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Bringing Research Insights to Institutional Investment Professionals
Factor Investing and Risk Allocation: From Traditional to Alternative Risk Premia Harvesting

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Outline

- Why Factor Investing?
- Taxonomy of Alternative Risk Premia
- Replicating Hedge Fund Performance with Alternative Risk Premia
- Generating Attractive Risk-Adjusted Performance with Alternative Risk Premia
- Conclusion
- Why Factor Investing?

- Taxonomy of Alternative Risk Premia

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- Conclusion
Risk versus Asset Allocation

- Risk factors have long been used for risk and performance evaluation of actively managed portfolios.

- Recently, a new approach known as factor investing has emerged, which recommends that allocation decisions be expressed in terms of risk factors, as opposed to standard asset class decompositions (see Ang (2014)).

- Fundamental question:
  - Is risk allocation a truly new welfare improving investment paradigm or yet another marketing fad?
  - In the end one always ends up investing in individual securities, so why would we expect a different form of grouping to add any value?
Investment decisions in delegated money management are typically made in two stages:

- (1) Allocation decisions to building blocks (asset class indices) by a chief investment officer;
- (2) Investment decisions in individual securities for each asset class by (internal or external) asset managers.

Are there any circumstances under which the efficiency loss inherent to the two step process can be eliminated?

Strong theoretical argument for factor investing: a sufficient condition for the two-step procedures to coincide with a one-step procedure is to take building block benchmarks to be replicating portfolios for asset pricing factors.
**Fundamental Asset Pricing Equation**

Any asset pricing model, including pricing models as diverse as Sharpe’s CAPM (1964) or Black-Scholes-Merton’s option pricing model (1973), boils down to a single equation, stating that the price \( p \) of any payoff \( x \) is the conditional expected value of the product of the payoff with a **stochastic discount factor** (SDF) \( m \):

\[
p_t = E_t(m_{t+1}x_{t+1})
\]

- Key insight: The **existence** of a SDF is guaranteed by the **absence of arbitrage**, and **uniqueness** by complete markets.

- Key implication: An asset earns a positive risk premium if and only if it covaries negatively with the SDF.

\[
E_t(R_{t+1}) - R_f = -\frac{1}{E_t(m_{t+1})} \text{cov}_t(m_{t+1}, R_{t+1})
\]
Equilibrium versus Arbitrage Asset Pricing Models

- In an equilibrium model, we interpret the SDF as marginal utility of consumption (unfortunately unobservable):
  - An asset that has a high expected return is an asset that tends to perform poorly in bad times, that is when consumption is low (marginal utility of consumption is high).
  - For example, value stocks and small cap stocks outperform over multiple market conditions, but they tend to take a bigger dip down in the worst market conditions.
  - Conversely, an investor is ready to pay a higher price and get a lower return to hold an asset that pays off well in bad times.

- As recalled above, more parsimonious arbitrage arguments also guarantee the existence of a SDF but do not tell us what it should be like – so the trade-off is between non-observable and ill-defined!
Asset Pricing Models in Practice: Factor Models

- The way out of this dilemma (non-observable versus ill-defined) is to use of a factor model.

- Formally, a factor model postulates that the SDF can be written as a linear combination of factors, called asset pricing factors.

- One key implication is that expected excess returns are linear in the betas (APT line, which generalizes the security market line):

  \[ E(R_i) - R_f = \sum_{k=1}^{K} \beta_{ik} \left( E(R_{F_k}) - R_f \right) \]

- Beware of factor fishing as you might get lost in the factor zoo!
  - Equilibrium: Factors should proxy for growth in marginal utility;
  - Arbitrage: Factors should explain cross-section of expected returns.
Pricing Factor versus Priced Factors

- An **asset pricing factor** is a factor that enter the linear proxy for the SDF when taken together with other asset pricing factors.

- A **priced (or rewarded) factor** is a factor that carries a non-zero premium, which can be identified through **sorting procedures**, or **Fama-MacBeth two-pass regressions** (time-series regression of asset returns on factors to get beta estimates, and then cross-sectional regression of returns on betas to get premia estimates).

- A rewarded factor is **not** in general an asset pricing factor; in fact **any variable correlated to an asset pricing factor** may be rewarded.
From Theory to Practice

- These results suggest that the most meaningful way for grouping individual securities is not by forming arbitrary asset class indices, but instead by forming replicating portfolios for a set of suitably designed **asset pricing factor indices**.

- Factor harvesting naturally starts with long-only exposure to “traditional” equity and bond risk premia.

- In an attempt to enhance the diversification of their portfolio, asset owners are now turning their attention to “alternative” risk premia:
  - They are loosely defined as risk premia that extend beyond fair rewards for long-only stock & bond exposure.
  - They are believed to be more difficult to harvest, so difficult indeed that investors have been willing to pay 2 and 20 for harvesting them.
In this presentation, we analyze the benefits and limits of alternative risk premia according to two main dimensions.

– We first empirically analyze whether systematic rule-based strategies based on investable versions of alternative (and traditional) factors allow for the satisfactory **in- and out-of-sample replication of hedge fund performance**, or whether it is instead the case that properly harvesting alternative risk premia does seem to require active managers' skills.

– In a second step, we shift the perspective from **hedge fund replication to hedge fund substitution**, and investigate whether suitably designed risk allocation strategies may provide a cost-efficient way for investors to get an attractive exposure to alternative factors, regardless of whether or not they can be regarded as proxies for any particular hedge fund strategy.
Why Factor Investing?

Taxonomy of Alternative Risk Premia

Replicating Hedge Fund Performance with Alternative Risk Premia

Generating Attractive Risk-Adjusted Performance with Alternative Risk Premia

Conclusion
We consider in our analysis only alternative factors that (i) are investable, and (ii) have been documented to exhibit significant and persistent premia justified by academic research and economic intuition.

These restrictions are most easily met in the equity universe with value and size (Fama and French (1992)) factors, momentum factor (Carhart (1997)), the low risk factor (Ang et al. (2006,2009)), among others.

Overall and given that we wish to set the analysis in a multi-asset context that includes stocks, bonds but also commodities and currencies, we choose to focus on the following four risk factors (see Asness et al. (2015)): value, momentum and low risk (other risk premia may exist such as size, carry, liquidity, quality, to name a few of the most popular ones).
The value risk factor is defined as a long exposure to assets that are “cheap” and a short exposure to those that are “expensive” according to some valuation measure.

The existence and persistence of the value effect has been empirically verified for many different markets and time periods (see Fama and French (1992,1998) for equities and Asness et al.(2013) for other asset classes), reducing the likelihood of a statistical fluke.

The value premium may be:
- A compensation for forms of systematic risk other than market risk (Fama and French (1992)), such as recession risk (Jagannathan and Wang (1996)), cash-flow risk (Campbell and Vuolteenaho (2004)), long run consumption risk (Hansen et al. (2008)), costly reversibility of physical capital leading to high sensitivity to economic shocks in bad times (Zhang (2005)).
- An anomaly due to a persistent behavioral bias (overreaction to bad news and extrapolation of the recent past leads to under-pricing and loss aversion and narrow framing as in Lakonishok et al. (1994)), Daniel et al. (2001), Barberis and Huang (2001), etc.).

Value: Definition
Value: Multi Asset Class Extension

- Asness et al. (2013) extend the value risk factor to other asset classes based on some measure of cheapness.
  - For stocks: ratio of book value of equity (lagged of six months) to market value of equity (most recent available);
  - For government bonds: 5-year change in the yields of 10-year bonds;
  - For currencies: 5-year change in purchasing power parity;
  - For commodities futures: the negative of the spot return over the last 5 years.

- We can use these definitions to build for each asset class a long-short value factor.

- Asness et al. (2013) also define the global multi-asset value « value everywhere » factor as the inverse volatility weighted value factor across asset classes.
Momentum

- The momentum risk factor is designed to buy assets that performed well and sell assets that performed poorly over certain historical time period.

- Since Jegadeesh and Titman (1993) reported momentum profits in the US equity markets, their findings have been confirmed and extended in a number of studies such as international equities, government bonds, currencies and commodities (Asness et al. (2013)) and one may define the global multi-asset momentum factor as the volatility-weighted-across-asset-class momentum factor (based on a momentum measure defined as past 12-month return skipping the most recent month).

- Daniel et al. (1998), Barberis et al. (1998), and Hong and Stein (1999) developed behavioral models to explain momentum profits; while authors that momentum factor can be at least partially explained by correlation with macro factor risks such as liquidity (e.g. Pastor and Stambaugh (2003), Cooper et al. (2004)).
The low-risk factor is designed to take advantage of the reported outperformance of low-risk assets over the high-risk assets.

- Empirically, the relation between stock beta and returns has been proven to be flatter than predicted by the CAPM (Black et al. (1972), Haugen and Heins (1975)).
- Ang et al. (2006, 2009) empirically showed in a number of different equity markets and extended time periods that stocks with low specific vol significantly outperformed stocks with high specific vol.
- From an economic perspective, poor long-run performance of high-risk assets compared to low-risk assets may be due to leverage constraints (Black et al. (1972), Frazzini and Pedersen (2014)) or lottery preferences (Bali et al. (2011)).

Frazzini and Pedersen (2014) build a market neutral long-short low-risk « BAB » factor for several asset classes and also define a multi-asset global BAB factor by considering a portfolio with an equal risk contribution in each asset class BAB factor.
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We consider the EDHEC hedge fund indices which regroups the following 13 categories of hedge fund strategies for the period ranging from January 1997 to October 2015:


We consider an overview of 19 traditional and alternative risk factors:

- We proxy 6 traditional L/O risk factors by returns of liquid and investable equity, bond, commodity and currency indices.
- We proxy 13 alternative L/S risk factors. We inter alia consider proxies for the two most popular factors, namely value and momentum for various asset classes, using data from Asness et al. (2013).

A key difference between the traditional and alternative factors is that the latter cannot be regarded as directly investable (well-known performance biases also exist in hedge fund index performance).
## Data for Empirical Analysis

| Risk Factors  | Proxies                  | Source                  | C | A | T | A | D | S | E | M | E | M | N | E | D | F | A | G | M | L | S | E | M | A | R | V | S | S | F | O | F |
| **Traditional Factors** |                          |                         |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Equity       | S&P 500 TR               | Bloomberg               | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Bond         | Barclays US Treasury Bond Index | Datastream | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Credit       | Barclays US Corporate Inv Grade Index | Datastream | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Currency     | US Dollar Index          | Bloomberg               | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Commodity    | S&P GSCI TR              | Bloomberg               | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Emerging market | MSCI EM TR                | MSCI Website            | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Alternative Factors** |                          |                         |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Multi-Class Value | Multi-Class Global VAL  | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Multi-Class Momentum | Multi-Class Global MOM  | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Equity Defensive | Eq Global BAB             | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Equity Size  | Eq Global SMB             | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Equity Quality | Eq Global QMJ             | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Equity Value | Eq Global VAL             | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Equity Momentum | Eq Global MOM             | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| FI Momentum  | FI Global MOM             | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| FI Value     | FI Global VAL             | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| FX Momentum  | FX Global MOM             | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| FX Value     | FX Global VAL             | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Commo Momentum | COM Global MOM            | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Commo Value | COM Global VAL            | AQR website             | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
Step 1: In-Sample Explanatory Analysis

- As a first step we perform an in-sample regression for each hedge fund strategy monthly returns against a set of K factors over the whole sample period ranging from January 1997 to October 2015.

- We estimate the explanatory power measured in terms of the linear regression adjusted R-squared on the sample period in three distinct cases:
  - Case 1: linear regression on an exhaustive set of factors (kitchen sink regression), i.e. the 19 factors set;
  - Case 2: linear regression on a subset of five traditional factors (equity, bond, credit, commodity and currency);
  - Case 3: linear regression on a bespoke subset of a maximum of 8 economically-motivated traditional and alternative factors for each hedge fund strategy (see previous slide).
**Step 1: In-Sample Explanatory Analysis**

- **Main findings:**
  - A substantial fraction of hedge fund strategy (particularly directional ones) return variability can ex-post be explained by their systematic risk exposures.
  - Improvement in the explanatory power when an economically motivated subset of factors that includes alternative factors (case 3) is considered compared to a situation where the same subset of traditional factors is used for all strategies (case 2).
Step 2: Out-of-Sample Replication Analysis

- Main findings:
  - Adjusted R-squared suggests that the actual replication power of the clones falls down sometimes sharply when taken out of the calibration sample.
  - Substantial RMSE.
  - Kalman filter does not necessarily improve the replication quality

- Overall these results confirm that hedge fund returns cannot be easily and satisfactorily replicated.
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From Hedge Fund Replication to Hedge Fund Substitution

- We revisit the problem from a different perspective: we move away from hedge fund replication, which anyway is not per se a meaningful goal for investors, and analyze whether optimized strategies based on systematic exposure to the same alternative risk factors perform better from a risk-adjusted perspective than the corresponding hedge fund clones.

- We compare from a risk-adjusted perspective each clone with the corresponding equally-weighted (EW) and equal risk contribution (ERC) portfolios built on the same risk factors.
Clones vs. Diversified Portfolios: Risk-Adjusted Performance

These graphs show for each hedge fund strategy corresponding clones and weighting schemes the annualized average excess return over the risk-free asset (%), the annualized volatility of the returns (%), the Sharpe ratio defined as the annualized average excess return over the annualized volatility of the excess returns, the maximum drawdown(%) over the period and the Value at Risk 99% with a 1-month horizon over the out-of-sample period ranging from January 1999 to October 2015.
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Clones vs. Diversified Portfolios: Volatility and Max DD (Non Directional Strategies)

**Annualized volatility (%)**

- HF Clone Rolling Windows
- HF Clone Kalman Filter
- Equal Risk Risk Contribution Portfolio
- Equally Weighted Portfolio

**Maximum Drawdown (%)**

- HF Clone Rolling Windows
- HF Clone Kalman Filter
- Equal Risk Risk Contribution Portfolio
- Equally Weighted Portfolio
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- While the replication of hedge fund factor exposures appears to be an attractive concept from a conceptual standpoint, our analysis confirms the intrinsic difficulty in achieving satisfactory out-of-sample replication power, regardless of the set of factors and the methodology used.

- Our results suggest that risk budgeting techniques applied to alternative risk factors could be a better alternative than hedge fund replication for harvesting alternative risk premia in an efficient way.