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Holding a commodity futures index fund in a globally diversified portfolio: A placebo effect?

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Abstract

An increasing number of investors are including futures-based commodity index funds in their portfolios. The argument is that these funds increase diversification, enhance returns and serve as an inflation hedge. Much of the recent literature served to reinforce these ideas. We update the literature by examining recent data on returns and volatility. We further extend the literature by comparing the efficient frontiers of globally diversified stock and bond portfolios with and without the inclusion of futures index funds. We find little difference between the portfolios. Additionally, the returns from such funds do not appear significantly different than zero. They also lag the returns on spot commodities which have lagged inflation over the long haul.

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Holding a commodity futures index fund in a globally diversified portfolio: A placebo effect?

1. Introduction

Commodity index funds replicate long positions in baskets of commodity futures contracts. Investment in commodities markets through index funds experienced rapid growth between 1998 and 2008. Birkner and Collins (2008) estimated these funds had reached values of $185 to $260 billion by May 2008. Since then, on the heels of declines in commodity prices, growth in these funds has waned. Recent estimates place the size at slightly less than $200 billion. The perceived benefits from such investments are high returns, reduced risk, a hedge against inflation and portfolio diversification. Gorton and Rouwenhorst (2006), by examining a commodity index constructed of equally-weighted futures, found that historical futures returns have carried about the same risk premium as equities with less realized risk and provided portfolio diversification via negative correlations with stocks and bonds. The authors' index exceeded the return on T-bills by about 5% during the period from July 1959 through December 2004. Using data from 1970-1996, Garrett and Taylor (2001) estimated optimal portfolios would include from 30% to 68% commodities for low risk to high risk investors respectively. However, for a different time period, they found that 0% commodity weighting was appropriate for all portfolios. Anson (1999) found that risk averse investors gain even more marginal utility from investing in futures index funds than less risk averse investors. The issue we examine here concerns the perceived advantages of including commodity index funds in a portfolio as if they were assets like stocks and bonds. Looking at returns, risk and diversification benefits with recent data, we find little evidence that index funds can be counted on to provide any of the benefits sought by investors.

In the sections that follow we look at the potential sources and nature of futures and index fund returns. We then examine recent data to compare index returns and volatility to other asset returns. We also examine the correlation between index and other asset returns. Next, optimal portfolios are constructed and those which include commodity index funds are compared to portfolios that do not include those funds. We conclude with a brief discussion.

2. Futures and physical commodities

Unlike physical (spot) commodity markets, futures are zero sum bets. A futures contract is created by a buyer and a seller who come to terms on a price. For each long position (buyer) there must be a short position (seller). A futures contract does not represent ownership in any actual commodity. Instead, a futures position represents a bet on the direction of the price of the commodity. A long position is a bet on higher prices; a short position is a bet on lower prices. At the end of each trading day the losers compensate the winners. Thus, for every dollar earned there must be a dollar lost. A futures price represents the momentary equilibrium between those who believe the futures price will rise and those who believe it will fall. The zero-sum nature of futures markets implies the overall expected return for futures positions must be zero. Hedge funds and managed futures accounts pursue speculative profit opportunities on both sides of the markets. Historically, such funds have reported highly successful outcomes of such trading.

However Bhardwaj, Gorton, and Rouwenhorst (2008) find that the success of these funds may be grossly overstated.

Despite the fact that futures contracts are merely bets with long and short positions always evenly matched, it is becoming increasingly popular to view futures as an asset class. Domanski and Heath (2007) present evidence of large increases of participation in futures markets by financial investors and suggest that futures markets are becoming more like financial markets. A term that has become popular to describe this phenomenon is "financialization" of derivatives markets. Among these new participants in the markets are the index funds, which are passive participants on the long side of the market only. Each index is made up of its own uniquely weighted market basket. For example, the largest index, S&P Goldman Sachs Commodity Index devotes a very large proportion to energy futures (roughly 71%) while the second largest fund, the Dow Jones UBS [DJUBS] Commodity Index [DJUBS-CI] has about 33% of its mix in the energy sector.

The success of long-only futures investing depends upon either persistent increases in commodity prices and futures markets' replication of those movements or a continuous increase in futures prices independent of underlying commodity prices. Unlike traditional investments, there are no cash flows or profits to produce positive commodity returns. Therefore, long-term upward price movement is primarily dependent upon individual supply and demand factors, which are short-term phenomena, and inflation, which is a long-term factor. The link between commodity prices and inflation has been found to be very weak, however. Pecchenino (1992), using cointegration analysis, found that commodity prices are not very useful in forecasting inflation. Blomberg and Harris (1995) show that the link between commodity prices and CPI is weak and has become weaker. Between mid-1967 and mid-2010, CPI inflation averaged about 4.4% while the CRB Continuous Commodity Index increased about 3.5%, moving in the same direction but not the same magnitude and not contemporaneously.

Even if commodity price increases could be counted on, the problems of storage costs, insurance, financing, feeding, veterinarian bills, and deterioration make it impossible to make long-term investments in most physical commodities and those costs would almost certainly exceed the gains from the historical price increases. In fact, interest payments alone would have exceeded the gains. In a full carrying charge market, the basis (spot price minus futures) reflects the negative of these costs (carrying charges). Financial futures, such as the S&P 500 e-Mini contract, are full carry markets due to the ease of arbitrage. On the other hand, the term structures of commodity futures, such as crude oil, are sometimes upward sloping (contango) and sometimes downward sloping (backwardation). As the expiration of the futures contract nears, the futures price and the spot price converge. Index funds contain long positions only and must roll forward by selling their long positions and taking new positions in contracts with more distant expirations. In contango markets, maintaining rolling long positions is similar to holding the physical commodity and paying the carrying charges in addition to the transaction costs involved with futures trading. *Ceteris paribus*, the term structure leads to gains from backwardated markets and losses from contango markets.

Gorton and Rouwenhorst (2006) report historical futures returns have exceeded those of spot returns. They infer a continuation of these returns based on the idea of a "risk premium" in futures created by either a "convenience yield" or "normal backwardation." A convenience yield depends upon producers' willingness to hold a commodity, foregoing the cash flow from selling the commodity, in anticipation of a price increase. Keynes (1930) theory of "normal backwardation" suggests that hedgers are typically net short the futures markets, which creates an opportunity for long positions to earn a positive return, essentially a risk premium. An efficient market would eliminate this possibility. Indeed, markets shift between contango and backwardation, seemingly at random. Gorton, Hayashi and Rouwenhort (2007) link these shifts to the level of inventories in the spot market. Because of its shifting nature, it is not possible to count on the term structure to produce profitable long positions. Indeed, Erb and Harvey (2006) show that the historical returns on individual futures contracts are not significantly different than zero (except corn, which had a negative return).

The relationship between physical and futures prices can be illustrated by comparing the DJUBS-CI with the DJUBS Spot Index [DJUBS-SI]. Although not tradable, the spot index should mimic the path of actual commodities. During the 1/2/1991 through 4/27/2010 period that these indexes have been in existence the spot index increased at an average annual rate of about 6.6% while DJUBS-CI increased at a 1.48% rate. Interestingly, the spot index return is significantly above zero (at the 5% significance level) while the futures index cannot be distinguished from zero. The theory of normal backwardation or a risk premium that rewards long positions would have predicted the opposite relationship.

If spot prices cannot be counted on to track inflation and futures prices cannot be counted on to provide a risk premium for long positions, can positive returns for index funds be generated? In a world where arbitrage pressure competes away profits in zero sum games, the answer would be "no." Current thought and previously introduced studies using historical data say otherwise. As every mutual fund prospectus states in one form or other, 'past returns are not indicative of future returns.'

Since inception on January 2, 1991 through April 27, 2010, the DJUBS-CI has advanced from 100 to 133.36, while the squeaky index, DJUBS-CI without the energy component [DJUBS-XE], stood at 105.21. This represents continuously compounded average annual returns of 1.48% and 0.26% respectively. Obviously, much of the increase in the DJUBS-CI was due to the effects of large increases in energy prices which are heavily weighted in the index. Adjusted for CPI inflation, the average annual returns were negative 0.79% and negative 2.21% respectively. To date, both indexes had reached their maximum values during 2008 at about 238 and 145 respectively. Their minimum values were about 74 and 60 respectively. These returns represent "excess returns." T-bill returns would be earned in addition to these returns in a fully collateralized index fund. For this period, the average daily excess return is not significantly greater than zero with a p-value of 67%. These same statistics for the period from inception through June 30, 2008, near the index' peak, however, show a positive excess return at the 10% significance level. The time period of the observations, due to the oil price increases in this case, can make a big difference in the perception of returns. Many past studies as well as the influx of new investors in index funds took place during periods of unusual activity in the commodity markets. In the next sections we analyze returns and volatility using more recent data. In addition, we compare optimal portfolios with and without commodity index funds.

3. Methodology and data description

An efficient portfolio is one that minimizes the portfolio variance for a given portfolio return.[1] In our study, we construct global portfolios for a U.S. investor with and without commodity futures index returns. The global portfolio is made up of U.S. stocks and bonds and global emerging market stocks and bonds. In particular, the portfolio with (without) commodity futures is based on five (four) index returns. Table 1 lists the index returns that make up the global portfolio along with the basic summary statistics for these returns.

Table 1. Descriptive statistics for daily index returns for the time period from 9/1/2003 to 4/1/2010

Index Returns	Mean	Median	Min	Max	Std Dev	Kurtosis	Skewness	Correlation Coefficient with CMD	Ret > 0 (p-value)
Commodity futures returns (CMD)	0.016	0.033	-6.200	5.813	1.255	1.976	-0.133	1.000	0.693
U.S. stock market returns	0.009	0.056	-9.469	10.957	1.348	12.517	-0.284	0.262	0.610
U.S. bond market returns	0.001	0.000	-2.716	3.667	0.524	3.025	0.111	-0.156	0.522
Global EM stock returns	0.061	0.174	-9.655	9.684	1.425	8.195	-0.628	0.022	0.961
Global EM bond returns	0.037	0.038	-6.114	4.857	0.463	48.424	-1.907	0.010	1.000
Average	**0.025**	**0.060**	**-6.831**	**6.996**	**1.003**	**14.827**	**-0.568**	**0.228**	

We set up a Lagrangian for the optimization problem of minimizing the global portfolio variance with commodity futures as follows:

$$\min_{w_1,\ldots,w_5} \quad \sigma^2_{portfolio} = w_1^2\sigma_1^2 + \ldots + w_5^2\sigma_5^2 + 2w_1w_2r_{1,2}\sigma_1\sigma_2 + \ldots + 2w_4w_5r_{4,5}\sigma_4\sigma_5$$

$$\text{s.t. } w_i > 0, i = 1,2,\ldots,5; \ \sum_{i=1}^{5} w_i = 1; \qquad \sum_{i=1}^{5} w_i\mu_i = \mu_{portfolio} \qquad (1)$$

The portfolio variance $\sigma^2_{portfolio}$ is a weighted average of the individual variances and pair wise covariance between the five index returns in the portfolio. The portfolio weight w_i is the index i weight in the portfolio. Also the portfolio return $\mu_{portfolio}$ is a weighted average of μ_i, which is the expected return for each index i.

As shown in equation (1), we minimize the portfolio variance subject to three constraints. First, all the weights are constrained to be positive. This is essentially a no short sales constraint, which is appropriate for commodity futures transactions and trading in emerging equity markets in general. The second constraint is that the weights all add up to one. The third is that the portfolio return is a weighted average of the individual index returns. When the constraints and optimality conditions are satisfied, we are able to solve for a minimum portfolio variance given a

[1] There is an extensive literature on the characteristics of the mean-variance, efficient portfolio frontier. See Markowitz (1952), Merton (1972), and Tobin (1958) for some of the earliest work on the topic.

specific portfolio return. The process is repeated for a range of target values for the portfolio return in order to plot the efficient market frontier. For the global portfolio without commodity futures, we repeat the optimization algorithm in the same manner. The only difference is that we now update equation (1) to include only four index returns instead of five.

Once we obtain the two efficient frontiers we draw the market line, a straight line through the origin that is tangent to each frontier. By doing so, we can identify the range of returns along the frontier that correspond to a risk free asset with a positive return. We focus on this range because investors are presumed to seek a risk-adjusted return on their investments that at least exceeds that on a risk free asset. Furthermore, in order to evaluate the statistical difference between the global portfolios with and without commodities, we also construct confidence bands for the two efficient frontiers for the appropriate range of returns. A significant overlap in the bootstrap confidence intervals would indicate that there is no statistical difference between the global portfolios with and without commodities.

We employ the stationary bootstrap method proposed by Politis and Romano (1994) to construct the confidence bands. The general advantage of bootstrap is that it can preserve both the serial dependence and cross-sectional correlation of the original time series. Unlike the traditional block bootstrap, stationary bootstrap does not introduce artificial nonstationarity into the bootstrap samples. To be specific, we first generate 1000 bootstrapped samples based on our full sample of returns. Then, for each bootstrap sample, we construct an efficient frontier. Finally, we construct the 95 percent confidence band for an efficient frontier using these 1000 bootstrapped efficient frontiers.

In our analysis, we use daily data for the time period from 9/1/2003 to 4/1/2010, a period of high participation in futures index funds, for a total of 1719 observations for each index. The U.S. stock returns are based on the S&P 500 composite price index (S&PCOMP) and the U.S. bond returns are based on the JP Morgan price index for the 10-15 year U.S. government bonds (JGUSOU$). Both are obtained from the DataStream database. In addition, the global emerging market stock returns are based on the Standard & Poor's (S&P)/International Finance Corporation's Investable prices denominated in U.S. dollars for the emerging market composite index (IFIDCM$). The global emerging market bond returns come from the JP Morgan emerging market bond/debt indices (JPM EMBI). To be specific, we use the JPM EMBI Global composite return index denominated in U.S. dollars (JPMGTOT). These data, too, are collected from the DataStream database. Finally, the commodity futures returns are based on the Dow Jones-UBS Commodity Index Total Return (DJUBSTR) index, representing fully collateralized futures positions. We measure the stock and futures index returns as one hundred times the log difference of stock prices. The bond returns, on the other hand, are measured as simple percentage returns.

We observe from Table 1 that the average daily returns are the highest for the global emerging market (EM) stock and bond returns. On the other hand, the average daily returns tend to be the lowest for the U.S. stock and bond market returns. The commodity futures returns lay between the two extremes. The returns on US stocks, bonds and futures index funds were not significantly greater than zero according to the z-test (p-value is included). It is also more likely to observe extreme losses in the emerging market stock (bond) index returns compared with the U.S. stock (bond) market returns. For commodity futures, the minimum losses on average resemble those of emerging market bonds. Not surprisingly, the standard deviation of returns is observed to be the highest for stock returns and the lowest for bond returns. In terms of volatility, futures returns are similar to stocks more than they are to bond returns. The coefficient of variation [CV] was much higher for US stocks and US bonds than that of the futures fund, but the CV of the futures fund was much higher than those of the global stocks and global bonds. In addition, both the kurtosis and skewness measures imply non-normality of the returns for all five indices especially due to the fat tailed nature of the data.

The second to last column of Table 1 shows the pair wise correlation coefficients for the commodity futures returns (CMD) with each of the other index returns. On average, we do not observe a high correlation between futures and other index returns. The highest correlation coefficient of 0.2619 is observed for CMD and the U.S. stock market returns. Apart from this, all other correlations are quite low and even negative for CMD and the U.S. bond market returns. The low correlation, by itself, would suggest some diversification benefits for U.S. investors who include commodity futures returns in their portfolios. However, previous studies showed low and even negative correlation between stocks and commodities as well as low correlations among commodities. More recent work by Tang and Xiong (2009) and Silvennoinen and Thorp (2010) have shown increasing correlation among commodities and between commodities and traditional investments.

4. Empirical results

Figure 1 plots the efficient frontiers for the global portfolios with and without commodity futures. In general, we observe that the portfolio with commodities envelopes the one without commodities. In other words, for a given portfolio return the minimum portfolio variance seems to be lower at least marginally for the global portfolio with commodities. However, this finding appears to be valid only for a range of returns that can be outperformed by a risk free asset. For the upper range of returns that cannot be outperformed by a risk free asset, the two efficient frontiers seem to overlap with one another. The visual evidence therefore suggests that holding a global portfolio with commodities may not be any better than holding a portfolio without commodities in terms of achieving greater diversification benefits.

Figure 1. Efficient portfolio frontiers for the global portfolio with and without commodity futures returns (CMD)

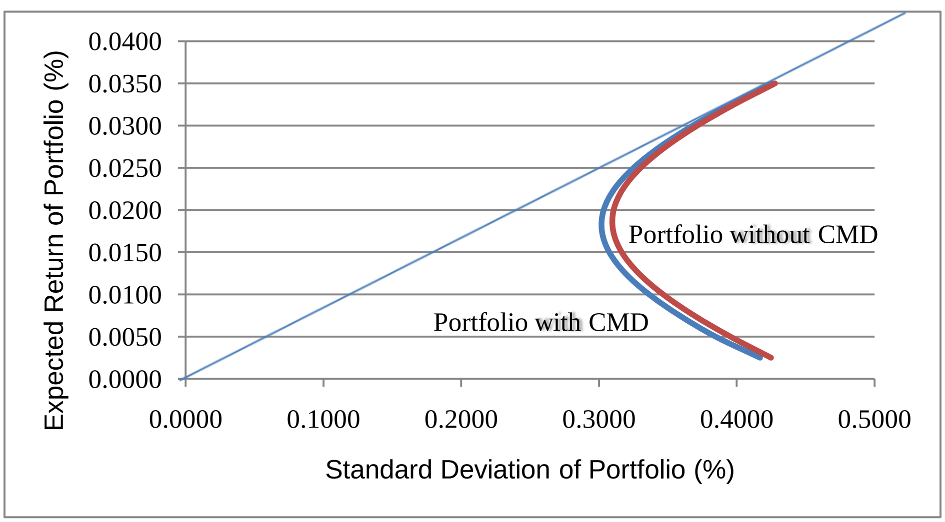
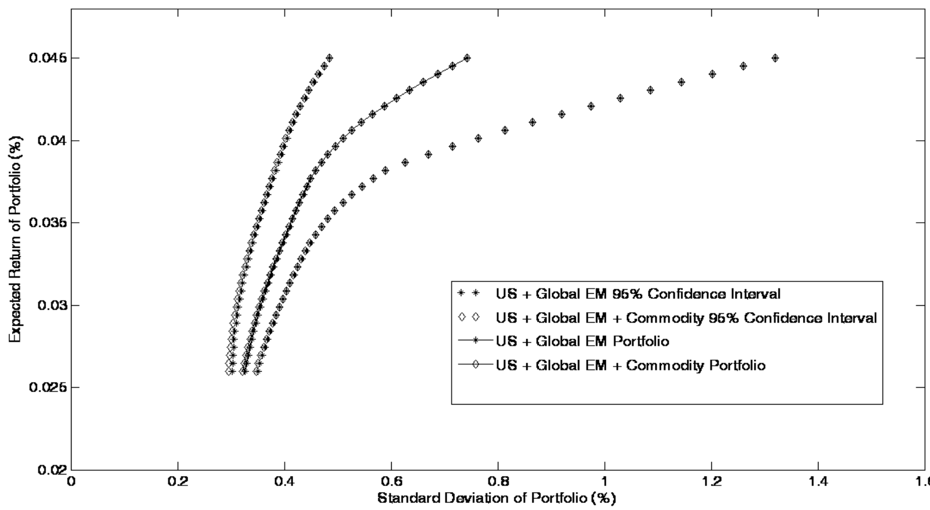


Figure 2 plots the efficient frontiers and their 95 percent bootstrap confidence bands for the global portfolios with and without commodities. We focus on the upper range of returns as appropriate. Following our previous result, we note that the two efficient frontiers exactly overlap with one another. Subsequently, the 95 percent confidence intervals for the two frontiers also overlap with each other. Therefore, we find statistical evidence that a significant difference does not exist between the global portfolios with and without commodity futures. In other words, a global portfolio that includes commodity futures does not minimize portfolio risk over and beyond a portfolio that in fact does not include commodity futures.

Figure 2. Efficient portfolio frontiers and their 95 percent bootstrap confidence intervals for the global portfolio with and without commodity futures.



Note: The global portfolio consists of U.S. stock and bond index returns and global emerging market (EM) stock and bond index returns.

In summary, the global portfolio frontiers that we constructed cast doubt on the benefits of adding commodity futures to one's investment portfolio. To be specific, based on financial market data for the past decade, we find significant evidence that U.S. investors diversifying in global emerging markets are not any better off adding commodity futures in their portfolios. This finding is in sharp contrast to popular belief that commodity futures enhance portfolio diversification benefits.

5. Conclusion

Long-only participation in commodity markets via investment in futures index funds has become so popular in recent years that these funds are being thought of as an asset class alongside traditional stocks and bonds. The perceived benefits include inflation hedge and the portfolio diversification advantages of enhanced returns with reduced risk. Some of the literature, projecting historical returns into the future, supports the financialization of these funds. Long-term data suggests that commodities may not be the inflation hedge that popular wisdom believes and that returns on long futures positions may not be different than zero. Using recent data spanning the period where the futures index funds became fashionable, we constructed efficient portfolios of global stocks and bonds and the Dow Jones-UBS fully collateralized futures fund. The efficient portfolios which include the futures fund and those which do not were found to be virtually indistinguishable, both visually and statistically.

What happened to the positive returns of the past? One possibility is that they were observed during periods where backwardation was more prevalent than contango. Another possibility is that $200 billion invested in long-only positions removed the risk premium from the futures markets. There is a line of research, beyond this paper's focus, that studies the effects of these market participants on the markets [see, for example, Domanski and Heath (2007)].

Our findings suggest that passive investing in long futures positions should not be approached on faith. Profitable risk premia are only sometimes available and even if underlying commodities did track inflation well, storage costs would consume any profits from the price increases in a full carry market. Considering a futures position as an investment asset is akin to thinking about a bet on one's favorite sports team as an investment asset [thanks to Black (1976)]. Over a long period of time, the returns from a fully collateralized futures index position would probably be like those of a super-volatile Treasury bill.

References

Anson, Mark J. P. (1999) "Maximizing Utility with Commodity Futures Diversification," *Journal of Portfolio Management*, 25:4, 86-94.

Bharwaj, Geetesh, Gary B. Gorton, and K. Geert Rouwenhorst (2008) "Fooling Some of the People All of the Time: The Inefficient Performance and Persistence of Commodity Trading Advisors," NBER Working Papers: 14424.

Birkner, Christine and Daniel P. Collins (2008) "Inside Commodity Index Funds," *Futures*, August 2008, 54-61.

Black, Fischer (1976) "The Pricing of Commodity Contracts," *Journal of Financial Economics*, 3:1/2, 167-179.

Blomberg, S. Brock and Ethan S. Harris (1995) "The Commodity-Consumer Price Connection: Fact or Fable?" *Economic Policy Review*, 1:3.

Domanski, Dietrich and Alexandra Heath (2007) "Financial investors and commodity markets," *BIS Quarterly Review*, March 2007, 53-67.

Erb, Claude B. and Campbell R. Harvey (2006) "The Strategic and Tactical Value of Commodity Futures," *Financial Analysts Journal*, 62:2, 69-97.

Garrett, Ian and Nick Taylor (2001) "Portfolio Diversification and Excess Comovement in Commodity Prices," *The Manchester School*, 69:4, 351-368.

Gorton, Gary and K. Geert Rouwenhorst (2006) "Facts and Fantasies about Commodity Futures," *Financial Analysts Journal*, 62:2, 47-68.

Gorton, Gary, Fumio Hayashi, and K Geert Rouwenhorst (2007) "The Fundamentals of Commodity Futures Returns," NBER Working Paper 13249.

Keynes, John M. (1930) *A Treatise on Money*, London: Macmillan.

Markowitz, Harry (1952) "Portfolio Selection," *Journal of Finance*, 7:1, 77-91.

Merton, Robert C. (1972) "An Analytic Derivation of the Efficient Portfolio Frontier," *Journal of Financial and Quantitative Analysis*, 7:4, 1851-1872.

Pecchenino, R. A. (1992) "Commodity prices and the CPI: Cointegration, information, and signal extraction," *International Journal of Forecasting*, 7:4, 493-500.

Politis, Dimitris N. and Joseph P. Romano (1994) "The stationary bootstrap," *Journal of the American Statistical Association*, 89(428):1303–1313.

Silvennoinen, Annastiina and Susan Thorp (2010) "Financialization, Crisis and Commodity Correlation Dynamics," *Quantitative Finance Research Center University of Technology Sydney*, Research Paper 267.

Tang, Ke and Wei Xiong (2009) "Index Investing and the Financialization of Commodities," Working Paper, Princeton University.

Tobin, James (1958) "Liquidity Preference as Behavior Towards Risk," *Review of Economic Studies*, 25:2, 65-86.