

# A Dynamic Multi-Asset Approach to Inflation Hedging

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## EXECUTIVE SUMMARY

Inflation is one of the most significant risks to investment returns over the long term.<sup>1</sup> Core equities and conventional bonds tend to deliver below-average returns in rising inflation environments, which can encourage investors to seek out inflation-sensitive assets, such as commodities, inflation-linked bonds, REITs, natural resource stocks, and gold, to protect their portfolios from inflation shocks.

In this paper, we construct a multi-asset index for inflation protection. First, we look into forecasting inflation. Next, we analyze the inflation sensitivity of various asset classes. Then, we identify strategies for different inflation regimes. Finally, we present portfolios that adjust their allocation dynamically to changes in the inflation regime.

## INTRODUCTION

As record levels of monetary and fiscal stimulus are pumped into the recovering global economy, inflation has returned to the discussion. The low-inflation environment of the past few decades has penalized inflation-sensitive assets. Given that inflation can be notoriously difficult to forecast, and market participants may experience unexpected inflation shocks, it is worthwhile to revisit the concept of inflation protection.

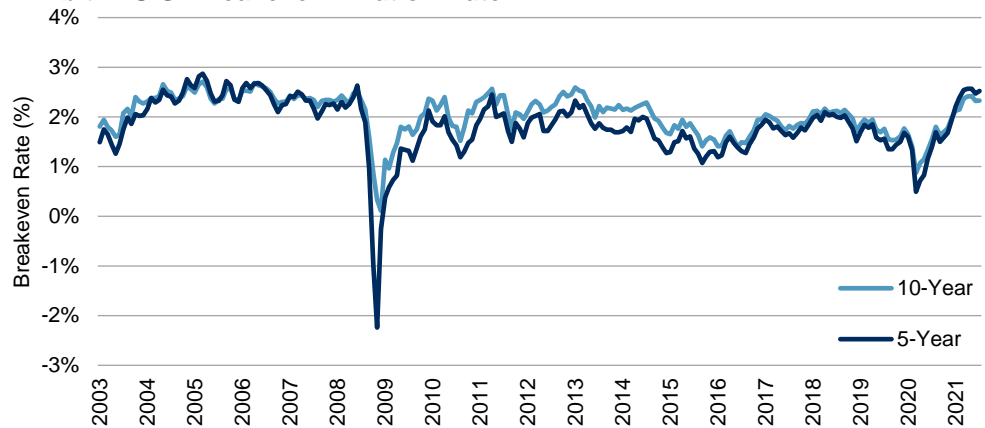
For many investors, the unprecedented and coordinated fiscal stimulus in the wake of the COVID-19 pandemic has justified concerns over inflation. Neville et al. summarized four factors that suggest heightened inflation risk: (1) unprecedented increase in money creation, (2) historically high fiscal deficit level, (3) recent increase in long-term yields, and (4) the inflation derivatives market pricing in a 31% probability that the average inflation rate will exceed 3% over the next five years.<sup>2, 3</sup>

<sup>1</sup> Inflation is the decrease of purchasing power in a currency over time. On the other hand, an increase of purchasing power is called deflation. Different currencies can experience different levels of inflation during the same period.

<sup>2</sup> According to data from the Minneapolis Fed; see <https://www.minneapolisfed.org/banking/current-and-historical-market-based-probabilities>

<sup>3</sup> Neville et al. (2021) *The Best Strategies for Inflationary Times*. Available at SSRN: <https://ssrn.com/abstract=3813202> or <http://dx.doi.org/10.2139/ssrn.3813202>

**Exhibit 1: U.S. Breakeven Inflation Rate**



Source: St. Louis Federal Reserve.<sup>4</sup> Data from January 2003 to June 2021. Chart is provided for illustrative purposes.

*Fiscal stimulus in the wake of the COVID-19 pandemic has raised concerns about inflation.*

The U.S. 10-year breakeven inflation rate implies what market participants expect inflation to be over the next 10 years, on average. Exhibit 1 illustrates that market participants have persistently revised their inflation expectations higher since the pandemic-induced low in March 2020.

*Currently, the risk of inflation centers on whether the post-pandemic recovery will be merely reflationary or truly inflationary.*

Currently, the risk of inflation centers on whether the post-pandemic recovery will be merely reflationary or truly inflationary. Quantitative easing since 2008 has only proved inflationary for paper assets (i.e., equities), but there is an argument to be made that after the COVID-19 pandemic, coordinated, real-asset heavy fiscal spending may prove inflationary. Even though the trajectory of real-asset inflation is likely lower due to structural changes in demographics, technology, consumption, and productivity, starting from a low inflation level means even a small increase in inflationary pressure can lead to notable asset repricing. As the last period of prolonged inflation occurred decades ago, most investors have not experienced it. It may be difficult for them to assign a probability to a sustained period of inflation as well as to adapt portfolio construction should the probability be sufficiently high. Investors tend to have short memories.

*As the last period of prolonged inflation occurred decades ago, most investors have not experienced it.*

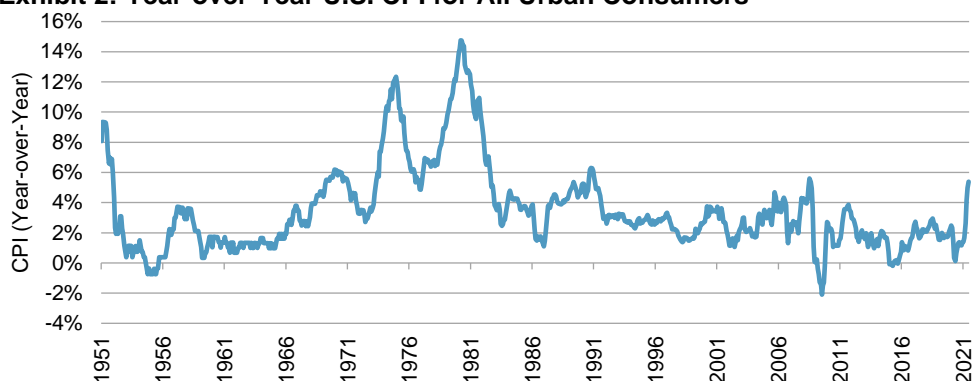
The most common measure of inflation in the U.S. is the Consumer Price Index (CPI), which represents the average price change over time for a market basket of consumer goods and services.<sup>5</sup> Using the CPI for all urban consumers, we see that periods of heightened inflation are not uncommon (see Exhibit 2). Extreme economic conditions can result in extreme inflation. Over the past six decades, inflation was highest in the 1970s, when the oil crisis helped push annual price increases to levels exceeding 10%, spilling over into the first few years of the 1980s. Inflation was lowest in the most recent decade (2011-2020), while the trend has clearly been upward over the first half of 2021.

<sup>4</sup> <https://fred.stlouisfed.org/series/T10YIE>

<sup>5</sup> <https://www.bls.gov/cpi/>

Over the past six decades, inflation was highest in the 1970s, when the oil crisis helped push annual price increases to levels exceeding 10%.

**Exhibit 2: Year-over-Year U.S. CPI for All Urban Consumers**



Source: St. Louis Federal Reserve. Data from January 1950 to May 2021. Chart is provided for illustrative purposes.

## FORECASTING INFLATION REGIMES

In order to construct a dynamic index that proactively adjusts to changes in inflation, we first need a reliable measure of forthcoming inflation. Several studies have evaluated approaches to forecasting inflation based on time-series models, macroeconomic measures such as the Phillips curve, the term structure of interest rates, and inflation-expectation surveys.<sup>6</sup> Inflation tends to be somewhat persistent,<sup>7</sup> but its persistence can vary over time due to sudden and unexpected changes in the economic factors that affect prices. As a consequence, different methods yield better forecasts depending on the time period being examined. But overall, the consensus is that surveys perform better out-of-sample when the root-mean-square error (RMSE) is used as the evaluation metric. It has also been found that combining surveys with other measures yields little improvement in terms of forecast accuracy.

Given the “sticky” nature of inflation, the current month’s realized year-over-year inflation rate could be considered an acceptable forecast of the following month’s inflation.

In practice, given the “sticky” nature of inflation, the current month’s realized year-over-year inflation rate could be considered an acceptable forecast of the following month’s inflation. This is often referred to as a naive forecast since it uses no additional information either from the historical time series or from related economic data. Research has shown that this simple approach is a good approximation of the survey-based measures.<sup>3</sup> Our own empirical validation using data since 1980 (see Exhibit 3) confirmed that surveys have a high correlation to realized inflation, but the naive approach was clearly better. We observe that surveys tend to be somewhat optimistic, and that they are particularly poor at forecasting low inflation (< 1%). They also fall short when the realized inflation is above 4%.

<sup>6</sup> Ang et al. (2007) *Do Macro Variables, Asset Markets, or Surveys Forecast Inflation Better?* Journal of Monetary Economics (Vol. 54, Issue 4, pp. 1163 – 1212). Elsevier. <https://www.sciencedirect.com/science/article/abs/pii/S0304393206002303>

<sup>7</sup> Jeffrey C. Fuhrer (2010) *Inflation Persistence*. Handbook of Monetary Economics (Vol. 3, pp. 423-486). Elsevier. <https://www.sciencedirect.com/science/article/pii/B9780444532381000090>

**Exhibit 3: Correlation between Inflation Forecasts and the Realized Inflation**

INFLATION FORECAST METHOD	CORRELATION TO CPI INFLATION (HEADLINE)
Naive Forecast	0.976
MichSPF: Average of Michigan Survey and Survey of Professional Forecasters (SPF)	0.849
Michigan Survey	0.816
SPF	0.801
Cleveland Survey	0.73
5-Year Treasury Inflation-Protected Securities (TIPS)	0.691
5-Year Breakeven Rate	0.653
10-Year TIPS	0.641
10-Year Breakeven Rate	0.632
Retail Sales	0.552
M2 Velocity	0.387
M1 Velocity	0.302

*Data since 1980 confirmed that while surveys have a high correlation to realized inflation, the naïve approach was clearly better.*

Source: St. Louis Federal Reserve, Philadelphia Federal Reserve,<sup>8</sup> and Cleveland Federal Reserve.<sup>9</sup> Data from January 1980 to June 2021. Past performance is no guarantee of future results. Table is provided for illustrative purposes.

Our choice of inflation forecast is guided by two additional considerations. First, we are less interested in precise forecasts, but aim to broadly assess how the inflation might turn out on a relative basis. Second, due to data limitations, we are confined to a relatively short back-test period (starting in 1997), during which time we have not seen prolonged periods of truly high (i.e., above 4%-5%) inflation.

One possible way to identify the inflation “regime” is to define cutoffs for specific levels of inflation. The only caveat is that we must be careful to apply cutoffs that yield enough data points in each regime, to allow for comprehensive back-testing. We evaluated a few different cut-off levels (see Exhibit 4) and found that a conservative set works best, i.e., realized inflation below 1.5% is classified as being “low”, 1.5% to 2.5% is labeled “medium”, and anything above 2.5% is considered “high” inflation.

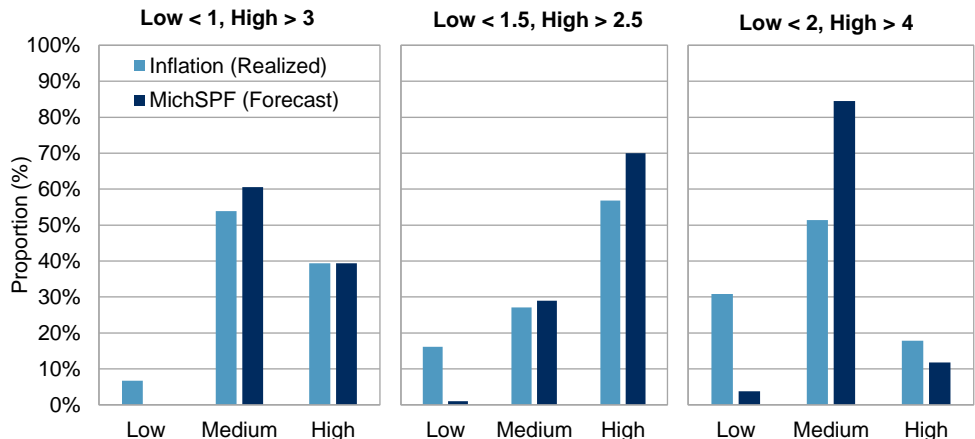
*We defined three inflation regimes: low (< 1.5%), medium (1.5% - 2.5%), and high (> 2.5%).*

Another approach is to use the trend in recently reported inflation rates. The idea here is to predict next month’s inflation based on the slope of a straight line fit to the preceding 10 months’ inflation readings. If the line is clearly trending upward, we would “bump up” our forecast regime to one level higher than the current month’s regime, and vice-versa.

<sup>8</sup> SPF: <https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/survey-of-professional-forecasters>

<sup>9</sup> Cleveland Survey: <https://www.clevelandfed.org/our-research/indicators-and-data/inflation-expectations.aspx>

**Exhibit 4: Inflation Regime Distribution**

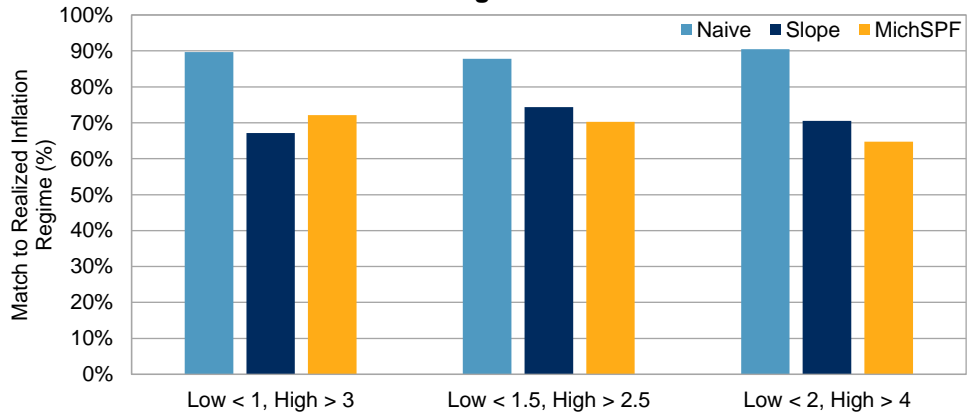


Source: St. Louis Federal Reserve and Philadelphia Federal Reserve. Data from January 1981 to June 2021. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

*We can tolerate some deviation in the numerical estimate of the inflation forecast...*

With both the cutoff-based and slope-based approaches, we can tolerate some deviation in the numerical estimate of the forecast, as long as it closely matches the regime of the realized inflation. With a match rate of about 90% (see Exhibit 5), the naive forecast has historically outperformed other measures in this respect. This is not surprising since the year-over-year CPI does not exhibit drastic changes between consecutive months too often.

**Exhibit 5: Match between Inflation Regimes – Realized versus Forecast**



Source: St. Louis Federal Reserve and Philadelphia Federal Reserve. Data from January 1981 to June 2021. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

*...as long as it closely matches the regime of the realized inflation.*

There are several different ways to characterize and quantify inflation, and we used the CPI headline version (for all urban consumers, before seasonal adjustment) since it is the most comprehensive and widely cited measure. But the results we present here are largely robust to alternative definitions such as the Core CPI, which excludes food and energy<sup>10</sup> or the personal consumption expenditures (PCE) trimmed-mean estimate.<sup>11</sup>

<sup>10</sup> <https://fred.stlouisfed.org/series/CPILFESL>

<sup>11</sup> <https://www.dallasfed.org/research/pce>

## ASSET CLASSES AND THEIR INFLATION SENSITIVITY

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Our goal is not just to seek protection in a high-inflation environment, but to achieve relatively standard risk-adjusted returns in other regimes as well. To that end, we selected asset classes that are differentiated in terms of inflation sensitivity and performance in various inflation regimes.

Equity and bonds, two of the most common asset classes, are known to perform well during periods of relatively low inflation. TIPS are a staple of any inflation portfolio since their coupon payments are linked to inflation rates. Real estate is a classic inflation-protected asset, although it can be difficult to effectively incorporate in a liquid, dynamic investment portfolio. We have included real estate investment trusts (REITs), broad commodity exposure, and a few select commodities, since they are all investable asset classes that are known to historically offer good inflation protection.

For each asset class, we chose the index that has the broadest coverage (e.g., [S&P Composite 1500®](#) for equity) and is both replicable and investable (see Exhibit 6).

*To that end, we selected asset classes that are differentiated in terms of inflation sensitivity and performance in various inflation regimes.*

**Exhibit 6: Representative Indices for Each Asset Class**

ASSET CLASS	INDEX NAME
Equity	S&P Composite 1500 (TR)
Bonds	S&P U.S. Aggregate Bond Index (TR)
Broad Commodities	S&P GSCI (TR)
Inflation-Protected Bonds	S&P U.S. TIPS Index (TR)
Real Estate	S&P United States REIT (USD) (TR)
Gold	S&P GSCI Gold (TR)
Copper	S&P GSCI Copper (TR)
Crude Oil	S&P GSCI Crude Oil (TR)

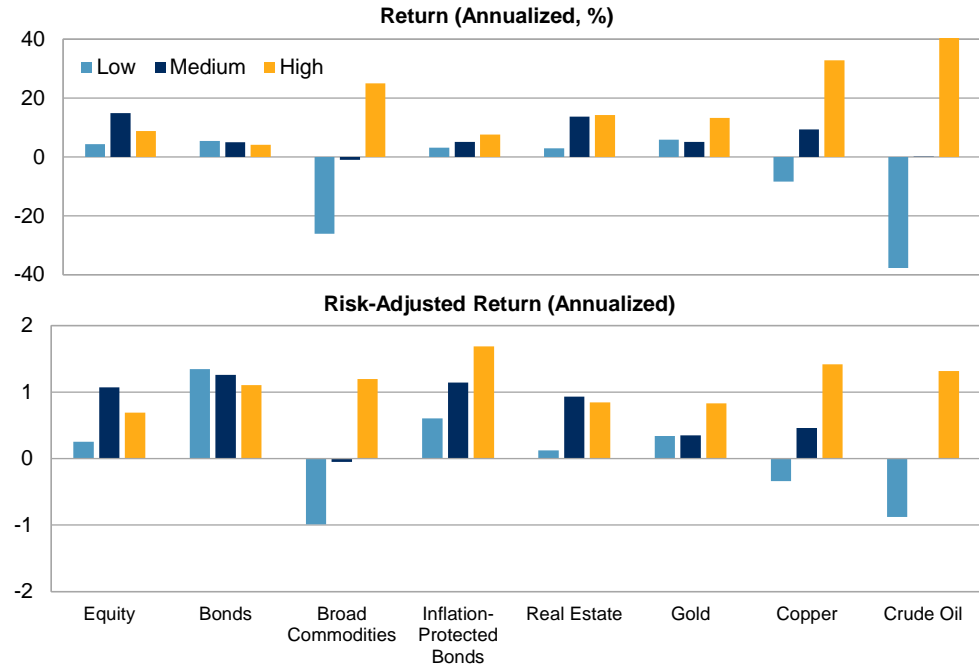
Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

We have restricted ourselves to U.S.-based assets since we use the U.S. CPI as our inflation measure. Incorporating assets from around the world seems like a reasonable hedge for an investor, but it creates the complexity of having to track and predict inflation in other regions while dealing with effects such as exchange rates and the possibly different timing of inflation across countries.

*We have restricted ourselves to U.S.-based assets since we use the U.S. CPI as our inflation measure.*

Using data from the past two decades, we see that equity and fixed income assets tend to perform well in low and medium inflation environments (see Exhibit 7). However, during the 1970s, when inflation was rising and persistently high, commodities outperformed both equity and fixed income by a significant margin.<sup>3</sup>

**Exhibit 7: Asset Class Performance (by Regime)**



*Equity and fixed income assets tend to perform well in low and medium inflation environments.*

*However, during the 1970s, when inflation was rising and persistently high, commodities outperformed both equity and fixed income by a significant margin.*

*To better understand the relationship between returns and inflation, we need to analyze the “inflation beta” of each asset class.*

Source: S&P Dow Jones Indices LLC. Data from March 1997 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

To better understand the relationship between returns and inflation, we need to analyze the “inflation beta” of each asset class. Inflation beta measures the sensitivity of asset returns to changes in inflation. For example, an inflation beta of 5 indicates that the asset return would go up by 5% for a 1% rise in inflation. Inflation beta truly quantifies the inflation hedging ability of a given asset class, since it captures both the direction and magnitude of the change in return against the change in inflation. Inflation beta is an important determinant of inflation protection: a relatively high inflation beta means that even a small allocation to such assets may offer sufficient inflation protection for the whole portfolio.

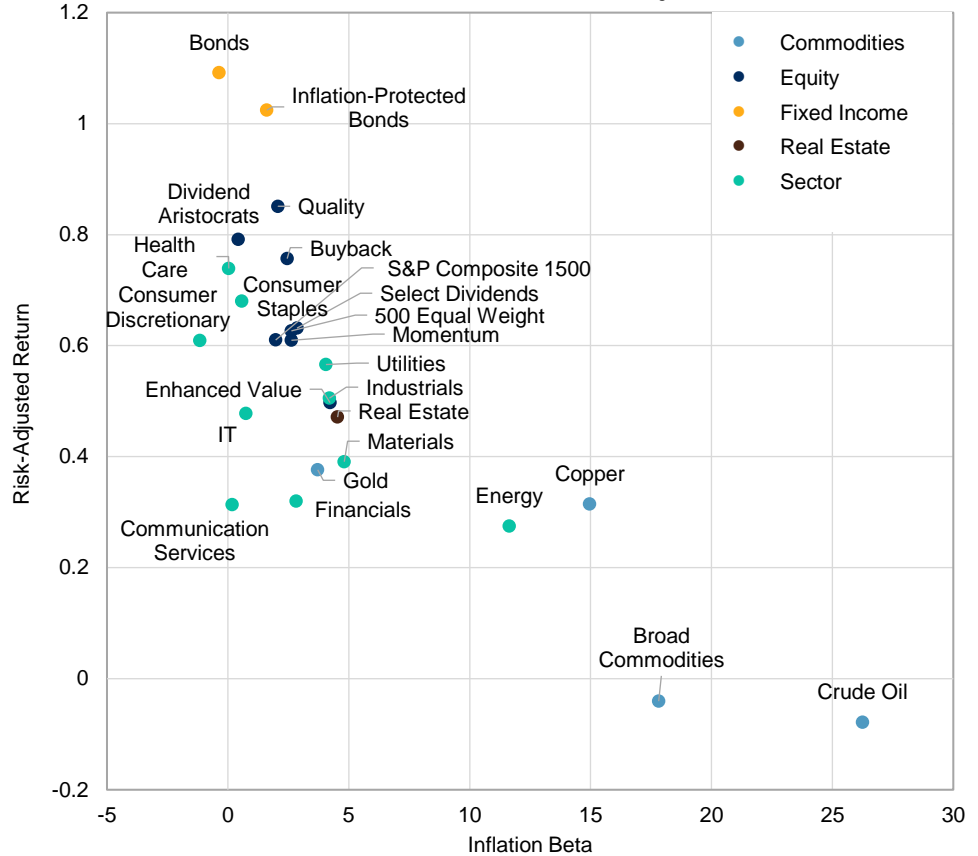
However, inflation sensitivity comes at a cost—asset classes that have high inflation beta are usually associated with higher volatility and lower risk-adjusted returns. Exhibit 8 illustrates the trade-off between inflation beta and risk-adjusted return among indices representative of broad asset classes, equity sectors, and equity factors. We observe that in general, commodity assets such as gold, copper, and crude oil have high inflation beta but low risk-adjusted returns, while fixed income instruments (bonds and TIPS) have the lowest inflation beta and relatively higher risk-adjusted returns.

*Inflation beta measures the sensitivity of asset returns to changes in inflation.*

*A relatively high inflation beta means that even a small allocation to such assets may offer sufficient inflation protection for the whole portfolio.*

*While the inflation beta of fixed income assets tends to be fairly stable over time, commodities have exhibited more variation in sensitivity.*

**Exhibit 8: Asset Class Inflation Beta versus Risk-Adjusted Return**

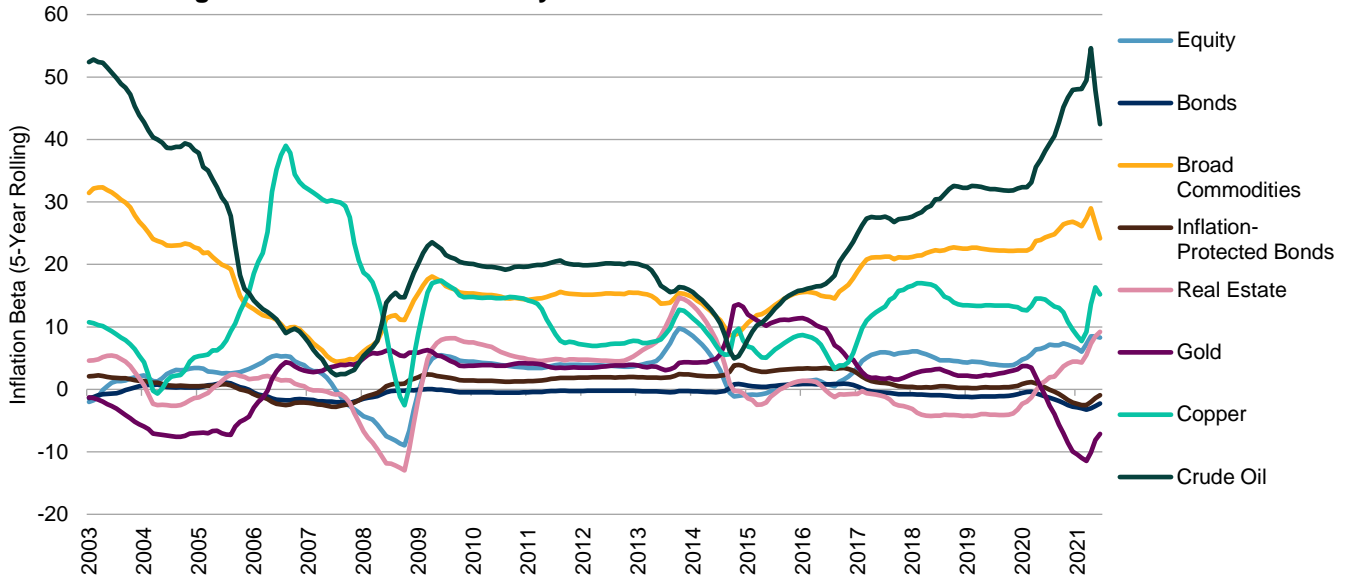


Source: S&P Dow Jones Indices LLC. Data from March 1997 to June 2021. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Another important characteristic of inflation beta is that it is not a static measure. Asset classes exhibit time-varying sensitivity to inflation, as illustrated in Exhibit 9. While the inflation beta of fixed income assets tends to be fairly stable over time, commodities have exhibited more variation in sensitivity, and even a widely accepted “inflation hedge” asset like gold has experienced short periods of negative inflation beta. This time-varying nature of inflation beta makes the construction of an inflation hedging portfolio more challenging.



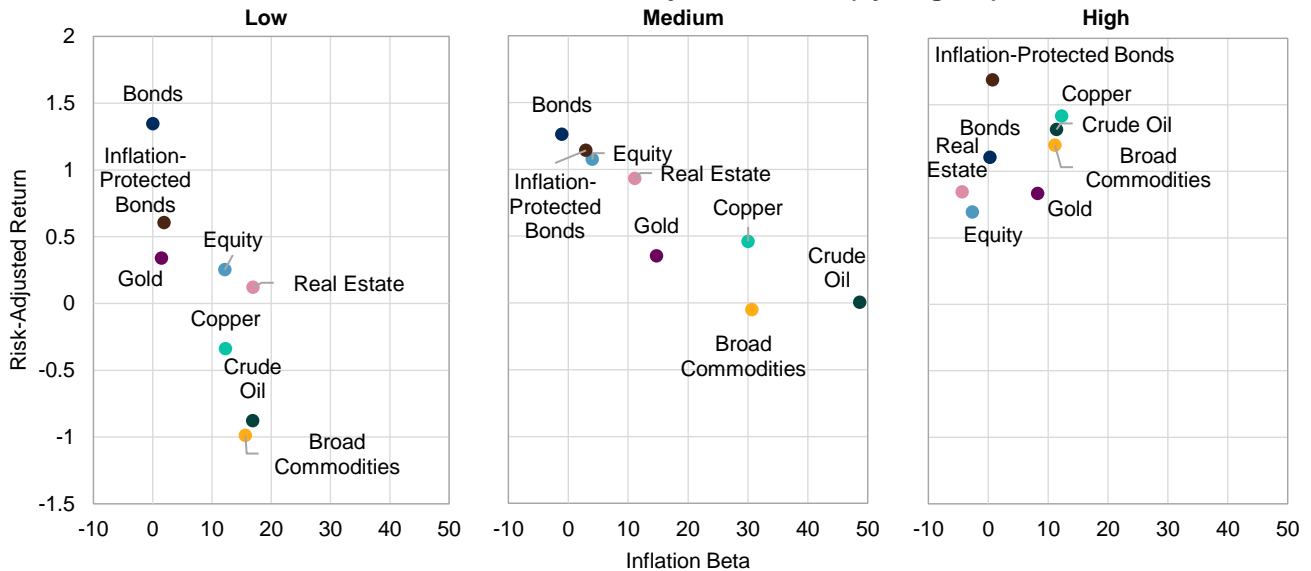
**Exhibit 9: Rolling Five-Year Inflation Beta by Asset Class**



Source: S&P Dow Jones Indices LLC. Data from March 1997 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Looking at inflation sensitivity across the different inflation regimes, we find that commodities have had higher inflation beta in the medium- and high-inflation regimes. We previously noted an inverse relationship between inflation beta and risk-adjusted return (see Exhibit 8), but when examined within each regime (see Exhibit 10), we see that in the high inflation regime, the relationship has actually been positive. Since commodities have exhibited positive inflation sensitivity and better performance during periods of high inflation, they could be good candidates to overweight in our portfolio during that regime.

**Exhibit 10: Asset Class Inflation Beta versus Risk-Adjusted Return (by Regime)**



Source: S&P Dow Jones Indices LLC. Data from March 1997 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

*It is beneficial to select assets that offer the greatest diversification, all else being equal.*

A natural question that arises at this point is: how many assets are required in order to create an inflation-protection portfolio? Given the typical benefits of diversification (lower volatility and better risk-adjusted return), it makes sense to select assets that offer the greatest diversification, all else being equal. Among the asset classes we considered, we found that using the first six (equity, bonds, broad commodities, inflation-protected bonds, real estate, and gold) resulted in the most diversified portfolio, with broad commodities and real estate contributing the most to overall volatility over the back-test period.

It is worth noting that none of the asset classes in our final selection are a pure play on inflation risk. The level of inflation protection they offer depends on other risk factors that may drive the return profile of specific assets at any point in time.

*One approach to building a dynamic inflation protection index is to construct several model portfolios that have historically performed well in various inflation regimes...*

## **DYNAMIC INDEX DESIGN**

### **Concept**

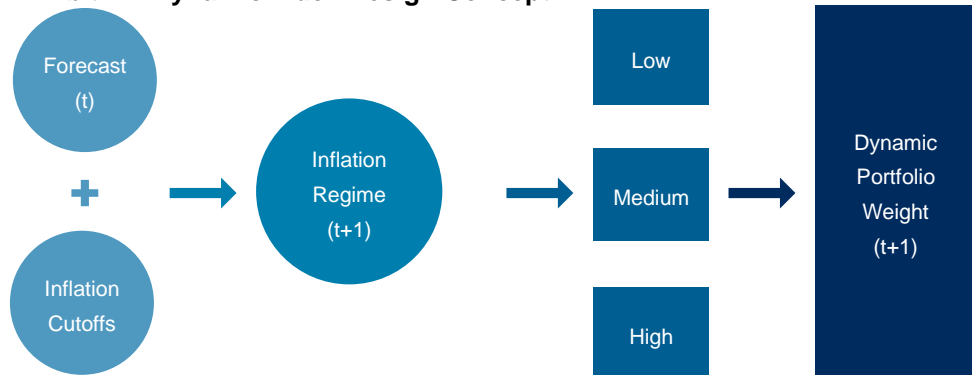
The performance characteristics of different asset classes, their time-varying inflation sensitivity, and the trade-off between the two need to be carefully considered when constructing a dynamic multi-asset index. A fixed allocation to major asset classes does not provide sufficient protection against inflation. For instance, the popular “60/40” allocation between equity and fixed income may appear suitable for the long term, but it suffers two potential drawbacks. First, it has no allocation to commodities, so it would be vulnerable in a prolonged high inflation environment (as seen in the 1970s). Second, it does not adjust its composition in response to changes in inflation over time. For an investor seeking protection against rising or high inflation, there is no “one size fits all” solution—the portfolio must dynamically adjust to changes in the market environment.

*...and switch between them based on a forecast of the inflation regime at regular intervals.*

One feasible approach is to construct several model portfolios that perform well in various inflation regimes and switch between them based on a forecast of the inflation regime at regular intervals (say, monthly or quarterly). This would result in periodic changes to the asset allocation, potentially reflecting the best response to the prevailing inflation regime (see Exhibit 11).

**Exhibit 11: Dynamic Index Design Concept**

*A successful dynamic allocation portfolio would offer participation in a low and stable inflation environment when major asset classes are known to perform well...*



Source: S&P Dow Jones Indices LLC. Chart is provided for illustrative purposes.

*...while switching to an inflation-hedging portfolio during a rising inflation environment to protect against inflation risk.*

The idea of dynamic switching is not an entirely new one. The [S&P Economic Cycle Factor Rotator Index](#) dynamically allocates among different factor subindices based on economic indicators. Other more quantitative approaches have also been studied. Kang et al. applied a risk parity framework to construct a multi-asset inflation hedging portfolio and found that overlaying simple risk-based allocation strategies on top of it could improve its risk characteristics without affecting its inflation-protecting ability.<sup>12</sup> Brière and Signori conducted portfolio optimization in a mean-shortfall probability framework to maximize above-target returns (inflation + x%) with the constraint that the probability of a shortfall remained lower than a threshold set by the investor.<sup>13</sup>

A successful dynamic allocation portfolio would offer market participation in a low and stable inflation environment when major asset classes such as equity and bonds are known to perform well, while switching to an inflation-hedging portfolio during a rising inflation environment to protect against inflation risk.

**Strategy Selection**

*To create the building blocks of our dynamic index, we explored a variety of investment strategies that suit different inflation regimes.*

To create the building blocks of our dynamic index, we explored a variety of investment strategies that suit different inflation regimes. The standard 60/40 portfolio has shown impressive performance in the past 10 years, owing to the equity bull market, while the equal-weight strategy (EqWt) outperformed it over a longer time period. Given their impact on consumer goods prices, commodities may offer a hedge against inflation, so we included two strategies that combine equity, bonds, and commodities in varying proportions (EBC10 and EBC20).

<sup>12</sup> Kang et al. (2013) *The Role of Multi-Asset Solutions in Indexing*. S&P Dow Jones Indices. <https://www.spglobal.com/spdji/en/documents/research/the-role-of-multi-asset-solutions-in-indexing.pdf>

<sup>13</sup> Marie Brière and Ombretta Signori (2011) *Inflation hedging portfolios in different regimes*. Portfolio and risk management for central banks and sovereign wealth fund (Vol. 58, pp. 139-163). Bank for International Settlements. <https://ideas.repec.org/h/bis/bisbpc/58-08.html>

We then explored a few strategies optimized to meet different objectives (see Exhibit 12). The MinVol allocation is based only on the portfolio volatility, while the MaxRaR strategy achieves the best trade-off between risk and return. The ProIB strategy allocates a higher weight to asset classes that exhibit higher inflation sensitivity. The VolWt strategy overweights asset classes that have had historically lower volatilities, resulting in a more balanced risk contribution, ex-ante. To avoid look-ahead bias, we constructed each strategy over rolling 10-year lookback windows. Given our limited data history, we used a shorter lookback period for the early years (1997 to 2006), effectively employing an “expanding window” that starts at a three-year minimum.

*To avoid look-ahead bias, we constructed each strategy over rolling 10-year lookback windows.*

Exhibit 12: Strategy Allocation							
STRATEGY	ASSET WEIGHT (%)						
	EQUITY	BONDS	BROAD COMMODITIES	INFLATION-PROTECTED BONDS	REAL ESTATE	GOLD	
<b>FIXED WEIGHTS</b>							
1	60/40	60	40	-	-	-	-
2	EqWt	16.7	16.7	16.7	16.6	16.7	16.7
3	EBC10	55	35	10	-	-	-
4	EBC20	50	30	20	-	-	-
<b>VARIABLE WEIGHTS</b>							
5	ProIB	Weights are proportional to the inflation beta of asset classes					
6	VolWt	Weights are inversely proportional to the realized volatility of asset classes					
7	MaxRaR	Weights maximize the risk-adjusted return of the portfolio					
8	MinVol	Weights minimize the volatility of the portfolio					

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

The performance characteristics of all eight strategies across the entire back-test period are presented in Exhibit 13. We observe varying levels of inflation sensitivity and risk-adjusted performance and a somewhat weak, but noticeable, inverse proportionality between the two. The ProIB strategy had the highest inflation beta (by design), while 60/40 was the least sensitive to inflation, and EqWt lay roughly in the middle.

*We observe varying levels of inflation sensitivity and risk-adjusted performance, and an inverse proportionality between the two.*

Exhibit 13: Strategy Performance								
CHARACTERISTIC	60/40	EQWT	EBC10	EBC20	PROIB	VOLWT	MAXRAR	MINVOL
Return (Annualized, %)	6.94	6.98	6.39	5.79	5.77	6.48	5.63	5.34
Volatility (Annualized, %)	9.06	9.1	9.44	10.27	16.06	5.82	5.87	4.63
Risk-Adjusted Return	0.77	0.77	0.68	0.56	0.36	1.11	0.96	1.15
Maximum Drawdown (%)	-32.21	-33.31	-34.74	-38.9	-53.45	-19.38	-19.09	-12.71
Inflation Beta	1.33	4.9	2.95	4.55	10.37	2.74	2.08	1.44

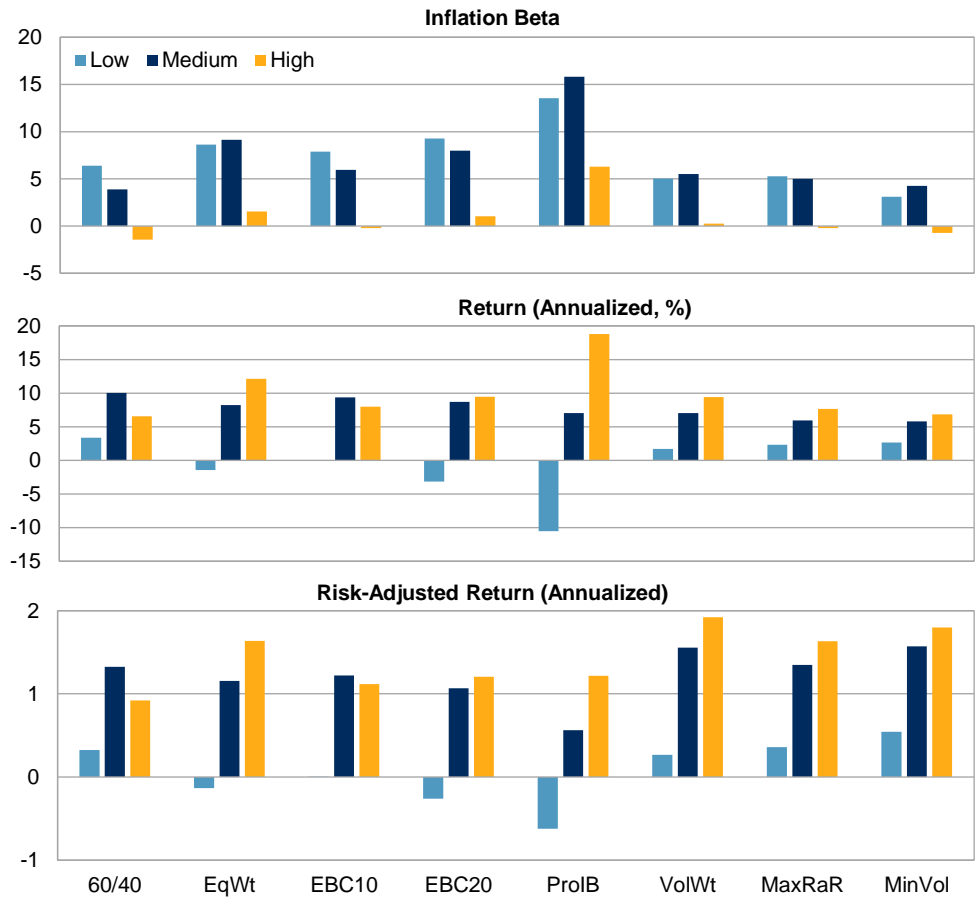
All portfolios are hypothetical

Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

*In the high inflation regime, the ProIB portfolio had the strongest inflation beta, while the 60/40 and MinVol portfolios had the strongest inflation beta...*

When we examine the characteristics by regime, we observe that all eight strategies showed high levels of inflation sensitivity in the low and medium inflation regimes. In the high inflation regime, the ProIB portfolio had the strongest inflation beta, while the 60/40 and MinVol strategies had negative inflation betas (see Exhibit 14). Most of the strategies exhibited better returns (on average) in the high inflation regime, with the ProIB strategy posting the highest absolute return. On a risk-adjusted basis, we saw better performance in the EqWt and VolWt strategies.

**Exhibit 14: Strategy Performance and Inflation Beta (by Regime)**



*...while the 60/40 and MinVol strategies had negative inflation betas.*

*The VolWt strategy has a higher allocation to fixed income assets due to their lower volatility.*

All portfolios are hypothetical. Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

The VolWt strategy had a higher allocation to fixed income assets (bonds and TIPS) due to their lower volatility. The ProIB strategy, on the other hand, had a dominant GSCI allocation over time (see Exhibit 15).

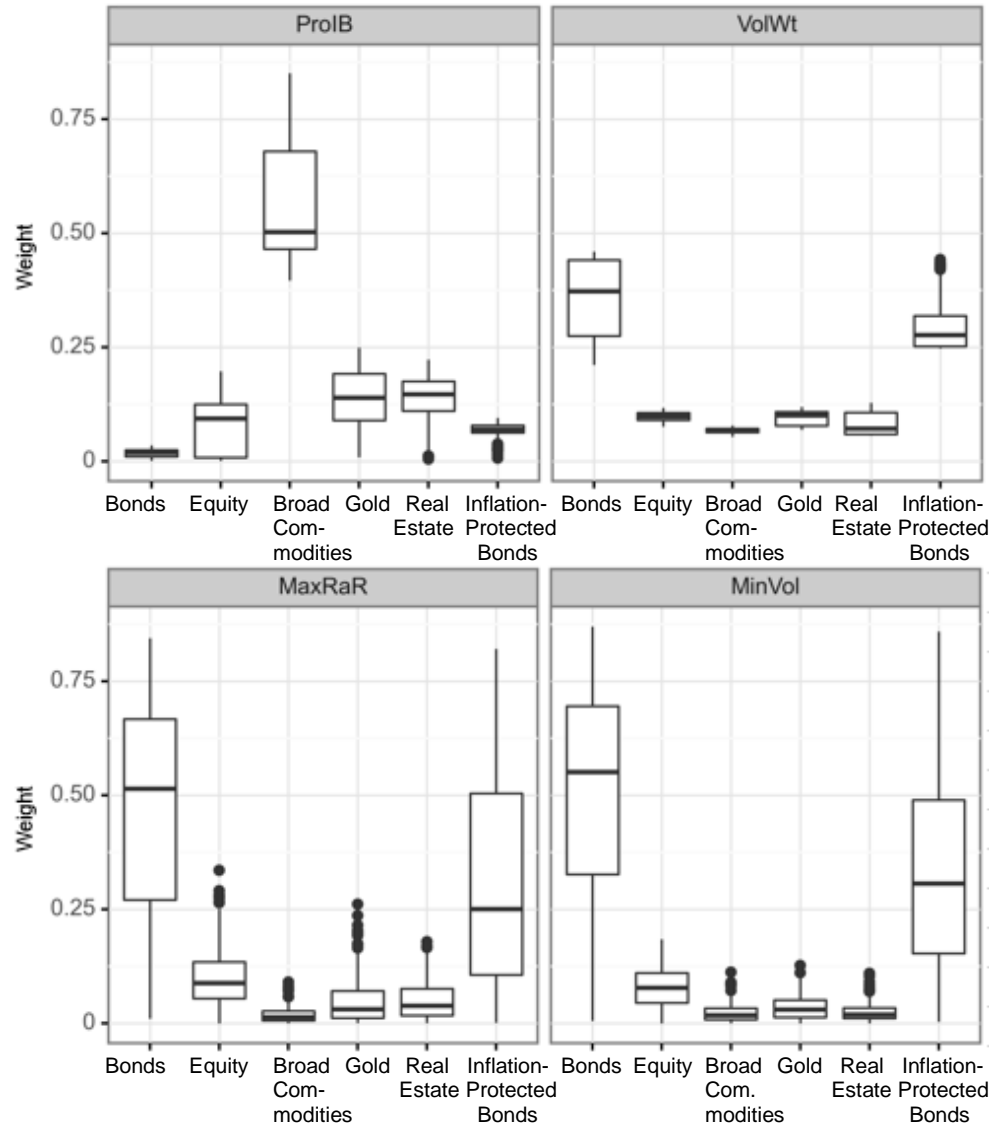
*Systematically identifying the best strategy for each inflation regime presents a few challenges.*

*First, we have a rather short time period for our back-testing.*

*Second, we need to be mindful of the inverse relationship between inflation beta and risk-adjusted performance.*

*Lastly, high turnover is undesirable since it can erode performance and introduce unnecessary operational risks.*

**Exhibit 15: Strategy Weight Distribution for Variable Weight Portfolios**



All portfolios are hypothetical.  
 Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

**Index Construction**

Systematically identifying the best strategy for each inflation regime presents three obstacles. First, we have a rather short time period for our back-testing since TIPS did not exist prior to 1997. Second, we need to be mindful of the inverse relationship between inflation beta and risk-adjusted performance, especially in the low and medium inflation regimes. Lastly, high turnover is undesirable since it can erode performance and introduce unnecessary operational risks.

*We looked for strategy combinations that strike a good balance between all three constraints.*

To satisfy each of these constraints, we created all possible combinations of strategy portfolios across the different inflation regimes. With eight strategy portfolios and three different regimes, this exercise resulted in 512 combinations in total. We then ranked all of the combinations by each individual metric (i.e., inflation beta, risk-adjusted performance, and turnover) and selected a few candidates from each separate ranking. We used some discretion to prefer combinations that had the ProIB strategy in the high inflation regime (see Exhibit 16), owing to its favorable characteristics as previously noted (see Exhibit 10). Lastly, we looked for a combination that strikes a good balance among all three constraints.

*To ensure consistency, all portfolios were rebalanced monthly.*

**Exhibit 16: Dynamic Portfolio Composition.**

REGIME	60/40_VOLWT_PROIB	EQWT_PROIB_PROIB	EQWT_60/40_PROIB	EQWT_VOLWT_PROIB
Low	60/40	EqWt	EqWt	EqWt
Medium	VolWt	ProIB	60/40	VolWt
High	ProIB	ProIB	ProIB	ProIB

Source: S&P Dow Jones Indices LLC. Table is provided for illustrative purposes.

To ensure consistency, all portfolios were rebalanced monthly, based on the naive forecast of inflation regime obtained by applying cutoffs on year-over-year CPI data as described previously.

### Performance, Turnover, and Inflation Sensitivity

We see that the four dynamic portfolios we selected exhibited similar levels of risk-adjusted performance over the back-test period (see Exhibit 17), but their inflation sensitivity and turnover<sup>14</sup> were more varied.

*The four dynamic portfolios we selected exhibited similar levels of risk-adjusted performance over the back-test period...*

**Exhibit 17: Dynamic Portfolio Performance and Risk**

CHARACTERISTIC	60/40_VOLWT_PROIB	EQWT_PROIB_PROIB	EQWT_60/40_PROIB	EQWT_VOLWT_PROIB
Return (Annualized, %)	5.4	4.86	6.18	5.27
Volatility (Annualized, %)	13.27	15.1	13.83	13.23
Risk-Adjusted Return	0.41	0.32	0.45	0.4
Maximum Drawdown (%)	-49.78	-48.92	-48.92	-48.92
Inflation Beta	6.17	8.98	6.21	6.61
Turnover (Annualized)	1.27	0.48	1.62	1.04

All portfolios are hypothetical.

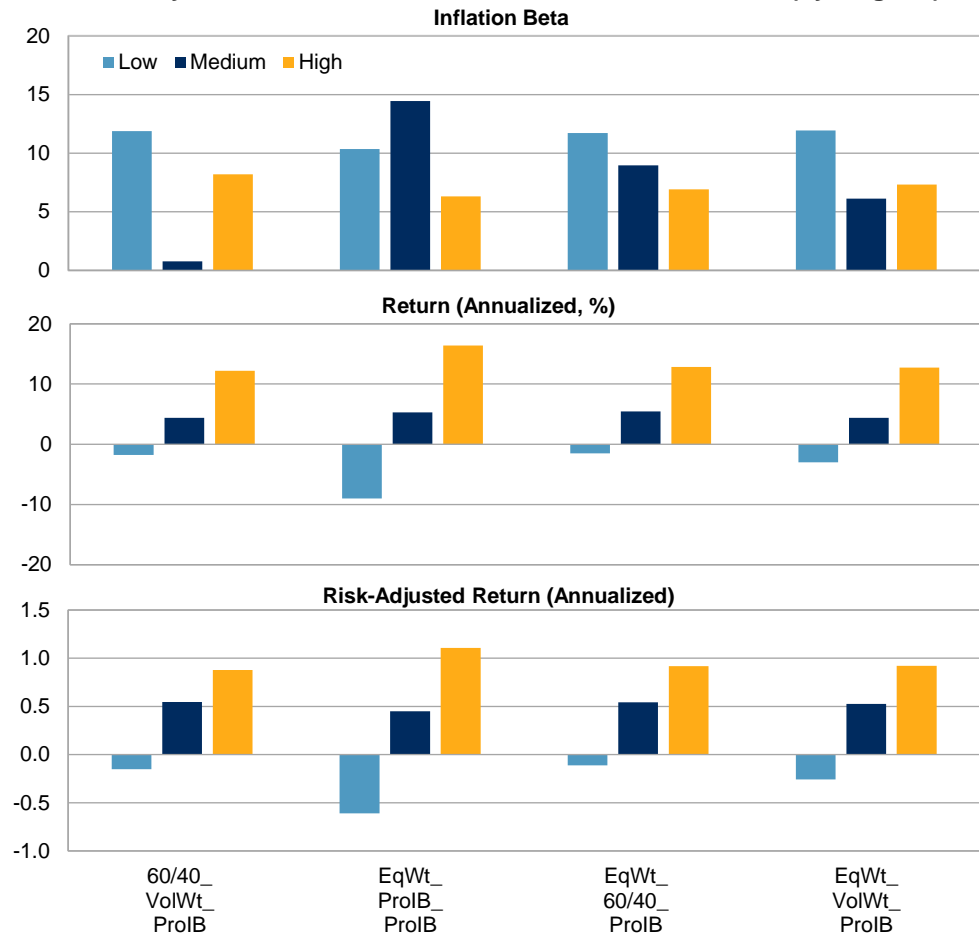
Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

*...but their inflation sensitivity and turnover were more varied.*

<sup>14</sup> Turnover is calculated as the annualized change in allocation to asset classes over time. This is a *theoretical* estimate that ignores modifications to the underlying index constituents. Nevertheless, it is a suitable metric for comparing dynamic portfolios to each other.

**Exhibit 18: Dynamic Portfolio Performance and Inflation Beta (by Regime)**

*The inflation sensitivity of dynamic portfolios is largely influenced by the strategies chosen for each inflation regime.*



*It is also dependent on how often regime shifts occur, which in turn determines how long each regime-specific strategy gets to play out.*

Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

The inflation sensitivity of dynamic portfolios is largely influenced by the strategies chosen for each inflation regime. However, owing to the switching mechanism, it is also dependent on how often regime shifts occur, which in turn determines how long each regime-specific strategy gets to play out. As a combined effect of these two factors, we see that, though all the dynamic portfolios had strong inflation betas in the high inflation regime, many of them had better inflation sensitivity in the low and medium inflation regimes (see Exhibit 18). To some extent, this could also be a consequence of our limited back-test period. During the past 20 years, we have seen longer periods of low and medium inflation, and the performance of dynamic portfolios within those regimes turned out to be more positively correlated to year-over-year CPI data.

*Though all the dynamic portfolios had strong inflation betas in the high inflation regime, many of them had better inflation sensitivity in the low and medium inflation regimes.*

While the overall distribution of weights allocated to each asset class has largely been in line with the choice of strategies (see Exhibit 19), the change in allocation over time depicts interesting patterns that explain the



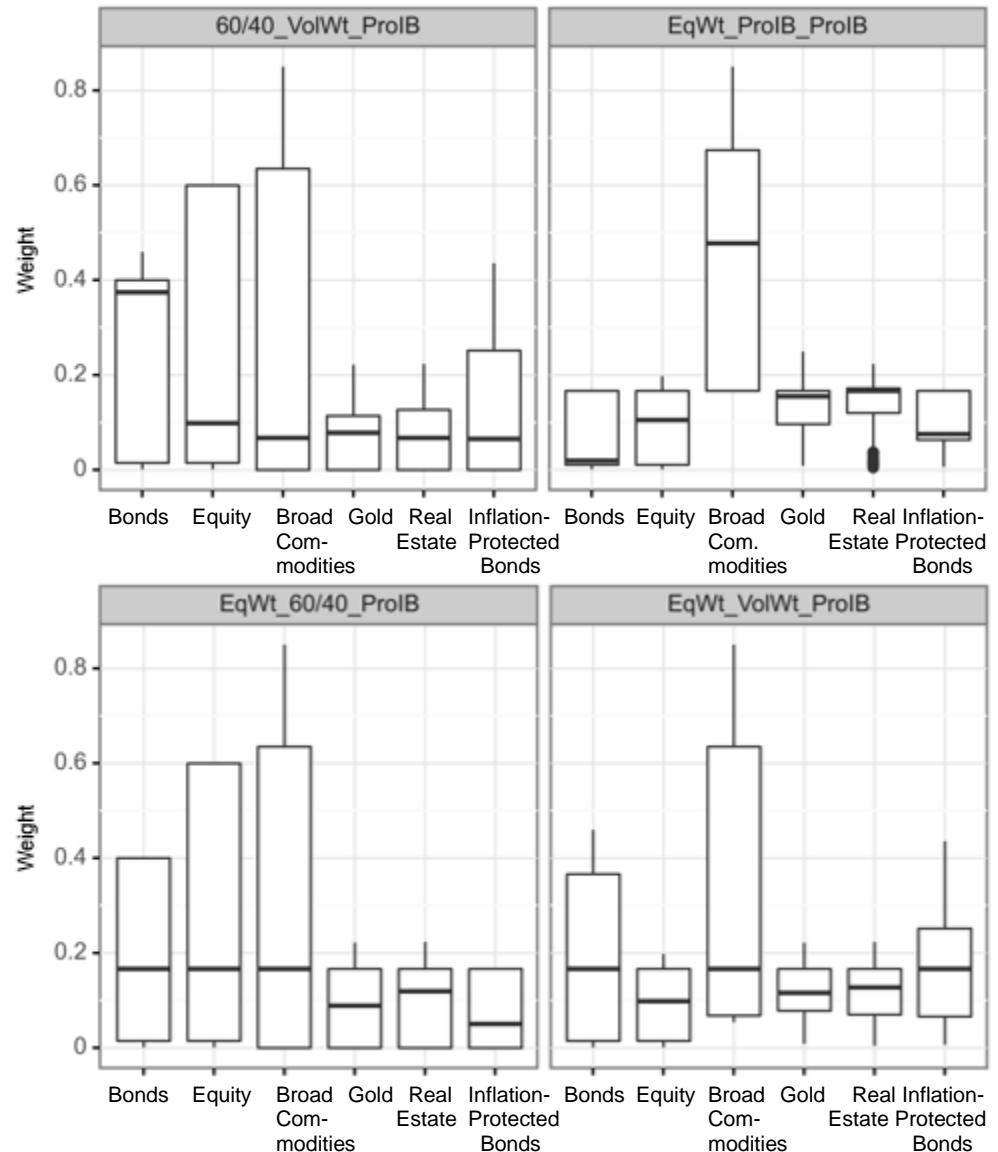
observed turnover in each dynamic portfolio (see Exhibit 20). We see that the EqWt\_ProIB\_ProIB portfolio had the least turnover, since it employs the same ProIB strategy in medium and high inflation regimes. The EqWt\_60/40\_ProIB portfolio employs strategies that differ the most in terms of weight allocations, resulting in relatively high turnover.

*The change in allocation over time depicts patterns that explain the observed turnover in each dynamic portfolio.*

*We see that the EqWt\_ProIB\_ProIB portfolio had the least turnover.*

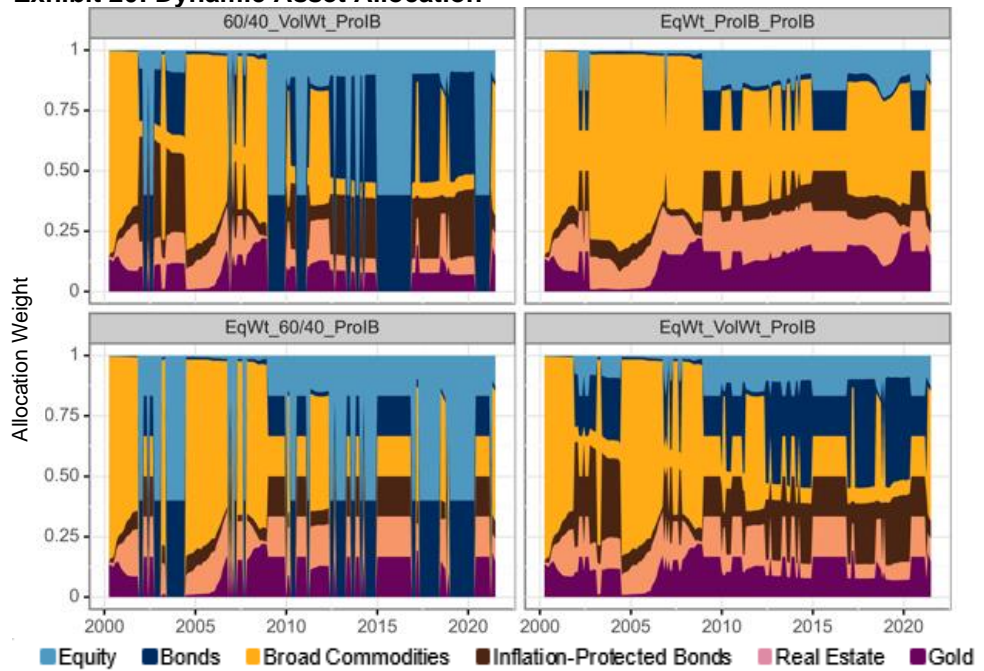
*The EqWt\_60/40\_ProIB portfolio employs strategies that differ the most in terms of weight allocations, resulting in relatively high turnover.*

**Exhibit 19: Dynamic Portfolio Weight Distribution**



All portfolios are hypothetical.  
 Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance is based on total return in USD. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

**Exhibit 20: Dynamic Asset Allocation**



*Comparing the characteristics of the four dynamic portfolios, we observe that each one has some advantages over the others.*

All portfolios are hypothetical.

Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

*The 60/40\_VolWt\_ProIB portfolio demonstrated stronger inflation beta in the high inflation regime and seems relatively easier to implement and manage.*

Comparing the characteristics of the four dynamic portfolios, we observe that each has some advantages over the others. The EqWt\_ProIB\_ProIB portfolio had high inflation beta overall and an attractively low turnover, but its risk-adjusted performance is inferior (owing to high volatility). The EqWt\_60/40\_ProIB portfolio had better risk-adjusted performance than the others, but its inflation beta was lower. The EqWt\_VolWt\_ProIB portfolio strikes a good balance between inflation beta, performance, and turnover, but its high allocation to commodities in the low inflation regime might not be desirable.

*The choice of strategies for the individual regimes could be economically justified.*

The 60/40\_VolWt\_ProIB portfolio demonstrated stronger inflation beta in the high inflation regime and seems relatively easier to implement and manage. The back-tests (though limited in terms of history) show that its performance and turnover are both reasonable. The choice of strategies for the individual regimes could be economically justified. In a low inflation environment, equities tend to perform well, and a traditional 60/40 allocation that is overweight equities could be expected to provide reasonable returns. During periods of medium inflation, fixed income assets tend to yield better risk-adjusted returns, so the VolWt strategy, which overweights them, is a reasonable choice. In a high inflation regime, it makes sense to switch to the ProIB strategy, which overweights commodities and real assets, since those asset classes have better inflation-hedging properties.

## Trade-Offs and Implications

*While switching between vastly different allocations creates more turnover on a monthly basis...*

Exhibit 21 illustrates the annual turnover by the type of regime in consecutive months. While switching between vastly different allocations creates more turnover on a monthly basis, how often such regime switches occur is also a key contributing factor to overall turnover. Due to the fact that some of the strategy portfolios (ProlB and VolWt) are designed using lookback windows, a small amount of turnover is sometimes incurred even when there is no change in regime from one month to the next.

*...how often such regime switches occur is also a key contributing factor to overall turnover.*

**Exhibit 21: Dynamic Portfolio Turnover by Regime Switch**

CHANGE	COUNT	PERCENT	60/40_ VOLWT_ PROIB	EQWT_ PROIB_ PROIB	EQWT_ 60/40_ PROIB	EQWT_ VOLWT_ PROIB
High -> High	83	32.55	0.04	0.04	0.04	0.04
High -> Low	1	0.39	0.05	0.03	0.03	0.03
High -> Medium	10	3.92	0.3	0	0.43	0.3
Low -> Low	56	21.96	0	0	0	0
Low -> Medium	11	4.31	0.28	0.2	0.35	0.17
Medium -> High	11	4.31	0.33	0	0.47	0.33
Medium -> Low	10	3.92	0.26	0.18	0.31	0.16
Medium -> Medium	73	28.63	0.01	0.03	0	0.01
<b>Total</b>	<b>255</b>	<b>100</b>	<b>1.27</b>	<b>0.48</b>	<b>1.62</b>	<b>1.04</b>

All portfolios are hypothetical.

Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

*One possible way to reduce the turnover is to restrict the allocation to specific asset classes.*

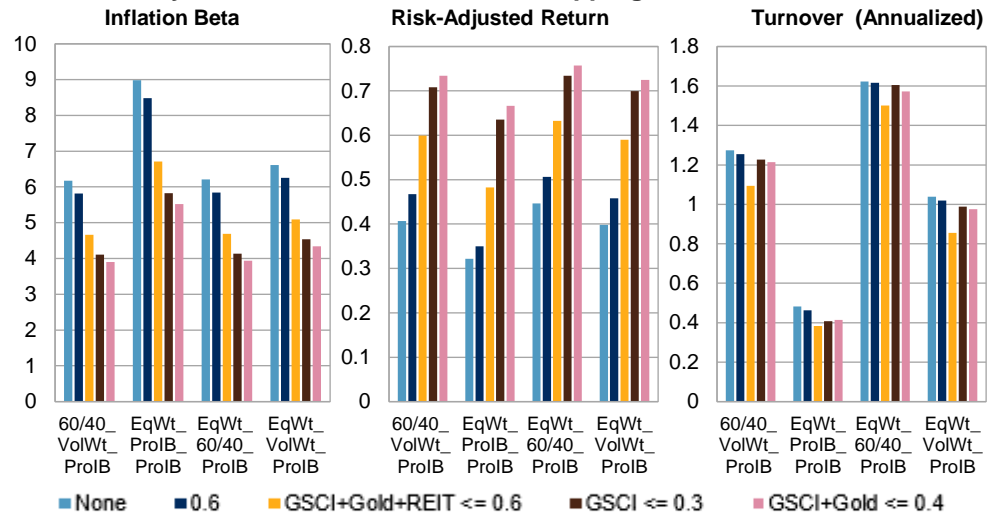
One possible way to reduce the turnover is to restrict the allocation to specific asset classes. We examined the effect of various capping rules on the performance, turnover, and inflation sensitivity of our dynamic portfolios (see Exhibit 22). When any of the allocation limits were breached, the excess weight was allocated to the remaining asset classes in proportion to their original allocation. We see that stringent capping reduced the inflation beta but improved the overall risk-adjusted return. The reduction in turnover might seem relatively small, but it is important to note that this is dependent on how often the capping rules are called into effect.

*Stringent capping reduced the inflation beta but improved the overall risk-adjusted return.*

**Exhibit 22: Dynamic Portfolios – Effect of Capping Rules**

*Another approach is to implement only a portion of the required turnover each month.*

*However, there could be a performance drag in the interim due to deviations from the target allocation*



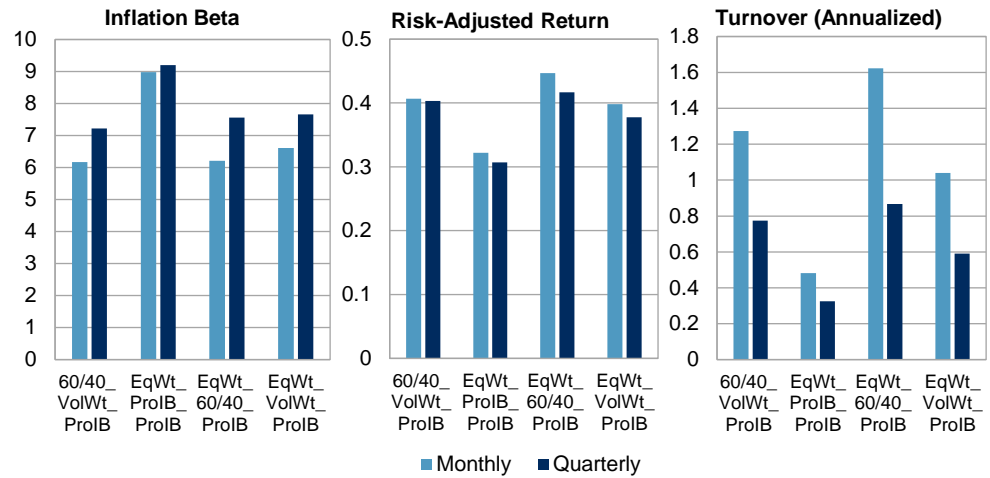
All portfolios are hypothetical. Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

Another approach is to spread out the changes over a few consecutive months, implementing only a portion of the required turnover each month. This may be feasible if the new regime stays constant until the desired exposure is achieved, but there could be a performance drag in the interim due to deviations from the target allocation.

Instead of adjusting our portfolios every month, we could hold the allocation steady until the end of the quarter before reassessing the inflation forecast. This would effectively implement a quarterly rebalance schedule for our portfolios by ignoring monthly changes in the inflation regime. We see that this led to significantly lower turnover and some loss in risk-adjusted performance, but the overall inflation beta improved slightly (see Exhibit 23). Interestingly, when this trade-off is examined within each regime, we find that quarterly rebalancing led to better inflation sensitivity only in the high inflation regime. This is likely due to the fact that the ProIB strategy tends to overweight commodities, which exhibited a positive relationship between inflation sensitivity and risk-adjusted return in the high inflation regime (see Exhibit 10). While it might be preferable to rebalance the dynamic portfolios on a quarterly basis (especially due to the significant reduction in turnover), it is worth considering that in the low and medium inflation regimes, monthly rebalancing has resulted in much better inflation sensitivity, since the portfolio weights are updated more frequently in response to changes in inflation.

*A quarterly rebalance led to significantly lower turnover and some loss in risk-adjusted performance, but the overall inflation beta improved slightly.*

**Exhibit 23: Dynamic Portfolios – Effect of Rebalance Frequency**

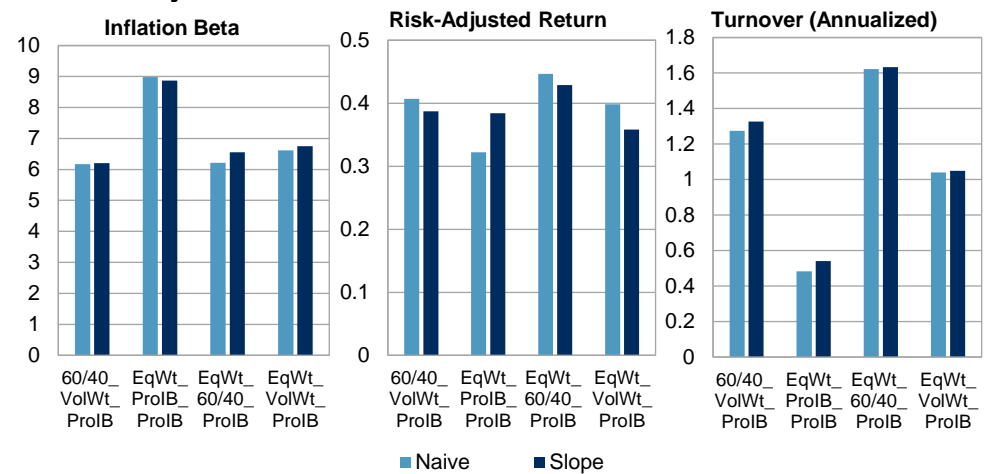


*In the low and medium inflation regimes, monthly rebalancing has resulted in much better inflation sensitivity.*

All portfolios are hypothetical. Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

The slope-based approach forecasts the inflation regime based on the trend in recently observed inflation, leading to smoother tactical changes to the portfolio on account of a slower transition in the forecast regime. This has resulted in slightly inferior performance but no significant change in the turnover or inflation beta (see Exhibit 24).

**Exhibit 24: Dynamic Portfolios – Effect of Forecast Method**



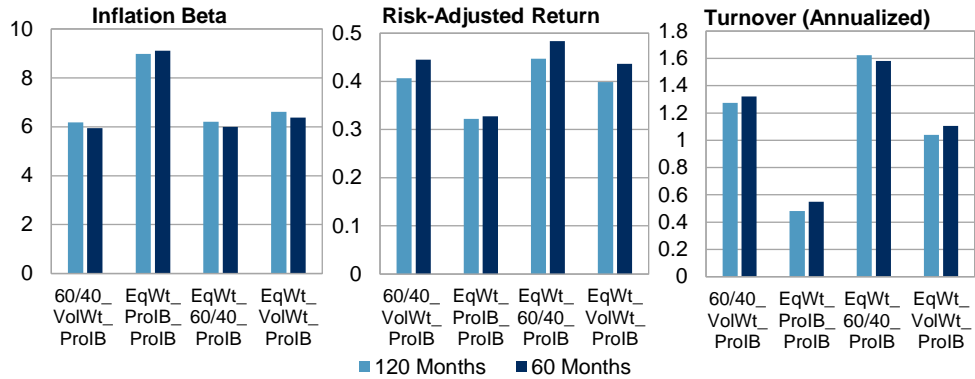
*Utilizing a slope-based approach to inflation forecasting led to smoother tactical changes to the portfolio on account of a slower transition in the forecast regime.*

All portfolios are hypothetical. Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

Using a longer lookback window has resulted in more stable weights over time, leading to generally lower turnover. This has caused some loss in risk-adjusted performance but no significant impact on the inflation sensitivity (see Exhibit 25).

*Using a longer lookback window has resulted in more stable weights over time, leading to generally lower turnover.*

**Exhibit 25: Dynamic Portfolios – Effect of Lookback Window Size**



All portfolios are hypothetical. Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

*It is valuable to understand how the dynamic portfolios performed during periods of rising inflation.*

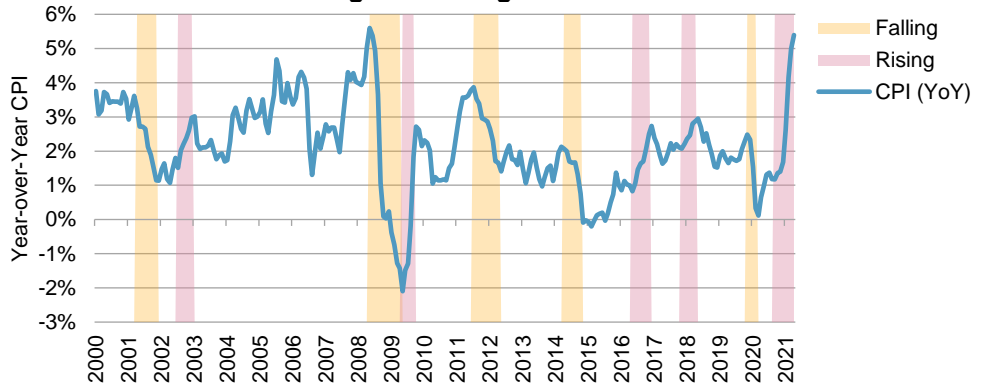
**Rising and Falling Inflation**

Since inflation concerns grow stronger and its negative effects begin to show when the CPI starts to tick upward, it is of interest to see how the dynamic portfolios performed during periods of rising inflation. Conversely, having an idea of how the portfolios might perform during periods of falling inflation could help an investor assess the risk/reward trade-off more comprehensively.

Based on inflation data from the past two decades, we picked specific time periods during which the year-over-year CPI exhibited a clear upward or downward trend (see Exhibit 26). We then compared the real return (i.e., nominal return after inflation adjustment) of our proposed dynamic portfolios and their component strategies during these time periods. The steepness of each decline or rise and its beginning and end points determine how quickly the switches occur between various regime-specific strategies.

*Conversely, having an idea of how the portfolios might perform during periods of falling inflation could help an investor assess the risk/reward trade-off.*

**Exhibit 26: Periods of Rising and Falling Inflation**



Source: St. Louis Federal Reserve. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

*We picked specific periods during which the year-over-year CPI exhibited a clear upward or downward trend...*

*...and compared the real return of our proposed dynamic portfolios and their component strategies during these time periods.*

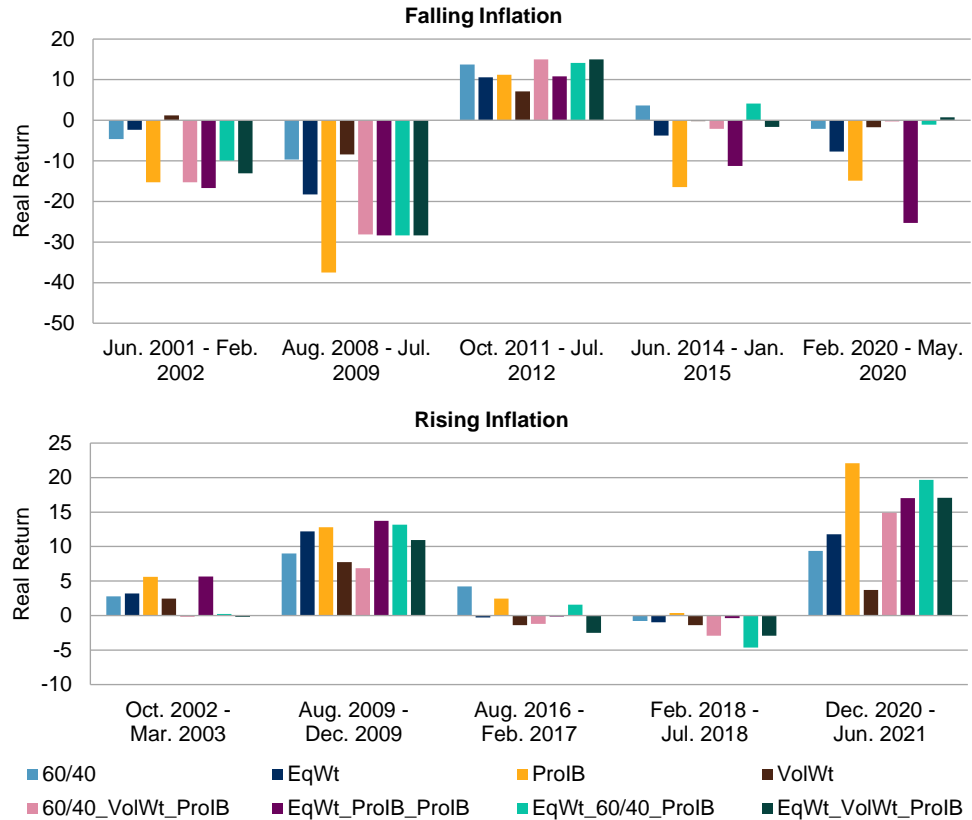
*The biggest drop in inflation coincided with the commodities crash of 2008.*

*During the recent period of rising inflation, most dynamic portfolios outperformed their component strategies.*

Evaluating the results leads us to the following observations (see Exhibit 27).

- The biggest drop in inflation coincided with the commodities crash of 2008. A sizeable allocation to commodities was severely penalized at that time, leading to large drawdowns for all four dynamic portfolios.
- Shorter declines in 2011-2012 and 2020 resulted in performance that was either in line with or better than the underlying strategy portfolios.
- Periods of rising inflation had narrower ranges (in terms of beginning and end point) and were relatively short in length, but the performance of dynamic portfolios was positive in almost all of them.
- During the recent period of rising inflation (H1 2021), most dynamic portfolios outperformed their component strategies with the exception of the ProIB strategy, whose performance has been particularly strong since the beginning of 2021.

**Exhibit 27: Dynamic Portfolio Performance during Specific Time Periods**



All portfolios are hypothetical.  
 Source: S&P Dow Jones Indices LLC. Data from March 2000 to June 2021. Past performance is no guarantee of future results. Index performance based on total return in USD. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

## CONCLUSION

*History suggests a positive relationship between the level of inflation and the returns of a broad basket of inflation-sensitive assets.*

History suggests a positive relationship between the level of inflation and the returns of a broad basket of inflation-sensitive assets. But the real-time responsiveness of this relationship can make it difficult to capture unless the exposure is held continuously, which, in turn, may be a drag on the performance of a diversified multi-asset portfolio. Specially designed strategies (such as ProIB and VolWt) may offer better risk-adjusted returns in broadly defined inflation regimes, but their success would depend on how long the regime stays constant.

*The portfolios we proposed exhibited varying levels of inflation sensitivity, performance, and turnover...*

Employing a rules-based approach, we have constructed a selection of portfolios that respond to shifts in the inflation regime by switching between suitable strategies. These dynamic portfolios tend to overweight inflation-protecting assets like commodities (as represented by the [S&P GSCI](#)) and real estate (as represented by the [S&P United States REIT](#)) and are seen to exhibit higher volatility than the standard 60/40 or equal-weight strategies, leading to larger drawdowns especially during periods of steeply declining inflation (e.g., 2008-2009). This affects cumulative performance over the entire back-test period, but when examined on a regime-specific basis, the dynamic portfolios perform better, on average. It is also worth noting that they generally outperformed their component strategies during periods of rising inflation.

*...presenting asset managers with a variety to choose from, depending on their objectives and constraints.*

Using multiple asset classes is clearly beneficial. For example, the ProIB strategy has a higher risk-adjusted return than the S&P GSCI alone, simply because it gains the benefit of diversification by including all six asset classes. Along the same lines, the dynamic portfolios time their exposures to various inflation-sensitive assets, overcoming some of the performance drag that would result from using just one or two assets.

The portfolios we have proposed exhibited varying levels of inflation sensitivity, performance, and turnover, presenting asset managers with choices according to their objectives and constraints.



## PERFORMANCE DISCLOSURE/BACK-TESTED DATA

The S&P U.S. TIPS Index was launched May 5, 2010. All information presented prior to an index's Launch Date is hypothetical (back-tested), not actual performance. The back-test calculations are based on the same methodology that was in effect on the index Launch Date. However, when creating back-tested history for periods of market anomalies or other periods that do not reflect the general current market environment, index methodology rules may be relaxed to capture a large enough universe of securities to simulate the target market the index is designed to measure or strategy the index is designed to capture. For example, market capitalization and liquidity thresholds may be reduced. Complete index methodology details are available at [www.spglobal.com/spdji](http://www.spglobal.com/spdji). Past performance of the Index is not an indication of future results. Back-tested performance reflects application of an index methodology and selection of index constituents with the benefit of hindsight and knowledge of factors that may have positively affected its performance, cannot account for all financial risk that may affect results and may be considered to reflect survivor/look ahead bias. Actual returns may differ significantly from, and be lower than, back-tested returns. Past performance is not an indication or guarantee of future results. Please refer to the methodology for the Index for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations. Back-tested performance is for use with institutions only; not for use with retail investors.

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