



Second Quarter 2022

Building a Better Commodities Portfolio

Executive Summary

Commodities as an asset class gained in popularity during the 2000s, but experienced dismal performance in the 2010s as inflation stayed low and many commodity prices fell. Now, in the early 2020s, interest is rising again. Commodities have tended to be particularly strong diversifiers during periods of rising or volatile inflation.

During its first wave in the 2000s, commodities investing was dominated by passive portfolios tracking indices such as the S&P GSC Index and the BCOM Index. But recently investors have become more aware of the

shortcomings of this approach - unfavorable contract roll costs, a lack of sector diversification, and missed active opportunities.

What does a “best-in-class” commodity portfolio look like? In this paper we first review the benefits of commodities as an asset class, and then explore the potential of three enhancements to a passive approach: better risk balance across sectors, dynamic risk management through time, and active tilts based on intuitive strategies that have been well-compensated historically.

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Contents

Introduction	3
The Benefits of Adding Commodities to a Traditional Portfolio	3
Building a Better Strategic Commodities Portfolio	7
Commodity Fundamentals and Active Management	9
Putting It All Together	11
Related Reading	12
Appendix	13
Disclosures	15

Introduction

For several decades, investors have sought alternative asset classes to diversify stock/bond portfolios dominated by equity risk. Commodities are one interesting candidate, though their popularity has varied through time. Over the long term, commodity returns have been diversifying, but many commodity indices suffered large drawdowns during the Global Financial Crisis, with little recovery during the disinflationary decade that followed. Some investors have questioned the presence of a positive premium, while others have ethical or sustainability concerns.

Yet the stark fact remains that most portfolios are exposed to rising inflation, and commodities are one of the only investments to have offered reliable inflation protection as well as positive long term returns. In the past, the majority of commodities assets tracked passive indices such as the S&P GSCI (GSCI) and the Bloomberg Commodity Index (BCOM). These indices do provide exposure to a broad set of commodities, but their allocation is based on production quantities or market liquidity, resulting in a concentration of risk in

sectors that dominate global production, like energy. Commodity sectors have shown low correlations to one another, so a portfolio that balances risk across sectors can better diversify idiosyncratic risks and therefore deliver higher risk-adjusted returns. In addition, passive indices have historically exhibited large swings in realized volatility, especially during periods of drawdown, presenting a sizing challenge to allocators. This can be mitigated by dynamically adjusting position sizes to target a more stable amount of portfolio volatility. Lastly, commodities portfolios can be enhanced through active tilts based on supply-and-demand fundamentals, global macroeconomic data, roll yield, and price trends within commodity markets.

By incorporating all of these features - risk balance across sectors, risk targeting, and active tilts - investors can make significant improvements in their commodity portfolios. In this short paper we review the benefits of commodities as an asset class, and then analyze each of these enhancements in turn.

The Benefits of Adding Commodities to a Traditional Portfolio

A commodities allocation offers investors three potential benefits: positive long-term returns, low correlations to stocks and bonds, and a hedge against inflationary pressures. In this section, we review some of the theoretical and empirical evidence supporting each.

Commodities as a source of long-term returns

An investment in commodity futures has historically provided significant positive returns. **Exhibit 1** uses a very long data set assembled by Levine et al. (and publicly available in the online AQR data library) to compare the returns to a portfolio of

commodities futures to investments in global equities and government bonds over nearly 150 years. All three asset classes have generated comparable positive risk-adjusted returns, and because commodities have exhibited low

correlations to stocks and bonds on average, a portfolio comprising all three has produced higher risk-adjusted returns than a 60/40 portfolio of stocks and bonds alone.

Exhibit 1: Commodities for the Long Run

Asset Class Performance (February 1, 1877 - December 31, 2021)

	Annualized Total Return	Volatility	Sharpe Ratio
Global Stocks	9.9%	13.4%	0.48
Global Bonds	5.0%	4.3%	0.36
Commodities	8.2%	17.5%	0.27
Global 60/40 Portfolio	8.0%	8.3%	0.53
10% Commodities, 90% 60/40	8.0%	8.0%	0.56

Sources: Chicago Board of Trade, Commodity Systems Inc., S&P, Goldman Sachs, Bloomberg, and DataStream. Commodities is a hypothetical equal-weighted portfolio, which takes equal notional weights of all commodities in the basket at each point in time. The risk free rate used to calculate the Sharpe ratios is New York call money rates until 1889, the New York Times money rates until 1918, secondary market rates on the shortest term U.S. bonds available until 1931 and T-bills thereafter. A rolling one-year average of the short-term rate is used. Aggregate global stocks returns are represented by GDP-weighted G6 (US, UK, Germany, Japan, Canada, and Australia) equities. Global bond returns are represented by GDP-weighted G6 government bonds. Global 60/40 is based on a 60% Global Stocks and 40% Global Bonds. Past performance is not a reliable indicator of future performance. Please read important disclosures in the Appendix. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix.

One theoretical argument for a risk premium to holding long commodity futures goes back at least to John Maynard Keynes (1923). Commodity producers tend to have concentrated businesses, reliant on only one or two crops, metals, or other products. To mitigate their risk, they hedge by selling commodity futures, creating a premium for investors who go long. Said differently, hedgers are willing to pay an insurance premium to stabilize future revenues, and this premium can be earned by investors willing to bear price risk. Another source of the long-term premium is likely to be commodities' exposure to economic growth. While individual commodities' macroeconomic exposures vary widely, a portfolio of commodities tends to exhibit some positive sensitivity to growth.

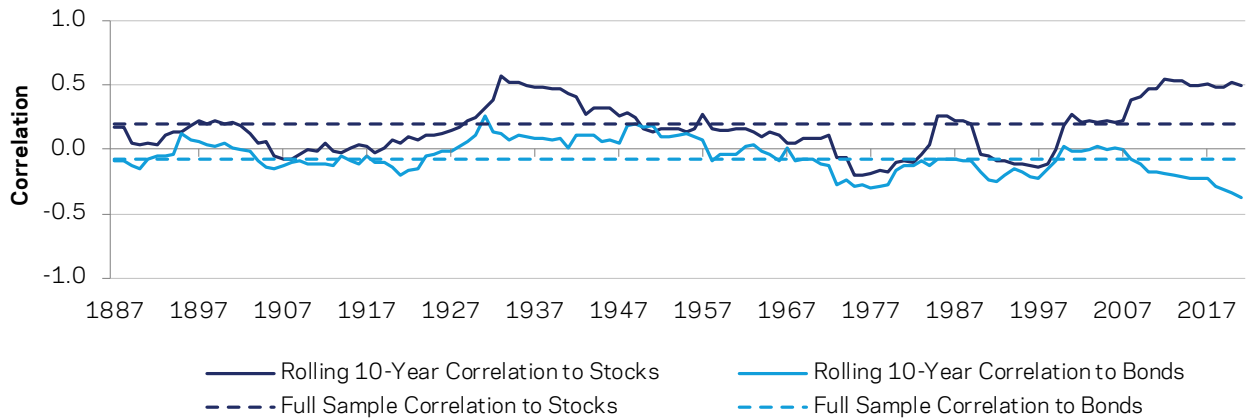
Commodities as a source of diversification

Because commodity prices are heavily influenced by fundamental supply-and-demand dynamics, commodity returns have historically shown a low correlation to other asset classes - though with some time variation - as seen in **Exhibit 2**, chart A. Other so-called alternatives and inflation protection candidates have shown much higher average correlations to either stocks or bonds - including private equity, real estate, natural resources equities, and inflation-linked bonds.

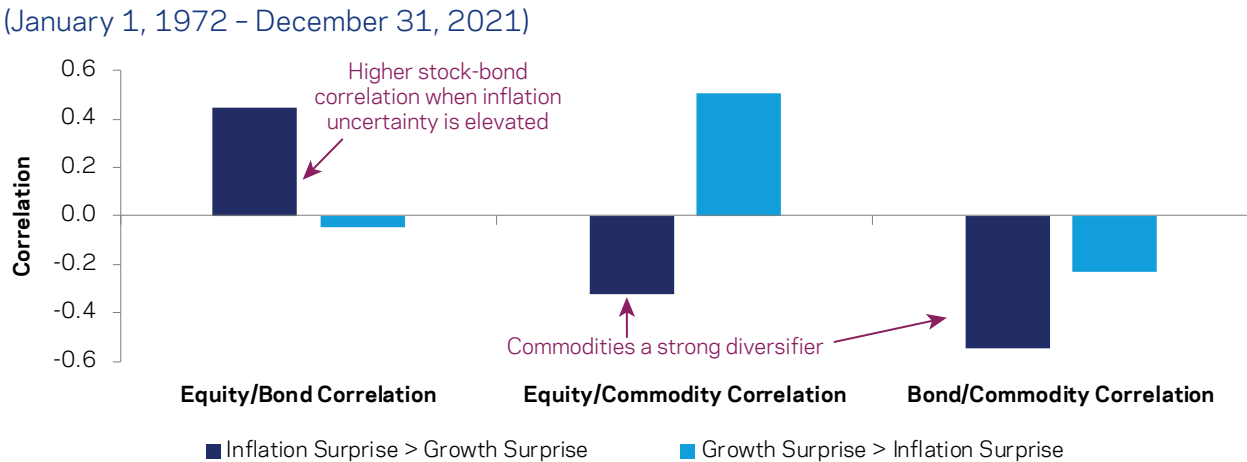
Chart B shows that during periods of heightened inflation uncertainty (defined here by the relative size of growth and inflation surprises), stocks and bonds have been less diversifying to each other, while commodities have been more diversifying to both.

Exhibit 2: Low Correlations to Major Asset Classes, Especially Amid Inflation Uncertainty

A. Rolling 10-Year Correlations to Stocks and Bonds (December 1, 1887 - December 31, 2021)



B. Correlations During Different Inflation vs. Growth Surprise Periods (January 1, 1972 - December 31, 2021)



Sources: Chicago Board of Trade, Commodity Systems Inc., S&P, Goldman Sachs, Survey of Professional Forecasters, Bloomberg, DataStream and AQR. Chart A: Commodities is a hypothetical equal-weighted portfolio, which takes equal notional weights of all commodities in the basket at each point in time. Aggregate global stocks returns are represented by GDP-weighted G6 (US, UK, Germany, Japan, Canada, and Australia) equities. Global bond returns are represented by GDP-weighted G6 government bonds. Chart B: Correlations are based on contemporaneous 12-month returns and surprises, at overlapping quarterly frequency. Surprise is defined as realized 12-month CPI or real GDP growth minus SPF starting forecast. Sample is divided into periods when magnitude of inflation surprise was bigger/smaller than growth surprise (ignoring sign of surprise), as a proxy for relative uncertainty. Equities is MSCI World index, Bonds is GDP-weighted portfolio of global government bonds, Commodities is BCOM index. Diversification does not eliminate the risk of experiencing investment losses. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix.

Commodities as a source of inflation protection

Commodities are one of the few investments to have earned higher returns during periods of high or rising inflation, when both stocks and bonds have tended to suffer. Commodities are physical assets whose prices may be expected to rise in an inflationary scenario where a fiat currency (like the U.S. dollar) devalues.

Moreover, commodity prices - including retail gasoline and food prices - are a key input to inflation measures such as the CPI.

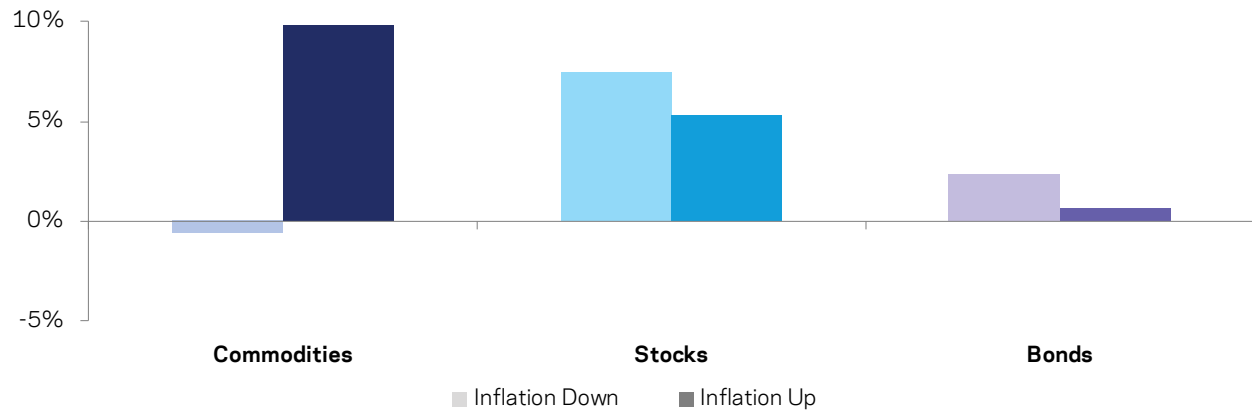
In **Exhibit 3**, chart A shows that commodities have earned all of their excess returns during inflationary environments, when both stocks and bonds have underperformed. Chart B shows that during the past 50 years, while inflation sensitivity varied across sectors,

it was positive for all of them, and broad portfolios (whether equal- or production-weighted), by diversifying idiosyncratic

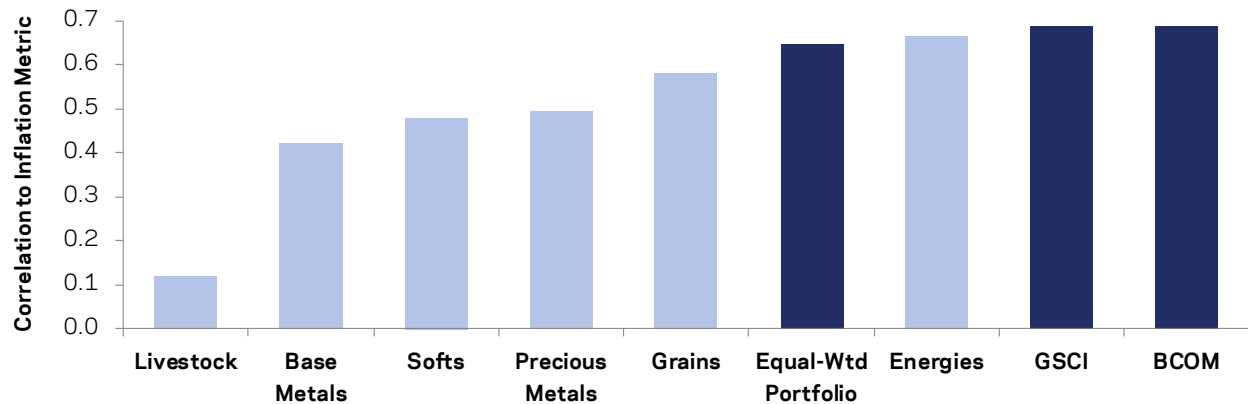
risks, had sensitivities as high as the highest individual sector.

Exhibit 3: Commodities have Delivered Higher Returns in Inflationary Environments

A. Average Excess Return Across Inflationary Environments (December 1, 1887 - December 31, 2021)



B. Inflation Sensitivities of Commodity Sectors and Portfolios (January 1, 1972 - December 31, 2021)



Sources: Chicago Board of Trade, U.S. Bureau of Labor Statistics, Commodity Systems Inc., S&P, Goldman Sachs, Bloomberg, and DataStream. Chart A: Commodities is a hypothetical equal-weighted portfolio, which takes equal notional weights of all commodities in the basket at each point in time. Please see Appendix for greater construction detail. The risk free rate used to calculate the excess return is New York call money rates until 1889, the New York Times money rates until 1918, secondary market rates on the shortest term U.S. bonds available until 1931 and T-bills thereafter. A rolling one-year average of the short-term rate is used. Aggregate global stocks returns are represented by GDP-weighted G6 (US, UK, Germany, Japan, Canada, and Australia) equities. Global bond returns are represented by GDP-weighted G6 government bonds. Inflation Up/Down refers to positive/negative 1-year inflation change (monthly with overlapping annual horizon). Chart B: Inflation sensitivity is contemporaneous partial correlation to a composite metric of inflation changes and surprises, controlling for growth exposure, based on quarterly data. Surprise is based on realization relative to forecasts of inflation from the Fed Survey of Professional Forecasters.

Building a Better Strategic Commodities Portfolio

While most portfolios can benefit from the addition of a commodities allocation, there are different ways for investors to access the asset class. Passive commodity portfolios tracking indices such as the GSCI and BCOM are likely to be the lowest-fee option. However, as we explain below, these indices suffer from poor risk-diversification and a lack of risk management. Another approach to constructing what we believe is a better strategic commodities portfolio differs from the passive indices in two key ways:

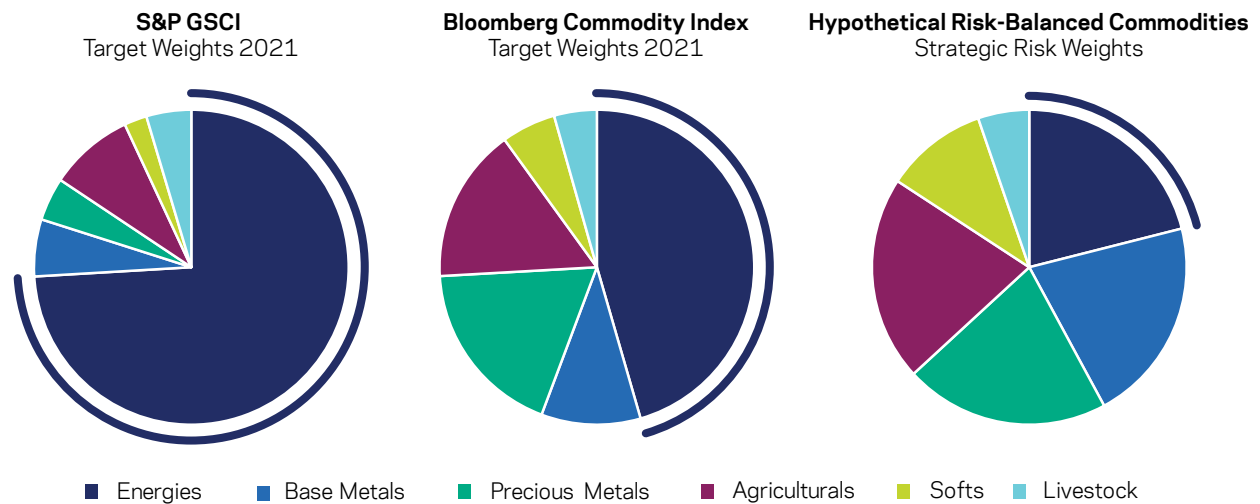
i. Better risk balance across sectors to improve diversification.

ii. Dynamic management of portfolio exposures to target a stable level of volatility.

Better risk balance across commodity sectors

As seen in **Exhibit 4**, the traditional commodity indices (GSCI and BCOM) have large risk allocations to energy commodities, especially crude oil, a risk that has historically not been rewarded with a commensurately higher return. We believe investors can increase their risk-adjusted returns through improved diversification by risk-balancing across commodity sectors.

Exhibit 4: Traditional Commodity Indices are Concentrated in Energies



Source: Bloomberg, AQR. Charts are for illustrative purposes only. Risk allocations based on 2021 target weights for the S&P GSCI and Bloomberg Commodity Indices, long-term strategic weights of a hypothetical risk-balanced commodities portfolio described in the Appendix, and AQR volatility and correlation estimates. There is no assurance that the target risk allocations will be achieved, and actual allocations may be significantly different than that shown here. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix. Please read important disclosures in the Appendix. Diversification does not eliminate the risk of experiencing investment losses.

In the risk-balanced portfolio (depicted on the right), every sector contributes to risk and returns, with no one sector dominating. Higher-risk sectors, notably energies, are

given smaller notional allocations; lower-risk sectors, such as precious metals, are given higher allocations. While more diversified,

this approach will have lower capacity than allocating by liquidity or global production.

The potential benefits, however, are significant. Because each commodity has unique supply-and-demand characteristics, commodity sectors are less correlated than equity or fixed income sectors. If diversifying across global equity markets is valuable, diversifying across commodity sectors is even more valuable.

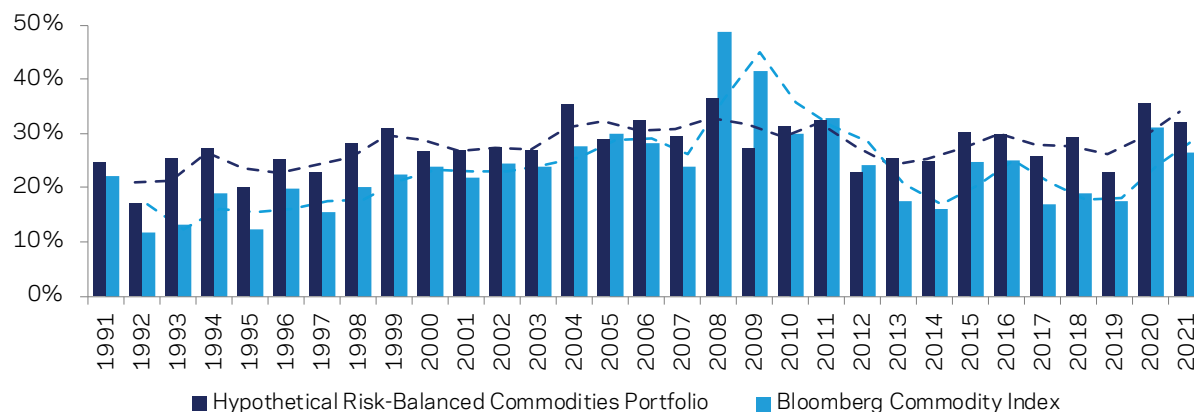
Targeting more stable risk through time

Just as concentrating risk in one or two sectors is better avoided, concentrating risk in one or two time periods can also cause problems for investors. Spikes in risk historically exhibited

by commodities can be managed by targeting a pre-specified level of volatility. **Exhibit 5** shows the realized volatility of a hypothetical risk-balanced commodity portfolio which is volatility-managed. Instead of an inflexible 100% notional exposure to commodities, the notional exposure to commodities is adjusted daily using a short-term volatility estimate. The realized volatility of the risk-managed portfolio stays much closer to its target, whereas the volatility of the Bloomberg Commodity Index spikes to much higher levels, especially during bear markets, while realizing a low volatility at other times. By maintaining a steadier level of volatility, a dynamically managed portfolio may experience a smoother ride and realize less severe negative tail events.

Exhibit 5: Volatility Targeting Provides a Smoother Ride

Annual Realized Volatility of Commodities Portfolios (January 1, 1991 – December 31, 2021)



Source: AQR, Bloomberg. Data using 3-day returns. Dotted lines are 2-period moving averages. Performance from January 1, 1991 through December 31, 2021 of a hypothetical risk-balanced commodities portfolio (described in the Appendix) and the Bloomberg Commodity Index. Performance is in USD, gross of fees and transaction costs. Past performance is not a reliable indicator of future performance. Please read important disclosures in the Appendix. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix. There is no guarantee, express or implied, that long-term return and/or volatility targets will be achieved. Realized returns and or volatility may come in higher or lower than expected.

We note that these improvements do not come without a cost. The risk-balanced and risk-targeted portfolio requires more frequent rebalancing of positions as risk levels change, and it allocates larger portfolio weights to less liquid contracts, compared to passive indices. These features lead to lower capacity and higher turnover, as well as significant

tracking error to passive indices. Indeed, the month-to-month and year-to-year performance will vary widely, with traditional approaches outperforming significantly at times. Nevertheless, we believe the potential benefits to holding a risk-balanced, risk-targeted commodities portfolio outweigh these costs in the long term.

Commodity Fundamentals and Active Management

Beyond the above *strategic* commodities portfolio, there can be considerable benefits to *active* commodity management, which involves overweighting commodities with strong current fundamentals, rising trends, and positive carry. Performance may be further improved through efficient trading implementation, including the selection of futures contracts and roll management.

An overview of commodity fundamentals and active signals

As mentioned, every commodity has its own unique supply and demand characteristics. Understanding the fundamental drivers within each market offers investors the opportunity to tilt a portfolio toward commodities with a higher likelihood of outperforming in the short-term. For instance, high or rising inventories may indicate excess supply, and lead to falling prices, whereas falling inventories may indicate strengthening demand.

Seasonal patterns also influence commodity prices in predictable ways. Agricultural commodities with a dominant growing season have a large supply entering the market during northern hemisphere harvest seasons, which tends to lower futures prices and increase hedging demands for those months. The winter surge in demand for natural gas and heating oil has the opposite effect, pushing up futures prices for those months. To the extent these seasonal effects lead to changes in commodity risk premia, investors may benefit from incorporating them in their allocation process.

Macroeconomic data can provide insight into commodity demand, since global economic growth and exchange rates are important drivers of commodity prices. By analyzing each commodity's global consumption profile, investors may be able to discern which commodities will benefit or suffer most from changes in the economic health of major commodity-consuming countries. For example, since Asia accounts for nearly 60% of global copper consumption, but only 32% of global crude oil consumption, copper is likely to benefit more than oil from strong Asian growth.

Certain commodities have close economic links that give rise to relative value bets. For example, there is a fundamental relationship between the prices of crude oil, heating oil, and gasoline, known as the "crack spread," in reference to the process of refining or "cracking" crude oil into other products. If the spread narrows too much, refineries will slow production and schedule maintenance in order to protect profit margins. This reduces demand for crude oil and supply of products, which should eventually push their relative prices back toward equilibrium. On the other hand, if the spread grows too wide, refineries tend to expand production to capitalize on the larger refining margins, which again pushes relative prices back toward equilibrium. An investor can potentially profit from this relationship by trading on the relative prices of crude versus its products.

The concept of carry - most familiar in currency markets - also naturally applies to commodity futures: a commodity futures contract has a high positive carry if the futures

price is far below the current “spot” price of the commodity. In this case, the owner of the contract earns carry as the futures price approaches the spot price over time. Of course, there is no guarantee that the expected carry will be earned; the spot price can change. But commodities with higher carry have historically earned higher returns.

Trend or momentum signals are another powerful predictor of commodity returns. Commodities that have been increasing (declining) in price over the past year have historically tended to continue in line with the trend. We believe price momentum works in commodity futures for the same reason it

works in other asset classes: Investors tend to anchor on prior prices in the near-term and do not fully adjust prices to reflect news, leading to initial under-reaction. In some cases, investors tend to over-react to price moves due to herding tendencies, also leading to price trends. Investors can benefit from these trends by tactically overweighting commodities with positive price trends, and underweighting commodities with negative price trends.

Exhibit 6 summarizes active investment themes in commodity markets, which can be applied in absolute return strategies, long-biased and long-only portfolios.

Exhibit 6: Active Investment Themes in Commodity Markets

Carry	Slope of commodity curves may reflect risk premia (due to hedging pressure) as well as the state of inventories
Momentum	Momentum seeks to take advantage of trends in commodity markets
Seasonal Risk Premia	Commodities exhibit time varying risk premia, which may be systematically harvested
Macroeconomic Drivers	Macroeconomic variables of commodity-consuming countries drive commodity prices
Fundamental Supply/Demand	Variety of fundamental data which measure or predict supply / demand dynamics
Value	Reversal and mean reversion factors take advantage of substitution and overreaction

Source: AQR.

Smarter contract selection and flexible trading

A passive equity index is close to a “buy-and-hold” portfolio. In contrast, a “passive” commodity futures investment must trade regularly. It must exit each futures contract before expiry or accept physical delivery of the commodity. In order to maintain exposure without taking delivery, the manager must “roll” the position, that is, exit the contract that is about to expire and enter a later-maturity

contract in its place. Standard commodity indices roll on a fixed schedule, and are vulnerable to traders who position themselves ahead of this predictable flow - buying the longer contracts ahead of time and selling them to passive index holders at a higher price.

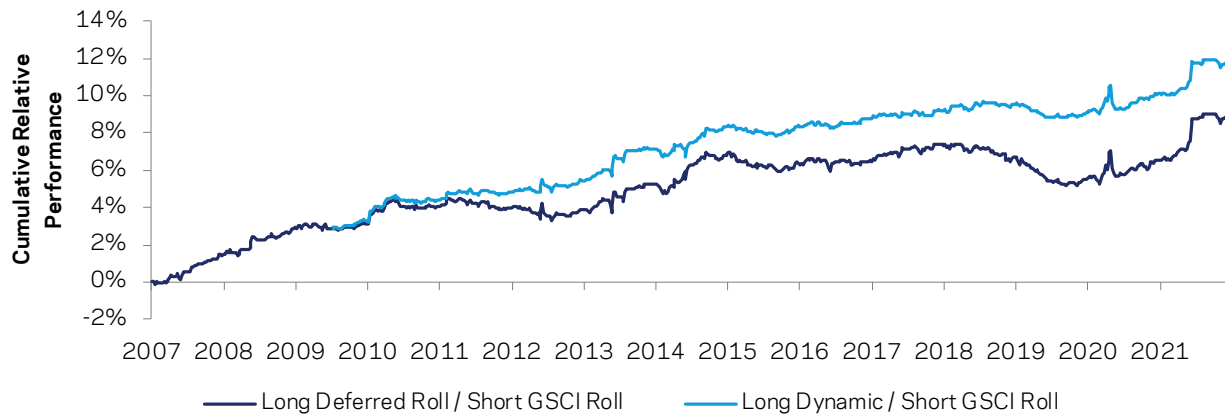
A number of “second generation” passive commodity portfolios attempted to avoid this by holding contracts with later expiry dates (“deferred roll”), but the advantages of this simple approach have diminished. A more

sophisticated approach - using return and cost forecasts to dynamically manage the process

- has conferred a more sustainable advantage, as shown in **Exhibit 7**.

Exhibit 7: Contract Selection Matters

Hypothetical Dynamic Roll May Offset Declining Premium to Deferred Roll over GSCI Roll
(January 1, 2007 - December 31, 2021)



Source: AQR, Bloomberg. Multiplies commodity weights used in a hypothetical risk-balanced commodities portfolio (described in the Appendix) by dynamically rolled commodity returns, deferred GSCI rolls, and standard GSCI rolls. Assumes 18% risk-targeted exposure to commodities. Hypothetical data has inherent limitations, some of which are described in the appendix. Please read important disclosures in the Appendix. Past performance is not a reliable indicator of future performance.

Putting It All Together

A long-biased investment in commodity futures may improve a traditional asset portfolio by adding diversification and helping preserve real value in periods of high or rising inflation. This paper shows how investors can build a better strategic commodities portfolio by risk-balancing across sectors and targeting steady volatility through time. Performance may be further improved through active signals based on commodity fundamentals, macroeconomic data, price trends, and roll management.

In **Exhibit 8** we show that this performance improvement has also been present for a hypothetical risk-balanced commodities portfolio over a longer 30-year history. The last two columns show that strategic design choices and active tilts both contributed to this outperformance.

Exhibit 8: Putting It All Together

Hypothetical Risk-Balanced Commodities vs. Passive Index
(January 1, 1991 – December 31, 2021)

	Hypothetical Risk-Balanced Commodities Portfolio	Bloomberg Commodity Index	Excess Return	Excess Return Decomposition	
				Strategic Allocation Differences	Active Tilts
1-Year Annualized Return	41.9%	27.1%	14.8%	6.6%	8.2%
3-Year Annualized Return	22.0%	9.9%	12.2%	8.4%	3.7%
5-Year Annualized Return	12.3%	3.7%	8.7%	4.7%	3.9%
10-Year Annualized Return	3.0%	-2.9%	5.8%	1.1%	4.7%
Full Period Ann. Return	12.5%	2.4%	10.1%	2.0%	8.2%
Volatility	16.1%	14.6%			
Sharpe Ratio	0.62	-0.02			

Source: AQR. Performance from January 1, 1991 through December 31, 2021 of a hypothetical risk-balanced commodities portfolio (described in the Appendix) and the Bloomberg Commodity Index. Performance is in USD, gross of fees and transaction costs. Past performance is not a reliable indicator of future performance. Please read important disclosures in the Appendix. The risk free rate used to calculate the Sharpe ratios is the ICE BofAML 3-month U.S. Treasury Bill. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix.

Related Reading

Brixton, A., T. Maloney and A. Thapar, 2021, “When Stock-Bond Diversification Fails – Managing Inflation Risk in Investor Portfolios,” AQR white paper.

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Katz, M. and C. Palazzolo, 2010, “Inflation in 2010 and Beyond? Practical Considerations for Institutional Asset Allocation,” AQR white paper in two parts.

Koijen, R., T. Moskowitz, L.H. Pedersen, and E. Vrugt (2012), “Carry,” working paper.

Levine, A., Y. Ooi, M. Richardson and C. Sasseville, 2018, “Commodities for the Long Run,” *Financial Analysts Journal*, 74(2).

Appendix: Data and Methodology

Data

Commodity contract prices are from Chicago Board of Trade for the period before 1951, Commodity Systems Inc. for 1951-2012, and Bloomberg for 2012-2021. Rolled return series for platinum, aluminum, copper, lead, nickel, tin, and zinc are from S&P, Goldman Sachs, Bloomberg, and DataStream. Results are for equal dollar-weighted portfolio, which takes equal notional weights of all commodities in the commodity basket at each point in time. The risk free rate used to calculate the Sharpe ratios is New York call money rates until 1889, the New York Times money rates until 1918, secondary market rates on the shortest term U.S. bonds available until 1931 and T-bills thereafter. A rolling one-year average of the short-term rate is used. Aggregate global stocks returns are represented by GDP-weighted G6 (US, UK, Germany, Japan, Canada, and Australia) equities. Global bond returns are represented by GDP-weighted G6 government bonds. Global 60/40 is based on a 60% Global Stocks and 40% Global Bonds.

Inflation data are from George F. Warren and Frank A. Pearson, *Gold and Prices* (New York: John Wiley and Sons, 1935) for the period before 1913 and the U.S. Bureau of Labor Statistics for 1913-2021.

Hypothetical Risk-Balanced Commodities Portfolio

The risk-balanced commodities portfolio studied herein rebalances monthly and is risk-balanced across the following 26 commodities in 6 sectors: Agriculturals (Corn, Soybeans, Wheat, Soybean Meal, Soybean Oil), Softs (Coffee, Cocoa, Cotton, Sugar), Energies

(WTI Crude, Brent Crude, Gas Oil, Gasoline, Heating Oil, Natural Gas), Livestock (Live Cattle, Feeder Cattle, Lean Hogs), Precious Metals (Gold, Silver), Base Metals (Aluminum, Platinum, Copper, Nickel, Zinc, Lead). It gives equal notional weight to commodities within each sector.

The portfolio targets a constant volatility of 18% at each monthly rebalance, subject to a risk reduction process. The portfolio volatility is estimated using a combination of individual volatilities and pair-wise correlations. The individual volatilities are calculated using historical daily returns, weighted exponentially with a 60 day center of mass. Correlation estimates are calculated using 5-day overlapping returns (to account for different market close times), exponentially weighted with a 150 day center of mass.

Inflation Sensitivity Methodology

The metric combines two measures of changing expectations for U.S. inflation:

1. year-on-year CPI inflation minus CPI for previous 1-year period (“change”)
2. year-on-year CPI inflation minus 1-year forecast at start of period (“surprise”)

We combine the two measures (standardized so they have equal influence) to reduce noise in either one. We construct a corresponding metric for U.S. GDP growth, as a control variable. Sensitivity is contemporaneous partial correlation to inflation metric, based on quarterly overlapping year-on-year periods, to avoid seasonal effects and mitigate the role of publication lags.

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