“Does commodity exposure benefit traditional portfolios? Evidence from India”

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DOES COMMODITY EXPOSURE BENEFIT TRADITIONAL PORTFOLIOS? EVIDENCE FROM INDIA

Abstract

Commodities and commodity futures are expected to benefit stock and bond portfolio diversification because traditional asset types like equities and bonds have low correlations with commodities. During periods when stocks and bonds may underperform, commodities may provide a hedge against inflation and other economic uncertainties. This study investigates the diversification benefits of adding commodities to a traditional portfolio of stock and bonds from the perspective of an Indian investor. It employs several commonly used asset allocation strategies such as mean-variance, equal risk contribution, most diversified portfolio, and equal weight portfolio on different commodity derivative groups. The performance of various portfolios indicates that not all commodity groups provide substantial diversification benefits to a traditional portfolio. Agricultural commodities enhance performance (with an Omega ratio of 1.654), whereas metal and energy-related commodities do not diversify the traditional portfolio significantly (Omega ratio of 1.087 and 0.945, respectively). Gold and different equity sectors also provide some diversification benefits. This study also supports the hypothesis that the behavior of different commodity groups is quite different.

Keywords commodity futures, portfolio diversification, asset allocation strategies, performance evaluation

JEL Classification G11, G12

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INTRODUCTION

Commodities are alternative investments generating considerable interest among researchers and portfolio managers. With the advent of commodity indices, commodity-specific funds, and ETFs, many institutional investors allocate their assets to commodity markets, especially commodity futures. According to Citigroup, global commodity assets under management stood at $391 billion in January 2017, up 50% from the previous year. Commodities differ from financial assets, as these are the real assets produced, consumed, and stored. Commodities are seen as an alternative asset class due to these qualities. Earlier research has found evidence that commodities returns are weakly correlated with stock and bond returns. However, the correlation between equities and fixed-income securities and commodities has increased due to a surge in commodity investments. The two markets are now becoming more integrated. Commodities are also considered a hedge against inflation. Since commodity price level is an important cause of inflation, commodity prices positively correlate with inflation. These characteristics make commodities attractive candidates for investment. The exchange-traded commodity futures are the most convenient instruments to add commodity exposure to one's portfolio.

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The futures trading in commodities started in India in 2003. Since then, the commodities futures market in India has grown substantially. MCX (Multi Commodity Exchange of India) ranks among the top twenty exchanges in the world in terms of traded volume[1]. For the participation of small retail investors, the exchanges have also introduced small lot sizes for different commodity futures. Not much research has been conducted on the diversification benefits of commodity investments in the Indian capital market. This study will answer the benefits of adding commodities to a portfolio for an investor in the Indian capital market. It also tries to understand the heterogeneous properties of different commodity groups. The research would also put some light on the possible influence of asset allocation strategies on the benefits of diversification.

1. LITERATURE REVIEW

Following the 2000 stock market meltdown, investors looking for an alternative asset class began to focus increasingly on commodities. Since then, investment in commodity futures has risen exponentially. Gorton and Rouwenhorst (2006) show that commodity futures and stocks have roughly the same average return, but equities have a somewhat larger risk. Furthermore, the skewness of the return distribution of stocks is negative, whereas the skewness of commodities returns is positive. This means that stocks have a higher downside risk than commodity futures. Commodity futures positively link inflation and are inversely related to stocks and bonds. (Erb & Harvey, 2006; Gorton & Rouwenhorst, 2006).

According to Bodie and Rosansky (1980), portfolio risk is reduced by one third if 40% of the portfolio is invested in commodity futures, vis-a-vis with a portfolio of stocks only, without compromising return. Their results also suggest that commodity futures provide a good inflation hedge. Several studies document that the efficient frontier of stock-bond portfolios improves by including commodities (Satyanarayan & Varangis, 1996; Abanomey & Mathur, 1999a; Jensen et al., 2000; You & Daigler, 2013; Huang & Zhong, 2013; Belousova & Dorfleitner, 2012; Letho et al., 2022). Abanomey and Mathur (1999) compared the performance of portfolios that included international stocks, bonds, and US commodity futures, with similarly constructed portfolios excluding commodity futures. They found that the portfolios, including commodity futures, outperform the portfolios, excluding them, by 1.67-2.34% a year on a risk-adjusted basis. Jensen et al. (2000) examined the performance of commodity futures to assess their effectiveness as a portfolio component. The return/risk optimization gave substantial weight to commodity futures and significantly enhanced the portfolio returns. Commodity exposure of more than 5% enhances an equity portfolio returns regardless of the investor's investment style (Conover et al., 2010).

The use of commodities, commodity futures, and commodity indices are studied for hedging and diversification benefit (Abanomey & Mathur, 1999b; Abid et al., 2020; Gagnon et al., 2020; Shah & Dar, 2021; Stoll & Whaley, 2011; Tiwari et al., 2022; Willenbrock, 2011; You & Daigler, 2010). However, some recent research has cast doubts on these findings. One major source of concern is the growing link between commodity and equities returns as a result of commodity financialization. (Tang & Xiong, 2012; Adams & Glück, 2015). Tang and Xiong (2012) attributed it to index traders who invest in equity and commodity markets by investing in commodity index futures. Adams and Glück (2015) show significant price shock transmission from equity to commodity markets due to large commodity investments. They suggest that the co-movement between commodity and equity markets is not only due to the financial distress of 2008 but also because commodity investing has become an investment style of institutional investors. The inclusion of energy futures contract in an equity portfolio are beneficial in hedging but not in diversification when compared to the energy stocks (Galvani & Plourde, 2010). Cheung and Miu (2010) provide support for the diversification of commodity futures, but it is not as significant as it is supported in the previous literature. The benefit of including commodities in the portfolio

1 FIA (Futures Industry Association) 2016 Volume survey

is due to the infrequent rise in commodity prices. Another issue is that most studies of commodity diversification use a commodity index as the investment vehicle. In reality, the futures based on different commodities have different properties.

Recent research has addressed these concerns by including single commodity futures in the study and by examining the out-of-sample performance of a stock, bond, and commodities portfolio (Daskalaki & Skiadopoulos, 2011; You & Daigler, 2013; Bessler & Wolff, 2015). Daskalaki and Skiadopoulos (2011) used a regression technique to investigate the benefits of commodity indexes and individual commodity futures for diversification. They conclude that commodities do not add value to the portfolios of investors. On the other hand, both Bessler and Wolff (2015) and You and Daigler (2013) conclude that commodities add value to the portfolio, but the out-of-sample performance of portfolios, including commodities, is worse than their in-sample performance. Agyei-Ampomah et al. (2014) examine the impact of gold on investors' wealth during economic turmoil. The results show that palladium and industrial metals, particularly copper, provide better compensation for bond market losses than gold. The time-varying relationships between US equity and commodity markets reveal co-movement patterns and causality across investment horizons (Bekiros et al., 2016). Using an asset pricing framework, Batten et al. (2015) investigate the benefits of holding commodities individually and in portfolios for Asian investors. The study finds that adding gold and rice commodities are beneficial but not other commodities. Compared to an equity portfolio, the portfolio consists of commodity futures, and equity provides better return and risk, supporting the use of commodity futures for diversification and portfolio optimization (Daigler et al., 2017; Henriksen et al., 2019). Daskalaki et al. (2014) explore the diverse properties of different commodity futures. Their results suggest that commodity markets are highly heterogeneous and different from the stock market. Investors can benefit by including commodity indices in their traditional asset class portfolio as the performance increases, but the results are heterogeneous. In non-energy commodities, metal commodities are found to be less risky than agricultural commodities (Hanif et al., 2023). Lean et al. (2023) conclude that integrating commodity futures in portfolios does not usually boost risk-return performance, except for gold in specific configurations, after comparing the performance of the stock only portfolio to the portfolio with stocks and commodity futures.

Given the inconclusive verdict favoring commodities, this study examines the benefits of portfolio diversification by including commodity futures to bonds and stocks portfolio in the Indian context. Only retail investors and domestic firms that use commodity futures to hedge their risk can participate in these exchanges. Financial institutions like banks, mutual funds, and foreign portfolio investors cannot invest in these markets. Moreover, there is no exchange-traded instrument, other than futures (index ETF, options are recently introduced in the Indian commodity derivatives market), for getting exposure to commodities. These characteristics make the Indian commodity futures market very different from the other developed commodity exchanges and an interesting market to study. The main hypothesis of this study is to assess whether adding commodity futures to a normal equities and debt portfolio provides a diversification advantage.

2. METHODOLOGY

2.1. Data

A benchmark portfolio of equities and bonds is constructed to investigate the diversification effects of commodity futures in Indian markets, as represented by the NSE Nifty 50 index (Nifty), a benchmark index of the Indian stock market. Bonds are represented by the S&P BSE India 10-year sovereign bond index (called Gsec, hereafter). It consists of the Benchmark Indian Sovereign Bond with fixed coupons and a remaining maturity of close to 10 years. The indices of India's two major commodity futures exchanges are utilized for investment in commodities. MCXCOMDEX of MCX is the proxy for the aggregate commodity futures investment. It is a composite commodity futures index based on the commodity futures prices of the exchange. The futures indices of metals, energy, and agricultural products are also used to examine the diversification benefits of

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different commodity groups. For metals and energy products, MCXMETAL and MCXENERGY of MCX are used. Dhaanya of NCDEX (National Commodity and Derivative Exchange) is employed for agricultural products. These commodity sectors are selected to ensure good coverage and availability of data.

The data consists of monthly returns of the stock, bond, and commodity futures indices from October 2005 to March 2017, except for the Dhaanya index. The data for the Dhaanya index is from January 2007 to March 2017, as January 1st, 2007 is the base date for this index. CCIL (Clearing Corporation of India Ltd.) The T-bill index is used for determining the risk-free rate. This index consists of the T-bills with less than 365 days of maturity. The CCIL T-bill Index data are taken from the CCIL website. Gold and gold futures data are sourced from MCX. All the prices are denominated in INR and are extracted from the Bloomberg database.

The benchmark portfolio of Nifty and Gsec (without any other asset) is used for judging the performance of different commodity groups and sectoral indices. The portfolio diversification improvement brought about by including various commodity groups and sectoral indices in the portfolio is then examined. Gold is studied as a separate class of investment (a special commodity) due to its characteristics. The diversification benefits of adding sectoral equity indices to Nifty and Gsec are also examined. The selected sectors are banking, FMCG, IT, auto, energy, financial services, and metals. Some sectors, such as energy and metals, may act as indirect investments in the corresponding commodities and provide similar diversification benefits.

2.1.1. Asset allocation strategies

While testing the diversification benefits, different commonly used asset allocation strategies are implemented to ensure that a particular asset allocation strategy does not bias the results. The methods employed are Naïve equally weighted portfolio (EW), mean-variance optimization (MV), minimum variance portfolio (Minvar), equal risk contribution portfolio (ERC), and maximum diversified portfolio (MDP).

2.1.2. EW strategy

In this strategy, the wealth is equally distributed among all the investments. The main advantage of this strategy is that no parameter needs to be estimated, and the implementation is straightforward. There is a good amount of empirical support in favor of this strategy. For instance, DeMiguel et al. (2009) report that the equal-weighted strategy outperforms the mean-variance optimization strategy in their out-of-sample tests. The portfolio weights are given by

$$w_i = \frac{1}{N} \forall i, \tag{1}$$

where N is the total number of assets in a portfolio, and w_i is the weight of the i-th asset.

2.1.3. MV strategy

In this framework, the investor trades off between the risk and expected returns, maximizing her utility (Markowitz, 1952). The mean-variance optimization problem is

$$\max_w \left(U = w'\mu - \frac{\delta}{2} w'\Sigma w \right), \tag{2}$$

where the investor's utility is denoted by U, μ is the (column) vector of expected return estimates, w is the (column) vector of portfolio weights (estimated by maximizing U), covariance matrix is Σ, and δ is the of risk aversion coefficient. The risk aversion coefficient used in this study is 2, corresponding to a low-risk aversion level.

2.1.4. Minvar strategy

This method chooses portfolio weights to minimize the portfolio return variance. The minimization problem is

$$\min_w w'\Sigma w, \tag{3}$$

where w is the (column) vector of portfolio weights.

This strategy implicitly assumes a very high-risk aversion. The key advantage of this technique is that no return estimation is required, which is normally vulnerable to substantial estimation errors.

2.1.5. ERC strategy

If the risk of a portfolio is measured by *R(w),* and the risk contribution of an asset *i* is $C_i(w)$, then

$$\sum_i^N C_i(w) = R(w). \quad (4)$$

If we use standard deviation as a proxy for the risk of the portfolio, then

$$(w) = \sqrt{w' \sum w}, \quad (5)$$

and the risk contribution of the asset *i* is

$$\sigma_i(w) = w_i \partial_{wi} \sigma(w), \quad (6)$$

where $\partial_{wi}\sigma(w)$ is the marginal risk contribution from the asset *i.* For an equal risk contribution portfolio, the portfolio weights are chosen so that the risk contribution of any asset i equals the risk contribution of any other asset *j.*

$$\sigma_i(w) = \sigma_j(w) \forall i, j, \quad (7)$$

2.1.6. MDP strategy

Following Choueifaty and Coignard (2008), the diversification ratio of a portfolio is defined as

$$DR(w) = \frac{\sum_{i=1}^n w_i \sigma_i}{\sqrt{w' \Sigma w}}. \quad (8)$$

It is the ratio of the weighted average of volatilities to the portfolio volatility. The portfolio has the optimal weights, for which the diversification ratio is maximized, and is the most diversified portfolio.

Each asset allocation strategy has additional constraints on the portfolio weights for ensuring full investments and long-only positions.

$$\sum_i w_i = 1, \quad \text{and} \quad w_i > 0 \forall i. \quad (9)$$

2.1.7. Performance evaluation

For out-of-sample analysis, this study employs the rolling window approach used in several previous studies (DeMiguel et al., 2009; Daskalaki & Skiadopoulos, 2011; Bessler & Wolff, 2015). The optimal portfolio weights for a month t are calculated using data up to and including month t to estimate the mean returns and covariance matrices. The realized portfolio return from t to t+1 is then calculated using these optimal weights. This procedure is repeated by advancing the sample period by one month and determining the optimal weights for the following month. A rolling window of 60 months is used to calculate the optimal weights, with monthly rebalancing.

This study uses various out-of-sample performance measures to evaluate the benefit of including commodity futures and sectoral indices in the traditional portfolio. These measures include risk-to-return ratios (Sharpe, Sortino, and Omega), downside risk measures (modified VaR and maximum drawdown), and upside potential ratio. The study also examines the annual return and volatility for the different asset allocation strategies. Sharpe ratio, the first measure, is the ratio of the average excess return of the portfolio to its standard deviation. Because it penalizes both the upside and downside risk, we use two more risks-to-return performance measures that account for the downside risk only. The Sortino ratio accounts for the downside risk by using the downside deviation as the risk measure. The Omega ratio is the probability-weighted ratio of gains over losses for a minimum acceptable level of return. Omega has the advantage of not assuming any specific return distribution and is non-parametric. A higher value of Omega would be preferred by a rational investor for a given level of expected return.

Modified VaR is used to adjust for the non-zero skewness and excess Kurtosis of the distribution of portfolio returns among the downside risk measures. This study also uses the upside potential ratio to measure the gain per unit of downside risk. It allows the investors to identify investments with better upside performance per unit of downside risk. A minimum acceptable return (MAR) is required to calculate the performance measures Omega, Sortino, and upside potential ratio. MAR is the lowest rate of return an investor is willing to accept to meet her financial objective. This study uses the risk-free rate of return as the MAR.

3. RESULTS & DISCUSSION

3.1. Descriptive statistics

Table 1 presents the descriptive statistics of the monthly return series for all the assets (gold and

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Table 1. Descriptive statistics

Portfolio	Constituents	Mean	Std. Dev.	Sharpe Ratio	VaR 95%	Skewness	Kurtosis
Benchmark Indices	Nifty	9.34%	23.66%	0.15	–9.77%	–0.72	3.69
	Gsec	6.28%	7.45%	0.22	–2.62%	1.00	7.87
Commodity Indices	MCXCOMD	3.15%	18.32%	–0.09	–7.78%	–0.68	3.15
	Dhaanya	15.03%	17.73%	0.55	–5.39%	0.52	1.30
	Energy	–3.43%	28.72%	–0.27	–13.30%	–0.78	1.66
	Metal	7.60%	19.37%	0.11	–7.07%	–0.10	1.93
Gold	Gold	11.48%	16.90%	0.36	–6.19%	0.08	–0.10
	Gold Future	11.55%	17.74%	0.33	–6.16%	0.36	0.16
Sectoral Indices	NSEBANK	9.89%	32.38%	0.14	–13.39%	0.03	1.68
	NSEFMCG	15.41%	18.79%	0.50	–6.94%	–0.71	2.12
	NSESRV	9.42%	23.26%	0.16	–10.46%	–0.45	1.77
	NSEIT	7.43%	25.70%	0.07	–10.98%	–0.43	1.00
	NSEAUTO	14.25%	26.75%	0.30	–11.86%	–0.45	2.01
	NSENRG	6.13%	25.70%	0.02	–10.42%	–0.67	3.83
	NSEFIN	11.32%	31.14%	0.18	–12.43%	–0.09	2.11
	NSEMET	1.14%	40.59%	–0.10	–16.71%	–0.34	2.58
Ris-Free Rate	T-Bill	4.67%	0.64%	–	0.00%	–0.15	4.21

Note: The table provides the summary statistics of the assets' returns for the full period. "Mean" is the annualized average of the monthly returns, while "Std.Dev." is the annualized standard deviation. Sharpe ratio is the annualized Sharpe ratio, and Kurtosis is the excess Kurtosis. VaR 95% is the historical VaR at the 95% confidence level.

indices) from October 2005 to March 2017 (other than Dhaanya), consisting of 138 observations. For the futures index of agricultural products, Dhaanya (agriculture index), the data is from January 2007 to March 2017, having 123 observations. The average annualized returns for Nifty and Gsec are 9.3% and 6.3%. Among the commodity futures indices, the agriculture sector has the best returns (15% p.a.), whereas the energy sector has the worst (-3.4%). Gold has 11.5% returns, whereas the sectoral equity indices' returns vary from 15.4% (FMCG) to 1.1% (metals). The average risk-free return is 4.7%, more than the returns of the energy and aggregate commodity indices.

The annualized standard deviation and VaR (at 95% confidence level), which reflect the riskiness of returns, reveal that the aggregate commodity futures index (aggregate index – MCXCOMD) is less volatile than the Nifty and has less value at risk (18.32% & –7.78% as compared to 23.66% & –9.77%). The most volatile commodity futures index is for energy-based products (28.72%), whereas the least volatile is the agriculture index and gold/gold futures (17.73% & 16.90%, respectively). The sectoral equity indices exhibit higher volatility and VaR than the commodity futures indices but are comparable to Nifty. The annualized standard deviations of T-bills and Gsec are 0.6% and 7.5%. All the return series are leptokurtic. The stock indices' returns are negatively skewed (–0.72), whereas those of the agriculture index and gold are positively skewed (0.52 & 0.08). This suggests that these two commodities have less downside risk than stock indices. This result is also corroborated by values at risk. The monthly VaR of the agriculture index and gold is a low of 5.4 % and 6.2%.

The Sharpe ratios are negative for the aggregate and energy futures indices (–0.09 & –0.27). For the metals futures index, it is less than that for the stock, bond, and sectoral index. This makes commodity futures, energy products, and metals unattractive as standalone investments. The Sharpe ratios for gold/gold futures and the agriculture index are the highest, and one can make standalone investments in these commodity groups/futures (0.36 & 0.55).

Table 2 indicates that the long-run correlation between Nifty and commodity futures is not significantly different from zero (all are close to zero). The only exception is the metals futures index, which has a low positive correlation with Nifty (0.19). Similarly, the commodity futures either show no correlation or a significant negative correlation with the Gsec. This suggests that commodities may provide diversification benefits for a stock portfolio. The correlation within the com-

Table 2. Correlation matrix of asset returns for the full period

	Nifty	Gsec	MCXCOMD	Agri	Energy	Metal	Gold	GoldF	NSEBANK	NSEFMCG	NSESRV	NSEIT	NSEAUTO	NSENRG	NSEFIN	NSEMET
Nifty	1.00															
Gsec	0.01*	1.00														
MCXCOMD	0.16*	–0.38	1.00													
Agri	0.04*	–0.08*	0.34	1.00												
Energy	0.13*	–0.43	0.86	0.23	1.00											
Metal	0.19	–0.23	0.81	0.26	0.47	1.00										
Gold	–0.10*	–0.14*	0.54	0.15*	0.26	0.75	1.00									
GoldF	–0.08*	–0.15*	0.55	0.15*	0.25	0.76	0.95	1.00								
NSEBANK	0.86	0.22	–0.03*	0.07*	–0.06	0.04*	–0.17	–0.20	1.00							
NSEFMCG	0.65	0.03*	0.02*	0.06*	–0.01*	0.10*	–0.04*	–0.01*	0.50	1.00						
NSESRV	0.97	0.09*	0.08*	0.03*	0.06*	0.12*	–0.17	–0.17	0.90	0.61	1.00					
NSEIT	0.60	–0.17*	0.28	0.04*	0.28	0.19	–0.12*	–0.12*	0.37	0.38	0.66	1.00				
NSEAUTO	0.86	–0.04*	0.14*	0.05*	0.10*	0.19	–0.06*	–0.04*	0.73	0.66	0.82	0.53	1.00			
NSENRG	0.91	–0.02*	0.18	–0.02*	0.16*	0.17	–0.06*	–0.04*	0.76	0.54	0.85	0.43	0.75	1.00		
NSEFIN	0.90	0.17	0.00*	0.06*	–0.03*	0.06*	–0.17	–0.18	0.99	0.54	0.93	0.42	0.77	0.79	1.00	
NSEMET	0.86	–0.04*	0.35	0.17*	0.29	0.34	–0.02*	0.01*	0.73	0.47	0.81	0.49	0.73	0.81	0.77	1.00

Note: This table provides the correlation matrix for asset returns for the full period. * indicates that the value is not significantly different from 0 at 5% level.

modity group also varies. The aggregate index correlates more with energy and metal group futures than the agriculture index. The agriculture index shows a low correlation with other commodity groups and an insignificant correlation with all the asset classes.

The out-of-sample risk and returns of the portfolios with and without commodity futures are presented in Table 3. Separate portfolios have been created with commonly used asset allocation strategies EW, MV, Minvar, ERC, and MDP. The summary results include the average annualized monthly return, the average annualized standard deviation, and the mean absolute deviation. Table 3 shows that the benchmark portfolio returns are higher than those of the portfolios consisting of an aggregate index, Nifty, and Gsec, for all the strategies (max 7.51% in MV strategy as compared to 4.39%). The out-of-sample returns of the three portfolios of the futures indices of energy, metal, and agriculture-based products, with Nifty and Gsec, are also reported. From the view of return maximization, there is not much benefit to adding energy and metal-related commodities to one's portfolio. The benchmark portfolio is better than the portfolios, including the futures indices of composite commodities, energy-based products, or metals.

The portfolio's performance comprising the agriculture index, Nifty, and Gsec is the best for all the strategies among all the portfolios. The portfolio's performance having an energy futures index, Nifty, and Gsec is the worst. It can be attributed to the fact that, since 2012, there has been a consistent decline in the prices of energy-related commodities and metals. Due to the low weight of agricultural commodities, and the high weight of energy and metal-related commodities, the portfolio's performance consisting of an aggregate index with Nifty and Gsec is also poor. From the strategy point of view, MV is the best, with the highest out-of-sample annualized return; but it also has the highest volatility(11.64% return 16.91% as the volatility). The combined effect of returns and risk is discussed in the following section.

Table 4 presents the performance of the portfolios created with different strategies within the framework of risk-adjusted returns. The agriculture index, Nifty, and Gsec portfolio have the best Omega and Sharpe ratios (2.079 and 0.242, respectively) for all the portfolio strategies. This indicates that the Minvar portfolio could be preferred to other strategies regarding the reward-to-risk consideration. The least Omega and Sharpe ratios are provided by the portfolios comprising the futures index of energy, Nifty, and Gsec; and with the MV strategy (–0.023 and 1.087, respectively).

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Table 3. Risk and returns of portfolios with different commodity groups

Portfolio strategies	Risk & Return	Benchmark	Nifty and Gsec with commodity futures Index			
			MCXCOMDOX	MCXENERGY	MCXMETAL	DHAANYA
EW	Annualized Return	6.93%	4.69%	4.00%	5.84%	10.55%
	Annualized Std Dev	9.02%	6.83%	9.41%	7.67%	7.97%
	Maximum Return	6.99%	4.70%	7.17%	6.41%	6.87%
	Minimum Return	–5.79%	–4.07%	–8.00%	–4.69%	–4.20%
	MAD	2.07%	1.58%	2.18%	1.76%	1.74%
MV	Annualized Return	7.51%	4.39%	3.85%	5.48%	11.64%
	Annualized Std Dev	6.49%	5.97%	5.98%	8.29%	16.91%
	Maximum Return	5.70%	5.03%	4.20%	6.24%	20.38%
	Minimum Return	–4.70%	–3.19%	–4.10%	–8.06%	–11.09%
	MAD	1.41%	1.35%	1.33%	1.82%	3.37%
MinVar	Annualized Return	7.75%	6.72%	6.87%	7.19%	9.96%
	Annualized Std Dev	4.99%	4.29%	4.29%	4.87%	5.19%
	Maximum Return	4.38%	4.49%	4.60%	4.38%	5.01%
	Minimum Return	–4.42%	–2.26%	–2.55%	–3.30%	–4.59%
	MAD	1.04%	0.92%	0.94%	1.07%	1.00%
ERC	Annualized Return	7.54%	6.01%	6.08%	6.72%	10.37%
	Annualized Std Dev	5.91%	4.54%	5.03%	5.35%	6.06%
	Maximum Return	4.54%	3.47%	4.70%	4.36%	5.94%
	Minimum Return	–3.99%	–2.53%	–3.07%	–3.66%	–4.30%
	MAD	1.33%	1.04%	1.15%	1.23%	1.28%
MDP	Annualized Return	7.54%	6.09%	6.16%	6.73%	10.23%
	Annualized Std Dev	5.91%	4.55%	5.00%	5.32%	6.04%
	Maximum Return	4.54%	3.63%	4.42%	4.04%	5.79%
	Minimum Return	–3.99%	–2.50%	–2.97%	–3.73%	–4.32%
	MAD	1.33%	1.03%	1.15%	1.21%	1.29%

Note: This table provides the summary results for different portfolios under different asset allocation strategies, for the out-of-sample period. MAD is mean absolute deviation.

The maximum drawdown value indicates that the investor would lose the most following the EW strategy, with the portfolio of futures index of energy products, Nifty, and Gsec (–0.256). This is because the weights are equal for all the assets in the EW strategy, and the energy futures index can pull down the portfolio returns much more with its low returns. In terms of maximum drawdown and value at risk, the best performance is shown by the portfolio of an aggregate index, Nifty, and Gsec, under the three risk-based strategies (Minvar, ERC, and MDP)(with as VaR of –0.015, –0.019 and –0.019, respectively).

As against the maximum drawdown, which measures the chances of losses, the upside potential ratio measures the chances of upside gains, and the Nifty and Gsec with the agriculture index have the highest upside potential ratio under the EW portfolio strategy. The metals futures index provides the lowest ratio.

The risk and returns of the portfolios, including gold/gold futures or sectoral indices, combined with Nifty and Gsec, are presented in Table 5. Nifty and Gsec with sectoral equity portfolios generally provide higher returns than the benchmark portfolio or the portfolios consisting of Nifty, Gsec, and gold/gold futures. The MV strategy offers the highest returns with the Nifty, Gsec, and sectoral equity indices portfolio (10.29%). The returns for gold and gold futures portfolios are similar to those of the standalone benchmark portfolio. Similar is the case with the annualized standard deviation. The portfolios of Nifty and Gsec with sectoral equity indices are generally the most volatile(15.43% for EW strategy) The volatility of Nifty, Gsec, and gold/gold futures portfolios is the least, except for the MV strategy(4.11% for minimum variance portfolio). There is no significant difference between the portfolios having gold or gold futures as the portfolio components.

Table 4. Performance measures of portfolios with different commodity groups

Portfolio strategies	Performance parameters	Benchmark	Nifty and Gsec with commodity futures Index			
			MCXCOMDOX	MCXENERGY	MCXMETAL	DHAANYA
EW	Sharpe Ratio	0.065	−0.011	−0.023	0.033	0.184
	Omega	1.177	0.972	0.945	1.087	1.654
	Sortino Ratio	0.098	−0.016	−0.031	0.049	0.332
	Max Drawdown	−0.126	−0.105	−0.256	−0.079	−0.039
	VaR	−0.036	−0.028	−0.042	−0.031	−0.024
	Upside potential ratio	0.809	0.846	0.701	0.857	1.028
MV	Sharpe Ratio	0.105	−0.030	−0.055	0.020	0.121
	Omega	1.319	0.927	0.867	1.055	1.439
	Sortino Ratio	0.157	−0.042	−0.073	0.028	0.226
	Max Drawdown	−0.079	−0.083	−0.094	−0.106	−0.124
	VaR	−0.025	−0.024	−0.026	−0.037	−0.035
	Upside potential ratio	0.714	0.698	0.715	0.573	0.998
Minvar	Sharpe Ratio	0.146	0.102	0.111	0.117	0.242
	Omega	1.487	1.313	1.338	1.357	2.079
	Sortino Ratio	0.210	0.151	0.170	0.171	0.408
	Max Drawdown	−0.078	−0.036	−0.054	−0.037	−0.056
	VaR	−0.019	−0.015	−0.014	−0.018	−0.017
	Upside potential ratio	0.631	0.621	0.768	0.666	0.597
ERC	Sharpe Ratio	0.115	0.054	0.054	0.084	0.227
	Omega	1.341	1.146	1.146	1.236	1.885
	Sortino Ratio	0.176	0.079	0.079	0.124	0.416
	Max Drawdown	−0.079	−0.036	−0.066	−0.042	−0.048
	VaR	−0.023	−0.017	−0.019	−0.021	−0.018
	Upside potential ratio	0.822	0.827	0.740	0.897	0.943
MDP	Sharpe Ratio	0.115	0.059	0.059	0.085	0.222
	Omega	1.341	1.161	1.160	1.241	1.844
	Sortino Ratio	0.176	0.086	0.087	0.124	0.400
	Max Drawdown	−0.079	−0.034	−0.063	−0.043	−0.050
	VaR	−0.023	−0.017	−0.019	−0.021	−0.018
	Upside potential ratio	0.822	0.796	0.806	0.790	0.886

Note: This table provides the performance measures for the out of sample performance of different commodity group portfolios with different assets allocation strategies. The portfolios are rebalanced with a monthly frequency. VaR is the modified value at risk at the 95% confidence level.

The portfolio's performance comprising gold futures, Nifty, and Gsec generally dominates the others for most strategies and measures. The portfolio's performance comprising gold, Nifty, and Gsec closely follows. The benchmark and the portfolio with sectoral equity indices are the best for MV strategy. Probably this strategy can effectively balance the high volatility and high returns of a sectoral index.

The performance indicators for the portfolios comprising Nifty and Gsec; Nifty, Gsec, and gold/ gold futures; and Nifty, Gsec, and sectoral equity indices are presented in Table 6. Gold portfolios provide the best values for most of the performance measures. The risk/ reward performance of gold futures portfolios is the best. They also have low downside risk and sometimes high upside potential. The values of performance measures for the benchmark portfolio, and the portfolios with sectoral equity indices, are generally the worst. The high returns of sectoral equity indices cannot improve their portfolio performance due to their high volatility. However, these portfolios perform well with the MV strategy.

The downside risk measures support adding gold and gold futures as a diversification asset to one's portfolio. Such portfolios have the lowest drawdown and the lowest value at risk. On the other hand, adding sectoral equity indices to Nifty and Gsec portfolios does not significantly decrease the maximum drawdown and value at risk. Only for the MV strategy, it gives better results than the other portfolios.

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Table 5. Risk and returns of portfolio with gold, gold futures and equity sectors

Portfolio strategies	Risk & Return	Benchmark	Nifty and Gsec with		
			Gold	Gold Future	Sectoral Indices
EW	Annualized Return	6.93%	6.66%	6.69%	6.18%
	Annualized Std Dev	9.02%	6.57%	6.58%	15.43%
	Maximum Return	6.99%	5.89%	5.56%	11.54%
	Minimum Return	–5.79%	–4.94%	–5.18%	–9.50%
	MAD	2.07%	1.46%	1.49%	3.50%
MV	Annualized Return	7.51%	6.64%	6.51%	10.29%
	Annualized Std Dev	6.49%	10.64%	11.38%	10.26%
	Maximum Return	5.70%	11.91%	13.16%	7.06%
	Minimum Return	–4.70%	–7.41%	–7.42%	–6.79%
	MAD	1.41%	2.19%	2.20%	2.36%
MinVar	Annualized Return	7.75%	7.75%	7.78%	7.90%
	Annualized Std Dev	4.99%	4.19%	4.11%	4.55%
	Maximum Return	4.38%	3.77%	3.98%	3.79%
	Minimum Return	–4.42%	–2.18%	–2.27%	–2.43%
	MAD	1.04%	0.93%	0.91%	1.03%
ERC	Annualized Return	7.54%	7.45%	7.45%	7.78%
	Annualized Std Dev	5.91%	4.80%	4.78%	8.68%
	Maximum Return	4.54%	4.29%	4.02%	6.85%
	Minimum Return	–3.99%	–3.23%	–3.41%	–5.47%
	MAD	1.33%	1.08%	1.08%	1.98%
MDP	Annualized Return	7.54%	7.36%	7.35%	7.61%
	Annualized Std Dev	5.91%	4.83%	4.80%	5.40%
	Maximum Return	4.54%	4.29%	4.02%	4.70%
	Minimum Return	–3.99%	–3.23%	–3.38%	–3.13%
	MAD	1.33%	1.10%	1.09%	1.23%

Note: This table provides the summary results for different portfolios under different asset allocation strategies, for the out-of-sample period. MAD is mean absolute deviation.

Comparing the portfolio with the agriculture index (the best portfolio in Table 4) with the portfolios having gold or sectoral indices confirms the overall dominance of the portfolio with the agriculture index. For all the strategies, almost all the portfolio performance measures comprising agriculture index, Nifty, and Gsec are substantially better than those of the other portfolios (including the portfolio containing gold futures). The only exception is the MV strategy, for which four performance measures (out of six) of the portfolios with sectoral equity indices are marginally better than those of the portfolio with the agriculture index.

There is evidence that all the commodity groups do not perform similarly. Contrary to the results of the more developed commodity markets, this study finds that the aggregate commodity basket, industrial and precious metals, and energy-related products substantially improve the stocks and bonds portfolio performance. On the other hand, agricultural commodities provide substantial diversification benefits to the stocks and bonds portfolio. A major reason for these results is the low correlation between the returns of equity/bond and agricultural commodities and a high average return on agricultural commodities. Including gold futures in one's equity portfolio improves performance due to a low correlation between gold and equity/bond returns. Still, this improvement is much less than that shown by the agricultural commodities because of their higher returns. Adding specific equity sectors to the traditional portfolio also somewhat improves performance. As portfolio constituents, the desirability of agricultural commodities and gold may also be ascribed to the low volatility and positive skewness of their returns. However, to some extent, the benefits of diversification depend on the strategy followed for portfolio construction (the MV strategy of portfolio construction shows some divergent results for specific measures). One can expect to improve the performance of equity and bond portfolios by adding futures contracts based on agricultural commodities or gold.

Table 6. Performance measures of portfolios with gold, gold futures, and sectoral equity indices

Portfolio strategies	Performance parameters	Benchmark	Nifty and Gsec with		
			Gold	Gold Future	Sectoral Indices
EW	Sharpe Ratio	0.065	0.069	0.071	0.039
	Omega	1.177	1.198	1.197	1.105
	Sortino Ratio	0.098	0.107	0.107	0.057
	Max Drawdown	–0.126	–0.051	–0.054	–0.243
	VaR	–0.036	–0.025	–0.026	–0.067
	Upside potential ratio	0.809	0.802	0.835	0.840
MV	Sharpe Ratio	0.105	0.052	0.047	0.148
	Omega	1.319	1.155	1.153	1.451
	Sortino Ratio	0.157	0.080	0.077	0.229
	Max Drawdown	–0.079	–0.170	–0.156	–0.115
	VaR	–0.025	–0.039	–0.038	–0.042
	Upside potential ratio	0.714	0.765	0.947	0.813
Minvar	Sharpe Ratio	0.146	0.171	0.176	0.167
	Omega	1.487	1.552	1.577	1.522
	Sortino Ratio	0.210	0.273	0.277	0.264
	Max Drawdown	–0.078	–0.029	–0.032	–0.044
	VaR	–0.019	–0.014	–0.013	–0.016
	Upside potential ratio	0.631	0.847	0.718	0.786
ERC	Sharpe Ratio	0.115	0.134	0.135	0.093
	Omega	1.341	1.405	1.405	1.262
	Sortino Ratio	0.176	0.211	0.211	0.142
	Max Drawdown	–0.079	–0.032	–0.034	–0.108
	VaR	–0.023	–0.017	–0.017	–0.034
	Upside potential ratio	0.822	0.839	0.836	0.843
MDP	Sharpe Ratio	0.115	0.128	0.128	0.128
	Omega	1.341	1.380	1.381	1.382
	Sortino Ratio	0.176	0.200	0.200	0.203
	Max Drawdown	–0.079	–0.032	–0.034	–0.054
	VaR	–0.023	–0.017	–0.017	–0.019
	Upside potential ratio	0.822	0.804	0.862	0.872

Note: This table provides the performance measures for the out of sample performance of gold, gold futures, and sectoral equity indices with different asset allocation strategies. The portfolios are rebalanced with a monthly frequency. VaR is the modified value at risk at the 95% confidence level.

The results of this study broadly demonstrate the diversification benefits of commodities for bonds and stocks portfolio in the Indian market. However, the effect of the individual commodity is studied only for gold. The effect of other commodities is studied with aggregate commodity futures index and sectoral commodity futures indices. Given the data availability, this approach was adopted to increase the scope. As the commodities differ in their properties, a study of the diversification benefits of individual commodities may shed more light on the nature and causes of these diversification benefits. Agricultural commodities hold a special promise in this area.

CONCLUSION

This study investigates the benefit of adding commodities/commodity futures as asset classes in a portfolio of equities and bonds in the Indian market.

The results of this study support the evidence that the behavior of different commodity groups is quite different. In general, the volatility of commodity groups (represented by their futures index) is lower than that of the stocks (represented by the composite equity index Nifty and sectoral equity indices), except for the energy-based commodity group. In the Indian market, commodities would generally not

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be beneficial as standalone investments, as their long-run return is lower than that of the stock market, except for agricultural commodities. More importantly, no significant correlation exists between the aggregate commodity index (or sectoral commodity indices) returns with the equity and bond returns. Out of these, the agricultural commodities have a low correlation with the other commodity groups (energy and metal, in our study) and an insignificant correlation with the bond and equity indices. The agricultural commodities and gold provide the highest and second-highest performance enhancement, whereas the aggregated commodities, energy, and metal-related commodities provide much lower diversification benefits. Gold also benefits from a low correlation with equity and bond returns, but its returns are not sufficiently high, which reduces the overall diversification benefits.

Contrary to the results of the more developed commodity markets, this study finds that the aggregate commodity basket, industrial and precious metals, and energy-related products do not improve the stocks and bonds portfolio performance. On the other hand, agricultural commodities provide substantial diversification benefits to the stocks and bonds portfolio. Gold also offers a good amount of diversification benefits. The addition of specific equity sectors to the traditional portfolio also improves the performance somewhat.

AUTHOR CONTRIBUTIONS

Conceptualization: Vikas Pandey.
Data curation: Vikas Pandey.
Formal analysis: Vikas Pandey.
Investigation: Vikas Pandey.
Methodology: Vikas Pandey.
Resources: Vikas Pandey.
Software: Vikas Pandey.
Validation: Vikas Pandey.
Visualization: Vikas Pandey.
Writing – original draft: Vikas Pandey.
Writing – review & editing: Vikas Pandey.

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REFERENCES

1. Abanomey, W. S., & Mathur, I. (1999). The hedging benefits of commodity futures in international portfolio diversification. *The Journal of Alternative Investments, 2*(3), 51-62. https://doi.org/10.3905/jai.1999.318904
2. Abid, I., Dhaoui, A., Goutte, S., & Guesmi, K. (2020). Hedging and diversification across commodity assets. *Applied Economics*, *52*(23), 2472-2492. https://doi.org/10.1080/00036846.2019.1693016
3. Adams, Z., & Glück, T. (2015). Financialization in commodity markets: A passing trend or the new normal? *Journal of Banking & Finance, 60,* 93-111. https://doi.org/10.1016/j.jbankfin.2015.07.008
4. Agyei-Ampomah, S., Gounopoulos, D., & Mazouz, K. (2014). Does gold offer a better protection against losses in sovereign debt bonds than other metals? *Journal of Banking & Finance, 40,* 507-521. https://doi.org/10.1016/j.jbankfin.2013.11.014
5. Batten, J. A., Szilagyi, P. G., & Wagner, N. F. (2015). Should emerging market investors buy commodities? *Applied Economics, 47*(39), 4228-4246. https://doi.org/10.1080/00036846.2015.1026586
6. Bekiros, S., Nguyen, D. K., Uddin, G. S., & Sjö, B. (2016). On the time scale behavior of equity-commodity links: Implications for portfolio management. *Journal of International Financial Markets,*

Institutions and Money, 41, 30-46. https://doi.org/10.1016/j.intfin.2015.12.003

7. Belousova, J., & Dorfleitner, G. (2012). On the diversification benefits of commodities from the perspective of euro investors. *Journal of Banking & Finance, 36*(9), 2455-2472. https://doi.org/10.1016/j.jbankfin.2012.05.003

8. Bessler, W., & Wolff, D. (2015). Do commodities add value in multi-asset portfolios? An out-of-sample analysis for different investment strategies. *Journal of Banking & Finance, 60,* 1-20. https://doi.org/10.1016/j.jbankfin.2015.06.021

9. Bodie, Z., & Rosansky, V. I. (1980). Risk and Return in Commodity Futures. *Financial Analysts Journal, 36*(3), 27-39. Retrieved from https://rpc.cfainstitute.org/en/research/financial-analysts-journal/1980/risk-and-return-in-commodity-futures

10. Cheung, C. S., & Miu, P. (2010). Diversification benefits of commodity futures. *Journal of International Financial Markets, Institutions and Money, 20*(5), 451-474. https://doi.org/10.1016/j.intfin.2010.06.003

11. Choueifaty, Y., & Coignard, Y. (2008). Toward Maximum Diversification. *Journal of Portfolio Management, 35*(1), 40-51. Retrieved from https://www.tobam.fr/wp-content/uploads/2014/12/TOBAM-JoPM-Maximum-Div-2008.pdf

12. Conover, C. M., Jensen, G. R., Johnson, R. R., & Mercer, J. M. (2010). Is Now the Time to Add Commodities to Your Portfolio? *The Journal of Investing, 19*(3), 10-19. https://doi.org/10.3905/joi.2010.19.3.010

13. Daigler, R. T., Dupoyet, B., & You, L. (2017). Spicing Up a Portfolio with Commodity Futures: Still a Good Recipe? *The Journal of Alternative Investments*, *19*(4), 8-23. https://doi.org/10.3905/jai.2017.19.4.008

14. Daskalaki, C., Kostakis, A., & Skiadopoulos, G. (2014). Are there common factors in individual commodity futures returns? *Journal of Banking & Finance, 40,* 346363. https://doi.org/10.1016/j.jbankfin.2013.11.034

15. Daskalaki, C., & Skiadopoulos, G. (2011). Should investors include commodities in their portfolios after all? New evidence. *Journal of Banking & Finance, 35*(10), 2606-2626. https://doi.org/10.1016/j.jbankfin.2011.02.022

16. DeMiguel, V., Garlappi, L., & Uppal, R. (2009). Optimal Versus Naive Diversification: How Inefficient is the 1/N Portfolio Strategy? *Review of Financial Studies, 22*(5), 1915-1953. https://doi.org/10.1093/rfs/hhm075

17. Erb, C. B., & Harvey, C. R. (2006). The strategic and tactical value of commodity futures. *Financial Analysts Journal, 62*(2), 69-97. https://doi.org/10.2469/faj.v62.n2.4084

18. Gagnon, M.-H., Manseau, G., & Power, G. J. (2020). They're back! Post-financialization diversification benefits of commodities. *International Review of Financial Analysis, 71,* 101515. https://doi.org/10.1016/j.irfa.2020.101515

19. Galvani, V., & Plourde, A. (2010). Portfolio diversification in energy markets. *Energy Economics, 32*(2), 257-268. https://doi.org/10.1016/j.eneco.2009.05.015

20. Gorton, G., & Rouwenhorst, K. G. (2006). Facts and Fantasies about Commodity Futures. *Financial Analysts Journal, 62*(2), 47-68. https://doi.org/10.2469/faj.v62.n2.4083

21. Hanif, W., Mensi, W., Vo, X. V., BenSaïda, A., Hernandez, J. A., & Kang, S. H. (2023). Dependence and risk management of portfolios of metals and agricultural commodity futures. *Resources Policy, 82,* 103567. https://doi.org/10.1016/j.resourpol.2023.103567

22. Henriksen, T. E. S., Pichler, A., Westgaard, S., & Frydenberg, S. (2019). Can commodities dominate stock and bond portfolios? *Annals of Operations Research, 282*(1), 155-177. https://doi.org/10.1007/s10479-018-2996-7

23. Huang, J., & Zhong, Z. (Ken). (2013). Time Variation in Diversification Benefits of Commodity, REITs, and TIPS. *The Journal of Real Estate Finance and Economics, 46*(1), 152-192. https://doi.org/10.1007/s11146-011-9311-6

24. Jensen, G. R., Johnson, R. R., & Mercer, J. M. (2000). Efficient use of commodity futures in diversified portfolios. *Journal of Futures Markets, 20*(5), 489-506. https://doi.org/10.1002/(SICI)1096-9934(200005)20:5<489::AID-FUT5>3.0.CO;2-A

25. Lean, H. H., Nguyen, D. K., Sensoy, A., & Uddin, G. S. (2023). On the role of commodity futures in portfolio diversification. *International Transactions in Operational Research, 30*(5), 2374-2394. https://doi.org/10.1111/itor.13067

26. Letho, L., Chelwa, G., & Alhassan, A. L. (2022). Cryptocurrencies and portfolio diversification in an emerging market. *China Finance Review International, 12*(1), 20-50. https://doi.org/10.1108/CFRI-06-2021-0123

27. Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance, 7*(1), 77-91. https://doi.org/10.2307/2975974

28. Satyanarayan, S., & Varangis, P. (1996). Diversification Benefits of Commodity Assets in Global Portfolios. *The Journal of Investing, 5*(1), 69-78. https://doi.org/10.3905/joi.5.1.69

29. Shah, A. A., & Dar, A. B. (2021). Exploring diversification opportunities across commodities and financial markets: Evidence from time-frequency based spillovers. *Resources Policy, 74,* 102317. https://doi.org/10.1016/j.resourpol.2021.102317

30. Stoll, H. R., & Whaley, R. E. (2011). Commodity Index Investing: Speculation or Diversification? *The Journal of*

http://dx.doi.org/10.21511/imfi.20(4).2023.04

Alternative Investments, 14(1), 50-60. Retrieved from https://www.pm-research.com/content/iijalt-inv/14/1/50

31. Tang, K., & Xiong, W. (2012). Index investment and the financialization of commodities. *Financial Analysts Journal, 68*(5), 54-74. Retrieved from https://www.princeton.edu/~wxiong/papers/commodity.pdf

32. Tiwari, A. K., Abakah, E. J. A., Karikari, N. K., & Hammoudeh, S. (2022). Time-varying dependence dynamics between international commodity prices and Australian industry stock returns: A Perspective for portfolio diversification. *Energy Economics, 108,* 105891. https://doi.org/10.1016/j.eneco.2022.105891

33. Willenbrock, S. (2011). Diversification Return, Portfolio Rebalancing, and the Commodity Return Puzzle. *Financial Analysts Journal, 67*(4), 42-49. https://doi.org/10.2469/faj.v67.n4.1

34. You, L., & Daigler, R. T. (2010). Using Four-Moment Tail Risk to Examine Financial and Commodity Instrument Diversification. *Financial Review, 45*(4), 1101-1123. https://doi.org/10.1111/j.1540-6288.2010.00287.x

35. You, L., & Daigler, R. T. (2013). A Markowitz Optimization of Commodity Futures Portfolios: A Markowitz Optimization of Commodity Futures Portfolios. *Journal of Futures Markets, 33*(4), 343-368. https://doi.org/10.1002/fut.21553