ASSET ALLOCATION FLASH

BNPP AM – Multi Asset, Quantitative and Solutions (MAQS)

INTRODUCING A PROPRIETARY PORTFOLIO CONSTRUCTION SYSTEM

THE NEW 'MULTI-FACTOR ALLOCATION' (MFA) MODEL

- **A new portfolio optimiser –** We introduce our asset allocation portfolio optimiser – 'MFA' – which uses factor analysis to map our core asset views to factor exposures across all multi-asset portfolios.

- **Robust optimisation & holistic portfolio construction –** Compared to traditional optimisation techniques, our proprietary approach is less sensitive to input changes and provides intuitive portfolio outputs. Using factorisation, investment views can be reflected in the asset allocation of even the more restricted portfolios.

- **Bespoke adaptation –** The portfolio optimisation process is run for each portfolio in a bespoke manner, taking into account specifications and desired outcomes. Our holistic approach fosters consistency across portfolios, with beta and factor exposures more aligned than in binary 'in-or-out' trade budgeting.

- **Factor exposures and asset classes –** We provide examples of the factor exposures of the main asset classes, and show how MFA can accurately map the inherent factor exposures from multiple cross-asset views to the asset allocation of all portfolios in our broad book of business.

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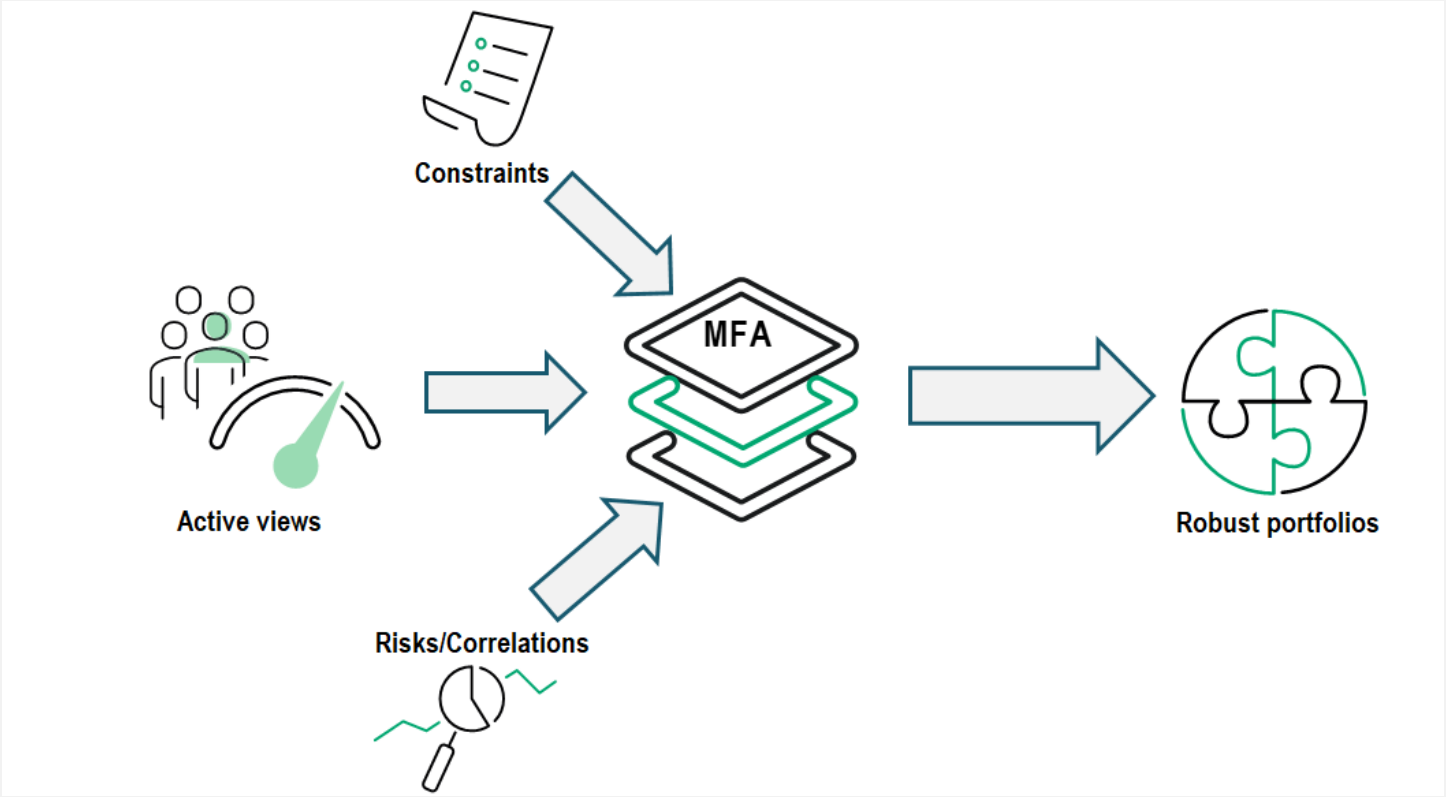
INTRODUCING THE 'MULTI FACTOR ALLOCATION' (MFA) MODEL

A NEW PROPRIETARY PORTFOLIO CONSTRUCTION SYSTEM

To enhance the robustness of our portfolios and in the spirit of fully committing to our Augmented Investments philosophy, the BNPP AM – Multi Asset, Quantitative and Solutions (MAQS) team has developed a proprietary portfolio construction system called Multi-Factor Allocation (MFA). Based on the latest academic insights, MFA provides us with an efficient and precise tool to translate our core asset views into individual benchmarked portfolios, taking into account specific constraints on a portfolio-by-portfolio basis.

This state-of-the-art portfolio construction tool takes into account in one single step our **active views** on core asset classes, **correlations**, **risks** and any clients' **constraints** with the objective of maximising risk-return and/or outcome-based targets. Compared to traditional optimisation techniques, our proprietary approach is less sensitive to input changes and provides intuitive portfolio outputs. Furthermore, with the help of factorisation (using principal component analysis, the uncorrelated drivers/factors of assets can be identified), investment views can be reflected in the asset allocation of even the more restricted portfolios.

Diagram 1: The principles underlying our proprietary MFA model



ROBUST OPTIMISATION & HOLISTIC PORTFOLIO CONSTRUCTION

MFA is based on a new robust optimiser algorithm. The size of trade positions (i.e. risk budgets) is directly linked to the strength of the conviction scores on core asset classes. Along with investment views, MFA incorporates client constraints as well as inputs on volatility and correlations between asset classes. It aims at calculating optimal portfolio weights, taking into account maximum tracking-error constraints and minimum/maximum exposures on asset classes.

The algorithm is based on proprietary techniques that focus on the robustness of our asset allocation through the introduction of an uncertainty term on assets' expected returns (see below). Moreover, using factor analysis, we are able to project all investment views on any kind of investable investment universe (i.e. also for very constrained portfolios).

This process allows for holistic portfolio construction, making the most efficient use of a portfolio's risk budget while dealing with correlations between portfolio positions and market factor exposure.

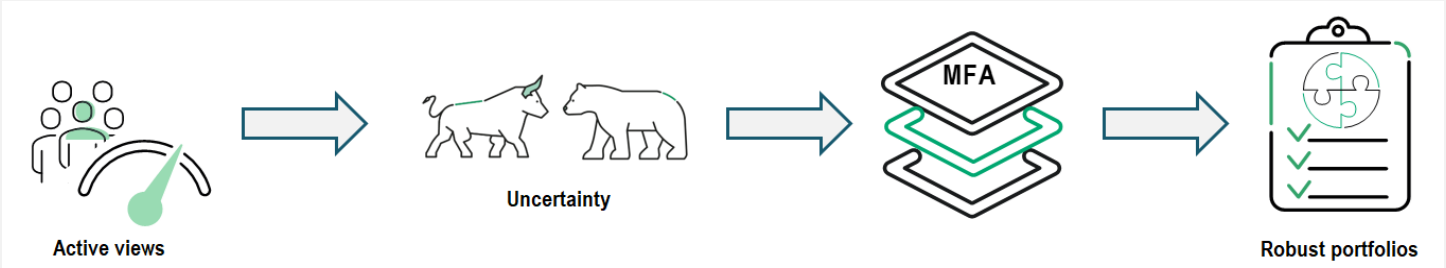
Source: BNPP AM, as of 11/10/2019

TAKING INTO ACCOUNT UNCERTAINTY

In a traditional optimisation algorithm (e.g. Markowitz's modern portfolio theory), portfolio weights often end up being very sensitive to initial conditions and sometimes counter-intuitive. Our robust optimiser mitigates these effects, leading to more stable/reliable and understandable outputs.

In practice, MFA's optimisation equation differs from Markowitz's as it aims at finding the most robust portfolio under a defined window of expected returns derived from investment views, i.e. it inserts uncertainty around the initial conditions. The optimal portfolio is thus taking into account alternative outcomes where reality deviates from the initial forecasts – either more negative or more positive than our investment view – ensuring the robustness of the asset allocation and reducing the sensitivity to initial conditions.

Diagram 2: Robust optimisation leads to stable and understandable outputs



FACTOR ALLOCATION & CONSTRAINED PORTFOLIOS

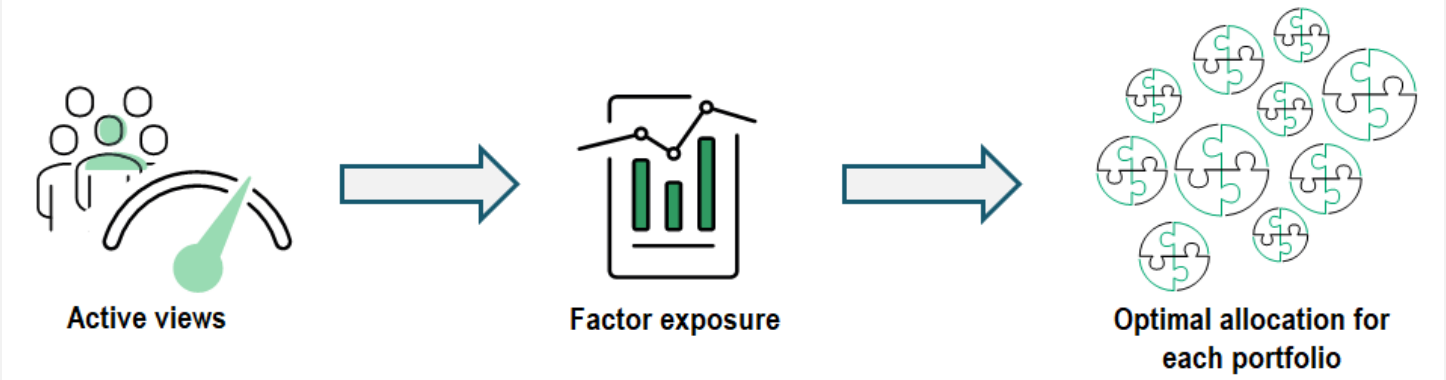
Another innovative feature of MFA is to be found in the way the tool deals with holistic portfolio construction. Within a traditional optimiser, portfolio weights can become counter-intuitive as the maximisation process may comply with portfolios' constraints in a complicated and circuitous way. In MFA, the holistic adaptation of views into portfolios with specific benchmarks and constraints is made with the help of factor analysis. Using principal component analysis, we arrive at factor exposures for each asset (via a 'cleaned' variance/covariance matrix). This allows us to project core asset views onto constrained portfolios in a straightforward manner.

Said differently, MFA allows us to disseminate more widely and consistently our Investment Committee views across our book of business, including more constrained or specific client accounts. MFA does not simply take into account Investment Committee views in isolation, but also considers risk factors and correlations between asset classes. Investment views can filter through to the asset allocation of even the most restricted portfolios in terms of investment universe, ensuring better adequacy in terms of risk taking across all of our multi-asset portfolios.

BESPOKE ADAPTATION

The portfolio optimisation process is run for each portfolio in a bespoke manner, taking into account specifications and desired outcomes. When one or several of the pre-defined constraints are hit, the algorithm finds the optimal allocation combining our investment views, the portfolio structure and its risk profile. If need be, the views are projected on investable assets in a holistic manner. This fosters consistency across portfolios, with beta and factor exposures more aligned than in binary 'in-or-out' trade budgeting.

Diagram 3: Mapping views to factor exposures allows us to asset allocate in a holistic manner



Source: BNPP AM, as of 11/10/2019

THE FACTORS USED BY MFA & PRACTICAL EXAMPLES

CORE ASSETS AND THEIR FACTOR EXPOSURES

So how does MFA work in practice? How are core asset class views translated into factors?

Using Principal Component Analysis (PCA), the uncorrelated drivers/factors of assets can be identified. We have used the first six factors in our MFA model, namely:

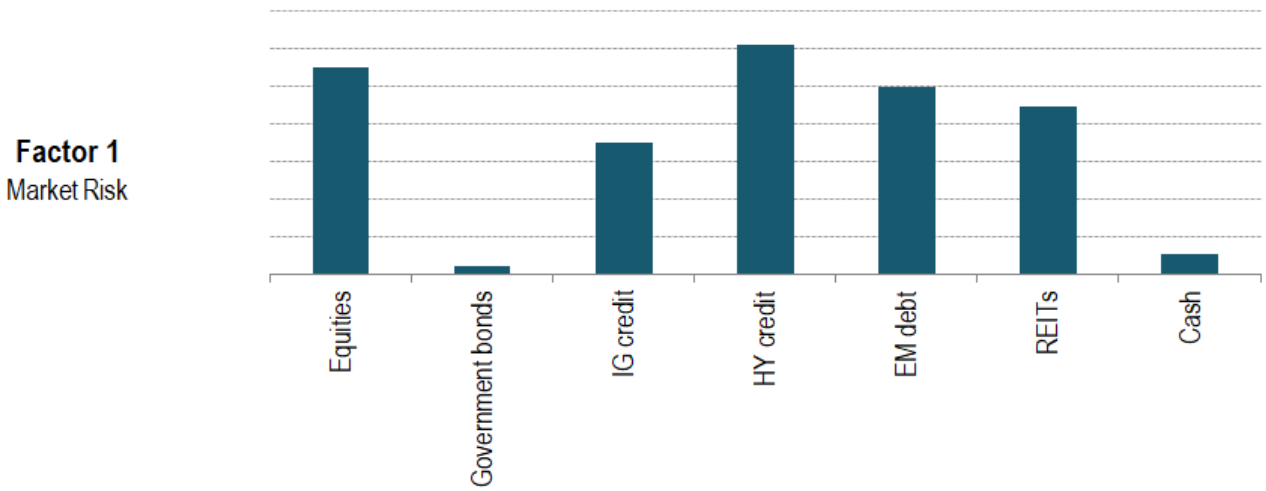
- ***Market risk***
- ***Duration***
- ***EM & Commodities***
- ***Corporate spreads***
- ***US***
- ***Asia & China.***

Below we provide an overview of how core asset classes are exposed to these six factors. As explained above, factor exposures will be mapped to all MAQS portfolios, taking into account portfolio constraints case by case. The below examples are for a theoretical unconstrained portfolio – i.e. they show the 'pure' translation from each asset into the MFA factor profiles.

Factor: Market risk

The first factor – ***Market Risk*** – can be seen as a risk asset/equity-driven factor. As such, equity and equity-like (e.g. real estate) assets as well as the riskier parts of the fixed income universe (high-yield credit, emerging market debt) have a large exposure to this factor. On the other hand, government bonds and cash have almost no exposure to this factor.

Factor loading 1: *Market risk* exposure of main asset classes

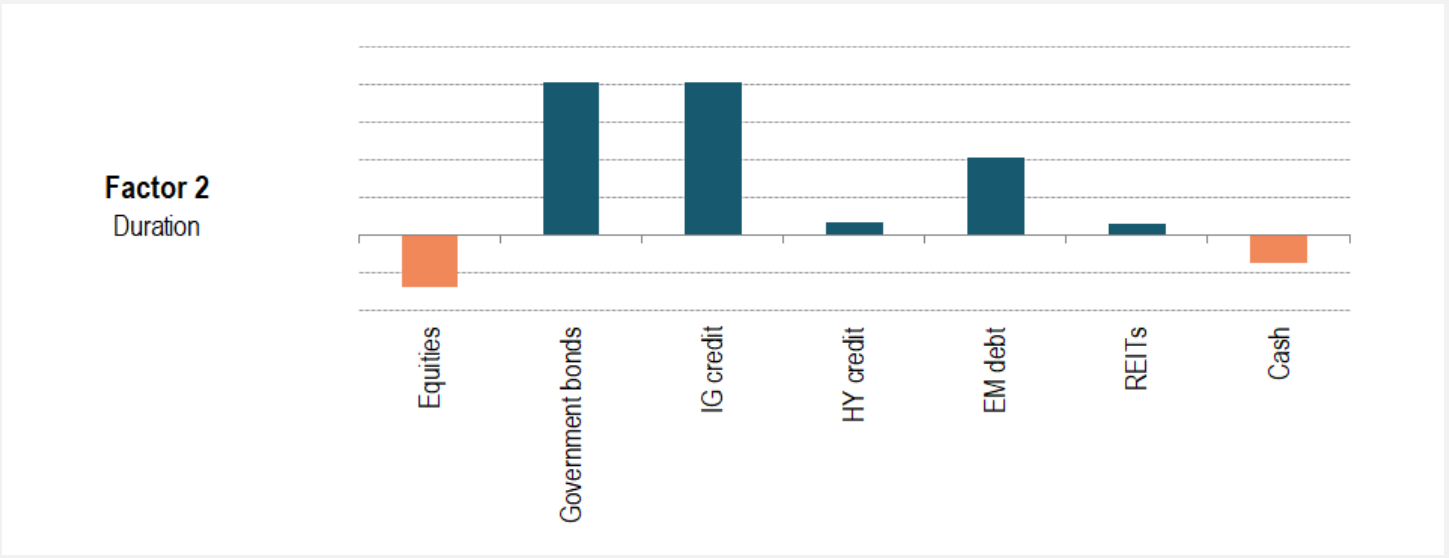


Source: BNPP AM, as of 11/10/2019

Factor: Duration

The second factor – ***Duration*** – can be seen as a bond-market driven factor. Government bonds and the safer parts of the fixed income universe (investment-grade debt) are exposed to this factor. On the other hand, as expected, equities have a negative exposure to duration.

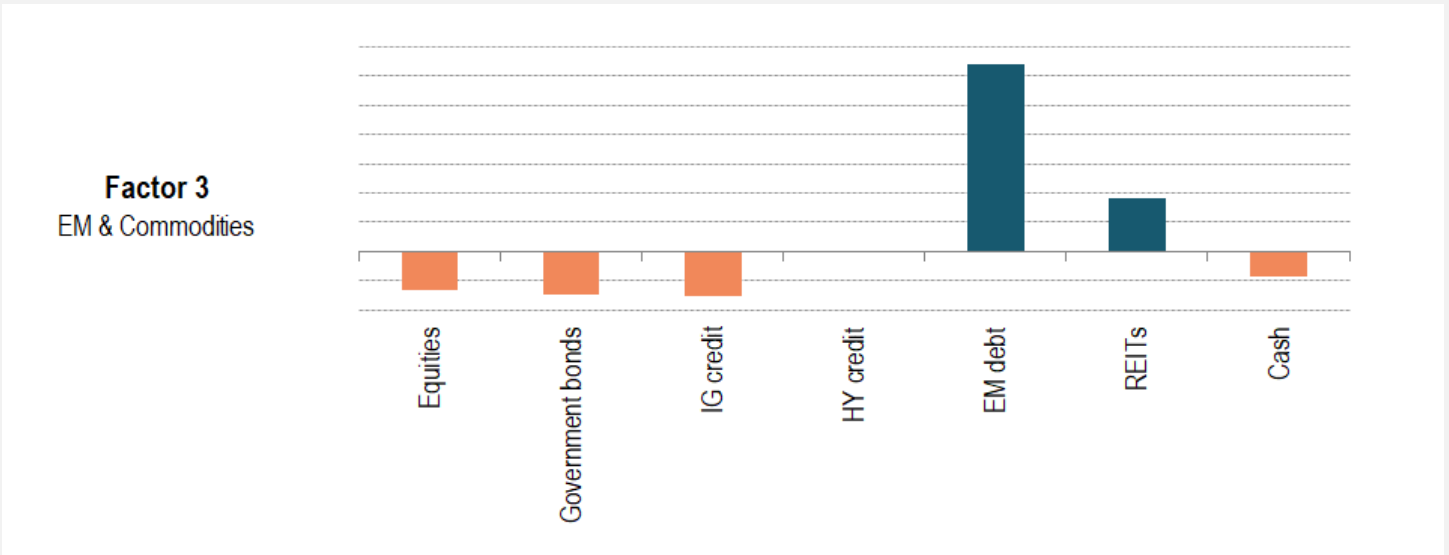
Factor loading 2: *Duration* exposure of main asset classes



Factor: EM & commodities

The third factor – ***EM & Commodities*** – mainly shows up with EM-specific assets such as EM debt and equites.

Factor loading 3: *EM & commodities* exposure of main asset classes

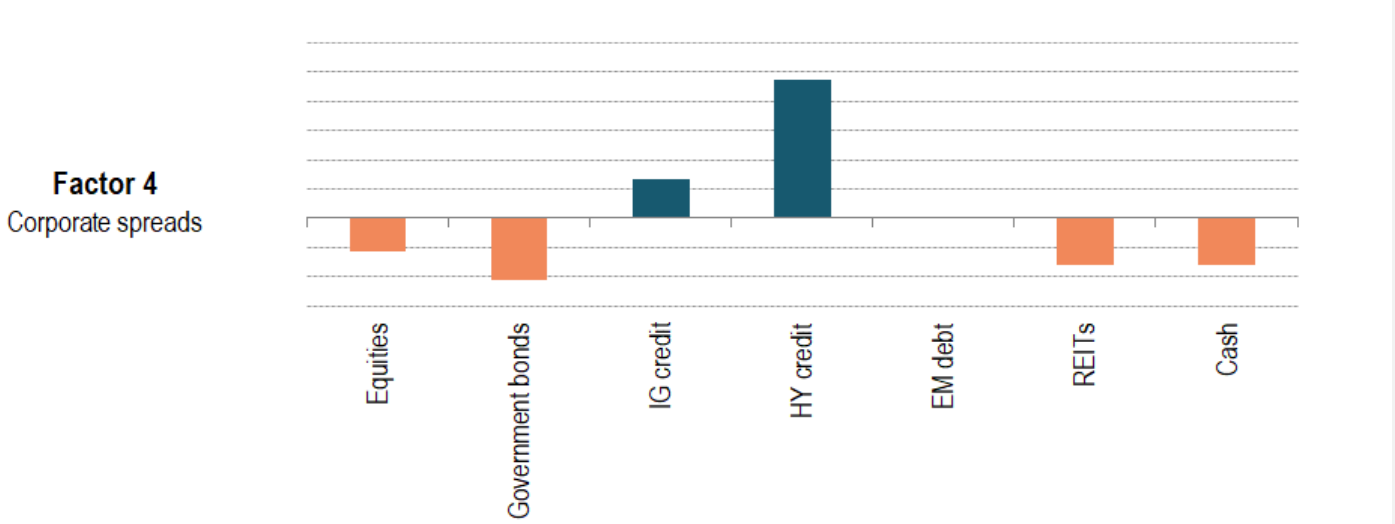


Source: BNPP AM, as of 11/10/2019

Factor: Corporate spreads

The fourth factor – ***Corporate spreads*** – can be seen as a credit market-driven factor. As such, credit markets are exposed to it, whereas other major asset classes have a slightly negative exposure.

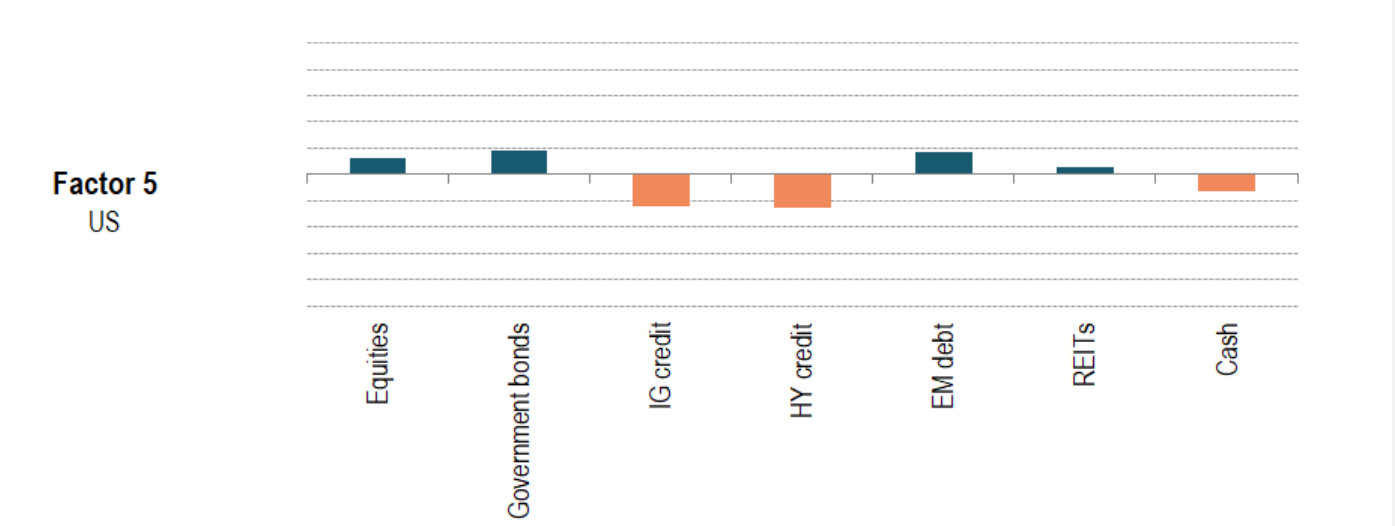
Factor loading 4: *Corporate spreads* exposure of main asset classes



Factor: US

The fifth factor – ***US*** – is specific to assets related to the US. As such, broad major asset classes show little exposure to it. Specific US assets (US equities, US bonds, etc.) are more exposed to it.

Factor loading 5: *US* exposure of main asset classes

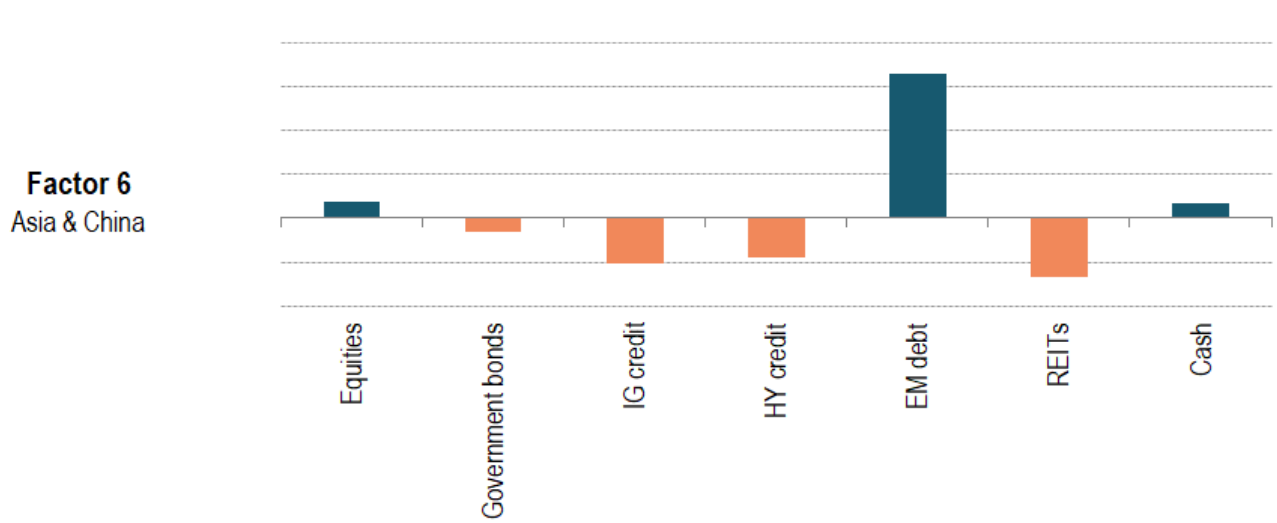


Source: BNPP AM, as of 11/10/2019

Factor: Asia & China

Similar to factor 3, the sixth factor – ***Asia & China*** – mainly shows up with EM specific assets such as EM debt and EM equites.

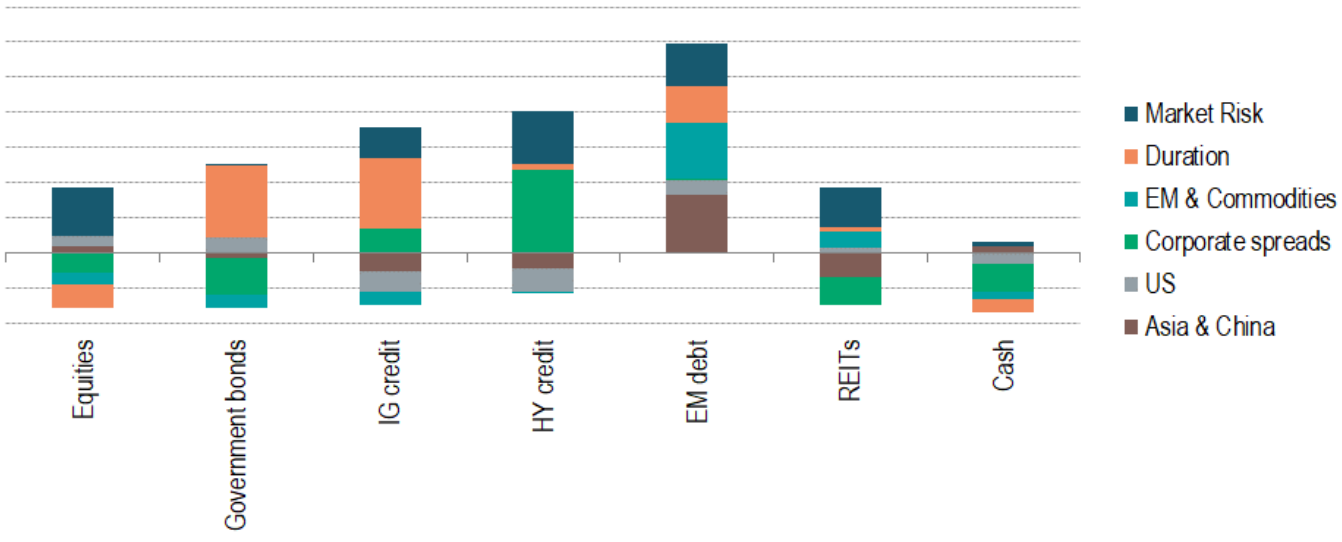
Factor loading 6: *Asia & China* exposure of main asset classes



Summary of factor exposures

This chart summarises the factor exposures of the main asset classes. What is immediately evident from the chart is the vast difference in factor loadings from asset class to asset class. This is precisely where MFA's power comes in: the optimiser can accurately map the inherent factor exposures from multiple cross-asset views and apply these to the asset allocation of all portfolios in our broad book of business – from the very flexible to the very constrained mandates.

Factor loading 7: Factor exposures of main asset classes



Source: BNPP AM, as of 11/10/2019

PRACTICAL EXAMPLES

To conclude, we show practical examples of how MFA applies to real life asset allocation.

Multi-asset views

MFA's most powerful feature is the simultaneous mapping of core views across asset classes onto a single set of factor exposures.

To illustrate this, see below example where inputs are: i) positive on equities and REITS, ii) positive on core duration, iii) negative on spreads/high-risk debt markets.

The resulting factor exposure is predominately exposed *to Market Risk*, albeit with only around 50% of the maximum, is slightly positive on *Duration* and is negative on *EM & Commodities* and *Corporate spreads*.

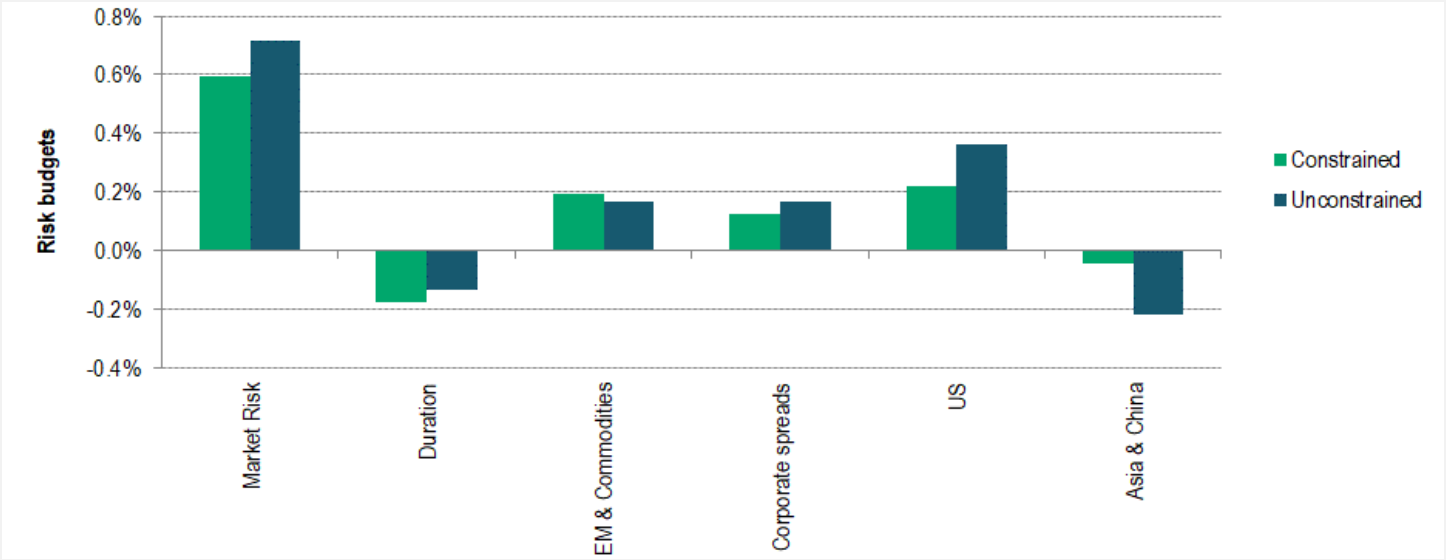
Example 1: Theoretical multi-asset views

Constraints

The above example factor exposure is for a theoretical unconstrained portfolio. In real life portfolios, MFA will take into account constraints and map the factor exposures related to the investment views onto tradeable assets on a portfolio-by-portfolio basis.

Put differently, the optimiser will try to achieve the same factor exposures for every portfolio, using the portfolio's tradeable assets. Of course, in practice, achieving identical factor exposures with only a limited set of assets is impossible, but as the below example for a Europe-centric portfolio shows, factor exposures in real-life portfolios will mimic the unconstrained exposures to a large degree.

Example 2: Unconstrained vs. a real life portfolio (Europe-centric multi-asset portfolio) – comparing the factors exposures of our current views



Source: BNPP AM, as of 11/10/2019

The views expressed are those of the Investment Committee of MAQS, as of October 2019. Individual portfolio management teams outside of MAQS may hold different views and may make different investment decisions for different clients.

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