Quantitative Portfolio Strategy

Commodity Futures and Inflation

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INTRODUCTION

It is a common belief that commodity futures can be used as a hedge against inflation. Numerous market commentators connect the recent rise in prices of gold, crude oil, and various other commodities to increased fears of high future inflation. Given the growing investor interest and exposure to commodities, it is important to understand the empirical basis for such claims.

In this paper, we present some empirical evidence on the connection between commodities and inflation. Using historical prices on twenty commodity futures covering a period from 1988 to early 2008,[1] we estimate correlations between futures returns and several inflation measures. We find that most commodity futures exhibit very weak correlation with several core inflation measures. Energy commodities have somewhat higher correlation with the total Consumer Price Index (CPI), which is due to the effect of volatile energy prices on the CPI level. We conclude that the average correlation between various commodities and overall price inflation is very low.

In addition to realized inflation, we investigate the relationship between commodity prices and changes in inflation expectations. Realized historical inflation can be decomposed into a sum of expected inflation and inflation shocks. Commodity futures may provide an inflation hedge partly because of the contemporaneous correlation of their returns with inflation shocks, which we document in the first part of our analysis. A long-horizon investor may further benefit from commodity futures returns' being correlated with changes in inflation trends, or changes in expected future inflation. Suppose an investor cares only about the total realized inflation at the end of a long investment horizon. Assume that this investor holds a long position in commodity futures. Moreover, suppose that futures returns are positively correlated with changes in inflation expectations. Specifically, realized futures returns tend to be positive when expectations of long-run inflation trends rise. Consider a scenario in which inflation expectations increase initially. This is a negative event from the point of view of the investor, because the total inflation realized over the investor's horizon is likely to be higher. However, the futures returns during this initial period are likely to be positive, partly mitigating the effect of the negative inflation news.

Given that changes in inflation trends are not directly observable, we use an empirical proxy for inflation expectations derived from market prices. Specifically, we use prices of Treasury Inflation-Protected Securities (TIPS) and nominal Treasuries. Because the cash flows of inflation-protected bonds are tied to the CPI, the difference in yields between a zero-coupon TIPS and a maturity-matched nominal Treasury, called break-even inflation, reflects investors' expectations of future inflation. TIPS prices can be observed daily, so we are able to estimate the relationship between futures returns and

[1] *This choice of the sample period is motivated by our desire to have a sample of inflation data free of structural breaks due to changes in monetary policy. Thus, we focus on the post-Volcker period between January 1988 and February 2008. The period prior to 1988 corresponds to a different monetary policy regime (Bernanke and Mihov, 1998).*

inflation expectations using relatively narrow observation windows and, thus, document how these correlations change over time.

We find that the relationship between commodity prices and inflation expectations is not constant during the sample period of 1997-2008. In particular, many commodities show increased correlation with inflation expectations over the past two years. This evidence confirms that there are times when commodity prices do have a significant connection to inflation expectations. However, an investor in commodities must pay close attention to the prevailing market conditions, because this relationship is unstable and, historically, has been rather weak on average.

HISTORICAL INFLATION AND COMMODITY FUTURES

First, we document the empirical relationship between various measures of inflation and futures returns.

Data

Our analysis covers twenty futures contracts listed in the following table.

Figure 1. Commodity Futures

Symbol	Commodity and the Exchange	Beginning of the Sample
ALUM	Aluminum-High Grade (LME)	Feb-99
BO	Soybean Oil (CBOT)	Apr-68
C	Corn (CBOT)	Jun-68
CL	Crude Oil-West Texas Interm (NYMEX)	Apr-83
COPPER	Copper (LME)	Feb-99
CT	Cotton-No. 2 (NYBOT)	Sep-72
GC	Gold (COMEX)	Jan-75
HO	Heating Oil (NYMEX)	Apr-79
HU	Gasoline (NYMEX)	Dec-84
KC	Coffee-C (NYBOT)	Sep-72
LC	Live Cattle (CME)	Mar-76
LH	Lean Hogs (CME)	Feb-69
NG	Natural Gas-Henry Hub (NYMEX)	Apr-90
NICKEL	Nickel-Primary (LME)	Feb-99
S	Soybean (CBOT)	Jul-59
SB	Sugar-World No. 11 (NYBOT)	Jan-61
SI	Silver (COMEX)	Sep-64
SM	Soybean Meal (CBOT)	Apr-68
W	Wheat-Chicago (CBOT)	Jul-59
ZINC	Zinc-High Grade (LME)	Feb-99

The series for gasoline futures corresponds to the HU contracts before 01/01/2007 and to the RB.UNL contracts after that, both traded on NYMEX.

Source: Lehman Brothers.

We consider four month-to-month seasonally adjusted inflation series based on: the total CPI; CPI less food and energy; median CPI; and 16% trimmed mean CPI, constructed by the Federal Reserve Bank of Cleveland.[2] The first of these captures changes in the Consumer Price Index for all urban consumers, which accounts for both inflation and relative price changes of various consumption goods. The other three series are measures of core inflation, designed to capture trends in the CPI inflation and minimize the effect of transient price changes of various CPI components. The most commonly used measure of core inflation is based on the CPI without its food and energy components. This measure has shortcomings, and several competing methods for constructing core inflation measures have been proposed. We consider two notable alternative core inflation measures: the median CPI and the 16% trimmed mean CPI series. Our inflation data sample covers the post-Volcker period between January 1988 and February 2008.

For each futures contract, our sample includes the entire period during which this contract has been traded.

Methodology

The analysis is based on monthly futures returns and monthly inflation rates. We construct a daily return series

$$r^{day}(t) = \frac{F_2(t)}{F_2(t-1)} - 1$$

where $F_2(t)$ denotes the closing price of the second-to-maturity contract on trading day t. For each month m we construct a monthly return

$$r^{month}(m) = \left(1 + r^{day}(1)\right)\left(1 + r^{day}(2)\right)\cdots\left(1 + r^{day}(T)\right) - 1$$

where $r^{day}(n)$ denotes the daily return on the n-th day of month m and T is the total number of trading days in the current month.[3] π^{month} denotes monthly inflation.

We estimate inflation exposure of various commodities by regressing multi-period futures returns on contemporaneous inflation shocks. We assume that futures returns are correlated mostly with the *unexpected* component of inflation and focus on inflation shocks instead of the total inflation rate. While futures prices may adjust in response to inflation news, the anticipated component of inflation should not generate sudden changes in futures prices. As a result, the average (unconditional) correlation between futures returns and inflation may be affected by the expected component of inflation only

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[2] We use revised series for median CPI and 16% trimmed mean CPI. The Federal Reserve Bank of Cleveland provides the following definitions of these two inflation measures:
"The trimmed mean removes from overall CPI inflation all large relative price changes in each month, with the set of excluded components changing from month to month. In particular, the trimmed mean excludes the percent changes in price that rank among the smallest or largest (in numerical terms) changes for the month. Both small and large percent changes represent large price movements relative to the average for the month."
"The median CPI trims all but the midpoint of the distribution of price changes. If, for example, the overall price index included 100 components with equal relative importance, the median CPI would simply be the 50th largest percent change in price. The statistical and economic rationale for the median CPI is the same as for the trimmed mean."
Further information can be found on http://www.clevelandfed.org/research/inflation/us-inflation/cpi.cfm
[3] We compute monthly returns only for the months with at least ten daily return observations.

if expected returns on the futures are correlated with the expected inflation rate, i.e., if futures returns are predicted by the expected inflation. The quantitative effect of futures return predictability is likely to be secondary compared with the contemporaneous correlation between futures returns and inflation shocks.

We estimate inflation shocks using a univariate time-series model. Let H denote the observation interval used to measure inflation shocks and futures returns. For example, when $H = 12$, we are measuring returns and inflation over a one-year interval, and correlation estimates reflect the relationship between them over a one-year horizon.

We define the average monthly return and the average monthly inflation over an H-month interval according to the same formula

$$x_{average}^{H,month}(m) = \left[\left(1 + x^{month}(m)\right)\left(1 + x^{month}(m+1)\right)\cdots\left(1 + x^{month}(m+H)\right)\right]^{\frac{1}{H}} - 1$$

The above equation can be used to define the H-month average of returns, $r_{average}^{H,month}(m)$, or the H-month average of inflation, $\pi_{average}^{H,month}(m)$, starting from month m. In order to separate realized inflation over an H-month interval into the expected and unexpected part (the shock), we estimate a predictive model for inflation. The shock is defined as the difference between realized inflation and the inflation forecast based on prior history. Specifically, we use the average realized inflation over the most recent twelve-month period as a predictor of average inflation during the following H months. Our forecasting model for inflation is

$$\pi_{average}^{H,month}(m) = a + b \times \pi^{12,month}(m-12) + \varepsilon^{H,month}(m)$$

We define inflation shocks as the residual in the forecasting model:

$$\pi_{shock}^{H,month}(m) = \varepsilon^{H,month}(m)$$

We evaluate the degree of exposure of commodity futures to inflation by regressing futures returns on inflation shocks

$$r_{average}^{H,month}(m) = a + b \times \pi_{shock}^{H,month}(m) + u^{H,month}(m)$$

The left-hand side of this equation is the average futures returns over an H-month interval. On the right-hand side is the average inflation shock over the same H-month period.

Results

Figure 2 summarizes the properties of the four inflation series over a twelve-month horizon ($H = 12$).

The R-squared numbers in Figure 2 record the fraction of realized inflation variance explained by the forecasting variable, i.e., the past twelve-month average inflation. A high R-squared implies that the inflation series has high persistence, and therefore the expected component accounts for a significant portion of realized inflation. The standard deviation of the residual measures the volatility of inflation shocks.

The three core inflation series exhibit much higher persistence than the total CPI series, which is consistent with the latter being affected by transient relative price shocks.

Figure 3 summarizes the relationship between futures returns and contemporaneous inflation shocks. In addition to statistical significance, one should also pay attention to *economic* significance of the estimated relationships. In particular, an investor should care about the explanatory power of inflation shocks—commodity futures can be considered a hedge against inflation only if inflation shocks account for a sufficiently high fraction of the futures return variance. The latter is measured by the R-squared numbers. High values of the R-squared imply that the commodity provides a useful hedge against inflation shocks. The quality of the hedge may be further improved by constructing a portfolio of futures with relatively high R-squared values and relatively low correlation with each other. Such a portfolio would benefit from diversification, yielding an even better hedge against inflation than any of its components.

We see a striking difference between the results for the total CPI and various core CPI series. Shocks to the total CPI have a significant positive effect on energy commodities and livestock futures. Industrial and precious metals, as well as agricultural commodities, have insignificant coefficients. In contrast, when we switch to inflation numbers based on the CPI without food and energy or to median CPI inflation, only the coefficient for lean hogs futures is positive and significant. Energy futures retain significance when we use the 16% trimmed CPI measure. Moreover, the effect of core inflation shocks on commodity futures tends to have little economic significance.

Figure 2. Inflation Series

Inflation Series	b	Standard Error (b)	R-squared	Std (Residual)
CPI	0.37	0.19	0.16	0.08
CPI Less Food and Energy	0.78	0.14	0.70	0.04
Median CPI	0.63	0.16	0.52	0.04
16% Trimmed CPI	0.73	0.14	0.68	0.03

Regression coefficients of the inflation forecasting model are estimated using OLS.4 The forecast horizon is twelve months. Inflation is expressed in percent.

Source: Lehman Brothers

[4] *Robust Newey-West standard errors are computed using 18 lags.*

A natural explanation for these findings is that the energy commodities are included in the CPI. The volatility of energy prices increases sensitivity of returns on the energy commodities to CPI changes. The resulting estimates are potentially misleading, since shocks to energy prices have been largely transient historically and did not necessarily reflect the overall price inflation. In line with this view, Figure 3 shows that most of the other commodities have no exposure to CPI inflation shocks. Moreover, once we switch to core inflation series to remove some of the effect of transient relative price changes within the consumption basket, energy commodities lose their exposure to inflation shocks.

Figure 3. Sensitivity of Futures Returns to Inflation Shocks

Inflation series		ALUMINUM	BO	C	CL	COPPER	CT	GC	HO	HU	KC
CPI	b	5.55	-0.08	-2.19	22.53	10.76	7.19	1.53	24.19	21.99	1.09
	Standard Error (b)	4.02	2.46	2.87	5.33	6.04	4.26	2.37	4.79	5.01	5.06
	R-squared	0.11	0.00	0.01	0.40	0.10	0.07	0.01	0.47	0.44	0.00
CPI less food and energy	b	9.11	-4.06	-2.96	5.32	22.72	0.77	-3.91	8.49	6.85	-5.21
	Standard Error (b)	5.73	6.63	4.14	7.20	12.35	9.52	3.66	8.73	6.84	8.39
	R-squared	0.08	0.01	0.01	0.01	0.12	0.00	0.03	0.02	0.01	0.00
Median CPI	b	0.42	-0.85	1.66	-6.81	10.38	2.61	-3.58	-0.37	-0.12	-10.45
	Standard Error (b)	6.87	9.20	4.89	9.00	14.93	10.90	4.75	10.95	8.86	13.12
	R-squared	0.00	0.00	0.00	0.01	0.03	0.00	0.02	0.00	0.00	0.01
16% trimmed CPI	b	11.36	-0.86	1.52	31.31	24.45	8.11	0.42	37.93	32.77	-4.61
	Standard Error (b)	9.45	7.24	5.81	9.65	17.89	9.06	5.42	10.53	9.42	12.97
	R-squared	0.09	0.00	0.00	0.17	0.10	0.02	0.00	0.25	0.21	0.00

Inflation series		LC	LH	NG	NICKEL	S	SB	SI	SM	W	ZINC
CPI	b	3.52	7.01	29.50	-2.72	-2.94	9.83	-5.48	-3.72	-4.00	4.85
	Standard Error (b)	1.80	3.09	10.18	10.75	2.59	5.38	3.09	2.99	4.74	9.58
	R-squared	0.08	0.09	0.18	0.00	0.02	0.09	0.07	0.02	0.02	0.02
CPI less food and energy	b	1.30	12.42	-25.69	27.18	-15.58	3.41	-6.83	-16.50	-19.73	25.37
	Standard Error (b)	3.79	4.32	23.17	28.70	6.12	8.25	6.84	5.86	4.91	15.82
	R-squared	0.00	0.09	0.04	0.03	0.15	0.00	0.04	0.15	0.17	0.13
Median CPI	b	-3.47	10.12	-35.09	35.97	-16.02	6.02	-8.06	-16.66	-12.04	13.52
	Standard Error (b)	4.52	6.24	26.37	43.40	8.22	10.49	7.46	6.95	7.88	18.24
	R-squared	0.02	0.04	0.07	0.06	0.12	0.01	0.04	0.12	0.05	0.04
16% trimmed CPI	b	5.12	21.56	26.84	49.74	-10.41	16.59	-9.50	-11.36	-14.36	21.25
	Standard Error (b)	3.99	6.76	29.47	42.55	7.44	11.86	7.12	8.23	9.21	17.62
	R-squared	0.03	0.18	0.03	0.08	0.05	0.06	0.05	0.05	0.06	0.06

Regression coefficients of twelve-month average monthly futures returns on shocks to twelve-month average monthly inflation. Coefficients are estimated using OLS.[5] *Highlighted coefficients are statistically significant at the 5% level. R-squared numbers are highlighted if they exceed 0.2. Inflation and returns are expressed in percent.*

Source: Lehman Brothers

[5] *Robust Newey-West standard errors are computed using 18 lags.*

Based on our historical analysis, we must conclude that there is little reason to believe that commodity futures provide a useful hedge against inflation. There are, however, a few caveats.

None of the core inflation series we use are perfect measures of true inflation. Thus, it is conceivable that the negative results are partly based on the limitations of these measures. However, given that only the energy group seems to have positive exposure to total CPI inflation shocks, the negative findings across the entire spectrum of commodities are probably not determined by the details of the core CPI construction.

We are measuring futures' sensitivity to inflation shocks over a relatively short horizon of twelve months. This horizon choice is dictated by data limitations. A long-horizon investor may care about the ability of commodity futures to hedge inflation over ten years or more. To the extent that the core inflation measures do not capture long-run inflation trends with perfect precision, it is difficult to discern a low-frequency pattern from historical series covering only twenty years. It is conceivable that while futures returns are not related to inflation shocks, they are related to shocks to expected inflation, or to long-run inflation trends. If true, this would make futures a valuable instrument for a long-horizon investor.

We are implicitly assuming that the relationship between commodity futures and inflation remains stable over time. It is possible, however, that while the relationship between commodity prices and inflation is rather weak on average, there are periods when the two become much more correlated. For example, while energy price shocks have been mostly transient, one may argue that the run-up in crude oil price during the past few years has been partly permanent. Thus, our conclusions apply only in the absence of regime shifts in the data.

In the next section, we address the second and third points above using a measure of inflation expectations instead of the historically observed inflation series.

INFLATION EXPECTATIONS AND COMMODITY FUTURES

In this section, we document the relationship between commodity futures and inflation expectations. Since expectations are not observed directly, we need an empirical proxy. Our analysis relies on the breakeven inflation rate (BEI) extracted from the prices of TIPS and maturity-matched nominal Treasuries. Specifically, we use the 10-year TIPS-derived expected inflation series constructed by the Federal Reserve Bank of Cleveland, which starts on February 3, 1997.

The break-even inflation rate is not a perfect proxy for inflation expectations. In addition to inflation expectations, it is affected by inflation risk premium, inflation risk, liquidity premium, and the compounding effect.[6] Thus, when interpreting regression results, one must keep in mind that the relationship between break-even inflation and futures returns might be affected by factors unrelated to inflation expectations. As a result, one cannot unambiguously attribute the empirically observed patterns to inflation expectations alone. However, this may not be a critical issue from the perspective of an investor concerned about long-term inflation risk, because he may also benefit from a hedge against changes in inflation risk and risk premium.

We define an H -day change in break-even inflation (BEI) as

[6] *See Lerkhof (2005, Sec. 4.5).*

$$\Delta BEI^{H,day}(t) = BEI(t+H-1) - BEI(t-1)$$

We estimate a forecasting model for break-even inflation

$$\Delta BEI^{H,day}(t) = a + b1 \times BEI(t-1) + b2 \times \Delta BEI^{H,day}(t-H) + \varepsilon^{H}(t)$$

and define break-even inflation shocks as

$$BEI^{H,day}_{shock}(t) = \varepsilon^{H,day}(t)$$

Estimated parameters of the forecasting model are reported in Figure 4.

We estimate the relationship between commodity futures and shocks to break-even inflation by regressing futures returns over H-day periods on contemporaneous break-even inflation shocks. Specifically, we define the H-day cumulative futures return as

$$r^{H,day}(t) = \big(1+r(t)\big)\big(1+r(t+1)\big)\cdots\big(1+r(t+H)\big) - 1$$

and regress it on changes in break-even inflation

$$r^{H,day}(t) = a + b \times BEI^{H,day}_{shock}(t) + \varepsilon^{H,day}(t)$$

We report our results for the five-day and twenty two-day horizons in Figures 5a, b and 6a, b, respectively.

Figure 4. Shocks to Break-Even Inflation

H	b1	Standard Error (b1)	b2	Standard Error (b2)	R-squared	Std (Residual)
5	-0.02	0.01	-0.07	0.04	0.02	0.09
22	-0.10	0.03	-0.02	0.07	0.07	0.18

Changes in break-even inflation are forecasted at a five-day and twenty two-day horizon (H=5 and H=22).[7] *Highlighted coefficients are statistically significant at the 5% level. Break-even inflation is expressed in percent.*

Source: Lehman Brothers.

[7] *Robust Newey-West standard errors are computed using 8 and 33 lags, respectively.*

Figures 5 and 6 illustrate a clear pattern: the effect of break-even inflation shocks on futures prices increased dramatically during the last two years in the sample, compared with the previous nine years. Gold futures are a striking example. The explanatory power of break-even inflation shocks is under 2% during the first nine years, with none of the estimated regression coefficients significant at conventional levels. In contrast, during the last two-year period, the explanatory power is 25% at the twenty-two day horizon, and the regression coefficient is highly significant. Silver futures behave similarly. This pattern of recently increased correlation with break-even inflation shocks is also observed for energy commodities and industrial metals. We do not observe the same effect among agricultural and livestock futures.

Figure 5a. Futures Sensitivity to Breakeven Inflation Shocks

	Beginning of period	**2/3/1997**	**5/5/1999**	**8/14/2001**	**10/28/2003**	**1/3/2006**
	End of period	**5/4/1999**	**8/13/2001**	**10/27/2003**	**12/30/2005**	**3/13/2008**
	Std of BEI shocks	**0.12**	**0.11**	**0.09**	**0.06**	**0.05**
Symbol						
ALUMINUM	b		0.62	3.50	5.76	**21.94**
	Standard Error (b)		1.42	1.93	3.13	5.24
	R-squared		0.00	0.03	0.02	0.10
BO	b	-0.30	-0.40	1.39	1.22	**17.70**
	Standard Error (b)	1.75	1.83	2.82	5.00	4.73
	R-squared	0.00	0.00	0.00	0.00	0.08
C	b	5.31	3.55	4.06	-1.23	**10.16**
	Standard Error (b)	1.68	2.27	2.39	4.03	4.51
	R-squared	0.05	0.01	0.01	0.00	0.01
CL	b	1.79	**10.02**	7.68	**10.97**	**34.90**
	Standard Error (b)	2.69	3.07	4.93	4.52	3.99
	R-squared	0.00	0.06	0.02	0.03	**0.22**
COPPER	b		0.13	**5.34**	6.75	**20.50**
	Standard Error (b)		1.79	2.29	3.98	5.63
	R-squared		0.00	0.04	0.02	0.05
CT	b	-0.83	2.81	-1.67	**8.87**	**13.72**
	Standard Error (b)	1.09	1.60	3.15	3.82	5.38
	R-squared	0.00	0.01	0.00	0.02	0.05
GC	b	2.16	-1.08	-1.71	-1.88	**20.40**
	Standard Error (b)	1.27	1.31	1.45	2.27	3.45
	R-squared	0.02	0.00	0.01	0.00	0.13
HO	b	0.26	**7.18**	7.79	9.52	**35.71**
	Standard Error (b)	2.41	2.93	4.86	5.04	4.37
	R-squared	0.00	0.03	0.02	0.02	**0.22**
HU	b	-0.19	**9.42**	8.97	**13.23**	**33.33**
	Standard Error (b)	2.29	3.30	4.73	5.30	6.14
	R-squared	0.00	0.05	0.02	0.03	0.15
KC	b	6.41	**7.30**	5.88	**11.26**	**12.48**
	Standard Error (b)	3.21	3.58	4.15	4.37	5.69
	R-squared	0.02	0.02	0.01	0.02	0.03

Regression of futures returns on contemporaneous break-even inflation shocks. Returns and inflation shocks are computed over a five-day horizon (H=5).[8] *Highlighted coefficients are statistically significant at the 5% level. R-squared numbers are highlighted if they exceed 0.2. Inflation and returns are expressed in percent. Source: Lehman Brothers.*

[8] *Robust Newey-West standard errors are computed using 8 lags.*

Figure 5b. Futures Sensitivity to Breakeven Inflation Shocks

	Beginning of period	**2/3/1997**	**5/5/1999**	**8/14/2001**	**10/28/2003**	**1/3/2006**
	End of period	**5/4/1999**	**8/13/2001**	**10/27/2003**	**12/30/2005**	**3/13/2008**
	Std of BEI shocks	**0.12**	**0.11**	**0.09**	**0.06**	**0.05**
Symbol						
LC	b	1.22	-0.48	2.97	-1.00	-0.24
	Standard Error (b)	1.10	0.81	1.54	3.42	2.72
	R-squared	0.01	0.00	0.02	0.00	0.00
LH	b	5.34	1.72	-3.70	**6.85**	-2.12
	Standard Error (b)	2.78	1.74	2.80	3.28	5.01
	R-squared	0.02	0.00	0.01	0.02	0.00
NG	b	-1.62	-5.82	**14.49**	**13.48**	**29.42**
	Standard Error (b)	3.84	5.05	5.97	6.07	8.86
	R-squared	0.00	0.01	0.03	0.02	0.05
NICKEL	b		3.91	**8.53**	**13.69**	**24.27**
	Standard Error (b)		2.74	3.25	6.71	8.73
	R-squared		0.01	0.03	0.03	0.04
S	b	2.26	1.33	3.92	2.90	**10.14**
	Standard Error (b)	1.74	1.72	2.41	4.91	4.36
	R-squared	0.01	0.00	0.02	0.00	0.03
SB	b	3.22	-1.59	3.39	-2.90	**14.29**
	Standard Error (b)	2.48	2.65	3.38	3.78	6.78
	R-squared	0.01	0.00	0.01	0.00	0.03
SI	b	3.26	2.31	-0.47	-0.68	**37.50**
	Standard Error (b)	2.40	1.30	1.87	4.91	6.70
	R-squared	0.01	0.01	0.00	0.00	0.14
SM	b	4.95	2.45	5.49	2.55	1.81
	Standard Error (b)	2.34	1.85	2.96	4.99	4.65
	R-squared	0.02	0.01	0.02	0.00	0.00
W	b	5.39	**4.19**	4.79	1.73	2.84
	Standard Error (b)	1.73	1.78	2.83	3.92	5.95
	R-squared	0.04	0.02	0.01	0.00	0.00
ZINC	b		-0.11	**5.14**	**8.60**	**26.95**
	Standard Error (b)		1.60	1.86	3.10	7.49
	R-squared		0.00	0.04	0.03	0.05

Regression of futures returns on contemporaneous break-even inflation shocks. Returns and inflation shocks are computed over a five-day horizon (H=5).[9] Highlighted coefficients are statistically significant at the 5% level. R-squared numbers are highlighted if they exceed 0.2. Inflation and returns are expressed in percent.

Source: Lehman Brothers.

[9] *Robust Newey-West standard errors are computed using 8 lags.*

Figure 6a. Futures Sensitivity to Breakeven Inflation Shocks

	Beginning of period	**2/3/1997**	**5/5/1999**	**8/14/2001**	**10/28/2003**	**1/3/2006**
	End of period	**5/4/1999**	**8/13/2001**	**10/27/2003**	**12/30/2005**	**3/13/2008**
	Std of BEI shocks	**0.22**	**0.21**	**0.16**	**0.12**	**0.09**
Symbol						
ALUMINUM	b		2.26	**5.71**	4.42	**32.51**
	Standard Error (b)		3.65	2.39	7.22	12.07
	R-squared		0.01	0.07	0.01	**0.21**
BO	b	-4.16	-4.90	-2.24	3.08	**34.19**
	Standard Error (b)	4.44	3.37	5.34	9.96	5.70
	R-squared	0.03	0.04	0.00	0.00	**0.28**
C	b	6.47	3.22	3.70	4.41	1.74
	Standard Error (b)	2.72	4.24	5.50	8.23	10.41
	R-squared	0.07	0.01	0.01	0.01	0.00
CL	b	3.03	**13.90**	**22.85**	1.73	**41.82**
	Standard Error (b)	5.30	6.11	9.52	8.79	12.01
	R-squared	0.00	0.12	0.12	0.00	**0.24**
COPPER	b		0.20	**8.59**	2.32	**51.37**
	Standard Error (b)		3.52	3.14	6.72	14.78
	R-squared		0.00	0.09	0.00	0.20
CT	b	-2.86	5.29	4.32	8.77	20.39
	Standard Error (b)	1.46	4.77	9.01	7.74	11.25
	R-squared	0.02	0.03	0.01	0.02	0.09
GC	b	-0.77	0.87	3.39	-0.88	**30.90**
	Standard Error (b)	1.91	2.57	2.50	4.71	8.81
	R-squared	0.00	0.00	0.02	0.00	**0.25**
HO	b	-1.10	8.60	**24.92**	1.76	**45.12**
	Standard Error (b)	4.75	5.29	10.07	8.68	11.76
	R-squared	0.00	0.04	0.13	0.00	**0.28**
HU	b	1.65	**14.08**	**26.87**	4.77	**39.96**
	Standard Error (b)	4.22	6.41	9.67	10.79	14.99
	R-squared	0.00	0.10	0.17	0.00	0.16
KC	b	20.06	**17.02**	10.66	**27.63**	5.80
	Standard Error (b)	5.31	4.06	7.23	10.64	9.99
	R-squared	0.13	0.11	0.05	0.14	0.01

Regression of futures returns on contemporaneous break-even inflation shocks. Returns and inflation shocks are computed over a twenty two-day horizon (H=22).10 Highlighted coefficients are statistically significant at the 5% level. R-squared numbers are highlighted if they exceed 0.2. Inflation and returns are expressed in percent.

Source: Lehman Brothers

[10] *Robust Newey-West standard errors are computed using 33 lags.*

Figure 6b. Futures Sensitivity to Breakeven Inflation Shocks

	Beginning of period	2/3/1997	5/5/1999	8/14/2001	10/28/2003	1/3/2006
	End of period	**5/4/1999**	**8/13/2001**	**10/27/2003**	**12/30/2005**	**3/13/2008**
	Std of BEI shocks	**0.22**	**0.21**	**0.16**	**0.12**	**0.09**
Symbol						
LC	b	2.23	-1.41	2.42	**9.60**	-4.90
	Standard Error (b)	1.85	1.70	5.16	4.66	3.86
	R-squared	0.02	0.02	0.01	0.06	0.02
LH	b	8.21	-1.49	**-16.66**	**17.87**	-9.46
	Standard Error (b)	4.55	3.35	4.77	6.07	7.05
	R-squared	0.04	0.00	0.11	0.15	0.02
NG	b	6.68	-21.46	16.77	18.83	42.90
	Standard Error (b)	5.86	18.49	15.18	14.37	24.95
	R-squared	0.01	0.06	0.03	0.02	0.10
NICKEL	b		**12.06**	**14.88**	-6.05	**49.58**
	Standard Error (b)		4.89	4.89	9.75	20.69
	R-squared		0.08	0.11	0.00	0.12
S	b	1.59	-0.11	3.58	4.35	**15.05**
	Standard Error (b)	3.56	3.68	5.38	12.82	6.83
	R-squared	0.00	0.00	0.01	0.00	0.06
SB	b	3.87	0.01	8.89	-9.34	20.04
	Standard Error (b)	4.33	4.63	7.70	7.34	11.98
	R-squared	0.02	0.00	0.03	0.02	0.04
SI	b	3.23	**3.58**	4.44	-7.77	**53.79**
	Standard Error (b)	3.60	1.72	3.47	8.51	8.91
	R-squared	0.01	0.05	0.02	0.01	**0.26**
SM	b	7.53	2.88	8.89	2.23	-0.56
	Standard Error (b)	3.43	4.30	6.89	13.90	7.52
	R-squared	0.06	0.01	0.04	0.00	0.00
W	b	4.08	4.49	1.19	8.79	3.70
	Standard Error (b)	4.58	2.56	7.01	7.92	11.95
	R-squared	0.02	0.04	0.00	0.03	0.00
ZINC	b		1.12	6.50	13.84	25.47
	Standard Error (b)		2.70	3.43	7.70	15.67
	R-squared		0.00	0.06	0.06	0.04

Regression of futures returns on contemporaneous break-even inflation shocks. Returns and inflation shocks are computed over a twenty two-day horizon (H=22).11 Highlighted coefficients are statistically significant at the 5% level. R-squared numbers are highlighted if they exceed 0.2. Inflation and returns are expressed in percent.

Source: Lehman Brothers.

It should be noted that our estimates in the early part of the sample may be affected by the lack of liquidity in the TIPS market. Another indication of this is the relatively high volatility of break-even inflation shocks during that period. The relationship between inflation expectations and futures returns can thus be obscured, with the estimated regression coefficients biased toward zero. This observation, however, does not apply to the sub-periods with relatively high liquidity in the TIPS market. Thus, we conclude that the relationship between inflation expectations and commodity futures returns is likely to be highly time-varying and has been relatively strong recently.

[11] *Robust Newey-West standard errors are computed using 33 lags.*

CONCLUSION

We have documented empirical patterns of correlation between commodity futures returns and inflation. Based on the historical sample of realized inflation of approximately twenty years, we conclude that, on average, such correlation is weak. This is particularly clear when one uses core inflation measures, which, unlike the total CPI inflation, are less affected by the volatility of relative price changes of various CPI components.

We have also shown that the break-even inflation derived from the TIPS market does exhibit a pattern of correlation with commodity futures. While, on average, this correlation is not high, it varies over time, having increased dramatically in recent years. One can debate the exact source of this correlation. It could be driven, for example, by the genuine correlation between commodity prices and inflation expectations, or it could reflect the relationship between commodity prices and inflation risk and risk premium. However, it is safe to conclude that we have recently observed a meaningful connection between commodity prices and the market's views on future inflation. We believe that this finding could be of value to a long-horizon investor interested in hedging inflation risk.

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