IMPROVED DIVERSIFICATION THROUGH A MIX OF OIL AND EQUITIES

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ABSTRACT

This study presents evidence of a statistically significant negative correlation between crude oil and equities over the past 20 years. Including proper proportions of negatively correlated assets in a diversified portfolio can improve the ratio of reward relative to risk, and therefore, adding crude oil with equities into a diversified portfolio can provide superior portfolio performance, compared with equities alone. Because crude oil prices held stable for nearly a century before the oil crisis of 1973, and oil derivatives did not begin trading actively on public markets until the 1980s, the diversification value of oil is a relatively new phenomenon. Also contributing to the phenomenon, the majority of oil reserves and the majority of crude oil production capacity worldwide are held by entities that are not traded in public equity markets, and therefore, the diversification benefits of oil cannot be fully realized by holding a portion of the global market portfolio of equities.

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1. INTRODUCTION

This study presents evidence of statistically significant negative correlation between crude oil and equities from 1987 through 2005. The methodology developed for the Goldman Sachs Commodity Index (GSCI) is applied to measure the risk and return profile of crude oil (Goldman Sachs Commodity Index Manual, 2005 edition). Although the GSCI method has been used to construct the returns of a basket of commodities, it has never been applied on individual commodities in previous investigations of the relationship between commodity returns and equity returns.

Froot (1995) applied GSCI methodology to construct the total returns for individual commodities, but when he studied the relationship between individual commodities and other assets, he used the percentage changes in the spot price of individual commodities because of data limitation. Rzepczynski, Belentepe, Feng, and Lipsky (2004) used cumulative returns method to figure out the crude oil returns. Georgiev (2004) calculated the spot returns, roll yield, and total returns of energy commodities, but he generated futures price data series by using a weighted average of the prices of the two contracts closest to expiration, which is different from GSCI method.

Using the GSCI methodology allows the use of readily available futures prices to extract information about the returns that can be earned by a wholesale dealer who buys and holds crude oil – including the potential for lending crude oil and receiving interest paid in kind.[1] By following the trading strategy involved in the GSCI methodology, an ordinary investor can capture much of the benefit available to wholesale dealers who buy and hold crude oil.

The results show that the return for buying and holding crude oil is significantly negatively correlated with the S&P 500 Index. Including proper proportions of negatively correlated assets in a diversified portfolio can improve the ratio of reward relative to risk, and therefore, adding oil into a diversified portfolio of equities can provide superior portfolio performance, compared with equities alone.

Because oil prices held steady for nearly a century before the oil crisis of 1973 and oil derivatives did not begin trading actively on public markets until the 1980s, the diversification value of oil is a relatively new phenomenon. Although oil derivatives began trading on the public exchanges in the early 1980s, it was not until 1987 that volume reached mature levels. Our study begins with data from this point and continues through the end of 2005.

Also contributing to the phenomenon, the majority of oil reserves and the majority of crude oil production capacity worldwide are held by entities that

are not traded in public equity markets. Therefore, the diversification benefits of oil cannot be fully realized by holding a portion of the global market portfolio of equities.

2. DATA

Crude oil futures contract trading volumes before 1987 were not very significant. As a result, the price information of crude oil futures contracts may not be very efficient before 1987. Therefore, daily crude oil futures contract closing prices are collected over the period from 1987 to 2005.

The S&P 500 Composite Index and the CRSP Value-Weighted Market Index are used to represent investment in stocks. The monthly returns of both indexes are collected from the CRSP database. This study also collects the monthly 91-day Treasury bill returns data from the CRSP database and the daily 91-day Treasury bill yield data from the Federal Reserve Bank database.

3. METHODOLOGY

This study directly estimates the return for buying and holding commodities based on the methodology developed to construct the GSCI. According to the GSCI Manual (2005), the quantity of each commodity in the index is determined by the average quantity of production during the past five years. The GSCI Total Return Index measures the return of a fully collateralized commodity investment that is rolled forward from the fifth to the ninth business day of each month. Using GSCI total return calculation methodology from the GSCI Manual, this study constructs a portfolio consisting of a certain value of the light crude oil futures contract and the equivalent value of 91-day Treasury bills and then calculates the return of the constructed portfolio from 1987 to 2005 monthly. The monthly return of the constructed portfolio consists of the monthly spot return of crude oil, return from the rolling process, and monthly return from holding Treasury bills. On the rolling day, which is set to be the fifth business day of the rolling month, the roll yield is equal to the ratio of the nearest futures contract closing price to the next nearest futures contract closing price minus one. Energy futures contracts mature every month; thus, the rolling process occurs on the fifth business day each month. Then, the following formula is used to calculate monthly total return of crude oil. Total return is

the crude oil investment return.

$$\text{Total return} = \text{spot return} + \text{roll yield} + \text{Treasury bill return}$$

After deriving the buy and hold return estimation, we consider the average monthly total return, standard deviation of total returns, and Pearson correlation coefficients between monthly total returns of crude oil and corresponding returns on stocks. For crude oil, the calculation period is a monthly observation rolling 3 years.

Based on the estimation of the risk and return profile of crude oil, this study decides whether crude oil provides diversification benefits for shareholders' portfolios. To illustrate the diversification benefit of crude oil with stocks, the author calculates the risk and returns profiles for portfolios with different combinations of crude oil and S&P 500 Index. Then, this study follows Georgiev's (2001) method to measure the diversification benefit of crude oil by the change in the Sharpe ratio. The Sharpe ratio change is equal to the Sharpe ratio of the portfolio consisting of 60% S&P 500 Index investment and 40% crude oil investment minus the Sharpe ratio of the portfolio consisting of 100% S&P500 Index investment. The more the Sharpe ratio increases, the more diversification benefit crude oil provides. As the return data of crude oil is monthly, the Sharpe ratio calculation period for crude oil is monthly observations rolling 3 years.

4. RESULTS

4.1. Negative Correlation between Crude Oil and Equity

Table 1 reports the correlation coefficient between the monthly rates of return on crude oil, and the monthly rates of return on S&P 500 market index is −0.136 and significant at the 5% level. The correlation coefficient between the

Table 1. Risk and Return Profile of Crude Oil.

	Mean (%)	Standard Deviation (%)	Correlation Coefficients with Crude Oil
Crude oil	12.24	17.08	1
S&P500 Index	12.36	15.21	−0.136**
CRSP Value-Weighted Index	12	15.42	−0.106

Note: Mean return and standard deviations are annualized.
**Statistically significant at 5% level (two-tailed test).

monthly rates of return on crude oil and the monthly rates of return on the CRSP Value-Weighted Market Index is −0.106 but not statistically significant. The reason that we find two correlation coefficients with different significance levels may be because S&P 500 Index represents the "old economy" and crude oil investment is more closely related to the "old economy." Overall, it is safe for us to say that crude oil has negative or zero correlation with the stock market. Table 1 also reveals that crude oil has approximately the same average return and standard deviation as the overall stock market.

Usually the commodities market is thought to be more volatile than the stock market. Investment in commodities incurs very high risk. Surprisingly, this study finds that crude oil has almost the same standard deviation as stocks. Crude oil has almost the same risk and return profile as stocks have, but is negatively correlated with stocks. Therefore, if crude oil is added into a portfolio consisting of equities, crude oil will be able to reduce portfolio risk and at same time keep the portfolio average rate of return. Crude oil can provide diversification benefit for equities.

Fig. 1 shows that during most of the period crude oil is negatively correlated with stocks. When the stock market crashed on Monday, October 19, 1987, however, the crude oil market was not affected significantly. In the 1990 Gulf War, there was a spike in crude oil market; yet, the stock market was sluggish.

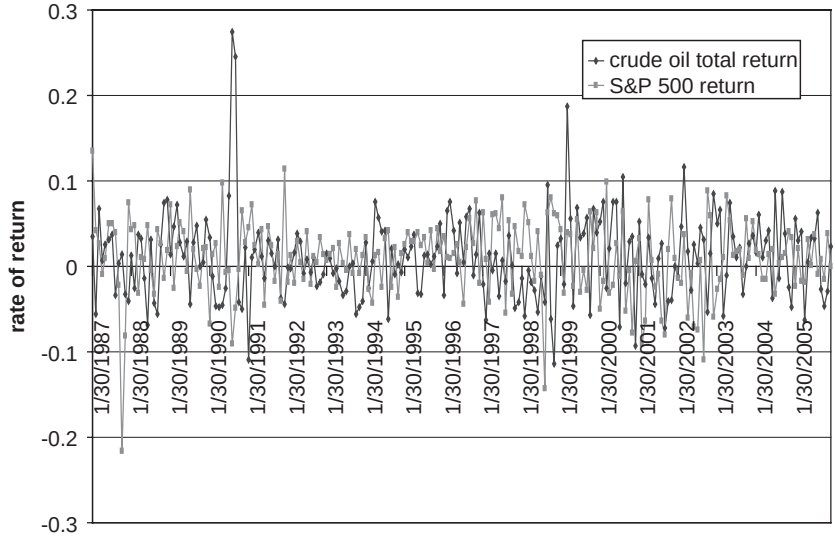

Fig. 1. Crude Oil Investment Returns versus S&P 500 Returns.

Table 2. Correlation Coefficients between Crude Oil and S&P 500 Index.

	Correlation Coefficients
01/1987–12/1989	−0.1
02/1987–01/1990	−0.16
…	…
01/2003–12/2005	−0.18
Mean	−0.13
Standard deviation	0.22
t-Test	−8.05***

***Statistically significant at 1% level (two-tailed test).

Before the Asian financial crisis, OPEC significantly increased the production of crude oil due to the economic developments of East Asian countries; yet nonetheless, because of the Asian financial crisis, the demand for crude oil by East Asian countries suddenly declined in 1998. OPEC adjusted the crude oil production level, and thus crude oil prices rose in 1999. At the same time, stock prices dropped significantly when the Asian financial crisis occurred at the end of 1997 and recovered at the end of recession.

The Dotcom Bubble in 2000 and 2001 moved investors' money from the stock market into the commodity market. During the 9/11 events, the crude oil market also dropped significantly. Consequently, there was a spike in crude oil return at the end of 2001. Concurrent with the Iraq War in 2003, crude oil returns rose when the stock market dropped. Overall when crude oil returns rise, S&P 500 Index returns decrease and vice versa. If they are combined together into one portfolio, the risk of the resulting portfolio will be significantly smaller than the risk of each individual component.

To further examine the correlation relationship between crude oil returns and stock returns, this investigation calculates the rolling correlation coefficients from 1987 to 2005 with monthly observations and a three-year rolling period (see Table 2). The average three-year correlation coefficient is −0.13 and significantly different from zero at the 1% level. Assuming investors apply a three-year correlation coefficient as the ex ante expectation of the relationship between crude oil returns and stock returns, this result implies that the average expected correlation between these two investments is significantly negative.

Fig. 2 illustrates correlation coefficients for all of the rolling time periods. For most of the time, correlation coefficients fall below zero and the minimum is −0.6, and even when correlation coefficients are positive, the

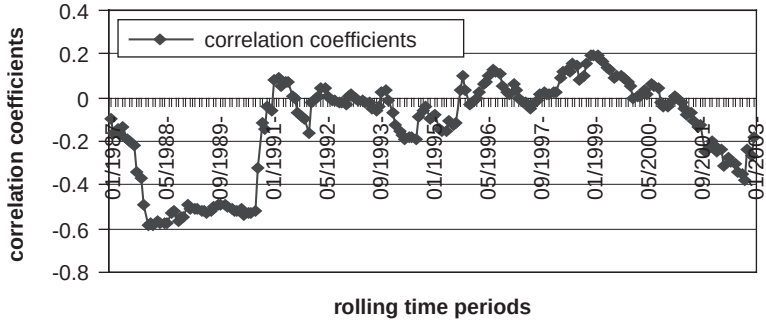

Fig. 2. Correlation between Crude Oil Returns and S&P 500 Index Returns.

Table 3. Diversification Benefit of Crude Oil with Equities.

Portfolio Composition	Rate of Return	Standard Deviation
100% of crude oil	0.0102	0.0493
90% of crude oil and 10% of S&P 500 Index	0.01021	0.0437
80% of crude oil and 20% of S&P 500 Index	0.01022	0.0390
70% of crude oil and 30% of S&P 500 Index	0.01023	0.0350
60% of crude oil and 40% of S&P 500 Index	0.01024	0.0320
50% of crude oil and 50% of S&P 500 Index	0.01025	0.0305
40% of crude oil and 60% of S&P 500 Index	0.01026	0.0304
30% of crude oil and 70% of S&P 500 Index	0.01027	0.0320
20% of crude oil and 80% of S&P 500 Index	0.01028	0.0349
10% of crude oil and 90% of S&P 500 Index	0.01029	0.0389
100% of S&P 500 Index	0.0103	0.0439

maximum is only 0.2. This evidence shows that crude oil and stocks are negatively correlated most of the time.

4.2. Diversification Benefits

Both Table 3 and Fig. 3 exemplify the diversification benefit of crude oil with equities. The portfolio consisting of 40% crude oil investment and 60% S&P 500 Index has the minimum variance and also is the optimal. The Sharpe ratio is also applied on both portfolio 1 (100% S&P 500 index) and portfolio 2 (60% S&P 500 index and 40% crude oil) to statistically measure the diversification benefit of crude oil with stocks.

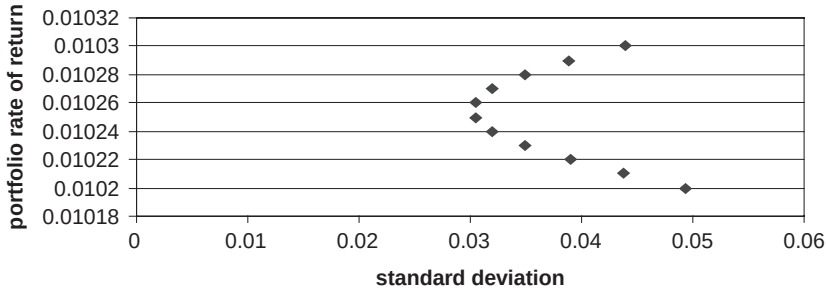

Fig. 3. Diversification Benefit of Crude Oil.

Table 4. Sharpe Ratios for Portfolio 1 and for Portfolio 2.

	Sharpe Ratio for Portfolio 1	Sharpe Ratio for Portfolio 2
01/1987–12/1989	0.16	0.21
02/1987–01/1990	0.06	0.13
…	…	…
01/2003–12/2005	0.39	0.58
Mean	0.18	0.23
Standard deviation	0.21	0.20
Wilcoxon Signed-Rank Test	5.1***	
Two-Sample *t*-test	5.71***	

***Statistically significant at 1% level (two-tailed test).

Table 4 summarizes the calculated Sharpe Ratios for portfolio 1 and for portfolio 2 from year 1987 to year 2005. We use monthly observations and three-year rolling period to calculate the rolling Sharpe ratios. The average three-year Sharpe ratio for a portfolio consisting of 100% investment in the S&P 500 index is 0.18. If we replace 40% of investment in the S&P 500 index with light crude oil investment, then the average three-year Sharpe ratio of the new portfolio increases to 0.23. Both the Wilcoxon signed-rank test and the two-sample *t*-test show that the average Sharpe ratio of portfolio 1 is significantly less than the average Sharpe ratio of portfolio 2. Therefore, adding crude oil into equities significantly increases the diversification profile of the equity portfolio.

Fig. 4 demonstrates the Sharpe ratio changes across time. The portfolio including 60% of investment in the S&P 500 index and 40% of investment in crude oil has dominated the portfolio consisting of 100% investment in the S&P 500 index during 2/3 of rolling periods from 1987 to 2005.

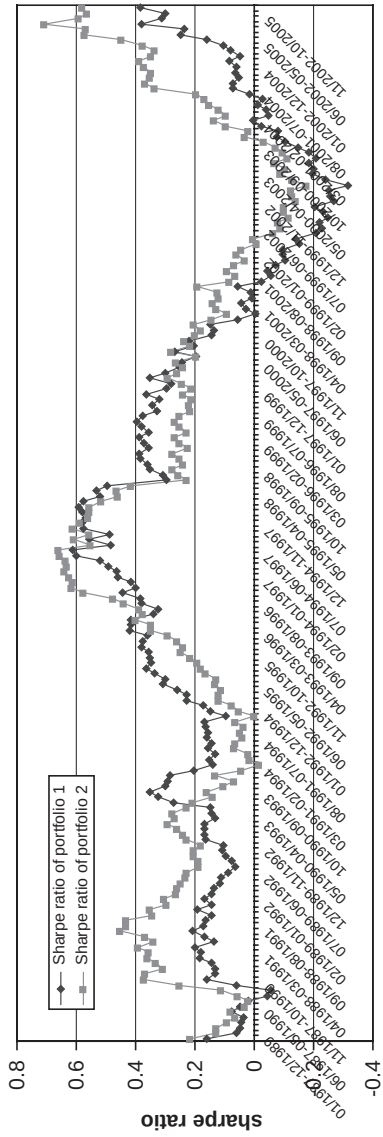

Fig. 4. Sharpe Ratios Comparison between Portfolio 1 and Portfolio 2.

4.2.1. Why Does Crude Oil Have Almost the Same Average Rate of Return as Stocks?

This study tries to explain this phenomenon from the following two aspects.

First, demand for energy products is increasing but the supply is limited. World economy development increases the demand for energy commodities. The resources for energy commodity are limited; hence, energy commodity prices keep going up.

Second, the energy commodity market is usually a market in backwardation, and thus investors obtain positive returns from rolling commodity futures contracts forward. In terms of cost of carry model, the futures contract price is equal to spot price plus cost of storage plus interest expense minus dividend yield obtained from the underlying asset. Because of crude oil loans, crude oil generates the crude oil loan rate of return, which is same as the dividend yield. When crude oil loan interest rates are greater than costs of storage and interest expenses, the futures price falls below the spot price. As futures contracts go near to maturity, futures price go up to approximate the spot price. If investors keep taking long positions in crude oil futures contracts, they are able to capture a positive return from this approximation process.

4.2.2. Why is There a Negative Correlation between Crude Oil and Equities?

First, industrial transportation costs, material costs, and other operation costs are very closely related to crude oil price. When the price of oil goes up, companies' operation costs increase. Therefore, crude oil price increases have negative effects on the future outlook of the whole economy, and stock price drop correspondently. Crude oil price increases also cause the cost of living to increase. Investors will reduce their investment on stocks, and thus stock price decreases.

Second, commodities offer a natural hedge for inflation. Becker and Finnerty (2000) find that equity and debt typically lose value during periods of unexpected inflation. Commodity investments rise with inflation, so thus, commodity investment is negatively correlated with equity.

Third, Gorton and Rouwenhorst (2005) contend that commodities and equities show different behaviors in business cycles. In the beginning of recession, stock prices usually drop but commodities prices do not drop significantly. At the end of recession, stock prices go up but commodities prices may decrease. The crude oil is a real asset and its prices are determined by the supply and demand of crude oil. Stocks are financial assets. These two kinds of assets can possibly show different patterns of price behavior.

5. RELATED RESEARCH

Dusak (1973) explains that the futures price data is more accessible than spot price data and using futures prices avoids the need to estimate storage costs directly. Therefore, futures prices near maturity might be used as a proxy for spot price. Cost of carry theory also shows that futures prices tend to move together with underlying spot prices and that at maturity futures prices equal spot prices, or else there would be risk-free arbitrage. As a result, most studies examine the systematic risk and return of spot commodities through commodity futures markets. Black (1976) and Dusak (1973) state that futures contracts do not have value by themselves because net cash flow is zero when futures transactions occur. The returns of futures contracts only derive from the returns of the underlying commodities. Dusak (1973) contends that futures transactions are actually leveraged transactions of the underlying spot commodity. The systematic risk in a futures market comes entirely from the systematic risk of the underlying spot market. Following Dusak's argument, extensive studies examine the systematic risk and return of commodity futures contracts to infer the systematic risk and return of spot commodities.

The methodologies used to calculate commodity returns are typically classified into four categories: the percentage change in the futures prices, the percentage change in the futures prices plus Treasury bill, a rollover strategy to measure futures return, and the GSCI style investment return. No matter what kind of methodology is used, most previous studies show that some commodities have zero or negative correlations with stocks and bonds.

Dusak (1973) applies the futures price near maturity to approximate underlying spot commodity price and the percentage change in the futures prices to approximate underlying spot commodity risk premium and shows that systematic risk and mean returns of wheat, corn, and soybean were near zero over the period 1952–1967. Fama and French (1987) also use futures prices of maturing contracts to measure spot prices. For the simple monthly returns, 5 out of 21 commodities are found to have significant and positive return; for the monthly logarithmic returns, 19 out of 21 commodities have zero return. Kolb (1992) uses the same methodology to derive the daily mean returns of 29 commodities and shows that currencies, financials, and precious metals rarely have positive returns. Kolb (1996) examines 4,735 futures contracts on 45 commodities. He also finds that there is no positive relation between systematic risk and realized return for futures contracts. Lee, Leuthold, and Cordier (1985) examine the relationship between daily returns of the commodity futures market index (CFI) and the stock market

index (S&P 500) over the period from 1972 to 1981 and find that they are independent of each other. Including commodity futures contracts in equity portfolios may reduce risk and improve portfolio performance.

Bodie and Rosansky (1980) find that an equally weighted portfolio consisting of 23 commodities had almost the same return and standard deviation as an equally weighted common stock portfolio over the period between 1950 and 1976. They find that 15 out of 23 commodities had negative correlations with the stock market. They also find that the systematic risk exposures of commodities are inversely correlated with their mean returns. They apply two methodologies to measure commodity returns. One follows Dusak's (1973) method, while the other calculates commodity futures return as the simple rate of return on commodities futures plus the risk-free rate because commodity exchanges permit the posting of Treasury bills as margin and investors can earn interest on Treasury bills. Fortenbery and Hauser (1990) apply the same methodology to show there are very small correlation coefficients between agricultural commodity returns and stock returns.

De Roon, Nijman, and Veld (2000) apply a rollover strategy to measure futures return. The rollover strategy is to roll the nearest contract to the next nearest contract on expiration month. The percentage change of futures contract prices is taken as futures return. They show that most futures contracts outside the financial groups are zero correlated with the stock market. Financial futures are positively correlated to the stock market, while gold and silver futures are negatively correlated to the stock market.

The fourth method is to calculate commodity investment return – GSCI style investment return. The GSCI Manual (2005) states that the GSCI represents the returns that would be earned by holding only passive long positions in commodity futures with the long positions fully collateralized with Treasury bills. The GSCI return represents a fully collateralized return, and thus is comparable to the returns of stocks and bonds. The GSCI investment return comes from three sources: spot return from price changes in the underlying commodities; roll yield from rolling the nearest futures contracts to the next nearest futures contracts each month; and Treasury bill yield.

Donohue, Froot, and Light (1992) show that by adding 5% of GSCI into a 60/40 stock/bond portfolio, the average returns over the 1970–1990 period would have increased from 9.6% to 9.8%, and the standard deviation of returns would have decreased from 12.1% to 11.5%. Ankrim and Hensel (1993) show that the monthly correlation of returns between the GSCI and the S&P 500 is −0.06, the monthly correlation between GSCI and the Ibbotson Intermediate Government Bonds Index is −0.11, and the correlation between the S&P 500 and the Ibbotson Intermediate Government

Bonds Index is 0.25. Greer (2000) shows that total return from the GSCI index is comparable in magnitude and volatility to equity returns but is negatively correlated with stocks and bonds. Georgiev (2001) finds that over the period 1990–2001, GSCI returns had a correlation of −0.04 with the S&P 500, a correlation of 0.02 with the Lehman Government/Corporate Bond Index, a correlation of −0.03 with the MSCI World Index, and a correlation of 0.05 with the Lehman Global Bond Index. Jensen, Mercer, and Johnson (2002) examine the diversification benefits of commodity futures for a traditional portfolio that consists of U.S. stocks, international stocks, corporate bonds, and Treasury bills over the period 1973–1999. Consistent with previous results, commodity futures can enhance portfolio performance very significantly. Metals and agricultural commodities offer the most diversification benefits. Gorton and Rouwenhorst (2005) construct an equally weighted commodity futures index and examine its monthly returns over the period from July 1959 to December 2004. The risk premium on the commodity index is shown to be as same as the risk premium on equities, but commodity returns are negatively correlated with equity and bond returns.

6. CONCLUSIONS

The results reported here show that crude oil is negatively correlated with stocks but have almost the same rate of return as stocks.[2] If crude oil is mixed with equities, it can improve the diversification profile of the portfolio. The changes mean that gaining exposure to crude oil make the market more complete.

NOTES

1. Typically, borrowers repay the loan of crude oil by returning the amount borrowed plus additional oil as payment of interest on the loan. This yield accounts for the backwardation typically displayed by oil futures.

2. We also have examined the risk and return profile of gold. Gold is shown to have zero correlation with equities and has a rate of return almost equal to zero. Therefore, gold may not be a good investment and gold does not provide diversification benefits when included with equities in a portfolio. We also notice that the standard deviation of bi-monthly rates of return on gold is less than the standard deviation of bi-monthly rates of return on stock investments. Gold investment is less risky than stock and crude oil.

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