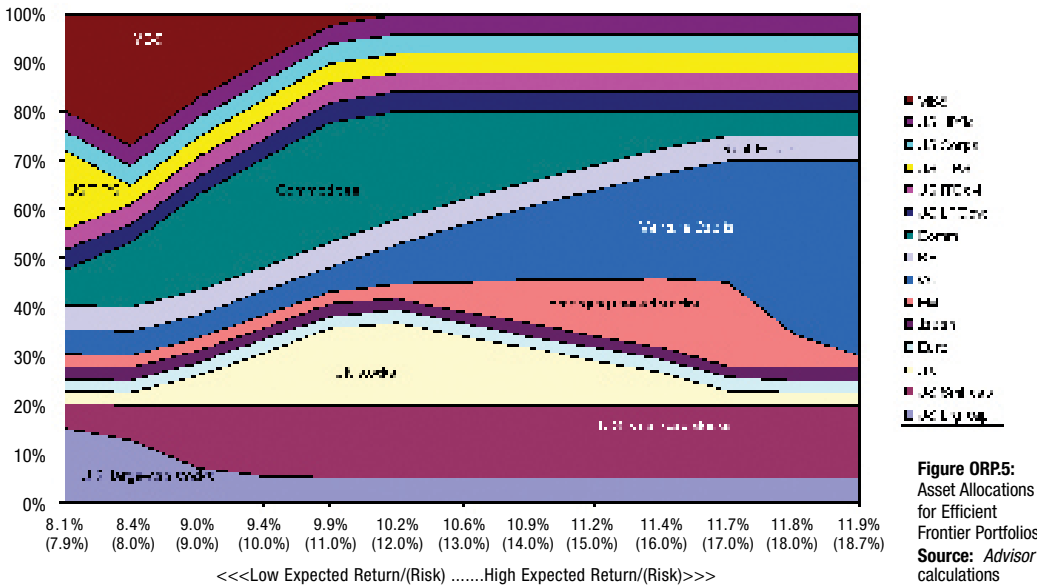


PROJECTED ASSET RETURN CORRELATIONS

	1- U.S. large-cap stocks	2- U.S. small-cap stocks	3- UK stocks	4- Euro area stocks	5- Japan stocks	6- Emerging-market stocks	7- Venture capital	8- Real estate	9- Commodities	10- Long-term Treasuries	11- Intermediate-term Treasuries	12- TIPS (inflation-indexed)	13- Long-term corporate bonds	14- High-yield bonds	15- Mortgage-backed bonds	16- Foreign investment-grade bonds	17- Emerging-market sovereign debt	
1	1.00	0.66	0.59	0.70	0.30	0.30	0.65	0.40	-0.28	0.10	0.05	-0.05	0.20	0.55	0.10	0.00	0.25	U.S. large-cap stocks
2		1.00	0.48	0.50	0.26	0.55	0.30	0.64	-0.35	0.00	-0.07	-0.15	0.10	0.65	-0.03	-0.04	0.56	U.S. small-cap stocks
3			1.00	0.76	0.45	0.53	0.57	0.30	-0.22	0.02	-0.02	0.00	0.10	0.40	-0.10	0.16	0.50	UK stocks
4				1.00	0.42	0.40	0.50	0.20	-0.12	0.23	0.08	0.05	0.20	0.52	-0.06	0.20	0.34	Euro area stocks
5					1.00	0.65	0.55	-0.09	0.07	-0.10	-0.20	-0.20	-0.16	0.15	-0.60	0.12	0.20	Japan stocks
6						1.00	0.25	0.22	0.14	-0.13	-0.12	-0.10	-0.09	0.41	-0.40	-0.07	0.60	Emerging-market stocks
7							1.00	-0.10	0.16	-0.15	-0.20	-0.25	-0.28	0.15	-0.04	-0.26	0.20	Venture capital
8								1.00	-0.22	0.16	0.14	0.20	0.20	0.59	0.12	0.00	0.60	Real estate
9									1.00	-0.20	-0.22	0.30	-0.26	-0.15	-0.04	-0.08	0.37	Commodities
10										1.00	0.90	0.25	0.93	0.35	0.85	0.20	0.20	Long-term Treasuries
11											1.00	0.40	0.90	0.33	0.88	0.29	0.19	Intermediate-term Treasuries
12												1.00	0.20	0.15	0.40	0.15	0.19	TIPS (inflation-indexed)
13													1.00	0.43	0.85	0.34	0.19	Long-term corporate bonds
14														1.00	0.15	0.38	0.64	High-yield bonds
15															1.00	0.25	0.20	Mortgage-backed bonds
16																1.00	0.05	Foreign investment-grade bonds
17																	1.00	Emerging-market sovereign debt

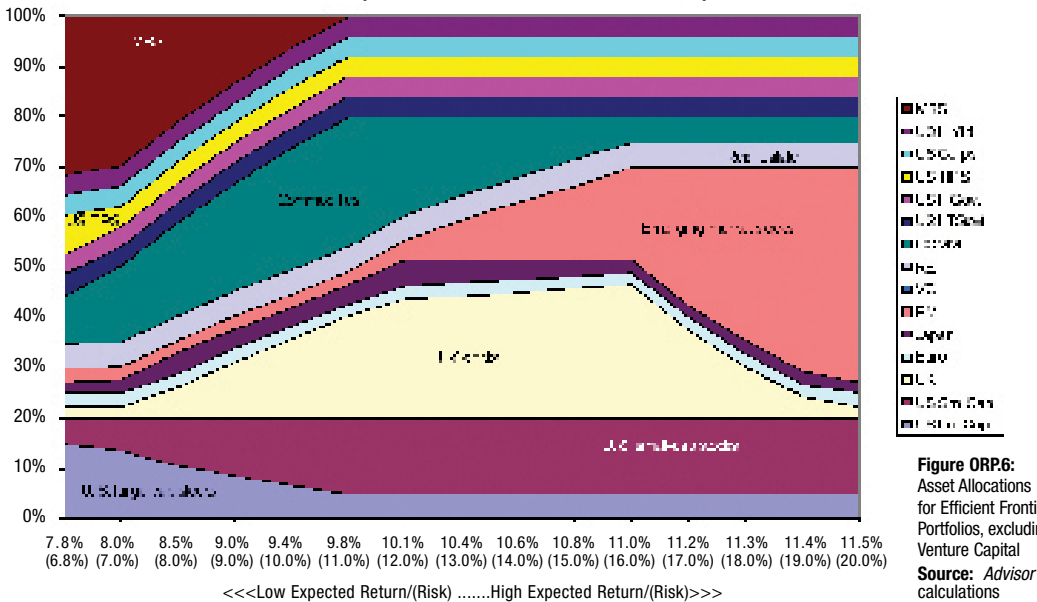
Figure ORP4: Projected Asset Return Correlations among Asset Classes
Source: Asset Allocation Advisor

ASSET ALLOCATION VS. EXPECTED RETURN/RISK FOR BROADLY DIVERSIFIED PORTFOLIOS



Commodities make up approximately 22% of our optimally risky portfolios.

ASSET ALLOCATION VS. EXPECTED RETURN/RISK FOR BROADLY DIVERSIFIED PORTFOLIOS (EXCLUDING VENTURE CAPITAL)



frontier curve. Or, we can borrow and invest more than 100% in the optimally risky portfolio —adopting a strategy not unlike the 120/20 or 130/30 leveraged investment strategies that are becoming popular. This second strategy can enable us to earn rates of return above the efficient frontier curve. However, since many endowment investment policies restrict borrowing, and since the subject requires more elaboration than space permits here, we will address the possibility in future issues.

The optimally risky portfolio in figure ORP.7 is the one on the efficient frontier with a standard deviation of approximately 9%. From figure ORP.6 we see that this portfolio has the asset allocation reported in figure ORP.8, which also reports the asset allocation for the optimally



EFFICIENT FRONTIERS WITH RISK-FREE ASSET FOR BROADLY DIVERSIFIED PORTFOLIOS (EXCLUDING VENTURE CAPITAL)

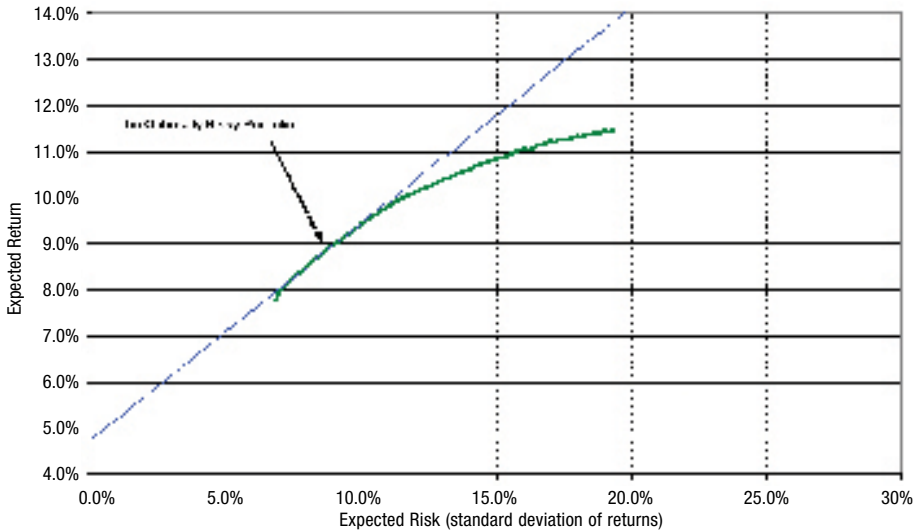


Figure ORP.7: The Efficient Frontier with the Risk-Free Asset, for Broadly Diversified Portfolios without Venture Capital
Source: Advisor calculations

risky portfolio with venture capital. Figure ORP.8 also compares the allocation of the optimally risk portfolios with the prior allocations without commodities.

The inclusion of commodities has a significant impact on optimal portfolio allocations. The weakly negative correlations with equity returns shifts more of the minimum 20% allocation to U.S. stocks towards the higher returning, but more variable, small-cap stocks. The inclusion of commodities also reduces the relatively large allocations to low-risk mortgage-backed securities. Overall, the optimally risky portfolios including commodities have a 0.5% higher expected rate of return—a significant increase, especially when compounded over time.



The optimally risky portfolio without venture capital has an expected return of 9.0% with an expected standard deviation of 9.0%.

THE OPTIMALLY RISKY PORTFOLIO ALLOCATIONS

	without Venture Capital		with Venture Capital	
	previous w/o commodities	w/ commodities	previous w/o commodities	w/ commodities
U.S. large-cap stocks	13.6%	8.6%	11.0%	5.4%
U.S. small-cap stocks	6.4%	11.4%	9.0%	14.6%
UK stocks	5.6%	11.4%	2.5%	10.8%
Euro area stocks	2.5%	2.5%	2.5%	2.5%
Japan stocks	8.7%	3.9%	4.2%	2.5%
Emerging-market stocks	5.2%	2.5%	7.4%	2.5%
Venture capital	n/a	n/a	7.7%	5.0%
Real estate	5.0%	5.0%	5.0%	5.0%
Commodities	n/a	21.5%	n/a	22.0%
Intermediate-term Treasuries	4.0%	4.0%	4.0%	4.0%
Long-term Treasuries	4.0%	4.0%	4.0%	4.0%
TIPS (inflation-indexed)	4.0%	4.0%	4.0%	4.0%
Long-term corporate bonds	4.0%	4.0%	4.0%	4.0%
High-yield bonds	4.0%	4.0%	4.0%	4.0%
Mortgage-backed bonds	33.0%	13.1%	30.7%	9.7%
Expected return	8.5%	9.0%	8.9%	9.4%
Expected risk	9.0%	9.0%	10.0%	10.0%

Figure ORP.8: Asset Allocations for the Optimally Risky Portfolios with and without Venture Capital
Source: Advisor calculations