Strategic Allocation to Commodity Factor Premiums

David Blitz and Wilma de Groot*

ABSTRACT

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JEL Classification: G12, G13, E44, Q11, Q41, Q14

Keywords: commodities, factor premiums, strategic asset allocation, momentum, carry, low-volatility

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Commodity futures initially served as hedging instruments for commodity producers and consumers, but have more recently also become popular with investors in general, as an asset class that can be considered next to traditional stocks and bonds. The classic reasons for investors to allocate to commodities have been threefold: 1) to capture a potential commodity risk premium, 2) to diversify a traditional equity/bond portfolio, and 3) to hedge inflation risk. These attractive features of commodities have been documented by empirical studies using data going back to the nineteen fifties, such as Bodie and Rosansky [1980] and Gorton and Rouwenhorst [2006]. A commonly used approach by commodity investors to capture the general commodity market premium is to follow a broad market index, such as the Standard & Poor's - Goldman Sachs Commodity Index (S&P GSCI) or the Dow Jones - UBS Commodity Index (DJ UBSCI); see, e.g., Stoll and Whaley [2009].

Investors may wonder, however, whether the traditional arguments for investing in commodities still apply. Over the past ten years, commodity investments were considerably more volatile than equities, but earned lower returns than bonds.[1] In addition, the diversification benefits offered by commodities appear to have diminished, as Tang and Xiong [2012] find that the correlation between commodities and equities has risen sharply over recent years. Consistent with these developments, Daskalaki and Skiadopoulos [2011] find little evidence for the added value of commodities for especially mean-variance investors using a dataset up to 2009. Nijman and Swinkels [2008] distinguish between investors with nominal and real (inflation-indexed) liability structures and suggest that there is only added value for investors with real liabilities. However, even the inflation-hedging ability of commodities has been questioned, as Ang [2012] argues that only energy has been a decent inflation hedge. The intuition here may be that commodities can provide an effective hedge for inflation that is caused by rising commodity prices, such as during the oil crisis in the seventies, but that it is questionable whether commodities also offer protection for other types of inflation, such as monetary inflation (money creation by central banks) or wage inflation, caused by ageing of the population.

However, the potential of commodities to add value may be underestimated if commodity investing is equated to following a traditional commodity broad market index. Such an index only captures a potential general commodity market premium, but ignores the additional factor premiums that may be systematically rewarded in the commodity market. Various studies have

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emphasized the benefits of allocating to alternative factor premiums, such as the value and momentum premiums within equities, or the term spread within fixed income; see Ang, Goetzmann and Schaefer [2009], Bender, Briand, Nielsen and Stefek [2010], Ilmanen and Kizer [2012] and Blitz [2012]. These studies conclude that augmenting a portfolio which only consists of traditional market premiums with various non-traditional factor premiums significantly increases performance, due to relatively low correlations between these premiums as well as due to higher Sharpe ratios of the alternative premiums on a stand-alone basis.

Motivated by these developments, we take another look at the decision whether and how to invest in commodities, considering not only the commodity market premium but also the momentum, carry and low-risk factor premiums documented to exist in the commodity market. The momentum factor is from Erb and Harvey [2006][2], the carry factor is from Gorton and Rouwenhorst [2006] and Erb and Harvey [2006], and the low-volatility factor is in the spirit of e.g. Miffre, Fuertes and Pérez [2012] and Frazzini and Pedersen [2011]. We find that the case for factor premium investing carries over to the commodity market. More specifically, we confirm the existence of sizable momentum, carry and low-risk factor premiums in the commodity market, and find that a commodity portfolio which simply invests equal amounts in these factor premiums achieves a significantly higher risk-adjusted performance than a traditional commodity market portfolio, with much smaller drawdowns. This result is robust to using other portfolio construction methodologies, such as risk parity or minimum-variance. During the most recent ten years of our sample, the volatility of the commodity factor premium portfolios is comparable to or lower than that of equities, while the return is at least twice as high. Moreover, the commodity factor premiums have a low correlation with the equity market and other equity factor premiums, even in recent years.

We also find that adding just the commodity market premium to a traditional equity/bond portfolio at best only marginally improves the overall risk-return ratio. In contrast, adding a diversified portfolio of commodity factor premiums adds significant value. If the equity portfolio is already organized to non-traditional factor premiums, we find that an allocation to just the commodity market premium even lowers the Sharpe ratio, while a commodity multi-factor portfolio still provides a clear improvement. These results imply that it is crucial to consider commodity factor premiums in the strategic asset allocation process. If investors only consider the general commodity market premium at this stage, they may conclude that commodities deserve little or no role at all in the portfolio, and thereby also miss out on the other factor premiums available to commodity investors. This might happen, for example, with the approach of Rallis, Miffre and Fuertes [2012], who envisage a process where investors first decide on their strategic allocation to commodities based on the conventional commodity market portfolio, and next on the possibility to improve this portfolio using "enhanced" commodity indices, i.e. indices which, starting from the commodity market portfolio, tilt the portfolio towards a certain factor premium. Similar to our approach this might result in a portfolio with intentional exposures to alternative commodity factor premiums (although probably smaller ones), but our approach avoids the risk that commodities may already be rejected in the first stage so that investors never even make it to the second stage of their approach.

The scope of our study is limited to considering three broadly recognized commodity factor premiums, but we note that investors might further expand their opportunity set by considering additional factors premiums documented to exist in the commodity market.[3] We also note that our aim is not to develop a deeper understanding of the roots and causes behind factor premiums in the commodity market, but to consider the implications of the strong empirical evidence for the existence of such premiums for investors. Finally, we note that we only investigate the risk, return and diversification properties of these premiums, and that their inflation hedging properties are beyond the scope of this research. Energy futures are often considered to be a good hedge against inflation, based on the oil-induced inflation spike of the nineteen seventies. Intuitively, precious metals might be effective hedges against monetary inflation, while soft commodities might be good hedges against food-price inflation. However, as high-inflation scenarios are mostly absent over our sample, it is extremely challenging to reliably assess the empirical inflation hedging properties of different types of commodity portfolios.

The remainder of this paper is organized as follows. We first describe our data and methodology. Next, we take a detailed look at the risk and return characteristics and diversification benefits of commodity factor premiums. Finally, we investigate the potential added value when allocating part of a traditional as well as a non-traditional equity/bond portfolio to commodity factor premiums.

DATA AND METHODOLOGY

Our sample covers the 24 individual commodities of the S&P GSCI. These include six energy-related commodities (crude oil, Brent crude oil, heating oil, gasoil, natural gas and RBOB gasoline), seven metals (gold, silver, copper, aluminum, zinc, nickel and lead), and eleven agricultural commodities (corn, soybeans, wheat, red wheat, sugar, coffee, cocoa, cotton, lean hogs, live cattle and feeder cattle). Our sample starts in January 1979 in order to ensure that at least 10 commodities are available each month.[4] The full set of 24 commodities is available from February 2002 until the end of our sample in June 2012. We use returns of the 24 individual S&P GSCI commodity futures indices to evaluate all factor portfolios and to compute the momentum and low-risk factors. These indices contain nearby futures contracts which are rolled forward on the fifth to ninth business days of each month before expiration date.[5] All return and price data are from Bloomberg.

To construct the momentum, carry and low-risk factor premiums, we rank the commodities, at the end of every month, based on respectively their past 12-month return[6], annualized ratio of nearby futures price to next-nearby futures price[7] and past 3-year volatility using daily data.[8] Next, we evaluate the equally-weighted returns of the long-only top 30 percent portfolio and the long/short top 30 percent minus bottom 30 percent portfolio over the subsequent month.[9] [10] We examine the momentum, carry and low-risk commodity factor premiums in a long-only as well as in a long-short context as, contrary to the equity market, the complexity and costs involved with long versus short positions in commodity futures are very similar. The S&P GSCI index is taken as a proxy for the commodity market premium. In addition, we examine three different multi-factor portfolios.[11] First, we construct a so-called 1/N factor portfolio which invests one third each in the momentum, carry and low-volatility portfolios. Second, we form a risk parity portfolio, in which the weights are inversely proportional to the (full-sample) volatilities of each of the three underlying portfolios. And third, we create a minimum-variance portfolio, where the weights of the underlying factor portfolios are such that the (full-sample) variance of the multi-factor portfolio is minimized. The weights of the underlying factor portfolios are rebalanced monthly.

The equity factors are formed in similar fashion as in Blitz [2012] who examines the momentum, value and low-volatility premiums in the equity market, and concludes that a major improvement can be achieved by augmenting a traditional equity portfolio with these alternative factor premiums. The equity market premium is based on the market factor of Kenneth French, which corresponds to the value-weighted return of the entire CRSP universe at each month-end. The equity value portfolio is the equally-weighted "big-value" portfolio of French, which consists of the 30% highest book-to-market stocks among the stocks in the CRSP universe with an above NYSE-median market capitalization. The equity momentum portfolio is the equally-weighted "big-momentum" portfolio of French, which consists of the 30% highest past 12-1 month return stocks among the stocks in the CRSP universe with an above NYSE-median market capitalization. The equity low-volatility portfolio is an equally-weighted "big-low volatility" portfolio constructed in the same spirit as the "big-value" and "big-momentum" portfolios of French, consisting of the 30% lowest past 36-month total volatility stocks among the stocks in the CRSP universe with an above NYSE-median market capitalization.[12] Finally, government bond returns are based on the JP Morgan US government bond index.[13] Average returns are calculated using geometric averaging, in order to take compounding effects into account. All prices and returns are in US dollars and do not include the impact of transaction costs.

PREMIUMS IN THE COMMODITY MARKET

In Exhibit 1 we present the annualized return and risk characteristics of the equity, bond and commodity market premiums over the whole sample period in Panel A and, due to the increased popularity of commodity investing, over the most recent ten years of our sample from July 2002 to June 2012 in Panel B. The government bond market premium has been relatively high with a risk-return ratio of 0.49 over the whole sample period and 0.74 over the most recent ten years of our sample. The Sharpe ratio of the commodity market premium has been lowest, amounting to only 0.06 over the whole sample period. The annual excess return of commodities of 1.16 percent is lower than the 2.73 percent excess return for bonds, while the annualized volatility of commodities of 19.50 percent is higher than the 15.95 percent volatility for equities. In addition to the lowest risk-adjusted returns, we observe the highest downside risk for commodities. Specifically, the average (maximum) drawdown of commodities is 28.06 (67.83) percent over the whole sample, compared to 13.30 (54.52) percent and 3.58 (21.81) percent for equities and bonds respectively, where we define the drawdown at month T as the gap between the cumulative return at month T and the all-time high cumulative return up to month T. Moreover, also in the most recent ten years of our sample the risk-adjusted return of commodities has been lowest due to a combination of high volatility and low return.

<<< INSERT EXHIBIT 1 ABOUT HERE >>>

Exhibit 2 shows the return and risk characteristics of the various premiums. We first consider the long-only commodity factor premiums over the whole sample period, shown in the first part of Panel A. We observe that the Sharpe ratios of the non-traditional factor premiums vary between 0.30 for the low-risk factor and 0.40 for the carry factor, which is much higher than the Sharpe ratio of only 0.06 for the commodity market premium. Not surprisingly, the lowest volatility can be observed for the low-risk factor, which reduces volatility compared to the market premium by almost forty percent, whilst even obtaining a higher average excess return. The momentum factor exhibits the highest volatility, of 23.17 percent, but also the highest excess return, of 8.90 percent. These results are consistent with studies that have previously examined these factor premiums, such as Gorton and Rouwenhorst [2006], Erb and Harvey [2006], Miffre, Fuertes and Pérez [2012] and Frazzini and Pedersen [2011]. Besides the higher risk-adjusted returns, we observe less downside risk for the individual factors compared to the market portfolio. Panel B shows results for the most recent ten year period. We observe even higher risk-adjusted returns, with Sharpe ratios varying between 0.52 and 0.71, compared to still only 0.06 for the commodity market premium, and much lower downside risk.

<<< INSERT EXHIBIT 2 ABOUT HERE >>>

When we consider the long-short commodity factor premiums we observe that the addition of short positions increases the long-term volatility of the carry, momentum and low-volatility factors, but their returns increase even more, resulting in higher Sharpe ratios.[14] Exhibit 2 also shows results for (long-only) equity factor portfolios. Consistent with Blitz [2012] we find strong results for the equity factor premiums. The Sharpe ratios of the equity momentum, value and low-risk portfolios are between 0.50 and 0.62, compared to 0.35 for the equity market portfolio.

We next consider the results of the multi-factor portfolios in Exhibit 3. Panel C shows the weights of the factors in the multi-factor portfolios. The weights of the risk parity portfolio differ slightly from the 1/N portfolio, with somewhat more weight in the low-risk portfolio and slightly lower weight in the momentum portfolio. Not surprisingly, the minimum variance portfolio is heavily tilted towards the low-risk factor. In Panel A we observe that the multi-factor portfolios generate Sharpe ratios between 0.39 and 0.49 over the whole sample period compared to 0.06 for the commodity market portfolio. Panel B shows that the results are even stronger over the most recent decade, with Sharpe ratios between 0.62 and 0.70 for the commodity multi-factor portfolio versus still only 0.06 for the commodity market portfolio. Besides the higher risk-adjusted returns, we observe a significant reduction in downside risk. Specifically, comparing Exhibits 1 and 3 we find that the multi-factor portfolios reduce the average drawdown by approximately half compared to the commodity market portfolio and the maximum drawdown by approximately a third.

<<< INSERT EXHIBIT 3 ABOUT HERE >>>

The long-short multi-factor portfolio exhibits a further performance improvement, with Sharpe ratios between 0.91 and 0.94 over the whole sample period and Sharpe ratios between 1.12 and 1.21 over the most recent ten years of our sample. This is driven by a higher excess return compared to the long-only factor portfolio as well as a lower volatility over the most recent ten year period. The low volatility of the multi-factor portfolios is perhaps surprising in light of the fact that factor volatilities on a stand-alone basis are higher in the long-short case, but can be explained by lower correlations between the long-short factors than between the long-only factors. Untabulated correlation figures show that the average correlation between the long-only commodity premiums amounts to 53 percent over the complete sample, compared to only 8 percent for the long-short commodity factor returns. Consistent with these results, the average drawdown of the long-short multi-factor portfolios is lowered further, amounting to only around 5 percent or even less.

Exhibit 3 also shows results for (long-only) equity factor portfolios. Consistent with Blitz [2012] we find strong results for the equity factor premiums. The Sharpe ratios of the equity multi-factor portfolios consisting of the equity momentum, value and low-risk premiums range between 0.59 and 0.62, compared to 0.35 for the equity market portfolio. Moreover, the average drawdown of the equity multi-factor portfolios is roughly halved compared to the equity market portfolio, although the maximum drawdowns remain large. If we compare the equity portfolios with the commodity long-only portfolios, we observe that the volatility of the long-only commodity multi-factor portfolios is more comparable to that of the equity market portfolio or the equity multi-factor portfolios. In terms of returns, the long-only commodity multi-factor premiums have been slightly weaker than the equity multi-factor premiums over the entire sample period, but much stronger over the most recent ten year period.

STRATEGIC ALLOCATION TO COMMODITIES

In this section we examine the added value of commodities in a portfolio context. We first analyze the diversification benefits of commodities by examining correlations with various equity and bond portfolios. We then investigate the impact of adding commodities to a traditional equity/bond portfolio, and the impact of adding commodities to an equity/bond portfolio that is already organized according to factor premiums. We focus here on the simple 1/N multi-factor commodity portfolio, as the results in the previous section indicate that the way in which commodity factor premiums are weighted is not critically important for the conclusions.

Diversification benefits

Before analyzing the impact of allocating to a commodity factor portfolio, we examine the possible diversification benefits to an equity/bond portfolio. The left-hand side graphs in Exhibit 4 show three-year rolling correlations between the returns of the commodity market portfolio and the equity and bond market portfolios. We observe that the historical commodity-equity and commodity-bond correlations are typically low, usually staying well below 50 percent. Consistent with Tang and Xiong [2012], however, we find that the correlation between commodities and equities has recently increased sharply to around 75 percent. Although a similar spike can be observed in the early eighties, this raises the question whether commodities still provide attractive diversification benefits to a traditional equity/bond portfolio. Büyükşahin, Haigh and Robe [2010] find that the co-movements between equities and commodities have in general not increased, suggesting that commodities retain their role as a diversification tool. However, their sample ends in November 2008 and they also find that during the second half of

2008 both asset classes experienced large negative returns, i.e. during this period the diversification of commodities was much needed, but failed to materialize.

<<< INSERT EXHIBIT 4 ABOUT HERE >>>

The right-hand side graphs in Exhibit 4 shows the correlations between the long-short returns of the commodity 1/N multi-factor factor portfolio on the one hand, and the returns of the equity market and the equity 1/N multi-factor factor portfolio in excess of the equity market premium on the other hand. Contrary to the recent high correlation between the equity and commodity market portfolio, we observe that the correlation between the commodity factor portfolio and the equity market and equity multi-factor portfolio has remained low and well below 50 percent. For example, at the end of our sample period in June 2012, the past three-year correlation with the equity market was only 22 percent and with the equity factor portfolio even minus 5 percent. This indicates that non-traditional commodity factor premiums have been an attractive diversifier, also in recent years.

In Exhibit 5 we present the correlations between the individual commodity factor premiums and the correlations between a factor premium in the commodity market and its counterpart in the equity market. The correlations between the commodity factor returns (left side) have been modest and most of the times below 50 percent. The correlations only exceed 50 percent for the commodity momentum and carry factor around the turn of the century, and for the commodity carry and low-risk factors briefly during the mid-eighties. We also observe that the correlations between the commodity factor premiums and their equity counterparts (right side) tend to be around zero on average and have hardly ever exceeded 50 percent.

<<< INSERT EXHIBIT 5 ABOUT HERE >>>

These results may also shed some light on why the equity and commodity factor premiums might exist in the first place. One stream of literature argues that a systematic return premium must reflect a reward for being exposed to some kind of risk[15]; another stream of literature suggests factor premiums are induced by constraints[16]; and yet another stream argues that the premiums are the result of structural mispricing, arising from systematic behavioral biases of investors[17]. As our results indicate that factor premiums in the commodity market are largely unrelated to factor premiums in the equity market, it seems unlikely that common global risk factors are driving these premiums. Constraints on leveraging and short-selling do also not appear to be a very plausible explanation for the existence of commodity factor premiums, as it is relatively easy to take a levered or short position with commodity futures. However, further research is needed to examine this in more detail and to disentangle the various explanations. This would be an interesting area for future research.

Adding commodities to a traditional equity/bond portfolio

We continue our analysis by examining the added value of allocating part of a traditional equity/bond portfolio to commodities. Starting from a simple portfolio that invests 60 percent in the equity market portfolio and 40 percent in the bond market portfolio we investigate the impact of allocating part of the portfolio to the commodity market or the 1/N commodity multi-factor portfolio, either constructed long-only or long-short.[18] The results are presented graphically in Exhibit 6 for the whole sample period and the most recent ten year period. The graphs show the effects on portfolio volatility and return of allocating to commodities from zero to 20 percent in steps of 5 percent. The Sharpe ratios of the portfolios are shown next to each portfolio in the graphs. We observe that the Sharpe ratio of the equity/bond portfolio is 0.48 over the whole sample period as well as over the most recent ten years of our sample. When we consider a 5 to 20 percent allocation to the general commodity market premium, we observe that the Sharpe ratio of the portfolio over the whole sample period improves at most marginally to 0.49. During the most recent ten years, we even observe a deterioration of the Sharpe ratio to 0.43, mainly due to increased portfolio volatility. These findings confirm our earlier concerns with regard to whether a traditional allocation to commodities is still attractive.

<<< INSERT EXHIBIT 6 ABOUT HERE >>>

Next, we investigate the added value of allocating to the commodity multi-factor portfolio. We observe substantial added value when allocating part of a traditional equity/bond portfolio to the long-only commodity multi-factor portfolio. The Sharpe ratio increases from 0.48 without commodities to 0.62 for a 20 percent allocation, both due to lower risk and higher return. In the most recent ten years of our sample period, the Sharpe ratio improves from 0.48 up to 0.66, due to higher returns. The added value of the long-short commodity factor portfolio is even larger, with a Sharpe ratio up to 0.81 over the whole sample period and 0.80 over the recent period. This further improvement is due to the higher return and lower correlation of the long-short commodity factors with the equity factors. As an example, investors who currently allocate 10 percent to commodities can improve their Sharpe ratio by 0.16 over the whole sample period by allocating to commodity factor premiums, and by 0.17 over the last ten years.

Adding commodities to an equity/bond factor portfolio

Investors willing to consider alternative commodity factor premiums are likely to have already considered alternative factor premiums for the traditional asset classes in their portfolio, such as equities and bonds. We therefore continue by investigating the attractiveness of commodities to investors who already include alternative equity factor premiums in their strategic asset allocation. A priori, the impact of such a more advanced equity/bond portfolio on the strategic allocation to commodities is not evident. The stronger risk-adjusted returns of this portfolio are likely to make commodities less attractive, possibly to the extent that even the alternative commodity factor premiums fail to add value in the strategic asset mix.

For that reason, we examine the added value of allocating to commodities in case of a portfolio that invests 60 percent in the 1/N equity multi-factor portfolio and 40 percent in bonds. The results are shown in Exhibit 7. As expected, we observe that the risk-adjusted return of the base-case portfolio is higher compared to the traditional equity/bond portfolio in Exhibit 6: the Sharpe ratio when allocating to equity factor premiums is 0.70 compared to 0.48 over the whole sample period. When we consider the impact of allocating to the commodity market premium, we observe no added value. In fact, the Sharpe ratio even deteriorates for allocations larger than 2.5 percent to the commodity market premium, due to lower returns. Over the last ten years of our sample the Sharpe ratio even drops from 0.60 to 0.51, due to a lower return as well as a higher volatility.

<<< INSERT EXHIBIT 7 ABOUT HERE >>>

However, when we consider allocations to the 1/N commodity multi-factor portfolio, we still observe clear added value. Over the whole period we observe Sharpe ratios ranging between 0.74

and 0.81 when allocating to the long-only commodity multi-factor portfolio, compared to 0.70 for the portfolio which does not include commodities. The improvement mainly comes from a reduction of portfolio volatility. Over the last ten years, these numbers range between 0.65 and 0.74, compared to 0.60 for the portfolio without commodities, with the improvement mainly coming from higher returns. Allocating to the long-short 1/N multi-factor portfolio further improves the risk-return ratio, up to 1.03 over the whole sample period and up to 0.89 during the most ten years of our sample, due to lower volatilities as well as higher excess returns.

CONCLUDING REMARKS

As the return, risk and diversification characteristics of commodities appear to have become less attractive over time, we have taken another look at the strategic allocation to commodities. Our study differs from previous studies by considering not just an allocation to the commodity market portfolio, but also a possible allocation to various other systematic factor premiums documented to exist in the commodities market. We find that commodity multi-factor portfolios consisting of the momentum, carry and low-volatility premiums result in a substantially improved risk-return ratio on a stand-alone basis compared to a conventional commodity portfolio. Moreover, contrary to the commodity market factor, these commodity factor premiums have a low correlation with the equity market, even in recent years. We also find that adding just the commodity market premium to a traditional equity/bond portfolio at best only marginally improves the overall risk-return ratio. In contrast, adding a diversified portfolio of commodity factor premiums adds significant value. The exact specific way in which the individual commodity factor premiums are weighted in a multi-factor portfolio does not appear to be a critically important consideration.

When the equity portfolio is already organized to return factors, we conclude that it is crucial to also organize the commodity portfolio to return factors, as only such a commodity multi-factor portfolio adds significant value to such a more advanced equity/bond factor portfolio. In fact, we find that Sharpe ratios may even decline when allocating just to the commodity market premium, especially over the most recent period. These results also imply that it is crucial to consider commodity factor premiums in the strategic asset allocation stage of the investment process, because if investors consider only the commodity market premium at this stage, they may conclude that commodities should have a very small role or no role at all in the portfolio, and thereby miss out on the other factor premiums that the commodity asset class has to offer.

A concern might be whether the premiums remain large and significant after adjusting for transaction costs. Compared to equities, however, costs will have a much smaller impact on returns, as the costs involved with trading in future markets are relatively low; see, e.g., Locke and Venkatesh [1997], or Shen, Szakmary and Sharma [2007], who argue that even the profits of the momentum strategy, which involves relatively high turnover, are too large to be subsumed by transaction costs. Another implementation issue is whether it is currently possible for investors to easily and efficiently obtain exposure towards the factor premiums discussed in this paper, or if new investment vehicles are needed for this. This would, in our view, be an interesting direction for follow-up research. A question which we also leave for future research is to which extent differences in the inflation-hedging properties of the various commodity portfolios may affect our conclusions regarding the optimal allocation to commodities. The main challenge here is how to reliably estimate inflation sensitivities over the past decades, during which periods of high inflation were largely absent. Finally, it would be interesting to investigate if the future magnitude of the various commodity factor premiums is predictable using information that is available *ex ante*. This should probably start from a better understanding of the driving force behind alternative commodity factor premiums, in particular whether these reflect priced risk factors, or mispricing due to constraints or behavioral biases of investors.

[1] For example, the annualized volatility of excess returns of the equity market factor of French [2013] was 16.18 percent over the period from July 2002 to June 2012, while the volatility of excess returns of the S&P GSCI was 25.13 percent. The total return of the JP Morgan US government bond index was 5.68 percent per annum over the same period, while the return of the S&P GSCI was 3.41 percent per annum. See also Table 1.

[2] More evidence for the existence of a momentum premium in the commodity market is given by Miffre and Rallis [2007], Shen, Szakmary and Sharma [2007] and Asness, Moskowitz and Pedersen [2013].

[3] An example of another alternative premium is an optimized roll yield strategy as described by Mouakhar and Roberge [2010].

[4] For instance, the S&P GSCI consists of only 4 commodities at inception in 1970.

[5] Mou [2010] argues that front-running the S&P GSCI generates positive excess returns. As all our factors are based on S&P GSCI indices, we ensure a fair comparison between our factor portfolios and the commodity market portfolio. However, we acknowledge that not only the commodity market portfolio but also our factor portfolios can likely be improved by rolling forward their futures positions at, for example, the end of the month.

[6] Consistent with most of the literature on commodities momentum, we include the most recent month when computing momentum as for commodities a 1-month momentum effect has been documented, see Shen, Szakmary and Sharma [2007]. This effect is inconsistent with the short-term reversal effect reported at the stock level (e.g. Jegadeesh [1990]), but consistent with the short-term momentum effect documented for industries in the equity market by Moskowitz and Grinblatt [1999]. We obtain similar results when we exclude the most recent month as done by Asness, Moskowitz and Pedersen [2013]. Results are available from the authors upon request.

[7] Our commodity carry (or term structure/basis) strategy can also be considered a value type of strategy. A direct equivalent of the book-to-market ratio used to define value in the equity market does not exist for commodities, but our ratio of nearby and next-nearby future prices may also be interpreted as a measure for assessing whether a commodity is currently relatively cheap or expensive.

[8] Blitz and van Vliet [2007] use a similar measure in their analysis of low- versus high-risk equity portfolios. Other studies have used slightly different but related measures to define the riskiness of specific commodity futures: Frazzini and Pedersen [2011] compute betas with respect to a diversified commodity portfolio, while Miffre, Fuertes and Pérez [2012] estimate idiosyncratic volatilities.

[9] The long-short low-volatility factor is constructed in the spirit of Frazzini and Pedersen's [2011] BAB factor, where we leverage the low-risk top portfolio to the average historical volatility of the long and short portfolio, and de-leverage the high-risk bottom portfolio also to this average.

[10] As an alternative to using equal weights we also considered momentum, carry and low-risk factors constructed using the entire cross-section of commodities, where the weights are proportional to the cross-sectional z-score of the underlying signal, as in Asness, Moskowitz and Pedersen [2013]. In this case we find directionally similar but slightly weaker results. Results are available from the authors upon request.

[11] These multi-factor portfolios serve as a base case and can be augmented with other factors, such as the market factor.

[12] From January 2010 onwards the equity low-risk premium is based on the MSCI USA Minimum Volatility Index.

[13] Before 1986, the bond market premium is based on the Lehman US aggregate treasury index.

[14] Note that the low-volatility strategy also has a substantially higher volatility and downside risk, because we leverage up the low-volatility portfolio.

[15] For instance, Gorton and Rouwenhorst [2006] suggest that changes in carry mirror differences in required risk premiums across commodities or the changing risk of a given commodity over time, and Johnson [2002] provides a risk-based explanation for the momentum anomaly.

[16] For instance, Frazzini and Pedersen [2011] argue that the low-risk anomaly is due to leverage constraints which cause investors to prefer high-risk securities.

[17] For instance, Lakonishok, Shleifer and Vishny [1994] attribute the value effect to extrapolation bias, and Barberis, Shleifer, and Vishny [1998] argue that the momentum anomaly is driven by investor underreaction.

[18] We ensure that the non-commodity part of the portfolio remains invested in equities and bonds according to the 60/40 ratio.

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EXHIBIT 1. Market premiums.

This table shows historical market premiums for various asset classes over the whole sample period from January 1979 to June 2012 (Panel A) and over the most recent ten years of our sample (Panel B). The equity market premium is based on the market factor of Kenneth French, which corresponds to the value-weighted return of the entire CRSP universe at each month-end. The government bond premium is based on the JP Morgan US government bond index. The S&P GSCI index is taken as a proxy for the commodity market premium. Average returns are calculated using geometric averaging. All prices and returns are in US dollars. We define the drawdown at month T as the difference between the cumulative return at month T and the all-time high cumulative return up to month T, and report the average drawdown as well as the maximum drawdown.

	Equities	**Bonds**	**Commodities**
Panel A: 1979-2012			
Total return	11.44%	8.38%	6.72%
Excess return	5.64%	2.73%	1.16%
Volatility	15.95%	5.63%	19.50%
Sharpe ratio	0.35	0.49	0.06
Average drawdown	-13.30%	-3.58%	-28.06%
Max. drawdown	-54.52%	-21.81%	-67.83%
Panel B: 2002-2012			
Total return	6.04%	5.68%	3.41%
Excess return	4.18%	3.83%	1.61%
Volatility	16.18%	5.18%	25.13%
Sharpe ratio	0.26	0.74	0.06
Average drawdown	-25.48%	-1.93%	-29.97%
Max. drawdown	-54.52%	-5.85%	-67.83%

EXHIBIT 2. Factor premiums.

This table shows historical factor premiums for commodities and equities over the whole sample period from January 1979 to June 2012 (Panel A) and over the most recent ten years of our sample (Panel B). For commodities we use the individual commodities of the S&P GSCI. We construct momentum, carry and low-risk factor portfolios by ranking the commodities, at the end of every month, based on respectively their past 12-month return, annualized ratio of nearby futures price to next-nearby futures price and past 3-year volatility using daily data. Next, we evaluate the equally-weighted returns of the long-only top 30 percent portfolio and the long/short top 30 percent minus bottom 30 percent portfolio over the subsequent month. We examine these factor premiums in a long-only as well as in a long-short context. In addition, we report equity factor premiums formed in similar fashion as in Blitz (2012). The equity value portfolio is the equally-weighted "big-value" portfolio of French, which consists of the 30% highest book-to-market stocks among the stocks in the CRSP universe with an above NYSE-median market capitalization. The equity momentum portfolio is the equally-weighted "big-momentum" portfolio of French, which consists of the 30% highest past 12-1 month return stocks among the stocks in the CRSP universe with an above NYSE-median market capitalization. The equity low-volatility portfolio is an equally-weighted "big-low volatility" consisting of the 30% lowest past 36-month total volatility stocks among the stocks in the CRSP universe with an above NYSE-median market capitalization. Average returns are calculated using geometric averaging. All prices and returns are in US dollars and do not include the impact of transaction costs.

	Commodities long-only			**Commodities long-short**			**Equities long-only**		
	Momentum	**Carry/Value**	**Low-risk**	**Momentum**	**Carry/Value**	**Low-risk**	**Momentum**	**Carry/Value**	**Low-risk**
Panel A: 1979-2012									
Total return	14.86%	13.79%	9.45%	21.35%	20.77%	13.68%	15.70%	14.55%	13.88%
Excess return	8.90%	7.89%	3.75%	15.11%	14.54%	7.79%	9.71%	8.60%	7.97%
Volatility	23.17%	19.80%	12.38%	25.70%	22.22%	22.10%	18.79%	17.08%	12.88%
Sharpe ratio	0.38	0.40	0.30	0.59	0.65	0.35	0.52	0.50	0.62
Average drawdown	-23.33%	-15.88%	-15.36%	-12.60%	-14.79%	-26.12%	-11.04%	-7.91%	-6.48%
Max. drawdown	-64.89%	-53.34%	-43.03%	-54.06%	-47.72%	-68.88%	-51.27%	-64.36%	-47.80%
Panel B: 2002-2012									
Total return	15.55%	17.11%	8.56%	10.90%	22.75%	9.65%	7.73%	8.49%	7.81%
Excess return	13.56%	15.09%	6.67%	8.99%	20.64%	7.74%	5.84%	6.59%	5.92%
Volatility	23.91%	21.12%	12.95%	22.81%	18.83%	18.33%	18.21%	21.48%	12.63%
Sharpe ratio	0.57	0.71	0.52	0.39	1.10	0.42	0.32	0.31	0.47
Average drawdown	-14.74%	-11.67%	-17.13%	-15.35%	-4.23%	-41.26%	-15.55%	-14.73%	-10.62%
Max. drawdown	-51.23%	-47.58%	-42.76%	-37.53%	-18.09%	-68.88%	-51.27%	-64.36%	-47.80%

EXHIBIT 3. Multi-factor portfolios.

This table shows historical factor premiums for commodities and equities over the whole sample period from January 1979 to June 2012 (Panel A) and over the most recent ten years of our sample (Panel B). We construct factor portfolios and compute returns as in Exhibit 2. Next, we examine three different multi-factor portfolios. First, we construct a so-called 1/N factor portfolio which invests one third each in the momentum, carry and low-volatility portfolios. Second, we form a risk parity portfolio, in which the weights are inversely proportional to the (full-sample) volatilities of each of the three underlying portfolios. And third, we create a minimum-variance portfolio where the weights of the underlying factor portfolios are such that the (full-sample) variance of the multi-factor portfolio is minimized. The weights of the factor portfolios are presented in Panel C and are rebalanced monthly. We examine multi-factor commodity portfolios in a long-only as well as in a long-short context. In addition we examine long-only multi-factor equity portfolios. Average returns are calculated using geometric averaging. All prices and returns are in US dollars and do not include the impact of transaction costs.

	Commodities long-only			**Commodities long-short**			**Equities long-only**		
	1/N	**Risk parity**	**Min var**	**1/N**	**Risk parity**	**Min var**	**1/N**	**Risk parity**	**Min var**
Panel A: 1979-2012									
Total return	13.36%	12.69%	10.45%	20.35%	20.21%	19.45%	14.94%	14.82%	13.88%
Excess return	7.48%	6.84%	4.71%	14.16%	14.02%	13.29%	8.98%	8.86%	7.97%
Volatility	15.31%	13.92%	11.94%	15.17%	14.99%	14.65%	15.13%	14.78%	12.88%
Sharpe ratio	0.49	0.49	0.39	0.93	0.94	0.91	0.59	0.60	0.62
Average drawdown	-13.91%	-12.96%	-13.02%	-4.53%	-4.55%	-5.31%	-6.81%	-6.67%	-6.48%
Max. drawdown	-43.40%	-41.61%	-38.91%	-23.35%	-22.50%	-25.63%	-54.50%	-53.98%	-47.80%
Panel B: 2002-2012									
Total return	14.20%	13.21%	10.20%	15.72%	15.88%	15.75%	8.22%	8.21%	7.81%
Excess return	12.23%	11.25%	8.28%	13.72%	13.87%	13.75%	6.33%	6.31%	5.92%
Volatility	17.49%	16.09%	13.25%	12.21%	11.96%	11.32%	16.65%	16.18%	12.63%
Sharpe ratio	0.70	0.70	0.62	1.12	1.16	1.21	0.38	0.39	0.47
Average drawdown	-10.91%	-11.02%	-13.36%	-3.06%	-2.86%	-2.79%	-11.72%	-11.62%	-10.62%
Max. drawdown	-43.40%	-41.61%	-37.35%	-14.84%	-14.22%	-14.49%	-54.50%	-53.98%	-47.80%
Panel C: weights									
Momentum	33.33%	24.74%	-	33.33%	30.12%	20.74%	33.33%	28.09%	-
Carry/Value	33.33%	28.95%	17.06%	33.33%	34.84%	34.91%	33.33%	30.92%	-
Low-risk	33.33%	46.32%	82.94%	33.33%	35.03%	44.35%	33.33%	40.99%	100.00%

EXHIBIT 4. Correlations market and multi-factor portfolios.

The left-hand side graphs shows rolling three year correlations between the returns of the commodity market portfolio and the equity and bond market portfolios. The right-hand side graphs show rolling three year correlations between the long-short returns of the commodity 1/N multi-factor portfolio on the one hand, and the returns of the equity market and the equity 1/N multi-factor portfolio in excess of the equity market premium on the other hand. All portfolios are constructed in the same way as in Exhibit 1, 2 and 3. The sample period is from January 1979 to June 2012.

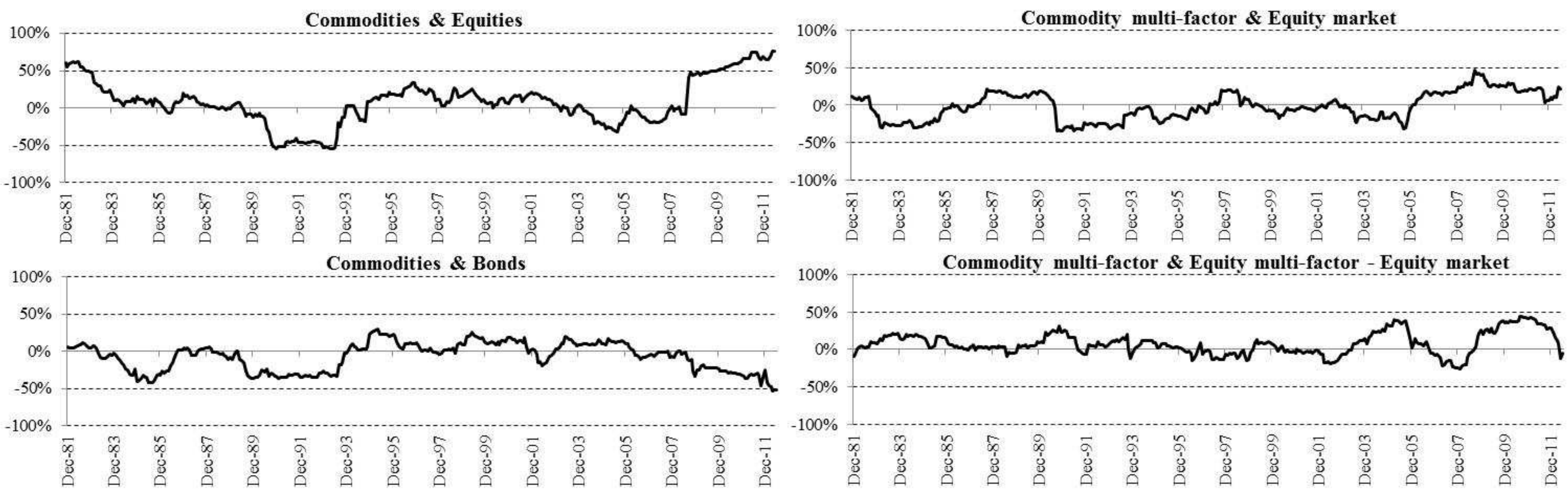


EXHIBIT 5. Correlations factor premiums.

The left-hand side graphs show rolling three year correlations between the individual commodity factor premiums and the right-hand side graphs show rolling three year correlations between a factor premium in the commodity market and its counterpart in the equity market. All factors are constructed in the same way as in Exhibit 2. The sample period is from January 1979 to June 2012.

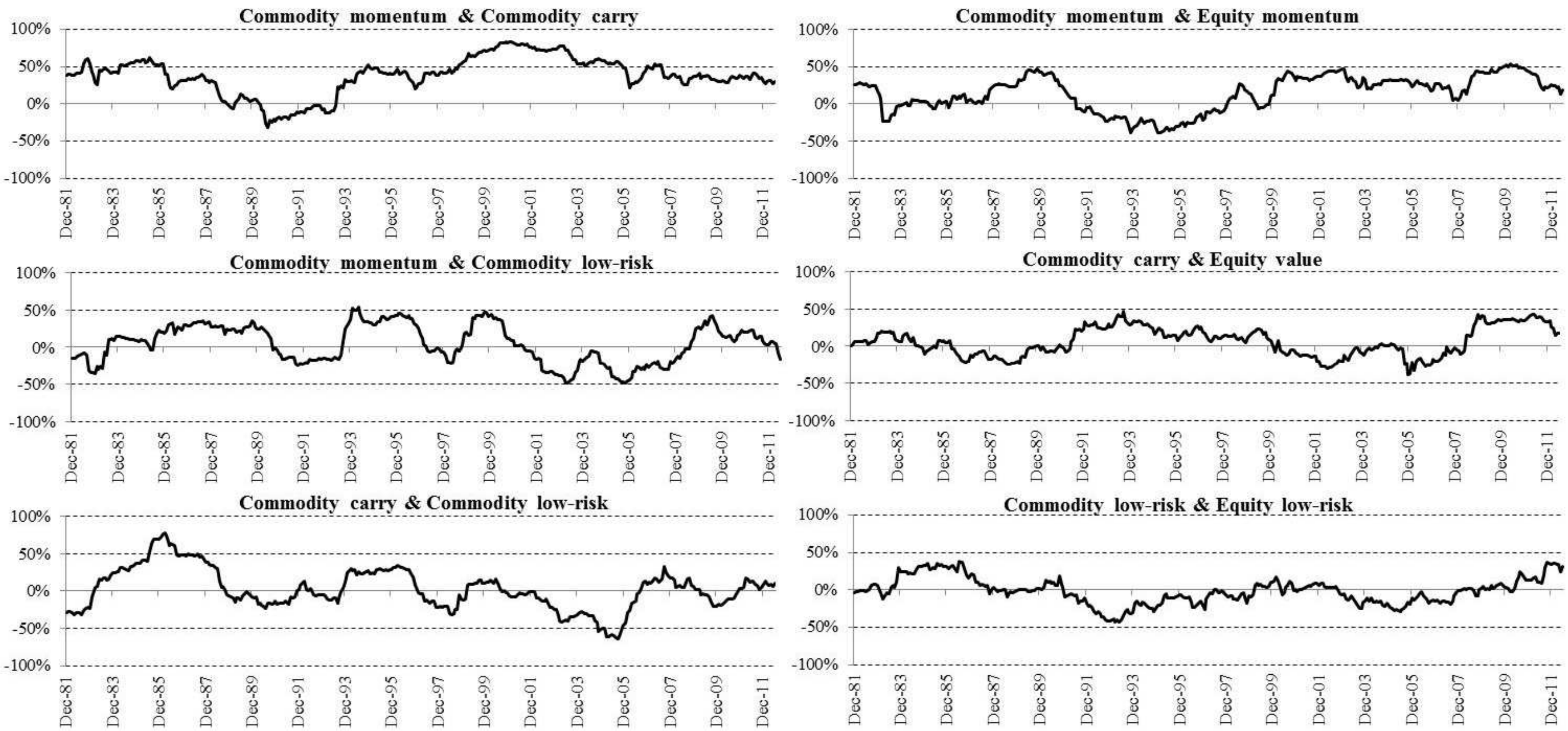
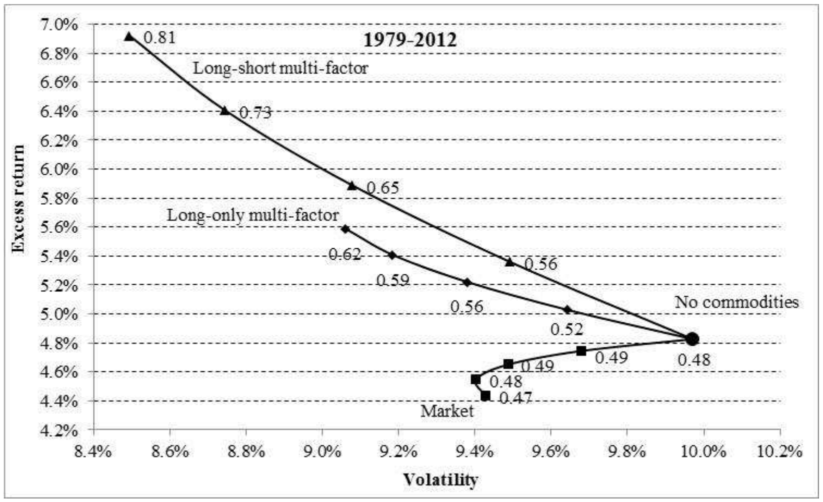


EXHIBIT 6. Strategic allocation in case of a traditional equity/bond portfolio.

These graphs show the impact on excess return and volatility of allocating part of a traditional equity/bond portfolio to commodities. We start with a simple portfolio that invests 60 percent in the equity market portfolio and 40 percent in the bond market portfolio and next investigate the impact of allocating to commodities from zero to 20 percent in steps of 5 percent, considering the commodity market portfolio, the 1/N long-only commodity multi-factor portfolio and the 1/N long-short commodity multi-factor portfolio. We ensure that the non-commodity part of the portfolio remains invested in equities and bonds according to the 60/40 ratio. The first graph shows the results for the whole sample period from January 1979 to June 2012 and the second graph the results for the most recent ten year period. The Sharpe ratios of the portfolios are shown next to each data point in the graphs. All portfolios are constructed in the same way as in Exhibit 1, 2 and 3.



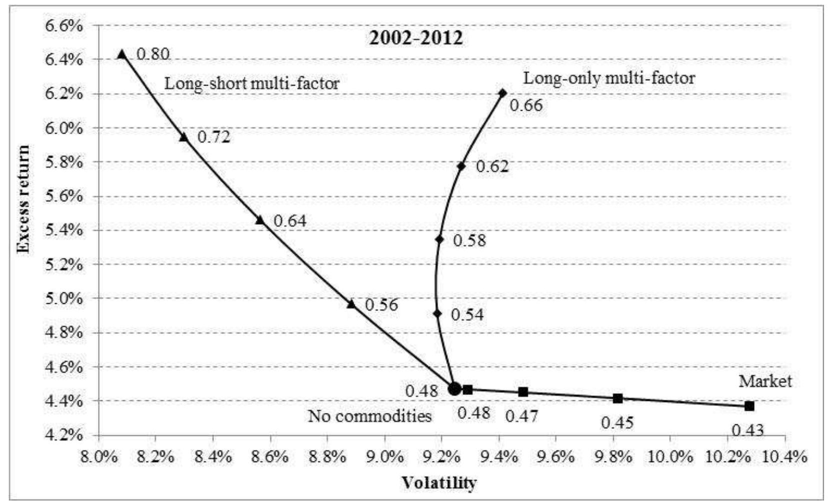


EXHIBIT 7. Strategic allocation in case of an equity/bond factor portfolio.

These graphs are similar to those in Exhibit 4, except that instead of assuming that the equity portfolio is equal to the market portfolio, we now assume that the equity portfolio is the 1/N equity multi-factor portfolio. All portfolios are constructed in the same way as in Exhibit 1, 2 and 3.