Commodity Futures in Portfolio Diversification: Impact on Investor's Utility

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Abstract
Purpose: The paper examines the role of Indian Commodity Futures as an asset class in a traditional portfolio consisting of equity and bond for an investor.
Design/methodology/approach: The paper identifies the optimum portfolio mix of all the three assets using Mean variance optimization technique and how the utility of commodity futures changes with the change in risk aversion levels of an investor.
Findings: The findings show that on comparing the portfolios with and without commodities, the introduction of commodities provided an increase in the returns without a corresponding rise in risk. It also provides evidence that with the increase in risk aversion levels of the investor, allocation to commodity future tends to increase.
Originality/value: The article empirically examines that whether Indian commodity futures can be treated as an alternative asset class for portfolio diversification by maximizing the utility for a risk averse investor, on including it to a traditional portfolio mix of equity and bond. So that the investor is better off by investing in commodity futures.

Keywords: Commodity Futures, Optimization Technique, Utility, Portfolio, Diversification, Efficient Frontier

Paper Type: Research Paper

Introduction

The traditional choice of asset allocation for a risk averse investor in the portfolio includes stocks, bonds, treasury bills (T-bills) and real estate. Due to uncertainty in the equity market returns and increase in interest rates seen in recent past, the attention of portfolio managers and investors has shifted to alternative assets, like commodities, to earn extra returns.

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For the reason, that the factors driving the commodity prices (e.g., weather and geopolitical conditions, supply constraints in the physical production, and event risk) are distinct from those that determine the value of stocks and bonds. Therefore, the diversifying properties that investors seek to balance their exposure to stocks and bonds can be obtained by investing in commodities (Bodie and Rosansky, 1980; Lee, Leuthold & Cordier, 1985; Anson, 1999; Edwards & Park, 1996). The benefits of diversification are best achieved when the investor holds a portfolio consisting of several asset classes that have the negative or low correlation between them.

The investment in commodities can be made via, Physical commodities, Commodity related stocks and Commodity futures. The investment in physical commodities is characterized by high storage costs, the perishable nature of commodities and the seasonal cycles for different commodities. Similarly investment in commodity related stocks, gives the investor an extra exposure to company specific risks like management competence of the company, trade risk and labor strikes (Laws & Thompson, 2007). On the contrary, it is relatively easy to purchase and sell commodity futures and therefore include them in the portfolio.

But the question arises, why should an investor think about diversifying the portfolio through commodity-linked instruments? The answer lies in the fact that an investment in the commodity market actually improves the return of the portfolio and significantly reduces the risk. The principal argument for investing in commodities is that investing in assets that rise in price with inflation provides a natural hedge against losses in equity and debt holdings that tend to lose value during periods of unexpected inflation.

So, the article has an aim of providing knowledge through facts and figures to the investors about the Indian Commodity futures market as an investment option and its inclusion in the traditional asset portfolio. The diversification benefits of commodity futures are explored by probing whether the selection of commodity futures to an alternative portfolio provide excess return or minimize risk as compared to a portfolio consisting of stocks and bonds using Mean variance optimization technique. Further, the concept of including alternative asset class is empirically tested by measuring a utility function and develop an understanding how risk aversion affects the asset allocation. The findings show that introducing commodity futures to a portfolio increases the returns without a corresponding rise in risk and with the increase in risk aversion levels of the investor, allocation to commodity future tend to increase.

The remainder of the article is structured as follows: a brief description of the methodology adopted followed by the data and empirical analysis and lastly summarizing the results.

Prior Research

A number of academic studies have examined the performance of portfolios composed of stocks, bonds, cash equivalents and demonstrate the advantage of adding alternative asset classes like commodity futures, real estate, private equity, in terms of risk-return to the traditional portfolios.

There are mixed evidences on their true benefits as an alternative asset class. The prominent justification of adding commodity futures to a portfolio is that it provides an inflation hedge (Anson, 1998; Greer, 1978; Bodie, 1983; Irwin & Landa, 1987) and thus may prove to be an excellent source of portfolio diversification. As an inflationary situation can be characterized by a persistent increase in commodity prices, long positions in futures contracts increase in value during such periods, whereas, stocks and bonds generally perform poorly during increased inflation (Jensen et al., 2009). Becker &

Finnerty (2000) proposed that due to high inflation in 1970s the risk and return of a traditional portfolio composed of stocks and bonds had increased with the inclusion of commodities in asset allocation. Cheung & Miu (2010) in their study highlighted that the long run diversification benefits of commodity futures is a result of the infrequent outburst in the commodity market & these benefits are not convincing in a bearish commodity environment.

Relatively, a number of empirical studies validate the low correlation among commodity futures and other asset classes over certain periods of time (Bodie & Rosansky, 1980; Erb & Harvey, 2006; Gorton & Rouwenhorst, 2006; Buyuksahin et al., 2010; Chong & Miffre, 2010) and these studies concluded that the return of an equal weight commodity futures portfolio was comparable to a stock portfolio. Following, Ankrim & Hensel (1993), Lummer & Seigel (1993), Satyanarayan & Varangis (1996), have shown that commodity futures provide a good diversification to the portfolio of equity & bond. Anson (1999) found out that commodity futures can prove to be a valuable asset for risk-averse investor, but the amount of investment in commodity futures depends upon certain factors like utility functions, level of risk tolerance & portfolio composition

On the contrary, Fama & French (1987) calculated the performance of an equally weighted portfolio of up to 21 commodity futures, over the time period 1967 to 1984, and found only marginal evidence of statistically significant portfolio returns. Edwards & Park (1996) and Jensen, Johnson & Mercer (2002), showed in their tests that commodity futures produced lower returns in comparison to stock returns with higher volatility.

So there are mixed evidences on diversification benefits of commodity futures. Looking at the Indian studies, where Dasgupta (2004) tried to find out that there is a co-movement among futures price, production decision and the inventory decision in order to justify the misconception that futures market creates artificial scarcity by allowing unnecessary hoarding. Lokare (2007) tried to test the efficacy and performance of commodity derivatives in steering the price risk management. Sahi & Raizada (2006) has studied the impact of commodity futures on welfare & inflation in the economy. Bose (2008) has studied whether prices indicate efficient functioning of the market.

Above research has shown that commodity futures when included into the traditional portfolio do improve the returns but most of the earlier studies that have been carried out in this context are confined to the global commodity markets only. In India, the studies available are few and they are in different context like efficiency of commodity future market advantages of market from the farmer's perspective, etc.

This paper adds to the literature by reviewing the Indian commodity future market for its diversifying properties as this region of study for in this particular perspective is found rare. The research areas on Indian commodity futures market covers the aspects like price discovery, efficiency in terms of flow of information from futures to spot and its risk management capacity.

Research Methodology

This study examines the benefits of commodity future investments using optimal portfolio strategy within a mean variance framework and also determines how an investor's investment policy changes when the objective function is to maximize expected utility. The diversifying properties of commodity futures are analyzed using daily average return, standard deviation (SD), Sharpe ratio and correlation coefficients for all the asset classes. To complement the diversification properties, the movement of all assets with inflation is also considered.

The study uses a two stage model of Asset allocation and Capital allocation for portfolio construction as proposed by Bodie, Marcus & Mohanty (2005). The *first stage* of our analysis is asset allocation, where we determine the combination of risky assets that provide the best risk-return trade off resulting in the optimal risky portfolio, using Markowitz portfolio optimization technique. To analyze the diversification benefits of commodity futures, two portfolios, without commodities (A) and with commodities (B) are computed. Firstly, the risk-return opportunities available to the investor in the form of minimum variance frontier of risky assets are determined, using the portfolio SD and expected return as calculated in following equations:

$$V_p = \sum_{i=1}^{k} \sum_{j=1}^{k} [X_i \times X_j \times Cov_{ij}] \quad \text{.... (I)}$$

where, V_p = variance of the portfolio return,
k = number of assets in the portfolio,
X = share of asset i or j within the portfolio, and
Cov_{ij} = covariance between assets i and j, and is calculated by:
$Cov_{ij} = s_i \times s_j \times r_{ij}$
where, s = SD for asset i and j,
r_{ij} = correlation coefficient between assets i and j.

The expected return is determined by:

$$E_{rp} = \sum_{i=1}^{k} [X_i \times E(R_i)] \quad \text{.... (II)}$$

where, E_{rp} = return on the portfolio, and
$E(R_i)$ = expected return for security i.

A constrained optimization program is run to determine the optimal risky portfolio bounded by the restriction that the exposure in any risky asset is greater than or equal to zero and that the sum of the weights adds up to 1. The quadratic programming is set up to maximize return and minimize variance;

$$Min\ z = V_p - Y$$

Subject to:

$$\sum_{i=1}^{k} X_i = 1$$

where, Y = slope of the objective function, and
Erp = expected return on the portfolio.

Y can be varied from zero to infinity in order to solve for different portfolio points on the efficient frontier. If the weights of assets in the portfolio are less than zero, the resultant portfolio would require short selling of certain assets (Shachmurove, 1998). Therefore, the weights are constrained to be more than or equal to zero, so as to produce short sales constrained efficient portfolio. The result of these portfolios is the efficient frontier, where each portfolio represents the lowest risk for a given return or the highest return for a given risk (Markowitz, 1959). Secondly, to select the optimal portfolio from the set of efficient portfolios, Capital Allocation Line (CAL) is drawn. The point on CAL tangent to the efficient set is the required optimal portfolio. This is also the portfolio that gives the maximum Sharpe Ratio (risk adjusted return). For the mean-variance analysis, arithmetic returns are considered more suitable in comparison to geometric returns as it is a better predictor of portfolio performance (Bekkers, Doeswijk & Lam, 2009).

The *second stage* of analysis is the optimal capital allocation between the obtained risky portfolio and the risk free asset. This allocation is determined by the risk aversion level of the investor as well as expectation for the risk-return tradeoff of the optimal risky portfolio. When presented with various portfolios of varying degree of return and risk based on numerous asset allocations, an investor would choose a portfolio that would give maximum utility (Anson, 1999). The rate at which investors are willing to trade off the return against risk can be quantified using utility levels. The issue that needs consideration is whether on including commodity futures to a portfolio of stocks and bonds, improves the utility for the investor. The utility function is given by the following equation:

$$E(U) = E_{rp} - \frac{1}{2} A V_p \qquad \text{.... (III)}$$

where, *E(U)* = expected utility value for investor

Er_p = expected return on the portfolio

A= index of the investor risk aversion

Vp = variance of the portfolio return

This form of utility function is consistent with the incorporated asset allocation approach (Sharpe, 1987). To determine the unique benefits of investing in commodity futures, a scale is developed to measure risk aversion levels(A) for different kind of investors i.e., 0(risk neutral), 1(aggressive), 2(moderately aggressive), 3(moderately conservative) and 4(conservative).

A risk neutral investor will judge a risky prospect solely by its expected return, regardless of the level of risk. On the contrary, a conservative investor penalizes risky asset more severely by preferring either higher return for a given level of risk or lower risk for a given level of return. With the increase in value of A from 0 to 4 and the associated level of risk aversion, there should be a larger investment in commodity futures. With the increase in the risk aversion level of the investor the allocation to commodity futures should also increase to dampen the negative impact of portfolio volatility on expected utility (Anson, 1999). The amount of investment in risky asset and the risk free asset is determined on the basis of different levels of risk aversion (A). The optimal position in the risky asset (*y*) is proportional to risk premium and inversely proportional to variance and degree of risk aversion, as given by the following equation:

$$y = \frac{E_{rp} - r_f}{A V_p} \qquad \text{.... (IV)}$$

where, *y* = optimal position in risky portfolio, and

r_f = risk free rate of return.

The above equation is derived by setting the utility equation III to maximization, meaning that if we allocate y% of funds to risky portfolio and (1-y)% of funds to risk free portfolio, the investor would achieve the maximum utility at A level of risk aversion.

To assess the impact of inclusion of commodities, we begin by considering an asset only investor in search of the optimal portfolio as taken by Bekkers *et al.* (2009). An asset only investor does not take liabilities into consideration and pursues the goal of wealth maximization with no other investment goal.

Data and Empirical Results

The daily returns for asset classes from Indian Capital market, viz., Equity (S&P CNX Nifty), Bond (NSE G-Sec), T-bill (NSE TB Index) and Commodity futures (MCX COMDEX) are examined for the period June 2005 to December 2011.

Table 1 presents the daily expected returns, SD and Sharpe ratio for different asset classes. The mean return among all the three assets is highest for MCX COMDEX and the SD is lowest at 17.21% as compared to 25.36% for S&P CNX Nifty and 22.02% for NSE G-Sec. The rationale being that the factors driving the commodity prices are different from the factors driving the equity and bond prices. Since the Sharpe ratio is highest for MCX COMDEX, it can also be treated as standalone investment.

Table 1: Sharpe Ratios (%) for the period 2005-2011

Asset Class	Expected Return	SD	Sharpe Ratio
S&P CNX Nifty	11.898873	25.367026	0.469069
NSE G- Sec	3.157037	22.023995	0.143345
MCX COMDEX	12.469598	17.211398	0.724496

The diversification potential of commodity futures is analyzed in Table 2, using the correlations between the asset returns and inflation. For the asset to be included in a portfolio, it should have low or negative correlation with other assets existing in the portfolio. Wholesale Price Index (WPI), as a measure of inflation, has a significant negative correlation with both equity and commodity futures. The MCX COMDEX also demonstrates significant negative correlation with the bond and low correlation with the equity during the analyzed period. Thus, commodity futures have the potential to reduce risk in a portfolio of stocks and bonds and thereby maximizing the utility to investors.

Table 2: Correlation Matrix for the asset classes (2005-2011)

Asset Class	WPI	CPI	S&P CNX Nifty	NSE G-Sec	NSE TB	MCXCOMDEX
WPI	1.00000					
CPI	0.35038**	1.00000				
S&P CNX Nifty	-0.38489**	-0.15027	1.00000			
NSE G-Sec	0.02027	0.00703	-0.01138	1.00000		
NSE TB	0.05250	-0.21637	-0.18278	-0.02050	1.00000	
MCXCOMDEX	-0.29363**	-0.18628	0.36436**	-0.35956**	-0.12306	1.00000

** denotes significance at the 1% level (2-tailed)

The optimal risky portfolios A and B are determined using constrained optimized technique. Table 3 and 4 depicts the set of risky portfolios at varying levels of risk and return for portfolio A and B respectively. The portfolio with the highest Sharpe ratio tangent to CAL is the optimal risky portfolio.

As evident from the Table 3 and 4, the optimal risky portfolio without commodity futures (A3) has a lower Sharpe ratio of 49.16% as compared to 82.27% for portfolio with commodity futures (B3).

Table 3: Risk-Return profile for construction of efficient frontier for portfolio A (without commodity futures)

Risk/ Return	Portfolios						
	A1	**A2**	**A3***	**A4**	**A5**	**A6**	**A7**
Expected Return	0.077000	0.081000	0.099999	0.105000	0.110000	0.120000	0.130000
SD	0.167564	0.171026	0.203427	0.215359	0.228313	0.256662	0.287453
Sharpe Ratio	0.459525	0.473612	0.491571	0.487557	0.481794	0.467540	0.452248
Weights							
S&P CNX Nifty	0.519681	0.565438	0.782772	0.839980	0.897176	1.011568	1.125961
NSE G-Sec	0.480319	0.434562	0.217228	0.160020	0.102824	0.011568	0.125961

* Optimal risky portfolio without commodity futures

Table 4: Risk-Return profile for construction of efficient frontier for portfolio B (with commodity futures)

Risk/ Return	Portfolios						
	B1	**B2**	**B3***	**B4**	**B5**	**B6**	**B7**
Expected Return	0.100000	0.111000	0.112999	0.115000	0.117000	0.120000	0.130000
SD	0.126202	0.135001	0.137353	0.139915	0.142668	0.147144	0.164590
Sharpe Ratio	0.792380	0.822219	0.822688	0.821929	0.820084	0.815529	0.789843
Weights							
S&P CNX Nifty	0.210995	0.236807	0.241498	0.246193	0.250884	0.257926	0.281391
NSE G-Sec	0.252259	0.132557	0.110804	0.089029	0.067276	0.034619	-0.074201
MCX COMDEX	0.536746	0.630636	0.647698	0.664778	0.681840	0.707455	0.792810

* Optimal risky portfolio with commodity futures

On constructing the efficient frontier for portfolio A and B (Figure 1), it can be seen that the risk dispersion for portfolio A is very high as compared to portfolio B. Besides, at the same level of risk, portfolio B that includes commodity futures has higher return as compared to the portfolio A that includes only equity and bond.

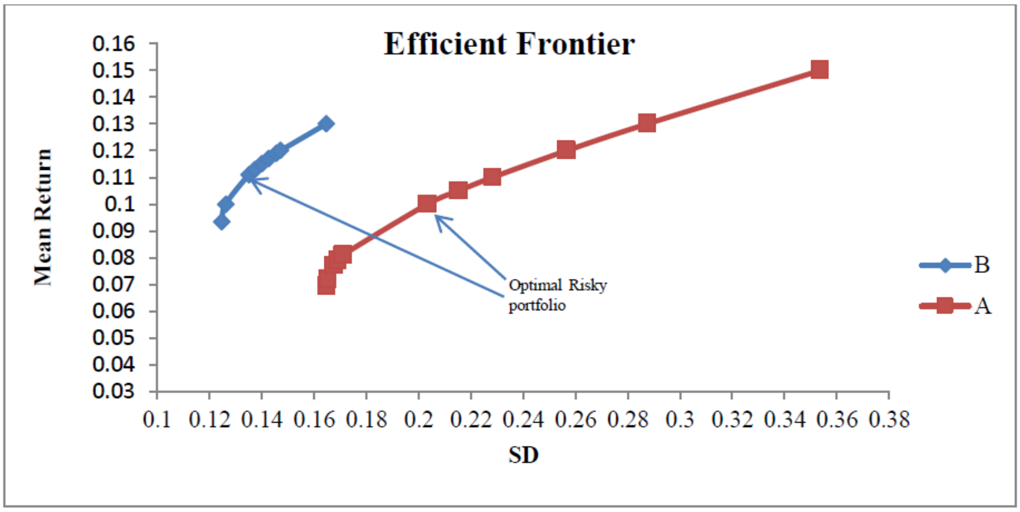

Figure 1: Efficient frontier for the portfolios A and B

The next step is the capital allocation among risky portfolio and risk free portfolio with the objective of maximization of utility. Using the equations III and IV, the weight of risky portfolio as against the risk free portfolio is computed for different type of investors by changing the risk aversion levels and determining the portfolio utility. The portfolio so attained would give investor the maximum utility.

Table 5: Maximizing the utility with inclusion of MCX COMDEX (2005-2011)

Type of Investor/ Asset	S&P CNX Nifty	NSE G-Sec	MCX COMDEX	NSE TB	Exp Utility	Exp Return	SD	Sharpe Ratio
Risk Neutral (A=0)	100.00	0.00	0.00	0.00	11.30	11.89	25.37	46.87
Aggressive (A=1)	69.00	31.00	0.00	0.00	10.36	8.70	18.68	46.57
Moderately Aggressive (A=2)	34.57	15.86	49.57	0.00	9.41	10.55	13.58	77.69
Moderately Conservative (A=3)	23.05	10.57	61.82	4.56	8.47	10.89	13.11	83.07
Conservative (A=4)	17.29	7.93	46.36	28.42	7.53	9.64	9.83	98.07

Note: All the values are in %

From Table 5, it is evident that with the increase in investor's risk aversion levels, the allocation to commodity futures also increases. A risk neutral investor judges the investment solely on the basis of return; therefore would not seek to add commodity futures to reduce risk. An aggressive investor (A=1) would allocate 69% to equity and 31% to bonds. Comparatively, for a moderately aggressive investor (A=2), 49.57% of allocation in commodity futures would maximize the utility. This exposure to commodity futures reduces the overall portfolio risk. Similarly, a moderately conservative investor commits 23.05% to equity, 10.57% to bonds, 4.56% in T-bill and 61.82%, in commodity futures. In this portfolio, adding commodity futures reduces the portfolio risk and increases the return, thereby providing some diversification benefit. For a conservative investor, although there is risk reduction but reducing the allocation in commodity futures has also lowered the returns. In addition, it can also be interpreted that with the increase in risk aversion levels, the Sharpe ratio is also increasing, thereby showing the diversification benefits of including commodity futures to a traditional portfolio consisting of equity and bond.

Concluding Remarks

The paper empirically examined the proposition that whether commodity futures can be treated as an alternative asset for risk-averse investor by including it to a traditional portfolio mix of equity and bond by using the data across 2005-2011. This is done by evaluating and comparing the respective returns on the portfolio by including the composite commodity futures index. Since the introduction of commodity futures in India is of late (2003), therefore the data available for analysis is not very large. The results show that commodity futures have higher returns and low risk as compared to equity. Thus it can also be treated as a standalone investment tool for a risk neutral investor. But on inclusion of commodity futures to a traditional portfolio, the mean return increases for a risk-averse investor for the reason that it has a negative correlation with bond and a low correlation with equity. With the increase in risk aversion levels, allocation to commodity futures increases along with an increase in the Sharpe ratio. So for a risk-averse investor the desire for high return- low risk and maximizing utility can be achieved by investing in commodity futures. Therefore, the investor is better off by holding a composite index, MCX COMDEX in the portfolio of equity and bond. Thus, the results of the analysis do support the diversifying properties of commodity futures on inclusion into the traditional portfolio with the ability to maximize the investor's utility and can be considered as an alternative asset class. The paper can be considered for future research by comparing the commodity futures as an asset class in international perspective and its diversifying properties can be verified globally. The inflation is a global concern which affects the return. Therefore, the extension of this study could look at the behavior of commodity futures as an asset class during inflationary conditions.

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