Factor Investing And Portfolio Strategy - Scope for Differential Portfolio Advice

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Why This Matters?

This paper lays a foundation for differential portfolio advice. It shows that when investor attitudes towards risk differ, their factor allocations should also vary. As a result, this paper provides a framework for developing investment strategies that are investor-segment specific.

Who Should Read This Paper?

This paper is relevant for investors who are developing multi-asset class solutions. Additionally, it is relevant for investment strategists and asset allocators.

01. Introduction

The premise of factor investing is investors can improve portfolio performance by exploiting so-called factor premiums. Empirically, equity factors such as size, style and profitability have received premiums relative to pure CAPM pricing. In fixed income and currencies, premiums have been observed for slope of the curve and relative curve slope. Quantitative strategies such as carry, momentum, trend and volatility have also received premiums, again relative to CAPM pricing.

However, positive historical factor premiums are not sufficient justification for investors to overweight factors in their portfolios. To overweight factor exposure, investors must address two questions:

- Are specific premiums persistent?
- Can all investors exploit the same premium in the same way?

This paper focuses on the second of these questions. Following the consumption-CAPM literature, we show that factor premiums could be a result of differences in exposure to macroeconomic risk. We then show that, relative to market capitalization weights, if one investor class chooses to persistently overweight factor exposure, there should be an offsetting investor class choosing to underweight. We illustrate our main points by focusing on equity factors such as size, style and profitability.

This paper is organized as follows. The next section compares historical factor premiums in equity markets with premiums implied by pure covariance pricing. Then, we show how incorporating exposure to macroeconomic risk produces equilibrium factor premiums. Finally, we apply the analysis of our earlier paper on investor segments to show how differences in attitudes towards risk can lead to different factor allocations.

02. Evidence of Factor Premiums

By definition, "premiums" are prices and "risk premiums" are prices for risk. By extension, factor premiums must be the price of a risk. For the purposes of this paper, we will measure factor premiums as the return in excess of covariance pricing.[1]

Multiple studies have documented the evidence of premiums in historical data. To illustrate, Exhibit 1 shows average factor premiums and standard deviations for the Fama-French HML (Style), SMB (Size), RMW (Profitability) and Market factors.[2] The data cover the period 1970-2015, and are measured quarterly (aggregated from monthly returns). For comparison purposes, Exhibit 1 also shows the factor premiums implied by pure CAPM pricing.[3] The implied factor premiums were calibrated to give the same

[1] Most academic studies of factor premiums measure them in this way. See, for example, Fama and French (1992).

[2] The returns were measured as the simple averages and standard deviations of the differences between the quantile portfolios from the Fama-French sorts. Data were taken from Ken French's website: www.ssss.edu.

[3] The implied premiums were calculated from the covariance pricing relationship. If x is a vector of portfolio weights, r a vector of expected excess returns and Ω a covariance matrix of excess returns, then implied returns are given by r = λΩ-1x, where λ is a risk aversion parameter. Setting x to be the vector of capitalization weights gives an interpretation of r as equilibrium expected excess returns.

Exhibit 1 - Style and Size Premiums

FACTOR	AVERAGE (%)	VOLATILITY (%)	CAPM-IMPLIED (%)
MARKET	5.3	17.9	5.3
SMB	2.7	11.1	1.0
HML	3.8	12.4	-1.2
RMW	2.7	8.5	-.5

premium on the market portfolio as the historical average. (Appendix A has the asset and factor volatilities and correlation levels).

It is evident from the exhibit that the style, size and quality factors had positive returns over our sample period and exceeded the CAPM returns, some of which were negative. The observation of positive premiums relative to CAPM returns would seem to provide an incentive for some investors to overweight factor exposure, relative to market capitalization weights. However, it is important to resist the temptation to assume that every investor should respond in the same way to positive factor premiums. There is an important additional consideration- the representative investor must hold the market portfolio. Thus, for one investor group to persistently receive a premium from the factors, it must also be the case that there is another investor group who is willing to forego the same factor premiums.

03. Portfolio Strategy With Factor Premiums

The previous section showed that historically, equity factors have generated excess returns relative to pure CAPM pricing. This observation raises two interrelated questions for investors- first, will these factors continue to generate premiums in the future, and second, whether the return premium can be exploited for portfolio strategy purposes.

Why are these questions interrelated? Suppose that investors believe that the historical premiums are an aberration and that CAPM pricing prevails. In this case, the optimal strategy is to hold equities in their capitalization weights. Alternatively, suppose that investors believe that the premiums will dissipate over time and pricing will revert to CAPM pricing. Then, the optimal strategy is to overweight the factors until CAPM pricing is restored. Finally, suppose that investors believe that the historical premiums are pricing an additional risk factor (relative to CAPM pricing). In this case, because the representative investor holds the market portfolio, the optimal strategy is for some investors to overweight factor exposure and for other investors to underweight.

Many approaches have been taken to explain the existence of factor premiums.[4] To illustrate our main points, we'll use a consumption-based approach to asset pricing. With this approach, the paths of asset prices, asset holdings and consumption are jointly, and dynamically, determined. One consequence of this modeling approach is that the path of future consumption plays a role in determining current asset prices and asset holdings. To capture this effect, investor preferences are modified to incorporate a parameter (the Elasticity of Intertemporal Substitution) that account for the timing of asset cash flows (see Appendix B for a longer discussion).[5]

Using a consumption-CAPM approach with modified preferences introduces an additional risk factor to asset pricing. That risk factor accounts for the

[4] An alternative to the macro-financed based approach discussed here is the behavioral finance literature.

[5] A macro-finance alternative to the recursive preferences that we use here is the idea of habit-persistence.

connection between asset returns and the growth of consumption. In the formulation of this paper, the additional risk factor is the covariance between the logarithm of the consumption-wealth ratio and asset returns. One significant advantage of introducing the consumption-wealth ratio is that we are able to generate expected returns that are sensitive to macroeconomic growth.

Exhibit 2 illustrates the effect on implied premiums of including an additional, macro-based, risk factor. The data in Exhibit 2 are the same as in Exhibit 1, with the exception that we've added bonds as an asset.[6] Similar to Exhibit 1, the premiums are derived from estimated covariances and the assumption of market equilibrium. For illustrative purposes, we've assumed that 65% of the market portfolio is held in equities and 35% held in bonds. Preferences are calibrated to generate the historical equity premium. The premiums in the exhibit are calculated with two alternative assumptions about the correlation between asset (or factor) returns and the logarithm of the consumption-wealth ratio. For each asset or factor, the exhibit shows the total premium, the pure CAPM premium and the premium attributable to the macro risk factor.[7] (Calculation details are in Appendix B).

Exhibit 2 illustrates the importance of the additional risk factor- without this risk factor, equilibrium asset prices are given by pure CAPM pricing. The exhibit suggests that in equilibrium, a factor premium (relative to CAPM) can persist only if there is an additional risk factor. The exhibit further suggests that investment strategists should incorporate the long-run relationship between the logarithm of the consumption-wealth ratio and asset returns.[8]

[6] Bond returns are given by the return to a 10- year zero (as reported by the FRED database) adjusted to a 6-year duration.
[7] We held the EIS constant at .97.
[8] There are two challenges to establishing the relationship between asset returns and the consumption-wealth ratio. The first is that the paths of consumption and asset prices are jointly determined. The second is that wealth includes the value of both physical and human capital, the latter of which is unobservable. Lettau and Ludvigson (2007?) estimate a time series for the relationship between consumption, physical capital and human capital, which they call cay. They show that the correlation between cay and equity returns is approximately .28

Exhibit 2 - Consumption-CAPM Implied Premiums

ASSET/FACTOR	C-W CORRELATION	CAPM PREMIUM (%)	C-W ADJUSTMENT (%)	TOTAL PREMIUM (%)
Bonds	-0.05	1.2	-0.3	0.9
Equities	0.28	3.1	2.2	5.3
SMB	0.20	0.6	1.0	1.6
HML	0.40	-0.7	2.1	1.4
RMW	0.45	-0.3	1.6	1.3

What are the implications for investment strategy? If all investors have the same attitudes towards risk, then it must still be the case that all investors will continue to hold the market portfolio. Consequently, an investor who chooses to deviate from the market portfolio must also have a different attitude towards risk than the representative investor. And, for equilibrium to continue to hold, there must be an offsetting investor class taking the other side. That investor must also have a different attitude towards risk than the representative investor.

In an earlier paper, we used publicly available data to segment investor classes by investment horizon.[9] We hypothesized that institutional investors and ultra high net worth investors have very long, possibly infinite, investment horizons, while DC/IRA investors and other high net worth investors have finite investment horizons. We further hypothesized that due to the risk associated with persistent shocks to economic growth, very long horizon investors could be more risk tolerant than short horizon investors. Under the assumptions of that paper, short horizon (risk averse) investors hold half of the identified assets. Long horizon (risk tolerant) investors hold the remaining 50% of identified assets.

Exhibit 3 shows three portfolios that illustrate the effect of segmentation by risk aversion. The first is the market portfolio, while the second and third are portfolios for investors who are either more risk averse or more risk tolerant than the representative investor. The exhibit uses the premiums and asset return covariances with the logarithm of the

[9] See "Differential Portfolio Advice: Defining Investor Segments", by Kurt Winkelmann, Attila Agod and Ferenc Szalai.

Exhibit 3 - Portfolio Allocations

ASSET/FACTOR	EQUILIBRIUM (%)	RISK AVERSE (%)	RISK TOLERANT (%)
Bonds	35	36	34
Equities	65	61	69
SMB	0	-3	3
HML	0	-5	5
RMW	0	-9	9
Cash(+) / Leverage(-)	0	+10	-10

consumption-wealth ratio shown in the second set of columns of Exhibit 2. Finally, Exhibit 3 draws on our earlier analysis and assumes that 50% of the investors are more risk averse than the representative investor, and 50% are more risk tolerant.

The portfolio allocations in Exhibit 3 illustrate the relevance of investor segments for portfolio strategy. In the exhibit, it is optimal for risk tolerant investors to overweight exposure to factors. The overweight factor positions are offset by underweight factor positions on the part of risk averse investors. Similarly, risk tolerant investors are more levered, while risk averse investors hold more cash.[10]

The magnitudes of the deviations from capitalization weights are driven by the percentage of investors in each segment and the absolute difference in risk aversion across segments. Exhibit 4 shows the effect on portfolio allocations of increasing the number of risk averse investors. The exhibit shows the factor and asset allocations for two cases. The first case is simply the same portfolio allocations from Exhibit 3, i.e. equal proportions of risk averse and risk tolerant investors. In the second case, 65% of the investors are assumed to be risk averse. Increasing the number of risk averse investors has the effect of decreasing the underweight positions for risk averse investors, but increasing the overweight positions for risk tolerant investors.

[10] The optimal portfolios were developed under the assumption that each investor segment takes as given the equilibrium expected returns. There is no game between risk averse and risk tolerant investors. An alternative way to approach the problem is to assume that all investors have the same attitudes toward risk, but to simply vary the investment horizon.

Exhibit 4 - Portfolio Effect of Changing Segment Proportions

ASSET/FACTOR	RISK AVERSE (%)	RISK TOLERANT (%)	RISK AVERSE (%)	RISK TOLERANT (%)
Bonds	36	34	35	34
Equities	61	69	62	69
SMB	-3	3	-2	3
HML	-5	5	2	5
RMW	-9	9	-5	9
Cash(+) / Leverage(-)	+10	-10	+11	-11
Proportion	50	50	65	35

The effect of changing the absolute difference in risk aversion is illustrated in Exhibit 5. Once again the portfolios from Exhibit 3 are the base portfolios. For the comparison portfolios, the absolute difference in risk aversion is increased by 50% (relative to Exhibit 3). The effects of the increase in differences in attitudes towards risk are to increase the deviations from capitalization weights for each investor segment; increase the leverage by the risk tolerant investors, and increase the cash holdings by the risk averse investors.

Three conclusions can be drawn from this section's analysis. First, another factor is necessary if we want to have persistent premiums relative to CAPM pricing. Since our analysis is based on consumption-CAPM, our factor is macro-finance based.

Second, adding another factor gives room for differential portfolio advice. In our analysis, we focused on differences in attitudes towards risk. We showed that risk averse investors (relative to the representative investor) are underweight factor exposure and risk tolerant investors are overweight the same factors.

Finally, our analysis suggests that the magnitudes of deviations from capitalization weights are driven by two factors. These are the relative proportions of investors in risk averse and risk tolerant segments, and the relative differences in risk aversion.

Exhibit 5 - Portfolio Effect of Changing Risk Attitudes

ASSET/FACTOR	RISK AVERSE (%)	RISK TOLERANT (%)	RISK AVERSE (%)	RISK TOLERANT (%)
Bonds	36	34	36	34
Equities	61	69	56	73
SMB	-3	3	-6	6
HML	-5	5	-9	9
RMW	-9	9	-19	19
Cash(+) / Leverage(-)	+10	-10	+42	-42
Risk Difference	Base	Base	Double Base	Double Base

04. Conclusions

This paper has explored the implications of factor premiums for portfolio strategy. We began by interpreting factor premiums as compensation for long-run macroeconomic risk. We measured long run macroeconomic risk as the covariance between asset returns and the logarithm of the consumption-wealth ratio. We showed that asset and factor premiums increase as this source of risk increases.

We then hypothesized that investor segments may vary in their attitudes toward risk. Under our assumptions, risk averse investors should underweight factor exposures relative to market capitalization weights. By contrast, risk tolerant investors should overweight factor exposures.

Our objective in this paper was to show how modern macro finance provides a foundation for differential portfolio advice. Here we focused on the role of investor attitudes towards risk in differentiation in factor exposures. The next paper in this series examines the effect on portfolio strategy of incorporating differences in underlying economic risk.

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APPENDIX A - ASSET RETURN COVARIANCE MATRIX

This appendix discusses the estimation of the asset class and factor covariance matrix. The appendix also shows the illustrative covariances between the log of the consumption wealth ratio and asset (or factor) returns.

The asset classes were a 10-year zero coupon US government bond, the US equity market portfolio and the HLM, SMB and RMW factor returns. The government bond series was taken from the St. Louis Fed FRED database. The equity return series were taken from the Fama-French database. The bond and market return series are calculated as excess returns, while the factor return series are the difference between the first and last quantile portfolio returns. All data are observed on a monthly basis, and are converted into a series of non-overlapping annual returns. Exhibit B-1 shows the correlation matrix of returns. The main diagonal shows the standard deviation of returns for each series.

Exhibit A-1 - Data-derived Volatility and Correlation

	BOND	MARKET	HML	SMB	RMW
Bond	13.0				
Market	-.09	17.0			
HML	.08	.23	11.0		
SMB	.18	-.16	.27	12.0	
RMW	.26	-.21	.09	.12	8.0

APPENDIX B - CONSUMPTION CAPM AND IMPLIED RETURNS

There are two parameters of interest- risk aversion (γ) and the elasticity of intertemporal substitution (ψ). Following Campbell and Viceira (2002) the equation for optimal portfolio weights becomes:

$$\text{(A.1)} \quad \alpha_t = (1/\gamma)\, \Sigma^{-1} (E_t r_{t+1} - r_{ft+1} I + \sigma^2_t/2) - (1/\gamma)\Sigma^{-1}[(\theta/\psi)(\sigma_{c,wt} - \sigma_{ct} I)].$$

The first term is the usual term from CAPM pricing. The second term in the optimal portfolio choice equation captures the effect of the correlation between the logarithm of the consumption-wealth ratio and asset returns.

Pre-multiply both sides of (A.1) by $\gamma\Sigma$. We have:

$$\text{(A.2)} \quad (\gamma\Sigma)\alpha_t = (E_t r_{t+1} - r_{ft+1} I + \sigma^2_t/2) - (\theta/\psi)(\sigma_{c,wt} - \sigma_{ct} I)$$

Now add the second term on the right side of (A.2) to both sides to get:

$$\text{(A.3)} \quad (\gamma\Sigma)\alpha_t + (\theta/\psi)(\sigma_{c,wt} - \sigma_{ct} I) = (E_t r_{t+1} - r_{ft+1} I + \sigma^2_t/2)$$

Notice that when the covariance between the logarithm of the consumption-wealth ratio and asset returns is zero, then equation (A.3) is the usual CAPM equation. Also notice the importance of the coefficient, (θ/ψ), to expected asset returns.

APPENDIX C - LONG RUN RISK AND PERSISTENCE OF FACTOR PREMIUMS

Positive factor premiums raise two natural questions: (a) what economic forces drove the historical factor premiums and, (b) whether premiums relative to CAPM pricing will persistent.

The long-run risk (LRR) literature argues that premiums (market and factors) are compensation for exposure to long-run macroeconomic risk.[11] LRR is a consumption-based model of asset pricing, where investors care about the discounted value of current and future consumption. Assets are held because they support future consumption. Consumption-based models of asset pricing link asset returns and their components (cash flows and discount rates) to the dynamics driving real economic growth and inflation.[12] Hence, one differentiation between assets is in terms of their exposures to shocks to real economic growth- some assets may be highly exposed to persistent shocks to growth and others less so.

LRR differs from standard consumption-based asset pricing in two respects. First, LRR assumes that the dynamics driving macroeconomic conditions are themselves unknown. For example, there is uncertainty about both the long-term level of real economic growth and the volatility around that mean. Secondly, LRR assumes that investors care about both risk and the resolution of long-run uncertainty about long-run real growth.[13] Including attitudes towards resolution of uncertainty gives a different interpretation of premiums. Premiums can now be viewed as compensation for exposure to persistent shocks to economic growth. Assets whose cash flows are highly correlated with long-run macroeconomic conditions should receive a premium relative to those assets whose cash flow correlation is lower.[14] Differences in premiums will persist as long as differences in exposures to long-term economic growth persist.

[11] Important contributors to this literature are Bansal and Yaron (2004), Schorfheide, Song and Yaron (2004), Hansen, Heaton and Li (2008) and Barillas, Hansen and Sargent (2008). This literature relies on consumption CAPM.

[12] Technically the LRR agenda assumes that real consumption growth and inflation are driven by unobservable (latent) factors: long term trend and uncertainty. Loadings on the latent factors can be found by regressing asset returns on the time series of latent factors (conditioned on having identified the latent factors from the macro-economic data). Thus, premiums (e.g. the equity premium or the size and style premium) reflect differences in exposures to the latent factors.

[13] More specifically, LRR relies on Epstein-Zin preferences. With E-Z preferences, there is a separation between risk aversion and the elasticity of intertemporal substitution.

[14] Technically the long run risk literature relies on the potential existence of a slow-moving and predictable underlying trend growth rate. In same spirit, but from a different direction, Barro et al (2009) study disaster risk in real economic growth rates.