Market Insight

Macro Risk and Strategic Asset Allocation: Deconstructing Risk Parity Portfolios

Kurt Winkelmann, Raghu Suryanarayanan, Ludger Hentschel, and Katalin Varga

Kurt.Winkelmann@msci.com

Raghu.Suryanarayanan@msci.com

Ludger.Hentschel@msci.com

Katalin.Varga@msci.com

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Abstract:

In our previous papers, we presented a framework for defining macroeconomic risk and its impact on asset pricing. Those papers showed how portfolios vary in their long-term return's correlation with macro economic shocks, which implied that so-called "high cash flow beta" assets should receive a premium relative to the market portfolio. In this paper, we show how that framework can be applied to the strategic asset allocation problem. We label assets as either risk premium or risk hedging assets, depending on their exposure to macroeconomic shocks. We show that uncertainty-averse investors might decrease their exposures to risk premium assets, while more uncertainty-tolerant investors might increase their exposures to risk premium assets. We apply our analysis to a risk-parity portfolio, showing how its relatively high exposure to inflation shocks makes it a risk premium portfolio. Finally, we present a methodology for designing and testing macroeconomic shocks.

Why This Matters:

- Our analysis provides a possible framework for treating horizon effects in portfolio choice.
- This framework is easy to implement for evaluating macro shocks.
- Our overall framework can be easily applied to analyze other investment strategies.

Introduction

This paper builds on the analysis in our previous three papers, which showed the following:

- Macro risk can be defined as persistent shocks to trend growth and inflation
- Dividend growth rates for size, style and sector portfolios vary in their responses to such shocks
- The variations in responses to such shocks is a risk that can be priced
- Long-run returns reflect compensations for this risk
- Macroeconomic shocks have a smaller impact on short-term risk decompositions
- Macro risk dominates long-run risk decompositions

The pricing model that we use to establish long-run returns is based on assumptions about a "representative" investor. In our analysis, this 'stand-in' investor cares about both the risk inherent in today's investment opportunity set, and also the uncertainty about the evolution of investment opportunities over time. It is the evolution of investment opportunities over time that is most sensitive to shocks to economic conditions. Our analysis in this paper shows how an investor's investment horizon and willingness to tolerate macroeconomic uncertainty informs asset allocation decisions.

We categorize strategies as either risk premium or risk hedging, depending on their long-run exposure to macroeconomic shocks. Keeping these shocks in mind, strategies with high long-term cash-flow betas relative to the market portfolio are defined as *risk-premium strategies*, while those with low cash-flow betas relative to the market portfolio are defined as *risk-hedging strategies*. In our analysis, investors with a low tolerance for long-run uncertainty can reduce their exposure to macroeconomic risk by shifting the asset allocation towards risk-hedging strategies. By contrast, investors with a high tolerance for long-run uncertainty can receive a premium by increasing their exposure to macroeconomic risk and tilting towards risk-premium strategies.

The distinction between risk-premium and risk hedging strategies, which incorporates attitudes towards uncertainty, is well-suited for analyzing risk-parity portfolios. Our analysis shows that a risk-parity portfolio tilts to risk-premium strategies. As such, it has greater exposure to macroeconomic risk than the market portfolio, and is especially exposed to inflation shock. Consequently, the risk parity portfolio is consistent with an investor who is willing to tolerate long-run uncertainty. Because risk-parity portfolios require the use of leverage to achieve their return targets, significant adverse macroeconomic shocks could also increase the potential for breaching margin requirements.

Assets are Either Risk Premium or Risk Hedging Strategies

The analysis in our earlier papers suggested that there are two principal sources of macro risk: 1) persistent shocks to economic trend growth, and 2) changes in the inflation regime. Relative to the market portfolio, strategies with high long-term cash flow betas have higher exposures to shocks to trend growth than the market portfolio. Because of their higher long-term cash flow betas, these strategies generate a higher long-run equilibrium return relative to the market; we label these *risk premium* strategies. In particular, our earlier analysis showed that value, small cap and cyclical industries all have higher cash flow betas relative to the market.

Conversely, strategies with low cash flow betas relative to the market portfolio are less exposed to shocks to trend growth. Our analysis showed that these strategies generate lower long-run returns than the market portfolio in equilibrium. As they have lower exposure to persistent shocks to trend growth, these strategies can hedge some of the effects of macro shocks relative to the market; we label these strategies *risk-hedging* strategies. Low cash flow beta strategies include growth, large cap and defensive

industries. Both Real and Nominal bonds have low cash-flow betas with respect to persistent shocks to real economic trend growth, and consequently are a risk hedging strategy.

Our earlier papers also analyzed the impact of inflation on asset cash flows, which showed there is negative feedback between inflation and growth in real output for most major economies; higher inflation translates into lower growth in real output. Furthermore, our analysis showed that increases in inflation have negative effects on equity cash flow growth. At the same time, inflation shocks are slightly positive for real bond prices; higher inflation translates into lower real growth and consequently higher real bond prices. The same effect does not work for nominal bonds, where the impact of higher inflation swamps the beneficial effect of higher real bond prices. In our study, inflation shocks can be quite disastrous for nominal bond prices. Moreover, the impact of inflation increases with duration. Because of the significant impact of inflation on nominal bond prices, we categorize nominal bonds as a risk premium strategy, where the risk premium is the inflation risk premium.

Table 1 summarizes our description of risk premium and risk hedging strategies. In the remainder of this paper we will analyze the conditions under which investors may shift to risk premium or risk hedging strategies.

Table 1. Investment Strategies Are Risk Premium or Risk Hedging Strategies.

Macro Risk	Risk Premia Strategies	Risk Hedging Strategies
Real Growth	▪ Value ▪ Small Cap ▪ Real Estate ▪ Cyclical Industries	▪ Growth ▪ Defensive Industries ▪ Nominal Bond ▪ Inflation-Linked Bonds
Inflation	▪ Nominal Bonds ▪ Equities	▪ Inflation-Linked Bonds

Asset Allocation Depends on Uncertainty Aversion and Horizon

Our earlier analysis showed that the assets with large cash flow betas should receive a premium relative to the market portfolio; that is, the observed historical premiums on strategies such as value and small cap are compensation for persistent shocks to trend growth. These premiums are also consistent with the *hypothetical* investor holding the market portfolio. However, *specific* investors can reasonably deviate from holding market cap weights. The issue is: what would cause investors to deviate from holding the market portfolio?

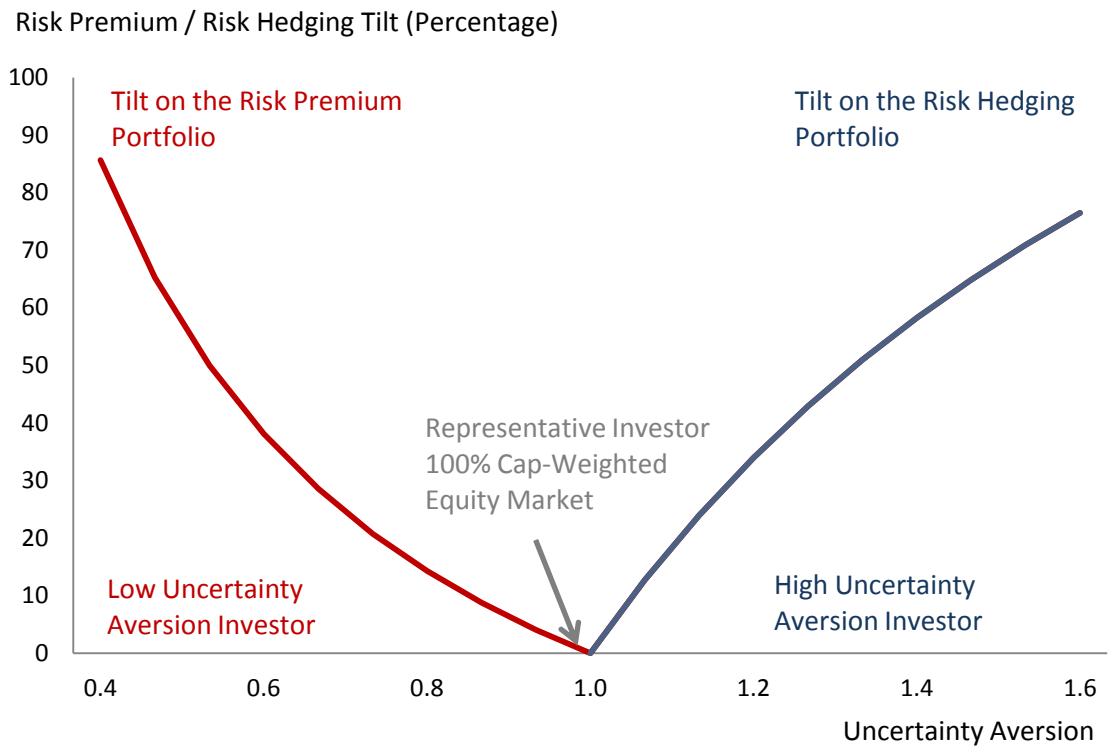
In the usual CAPM framework, investors care about risk aversion. Differences in risk aversion among investors lead to adjustments in the split between risky and risk-free assets, but not in the composition of the risky portfolio; in equilibrium, the risky portfolio for all investors is the market portfolio. In our analysis, investors are both risk averse *and* uncertainty averse. Aversion or tolerance to uncertainty is what dictates an investor's aversion to, or preference for, high cash flow beta portfolios. Preferences for high cash flow betas, in turn, drive allocations to either the risk premium portfolio or the risk hedging portfolio.

Figure 2 illustrates these points. In the graph, the representative investor holds the market portfolio where all strategies and assets are held in their capitalization weights. Now suppose that an investor can tilt towards either risk premium or risk hedging portfolios. For this example, the risk premium portfolio is assumed to be a value-weighted portfolio of value, small cap, consumer discretionary, financials, real estate and materials, while the risk hedging portfolio is assumed to be a value-weighted portfolio of growth, large cap, utilities, health care, industrials, telecoms, energy, information technology, and consumer staples.[1]

What happens to the strategy mix as uncertainty aversion changes? As Figure 2 illustrates, the uncertainty averse investor (represented by a high uncertainty aversion parameter) tilts away from the market portfolio and allocates a larger proportion of the portfolio to the risk hedging portfolio. By contrast, the uncertainty seeking investor (represented by a low uncertainty aversion parameter) tilts away from the market portfolio and allocates a larger proportion of the portfolio to risk premium assets.

[1] We found the long run cash-flow betas of industrials, telecoms, energy, and information technology sectors to be moderately positive, although lower than the equity market's cash-flow beta.

Figure 2. Portfolio Holdings Change with Uncertainty Aversion.



The Figure shows how long-run portfolio holdings change with an investor's uncertainty aversion. The representative investor holds the 100 percent capitalization-weighted equity market portfolio. The uncertainty aversion (UA) scale is normalized so that the representative investor has an UA of 1. For example, an investor with an UA of 1.2 is 20% more uncertainty averse than the representative investor, and an investor with an UA of 0.8 is 20% more uncertainty tolerant. The representative investor's uncertainty aversion was calibrated to match the observed equity market average return of 7.9 percent from 1950 to 2011. Investors that are more uncertainty averse tilt towards the Risk Hedging portfolio, while investors that are more uncertainty tolerant tilt towards the Risk Premium portfolio.

The asset allocation differences in Figure 2 raise the question: why does uncertainty aversion vary among investors? One possibility is that there are classes of investors for whom short-run horizon effects are important. These investors may not be willing to tolerate large short-term swings in portfolio value, nor have the patience for the long-term resolution of uncertainty. An example of such an investor class could be individual investors.

By contrast, other classes of investors may exist for whom short term effects are less relevant. They may be long-lived organizations whose short term spending needs are not driven by portfolio value. Consequently, they may have the patience required for the long-term resolution of uncertainty.

While investor attitudes about uncertainty can vary by investor class, it is important to recall that the *aggregate of all investor holdings must equal the market portfolio*. Looking again at Figure 2, the differences in asset allocation illustrate how an equilibrium, where the representative investor holds the market portfolio, can be compatible with differences in asset allocations across investor classes.

Risk Parity Portfolios are also Risk Premium Portfolios

Recently, investors have been considering so-called "risk-parity" investment strategies. The premise behind these portfolios is that capital should be allocated so that the marginal contribution to portfolio risk is the same for each asset. It is argued that allocating capital in this way provides a better diversified portfolio, relative to a cap-weighted equity portfolio. Since bond returns are viewed as less volatile than (and exhibiting little correlation with) equity returns, the total portfolio volatility of a risk-parity portfolio is less than that of a cap-weighted equity portfolio. Consequently, to achieve equivalent target returns, investors must apply leverage at either the portfolio or asset class level.[2]

The following simple example illustrates these points. The reference is a capitalization-weighted equity portfolio. The risk parity portfolio reallocates capital away from equities and into bonds. Furthermore, the remaining equity allocation is re-distributed between size and style portfolios. Since this is a form of a risk-parity portfolio, the target risk allocations will be 50 percent from nominal bonds and 12.5 percent each from the size and style portfolios. Table 3 shows the asset allocations and asset class risk contributions for the reference and risk-parity portfolios.

Table 3. Risk is More Diversified in the Risk-Parity Portfolio.

	Asset Allocation		Contribution to Total Risk	
	Risk-Parity	100% Market Cap Weighted Equity	Risk-Parity	100% Market Cap Weighted Equity
Asset Class				
Market Cap Weighted Equity	0.0%	100.0%	0.0%	100.0%
Small Cap	8.8%	0.0%	12.5%	0.0%
Large Cap	10.7%	0.0%	12.5%	0.0%
Value	10.6%	0.0%	12.5%	0.0%
Growth	10.8%	0.0%	12.5%	0.0%
Bonds	59.1%	0.0%	50.0%	0.0%
Volatility	8.5%	15.6%		

The table shows the asset allocation and asset class risk contributions for the Risk-Parity and the 100 percent market cap-weighted equity portfolio. Asset allocations and risk contributions are based on monthly historical portfolio returns from 1985 to 2011. The style portfolios are long only, respectively sorted by size and book-to-market. The portfolio total return series are available from Kenneth French's website. We used the Citigroup US 10-Year+ Government Bond Index to represent the bonds portfolio.

Two points stand out from Table 3. First, the risk-distributions show that total portfolio volatility is evenly split between equities and bonds in the risk-parity portfolio, and that equity risk is evenly split by size and style. Secondly, it is clear that the risk-parity portfolio has less volatility than the cap-weighted

[2] For a description of risk parity portfolios and the use of leverage, see the special section on risk parity in the Spring 2011 issue of The Journal of Investing.

equity portfolio, mostly because of the low correlation between equity and bond returns. Holding asset class return expectations constant (and treating them as given), the risk-parity portfolio will generate a lower expected return than the cap-weighted equity portfolio. Consequently, to achieve the same return target as cap-weighted equities, the risk-parity portfolio must be levered.[3] Alternatively, the risk-parity portfolio can be levered to have the same projected volatility as equities. In this case, expected returns would exceed those of the reference portfolio. In this example, applying a leverage of about 1.8 to 1 would achieve the same volatility as the equity portfolio.

As Table 3 shows, the reduction in initial (pre-leverage) total portfolio volatility is achieved by tilting towards value, small cap and nominal bonds; in short, the risk parity portfolio tilts towards risk premium strategies. In Figure 2, we showed that investors with a high tolerance for uncertainty (e.g., long horizon investors) should tilt towards risk premium strategies. Consequently, in our analysis, the risk parity portfolio is suitable for uncertainty tolerant investors. Since an important reason for the existence of premiums is investment horizon, it is reasonable to wonder whether there are macro risks that may emerge only over longer time horizon.

Inflation Shocks Can Be More Consequential for Risk Parity Portfolios

In the previous section, the risk-parity portfolio tilts towards holding risk premium strategies. The analyses in our earlier papers showed that risk premium assets have higher exposures to macroeconomic risk. Thus, the risk-parity portfolio would appear to have a higher exposure to macro-shocks than, say, the reference portfolio.

This point can be illustrated in two ways. First, we can calculate the long-term variance of each portfolio, and decompose it into the principal sources of macro risk. Secondly, we can examine the impact of macroeconomic shocks on each portfolio.

Table 4 shows the long-term risk levels for the cap weighted equity portfolio and the unlevered and levered risk parity portfolios. Risk levels in the table are calculated using both the historical time series of returns and our macro factor model. Table 4 also shows the attribution of risk to the principal macro risk factors.[4] What is evident from the table is that the risk-parity portfolio is more exposed to inflation risk than the reference portfolio. Correspondingly, the risk-parity portfolio is less exposed to persistent shocks to real economic growth than the reference portfolio. The differences in the allocation of macro risk can be attributed to the higher exposure to nominal bonds in the risk-parity portfolio. Because the principal source of long-run risk in nominal bonds is inflation, the higher allocation to nominal bonds in the risk-parity portfolio means that the portfolio itself will have a larger proportion of risk attributable to inflation shocks.

[3] The amount of leverage depends on the expected return assumption for bond and equity returns.

[4] Macro risk attribution is discussed in our earlier paper ("Pricing and Analyzing Macro Risk").

Table 4: The Risk-Parity Portfolio Has More Inflation Exposure.

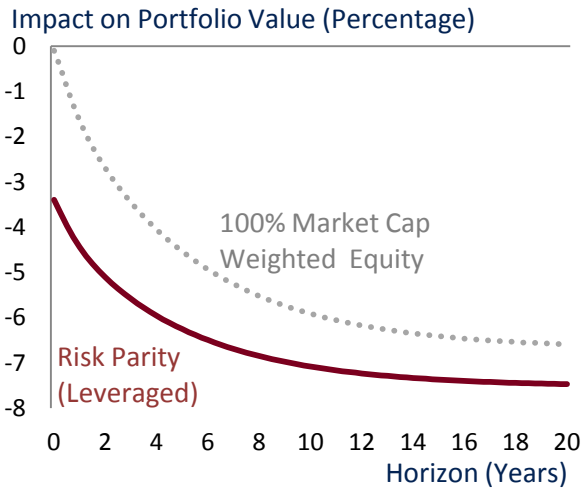
	100% Market Cap-Weighted Equity	Risk-Parity	Risk-Parity with Leverage
Historical Long Term Risk	15.6	8.5	15.6
Model Long Term Risk	10.6	8.1	14.6
Macro Risk Contribution	87.9	95.5	95.5
Real GDP	77.8	51.7	51.7
Inflation	10.1	43.8	43.8

The table shows the long-term (80-quarter) portfolio volatility and variance contributions from real GDP growth and inflation for the 100 percent Market Cap-Weighted Equity, Risk-Parity, and levered Risk-Parity portfolios. The long term historical risk is the equally weighted standard deviation of portfolio monthly real returns from 1985 to 2011. The model volatility and variance contributions from real GDP growth and inflation are derived from our asset pricing model.

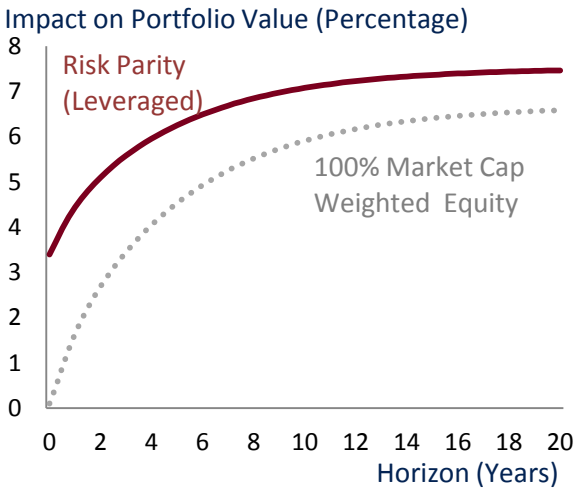
The impact of shocks to trend growth and inflation can also be seen through stress tests. Figure 5 and Figure 6 show the effects on the risk-parity portfolio and the reference portfolio of positive and negative shocks to our two principal sources of macro risk: shocks to real GDP growth and shocks to inflation. Because our macro risk model is one where the persistency of shocks are not revealed immediately, the graphs show the cumulative effect measured in cumulative real returns over an 80 quarter horizon; however, the marginal effects seem to diminish after about 20 quarters.

Figure 5: The Risk-Parity Portfolio is Highly Sensitive to Real Economic Growth.

Impact of a -1.5 percent Negative and Persistent Shock to Trend Growth.



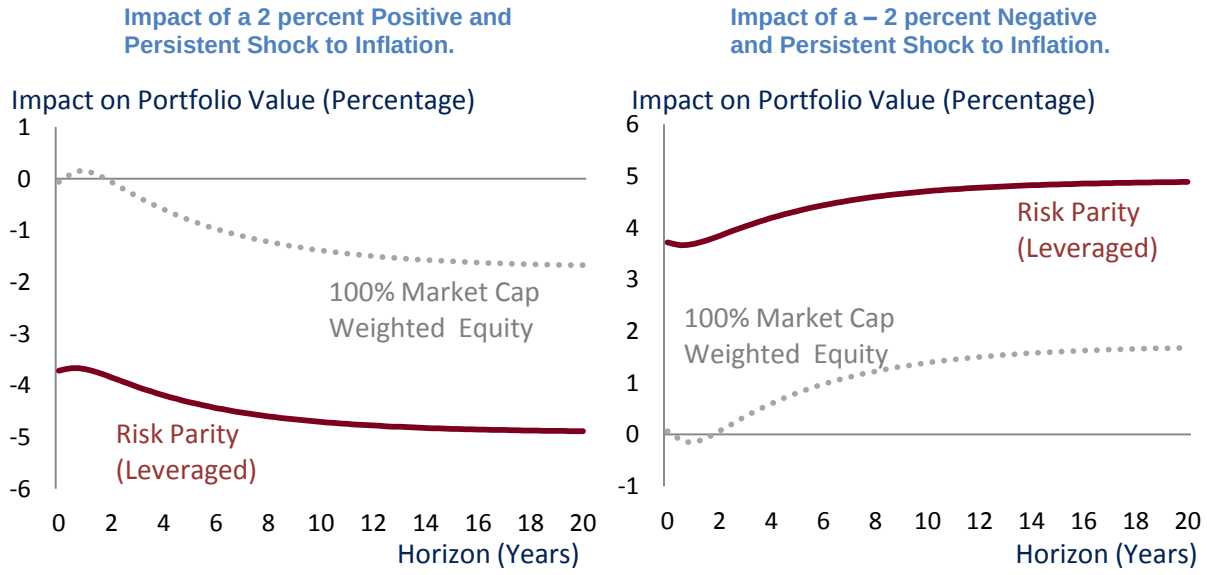
Impact of a 1.5 percent Positive and Persistent Shock to Trend Growth.



It is evident from the graphs in Figure 5 that the risk-parity portfolio thrives, relative to the reference portfolio, in conditions of stable or positive shocks to real output, and stable or falling in periods of inflation. In contrast to the reference portfolio, the risk-parity portfolio is hurt during periods with large and persistent shocks to real output growth, and large increases in inflation.

Our analysis in this section indicates that the risk-parity portfolio is a levered tilt on risk premium strategies. In the previous section, our analysis showed that investors who have a tolerance for the long-term resolution of uncertainty tilt their portfolios towards risk premium strategies. Combining these two results suggests that risk-premium strategies may be more suitable for investors who are uncertainty seekers and not for the uncertainty averters.[5]

Figure 6: The Risk-Parity Portfolio is Highly Sensitive to Inflation Shocks.



In our analysis, the risk-parity portfolio has a substantially different set of macro risk exposures than the reference portfolio. As discussed throughout this series, the impact of these macro risks is not revealed over short horizons. Consequently, our analysis suggests that to understand the total risk picture and design better investment strategies, standard risk analyses based purely on the volatility of returns can be complemented with analyses of macro risk exposures.[6]

[5] There is some uncertainty aversion parameter that makes the risk-parity portfolio optimal, conditioned on using Epstein-Zin preferences. The uncertainty aversion parameter for this portfolio is less than that of the market portfolio (i.e. representative investor).

[6] This point is especially important for strategies using leverage. Larger exposures to macro shocks could increase the potential for margin calls relative to measures expressed only in terms of volatility.

Macro Scenarios Can Be Evaluated in a Structured Way

In the previous section, Figure 6 shows that the risk-parity portfolio does well, relative to the reference portfolio, in periods of stable and above trend economic growth combined with stable and declining inflation. In our previous papers, we have argued that macro risk is best defined as a persistent shock to real GDP growth and inflation. A reasonable next step is to systematically evaluate macro scenarios and their impact on the risk-parity and reference portfolios.

The first step in systematically evaluating a macro scenario is the definition of a baseline. The purpose of the baseline scenario is to set bands against which stress scenarios can be measured. Since the effects we are concerned about are long-term, the baseline scenario should also be long-term. Finally, the baseline should be easy to calculate on the basis of readily available data.

Table 7 shows an example of such a baseline scenario, which shows the projected growth rate for US real GDP and inflation in 12 quarters (the choice of 12 quarters is arbitrary). The scenario was calculated using a Bayesian Vector Autoregression (BVAR).[7] The table also shows confidence bands around the baseline, set at the 70 and 30 percent levels. Most of the time, realized real GDP and inflation will be within the confidence bands. These bands are important for us in developing stress scenarios.

Table 7: Baseline Scenario and Confidence Bands for US Real GDP Growth and Inflation, 12 quarters out.

	Baseline	Confidence Bands	
		30th Percentile	70th Percentile
Real GDP Growth (%)	2.0	0.3	3.8
Inflation (%)	1.8	0.8	2.8

Our earlier papers argued that macro risk is a persistent shock to trend growth and/or inflation; that is, what matters to portfolio value is not a one-time shock, but a shock whose effects linger for many quarters. In the context of our confidence bands, these shocks must be large enough so that real output and inflation fall outside the confidence bands in 12 quarters time. Table 8 shows illustrative scenarios for such shocks to real economic growth and inflation.[8] We have categorized the shocks as falling into one of four groups: high real growth/high inflation, high real growth /low inflation, low real growth/high inflation, and low real growth/low inflation.

[7] Vector autoregressions are a standard statistical tool for multivariate time series analysis. They have widespread application in macroeconomic analysis. A benefit of VARs is that it becomes very easy to make projection over many periods, and to calculate confidence bands over those same periods. Our BVAR model builds on the long-run risk model for real GDP growth described in our previous paper ("Macroeconomic Risk and Asset Cash Flows"). In addition to real GDP growth and corporate profits, that are only observed on a quarterly basis, typically with a lag, we also made efficient use of variables available on a more timely, monthly basis: CPI inflation, term spread (10-Year minus 3 month), money growth (M2), Fed base rate, the SPGS Commodity Index, unemployment rate, exports, capacity utilization, and labor unit cost. Last, we impose restrictions (Bayesian priors) based on empirical regularities found in the observed time series of these variables.

[8] A nice feature of our BVAR model is that it allows us to evaluate the likelihood of such scenarios, conditioned on what has happened in the past. In each scenario, the likelihood of the (negative/positive) 1 percent persistent shock to inflation, relative to baseline, is about 18 percent. The likelihood of the (negative/positive) 1.8 percent shock to real GDP growth is close to 0. In other words, each scenario portrays an extreme (negative/positive) change in real GDP growth, and a significant, although plausible change in inflation.

Table 8: Macro Scenarios.

	High Real Growth / High Inflation	High Real Growth / Low Inflation	Low Real Growth / High Inflation	Low Real Growth / Low Inflation
Real GDP Growth (%) 3-Years Out	3.8	3.8	0.3	0.3
Inflation(%) 3-Years Out	2.8	0.8	2.8	0.8

The final step in the process is to assess the impact of each scenario on both the reference portfolio and the risk-parity portfolio. The output from the assessment is a projected value (i.e., what happens to portfolio value in the long run if this scenario occurs), and the implicit correlation between equity and bond returns.[9] Table 9 summarizes the results of this stress test for the reference and risk parity portfolio.

Table 9: Macro Scenario-Based Stress Testing Results.

	High Real Growth / High Inflation	High Real Growth / Low Inflation	Low Real Growth / High Inflation	Low Real Growth / Low Inflation
Impact on 100% Market Cap-Weighted Equity Portfolio Value (%)	6.9	8.9	-8.9	-6.9
Impact on (Leveraged) Risk-Parity Portfolio Value (%)	6.2	11.8	-11.8	-6.2
Implied Equity/Bond Correlation (%)	22.7	63.4	63.4	22.7

The table shows the projected long-run change in the equity market and risk-parity portfolio value, and the implied equity/bond correlation under the four scenarios described in Table 8.

As anticipated, major shocks to inflation are likely to be much more significant for the risk-parity portfolio than the reference portfolio. Both portfolios do well with positive shocks to trend growth. What is just as interesting as the impact on portfolio returns is the impact of shocks on the correlation between bond and equity returns. While the correlation between equities and bonds was usually found to be low and negative before the 2008 crisis, we found this correlation to be actually significantly

[9] We report the implied quarterly time series correlation between equity and bond returns under each scenario, and over 80 quarters following the shock. This measure excludes (macro) sources of fluctuations in equity and bond returns that may prevail following the shock. Accounting for these additional fluctuations may result in lower correlation estimates in magnitude.

positive under all four macro scenarios. Thus, the risk-parity portfolio is also exposed to a "correlation risk," meaning a dramatic change in the macro environment produces a change in asset correlations.

To further explore this point, we consider two scenarios that now combine an extreme inflation rate of 4.8 percent (three-years out), with the same low and high real GDP growth rates of 0.3 percent and 3.8 percent. Table 10 shows the results of these stress tests. We find that the implied correlation between equities and bonds is negative in the extreme high real GDP growth and inflation regime. Thus, the risk-parity portfolio helps to diversify risk in such a macroeconomic environment. However, as shown in Table 10, its performance is severely hurt relative to the reference portfolio.

Table 10: Extreme Inflation Scenario Stress Tests Results.

	High Real Growth High Inflation	Low Real Growth High Inflation
Impact on 100% Market Cap-Weighted Equity Portfolio Value (%)	5.0	-10.8
Impact on (Leveraged) Risk-Parity Portfolio Value (%)	0.6	-17.3
Implied Equity/Bond Correlation (%)	-47.4	60.2

The table shows the projected long-run change in the equity market and risk-parity portfolio value, and the implied equity/bond correlation under two extreme inflation scenarios. In both scenarios, the three-years out inflation rate is 4.8 percent. The three-years out Real GDP growth rate is 3.8 percent in the High Real Growth/High Inflation scenario, and 0.3 percent in the Low Real Growth/High Inflation scenario.

Conclusion

The principal theme of this series has been that macroeconomic risks appear to be revealed only over longer time horizons. Our analysis suggests that investment strategies can be categorized as risk hedging or risk premium strategies. Relative to shocks to the economy, risk premium strategies are those with high cash flow betas, and risk hedging strategies are those with low cash flow betas.

In our analysis, investors with a low tolerance for long-run uncertainty (relative to the representative investor) can allocate away from the market capitalization weighted portfolio, and towards risk-hedging strategies. By contrast, investors with a high tolerance for long-run uncertainty can receive a premium by reallocating away from the market capitalization weighted portfolio and into risk-premium strategies.

We have applied the concepts of risk premium and risk hedging portfolios to analyze a stylized version of a "risk-parity" portfolio. Because risk-parity portfolios are tilts away from market capitalization weights towards risk premium strategies, the attribution of macro risk in the risk-parity portfolio is different than that of the capitalization weighted portfolio. In particular, our version of the risk-parity portfolio is more exposed to inflation shocks than a capitalization weighted portfolio. Thus our analysis suggests that the risk-parity portfolio may be better suited for investors who can tolerate the long-run

resolution of uncertainty. Furthermore, we have developed a structured approach to setting up macro stress tests and used it to show that the risk-parity portfolio is also exposed to a "correlation risk," meaning changes in the macro environment could produce changes in asset correlations.

Approaching asset allocation through macro risk factors opens up a wide range of topics. This paper has outlined an approach to developing and analyzing strategic asset allocations. In future papers we will discuss how this framework can be applied to developing inflation-sensitive portfolios; analyze illiquid alternatives such as real estate, infrastructure and hedge funds, and analyze dynamic asset allocation strategies.

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Seoul	00798.8521.3392 (toll free)
Singapore	800.852.3749 (toll free)
Sydney	+ 61.2.9033.9333
Tokyo	+ 81.3.5226.8222

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[1] *As of September 30, 2012, as published by eVestment, Lipper and Bloomberg on January 31, 2013*

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