



Vanguard[®]

Hedging inflation: The role of expectations

Vanguard research

March 2011

Executive summary. The growing interest in inflation hedging spotlights investors' need for a clear understanding of the relationship between asset returns and inflation.¹ For those with long-term investment horizons, risky assets like stocks and bonds may earn returns high enough to overcome erosion in purchasing power due to inflation, on average. However, investors looking to hedge against inflation are typically concerned with short- and medium-term protection.

These investors need to be aware of the difference between *expected* and *unexpected* inflation. Expected inflation is essentially the market's consensus view on the future path of inflation; because financial markets are forward-looking, they presumably incorporate this view into current asset prices. By definition, "inflation risk" is generally a worry about unexpected inflation. Any asset being considered as an inflation hedge should be evaluated based on its relationship to both components.

Authors
Geetesh Bhardwaj, Ph.D.
Dean J. Hamilton
John Ameriks, Ph.D.

¹ See Davis (2007) for a detailed discussion.

Some assets, such as commodity futures, have historically provided returns that tend to rise with unexpected inflation, while others, such as Treasury bills, have had returns that tend to rise with expected inflation. In this paper, we examine the historical correlation of these and other asset classes to both aspects of inflation. We find that a commodity futures position fully collateralized with T-bills may offer some attractive features as an inflation hedge; however, investors need to be aware of the associated risks. A well-diversified portfolio of stocks, bonds, and other asset types remains the most suitable strategy for managing multiple dimensions of risk over the long term.

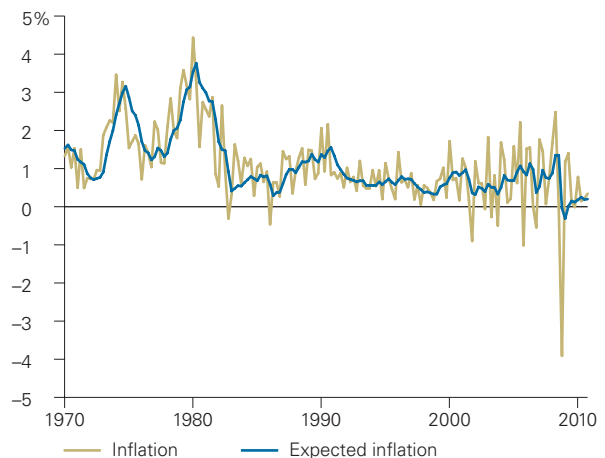
Decomposing inflation

To break down historical inflation into its expected and unexpected components, we applied a commonly used econometric technique to identify expected inflation,² and then compared the result with actual observed inflation. **Figure 1** shows the results of this comparison from 1970 through 2010. It reveals that, although observed inflation has been generally in line with expected levels,³ it has been more than three times as volatile over short periods. Those short-term fluctuations can come as a significant surprise to market participants.

Separating inflation into expected and unexpected components reveals important relationships between returns on various assets and these components. **Figure 2** displays the historical correlations we found. It confirms that Treasury bills provide returns that tend to be positively related to expected inflation, but unrelated to unexpected inflation. In contrast, returns for commodity futures and Treasury Inflation-Protected Securities (TIPS) show significant positive correlation to unexpected inflation but are basically unrelated to expected inflation. The correlations for other asset classes are less remarkable, as discussed later.

Figure 1. Expected inflation and observed inflation, 1970–2010

Although observed inflation roughly matches consensus inflation expectations over long periods, surprises can occur in the short term. We found that the expected component of inflation explained more than 40% of the variation in actual inflation; however, the latter was more than three times as volatile.



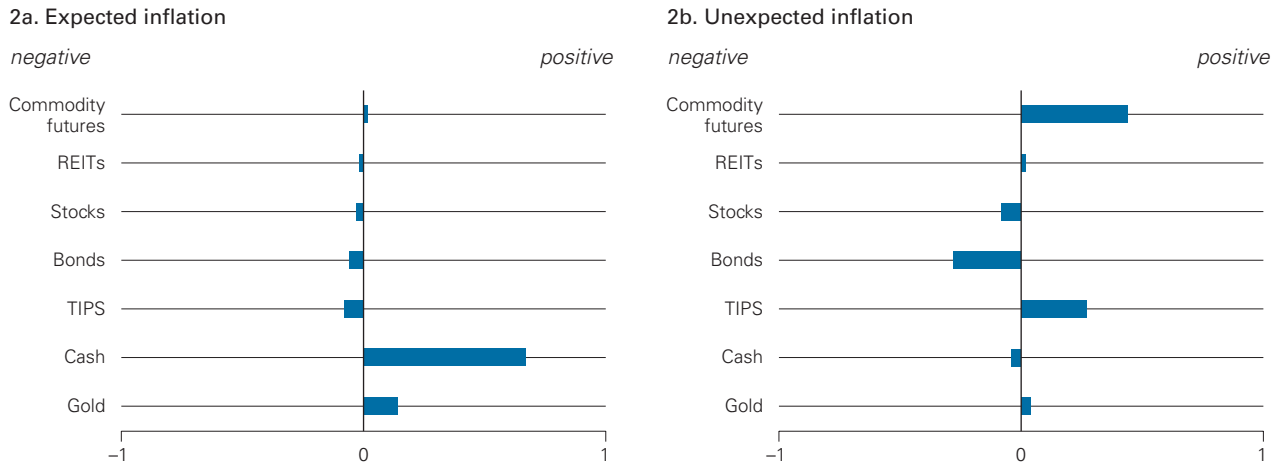
Note: Quarterly inflation data are from the Consumer Price Index for All Urban Consumers—All Items NSA (non-seasonally adjusted), provided by the Federal Reserve Bank of St. Louis.

Source: Vanguard.

² We used the Hodrick-Prescott Filter; see the appendix for further discussion on the decomposition of inflation.

³ During the hyperinflation of 1973–1982, average quarterly inflation was 2.10%, while average expected inflation was 2.18%. For the decade through 2009, quarterly actual and expected inflation averaged 0.63% and 0.65%, respectively.

Figure 2. Correlation of asset returns with expected and unexpected inflation



Source: Vanguard calculations based on benchmark returns for each asset class. Commodity futures are represented by the S&P GSCI Excess Return Index from 1970 through 2010. REITs are represented by the FTSE NAREIT Equity REIT Index from 1972 through 2010. Stocks are represented by the Standard & Poor's 500 Index from 1970 through 1974; the Dow Jones Wilshire 5000 Composite Index from 1975 through April 22, 2005; and the MSCI US Broad Market Index thereafter through 2010. Bonds are represented by the Citigroup High Grade Index from 1970 through 1972; the Lehman Brothers Long-Term AA Corporate Index from 1973 through 1975; and the Barclays Capital U.S. Aggregate Bond Index from 1976 through 2010. TIPS are represented by the Barclays Capital U.S. Treasury Inflation Protected Securities Index from April 1997 through 2010. Cash returns are represented by the Ibbotson U.S. 30-Day Treasury Bill Index from 1970 through 1977 and the Citigroup 3-Month U.S. Treasury Bill Index from 1978 through 2010. Gold is represented by the S&P GSCI Gold Spot Index from 1978 through 2010.

Expected inflation: Why T-bills lead

The high correlation of T-bills with expected inflation rates reflects the nature of these securities—short-term, government-guaranteed debt with virtually no credit risk. As T-bills are frequently considered a “risk-free” asset, inflation expectations are often gauged using T-bill yields.

Economist Irving Fisher proposed⁴ that nominal interest rates generally represent the sum of the real rate of interest and expected inflation. Consistent with the theory, cash returns (T-bills) historically have had a strong tendency to rise with expected inflation. Indeed, in Figure 2 the quarterly correlation of cash returns and expected inflation is very positive (0.68), while returns for other asset classes (stocks, bonds, commodity futures, REITs, gold, and TIPS) all have insignificant correlation with expected inflation.

Notes on risk: All investments are subject to risk. Past performance is no guarantee of future returns. Futures trading is speculative in nature and involves substantial risk of loss; futures are not suitable for all investors. Investments in bonds are subject to interest rate, credit, and inflation risk. Unlike stocks and bonds, U.S. Treasury bills are guaranteed as to the timely payment of principal and interest. The performance of an index is not an exact representation of any particular investment, as you cannot invest directly in an index. Diversification does not ensure a profit or protect against a loss in a declining market.

4 Fisher (1907), *The Rate of Interest*.

Regarding commodity futures, Figure 2 illustrates the complexities that can bedevil commonly held assumptions. Conventional wisdom suggests that these futures provide a natural inflation hedge by virtue of their close link to commodity prices, a key component of inflation. However, as Figure 2 shows, this is not the case in terms of *expected* inflation.

Investors should note that buying a commodity futures contract is not the same as directly investing in a physical commodity; rather, commodity futures prices are based on a forecast of the commodity's spot price on the date when the contract expires. Futures prices therefore reflect consensus expectations of commodity price changes, including changes expected to result from inflation. Futures investors will earn no return (above any risk premium) if final prices match these expectations. (For a detailed discussion of commodities as an asset class, see the Vanguard research paper *Investment Case for Commodities? Myths and Reality*; Bhardwaj, 2010.)

Commodity futures are generally unaffected by expected inflation because their valuations incorporate it. However, their returns may rise and fall with unexpected inflation (Gorton and Rouwenhorst, 2006).

Unexpected inflation

Figure 2 bears this out, showing that the correlation between quarterly unexpected inflation and commodity futures returns is positive, on the order of 0.44. TIPS index returns also show a significant positive correlation with unexpected inflation—but this is what TIPS are designed to do. TIPS principal is adjusted to reflect actual inflation, and thus provides an excellent inflation hedge over the term of the bond for a hold-to-maturity investor. (However, theory suggests that investors must pay an insurance premium for this protection from unexpected shocks; see Durham, 2006.)

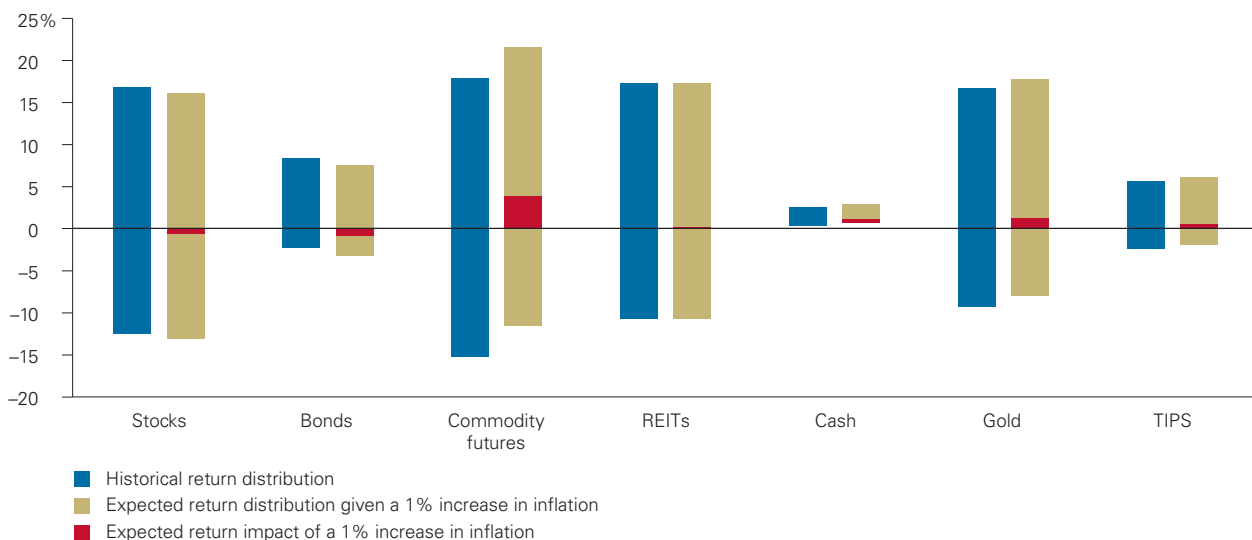
Stock and REIT returns show little or no relationship to unexpected inflation at the quarterly horizon. Although these investments represent claims on real assets, unexpected inflation may have an adverse affect on their returns, particularly in the near term. Some companies may not be able to freely adjust final output prices, and some expenses, such as wages, may also be inflexible in the short run. Rental income in public REITs may provide a partial hedge, but the price component of REITs is highly correlated with stocks. Furthermore, interest rate increases that are typically imposed as a monetary policy response to inflationary pressures can cause declines in capital values in real estate and hurt corporate profitability.

Altogether, the results shown in Figure 2 confirm that asset prices have tended to reflect consensus inflation expectations. Thus, if all investors believe future inflation will be high, then they will not be rewarded if they are right.

Figure 3. Potential impact on returns of a one-percentage-point increase in inflation

For each asset class, this chart shows how the historical distribution of quarterly returns might shift if inflation rose by a percentage point, with all other factors held constant. The potential impact appears greatest for commodity futures.

95% probability distribution of return



Source: Vanguard calculations based on returns for the indexes cited in Figure 2.

Hedging inflation: Caveats and cautions

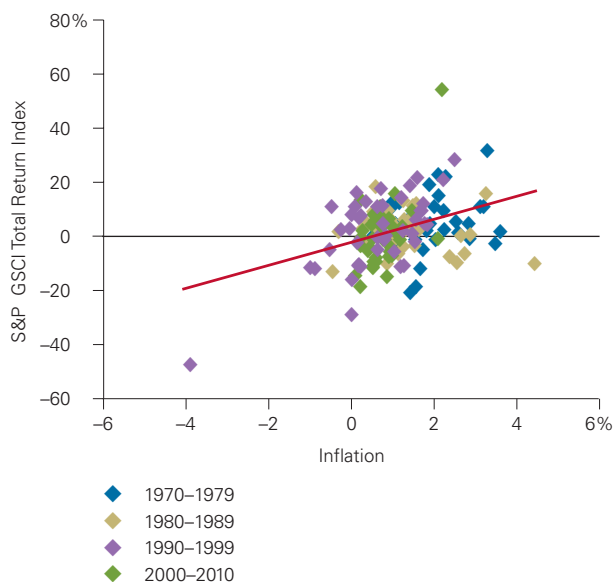
While it is instructive to analyze the decomposition of inflation, investors ultimately want to hedge against total, headline inflation and not just potential shocks. A portfolio consisting of stocks, bonds, commodity futures, and TIPS can help accomplish this. As we have noted, commodity futures and T-bills historically have provided returns that can hedge inflation to some degree.

An asset’s use as an inflation hedge should be weighed against its potential impact on overall portfolio return. We therefore examined the relationship between inflation and the distribution of potential returns for the asset classes discussed previously. On the basis of that analysis, **Figure 3** shows the range of returns one might expect as a holder of several different assets, given a one-percentage-point increase in inflation. The results

suggest that, on average—and keeping all else constant—the S&P GSCI Commodity Excess Return Index has earned an additional 3.7 percentage points in excess return for each percentage-point increase in inflation, while cash investments have returned an additional half percentage point. These results also imply that negative inflation (deflation) tends to reduce returns from these asset classes to similar degrees.

Given the equity-like volatility of commodity futures returns, even in situations with a one-percentage-point increase in quarterly inflation, there is still a 29% chance that commodity futures will produce a negative return, and hence fail to hedge inflation. (Note that a diversified portfolio of TIPS also can be volatile, producing a 15% chance that returns from TIPS will be negative in the face of a one-percentage-point increase in quarterly inflation.)

Figure 4. Scatter plot of commodity futures returns and inflation



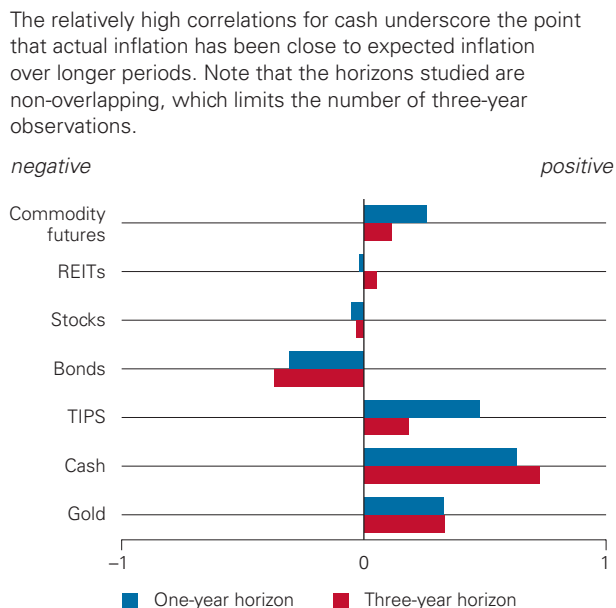
Source: Vanguard, using quarterly returns for the S&P GSCI Total Return Index from 1970 through 2010 and quarterly inflation data from the Consumer Price Index for All Urban Consumers—All Items NSA (non-seasonally adjusted).

In addition, while commodity futures possess some attractive features with respect to inflation sensitivity, investors should note that the potential inflation hedge provided by these securities is far from perfect. Investments in commodity futures represent exposure to a basket of raw materials and do not directly hedge “core” consumer costs such as health care, housing, and education. These core costs are not as volatile in the short term as food and energy prices, but they can account for significant portions of investors’ expenses.

Investors also should note that unexpected inflation happens randomly, with roughly equal probability of coming in above or below expectations. For commodity futures historically, the “flip side” of providing better returns when inflation was unexpectedly high has been producing unfavorable results when inflation was unexpectedly low. Investors should hold a well-diversified portfolio to help protect against both outcomes.

5 Note that the REIT, TIPS, and gold series begin after 1970.

Figure 5. Correlation of asset returns with inflation at one-year and three-year horizons, 1970–2010



Source: Vanguard calculations based on returns for the indexes cited in Figure 2.

Historically, variation in inflation accounts for only 13% of the variation in returns for commodity futures (see Figure 4). Holding any investment based solely on its expected relationship to inflation may lead to unanticipated and unfavorable results.

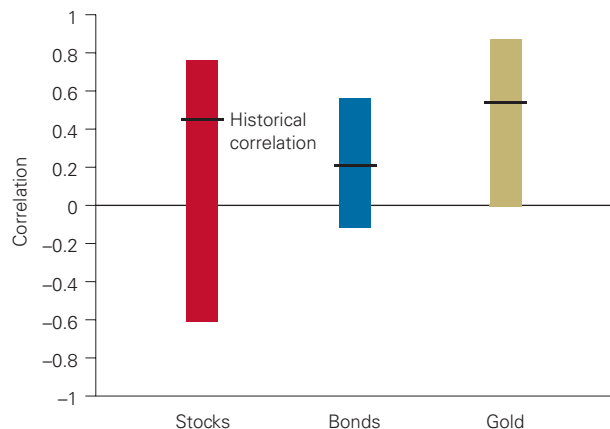
Long-term inflation hedging

The main line of analysis in this paper is concerned with the short- and medium-term impact of inflation on asset returns. For investors with long-term horizons, risky assets may earn a return high enough to overcome erosion in purchasing power due to inflation, on average. (See Figure 6b for historical real returns on stocks, bonds, and gold.)

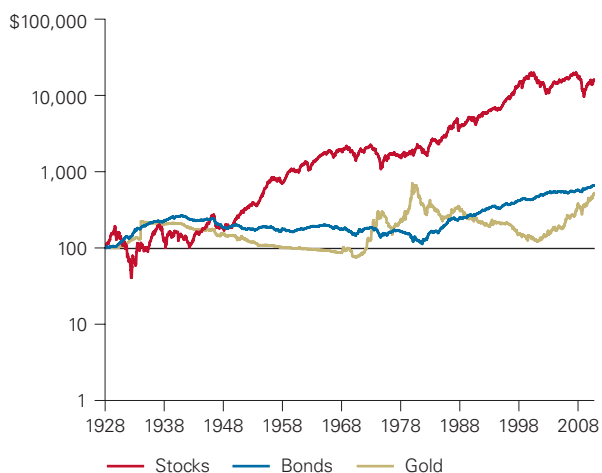
Figure 5 shows the correlation of inflation with returns for the various asset classes over non-overlapping one- and three-year horizons, starting in 1970.⁵ The three-year results should be interpreted with great caution, as there are only 13 three-year

Figure 6. Five-year inflation correlations and long-term real returns for stocks, bonds, and gold, 1928–2010

6a. Correlations (and 95% confidence intervals) for non-overlapping five-year horizons



6b. Cumulative inflation-adjusted returns



Sources: Stocks are represented by the Standard & Poor's 90 Index from 1928 through March 3, 1957; the S&P 500 Index from March 4, 1957, through 1974; the Dow Jones Wilshire 5000 Composite Index from January 1, 1975, through April 22, 2005; and the MSCI US Broad Market Index from April 23, 2005, through 2010. Bonds are represented by the S&P High Grade Corporate Index from 1928 through 1968; the Citigroup High Grade Index from 1969 through 1972; the Lehman Brothers Long-Term AA Corporate Index from 1973 through 1975; and the Barclays Capital U.S. Aggregate Bond Index from 1976 through 2010. Gold spot return data are from the Commodity Research Bureau. Inflation data are based on the the Consumer Price Index for All Urban Consumers—All Items NSA (non-seasonally adjusted).

periods from 1970 through 2010, and for TIPS much less data is available. Cash returns have significantly positive correlation with inflation at three-year horizons, underscoring the point that actual inflation has been close to expectations over longer periods.

In **Figure 6** we plot the correlation of inflation with returns for stocks, bonds, and gold over non-overlapping five-year horizons starting in 1928. We also plot the 95% confidence interval.⁶ Even in this time series, there are only 18 independent observations for calculating return correlation at five-year horizons. As a result, long-term return correlations cannot be estimated without a great deal of uncertainty. Although returns for stocks, bonds, and gold all are positively correlated with inflation, none of the correlations is positive to a statistically significant degree. While the correlation of five-year stock returns with inflation for data starting in 1928 is 0.45, if we exclude just the first five-year period (1928–1932), the correlation estimate becomes *negative* at -0.11 . The 95% confidence

limits for correlation of stocks with inflation are -0.61 and 0.76 . The historical record simply does not permit a firm conclusion regarding the inflation-hedging potential of stocks.

For gold, correlation estimates are also very wide, but uniformly positive. Caution is in order, however, as interpretation of the correlation between gold returns (changes in spot prices) and inflation is complicated by the existence of the gold standard in the United States until 1971. Because the dollar was pegged to a fixed quantity of gold, U.S. inflation was effectively *defined* as the change in the value of gold relative to a broad-based basket of goods. The gold standard also imposed restrictions on monetary policy that might have influenced the relationship between inflation and other asset-return dynamics. Further, while the correlation estimate for gold is positive, over the long term (1928–2010) total returns have not kept up with the returns for bonds, and are significantly lower than those for stocks (see **Figure 6b**).

⁶ The bootstrap confidence interval is based on 1,000 replications.

Conclusion

Our analysis suggests that commodity futures and T-bills can provide an effective partial hedge against inflation, particularly in the near term. Commodity futures have historically provided returns that tend to be positively related to unexpected inflation, while T-bills have provided returns positively related to expected inflation. Because most investments in commodity futures are fully collateralized by T-bills, investors may potentially use these futures as a hedge against both expected and unexpected inflation. Although many traditional asset classes have not provided a significant inflation hedge over the short and medium term, over the long term they may earn high enough returns to overcome the erosion in purchasing power caused by inflation. Holding a well-diversified portfolio can help to provide both reasonable long-term returns as well as some protection from inflation.

References

- Bhardwaj, Geetesh, 2010. *Investment Case for Commodities? Myths and Reality*. Valley Forge, Pa.: The Vanguard Group.
- Davis, Joseph H., 2007. *Evolving U.S. Inflation Dynamics: Explanations and Investment Implications*. Valley Forge, Pa.: The Vanguard Group.
- Durham, J. Benson, 2006. *An Estimate of the Inflation Risk Premium Using a Three-Factor Affine Term Structure Model*. Finance and Economics Discussion Series 2006-42, Board of Governors of the Federal Reserve System.
- Gorton, Gary, and K. Geert Rouwenhorst, 2006. Facts and Fantasies About Commodity Futures. *Financial Analysts Journal* 66(2):47–68.
- Razzak, Weshah, 1997. The Hodrick-Prescott Technique: A Smoother Versus a Filter. An Application to New Zealand GDP. *Economics Letters* 57(2): 163–168.

Appendix

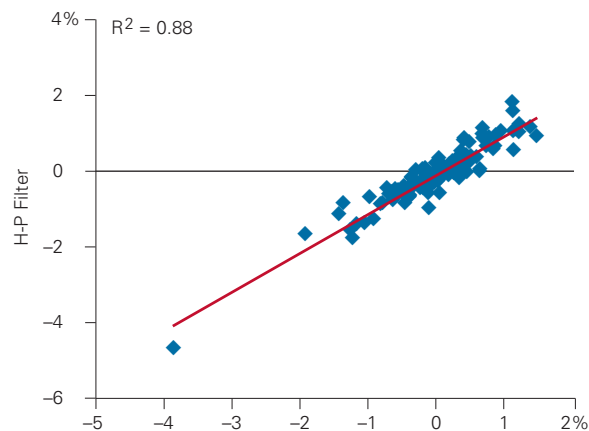
Calculating expected inflation

The Hodrick-Prescott or H-P Filter separates the long-term trend in a time series from short-term shocks. We obtained expected inflation using a rolling 30-year sample to derive a true filter for end-of-sample observation, following Razzak (1997): “The Hodrick-Prescott filter acts as a ‘smoother’ over the sample and as a true ‘filter’ at the end of the sample. Using these two different concepts, the output gap resulting from the true filter is consistent with the policy maker’s interpretation of the cyclical component of real output and provides better out-of-sample forecasts of inflation.”

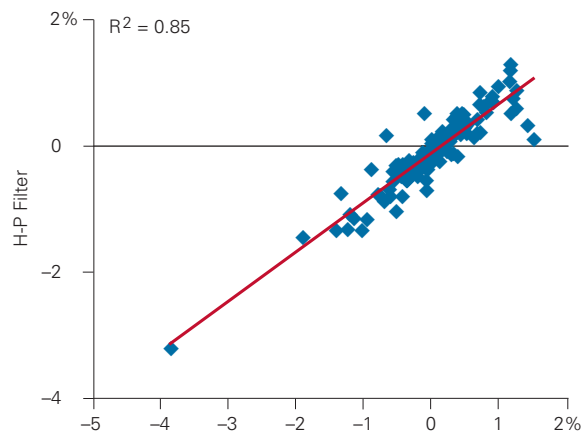
Although the H-P Filter is a commonly used econometric technique, we also applied other methods to derive expected inflation to further validate our results. We estimated expected inflation using metrics such as modeling expectations with an autoregressive model; using data about expectations from the Philadelphia Federal Reserve Bank’s *Survey of Professional Forecasters* (Q4 1981 through Q4 2010); and applying T-bill rates as a proxy for expected inflation. These different measures produced highly comparable results; for example, expected inflation derived by using the H-P Filter had a correlation of 0.94 with expected inflation based on the Philadelphia Fed survey. **Figure A1** shows the scatter plot of unexpected inflation using the H-P Filter and data from the Philadelphia Fed survey, as well as a scatter plot of unexpected inflation using the H-P Filter and unexpected inflation from an out-of-sample autoregressive model with 12-month lags.

Figure A1. Comparing unexpected inflation derived from the H-P Filter with data derived from two other sources

Survey of Professional Forecasters



Out-of-sample autoregressive model with 12-month lags



Source: Vanguard.



P.O. Box 2600
Valley Forge, PA 19482-2600

Connect with Vanguard® > vanguard.com

Vanguard research >

Vanguard Center for Retirement Research
Vanguard Investment Counseling & Research
Vanguard Investment Strategy Group

E-mail > research@vanguard.com