

# Optimal Real Return Portfolios

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Nations worldwide rapidly and meaningfully expanded their balance sheets in response to the gripping credit crisis of 2008, potentially sowing seeds of higher inflation. Whether or not these expansionary fiscal and monetary policies result in higher inflation, investors will continue to be concerned with generating consistent real returns. In our studies of inflationary and deflationary environments over the past century, we have found no single asset best suited to hedge against varying inflation regimes. Rather, we have found that a multi-asset approach provides a better hedge against inflation by providing real return with a low tracking error to inflation.

Treasury Inflation-Protected Securities (TIPS), gold, and oil are assets typically used to achieve real returns to protect against inflation. Issues associated with each of these, however, make them potentially inadequate for hedging inflation on a stand-alone basis. Specifically, the volatility of returns of these assets reduces their correlation to inflation and may limit their effectiveness as hedges. Our research shows that a combination of assets, each with varying levels of sensitivity to inflation, may provide a more-stable real return and thus be more effective. We show that a core position in short-term Treasury bills or one-month certificates of deposit (CDs) with satellite positions in longer-term bonds, gold, oil, and emerging-market equities is a better foundation for a positive real return with minimized downside inflationary risk. We also find that TIPS are minimally effective against inflation when using a group of assets. The out-of-sample performance of the real return optimizations is promising, thus forming the basis for an investable

**TABLE 1: 20-BASIS-POINT (+0.20%) INCREASE IN INTEREST RATES FOR TIPS BONDS**

Maturity (years)	Duration	% Price Change
5	4.24	-0.85%
10	8.75	-1.74%
20	15.34	-3.03%

Source: Bloomberg data as of December 9, 2009, for CUSIP #'s 912828KM, 912828LA, 912810PZ5, respectively.

inflation-protection strategy for U.S. investors.

## Single-Asset Real Returns as Inflation Hedges

TIPS were introduced in 1997 to provide protection against inflation. The TIPS principal increases with inflation and decreases with deflation, as measured by the Consumer Price Index (CPI). TIPS are issued in 5-, 10-, and 30-year maturities. When TIPS mature, investors are paid the adjusted principal or original principal, whichever is greater. TIPS pay fixed-rate interest twice a year. The rate is applied to the adjusted principal, so, like the principal, interest payments rise with inflation and fall with deflation.

Commodities are frequently components of real return strategies because they are considered to be a hedge against inflation. Retail investors typically choose mutual funds or exchange-traded funds (ETFs) to get commodity exposure; they avoid physical commodity positions due to storage and carry costs.

Significant structural hurdles, discussed below, make each of these investments inadequate stand-alone hedges against inflation.

## Duration Risk

A principle of all fixed income instruments is that their prices are affected

by movements in interest rates. If a TIPS security is held to maturity, it will provide a desired real return; however, its actual return in any sub-period may fluctuate dramatically as interest rates change. As the maturity increases, the effective duration increases, and bonds with greater duration also have greater percentage-price changes. Table 1 shows the effect of a 20-basis-point (0.20 percent) increase in interest rates on the price of TIPS bonds with increasing duration.

Thus, depending on an investor's goals and investment horizon, inflation-protected bonds may not be the best inflation-protecting investment because increases in yields can erode the value of the bond.

## Volatility

Duration risk is the main driver of volatility in fixed income instruments, whether they are TIPS or any other type of bond. As shown in table 1, this duration risk can lead to volatility in the price of the bonds. Thus for holding periods shorter than the bond's maturity, the risk of loss of principal grows for higher-duration bonds.

Volatility is endemic for commodities such as oil and gold. Used by some investors as inflation hedges, these commodities also play important roles in other aspects of the world economy, and their prices may be affected by

supply and demand imbalances that have little to do with inflation. Both oil and gold are used as raw materials in the industrial cycle and their prices are impacted by geopolitical considerations and political unrest. Gold's "safe-haven" status makes its price particularly volatile during periods of political uncertainty.

Figure 1 shows the rolling 12-month standard deviation of year-over-year returns for oil and gold vs. year-over-year inflation.

Note that the volatility of year-over-year returns for oil and gold are higher than for the CPI. This mismatch in volatility may detract from the effectiveness of oil and gold as inflation hedges.

**Correlation**

One would expect that asset classes used as hedges against inflation would exhibit high correlations with inflation. However, as table 2 shows, that is not necessarily the case. Note that the correlation of the TIPS index to CPI is only 0.21.

**Taxation**

TIPS interest is exempt from state and local taxes but subject to federal tax. TIPS investors pay federal income tax on interest payments in the year payments are received and on growth in principal in the year that it occurs (see <http://www.treasurydirect.gov/instit/marketables/tips/tips.htm>). Therefore, if the principal grows, an investor pays taxes on the unrealized growth in principal.

Exchange-traded products that provide exposure to commodities frequently are organized as commodity pools, and they are structured more like partnerships than open-ended funds. Commodity pools (and partnerships) report distributed income using K-1 forms rather than 1099 forms. K-1 tax reports typically are less timely, subject to more revision, and generally require taxpayers to report more information, adding relatively more burden to the tax-filing process.

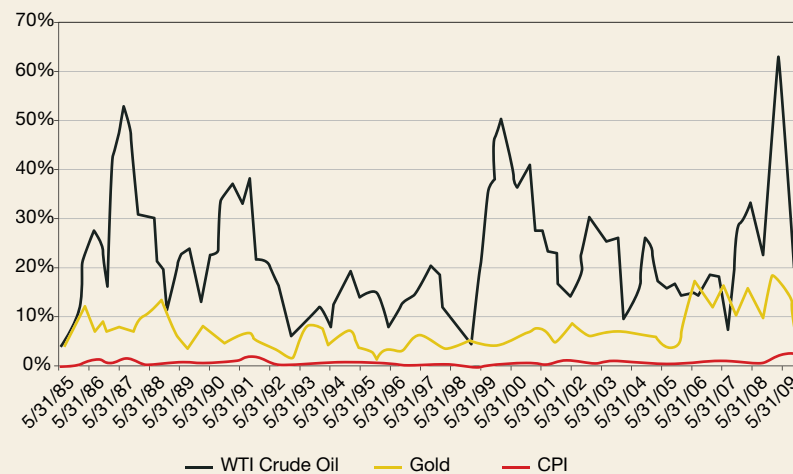
**Optimal Real Return Portfolios**

We take the approach of finding the optimal combination of assets to provide a given real return while minimizing the tracking error to inflation using a mean-variance optimization. More details of the in-sample and out-of-sample procedures can be found in Bruno and Chincarini (forthcoming a, b).

Table 3 shows results from the optimizations. Table 3 shows the portfolios with minimum tracking error to inflation for a given annual target return of 5 percent. We optimized for two time periods, one starting in 1970 and the other in 1990, using the full set of variables for each time period. A dot (".") indicates that a particular variable was not available for the optimization, and a zero ("0.0") indicates that the variable was available but received a weight of 0.

For the 1970 period, the in-sample allocation was 33.7-percent corporate bonds, 7.3-percent oil, 4-percent gold, 43.4-percent one-month CD, and 11.6-percent emerging equity. The tracking error of the position was

**FIGURE 1: ROLLING 12-MONTH STANDARD DEVIATION OF YEAR-OVER-YEAR RETURNS**



Source: Bloomberg, www.BLS.gov, IndexIQ research

**TABLE 2: QUARTERLY CORRELATION OF RETURNS TO U.S. INFLATION, JANUARY 2002–MARCH 2009**

Asset Class	Index	Correlation
Bank Loans	Credit Suisse Leverage Loan USD	0.66
Commodities	DJ UBS Commodity TR USD	0.63
High Yield	BarCap US Corporate High Yield	0.39
Convertibles	ML Convertible Bonds All Qualities	0.39
Private Real Estate	NCREIF Property	0.39
REITS	FTSE NAREIT All REITS	0.19
TIPS	BarCap Gbl Intl Linked US TIPS TR USD	0.21
Local Currency EM	JPM ELMI+ TR USD	0.20
Infrastructure	S&P Global Infrastructure TR USD	0.17
Equities	IA SBBA S&P 500 TR USD	0.15
Timberland	NCREIF Timberland	-0.31
Core Fixed Income	BarCap US Agg Bond TR USD	-0.48



5.1 percent per year with a 0.98 return-risk ratio.

The 1990 period in-sample allocation was 1.1-percent consumer staple stocks, 9.1-percent energy stocks, 0.4-percent health care stocks, 0.4-percent 10-year government bonds, 25.8-percent 30-year government bonds, 2.8-percent corporate bonds, 5.6-percent oil, 5.1-percent in gold, 45.9-percent one-month CDs, and 3.7-percent emerging market equities.

Because TIPS were not available in 1970 or in 1990, the authors also conducted a similar analysis covering the period from 1997 when TIPS first became available. The authors found little difference in performance between the portfolio that included TIPS and the portfolio that did not (see Bruno and Chincarini forthcoming a).

The out-of-sample weights are consistent with the in-sample weights. The average allocation from the out-of-sample optimizations for 1970 is 1.5-percent equities, 20.2-percent corporate bonds, 7.2-percent oil, 3.1-percent gold, 54.7-percent one-month CDs, and 13.2-percent emerging equity. The results are somewhat similar for the 1990 period; however, much of the 30-year government bond weight was shifted to world bonds.

Two consistent themes emerge in the optimizations: A large part of the portfolio should be held in short-term fixed income instruments, either government Treasury bills or one-month CDs, and less than 10 percent should be held in gold and oil. Also, a good portfolio should hold a combination of government bonds, 30-year bonds, and corporate bonds.

Perhaps most surprising is the small role that equity plays in the allocations. For many practitioners, this may seem counterintuitive as well as contrary to a commonly held belief that equities are potentially a good hedge against inflation. However, this is not as counterintuitive as it first seems given our objective of earning a target real return while minimizing the deviation

**TABLE 3: AVERAGE OPTIMAL WEIGHTS**

Asset Class	In-Sample Weights		Out-of-Sample Weights	
	1970–	1990–	1970–	1990–
	Real Return Target		Real Return Target	
Asset Class	5.0	5.0	5.0	5.0
Equity Index	0.0	0.0	1.5	0.0
Small-Cap	.	0.0	.	0.0
Value	.	.	.	.
Growth	.	.	.	.
S. CD	.	0.0	.	0.0
S. CS	.	1.1	.	3.6
S. Energy	.	9.1	.	2.7
S. Finance	.	0.0	.	0.0
S. Health	.	0.4	.	1.8
S. Indust.	.	0.0	.	0.9
S. IT	.	0.0	.	0.1
S. Material	.	0.0	.	0.0
S. Telcomm	.	0.0	.	2.5
S. Utility	.	0.0	.	0.0
Bill Govt.	0.0	0.0	0.0	0.0
10-Yr Govt.	0.0	0.4	0.0	0.3
30-Yr Govt.	0.0	25.8	0.0	2.1
Corp. Bond	33.7	2.8	20.2	5.9
HY Bond	.	0.0	.	0.0
IP Bond	.	.	.	.
Commodity	0.0	0.0	0.0	0.1
Oil	7.3	5.6	7.2	5.3
Gold	4.0	5.1	3.1	0.2
Silver	0.0	0.0	0.0	0.2
Wheat	0.0	0.0	0.0	0.0
FX1	0.0	0.0	0.0	2.1
FX2	0.0	0.0	0.0	0.4
FX3	0.0	0.0	0.0	0.0
One-month CD	43.4	45.9	54.7	49.7
R. Estate	.	0.0	.	2.3
World Eq.	0.0	0.0	0.0	0.0
World Bond	0.0	0.0	0.0	16.9
Emerge Eq.	11.6	3.7	13.2	2.9
Emerge Bond	.	.	.	.
Tracking Error	5.1	3.1	4.7	4.4
Return/Risk	0.98	1.59	0.79	0.63

from inflation over any given 12-month period. Thus for a 5-percent real return, other combinations of asset classes achieve this goal with much less risk than equities. For example, corporate

bonds provide a high return with lower risk than equities.

Table 4 shows the performance of the optimization analysis. For the 1970 in-sample optimizations, the mean

yearly real return was 5 percent and the standard deviation of real returns was 5.11 percent (this is also the tracking error with respect to inflation). The worst real return of this allocation was -14.14 percent for the year ending October 2008. This model produced a negative real return in 15.22 percent of the periods.

To help investors better understand these results, we produced three benchmarks: an all-equity allocation, an all-bond allocation, and one with 50-percent bonds and 50-percent equities. These are the out-of-sample optimization results in table 4. The all-equity portfolio had a higher mean real return of 6.38 percent; however, this increase came at a cost. In particular, this portfolio had a much larger volatility around inflation of 18.43 percent. The worst year-on-year real return for the portfolio was -50.89 percent in the year ending September 1974. In 31.71 percent of the periods it produced a negative real return.

The all-bond allocation led to a slightly lower mean real return of 4.22 percent but a surprisingly higher volatility around inflation of 11.85 percent, a worst year-on-year return of -27.57 percent, and a negative real return 38.69 percent of the time.

The 50-50 portfolio provided a mean real return of 5.30 percent, volatility of 12.56 percent, a worst-case return of -31.51 percent, and a negative real return 36.58 percent of the time.

Thus, the optimized 1970 allocation produced a portfolio with a reasonable real return versus the standard alternatives but with a much lower downside with respect to inflation. The results over the 1990 time period support the conclusions drawn from the 1970 time period.

For the out-of-sample optimizations, we note that the 5-percent target real return was not achieved in either time period. Instead, a real return of 3.70 percent with a volatility of 4.66 percent was obtained for the 1970 period and

a real return of 2.81 percent with a volatility of 4.44 percent was achieved for the 1990 period. The worst performance in any given month was -6.31 percent for the 1970 time period and -5.75 percent for the 1990 time period. The percentage of months with negative real returns was higher than the in-sample case—roughly 39 percent for both time periods.

Our out-of-sample benchmark allocation to all equity resulted in an average return of 7.81 percent for the 1970 period and 5.44 percent for the 1990 period. The all-equity allocation underperforms in the worst case by 22 percent and 16 percent, respectively, and it provides negative real returns roughly 40 percent of the time.

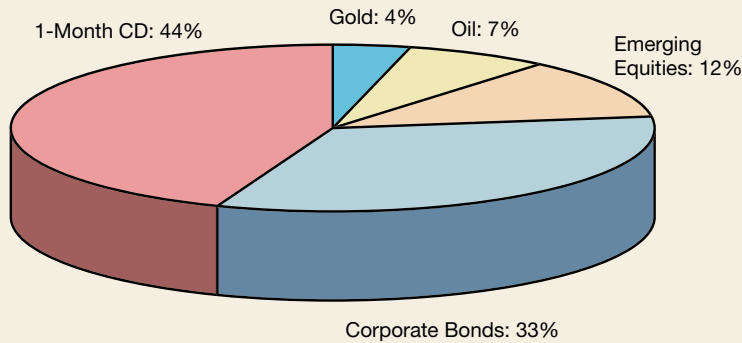
Given the difficulty of performing well out-of-sample, these results are encouraging and suggest that the multi-asset inflation hedging methodology may achieve a desired target real return while minimizing downside exposure to inflation.

**TABLE 4: PERFORMANCE OF OPTIMAL PORTFOLIOS**

	Period	Target Real Return	Mean Yearly Real Return	Standard Deviation of Real Returns	Max Value	Max Date	Min Value	Min Date	
<b>In-Sample Optimizations</b>									
Optimal Portfolio	1970	5.00	5.00	5.11	17.92	2000:02	-14.14	2008:10	
Optimal Portfolio	1990	5.00	5.00	3.15	15.10	1995:12	-4.63	2008:10	
100% Equity	1970	.	6.38	18.43	58.60	1983:06	-50.89	1974:09	
100% Equity	1990	.	6.84	17.67	49.91	1997:07	-43.56	2009:02	
50% Equity/50% Bond	1970	.	5.30	12.56	48.10	1983:06	-31.51	1974:09	
50% Equity/50% Bond	1990	.	6.09	9.46	30.88	1998:03	-18.02	2009:02	
100% Bond	1970	.	4.22	11.85	45.88	1986:03	-27.57	1980:03	
100% Bond	1990	.	5.33	7.26	23.40	1995:12	-12.78	1994:10	
<b>Out-of-Sample Optimizations</b>									
Optimal Portfolio	1970	5.00	3.70	4.66	5.81	2009:05	-6.31	2008:10	
Optimal Portfolio	1990	5.00	2.81	4.44	3.85	2003:05	-5.75	2008:10	
100% Equity	1970	.	7.81	15.53	12.83	1987:01	-21.80	1987:10	
100% Equity	1990	.	5.44	15.92	9.32	2009:04	-15.78	2008:10	
50% Equity/50% Bond	1970	.	6.20	9.85	9.48	1982:10	-7.95	1987:10	
50% Equity/50% Bond	1990	.	5.27	8.55	5.96	1997:07	-7.84	2008:10	
100% Bond	1970	.	4.59	9.59	13.22	1980:04	-10.46	1980:02	
100% Bond	1990	.	5.10	7.87	10.94	2008:11	-6.82	2003:07	



**FIGURE 2: INVESTMENT ALLOCATION WITH AVERAGE 5-PERCENT REAL RETURN**




**Conclusion**

We studied the possibility of creating an optimal portfolio with a target real return as a means to hedge inflation. We examined this from the perspective of a U.S. investor for two time periods. (See Bruno and Chincarini [forthcoming a, b] for time periods dating to 1901 and for the perspective of non-U.S. investors.) We constructed these portfolios

using mean-variance optimization of real returns.

We found that for an investor who wishes to achieve a given real return while minimizing the portfolio deviation from inflation in any given period, the best allocation consisted of some combination of Treasury bills or one-month CDs, government bonds, gold, oil, and emerging-market equity. We also found that while oil and gold are important in providing a real return while considering inflation, their values are about 5 percent of an optimized portfolio and never more than 10 percent. In Bruno and Chincarini 2010 (forthcoming a), we found that although TIPS may be good instruments for hedging inflation when owned in isolation, they have higher volatility than a portfolio of assets and seem to be less important when combined with other asset classes. Structural issues of duration risk, volatility, and taxation remain.

We found that the portfolio approach did well in-sample and out-of-sample. The average realized real returns were positive, close to the target real returns, and had low tracking errors.

Based on this analysis, we estimate that for a U.S. investor, an allocation for a 5 percent real return might look similar to that shown in figure 2. 

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*Disclaimer: This article does not constitute tax advice. Please consult a tax professional for tax advice.*

	# < Inflation	MAE	RMSE	# of Months of Data
	15.22	5.91	7.15	473
	5.58	2.57	4.07	473
	31.71	16.03	19.49	473
	25.32	7.76	13.26	473
	36.58	10.62	13.62	473
	26.18	4.50	7.85	473
	38.69	9.31	12.56	473
	25.32	3.66	6.29	473
	38.50	1.03	1.38	413
	39.88	0.98	1.29	173
	40.92	3.46	4.52	473
	38.15	3.60	4.59	173
	42.62	2.23	2.89	473
	43.35	1.97	2.48	173
	42.13	2.06	2.79	473
	41.04	1.76	2.29	173