# Uncommon truths
## Are we boiling?

**Recent experience suggests the world's climate is changing. We may not be boiling but things could get worse and large mitigation and adaptation investments are likely to be needed.**

"The era of global warming has ended; the era of global boiling has arrived.", according to United Nations (UN) Secretary General Antonio Guterres. Is he correct? In this paper I try to give an answer by updating my global temperature change model.

The Secretary General's comments were in reaction to news that July 2023 was the hottest month on record. According to the European Union's Copernicus Climate Change Service, the global average surface air temperature for July was 16.95°C, the highest for any month since detailed records began in 1940.

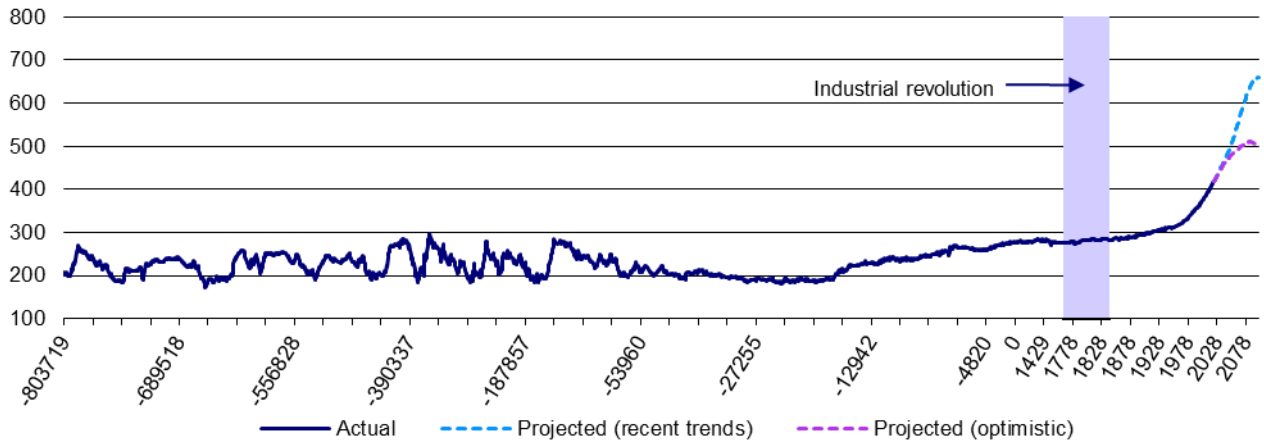
That was 0.3°C warmer than the previous record monthly high (July 2019), 0.7°C warmer than the 1991-2020 average for July and 1.5°C warmer than the estimated 1850-1900 average July temperature. The latter is symbolic, as the Paris Agreement aims to limit the rise in temperature since 1850-1900 to 1.5°C.

Perhaps contributing to those record air temperatures are elevated sea surface temperatures (SSTs), which have been at record seasonal levels since April and on July 31 reached a record high of 20.96°C (global average 60°S-60°N). The July 2023 global average sea temperature was 0.51°C above the 1991-2000 July average (the North Atlantic anomaly was 1.05°C). Not surprisingly, Antarctic Sea ice extent broke the July record, being 15% below the 1991-2020 July average (for the Arctic, the anomaly was a smaller -3%).

Those temperature data points simply confirmed what many people were thinking based on the extreme temperatures experienced in places as far-flung as China, Southern Europe and the Southwest of the USA. Meanwhile, Asia, Africa and South America each had their warmest July on record.

Are rising temperatures (and broader climate change) caused by human activity? NASA says: "the vast majority of actively publishing climate scientists – 97 percent – agree that humans are causing global warming and climate change." Perhaps it is just coincidence but the atmospheric concentration of CO2 reached a new high of 418.53 parts per million (ppm) in 2022 (despite the temporary depressing effects of La Nina), according to data from the US National Oceanic and Atmospheric Administration. **Figure 1** shows this to be well above the norms of the last 800,000 years. As CO2 concentration appears to be correlated to CO2 emissions in the previous one hundred years, it seems likely that industrialisation and rising CO2 emissions may have contributed to rising temperatures (the molecules of greenhouse gases such as CO2 absorb energy, thus holding heat in the atmosphere that would otherwise have escaped). If so, there is hope that we can do something about it.

**Figure 1 – Atmospheric concentration of CO2 from -803,719 to 2100 in parts per million (ppm)**




Note: "Actual" data is from the year -803,719 (i.e. 803,719 B.C.) to 2023. Data is not available for all years, so the date axis is not to scale. Data is shown for each year from 1750, using simple interpolation to fill any gaps. Data from 1958 to 2022 is based on observations at the US National Oceanic and Atmospheric Administration's (NOAA) Mauna Lao Observatory on Hawaii. The 2023 datapoint (420.5 ppm) is based on the forecast change for 2023 produced by the UK's Meteorological Office. Data prior to 1958 is derived from ice core records, as provided by NOAA Earth System Research Laboratories. Projections assume that CO2 concentration is determined by emissions in the previous 100 years (using an econometric relationship derived from data since 1750). Projections rely on forecasts of future CO2 emissions by low, middle and high-income countries (the global total being an aggregation of the three): "recent trends" assumes a continuation of recent trends in declines in the CO2 intensity of GDP and growth in GDP per capita, whereas "optimistic" assumes a more aggressive reduction in CO2 intensity (see the detailed explanation in the appendix). In both cases, population forecasts are taken from the UN's World Population Prospects 2022. "Industrial revolution" is the period 1760-1840. Source: NOAA, Our World in Data, UK Meteorological Office, United Nations, World Bank, Refinitiv Datastream and Invesco Global Market Strategy Office

But, first, the bad news. CO2 emissions reached a new high in 2022 (39.3bn tonnes according to the Energy Institute Statistical Review of World Energy). I reckon they will continue climbing, using a model that calculates CO2 emissions as the product of population, GDP per capita and the CO2 intensity of GDP.

Of course, the outcome depends on the assumptions. UN projections suggest the world's population will rise from 7.98bn in 2022 to a peak of 10.43bn in 2086. If real incomes (and spending) continue to rise, that 31% gain in population will require massive technological shifts to stabilise CO2 emissions. **Figure 2a** shows that we are on the right path, with a gradual decline in the CO2 intensity of economic activity. Technological change will hopefully drive it even lower.

Unfortunately, it isn't happening fast enough. If CO2 intensity declines at the same rate as in the decade to 2020, I estimate that annual global CO2 emissions will have doubled by the time they peak in 2071 (see the appendix for detailed assumptions). Based on my models, this, along with what has already been emitted in recent decades, results in a continued rise in the atmospheric concentration of CO2 (see "Projected (recent trends)" in **Figure 1**). This leads me to conclude that the temperature change by the end of the century will be 3.9 degrees versus the 1850-1900 average, based on the model shown in **Figure 2b** (note that the chart shows the variance versus the 1961-1990 average).

A more optimistic scenario, that sees high income country gross emissions fall to zero by 2060 and a doubling of the rate of decline in CO2 intensity in low and middle income countries, gives the result that global CO2 emissions fall from here and would halve by 2090. That would be good news but CO2 concentration would continue to climb because of emissions over recent decades (see "Projected (optimistic)" in **Figure 1**). However, my model suggests that concentration would peak in 2086 (by coincidence just as the world's population is expected to peak), though I still predict a temperature gain of 3.2 degrees versus 1850-1900 by the end of the century.

So, I wouldn't say the world is boiling but it may be simmering. Even on my most optimistic scenario (accepting the simplicity of my models), the temperature change outcomes are likely to be dramatic, as are the potential implications in terms of volatile weather patterns, rising sea levels, agricultural production and migration flows. We may need big investment in carbon reducing and carbon removing technology, running the gamut from reforestation, through electrification of transport systems to renewable energy sources (as previously covered in *The 21st Century Portfolio*, November 2019, and recent editions of *Economic Transition Monitor*). In the meantime, large scale adaptation spending could be needed as we learn to live in a changing world.

*Unless stated otherwise, all data as of 25 August 2023.*

**Figure 2a – kg of CO2 per 2011 PPP $ of GDP**

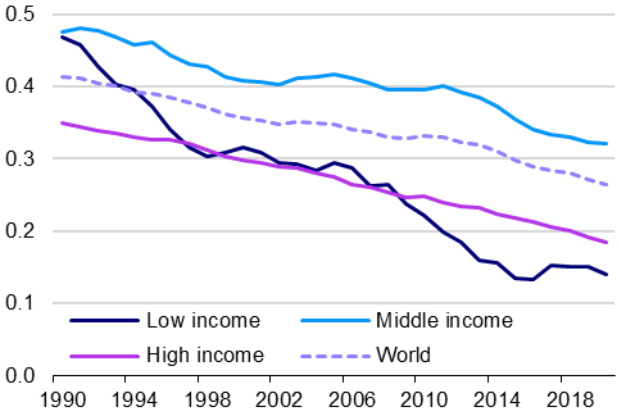
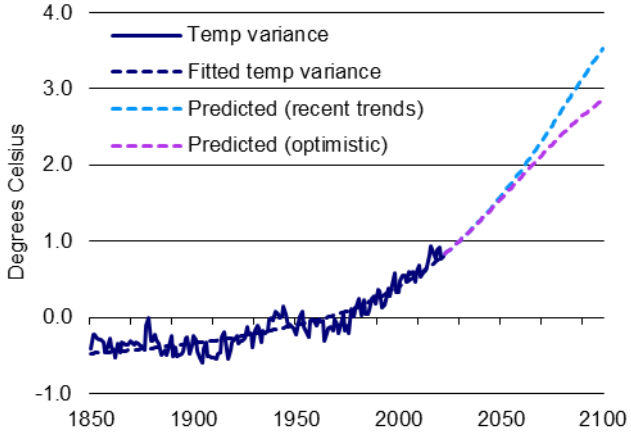



**Figure 2b – Temperature variance (deg. Celsius)**




Notes: Figure 2a shows the CO2 intensity of GDP annually from 1990 to 2020 for low, middle and high-income countries (as currently defined by the World Bank). Figure 2b shows annual data from 1850 to 2100. It shows the historical global temperature variance ("Temp variance"), which is the global average land-sea temperature anomaly relative to the 1961-1990 average temperature in degrees Celsius, median estimate, as provided by UK Met Office Hadley Centre. "Fitted temp variance" is the result of a regression analysis that fits historical temperature variance to atmospheric CO2 concentration (using the natural logarithm of the 100-year moving average of concentration, on the assumption that temperature at any moment is determined by CO2 concentration during the previous 100 years). "Predicted (recent trends)" applies that fitted relationship to our forecast of CO2 concentrations, assuming that recent trends in CO2 intensity and GDP per capita continue, though with some convergence between World Bank income groups after 2050 (see appendix for details). "Predicted (optimistic)" assumes a doubling of the rate of decline in CO2 intensity (with the added assumption that high income CO2 emissions trend to zero in 2060).
Source: NOAA, Our World in Data, UK Meteorological Office, United Nations, World Bank, Refinitiv Datastream and Invesco Global Market Strategy Office

## Figure 3 – Asset class total returns (%)

| Data as at 25/08/2023 | | Current | Total Return (USD, %) | | | | | Total Return (Local Currency, %) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Index | Level/RY | 1w | 1m | QTD | YTD | 12m | 1w | 1m | QTD | YTD | 12m |
| **Equities** | | | | | | | | | | | | |
| World | MSCI | 670 | 0.5 | -4.4 | -1.6 | 12.5 | 6.7 | 0.7 | -3.4 | -1.1 | 13.1 | 6.5 |
| Emerging Markets | MSCI | 971 | 0.7 | -5.7 | -1.2 | 3.9 | -0.2 | 0.3 | -4.2 | -0.5 | 5.2 | 1.1 |
| China | MSCI | 58 | -0.1 | -7.3 | -1.6 | -6.9 | -9.7 | 0.0 | -6.7 | -1.5 | -5.7 | -8.7 |
| US | MSCI | 4186 | 0.8 | -3.5 | -0.8 | 16.2 | 6.4 | 0.8 | -3.5 | -0.8 | 16.2 | 6.4 |
| Europe | MSCI | 1861 | -0.2 | -5.6 | -3.2 | 10.6 | 16.3 | 0.8 | -3.0 | -2.2 | 8.7 | 9.2 |
| Europe ex-UK | MSCI | 2310 | -0.2 | -5.4 | -3.2 | 12.3 | 19.2 | 0.7 | -2.7 | -2.3 | 11.2 | 11.6 |
| UK | MSCI | 1095 | -0.4 | -6.2 | -3.0 | 5.2 | 7.4 | 1.0 | -3.9 | -1.8 | 0.8 | 1.2 |
| Japan | MSCI | 3398 | 0.2 | -5.0 | -3.1 | 9.8 | 9.3 | 1.1 | -1.3 | -1.7 | 21.9 | 17.2 |
| **Government Bonds** | | | | | | | | | | | | |
| World | BofA-ML | 3.44 | -0.2 | -3.1 | -2.3 | -1.9 | -4.0 | 0.3 | -1.4 | -1.5 | 0.1 | -4.3 |
| Emerging Markets | BBloom | 8.26 | 1.1 | -2.5 | -0.8 | 4.7 | 4.3 | 1.1 | -2.5 | -0.8 | 4.7 | 4.3 |
| China | BofA-ML | 2.42 | 0.2 | -1.3 | 1.1 | -0.7 | -2.2 | 0.2 | 0.8 | 1.4 | 4.1 | 4.0 |
| US (10y) | Datastream | 4.25 | 0.2 | -2.5 | -2.9 | -0.7 | -6.1 | 0.2 | -2.5 | -2.9 | -0.7 | -6.1 |
| Europe | Bofa-ML | 3.28 | -0.5 | -3.1 | -1.9 | 2.4 | 1.7 | 0.5 | -0.7 | -0.6 | 1.4 | -5.8 |
| Europe ex-UK (EMU, 10y) | Datastream | 2.53 | -0.3 | -3.3 | -2.1 | 3.2 | -0.5 | 0.6 | -0.8 | -0.8 | 2.3 | -7.8 |
| UK (10y) | Datastream | 4.44 | 0.5 | -3.4 | -1.1 | 1.3 | -6.0 | 1.9 | -1.0 | 0.2 | -2.9 | -11.4 |
| Japan (10y) | Datastream | 0.65 | -1.2 | -5.4 | -3.5 | -8.9 | -7.1 | -0.3 | -1.7 | -2.1 | 1.2 | -0.4 |
| **IG Corporate Bonds** | | | | | | | | | | | | |
| Global | BofA-ML | 5.44 | 0.1 | -2.0 | -1.1 | 2.4 | 0.9 | 0.5 | -1.1 | -0.6 | 2.1 | -0.9 |
| Emerging Markets | BBloom | 7.86 | 0.2 | -2.1 | -1.7 | 2.4 | 2.5 | 0.2 | -2.1 | -1.7 | 2.4 | 2.5 |
| China | BofA-ML | 3.24 | 0.1 | -1.7 | 0.5 | -1.3 | -3.4 | 0.1 | 0.4 | 0.9 | 3.5 | 2.8 |
| US | BofA-ML | 5.84 | 0.6 | -1.5 | -1.2 | 2.0 | -1.0 | 0.6 | -1.5 | -1.2 | 2.0 | -1.0 |
| Europe | BofA-ML | 4.36 | -0.8 | -2.7 | -0.6 | 3.7 | 6.7 | 0.2 | -0.2 | 0.7 | 2.8 | -1.1 |
| UK | BofA-ML | 6.38 | -0.1 | -3.0 | 0.1 | 4.8 | 1.8 | 1.3 | -0.6 | 1.4 | 0.5 | -4.1 |
| Japan | BofA-ML | 0.84 | -1.0 | -4.3 | -2.0 | -9.0 | -7.2 | -0.1 | -0.6 | -0.7 | 1.0 | -0.5 |
| **HY Corporate Bonds** | | | | | | | | | | | | |
| Global | BofA-ML | 8.76 | 0.1 | -0.8 | 0.4 | 5.7 | 6.0 | 0.4 | -0.2 | 0.7 | 5.4 | 4.3 |
| US | BofA-ML | 8.67 | 0.4 | -0.5 | 0.7 | 6.1 | 3.9 | 0.4 | -0.5 | 0.7 | 6.1 | 3.9 |
| Europe | BofA-ML | 7.54 | -0.7 | -2.1 | -0.3 | 6.4 | 13.0 | 0.2 | 0.4 | 1.0 | 5.4 | 4.7 |
| **Cash (Overnight LIBOR)** | | | | | | | | | | | | |
| US | | 5.06 | 0.1 | 0.4 | 0.8 | 3.2 | 4.4 | 0.1 | 0.4 | 0.8 | 3.2 | 4.4 |
| Euro Area | | 3.65 | -0.5 | -2.0 | -0.5 | 2.8 | 10.7 | 0.1 | 0.3 | 0.5 | 1.9 | 2.2 |
| UK | | 5.19 | -1.1 | -2.1 | -0.2 | 6.9 | 10.3 | 0.1 | 0.5 | 0.8 | 2.8 | 3.7 |
| Japan | | -0.06 | -0.7 | -3.8 | -1.4 | -10.5 | -6.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Real Estate (REITs)** | | | | | | | | | | | | |
| Global | FTSE | 1503 | 0.6 | -6.0 | -1.8 | -0.7 | -9.7 | 1.5 | -3.6 | -0.5 | -1.6 | -16.3 |
| Emerging Markets | FTSE | 1233 | 0.4 | -5.5 | -1.8 | -6.3 | -4.5 | 1.4 | -3.1 | -0.5 | -7.1 | -11.5 |
| US | FTSE | 2845 | 0.7 | -5.9 | -2.1 | 3.1 | -9.7 | 0.7 | -5.9 | -2.1 | 3.1 | -9.7 |
| Europe ex-UK | FTSE | 2017 | 0.8 | -6.7 | 3.9 | -3.1 | -11.0 | 1.8 | -4.3 | 5.2 | -4.0 | -17.5 |
| UK | FTSE | 705 | 0.2 | -8.3 | 0.6 | -2.3 | -16.1 | 1.6 | -6.1 | 1.9 | -6.4 | -20.9 |
| Japan | FTSE | 2054 | 1.1 | -2.8 | 0.8 | -3.1 | -6.3 | 2.0 | 1.0 | 2.2 | 7.6 | 0.4 |
| **Commodities** | | | | | | | | | | | | |
| All | GSCI | 3559 | 0.6 | 0.3 | 10.1 | 1.8 | -5.4 | - | - | - | - | - |
| Energy | GSCI | 633 | 0.3 | 4.5 | 17.2 | 3.7 | -9.5 | - | - | - | - | - |
| Industrial Metals | GSCI | 1544 | 1.5 | -3.9 | 0.7 | -7.9 | -4.0 | - | - | - | - | - |
| Precious Metals | GSCI | 2169 | 1.8 | -2.6 | 0.0 | 4.4 | 10.2 | - | - | - | - | - |
| Agricultural Goods | GSCI | 542 | 0.9 | -9.9 | 0.3 | -3.1 | -2.0 | - | - | - | - | - |
| **Currencies (vs USD)*** | | | | | | | | | | | | |
| EUR | | 1.08 | -0.6 | -2.3 | -1.0 | 0.9 | 8.3 | - | - | - | - | - |
| JPY | | 146.42 | -0.7 | -3.8 | -1.4 | -10.4 | -6.8 | - | - | - | - | - |
| GBP | | 1.26 | -1.4 | -2.4 | -1.3 | 4.3 | 6.1 | - | - | - | - | - |
| CHF | | 1.13 | -0.3 | -2.4 | 1.2 | 4.5 | 9.0 | - | - | - | - | - |
| CNY | | 7.29 | -0.1 | -2.1 | -0.5 | -5.4 | -6.0 | - | - | - | - | - |

Notes: *The currency section is organised so that in all cases the numbers show the movement in the mentioned currency versus USD (+ve indicates appreciation, -ve indicates depreciation). **Past performance is no guarantee of future results.** Please see appendix for definitions, methodology and disclaimers.
Source: Refinitiv Datastream and Invesco Global Market Strategy Office

**Figure 4 – Global equity sector total returns relative to market (%)**

| Data as at 25/08/2023 | Global | | | | |
|---|---|---|---|---|---|
| | 1w | 1m | QTD | YTD | 12m |
| **Energy** | **-1.3** | **6.0** | **7.7** | **-2.0** | **-2.7** |
| **Basic Materials** | **0.5** | **-3.3** | **-0.2** | **-8.5** | **-1.7** |
| Basic Resources | 0.8 | -5.1 | -0.4 | -9.9 | 1.7 |
| Chemicals | 0.0 | -0.9 | 0.0 | -6.5 | -5.9 |
| **Industrials** | **-0.2** | **-0.8** | **-0.8** | **-1.7** | **2.4** |
| Construction & Materials | -0.5 | 0.1 | 0.9 | 5.2 | 10.2 |
| Industrial Goods & Services | -0.1 | -0.9 | -1.0 | -2.6 | 1.4 |
| **Consumer Discretionary** | **-0.3** | **-1.1** | **-2.3** | **5.9** | **-1.1** |
| Automobiles & Parts | 2.6 | -4.3 | -4.5 | 19.1 | -9.5 |
| Media | -1.1 | -0.3 | -4.6 | 0.0 | -1.9 |
| Retailers | -1.0 | 2.7 | 1.5 | 6.0 | -4.2 |
| Travel & Leisure | -0.6 | -1.4 | -2.3 | 3.7 | 10.1 |
| Consumer Products & Services | -0.9 | -3.2 | -4.6 | 0.4 | 5.2 |
| **Consumer Staples** | **-0.3** | **0.2** | **-0.7** | **-9.7** | **-5.2** |
| Food, Beverage & Tobacco | -0.2 | 0.1 | -0.6 | -9.2 | -4.8 |
| Personal Care, Drug & Grocery Stores | -0.4 | 0.2 | -0.9 | -10.7 | -6.0 |
| **Healthcare** | **-0.4** | **2.1** | **1.1** | **-8.7** | **-1.4** |
| **Financials** | **-0.5** | **-0.4** | **1.2** | **-6.7** | **-0.3** |
| Banks | -0.8 | -1.6 | 0.5 | -8.3 | -1.9 |
| Financial Services | 0.0 | 0.4 | 2.5 | -3.5 | -0.5 |
| Insurance | -0.4 | 1.2 | 0.7 | -7.8 | 4.7 |
| **Real Estate** | **0.1** | **-1.8** | **-1.1** | **-11.5** | **-15.4** |
| **Technology** | **1.4** | **-0.6** | **-1.1** | **22.0** | **9.6** |
| **Telecommunications** | **-0.1** | **0.8** | **-0.8** | **-6.1** | **-5.7** |
| **Utilities** | **0.2** | **-1.2** | **-1.3** | **-10.6** | **-9.9** |

Notes: Returns shown are for Datastream sector indices versus the total market index. **Past performance is no guarantee of future results.** Source: Refinitiv Datastream and Invesco Global Market Strategy Office

**Figure 5a – US factor index total returns (%)**

| Data as at 25/08/2023 | Absolute | | | | | Relative to Market | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1w | 1m | QTD | YTD | 12m | 1w | 1m | QTD | YTD | 12m |
| **Growth** | 0.4 | -3.8 | -0.6 | 19.1 | 9.2 | -0.4 | -0.4 | 0.2 | 2.7 | 2.3 |
| **Low volatility** | 0.3 | -5.0 | -2.6 | -0.2 | -0.4 | -0.5 | -1.6 | -1.9 | -14.0 | -6.7 |
| **Price momentum** | 0.8 | -3.3 | -2.1 | 3.3 | 3.0 | -0.1 | 0.1 | -1.4 | -10.9 | -3.5 |
| **Quality** | -0.3 | -2.4 | 1.3 | 12.4 | 10.2 | -1.1 | 1.1 | 2.1 | -3.1 | 3.2 |
| **Size** | -0.4 | -5.0 | -0.3 | 5.3 | -1.3 | -1.2 | -1.7 | 0.5 | -9.2 | -7.5 |
| **Value** | -0.9 | -5.2 | 0.7 | -1.1 | -6.4 | -1.7 | -1.9 | 1.5 | -14.7 | -12.3 |
| **Market** | 0.8 | -3.4 | -0.8 | 16.0 | 6.7 | | | | | |
| **Market - Equal-Weighted** | 0.0 | -4.8 | -1.6 | 5.3 | 0.9 | | | | | |

Notes: **Past performance is no guarantee of future results**. All indices are subsets of the S&P 500 index, they are rebalanced monthly, use data in US dollars and are equal-weighted. Growth includes stocks in the top third based on both their 5-year sales per share trend and their internal growth rate (the product of the 5-year average return on equity and the retention ratio); Low volatility includes stocks in the bottom quintile based on the standard deviation of their daily returns in the previous three months; Price momentum includes stocks in the top quintile based on their performance in the previous 12 months; Quality includes stocks in the top third based on both their return on invested capital and their EBIT to EV ratio (earnings before interest and taxes to enterprise value); Size includes stocks in the bottom quintile based on their market value in US dollars. Value includes stocks in the bottom quintile based on their price to book value ratios. The market represents the S&P 500 index.
Source: Refinitiv Datastream and Invesco Global Market Strategy Office

**Figure 5b – European factor index total returns relative to market (% annualised)**

| Data as at 25/08/2023 | Absolute | | | | | Relative to Market | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1w | 1m | QTD | YTD | 12m | 1w | 1m | QTD | YTD | 12m |
| **Growth** | -0.1 | -7.5 | -4.0 | 4.5 | -1.3 | -0.8 | -4.3 | -2.1 | -4.4 | -8.3 |
| **Low volatility** | 1.0 | -3.3 | -2.7 | 7.5 | 3.1 | 0.3 | 0.0 | -0.8 | -1.7 | -4.2 |
| **Price momentum** | 0.2 | -2.7 | -2.2 | 3.6 | 0.0 | -0.4 | 0.6 | -0.2 | -5.2 | -7.1 |
| **Quality** | 0.1 | -4.9 | -0.5 | 5.0 | 2.4 | -0.5 | -1.7 | 1.5 | -3.9 | -4.9 |
| **Size** | -0.3 | -6.5 | -1.7 | 1.9 | -0.6 | -1.0 | -3.4 | 0.3 | -6.8 | -7.6 |
| **Value** | 0.2 | -5.5 | 0.7 | 6.2 | 10.8 | -0.5 | -2.3 | 2.7 | -2.8 | 2.9 |
| **Market** | 0.7 | -3.3 | -1.9 | 9.3 | 7.6 | | | | | |
| **Market - Equal-Weighted** | 0.3 | -4.9 | -1.8 | 6.3 | 3.3 | | | | | |

Notes: **Past performance is no guarantee of future results.** All indices are subsets of the STOXX 600 index, they are rebalanced monthly, use data in euros and are equal-weighted. Growth includes stocks in the top third based on both their 5-year sales per share trend and their internal growth rate (the product of the 5-year average return on equity and the retention ratio); Low volatility includes stocks in the bottom quintile based on the standard deviation of their daily returns in the previous three months; Price momentum includes stocks in the top quintile based on their performance in the previous 12 months; Quality includes stocks in the top third based on both their return on invested capital and their EBIT to EV ratio (earnings before interest and taxes to enterprise value); Size includes stocks in the bottom quintile based on their market value in euros; Value includes stocks in the bottom quintile based on their price to book value ratios. The market represents the STOXX 600 index.
Source: Refinitiv Datastream and Invesco Global Market Strategy Office

**Figure 6 – Model asset allocation**

| | Neutral | Policy Range | | Allocation | Position vs Neutral | Hedged | Currency |
|---|---|---|---|---|---|---|---|
| **Cash Equivalents** | **5%** | **0-10%** | | **10%** | | | |
| Cash | 2.5% | | | 10% | | | |
| Gold | 2.5% | | | 0% | | | |
| **Bonds** | **40%** | **10-70%** | ↓ | **46%** | | | |
| Government | 25% | 10-40% | ↓ | **20%** | | | |
| US | 8% | | ↓ | 11% | | | |
| Europe ex-UK (Eurozone) | 7% | | ↓ | 2% | | | |
| UK | 1% | | ↓ | 1% | | | |
| Japan | 7% | | | 2% | | | |
| Emerging Markets | 2% | | | 4% | | | |
| China** | 0.2% | | | 0% | | | |
| Corporate IG | 10% | 0-20% | ↑ | **18%** | | | |
| US Dollar | 5% | | ↑ | 10% | | 40% | JPY |
| Euro | 2% | | ↑ | 3% | | | |
| Sterling | 1% | | | 2% | | | |
| Japanese Yen | 1% | | | 0% | | | |
| Emerging Markets | 1% | | ↑ | 3% | | | |
| China** | 0.1% | | | 0% | | | |
| Corporate HY | 5% | 0-10% | | **8%** | | | |
| US Dollar | 4% | | | 6% | | | |
| Euro | 1% | | | 2% | | | |
| **Equities** | **45%** | **25-65%** | | **34%** | | | |
| US | 25% | | | 12% | | | |
| Europe ex-UK | 7% | | ↑ | 6% | | | |
| UK | 4% | | ↓ | 4% | | | |
| Japan | 4% | | | 4% | | | |
| Emerging Markets | 5% | | | 8% | | | |
| China** | 2% | | | 4% | | | |
| **Real Estate** | **8%** | **0-16%** | ↑ | **10%** | | | |
| US | 2% | | ↑ | 4% | | | |
| Europe ex-UK | 2% | | | 1% | | | |
| UK | 1% | | | 2% | | | |
| Japan | 2% | | | 1% | | | |
| Emerging Markets | 1% | | ↑ | 2% | | | |
| **Commodities** | **2%** | **0-4%** | | **0%** | | | |
| Energy | 1% | | | 0% | | | |
| Industrial Metals | 0.3% | | | 0% | | | |
| Precious Metals | 0.3% | | | 0% | | | |
| Agriculture | 0.3% | | | 0% | | | |
| **Total** | **100%** | | | **100%** | | | |

| **Currency Exposure (including effect of hedging)** | | | | |
|---|---|---|---|---|
| USD | 50% | | ↓ | 42% |
| EUR | 19% | | ↓ | 17% |
| GBP | 7% | | ↓ | 12% |
| JPY | 14% | | ↑ | 14% |
| EM | 9% | | ↑ | 17% |
| **Total** | **100%** | | | **100%** |

Notes: **China is included in Emerging Markets allocations. This is a theoretical portfolio and is for illustrative purposes only. See the latest The Big Picture document for more details. It does not represent an actual portfolio and is not a recommendation of any investment or trading strategy. Arrows indicate the direction of the most recent changes.
Source: Invesco Global Market Strategy Office

**Figure 7 – Model allocations for global sectors**

| | Neutral | Invesco | Preferred Region |
|---|---|---|---|
| **Energy** | **7.3%** | **Underweight** | **EM** |
| **Basic Materials** | **4.1%** | **Neutral** ↑ | **Europe** |
| Basic Resources | 2.3% | Neutral ↑ | Europe |
| Chemicals | 1.8% | Neutral | US |
| **Industrials** | **13.0%** | **Neutral** | **Europe** |
| Construction & Materials | 1.6% | Underweight | US |
| Industrial Goods & Services | 11.4% | Neutral | Europe |
| **Consumer Discretionary** | **14.9%** | **Neutral** ↓ | **Europe** |
| Automobiles & Parts | 2.9% | Underweight ↓ | Japan |
| Media | 1.0% | Underweight ↓ | Japan |
| Retailers | 4.8% | Overweight | Europe |
| Travel & Leisure | 2.2% | Underweight | EM |
| Consumer Products & Services | 4.0% | Neutral ↓ | Europe |
| **Consumer Staples** | **6.1%** | **Overweight** | **Europe** |
| Food, Beverage & Tobacco | 4.0% | Overweight | Europe |
| Personal Care, Drug & Grocery Stores | 2.1% | Overweight | US |
| **Healthcare** | **9.7%** | **Overweight** | **US** |
| **Financials** | **14.7%** | **Neutral** ↑ | **Europe** |
| Banks | 7.1% | Neutral ↑ | Europe |
| Financial Services | 4.7% | Underweight | US |
| Insurance | 2.9% | Neutral | Europe |
| **Real Estate** | **2.9%** | **Overweight** ↑ | **US** |
| **Technology** | **20.5%** | **Neutral** ↓ | **US** |
| **Telecommunications** | **3.3%** | **Overweight** ↑ | **Europe** |
| **Utilities** | **3.4%** | **Underweight** | **Europe** |

Notes: These are theoretical allocations which are for illustrative purposes only. They do not represent an actual portfolio and are not a recommendation of any investment or trading strategy. See the latest Strategic Sector Selector for more details.
Source: Refinitiv Datastream and Invesco Global Market Strategy Office

# Appendix

## Methodology for asset allocation, expected returns and optimal portfolios

### Portfolio construction process

The optimal portfolios are theoretical and not real. We use optimisation processes to guide our allocations around "neutral" and within prescribed policy ranges based on our estimations of expected returns and using historical covariance information. This guides the allocation to global asset groups (equities, government bonds etc.), which is the most important level of decision. For the purposes of this document the optimal portfolios are constructed with a one-year horizon.

### Which asset classes?

We look for investibility, size and liquidity. We have chosen to include equities, bonds (government, corporate investment grade and corporate high-yield), REITs to represent real estate, commodities and cash (all across a range of geographies). We use cross-asset correlations to determine which decisions are the most important.

### Neutral allocations and policy ranges

We use market capitalisation in USD for major benchmark indices to calculate neutral allocations. For commodities, we use industry estimates for total ETP market cap + assets under management in hedge funds + direct investments. We use an arbitrary 5% for the combination of cash and gold. We impose diversification by using policy ranges for each asset category (the range is usually symmetric around neutral).

### Expected/projected returns

The process for estimating expected returns is based upon yield (except commodities, of course). After analysing how yields vary with the economic cycle, and where they are situated within historical ranges, we forecast the direction and amplitude of moves over the next year. Cash returns are calculated assuming a straight-line move in short term rates towards our targets (with, of course, no capital gain or loss). Bond returns assume a straight-line progression in yields, with capital gains/losses predicated upon constant maturity (effectively supposing constant turnover to achieve that). Forecasts of corporate investment-grade and high-yield spreads are based upon our view of the economic cycle (as are forecasts of credit losses). Coupon payments are added to give total returns. Equity and REIT returns are based on dividend growth assumptions. We calculate total returns by applying those growth assumptions and adding the forecast dividend yield. No such metrics exist for commodities; therefore, we base our projections on US CPI-adjusted real prices relative to their long-term averages and views on the economic cycle. All expected returns are first calculated in local currency and then, where necessary, converted into other currency bases using our exchange rate forecasts.

### Optimising the portfolio

Using a covariance matrix based on monthly local currency total returns for the last 5 years and we run an optimisation process that maximises the Sharpe Ratio. Another version maximises Return subject to volatility not exceeding that of our Neutral Portfolio. The optimiser is based on the Markowitz model.

### Currency hedging

We adopt a cautious approach when it comes to currency hedging as currency movements are notoriously difficult to accurately predict and sometimes hedging can be costly. Also, some of our asset allocation choices are based on currency forecasts. We use an amalgam of central bank rate forecasts, policy expectations and real exchange rates relative to their historical averages to predict the direction and amplitude of currency moves.

**Definitions of data and benchmarks for Figure 3**

**Sources:** we source data from Refinitiv Datastream unless otherwise indicated.

**Cash:** returns are based on a proprietary index calculated using the Intercontinental Exchange Benchmark Administration overnight LIBOR (London Interbank Offer Rate). From 1st January 2022, we use the Refinitiv overnight deposit rate for the euro, the British pound and the Japanese yen. The global rate is the average of the euro, British pound, US dollar and Japanese yen rates. The series started on 1 January 2001 with a value of 100.

**Gold:** London bullion market spot price in USD/troy ounce.

**Government bonds:** Current levels, yields and total returns use Datastream benchmark 10-year yields for the US, Eurozone, Japan and the UK, and the ICE BofA government bond total return index for the World and Europe. The emerging markets yields and returns are based on the Barclays Bloomberg emerging markets sovereign US dollar bond index.

**Corporate investment grade (IG) bonds:** ICE BofA investment grade corporate bond total return indices, except for in emerging markets where we use the Barclays Bloomberg emerging markets corporate US dollar bond index.

**Corporate high yield (HY) bonds:** ICE BofA high yield total return indices

**Equities:** We use MSCI benchmark gross total return indices for all regions.

**Commodities:** Goldman Sachs Commodity total return indices

**Real estate:** FTSE EPRA/NAREIT total return indices

**Currencies:** Global Trade Information Services spot rates

**Climate change scenarios (Figures 1 and 2)**

In all cases, global CO2 emissions are calculated as the sum of emissions from low-, middle- and high-income countries (as currently defined by the World Bank). Emissions for each group are calculated as the product of population, GDP per capita and the CO2 intensity of GDP (kg of CO2 per 2011 PPP US dollar of GDP). Population estimates are provided by the UN's World Population Prospects 2022. World Bank data is used for emissions in the 1960 to 1989 period. Estimates for the period 1990 to 2020 are calculated using actual data for population, GDP per capita and CO2 intensity (though because CO2 intensity is only available to 2020, recent trends are used to estimate more recent years).

Two scenarios are imagined for future emissions (starting in 2023):

- "Recent trends" assumes that for high-income countries, CO2 intensity continues to decline at the same annual rate as in the last 10 years (to 2020) and that GDP per capita continues to grow at the same rate as in the 10 years to 2022. For middle-income countries, it is assumed that CO2 intensity declines at the same rate as in the last 10 years (to 2020) until 2050, after which time it is assumed that the decline accelerates such that CO2 intensity matches that of high-income countries by 2100. Middle-income GDP per capita is assumed to grow at the same rate as in the last 10 years (to 2022) until 2050 and thereafter to grow more rapidly such that convergence with high-income GDP per capita occurs in 2100. Low-income countries are assumed to start industrialising, so it is assumed that CO2 intensity increases until it matches that of middle-income countries in 2050 and that it thereafter declines at the rate seen in middle-income countries in the last 10 years (to 2020). Low-income GDP per capita is assumed to grow at the same rate as in the last 10 years (to 2022) until 2050 and thereafter to grow at the rate seen in middle-income countries in the last 10 years (to 2022).
- "Optimistic" assumes for high-income countries that CO2 intensity reaches zero in 2060 (at which point gross emissions will be zero) and that in the meantime there is a linear convergence to zero. High-income GDP per capita is assumed to grow at the same rate as in the last 10 years (to 2022), as with the "recent trends" scenario. Middle-income CO2 intensity is assumed to decline at twice the rate seen in the last 10 years (to 2020) until 2050, after which it is assumed to linearly converge to zero by 2100. Middle-income GDP per capita is assumed to grow at the same rate as in the last 10 years (to 2022),

until 2060 after which point it is assumed to accelerate, allowing linear convergence on high-income GDP by 2100 (the “recent trends” scenario assumed that convergence started in 2050). Low-income CO2 intensity is assumed to increase (due to industrialisation), converging on (the now more rapidly declining) middle-income CO2 intensity by 2050 and thereafter falling at twice the rate seen in middle-income countries in the last 10 years (to 2020). Low-income GDP per capita is assumed to increase at the same rate as in the last 10 years (to 2022) until 2050 and to then grow at the same rate as in middle-income countries in the last 10 years (to 2022).

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