

# ESS Calibration Update

2020-06

ESS Team

Friday, 13 November 2020

## Introduction

This document is intended to provide consultants and other interested parties<sup>1</sup> with a high-level overview of Hymans Robertson's Economic Scenario Service (ESS), our proprietary economic scenario generator (ESG). The document is refreshed on a regular basis by the ESS Team and includes:

- A short description of the ESS and how it can be used;
- An illustration of the changes to the summary statistics generated from ESS output, which are primarily driven by changes in market conditions. More material movements stemming from model changes will be communicated separately, and in more detail;
- A snapshot of projected returns, volatilities, and other relevant outputs associated with the key building blocks (i.e. models) of the ESS;
- A brief description of the structure of the ESS, i.e. the different models within the ESS and how they relate to each other;
- A summary of the general approach to model calibration;
- An overview of the governance framework for the ESS, i.e. the process by which decisions relating to model choice or calibration methodology are made.

We have avoided delving into the details of the models in order to control the document's length; please speak to the ESS team if a more in-depth description of any aspect of the ESS is needed.

## What is the ESS?

An Economic Scenario Generator (ESG) is a collection of mathematical models that enable us to generate thousands of random, but plausible, scenarios of what might happen to economic and financial variables (such as interest rates and stock market returns) at future time horizons. The ESS is a particular example of an ESG.

The models within the ESS are statistical models that are intended to mimic the statistical properties of the returns, interest rates, and other variables that are projected by the ESS, rather than explain or predict any particular future. The range and dispersion of outcomes are usually more helpful to consider than only the average across all outcomes. The model projects financial economic variables over multiple time steps beginning from current market conditions. The fundamental uncertainty about the future means that we cannot know all the information sources that would be needed to inform projections; however, historical evidence suggests that the statistical impacts of the unknown economic and financial drivers are reasonably stable even if the drivers themselves change dramatically over time.

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<sup>1</sup>E.g. clients who take an interest in the technical details underlying our stochastic modelling.

There does of course remain the chance that the political economy or market constructs break down or change completely (e.g. a move from a broadly capitalist to a communist system); the ESS does not allow for those very rare, but potentially very extreme scenarios.

The models within the ESS are chosen to find a balance between:

- **Realism** to ensure our models capture important features of the variables we wish to model;
- **Tractability** so that we can exert control over the statistical properties of the models, and efficiently calculate important quantities such as prices.

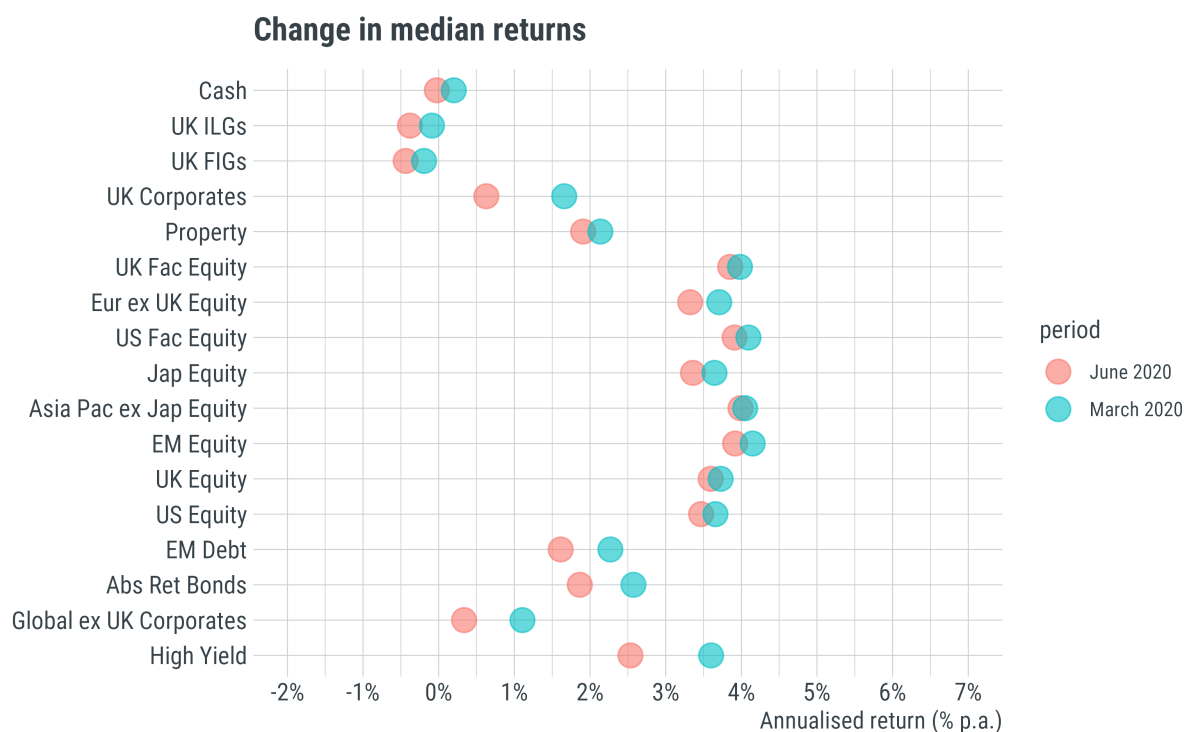
## Output summary

### Changes in returns and volatilities: March 2020 to June 2020

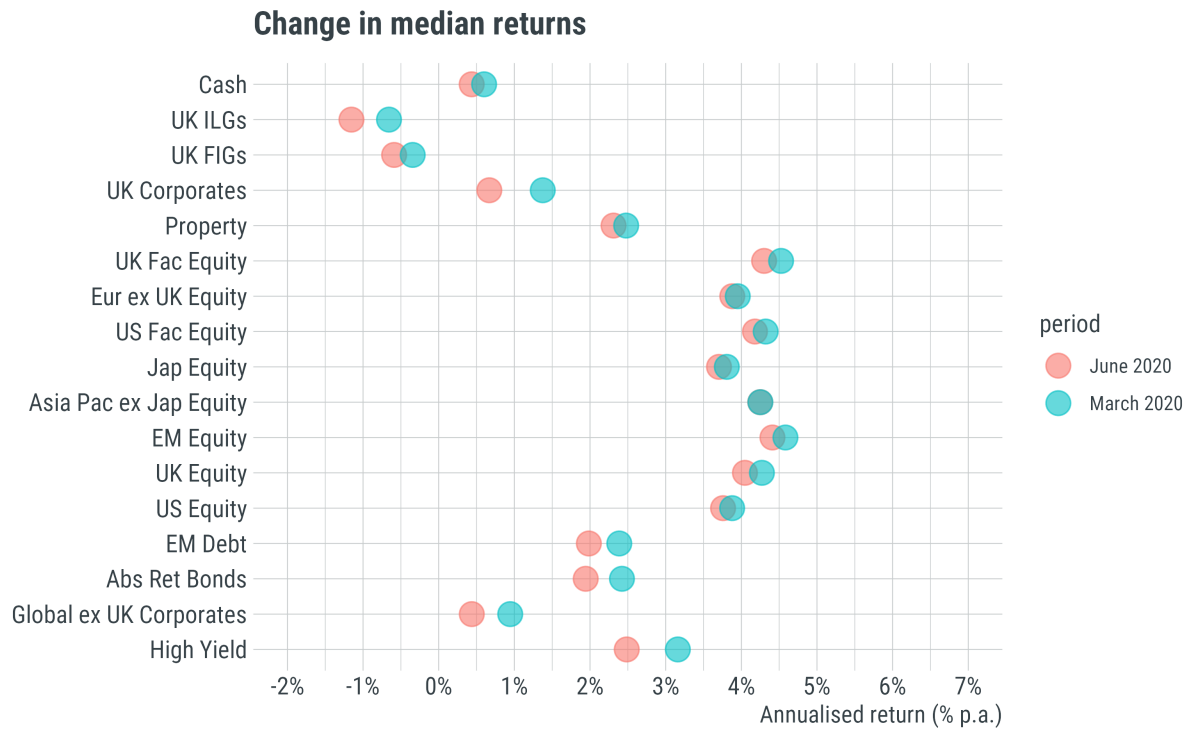
These charts highlight movements in median returns and volatilities over the period. Changes are mainly driven by changing market conditions which get captured in our monthly *minor* calibration process. A full summary of returns at the latest calibration date is included in the Appendix 1.

The asset class labels appearing in all charts in this report are shortened versions of the full names recognised by the GO Plan Projection API; please see Appendix 2 for the key that maps API names to chart labels.

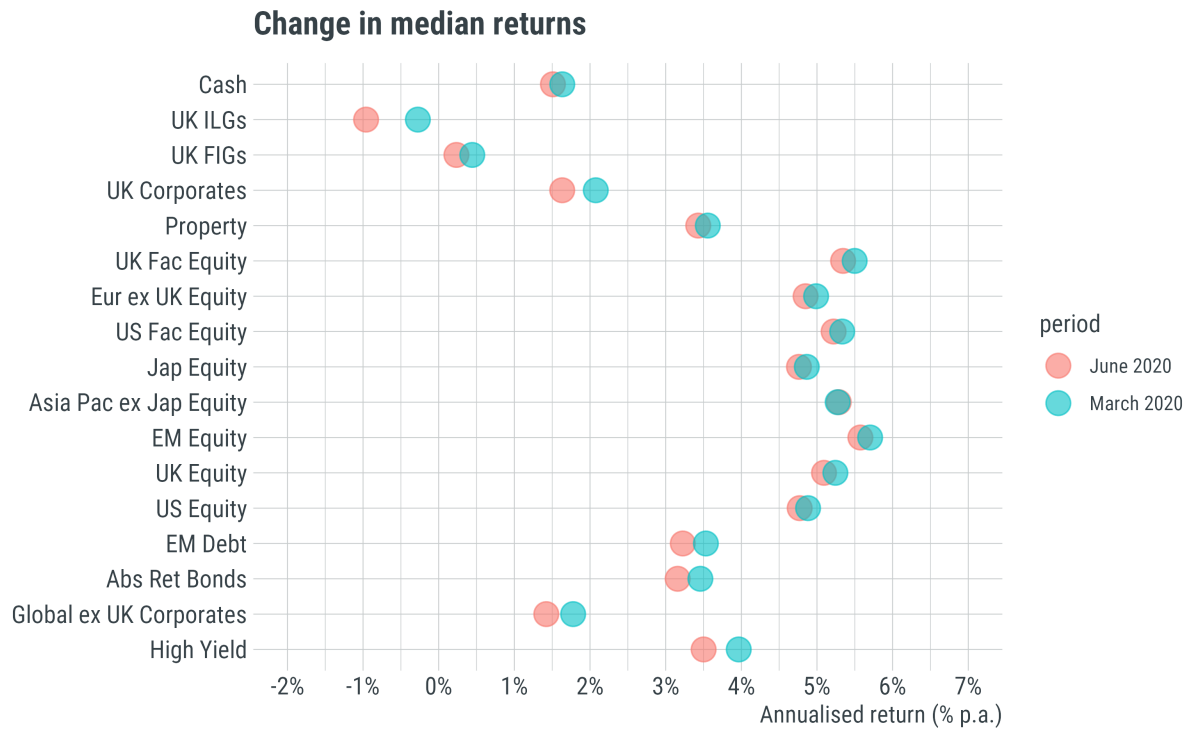
#### 5 year returns



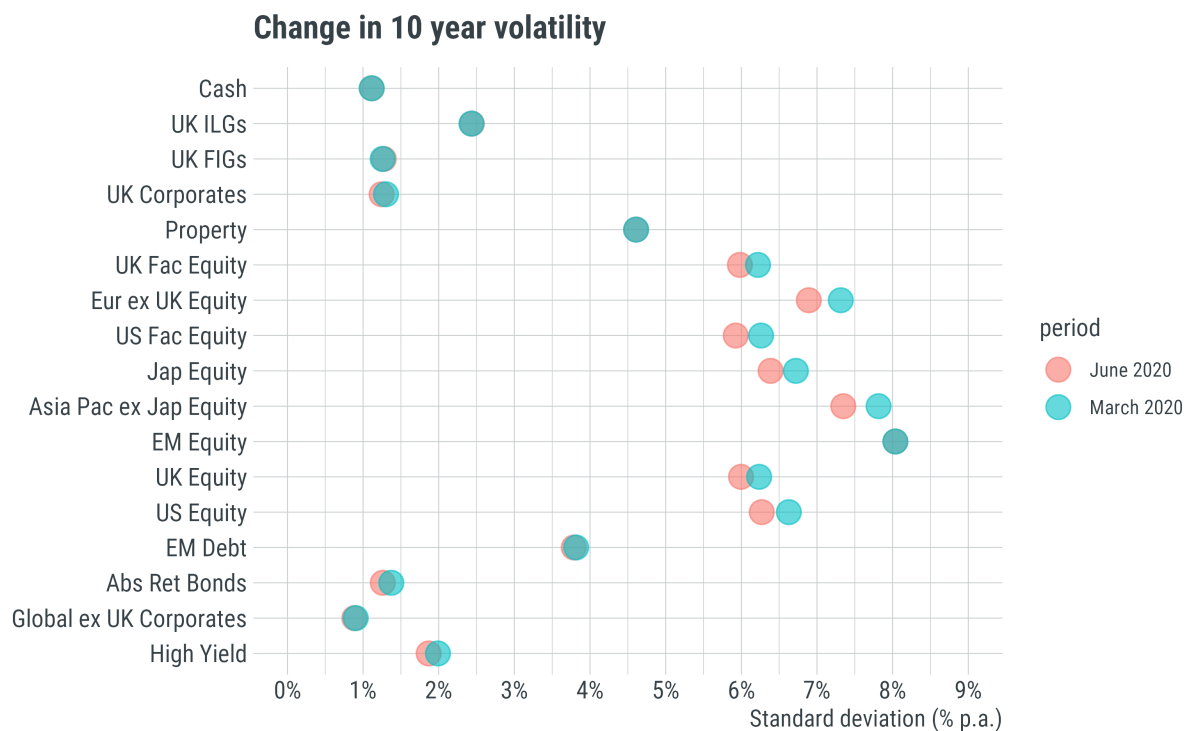
## 10 year returns



## 20 year returns



## 10 year standard deviations



## Interpreting movements in summary statistics over the interval

The main drivers of changes in returns over the interval are movements in nominal yield curves, credit spreads, and option-implied equity volatility. These are updated as part of our monthly minor calibration to ensure that the starting point of our projections is consistent with observed market conditions.

Nominal yield curve movements affect the risk-free (cash) interest rate underlying all asset returns (see ESS framework). Credit spreads and short-term equity volatility affects the risk premium element of returns on credit-linked securities and equities respectively.

Current market conditions have less influence on returns over longer projection horizons, which are primarily driven by more subjective assumptions about long-term returns. These subjective elements of the ESS are updated less frequently; consequently, longer-term returns tend not to change significantly from one period to the next.

## Current ESS outputs

In this section we present a selection of outputs from the different models in the ESS, calculated using the June 2020 calibration.

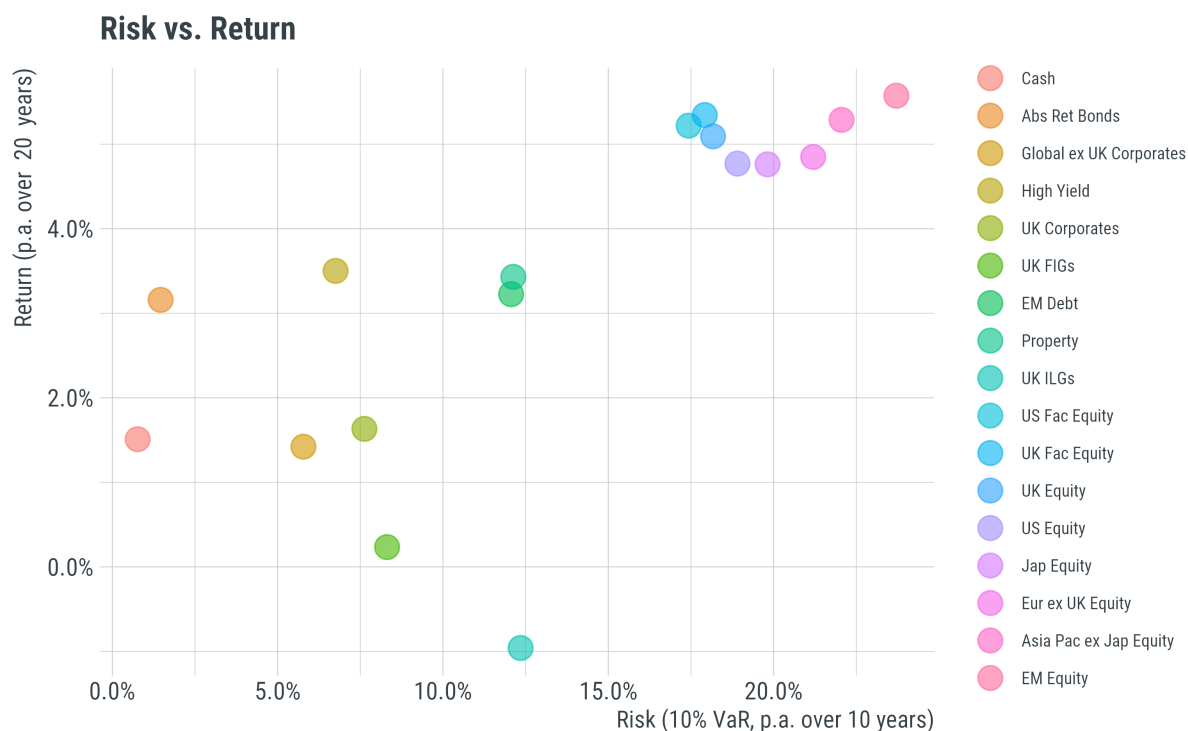
### Risk & return

These charts present the risk and return characteristics of the ESS asset classes. We produce two versions using a different risk metric in each case; one uses the Value at Risk (VaR) over 10 years at the 10th percentile

level,<sup>2</sup> while the other uses the Tail VaR (i.e. *expected shortfall*) metric over the same horizon and at the same confidence level as the VaR measure. Median returns are evaluated over a 20 year horizon.

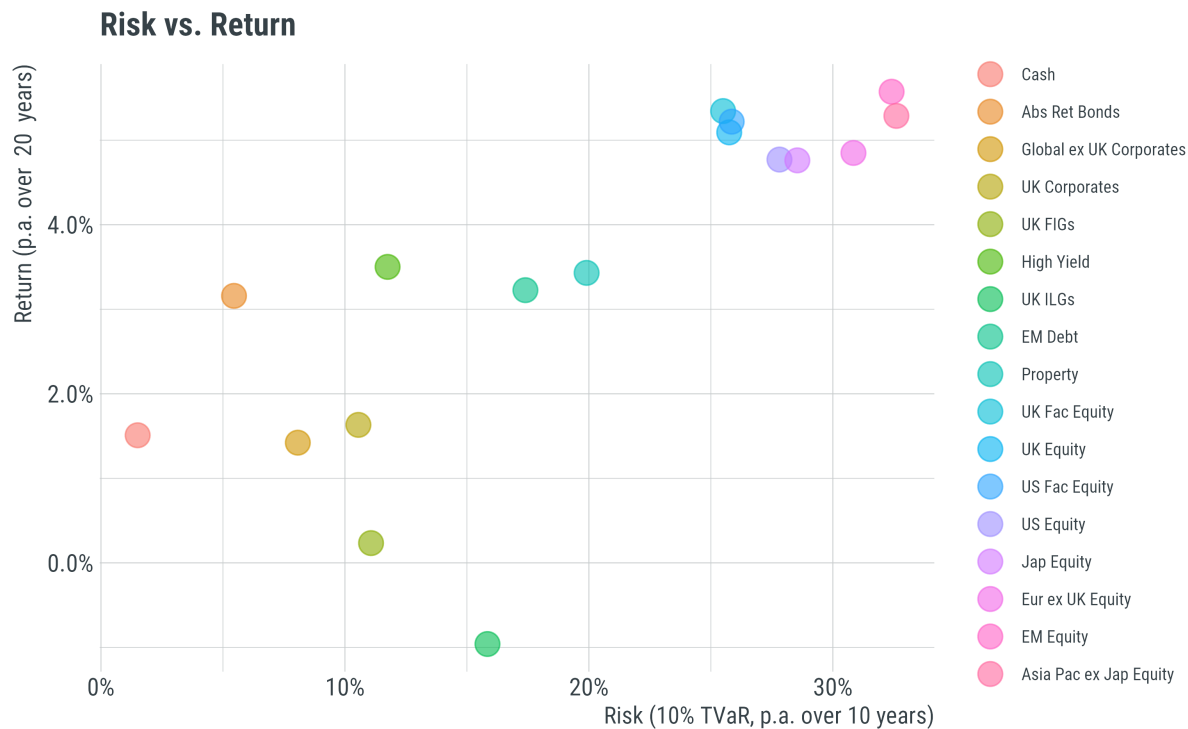
Note that we have plotted the absolute values of the risk metrics on the x-axis of the charts below.

### Median vs. VaR (10 year @ 10th Percentile)



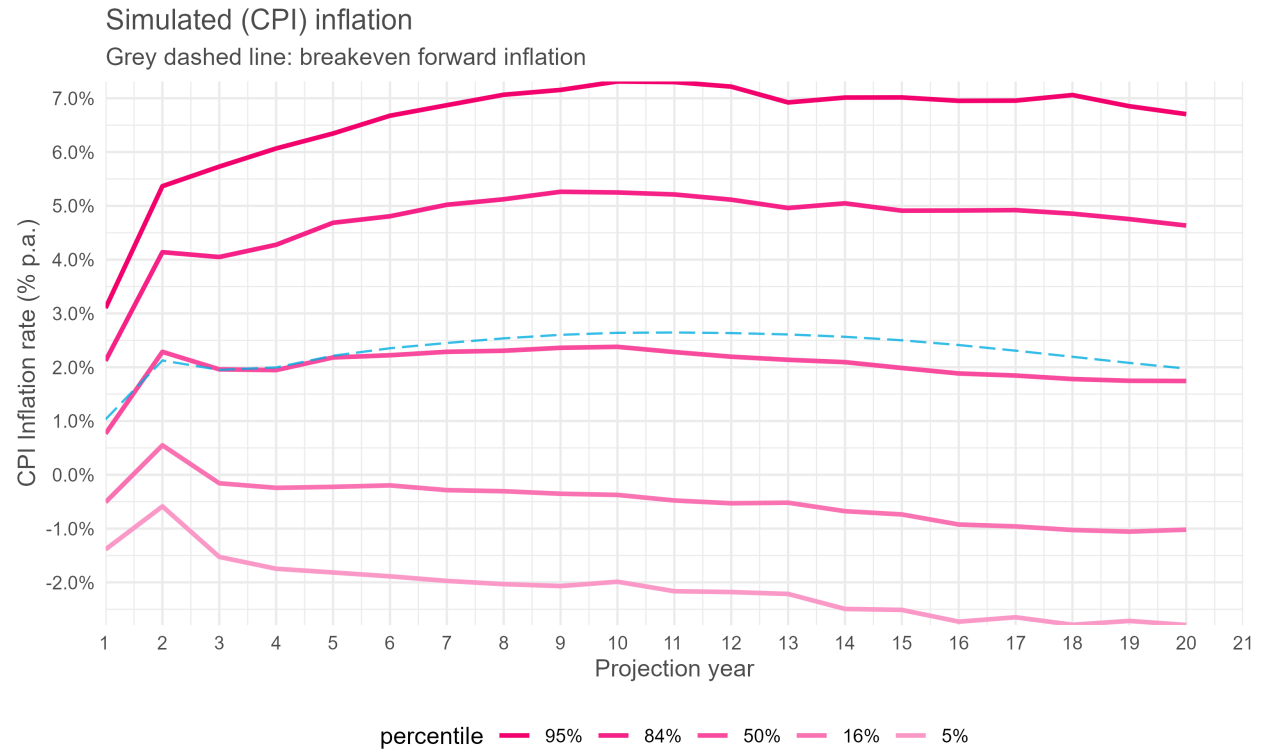
### Median vs. TailVaR (10 year @ 10th Percentile)

<sup>2</sup>The  $p$ -th percentile of a statistical distribution is the value below which  $p\%$  of the observations fall.



### Realised inflation

The chart below shows how the distribution of projected CPI inflation evolves over time (coloured solid lines), and how this compares to breakeven inflation at the projection date (dashed grey line).

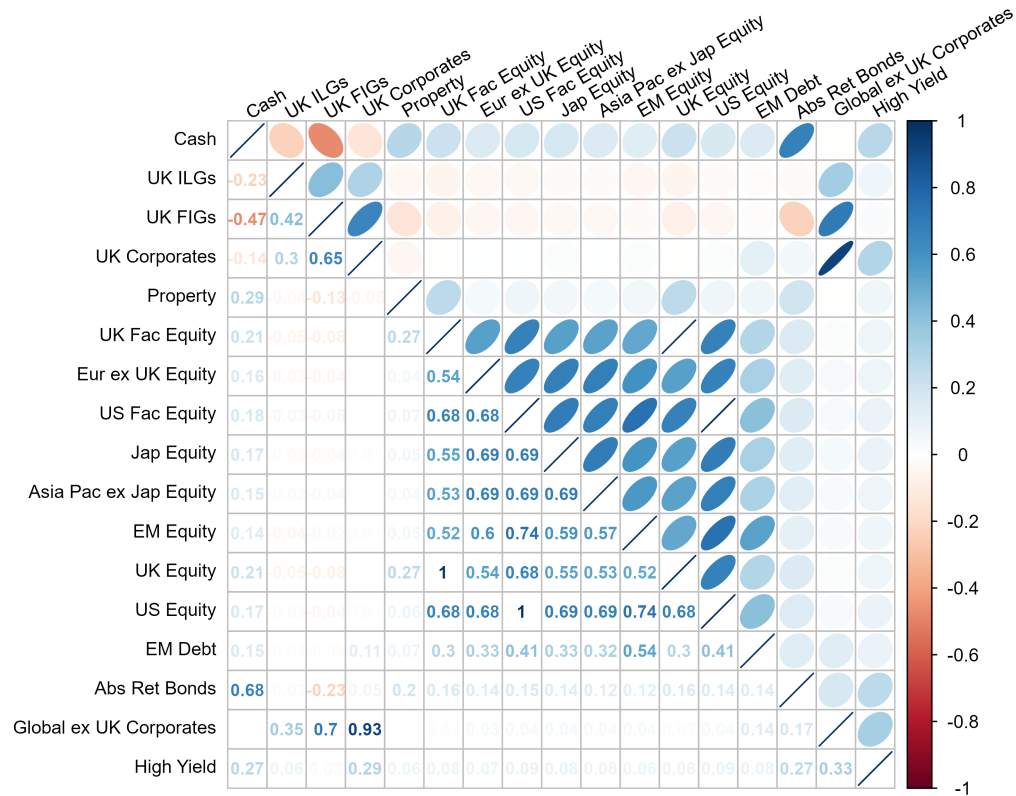




## Correlations

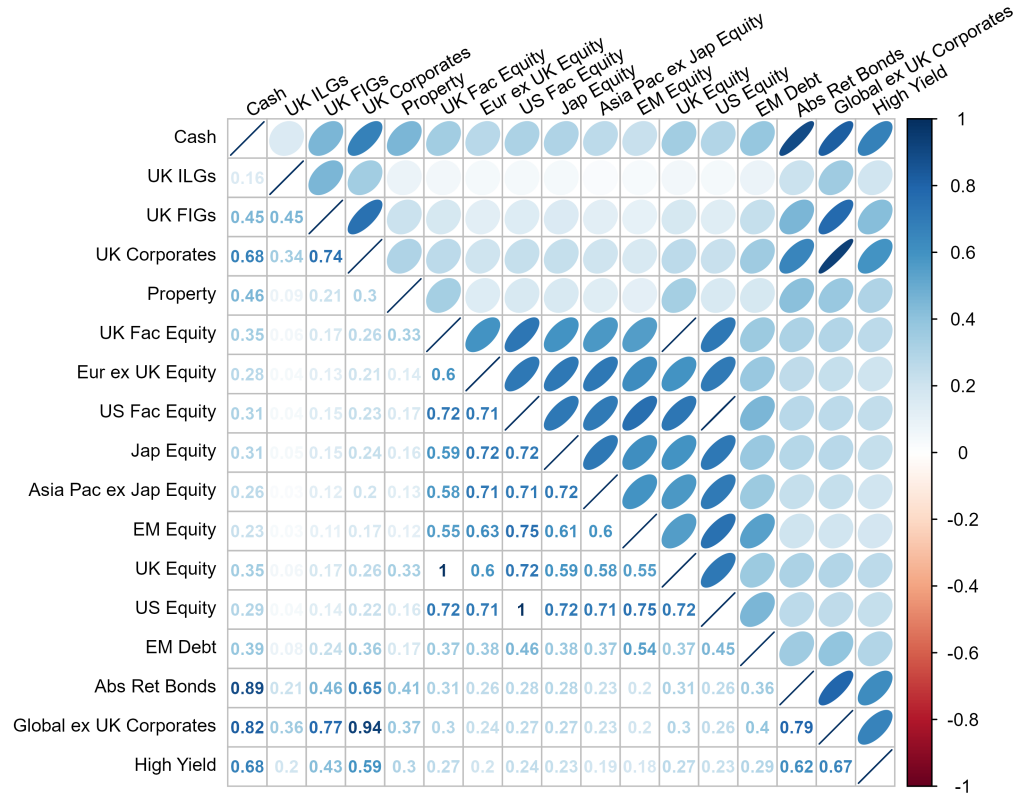
Below we present the return correlations between annualised returns over a 10-year and 20-year horizon.<sup>3</sup>

### 10 year annualised returns



<sup>3</sup>FIG and ILG are abbreviations for fixed-interest gilts and index-linked gilts respectively.

## 20 year annualised returns



## ESS framework

At its core the ESS is a collection of stochastic models, each of which represent a particular variable of interest. For example, one model generates simulated nominal interest rate scenarios, while another model is responsible for generating simulated UK equity returns. These models are interrelated in several ways:

- The output from some models serve as inputs to other models within the ESS. For example, the nominal interest rate scenarios feed into the equity models, which generate returns in the form of:

$$\text{simulated equity return} = \text{risk-free cash rate} + \text{equity risk premium} + \text{uncertainty}$$

- The randomly generated samples from one model can be correlated with the outputs from another model, e.g. credit spreads associated with different ratings are positively correlated to reflect systemic risks which affect issuers across the market.

## Calibrating the ESS models

Model calibration is the process by which our models are parameterised so as to generate realistic dynamics. Our calibration approach involves combining three sources of information:

1. **Market data** (current and historical) which is useful for understanding how returns and other variables have behaved in the past (and therefore provide some information about how they might behave in future);
2. **Economic theory** which helps frame the historical data, providing a guide to the range of plausible outputs we might want our model to generate. E.g. we would want to avoid generating nominal interest rates that are significantly below zero, on the basis that lenders would rather hold cash than lend at substantially negative rates;
3. **Expert judgement** is also needed because the past isn't always like the future, and in some cases there is very little objective information to rely on. One such example is the level to which we expect risk-free interest rates to tend over very long time horizons; there is a paucity of traded instruments at ultra-long maturities to guide this decision and so we incorporate market views from central banks, asset managers, etc. when forming these assumptions.

There are two types of calibration that the ESS Team undertakes:

- **Major calibration:** Major calibrations take place roughly once per year and are used as an opportunity to assess the appropriateness of the choice of models used in the ESS, and whether the longer-term, subjective aspects of the calibration (i.e. source 3 above) are still appropriate. A selection of subjective assumptions currently embedded within the ESS's output are presented in the table below:<sup>4</sup>
- **Minor calibrations:** More frequent than major calibrations and involve refreshing the model calibration to allow for updated market conditions like movements in yield curves and equity implied-volatility. These adjustments to the model calibration ensure that the starting point for our simulations matches observed conditions in the markets. The more subjective elements of the calibration (e.g. long term interest rate targets) are typically not adjusted during minor calibrations. Short term equity volatility, initial credit spreads, and initial yield curves are the main variables that often change from month to month.

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<sup>4</sup>As *implied by initial yield curve* means that the target is derived from market conditions; for real and nominal interest rates, this means the expected path of interest rates over the short term is determined by the shape of the market yield curve at the outset of the projection.

| ESS output                                     | Target value                      |
|--|-----------------------------------|
| Nominal short/long rate short-term expectation | As implied by initial yield curve |
| Nominal short rate long-term expectation       | 3.6% p.a.                         |
| Nominal long rate long-term expectation        | 3.6% p.a.                         |
| Real short/long rate short-term expectation    | As implied by initial yield curve |
| Real short rate long-term expectation          | 0.8% p.a.                         |
| Real long rate long-term expectation           | 0.3% p.a.                         |
| Equity risk premium                            | 3.6% p.a.                         |
| Default recovery rate                          | 35.0%                             |

The standard simulation consists of 5,000 projections of up to 100 years at monthly time steps and are available across over 70 financial instruments including various forms of equity, property, bonds and credit instruments. Bespoke funds, portfolios, and further individual instruments can be modelled within the same environment if required.

The granular nature of the projections enables detailed risk metrics to be calculated for any strategic asset allocations and rebalancing mechanisms. In particular, the use of scenarios rather than just summary statistics (such as volatility, average returns or single correlation assumptions) means that risks of adverse outcomes can be measured directly.

## Governance and compliance

The ESS is used across virtually all Hymans Robertson’s institutional investment clients (representing over 200 investment and actuarial clients) as well as underpinning the GO (Guided Outcomes) offering and the risk models embedded in the APIs used by some asset managers.

The model is supported within the wider Insights & Analytics team of over 100 people, with a dedicated team of 8 people comprising actuaries, financial modelling experts, and software developers. The model was originally developed in 2000 and has been maintained and used continuously since then. It was extensively redeveloped in a major overhaul lasting 2 years from 2014 in order to accommodate a wider set of asset classes and improve performance. The use of the model to support actuarial and regulated advice means the ESS and output from it are subject to scrutiny by many professionals, both internal to Hymans Robertson and third parties, as well as regulators.

The model and its calibration are governed and documented in accordance with our professional actuarial requirements (Institute and Faculty of Actuaries) and the requirement to provide fair customer treatment. Two separate groups help define the governance framework surrounding the ESS: the Change Group (*CG*) and the Technical Modelling and Assumptions Group (*TMAG*).

The CG is made up of stakeholders from around the business and its purpose is to ensure that the functionality offered by the ESS continues to be well-aligned with the needs of its users.

The TMAG is a group of modellers, actuaries, investment researchers, and consultants who work together to identify appropriate financial-economic assumptions that feed into ESS calibrations.

## Appendix 1

A selection of summary statistics associated with a subset of the ESS asset classes are presented below. Returns correspond to annualised cumulative returns; *dispersion* refers to standard deviation of returns over the first subsequent projection year.

### Risk statistics

|                         | After 10 years         |                                   |                                       |
|-------------------------|------------------------|-----------------------------------|---------------------------------------|
|                         | Dispersion<br>(% p.a.) | TailVar (%<br>p.a.) @ 10<br>pctle | Probability<br>of negative<br>returns |
| Cash                    | 1.1%                   | -1.3%                             | 34.7%                                 |
| UK ILGs                 | 2.4%                   | -5.3%                             | 68.5%                                 |
| UK FIGs                 | 1.3%                   | -2.8%                             | 67.4%                                 |
| UK Corporates           | 1.2%                   | -1.7%                             | 30.4%                                 |
| Property                | 4.6%                   | -5.5%                             | 29.7%                                 |
| UK Fac Equity           | 6.0%                   | -6.5%                             | 24.6%                                 |
| Eur ex UK Equity        | 6.9%                   | -8.8%                             | 30.4%                                 |
| US Fac Equity           | 5.9%                   | -6.6%                             | 24.2%                                 |
| Jap Equity              | 6.4%                   | -8.0%                             | 28.6%                                 |
| Asia Pac ex Jap Equity  | 7.3%                   | -9.3%                             | 29.6%                                 |
| EM Equity               | 8.0%                   | -9.3%                             | 29.5%                                 |
| UK Equity               | 6.0%                   | -6.7%                             | 26.3%                                 |
| US Equity               | 6.3%                   | -7.6%                             | 27.4%                                 |
| EM Debt                 | 3.8%                   | -4.6%                             | 30.2%                                 |
| Abs Ret Bonds           | 1.3%                   | -0.3%                             | 5.5%                                  |
| Global ex UK Corporates | 0.9%                   | -1.2%                             | 32.6%                                 |
| High Yield              | 1.9%                   | -1.3%                             | 11.6%                                 |

## Returns after 5 years

| Returns after 5 year(s) | Annualised return percentiles (% p.a.) |        |       |       |       |       |       |
|-------------------------|--|--------|-------|-------|-------|-------|-------|
|                         | 1%                                     | 5%     | 16%   | 50%   | 84%   | 95%   | 99%   |
| Cash                    | -1.7%                                  | -1.2%  | -0.8% | -0.0% | 0.8%  | 1.3%  | 1.9%  |
| UK ILGs                 | -8.2%                                  | -6.1%  | -3.8% | -0.4% | 3.2%  | 5.6%  | 8.2%  |
| UK FIGs                 | -6.0%                                  | -4.3%  | -2.8% | -0.4% | 2.0%  | 3.5%  | 5.3%  |
| UK Corporates           | -5.3%                                  | -3.2%  | -1.6% | 0.6%  | 2.8%  | 4.2%  | 5.4%  |
| Property                | -13.2%                                 | -8.4%  | -3.9% | 1.9%  | 8.4%  | 13.5% | 20.7% |
| UK Fac Equity           | -15.2%                                 | -10.0% | -4.6% | 3.9%  | 12.9% | 18.9% | 24.6% |
| Eur ex UK Equity        | -19.8%                                 | -12.6% | -6.2% | 3.3%  | 13.1% | 19.6% | 26.7% |
| US Fac Equity           | -16.2%                                 | -10.4% | -4.6% | 3.9%  | 12.7% | 18.3% | 24.1% |
| Jap Equity              | -17.8%                                 | -11.8% | -6.2% | 3.4%  | 12.6% | 18.6% | 25.1% |
| Asia Pac ex Jap Equity  | -20.6%                                 | -13.4% | -6.8% | 4.0%  | 14.6% | 21.6% | 28.6% |
| EM Equity               | -19.6%                                 | -13.6% | -6.9% | 3.9%  | 16.2% | 24.9% | 34.9% |
| UK Equity               | -15.4%                                 | -10.3% | -4.9% | 3.6%  | 12.6% | 18.6% | 24.3% |
| US Equity               | -17.6%                                 | -11.6% | -5.5% | 3.5%  | 12.7% | 18.6% | 24.8% |
| EM Debt                 | -10.5%                                 | -7.0%  | -3.6% | 1.6%  | 7.1%  | 10.9% | 15.1% |
| Abs Ret Bonds           | -2.6%                                  | -0.8%  | 0.7%  | 1.9%  | 2.8%  | 3.5%  | 4.3%  |
| Global ex UK Corporates | -3.7%                                  | -2.4%  | -1.3% | 0.3%  | 1.9%  | 3.0%  | 3.9%  |
| High Yield              | -5.5%                                  | -2.8%  | -0.5% | 2.5%  | 5.0%  | 6.1%  | 7.4%  |

## Returns after 10 years

| Returns after 10 year(s) | Annualised return percentiles (% p.a.) |       |       |       |       |       |       |
|--------------------------|--|-------|-------|-------|-------|-------|-------|
|                          | 1%                                     | 5%    | 16%   | 50%   | 84%   | 95%   | 99%   |
| Cash                     | -1.9%                                  | -1.2% | -0.6% | 0.4%  | 1.6%  | 2.4%  | 3.5%  |
| UK ILGs                  | -6.7%                                  | -5.0% | -3.5% | -1.2% | 1.3%  | 2.9%  | 4.8%  |
| UK FIGs                  | -3.5%                                  | -2.7% | -1.9% | -0.6% | 0.7%  | 1.5%  | 2.2%  |
| UK Corporates            | -2.4%                                  | -1.5% | -0.6% | 0.7%  | 1.9%  | 2.5%  | 3.3%  |
| Property                 | -8.3%                                  | -4.9% | -2.0% | 2.3%  | 7.0%  | 10.6% | 14.4% |
| UK Fac Equity            | -9.7%                                  | -5.9% | -1.8% | 4.3%  | 10.6% | 14.7% | 19.1% |
| Eur ex UK Equity         | -13.1%                                 | -7.9% | -3.4% | 3.9%  | 10.7% | 15.2% | 19.5% |
| US Fac Equity            | -10.0%                                 | -6.0% | -1.8% | 4.2%  | 10.3% | 14.5% | 18.6% |
| Jap Equity               | -11.4%                                 | -7.4% | -2.8% | 3.7%  | 10.2% | 14.5% | 18.9% |
| Asia Pac ex Jap Equity   | -14.0%                                 | -8.5% | -3.3% | 4.2%  | 11.7% | 16.5% | 21.8% |
| EM Equity                | -12.9%                                 | -8.6% | -3.6% | 4.4%  | 13.1% | 19.2% | 25.5% |
| UK Equity                | -9.9%                                  | -6.2% | -2.0% | 4.0%  | 10.3% | 14.5% | 18.8% |
| US Equity                | -11.1%                                 | -7.0% | -2.6% | 3.8%  | 10.2% | 14.5% | 19.0% |
| EM Debt                  | -6.9%                                  | -4.3% | -1.7% | 2.0%  | 5.8%  | 8.4%  | 11.7% |
| Abs Ret Bonds            | -1.3%                                  | -0.1% | 0.7%  | 1.9%  | 3.2%  | 4.1%  | 5.1%  |
| Global ex UK Corporates  | -1.8%                                  | -1.1% | -0.5% | 0.4%  | 1.3%  | 1.8%  | 2.4%  |
| High Yield               | -2.8%                                  | -1.0% | 0.5%  | 2.5%  | 4.1%  | 5.2%  | 6.3%  |

## Returns after 20 years

| Returns after 20 year(s)       | Annualised return percentiles (% p.a.) |       |       |       |       |       |       |
|--------------------------------|--|-------|-------|-------|-------|-------|-------|
|                                | 1%                                     | 5%    | 16%   | 50%   | 84%   | 95%   | 99%   |
| <b>Cash</b>                    | -1.4%                                  | -0.6% | 0.1%  | 1.5%  | 3.2%  | 4.5%  | 5.8%  |
| <b>UK ILGs</b>                 | -4.8%                                  | -3.7% | -2.6% | -1.0% | 0.8%  | 2.0%  | 3.3%  |
| <b>UK FIGs</b>                 | -1.4%                                  | -1.0% | -0.5% | 0.2%  | 1.0%  | 1.5%  | 2.1%  |
| <b>UK Corporates</b>           | -0.6%                                  | 0.1%  | 0.7%  | 1.6%  | 2.6%  | 3.4%  | 4.2%  |
| <b>Property</b>                | -4.1%                                  | -2.1% | 0.1%  | 3.4%  | 7.3%  | 9.7%  | 12.5% |
| <b>UK Fac Equity</b>           | -4.7%                                  | -2.0% | 0.8%  | 5.3%  | 10.0% | 13.0% | 16.1% |
| <b>Eur ex UK Equity</b>        | -6.8%                                  | -3.6% | -0.3% | 4.8%  | 10.1% | 13.6% | 17.1% |
| <b>US Fac Equity</b>           | -5.4%                                  | -2.3% | 0.8%  | 5.2%  | 9.9%  | 12.8% | 15.8% |
| <b>Jap Equity</b>              | -6.7%                                  | -3.1% | 0.0%  | 4.8%  | 9.7%  | 12.8% | 16.1% |
| <b>Asia Pac ex Jap Equity</b>  | -8.1%                                  | -3.9% | -0.3% | 5.3%  | 10.8% | 14.5% | 18.0% |
| <b>EM Equity</b>               | -7.5%                                  | -3.8% | -0.4% | 5.6%  | 11.9% | 16.1% | 20.9% |
| <b>UK Equity</b>               | -5.0%                                  | -2.3% | 0.6%  | 5.1%  | 9.7%  | 12.7% | 15.8% |
| <b>US Equity</b>               | -6.4%                                  | -3.1% | 0.1%  | 4.8%  | 9.6%  | 12.8% | 15.8% |
| <b>EM Debt</b>                 | -3.2%                                  | -1.5% | 0.3%  | 3.2%  | 6.2%  | 8.2%  | 10.5% |
| <b>Abs Ret Bonds</b>           | -0.1%                                  | 0.9%  | 1.7%  | 3.2%  | 4.8%  | 6.1%  | 7.5%  |
| <b>Global ex UK Corporates</b> | -0.4%                                  | 0.1%  | 0.6%  | 1.4%  | 2.4%  | 3.1%  | 4.0%  |
| <b>High Yield</b>              | -0.5%                                  | 0.8%  | 1.8%  | 3.5%  | 5.2%  | 6.3%  | 7.6%  |

## Appendix 2

The table below contains details of the naming convention used in the charts that appear in this report.

The “API key” column contains the asset class names that are recognised by the GO Plan Projection API, and the “Pretty name” column contains the corresponding chart labels.

| API key   | Pretty name             |
|---|-------------------------|
| cash_uk_giltsMoneyMarket_gbp_hedged_return                          | Cash                    |
| govBond_uk_il_MerrillLynchUKGiltsIndexLinkedIndex_gbp_hedged_return | UK ILGs                 |
| govBond_uk_fi_MerrillLynchUKGiltsIndex_gbp_hedged_return            | UK FIGs                 |
| corpBond_uk_MerrillLynchSterlingCorpSecIndex_gbp_hedged_return      | UK Corporates           |
| property_uk_commercial_gbp_hedged_return                            | Property                |
| equities_uk_broadFactor_gbp_hedged_return                           | UK Fac Equity           |
| equities_europeExUk_allCap_gbp_unhedged_return                      | Eur ex UK Equity        |
| equities_us_broadFactor_gbp_unhedged_return                         | US Fac Equity           |
| equities_japan_allCap_gbp_unhedged_return                           | Jap Equity              |
| equities_asiaPacificExJpn_developed_allCap_gbp_unhedged_return      | Asia Pac ex Jap Equity  |
| equities_emergingMarket_gbp_unhedged_return                         | EM Equity               |
| equities_uk_allCap_gbp_hedged_return                                | UK Equity               |
| equities_us_allCap_gbp_unhedged_return                              | US Equity               |
| debt_global_emergingMarket_gbp_unhedged_return                      | EM Debt                 |
| debt_uk_absReturnBonds_gbp_hedged_return                            | Abs Ret Bonds           |
| corpBond_global_MerrillLynchGlobalBroadIndexExUK_gbp_hedged_return  | Global ex UK Corporates |
| debt_global_highYield_gbp_hedged_return                             | High Yield              |