Conquering Misperceptions about Commodity Futures Investing

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ABSTRACT

Long-only commodity futures returns have been very disappointing over the last decade, leading some to wonder if it was a mistake to invest in commodities. The poor performance is the result of poor "income returns" and not of falling commodity prices. This observation may be surprising for many commodity investors who were not aware, who misperceived, they were making a bet on income returns, a return building block similar to a stock's dividend yield or a bond's yield. For investors seeking an inflation hedge, it may be surprising that the historical linkage of commodity returns with inflation seems to be the result of a connection between commodity income returns and inflation, not, as commonly misperceived, commodity price returns and inflation. It may be surprising that the value of commodity investments is smaller than the market capitalization of Facebook, a potentially striking misperception for investors seeking a portfolio diversifier with abundant capacity. There has been no change in the way that price returns and income returns drive the total returns of stocks, bond and commodities. What has changed is that maybe a good number of commodity investors now realize that they were operating outside of their "circle of competence" and did not have a sense of what future price and income returns could be and would be.

Keywords: *Commodity futures, price return, income return, roll return, real return, inflation, backwardation, contango, inflation hedge, asset class.*
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Introduction

The last ten years have been challenging for many long-only commodity futures investors and given many a reason to question whether a 'bad' investment strategy drove a bad outcome or a 'good' strategy experienced an unlucky outcome. Picking up roughly where Erb and Harvey (2006) and Gorton and Rouwenhorst (2006) ended their analyses of commodity returns, Exhibit 1 provides some perspective about the performance of widely used indices of stocks, bonds and commodities.[i] For instance, the total return of the S&P GSCI commodity index was -4.6% per year, much lower than the +7.4% return for the S&P 500 stock index and the +4.5% return for the Barclays U.S. Aggregate bond index. The key driver of the poor S&P GSCI performance has been a -8.0% income return (another widely used commodity index, the Bloomberg Commodity Index, also had both low total and income returns[ii]). Buffett (1987) noted that "as they say in poker, if you've been in the game 30 minutes and don't know who the patsy is, you're the patsy." Whether it is equally difficult to forecast future price and income returns for stocks, bonds and commodities is open to debate. Nonetheless, in order to avoid the impact of outcome bias linking past performance to the value of a strategy or the cognitive dissonance of ignoring past performance in favor of personally held beliefs, investors have to correctly forecast the drivers of total return or risk ending up as patsies.[iii]

Exhibit 1
Decomposing Total Returns: Stocks, Bonds, and Commodities

Decomposition	S&P 500	Barclays U.S. Aggregate	S&P GSCI	Bloomberg Commodity
Price Return	5.20%	0.43%	3.39%	5.47%
Income Return	2.22%	4.04%	-7.97%	-7.39%
Total Return	7.41%	4.47%	-4.58%	-1.92%

Source: Bloomberg, December 2004-June 2015

For many investors, it may be hard to contemplate what a -8.0% income return means. Looking at the S&P 500 stock index, the income return would be equivalent to a -8.0% dividend yield (shareholders would be paying to own stocks). Looking at the Barclays U.S. Aggregate fixed income index, the income return would be roughly consistent with investing in bonds with a yield of -8.0% (bondholders would be paying interest to own bonds). One way to think about a -8.0% commodity income return is that commodity index investors paid 8.0% per year to "own" commodities. Each of these income returns can also be viewed broadly in the spirit of a more general "carry return", "the income you earn if the price stays the same over the holding period" and a "model-free measure of the risk-premium in a given asset class".[iv] It may be appealing to want, or expect, commodity income returns to be positive, yet negative income returns are clearly possible in the commodity futures space (just as negative income returns are possible, currently, with some German and Swiss sovereign bonds).

So, what is the income return for a commodity portfolio? Mechanically, as Exhibit 2 illustrates for the decomposition of the total return of the S&P GSCI commodity index,[v] the commodity income return is the sum of a collateral return (in this case the three-month Treasury bill) and a roll return (the cost, or benefit, of staying invested in futures contracts over time). For instance, from December 2004 to June 2015, the three-month US Treasury bill had a return of about 1.3% per year and the S&P GSCI had a roll return of about -9.3% per year (for an income return of -8.0%). Informally, the commodity income return can be thought of as the "dividend return" of a collateralized commodity futures portfolio. From the inception of

the S&P GSCI to the end of 2004, the income return was 8.7% per year. Clearly, income returns, roll returns and T-bill returns are not constant and as a result history can be a poor guide to the future.

Exhibit 2

The Drivers of Commodity Futures Index Returns

	In-Sample		Out-of-Sample		Overall		Difference	
Component	January 1970-December 2004		December 2004-June 2015		January 1970-June 2015		Out-of-Sample - In-Sample	
Treasury bill	6.78%		1.32%		5.39%		-5.47%	
Roll return	1.95%		-9.29%		-0.76%		-11.24%	
Income return		8.74%		-7.97%		4.64%		-16.71%
Inflation (CPI)	4.75%		2.07%		4.12%		-2.68%	
Real Price return	-1.52%		1.32%		-0.85%		2.84%	
Price return		3.23%		3.39%		3.27%		0.16%
Total return		11.97%		-4.58%		7.91%		-16.55%

Source: Bloomberg, based on the S&P GSCI

Erb and Harvey (2006) provide an example of decomposing the total return of a commodity portfolio into three return drivers: a price return, a roll return and a collateral return.[vi] Though roll returns may be instructive for understanding commodity futures returns, roll returns are not unique to commodities or commodity futures.[vii] It also turns out that strategies that combine collateral with stock or bond futures have the same three return drivers: a price return, a roll return and a collateral return. The roll return is a characteristic of any collateralized futures strategy, not just of a commodity futures strategy. For collateralized stock and bond futures portfolios, the roll return and the collateral return sum up to the income return. Though stock and bond roll returns exist, they are generally ignored. If the roll return and the collateral return for collateralized stock and bond portfolios sum up to the income return, then the roll return and collateral return of a collateralized commodity futures portfolio sum up to the income return. This process of summing up is not just limited to the income return. As Exhibit 2 shows, the price return can be thought of as the sum of the rate of inflation and a real price return (other decompositions are, of course, possible). Though it may seem obvious to some, stock, bond and commodity investors cannot separately invest in the building block returns of total return, such as price return, income returns and roll returns.

There are at least two ways to explore commodity price and income returns. The first is to look at the returns of traded commodity indices referencing the work of index providers, such as S&P with the S&P GSCI and Bloomberg with the Bloomberg Commodity Index, which publish total return, excess return and price return indices defined in substantial index methodology documents.[viii] In addition, time series of these indices are generally downloadable. The details of the construction of a total return index (excess return plus collateral return), an excess return index (price return plus roll yield, also known as roll return) and a price index (used to produce price returns), all appropriately weighted by a well-defined portfolio construction scheme, are laid out in a way intended to promote trade and limit legal frictions.

There are many details in an index methodology including the weighting of different contracts and the mechanics of rolling from one contract to the next. Index trading days can be divided into non-roll days and roll days. On non-roll days the excess return of a commodity index, such as the S&P GSCI, equals its price return. On roll days the index excess return equals the index price return and an adjustment for

rolling from one futures contract to another (the roll return, also called a roll yield, is positive when two contracts are in backwardation, negative when two contracts are in contango and zero when the term structure between two contracts is unchanged or flat).[ix] "Rolling" from one contract to another does not have any cash flow implications for investors though it does trigger an accounting-like recognition of price and roll returns. It is worth noting that, though some investors may be focused on tracking "spot" commodity prices, given the way commodity futures indices are constructed there is no reason to expect a commodity futures price index to track "spot" prices.

The second way of examining price and income returns is much more problematic. It entails researchers selecting their own universe of commodities (which may or may not overlap with the universes investors are exposed to in actually traded indices), contract roll method, contract selection methodology and portfolio weighting method. Unlike the world of daily priced and updated professional indices, these one-off research commodity indices are rarely supported by well-developed index methodology documents and may not have readily available and downloadable total return, excess return and price indices.

There are at least two competing camps of thought with regards to the value of decomposing commodity index returns into constituent returns. At least superficially, the differences in opinion can be associated with dissatisfaction or acceptance of what might ambitiously be called Keynes' theory of "normal backwardation". For Arnott, Chaves, Gunzberg, Hsu and Tsui (2014) decomposing commodity futures excess returns into price and roll returns "offers important insights into the characteristics and performance of commodity indexes". Focusing on perceived recent unattractive commodity performance, and reasons for that performance, they noted that "while Keynes may have predicted positive roll yields for the last quarter-century, they've been more the exception than the rule". Goldman Sachs (2016), which sold the GSCI to S&P in 2007, has a public webpage that may suggest that it is not possible to decompose S&P GSCI returns into constituent returns. Goldman Sachs researchers Shemilt and Unsal (2004) observed that the "GSCI historically has had high equity-like returns" and suggested this performance might be driven by the "supply and demand for risk capital" and "the Keynes argument". Investors have differing opinions about the efficiency or inefficiency of markets, the rationality or irrationality of investor behavior and it's not surprising that within the microcosm of commodity futures investment differences of opinion exist. Buffett (1982) noted "don't ask the barber whether you need a haircut". Differences of opinion exist and it is important for investors to know which opinions matter for them and why.

What has driven commodity portfolio returns? Focusing on the investable commodity index with the longest performance history, the S&P GSCI, Exhibit 3 shows correlations for rolling 10-year returns for the drivers of the S&P GSCI. What seemingly drove commodity total returns? Interestingly, the first row shows that, historically, there has been little correlation between total return and price return (-0.07), a high correlation between total return and income return (0.73) and a positive correlation between total return and inflation (0.55). What drove commodity price returns? The third row shows that historically price returns were negatively correlated with income returns (-0.73), with roll returns (-0.71), with collateral returns (-0.63) and with inflation (-0.26). What drove income returns? The fourth row shows that historically income returns were positively correlated with roll returns (0.97), with collateral returns (0.87) and with inflation (0.55). Finally, which commodity return components were correlated with inflation? The seventh row shows that price returns were negatively correlated with inflation (-0.26), positively correlated with income returns (0.55), positively correlated with roll returns (0.36) and positively

correlated with collateral returns (0.83). In a broad sense, Exhibit 3 suggests: 1) a weak link between commodity price returns and commodity total returns, 2) a negative link between inflation and commodity price returns, 3) a positive link between commodity income returns and commodity total returns, 4) a positive link between inflation and commodity income returns and 5) a negative relationship between income returns and price returns.

Exhibit 3

Correlations of 10-year Returns (January 1970 - June 2015)
S&P GSCI Return Drivers

	Total	Excess	Price	Income	Roll	T-bill	Inflation
1. Total Return	**1.00**	0.85	-0.07	0.73	0.71	0.64	0.55
2. Excess Return	0.85	**1.00**	0.34	0.35	0.43	0.14	0.15
3. Price Return	-0.07	0.34	**1.00**	-0.73	-0.71	-0.63	-0.26
4. Income Return	0.73	0.35	-0.73	**1.00**	0.97	0.87	0.55
5. Roll Return	0.71	0.43	-0.71	0.97	**1.00**	0.71	0.36
6. T-Bill (Collateral)	0.64	0.14	-0.63	0.87	0.71	**1.00**	0.83
7. Inflation Rate	0.55	0.15	-0.26	0.55	0.36	0.83	**1.00**

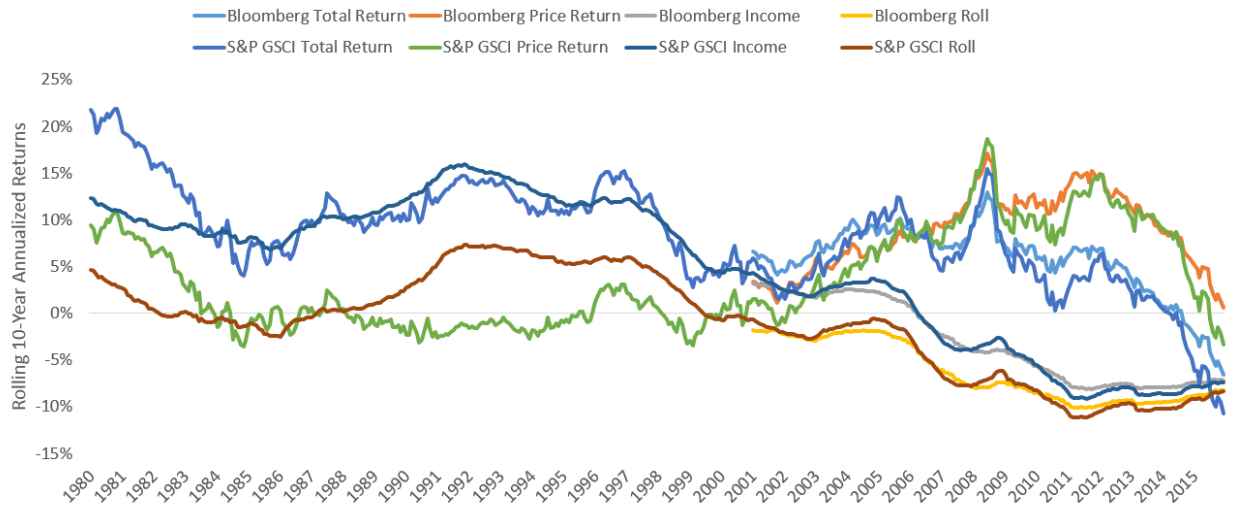
How representative is the S&P GSCI? Erb and Harvey used the value of futures contract open interest[x] and noted that in 2004 the S&P GSCI had 86% of combined futures open interest value, the Bloomberg Commodity Index accounted for 10% of open interest value, and the Commodity Research Bureau index made up the remaining 4% of open interest value. Exhibit 4 illustrates rolling 10-year total, price, income and roll returns for the two most popular commodity indices in 2004, the S&P GSCI and the Bloomberg Commodity Index. Did the two most popular commodity indices actually available to investors in 2004 behave similarly or dissimilarly?

Exhibit 4 conveys a picture of two commodity indices with roughly the same pattern of total, price, income and roll returns.[xi] The difference between income and roll returns is just the Treasury bill collateral return embedded into the calculation of the two income return time series. The Bloomberg Commodity Index (originally called the Dow Jones AIG Commodity Index and later the Dow Jones UBS Commodity Index) was launched in 1998 as an alternative to the S&P GSCI, largely using "liquidity" based portfolio weights rather than "production" based portfolio weights and a much smaller exposure to energy futures. Rolling 10-year total, price, income and roll returns for the two indices have been largely the same over the full sample.[xii] Total, income and roll returns for both indices have declined over time. The fact that performance of the return drivers of the S&P GSCI and the Bloomberg Commodity Index have been similar suggests that if one of the indices is a real commodity index then so is the other.[xiii]

The fact that the performance of the "newer" Bloomberg Commodity Index echoes the performance of the "older" S&P GSCI is also consistent with the idea that out-of-sample there is no compelling evidence of a "new product" free lunch,[xiv] that is, a newer commodity index should outperform an older commodity index. Since 2004, many new commodity indices have been launched (such as the UBS Bloomberg CMCI, the Credit Suisse Commodity Benchmark and the Dow Jones RAFI Commodity Index) demonstrating impressive backtested total and income return performance relative to previously existing commodity indices. Focusing on the promise that "newer might be better", Brightman, Li and Liu (2015) constructed

an ETF strategy "event study" and by chasing the performance of backtested investment strategies, concluded that "disappointing subsequent performance is inevitable".[xv]

Exhibit 4
Commodity Total, Income And Roll Returns Have Been Positive and Negative
January 1970 to June 2015



There are at least two opposing views to explain the decline in income and roll returns. The first view offered by Bhardwaj, Gorton and Rouwenhorst (2015) is that there is in fact no difference between pre-2004 commodity performance and post-2004 commodity performance. Their view is illustrated by looking at the performance of a hypothetical, equally-weighted paper portfolio created by Gorton and Rouwenhorst (2006). This paper portfolio embeds a common smart beta strategy, rebalancing an equally weighted portfolio.[xvi] Working with an intuition that commodity futures markets are risk transfer insurance markets for commodity hedgers,[xvii] Bhardwaj, Gorton and Rouwenhorst also find no evidence that an influx of long-only financial commodity investors over the last decade has impacted the historical or prospective returns of their hypothetical paper portfolio. Summing up the impact of the last decade, they find "the risk premium has been comparable to its long-term historical average".

Norrish (2015) argues that Gorton and Rouwenhorst's hypothetical paper portfolio "is not a viable option for most investors",[xviii] and reflects an alternative view that over the last decade an influx of long-only financial investors significantly lowered returns for actual and tradable long-only commodity indices. Echoing the view that commodity futures markets can be viewed as price insurance markets, Norrish's view is that there has been too much long-only insurance capital chasing too few insurance opportunities. If too much insurance-inspired capital has lowered returns then perhaps a contraction in insurance-inspired capital might increase returns. The debate over whether or not income and roll returns have declined is a bit Rashomon-esque, seemingly presenting contradictory interpretations of the same historical data. What matters, though, for investors is to learn from the performance of the investment choices they actually have and not the performance of paper portfolios they never invested in.

Two oracles

Consider the following thought experiment. Suppose in January 1970, an investor wanted to forecast the future rolling 10-year total returns of the S&P GSCI and is faced with the choice of choosing between two oracles, a price return oracle and an income return oracle. The first oracle knows the exact upcoming 10-year price returns of the S&P GSCI. The second oracle knows the exact upcoming 10-year income returns of the S&P GSCI. Neither oracle knows what future ten-year total returns will be and each oracle acts independently of the other. Obviously, if the investor had access to both clairvoyant forecasts, it would be possible to perfectly forecast the S&P GSCI total returns.

Suppose the investor chooses the income returns oracle and as a result knows the future income returns from January 1970 to present. How well have these perfect forecasts of future income returns lined up with actual 10-year *total* returns for the S&P GSCI? Exhibit 5 provides an answer. The blue dots represent each possible pair of ten-year income returns and ten-year total returns. The solid rust colored line is a regression line showing the best fit prediction of total return given a perfect forecast of income returns. Income returns explained about 54% of the time series variability in total return.[xix]

Exhibit 5
Historically, Perfect Foresight of Commodity Income Returns has been Helpful
January 1970 – June 2015

Source: Bloomberg. Overlapping monthly observations.

Exhibit 5 illustrates the seemingly obvious idea that having perfect foresight of future, though impossible to obtain, income returns should be of some value in predicting future S&P GSCI total returns. Given that many commodity futures investors do not have a clairvoyant oracle and have at best a limited understanding of commodity futures term structures and income returns, Exhibit 5 merely represents an unattainable ideal. If income returns explained 54% of S&P GSCI total return variability, does that suggest that price return described the other 46%?

Let's return to our thought experiment with the two oracles. Now suppose the investor chose the oracle that foretold S&P GSCI price returns. It is common, as Ritholtz (2015) illustrates, to believe that going-nowhere or falling commodity prices have been a reason for disappointing historical commodity returns.

Exhibit 6 illustrates the ability of clairvoyant 10-year S&P GSCI price return forecasts to explain the variability of 10-year S&P GSCI total returns.

Exhibit 6
Historically, Perfect Foresight of Commodity Price Returns has not been Useful
January 1970 – June 2015

Source: Bloomberg. Overlapping monthly observations.

The rust colored line, and the R-squared of approximately 0%, suggests the absence of a significant linear relationship between perfect price return forecasts and total returns for the S&P GSCI (this finding is robust to using non-overlapping price and total returns).[xx] For an investor who believes there should be a powerful relation between the price return of a commodity futures portfolio and its total return, this result may seem unwelcome and preposterous. There is nothing wrong with rejecting the message of Exhibit 6 that historically there seems to have been little connection between price returns and total returns. Exhibit 6 is simply an expression of what actually happened in the past to the historically most widely used commodity index. It is possible to look at Figure 6 and see vague clusters of returns that speak to the possible existence of two, three, or even more possible total return-price return correlation regimes. Possible regimes could be the oil price shock of the 1970s, the Volcker inflation fix and the more modern era following the global financial crisis. A challenge with focusing on changing regimes is that it is prone to narrative fallacy since no one knew about the existence of, or the labels that would be applied to, these regimes before they happened. Of course the existence of multiple total return-price return correlation regimes means that there is no single stable total return-price return relationship and that precisely identifying future price return-total return correlation regimes will be critical. Or it is possible that the desire to reject historical evidence in favor of personal beliefs may be a manifestation of cognitive dissonance. Taken as-is, Exhibit 6 presents the message that the S&P GSCI was not a good way to capture S&P GSCI commodity price moves. If perfect forecasts of income returns explain 54% of total return variability and perfect forecasts of price returns explain about 0% of total return variability, what is the missing link that drives the other 46% of total return variability?

Exhibit 7 shows that historically S&P GSCI price returns and income returns have been negatively correlated. It illustrates the Croesus problem, in which foresight doesn't mean what one hopes it means, and hints at why the relation between S&P GSCI total returns and S&P GSCI price returns has been so slight. Croesus was the king of Lydia and he asked the Oracle at Delphi whether he should go to war with Persia. The oracle responded "if Croesus goes to war, he will destroy a great empire". Unfortunately for Croesus, Lydia went to war with Persia and Lydia lost to Persia. The oracle was correct but Croesus assumed that he understood the mutterings of the oracle. The Croesus problem for the investor who received the oracular price return forecasts is the assumption that price returns by themselves mattered. Focusing on the rust colored line, an income return of about 12% has been associated with a price return of about 0% and an income return of -8% has been associated with a price return of about 10%. Is Exhibit 7 an example of behavioral errors on the part of investors, errors that possibly could be corrected in the future? If the behavioral errors of the past are corrected will they be replaced by different behavioral errors of the future or some semblance of "the truth"? Could there be another explanation?

Exhibit 7
Historically, High Commodity Income Returns Associated with Low Price Returns
January 1970 – June 2015

Source: Bloomberg. Overlapping monthly observations.

One question might be "other than odd investor behavior, why has there been a negative correlation between price returns and income returns?" A tentative answer might be found in the "carry" literature. The early carry literature focused on foreign exchange rates and how they were related to differences in interest rates between two countries. A concept called uncovered interest rate parity suggested that in order to avoid an economic free lunch, the difference in interest rates between two countries, the carry, should be offset by an opposite change in the value of an exchange rate. For instance, if country A had an interest rate of 10% and country B had an interest rate of 5% then the no free lunch idea suggests that A's currency should devalue by 5% relative to country B (uncovered interest rate parity held that the correlation between income returns and price returns should be -1.0). Koijen, Moskowitz, Pedersen and Vrugt (2015) found evidence that for many investments (such as equities, bonds and commodities) there seemed to be a free lunch in that income return differences were not offset completely with price return differences. Exhibit 7 illustrates that for the S&P GSCI the trade-off between income returns and price

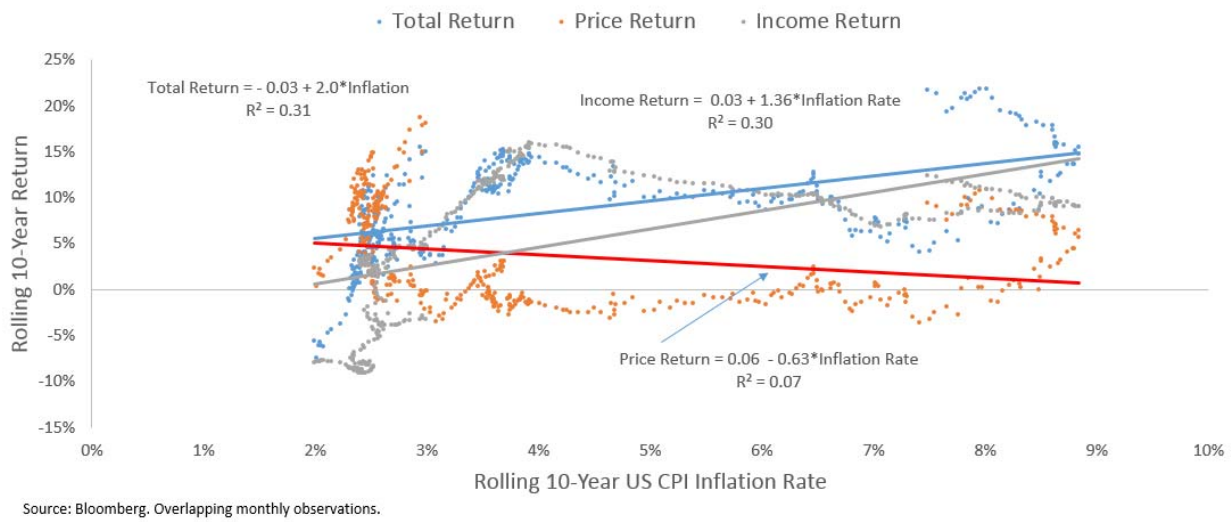
returns has been close to the trade-off suggested by uncovered interest rate parity. From a carry perspective, the income return can broadly be viewed as a risk premium but it is a risk premium subject to a possibly offsetting price return.

Commodities and Inflation

A frequently advanced reason for investing in commodities it that commodity total returns are supposed to be an inflation hedge.[xxi] But what does this mean? For instance, Treasury Inflation Protected Securities (TIPS) are viewed as an inflation hedge because they pass through realized, and "unexpected", inflation and nominal bonds are not an inflation hedge because they do not pass through realized, and "unexpected", inflation. If a characteristic of an inflation hedge is that it passes through realized inflation, then how well have commodities passed through realized inflation?[xxii]

Exhibit 8 illustrates where the link between rolling 10-year realized inflation and S&P GSCI total returns has come from historically. It shows that S&P GSCI price returns have been negatively correlated with realized inflation and both income and total returns have been positively correlated with realized inflation. Exhibit 3 showed that inflation was positively correlated with the constituents of the income return, collateral returns and roll returns. If an investor expects commodity price returns to be the driver of a positive correlation between commodity total returns and inflation then this exhibit is probably disconcerting. It is unlikely that many investors have tied their "commodities are an inflation hedge" bet to the existence of a positive correlation between income returns and inflation. Viewing commodity income returns as a carry inspired proxy for a commodity risk premium, the observed positive correlation between inflation and income returns would suggest that the higher the rate of inflation the higher the commodity risk premium and the lower the rate of inflation the lower the commodity risk premium.

Exhibit 8
Historically, Perfect Foresight of Inflation Has Been A Mixed Bag
January 1970 – June 2015



Source: Bloomberg. Overlapping monthly observations.

This negative relationship between realized inflation and commodity price return echoes a finding by Erb and Harvey (2013) that historically the 10-year total return of gold, sometimes viewed as a commodity and sometimes viewed as a currency, has largely been driven by the 10-year real price return of gold and not the 10-year rate of inflation. As a result, gold has been a poor hedge of 10-year inflation. The strongest support for the idea that commodities, in general, and gold, specifically, are inflation hedges comes from a belief that reported measures of inflation are seriously flawed and that the flawed inflation measures do not capture the true covariation of commodity returns with inflation.

Commodity Asset Allocation

How much should be invested in commodities? There is no single answer since an answer depends upon investor perspective. Some views argue for a tactical approach and others suggest a strategic, permanent, allocation. Erb and Harvey (2006) viewed commodities as a tactical opportunity that made sense when and if commodities had attractive prospective returns relative to other investments. Bhardwaj and Janardanan (2014) suggest that for long-only portfolios a "5-10 percent allocation is commonly used by practitioners" and that the optimal allocation to commodities in a risk parity portfolio is 18%.[xxiii] Gorton[xxiv] (2015) also took a strategic approach and noted "I think you should always have exposure to commodity futures if you're a large investor". Idzorek (2006) focused on strategic asset allocation and, using a number of ways to estimate capital market returns, found that "optimal" allocations to commodities ranged from about 10% for "conservative" portfolios, 25% for "moderate" risk portfolios and 19% for "aggressive" portfolios.

Exhibit 9

Macro-consistency and Asset Allocation

	Market value ($ trillions)	Share
Bloomberg Global Equity	$64.80	58.46%
Barclays Multiverse	$45.80	41.32%
Commodities	$0.24	0.22%
Total	$110.84	100.00%
Note: Facebook market capitalization	$0.29	

Source: Bloomberg, Norrish (2015)

It is possible that all assets are owned by someone, somewhere. Sharpe (2010) looked at "adaptive asset allocation" and noted that the tactical and strategic asset allocations of all asset owners have to add up to the value of all the assets available to all asset owners. This concept, which Sharpe calls macro-consistency, poses a challenge for commodity investments. Exhibit 9 suggests that the total value of stock, bond and commodity investments is about $110 trillion.[xxv] Stocks account for a little more than 58% of the total. The Barclays Multiverse, which includes the value of the Barclays Global Aggregate Bond Index

and global high yield bonds, accounts for more than 41% of the total.[xxvi] Commodities account for 0.22% of the total, about $240 billion.[xxvii] It is interesting that the total market value of commodity investments is less than the market capitalization of Facebook. A 10% allocation to commodities would require shifting about $10 trillion into commodities and a 20% commodity allocation would require about a $20 trillion exposure. Currently, total investment in commodities is an asset allocation rounding error and, in a macro-consistent sense, it is impossible for investors large and small to collectively allocate 5%, 10% or 20% to commodities.

Conclusions

Price returns and income returns drive the total returns of commodities, stocks and bonds. Knowing this decomposition does not make it easy to forecast future price and income returns. Buffett (1996) expressed his view that it is important to know one's investing "circle of competence" and invest in what one understands and avoid what one does not understand. Commodities will be within the circle of competence of some investors and outside of the circle of competence of others. For instance, some investors will have a good feel for what commodity income and price returns will be over the next 10 years. The appeal of commodities for investors is unlikely to reside in easy misperceptions that commodities are an inflation hedge, a portfolio diversifier or a source of a risk transfer risk premium. As Charlie Munger mentioned to Howard Marks on the subject of being a successful investor, "It's not supposed to be easy. Anyone who thinks so is stupid". The last decade of poor commodity performance has not changed the fact that commodity total returns are driven by price and income returns. Going forward, we hope that our research helps investors conquer some key misperceptions about investing in commodities, and by conquering these misperceptions to avoid the mistakes of the past.

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Endnotes

[i] Often a reference to "investing in commodities" means "investing in a portfolio of collateralized commodity futures". A collateralized commodity portfolio could consist of commodity futures, or swaps, and collateral (T-bills, notes and bonds are common choices).

[ii] The Bloomberg Commodity Index (Bloomberg total return ticker: BCOMTR) was originally called the Dow Jones AIG Commodity Index and later called the Dow Jones UBS Commodity Index.

[iii] Exhibit 1 decomposes the total return of the S&P 500, the Barclays U.S. Aggregate Bond Index, the S&P GSCI and the Bloomberg Commodity Index (the two most popular investable commodity indices that existed in 2004) into price and income returns. For stocks the majority of returns came from price return, for bonds the majority of returns came from income returns and for commodities price and income returns were both significant return drivers. Obviously this sort of historical return decomposition does not forecast what future price and income returns will be. However, for practitioners, it will be hard to be precise about future total returns without being precise about future price and income returns. It is possible to argue that for any given actual total return there are an infinite number of expected price and income return pairs that would yield the actual return. However, there is only one pair of actual price and income returns that would produce the actual total return.

[iv] See Koijen, Moskowitz, Pedersen and Vrugt (2015) and Bhansali, David, Dorsten and Rennison (2015). Asness, Ilmanen, Pedersen and Israel (2015) refer to carry returns as "the return achieved if prices do not change".

[v] The total return of the S&P GSCI commodity index is the return of a collateralized (with three-month U.S. Treasury bill) futures portfolio**.** The Bloomberg tickers for the various S&P GSCI indices we use in this paper are: SPGSCITR (S&P GSCI Total Return Index), SPGSCIP (S&P GSCI Excess Return Index) and SPGSCI (S&P GSCI Spot Index)

[vi] Commodity index creators usually provide total return, price return and excess return indices. For instance, the "S&P GSCI Index Methodology" notes that "in order to reflect the performance of a total return investment in commodities, four separate but related indices have been developed based on the S&P GSCI — (1) the S&P GSCI Spot Index, which is based on price levels of the contracts included in the S&P GSCI; (2) the S&P GSCI Excess Return Index (S&P GSCI ER), which incorporates the returns of the S&P GSCI Spot Index as well as the discount or premium obtained by "rolling" hypothetical positions in such contracts forward as they approach delivery; (3) the S&P GSCI Total Return Index (S&P GSCI TR), which incorporates the returns of the S&P GSCI ER and interest earned on hypothetical fully collateralized contract positions on the commodities included in the S&P GSCI".

[vii] It may be worth pointing out that in addition to roll returns it is possible to look at roll yields. Roll returns can be different from roll yields. Roll returns are embedded in the after-the-fact excess returns that investors receive from a futures strategy over a given period of time. Roll yields are a measure of the steepness of a futures term structure at a given point in time. For a given futures strategy, such as the S&P GSCI, there is a unique roll return. There is nothing unique about a roll yield since there is no unique definition of a roll yield. Term structure steepness can be measured over different term structure time spans, for instance over three months or one year, and on different dates.

[viii] The S&P GSCI methodology document is about 70 pages long and the Bloomberg Commodity Index methodology document is about 100 pages long. See S&P GSCI Index Methodology (2016) and Bloomberg Commodity Index Methodology (2016).

[ix] The price return is the return of a published price index. This price index is not investible. Depending on the index, the price return may be a "spot" price return or some other price return. In the context of a commodity futures index, price return may be well defined but there is typically no well-defined "spot" price.

[x] Open interest is the number of derivative contracts (futures, options, etc.) outstanding at any given time. The value of open interest is the number of open derivative contracts times the price of the contracts.

[xi] For the two indices, the correlation of rolling ten year total returns was about 0.95, the correlation of rolling ten year price returns was about 0.97, the correlation of rolling income returns was about 0.99 and the correlation of rolling roll returns was about 0.99. Rolling ten year price returns were excluded from the exhibit to cut down on clutter.

[xii] The Bloomberg Commodity Index may benefit from a rebalancing return (see Erb and Harvey (2006)) though "may" does not mean "did" or "will".

[xiii] Arnott, Chaves, Gunzberg, Hsu and (2014) examine the performance of three commodity indices (the S&P GSCI, the Bloomberg Commodity index and a Research Affiliates commodity index) and find that price returns were fairly similar though roll, income returns, varied amongst indices.

[xiv] A challenge with comparing the out-of-sample/since-going-live performance of many commodity indices is that the common time span for "old" and "new" commodity indices is dictated by the common start date of the index with the shortest live performance history. Brightman, Li and Liu (2015) expresses a view that "new" ETFs have backtested returns that look attractive but have average out-of-sample performance.

[xv] Also see Harvey and Liu (2015).

[xvi] Erb and Harvey (2006) suggested that equally weighting a portfolio of commodity futures might have boosted returns by about 4% per year. This result was sample dependent upon the choice of commodities, the volatilities of the individual commodities and the correlations of the commodities with one another. In general, the rebalancing return should increase as the volatility of commodities rises and the correlations fall. Willenbrock (2011), Hallerbach (2014), Granger, Greenig, Harvey, Rattray and Zou (2014) explore instances under which rebalanced portfolio returns differ from buy and hold portfolio returns. Some commodity indices seek to boost price returns by capturing a common smart beta rebalancing return, though as Ilmanen and Maloney (2015) note "rebalancing is not a surefire winner: the return impact will always depend on investment outcomes".

[xvii] Gorton and Rouwenhorst's (2006) paper portfolio had an average annualized excess return of about 5% per year. They suggest that Keynes' "Theory of Normal Backwardation" provides an explanation for this return, as risk averse hedgers find an invisible hand market clearing price for hedging insurance. It is important to realize that there is nothing formal about this assumed commodity price insurance market. It is not like the markets for automobile, homeowners or specialty insurance coverage, such as those offered by Lloyd's of London. Asness (2015) refers to the issue of "who is on the other side" of a trade", "whose money are you taking"? Commodity investors who expect a positive risk premium have to have a clear sense of where the risk premium comes from. Auto insurers know whose money they are taking, they know the price they are charging to offer insurance and they know why they are getting the price they are charging. Investors who subscribe to the Theory of Normal Backwardation generally have no idea whose money they are taking, do not know who is on the other side of the trade and know little if anything about whether the "insurance" they have sold is attractively priced for the buyer or the seller. Real insurance companies do not rely on the invisible hand to properly price insurance policies yet the Theory of Normal Backwardation is a popular framework among some investors because it suggests they can participate in a profitable insurance operation without knowing anything about insurance.

[xviii] Norrish notes that the Gorton and Rouwenhorst (2006) paper portfolio allocates as much to butter as to crude oil, though the butter futures market is miniscule relative to the oil futures market. Another nuance is that when investors interact with markets, they affect prices. When a paper portfolio pretends to interact with markets, it does not affect prices.

[xix] Depending upon personal perspective, it is possible to dismiss this result since a 0.73 correlation (R-square 0.54) may not seem very high. There are certainly some econometric objections: omitted variable bias (we know that total return consists of price return and income return, yet total return is only regressed on income return) and a host of issues associated with using overlapping returns (the return history of the S&P GSCI goes back 40+ years, that leads to only four non-overlapping 10 year data points, yet Exhibit 4 plots over 400 overlapping data points). However, even if the data are sampled at different intervals, the message is the same: income returns have been the key driver total return variability.

[xx] We also looked at two other ways to measure the statistical linkage between 10-year price returns and 10-year total returns. In the first approach, we calculated the correlation of 10-year non-overlapping price returns with 10-year non-overlapping total returns. Doing this we first calculated non-overlapping returns starting in January 1970, then we repeated the process for February 1970 and then all the way up to June of 1975. This meant that we covered all end dates from January 2010 to June 2015. This resulted in 66 estimated correlations using non-overlapping returns. The average correlation was about -0.30, lower than the -0.07 correlation reported in Exhibit 3. In this case going from overlapping return correlations to non-overlapping return correlations lowered the measured price return-total return correlation. Next we looked at the correlation of price returns adjusted for the influence of income returns. Using the "residual" price return from this calculation the correlation between total return and "residual price return" was 0.62. Adjusting price returns for the impact of income returns increased the correlation from -0.07 to 0.62. In this sense what investors needed to know was not the existence of possible, but unknown before and after the fact, economic regimes. Rather what they needed to know about was the Croesus effect, the

question they should have asked the oracle had there been any reason to believe that the oracle's answer would be truthful but nuanced or if the oracle's interpretation of the question that was asked was different from the question that was actually asked.

[xxi] Actual inflation = expected inflation + unexpected inflation.

[xxii] Whether investors believe commodities are supposed to hedge realized inflation over some time period, expected inflation at the beginning of some time period or unexpected inflation (the difference between realized and expected inflation) is never completely clear. One of the reasons is that while it is easy to measure realized inflation there seem to be a number of definitions of expected and unexpected inflation. Gorton and Rouwenhorst suggested that "because commodity futures are a bet on commodity prices, they are directly linked to the components of inflation", mention that commodities "are positively correlated with inflation, unexpected inflation, and changes in expected inflation", use "the 90-day T-bill yield as our measure of expected inflation", and proxied unexpected inflation "as the actual inflation rate minus the nominal interest rate". Greer (2000) suggests that commodities are positively correlated with "unexpected changes in inflation", which he proxied with one year changes in realized inflation. Bhardwaj, Hamilton and Ameriks (2011) used a Hodrick-Prescott filter to proxy unexpected inflation and suggested that "commodity futures have historically provided returns that tend to rise with unexpected inflation". The fact that unexpected inflation was proxied in three different ways highlights that there is no single measure of unexpected inflation. Feynman's observation that "you cannot prove a vague theory wrong" suggests that vague proxies of unexpected inflation make it difficult to reject a linkage with commodity returns.

[xxiii] Chaves (2014) took a strategic approach and noted that "Commodities have special characteristics that make them ideal candidates to receive at least a small allocation in every investor's portfolio".

[xxiv] See Gregory Meyer and John Authers, "Investment: Revaluing Commodities"

[xxv] As of October 2015.

[xxvi] Macro-consistency is an interesting idea. However it may not be easy to agree on the size of an investment opportunity. For instance PIMCO (2015) observes that "bonds have evolved into a $100 trillion global marketplace", twice the size of the Barclays Multiverse.

[xxvii] See Norrish, Kevin. 2015. "Commodity Investor", Barclays research, October 2, 2015. Also, see CFTC data available at http://www.cftc.gov/marketreports/indexinvestmentdata/index.htm.