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The standalone and the portfolio risk of the Rogers energy commodity index

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Introduction

There is plenty of research on the relation between commodity prices and inflation. In this vein, authors have adopted the overshooting notion of commodity prices. Moreover there is a vast literature on the forecasting ability of commodity prices, and on the relation between commodity prices, the money supply, and the stock markets. There is little interest on the portfolio behavior of commodities, except maybe in finding out whether commodities are in general hedges or diversifiers. This paper stands within this niche. A portfolio of only commodity indexes, and a broad stock market index is constructed. The statistical properties of this portfolio are studied, with a special stress on the additional portfolio impacts of the energy index on the stock market.

COMPOSITION OF THE

Rogers International Commodity Index® - Energy

SIX commodity futures contracts

	Allocation
Crude Oil	37.50%
Brent	32.50%
Natural Gas	15.00%
RBOB Gasoline	7.50%
Heating Oil	4.50%
Gas Oil	3.00%
Total	100.00%

BASIC PORTFOLIO
(short sales allowed)

Intends to show the contribution of three commodity indexes to a well-diversified stock market index, and is made up of the:

1. Rogers International Commodity Index-Energy
2. Rogers International Commodity Index-Agriculture
3. Rogers International Commodity Index-Metals
4. S&P 500

The variance/covariance matrix (annualized data)

$$\begin{pmatrix} 0.10744 & 0.02265 & 0.03461 & 0.02047 \\ 0.02265 & 0.03218 & 0.01756 & 0.01077 \\ 0.03461 & 0.01756 & 0.04508 & 0.01325 \\ 0.02047 & 0.01077 & 0.01325 & 0.02799 \end{pmatrix}$$

The standard deviation of the S&P 500 is smallest at 16.7%. The standard deviation of the Energy index is highest at 32.8%. Variance analysis shows that this index has statistically the highest variance, followed in rank by the Metals index, and followed with the rest all together. Covariances vary between 1% and 3.5%.

Optimization Results (1)

$$
\begin{aligned}
&share\ in\ S\&P\ 500 \\
&= 171.2514E(\tilde{R}) + 0.344403
\end{aligned}
$$

Always positive as long as the expected return is positive.

Optimization Results (2)

$$metals\ share = 228.2411E(\tilde{R}) - 0.03454$$

The share in the metals index is nearly always positive too, because the coefficient on the first term is positive and the second term is close to zero

Optimization Results (3)

$$agriculture\ share = -213.122E(\tilde{R}) + 0.569495$$

The share in the agriculture index is zero for a value for $E(\tilde{R})$ of 0.00267, or 13.36%, in annualized terms. This means that for practically reasonable values for $E(\tilde{R})$ the share in this index is also positive, and is rarely shorted.

Optimization Results (4)

$$energy\ share = -186.37E(\tilde{R}) + 0.120638$$

The energy share is zero for $E(\tilde{R}) = 0.0006473$, or 3.24% in annualized terms. Any value for $E(\tilde{R})$ higher that this rate produces a negative share. Since the Minimum Variance Portfolio (MVP) has a return of 0.00091893, or 4.60% in annualized terms, the share in the energy index is never positive.

The Negative Energy Share

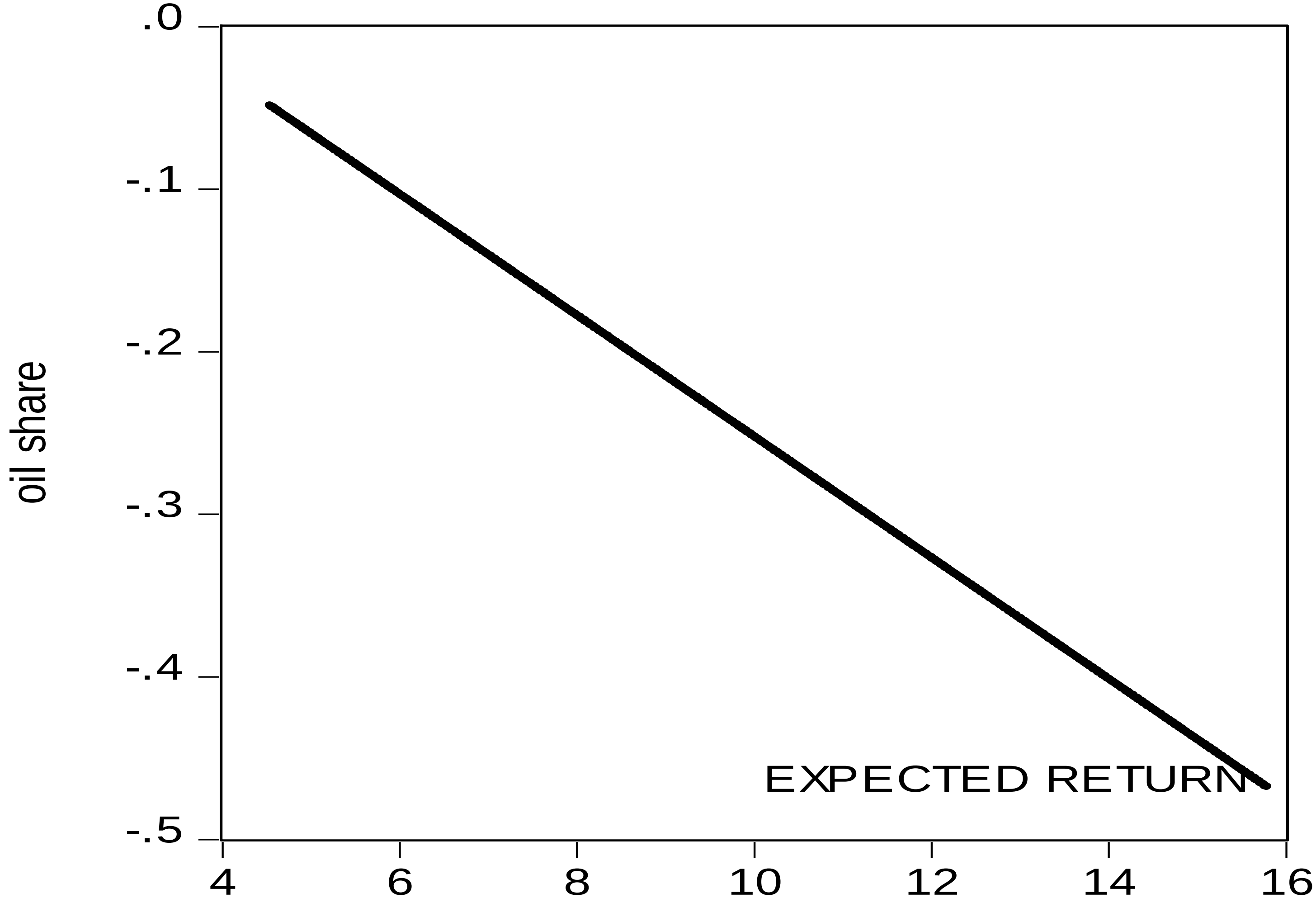


EXHIBIT 1: SHARE OF OIL IN OPTIMAL PORTFOLIOS

The Efficient Frontier and the Capital Market Line (CML)

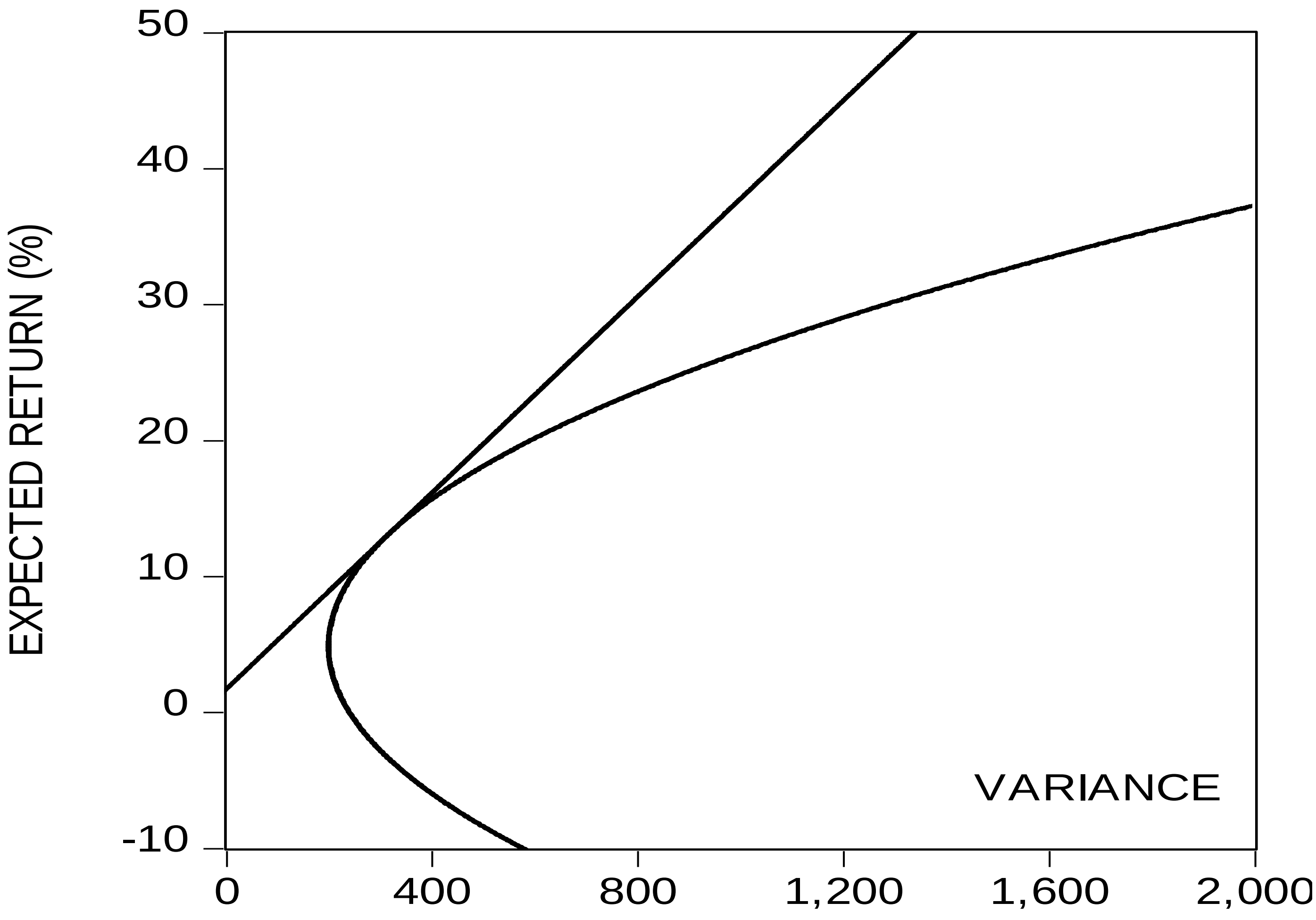


EXHIBIT 8: THE EFFICIENT FRONTIER

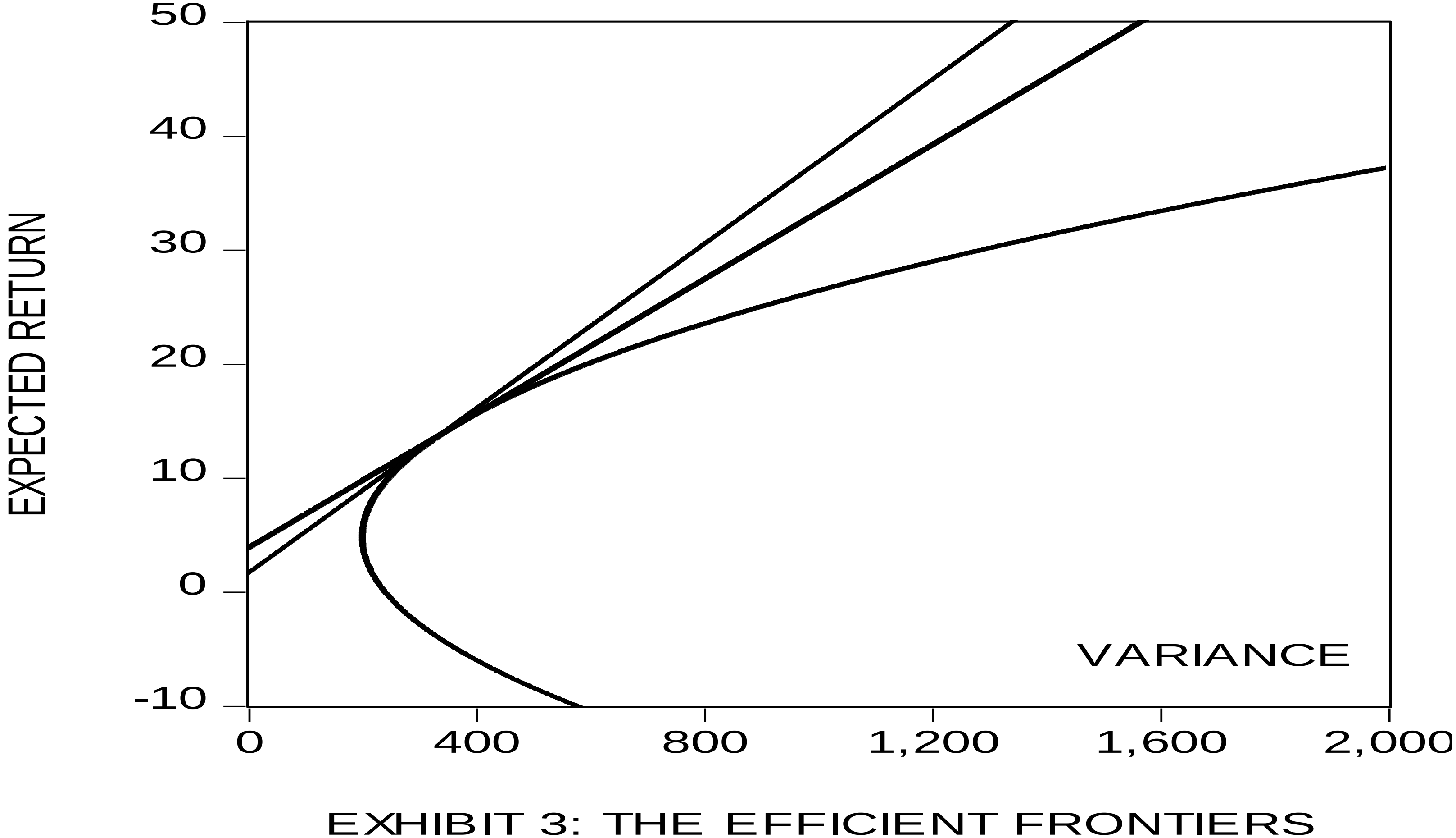
The Efficient Frontier (2)

The variable on the x-axis is the variance of the portfolio, and the variable on the y-axis is the expected return. The efficient frontier has the same shape as found in all finance textbooks. It is a parabola convex to the y-axis. The vertex is the Minimum Variance Portfolio (MVP), which has a return of 0.00091893, or 4.60% in annualized terms, and a variance of 0.0003871, or around 1.94% in annualized terms. The annualized standard deviation is 13.9%. Moving from the vertex of the MVP rightward on the curve one draws the efficient frontier, which provides for all portfolios that dominate all others either in terms of expected return, or in terms of variance.

The Efficient Frontier (3)

The three assets, energy index, agriculture index, and the average return of the portfolio, are characterized by optimal variances that lie on the lower or inefficient part of the efficient frontier. Assuming that the optimal substitute for these three assets is to match their variances, the three optimal portfolios should have respectively expected returns of 0.00537 (26.85%), 0.00262 (13.1%), and 0.00230 (11.5%), with the annualized returns in parentheses. These figures give the extent by which the return on each one of these three assets must increase to become optimal, i.e. on the efficient frontier.

A Flatter CML with a Higher Risk-free Rate



The Tangency Portfolio

Exhibit 2 portrays the efficient frontier together with the tangency portfolio. This portfolio depends on the assumed risk-free rate. If one chooses a rate of 1.56% per annum, which is the in-sample average Eurodollar rate, one gets the straight line in Exhibit 2. Exhibit 3 presents the tangency portfolios from two assumptions of the risk-less rate: 1.56% as above, and 3.80%, as estimated from long historical data. The second one is flatter as expected. These tangency portfolios were obtained by maximizing the ratio:

$$\theta = \frac{E(\tilde{R}) - rf}{\sigma_p^2}$$

where $E\left(\tilde{R}\right)$ is the random expected return, σ_p^2 is the portfolio variance, and where rf is the fixed risk-free rate. The first tangency line, which happens to be the Capital Market Line (CML) for that specific risk-less return, has an average return of 0.00248 (12.90% annualized), a figure which is quite close to the return on a well-diversified portfolio of common stocks (Brealey et al., 2017). The fact that the data in this paper result in reasonable values for the tangency portfolio is testimony to the soundness of the model. The second CML with the second estimate of the risk-free rate, carries an average return of 0.00282 (14.66% annualized), which is still reasonable for the US financial markets. The two estimated slopes of the CML produce two estimates of the market variance: 0.000604 (3.14% annualized variance) and 0.000709 (3.69% annualized variance). These two variances represent the estimates of the variance of the market portfolio. In terms of standard deviations, the figures become 17.72% and 19.20% respectively. Again such estimates are quite close to the standard deviation of a well-diversified portfolio of common stocks in the US financial markets.

Statistics on actual and optimal energy commodity index returns

Actual variance	Predicted return		Annualized predicted return	
	Efficient frontier	Capital market line	Efficient frontier	Capital market line
0.002153	0.00536	0.008063	27.872%	41.928%
0.002153	0.00536	0.007075	27.872%	36.790%

The synthetic two-fund portfolio of the energy commodity index.

Actual variance	Risk-free rate	Share in market return	Share in risk free asset	Portfolio variance	Portfolio return
0.002153 (10.765%)	0.000300 (1.56%)	3.5646	-2.5646	0.002153 (10.765%)	0.008070 (40.35%)
0.002153 (10.765%)	0.000731 (3.80%)	3.0367	-2.0367	0.002153 (10.765%)	0.007075 (35.375%)

CONCLUSION

- The energy index has the highest standalone risk, both economically and statistically with an annualized standard deviation of 32.8%. The next in line is the metals index with an annualized standard deviation of only 21.2%.
- An annualized return of at least 27.9% is required to hold long the energy index. This required return can reach 41.9% with different assumptions.
- A highly leveraged and aggressive position is needed to hold the energy index, e.g. the investor must borrow some three times her wealth.
- The energy share in any portfolio is always negative, i.e. the energy index is always shorted.
- It is unclear whether shorting the energy index to this extent is practicable and feasible.