

# A core-satellite approach to hedging inflation

- Inflation risk has reentered the investment conversation. This is not because inflation has already reaccelerated, but because heightened volatility in commodity markets, elevated trade uncertainty, and geopolitical tensions—most notably through their impact on energy prices—have renewed concerns that inflation pressures could reemerge. Even in the absence of a sustained pickup in realized inflation, investors are increasingly reassessing how portfolios might behave if inflation surprises to the upside.
- Long-term purchasing power is still best preserved through growth assets, particularly equities, which remain the most reliable way to outpace inflation over 10- and 30-year horizons. However, assets such as commodities and, to an extent, Treasury Inflation-Protected Securities (TIPS) exhibit stronger short-term sensitivity to inflation and can help improve portfolio outcomes for investors with nearer-term inflation protection needs.
- A core-satellite approach offers a practical way to enhance inflation protection without materially increasing overall portfolio risk. The approach entails making modest allocations to inflation-sensitive assets that can raise a portfolio's inflation beta while preserving diversification and long-term return efficiency. However, investors taking this approach must be comfortable with higher tracking error and periods of potential underperformance.

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## Introduction

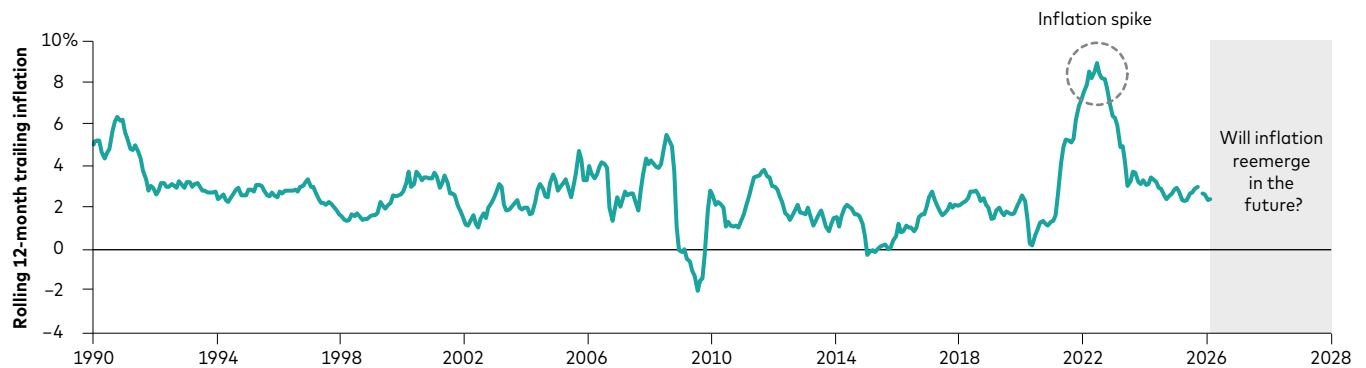
For more than three decades, until 2021, investors had largely operated in an environment of relatively low, stable inflation, shaped by powerful structural forces such as globalization, technological progress, and favorable demographics. That environment was disrupted from 2021 to 2023, when inflation surged following pandemic-related supply chain constraints and the war in Ukraine, prompting renewed focus on inflation risk and its implications for portfolio construction (**Figure 1**).

While inflation subsequently moderated and appeared to be settling into a lower, more stable, range, recent geopolitical developments—along with renewed volatility in energy and broader

commodity markets—have raised concerns that inflation pressures could reemerge. As a result, investors are increasingly revisiting whether, and how, their portfolios should be positioned to manage inflation risk without unduly sacrificing long-term return efficiency.

This paper revisits our earlier framework (Schlanger et al., 2023) to assess what has changed, what remains structurally intact, and how investors can think about protecting their portfolios in the face of renewed inflation uncertainty.

**FIGURE 1**  
**Will the unexpected inflation spike of 2022 reemerge?**



**Notes:** Rolling 12-month trailing inflation is represented by the Consumer Price Index for All Urban Consumers: All Items in U.S. City Average. Data are from January 1, 1990, to February 28, 2026.

**Sources:** Vanguard calculations, using data from the Federal Reserve Bank of St. Louis.

Investors tend to approach inflation risk with different goals in mind. Some are focused on growing their wealth over the long run and staying ahead of inflation over time, while others—such as income-focused investors—care more about how their portfolios respond to inflation over shorter horizons, such as the next several years.

In this paper, we examine how different asset classes are expected to behave over 10- and 30-year periods using the Vanguard Capital Markets Model (VCMM) and assess which investments are most effective at helping portfolios keep pace with inflation. For long-term investors, equities remain the most reliable way to grow purchasing power over time. For investors with a more immediate need for inflation protection, assets such as commodities—and to a lesser extent TIPS—can play a role. While including these assets can introduce additional risk, we find that using them as part of a core-satellite approach allows investors to improve inflation protection while maintaining a more balanced overall portfolio.

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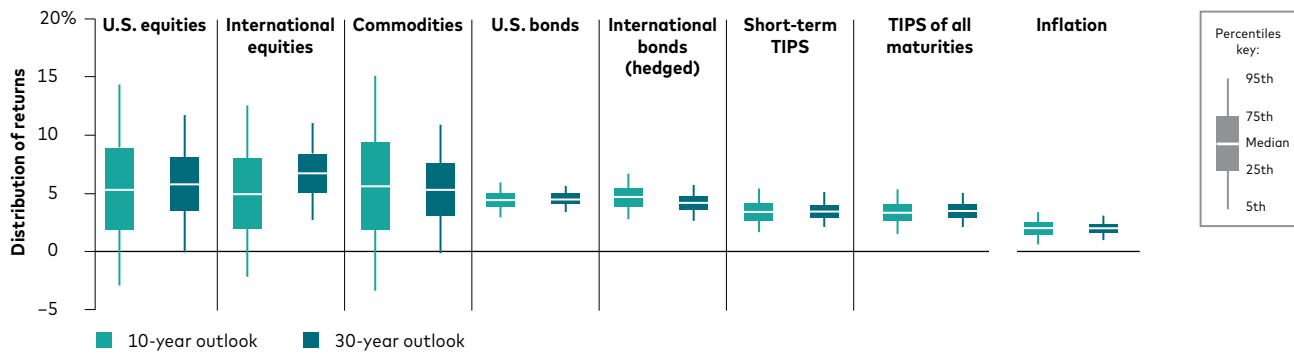
## Capital market assumptions

### Asset return distributions

To estimate how different asset classes may perform and how they relate to inflation, we rely on the VCMM. It is a long-standing forecasting framework that uses a wide range of economic and market data to generate thousands of possible future outcomes for asset returns. Rather than relying on a single forecast, the model reflects the uncertainty investors face by capturing a broad range of potential market environments, including periods of higher volatility and market stress.

The VCMM also incorporates current market conditions—such as interest rates, valuation levels, and credit spreads—to form return expectations over medium- to long-term horizons, typically 10 to 30 years. This approach allows us to evaluate not only expected returns, but also the trade-offs between risk and return that investors may face over time. **Figure 2** shows the projected 10- and 30-year return ranges for four core asset classes—U.S. equities, international equities, U.S. bonds, and hedged international bonds—alongside asset classes commonly used for inflation protection, including TIPS and commodities.

**FIGURE 2**  
**Capital market outlook from VCMM for selected asset classes**



**Notes:** Data are as of February 28, 2026.

**Source:** Vanguard.

**IMPORTANT:** The projections and other information generated by the Vanguard Capital Markets Model® (VCMM) regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Distribution of return outcomes from the VCMM are derived from 10,000 simulations for each modeled asset class. Simulations are as of February 28, 2026. Results from the model may vary with each use and over time. For more information, please see page 10.

Equities are expected to remain the most effective way to grow purchasing power over time. Over the next 30 years, U.S. and international equities are projected to deliver the highest returns, reflecting their strong long-term growth potential. Commodities also show relatively attractive expected returns, but with a more dispersed return profile. As standalone investments, commodities can exhibit higher volatility and a greater likelihood of drawdowns over shorter horizons. Over the next decade, commodities, U.S. equities, and international equities are projected to offer the strongest absolute return potential and, as a result, the highest likelihood of outperforming inflation.

However, when returns are evaluated on a risk-adjusted basis, lower-volatility assets such as TIPS, U.S. bonds, and international bonds appear more attractive. While their expected returns are lower, their greater stability leads to more efficient outcomes per unit of risk compared with equities.

### **Inflation-hedging properties**

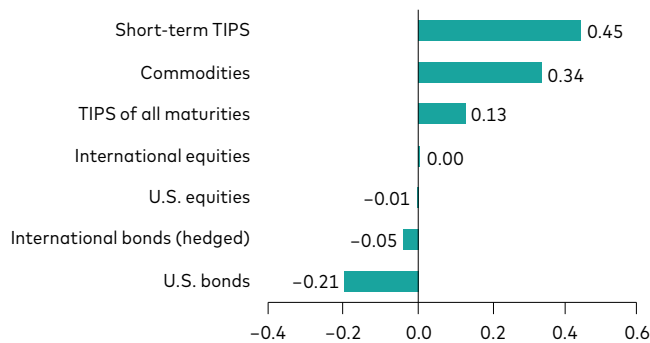
One benefit of using the VCMM is that it helps us understand how different investments tend to behave when inflation rises. Investments that move closely with inflation are often viewed as more effective inflation hedges.

**Figure 3a** illustrates how the expected returns of each asset class relate to inflation over time. Short-term TIPS show the strongest relationship with inflation, reflecting their direct inflation adjustment and lower sensitivity to interest rate changes. Commodities follow closely, as prices for energy and raw materials often rise during inflationary periods, with TIPS of all maturities also showing a meaningful connection. By contrast, equities tend to have little direct relationship with inflation in the short run, while broad-market bonds—both U.S. and international—often move in the opposite direction from inflation, since inflation is typically associated with higher interest rates and lower bond prices.

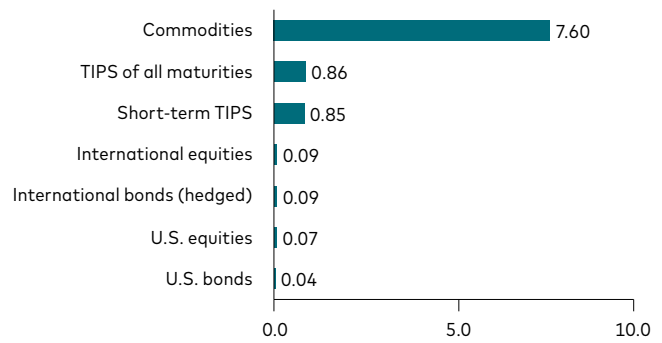
Inflation beta measures how much an investment's return tends to increase when inflation rises—for example, how much an asset is expected to gain if inflation moves up by 1%. As shown in **Figure 3b**, this provides a more complete picture of inflation protection than correlation alone. While correlation tells us whether an asset generally moves in the same direction as inflation, inflation beta captures the size of that response. Some assets may track inflation closely but still provide only limited protection for the broader portfolio.

**FIGURE 3**  
**Inflation-hedging properties of selected asset classes**

a. Correlation with inflation



b. Inflation beta



**Notes:** Correlation with inflation was calculated across the median return from the VCMM distribution of each asset class and inflation within equilibrium market conditions. Inflation beta was calculated as the slope of each asset class and inflation across all 10,000 paths cross-sectionally across the 30th year to best represent equilibrium market conditions.

**Source:** Vanguard.

Importantly, stronger inflation protection comes with trade-offs. Assets with higher inflation beta tend to experience larger swings in performance. For example, if inflation were to rise by 3%, TIPS would be expected to increase by roughly 2.6%, while commodities could rise by more than 20%. While these higher-beta assets can help offset inflation's impact on other parts of a portfolio, they also increase overall portfolio volatility and drawdown risk. This dynamic is illustrated in **Figure 4**. The two-year rolling returns highlight the pronounced short-term performance swings in commodities—both positive and negative—while the five-year rolling returns underscore the potential for extended periods of underperformance despite strong inflation-hedging characteristics.

### Portfolio construction considerations

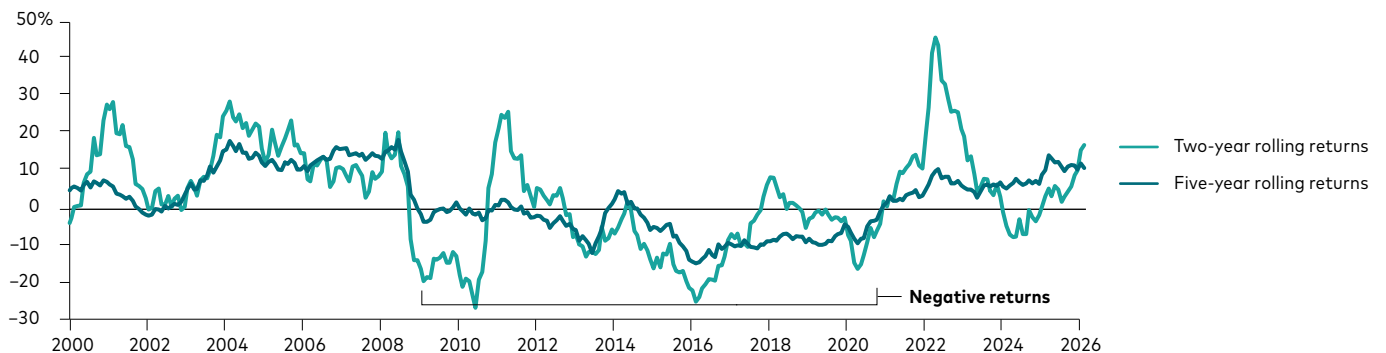
For most long-term investors, the primary objective is to grow wealth over time while keeping pace with inflation. Because inflation erodes purchasing power gradually, managing it is typically a by-product of pursuing strong long-term returns rather than a standalone goal. This is most often achieved through a strategic mix of growth-oriented assets, such as equities, combined with fixed income to help manage portfolio volatility.

That said, some investors with near-term or more predictable spending needs place greater emphasis on how their portfolios respond to inflation over shorter horizons. For these investors, achieving a degree of inflation sensitivity may help smooth the relationship between portfolio returns and consumption. In such cases, selectively allocating to assets with stronger inflation-hedging characteristics—most notably commodities, and to a lesser extent TIPS of all maturities—can play a complementary role in the portfolio.

### Optimizing portfolios with a high expected inflation beta

To evaluate how portfolios can be constructed with greater inflation sensitivity, we used the Vanguard Asset Allocation Model (VAAM) (Aliaga-Díaz et al., 2019) as the foundation for our analysis. The VAAM is a portfolio construction framework that evaluates trade-offs between risk and return across a wide range of asset combinations, using forward-looking return projections from the VCMM. The VAAM incorporates multiple dimensions of portfolio behavior—including expected returns, volatility, diversification benefits, and inflation sensitivity—to identify portfolios that best align with an investor's risk tolerance.

**FIGURE 4**  
**Historical commodity negative returns**



**Notes:** Two-year and five-year rolling returns for commodities are represented by the Bloomberg Commodity Index Total Return. Data are from January 1, 2000, to February 28, 2026. **Past performance is no guarantee of future results. The performance of an index is not an exact representation of any particular investment, as you cannot invest directly in an index.**

**Sources:** Vanguard calculations, using data from Bloomberg.

To focus on inflation protection, we enhanced the optimization process to target portfolios within a defined range of expected inflation beta. In practice, this meant identifying portfolios that not only seek to maximize long-term risk-adjusted returns but also exhibit a minimum level of responsiveness to changes in inflation. We applied this framework using long-term VCMM simulations, where the relationship between asset returns and inflation tends to be more stable over time. Inflation beta is calculated as the covariance between our expectation of inflation and the expected portfolio total return, divided by the variance of our expectation of inflation at Year 30.

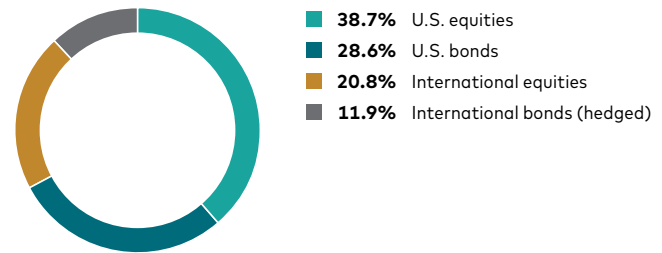
$$\beta = \frac{\text{Covariance}(R_{CPI30}, R_{TR30})}{\text{Variance}(R_{CPI30})}$$

The portfolio's inflation beta is computed cross-sectionally between the portfolio's total return (TR) and our expectation of inflation (CPI) across Year 30 of the VCMM forecast.

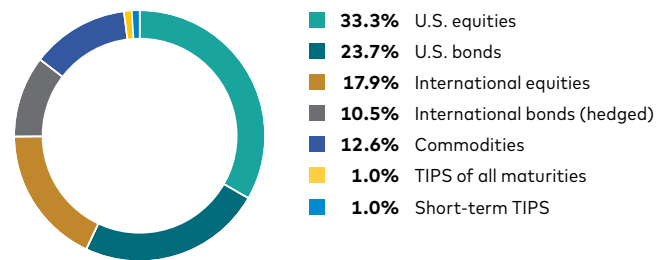
Our analysis began with a traditional 60% equity/40% fixed income core portfolio, shown in **Figure 5a**. We then constructed an alternative, inflation-aware portfolio using a core-satellite approach (**Figure 5b**), where the core allocation maintains its relative structure and a modest satellite allocation is added to increase the portfolio's overall inflation beta. The resulting core-satellite portfolio allocates approximately 13% to commodities, with smaller allocations to short-term TIPS and TIPS of all maturities, while maintaining the same overall risk tolerance as the core portfolio.

**FIGURE 5**  
**Inflation beta-optimized portfolios relative to 60/40 core portfolio**

a. Core only



b. Core satellite (inflation beta=1)



Source: Vanguard.

As shown in **Figure 6**, the core-satellite portfolio is expected to deliver slightly higher median returns over the next decade compared with a traditional 60/40 portfolio, though not without trade-offs. While total exposure to risky assets increases only modestly, the diversification benefits of commodities help keep overall portfolio volatility in check. However, this approach also introduces tracking error and a probability of underperformance relative to a traditional 60/40 portfolio.

For investors who are comfortable with these trade-offs and are seeking to enhance inflation protection without materially increasing portfolio risk, a core-satellite approach offers a balanced, flexible way to incorporate inflation-sensitive assets into an otherwise well-diversified portfolio.

**Figure 6**  
**Portfolio expectations over the next decade of inflation beta-optimized allocations relative to a core 60/40 portfolio**

	Core 60/40	VAAM-optimized core satellite (inflation beta=1)
Annualized total return	5.3%	5.5%
Annualized volatility	9.2%	8.3%
Excess return	—	0.2%
Probability of underperforming (annually)	—	50.6%
Tracking error	—	2.5%
Maximum drawdown	-58.7%	-50.1%
Sharpe ratio	0.20	0.25
Inflation beta	0.07	1.0
Satellite weight	—	15%
Risky allocation (equities plus commodities)	60%	64%

**Note:** Portfolio expectations are based on the 10-year-ahead VCMM asset class forecasts as of February 28, 2026.

**Source:** Vanguard.

## Conclusion

Inflation remains a complex, multifaceted risk that cannot be fully addressed through any single asset or strategy. While equities continue to offer the most reliable protection against inflation over long horizons, their short-term relationship with inflation is weak, leaving some investors exposed during inflationary shocks. Assets such as commodities and TIPS provide more direct inflation sensitivity. Relative to a market-capitalization-weighted core portfolio, these strategies will have a greater chance of achieving higher median returns over the next decade, albeit with higher tracking error and periods of underperformance.

Our analysis shows that a disciplined core-satellite framework—anchored by a diversified, growth-oriented core and complemented by selective allocations to inflation-sensitive assets—can improve a portfolio's responsiveness to inflation without materially compromising long-term risk-adjusted returns. Ultimately, the appropriate role of inflation-hedging assets depends on an investor's time horizon, risk tolerance, and spending needs, reinforcing the importance of aligning portfolio construction decisions with the specific ways inflation risk is experienced.

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## Appendix

### Asset returns: Vanguard Capital Markets Model

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The VCMM projections are based on a statistical analysis of historical data. Future returns may behave differently from the historical patterns captured in the VCMM. More important, the VCMM may be underestimating extreme negative scenarios unobserved in the historical period on which the model estimation is based.

The VCMM is a proprietary financial simulation tool developed and maintained by Vanguard's Investment Strategy Group. The model forecasts distributions of future returns for a wide array of broad asset classes. Those asset classes include U.S. and international equity markets, several maturities of the U.S. Treasury and corporate fixed income markets, international fixed income markets, U.S. money markets, commodities, and certain alternative investment strategies. The theoretical and empirical foundation for the Vanguard Capital Markets Model is that the returns of various asset classes reflect the compensation investors require for bearing different types of systematic risk (beta).

At the core of the model are estimates of the dynamic statistical relationship between risk factors and asset returns, obtained from statistical analysis based on available monthly financial and economic data. Using a system of estimated equations, the model then applies a Monte Carlo simulation method to project the estimated interrelationships among risk factors and asset classes as well as uncertainty and randomness over time. The model generates a large set of simulated outcomes for each asset class over several time horizons. Forecasts are

obtained by computing measures of central tendency in these simulations. Results produced by the tool will vary with each use and over time. The asset-return distributions shown in this paper are drawn from 10,000 VCMM simulations based on market data and other information available as of February 28, 2026.

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### Indexes for VCMM simulations

The long-term returns of our hypothetical portfolios are based on data for the appropriate market indexes through February 28, 2026. We chose these benchmarks to provide the most complete history possible, and we apportioned the global allocations to align with Vanguard's guidance in constructing diversified portfolios. Asset classes and their representative forecast indexes are as follows:

- U.S. equities—MSCI US Broad Market Index.
- Global ex-U.S. equities—MSCI All Country World ex USA Index.
- U.S. bonds—Bloomberg U.S. Aggregate Bond Index.
- Global ex-U.S. bonds—Bloomberg Global Aggregate ex-USD Index (hedged).
- U.S. TIPS—Bloomberg U.S. Treasury Inflation Protected Securities Index.
- U.S. short-term TIPS—Bloomberg U.S. 1–5 Year Treasury Inflation Protected Securities Index.

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