Uncommon truths

Climate change revisited

A range of emission and temperature change scenarios are examined. It is clear that technology will be key in mitigating change. However, we think large-scale adaptation could benefit infrastructure, engineering, housing and materials sectors.

The last two years have been dominated by Covid-19. Its persistence in countries such as Israel, the UK and the US suggests the vaccine optimism of earlier this year may have been overstated. This, along with the imminence of Fed tapering appears to have taken the froth out of risk assets.

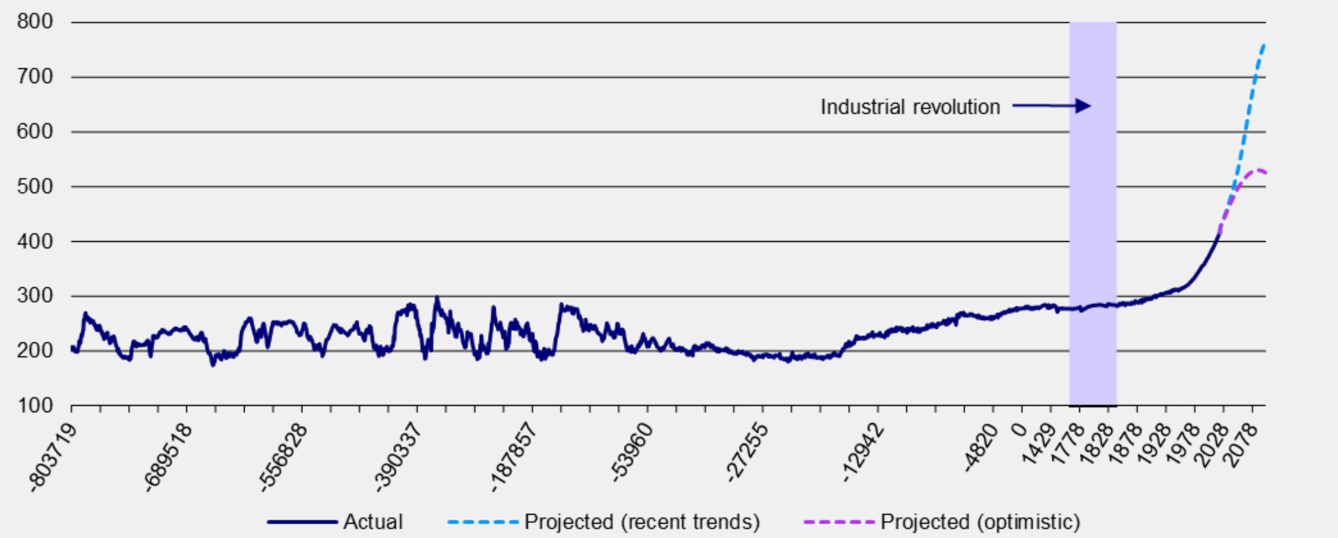
However, what may turn out to be a more destructive force has been baring its teeth without causing market angst. Climate change has variously revealed itself this year through the heat dome in Canada and the US, floods in China and Europe and wildfires from North America, through Southern Europe to Siberia.

This was a topic that we covered extensively in our 2019 report The 21st Century Portfolio and, if anything, the situation is worsening faster than we imagined. In particular, it feels as though "tipping points" are being crossed: ice sheets are disappearing more rapidly than imagined; the melting of Siberian permafrost (and release of methane) is being accelerated by wildfires and there is evidence of slowing of the Atlantic meridional overturning circulation (AMOC). Halting of the latter could have big implications for the climates of Europe, South America, West Africa and even India (as well as boosting sea levels).

Right on cue, Climate Change 2021 was published by the Intergovernmental Panel on Climate Change (IPCC) and gave a sombre evaluation of the current situation and dire warnings of how bad things could become. The scientists responsible for the report are now willing to say that it is "unequivocal that human influence has warmed the atmosphere, ocean and land". They also found that in 2011-2020 the global surface temperature was 1.09 degrees Celsius higher than in 1850-1900 (the usual reference period) and that the global mean sea level has increased by 20cm since 1901 (with acceleration over time).

To the extent that higher concentrations of greenhouse gases (GHGs) in the atmosphere cause global warming and climate change (which seems likely), **Figure 1** points to the influence of humans. Atmospheric CO2 concentration had never gone above 300 parts per million (ppm) in the more than 800,000 years prior to the industrial revolution. They have since broken above that historical ceiling and in recent years have breached 400 ppm (the UK Met Office forecasts it will be 416.3 ppm in 2021).

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



Note: data is from the year -803,719 (i.e. 803,719 B.C.) to 2021. 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 2020 is based on observations at the US National Oceanic and Atmospheric Administration's (NOAA) Mauna Lao Observatory on Hawaii. The 2021 datapoint (416.3 ppm) is the forecast of 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 as "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 2019. "Industrial revolution" is the period 1760-1840.
Source: NOAA, Our World in Data, UK Meteorological Office, United Nations, World Bank, Refinitiv Datastream and Invesco

Even worse, as we continue to emit CO2 and other GHGs in increasing quantities, those concentrations are likely to rise. The projections shown in **Figure 1** are our attempt to imagine how bad it could become.

Logically, the atmospheric concentration of CO2 is related to previous CO2 emissions but it is not an easy relationship to establish. For one thing, the earth absorbs some of those emissions (the IPCC report estimates that land and ocean have taken up a near constant 56% of CO2 emissions over the last six decades). Whether the earth can continue to absorb such a high proportion is not clear (there seems to be evidence that the Amazon is now a net emitter of CO2 and it is thought that as the oceans warm and become more acidic they will absorb less CO2).

Our projections assume that CO2 concentrations depend on CO2 emissions in the previous 100 years and we have used historical data to fit a simple relationship between the two. We then apply that relationship to our projections for CO2 emissions to come up with the projected concentrations (see the appendix for details of the methodology). Note that we are implicitly assuming the relationship will be unchanged. Given the doubt expressed above about the earth's ability to continue absorbing as much CO2, our projections may be an understatement.

Even our most optimistic estimate envisages a rise in CO2 concentration to above 500ppm, with a peak at 530.2 in 2087 (at the risk of being overly precise). Integral to the "optimism" is the assumption that technological developments accelerate such that there is a doubling of the rate of decline in the CO2 intensity of economic activity in the middle-income and low-income group of countries versus recent historical trends, while CO2 emissions in high-income countries fall to zero by 2060 (see **Figure 2a** for the historical path of CO2 intensity).

As indicated in **Figure 2b**, this optimistic scenario still implies a further temperature gain of almost 2 degrees Celsius between now and 2100. Note that **Figure 2b** shows temperature variance versus the 1961-1990 average used by the UK's Met Office Hadley Centre and not the more common 1850-1900 benchmark. Our calculations suggest that roughly 0.3 degrees Celsius needs to be added to the temperature measure shown in **Figure 2b** to recalibrate to the 1850-1900 benchmark. Hence, even our optimistic scenario suggests that by 2100 there will be a temperature gain of 2.9 degrees Celsius versus the commonly used 1850-1900 benchmark.

This is well above the UN target of limiting the global temperature gain to 1.5 degrees Celsius. Hence, if our methodology has any merit, it would appear that target is a forlorn hope. Indeed, the above referenced IPCC report considers five scenarios and only in the very low emission case is the temperature gain thought likely to remain below 1.5 degrees by 2081-2100 (it suggests 1.4 degrees). The report's intermediate scenario has a best estimate temperature gain of 2.7 degrees by 2081-2100, in line with our optimistic scenario of 2.9 degrees by 2100.

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

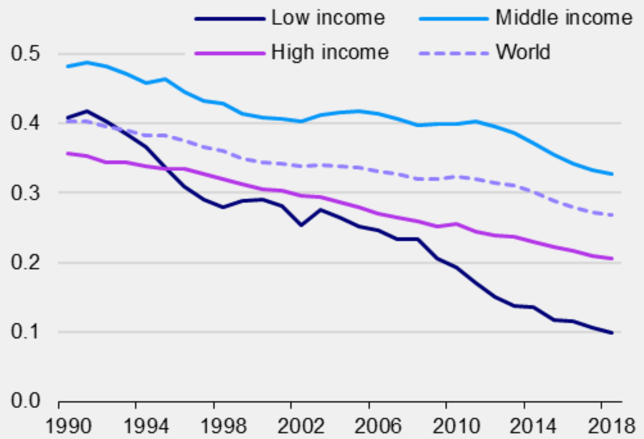
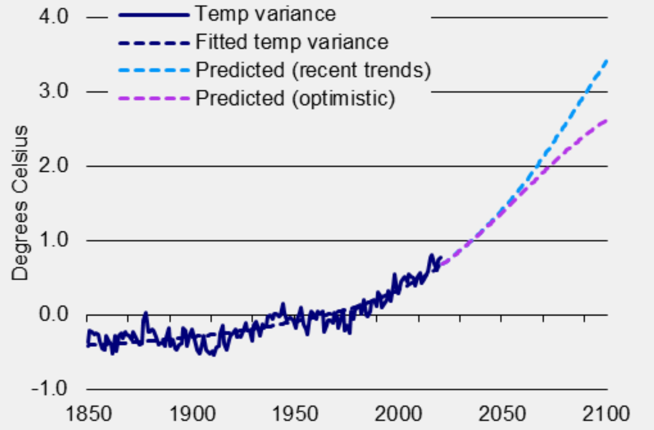


Figure 2b – Temperature variance (deg. Celsius)



Notes: Figure 2a shows the CO2 intensity of GDP annually from 1990 to 2018 for low, middle and high-income countries (as currently defined by the World Bank), with our estimate for low income countries in 2017/18. 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

As for the implications, the IPCC report is an alarming read. Not surprisingly, it concludes that each 0.5 degree of warming is likely to cause increases in the intensity and frequency of hot extremes, heavy precipitation and agricultural, ecological and hydrological droughts (in some regions).

Under all five IPCC scenarios, it is thought that the Arctic will be practically sea ice free in September at least once before 2050. The report concludes that the global mean sea level is likely to rise over the rest of this century, with a gain of 0.28-0.55m under the very low emission scenario, 0.44-0.76m under the intermediate scenario and 0.63-1.01m under the very high emission scenario (0.98-1.88m by 2150).

Alarmingly, it also concludes that deep ocean warming and ice sheet melt will keep the oceans rising over the coming centuries and millennia. Though confidence in the estimates is low, it is feared that a temperature gain of only 1.5 degrees (versus 1850-1900) will raise the global mean sea level by 2-3m over the next 2000 years, rising to 19-22m if the temperature gain reaches 5 degrees (it is estimated that 3 million years ago global temperatures were 2.5-4.0 degrees higher than in 1850-1900 and the global mean sea level was 5-25m higher).

Our own analysis suggests that if recent trends are followed (in terms of technological change and GDP per capita gains – see appendix for details), the likely temperature gain versus the 1850-1900 average will be around 3.7 degrees by 2100 (see **Figure 2b**). This is close to what is imagined in the IPCC's second worst (high emission) scenario, which sees a gain of 3.6 degrees by 2081-2100. Our "recent trends" scenario envisages a peak in annual CO2 emissions at around 85 billion tonnes in the mid-2070s, versus 33 bn tonnes in 2021 (having fallen in 2020).

As can be seen in **Figure 3a**, it is middle-income countries that we expect to drive the higher emissions, not surprising given that they currently account for around 75% of the global population, have the fastest growing incomes and are rapidly industrialising (which is why they have seen the slowest decline in CO2 intensity over the last decade). In our more optimistic scenario (**Figure 3b)**, those countries still dominate but global emissions are expected to have already peaked (in 2019) and to decline after 2030.

The main difference between our two scenarios is the assumed rate of decline in CO2 intensity of economic activity, which shows the critical role of technology. The more rapid the technological gains, the more likely we are to see an earlier peak in global emissions and the lower is likely to be the eventual temperature gain.

However, a lot of change is already baked-in by our previous behaviours and we find it hard to imagine the world escaping with a temperature gain of less than three degrees by 2100. This suggests that as well as investing in carbon reducing and carbon removing technologies, the world will be forced to spend a lot on adaptation, which in our opinion will be to the long-term benefit of infrastructure, housing, engineering and materials sectors.

Unless stated otherwise, all data as of 20 August 2021.

Figure 3a – CO2 emissions (recent trends, bn t)

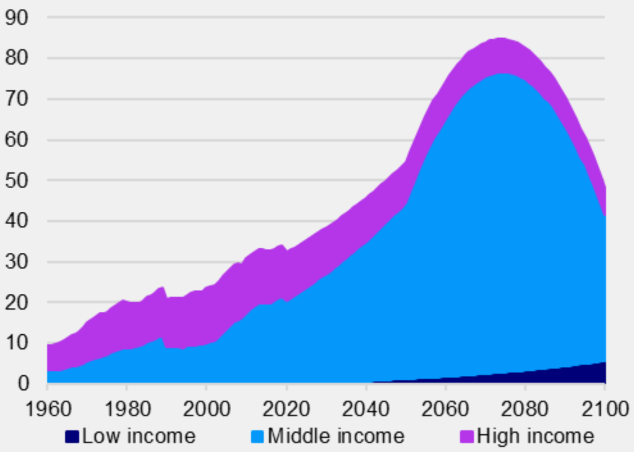
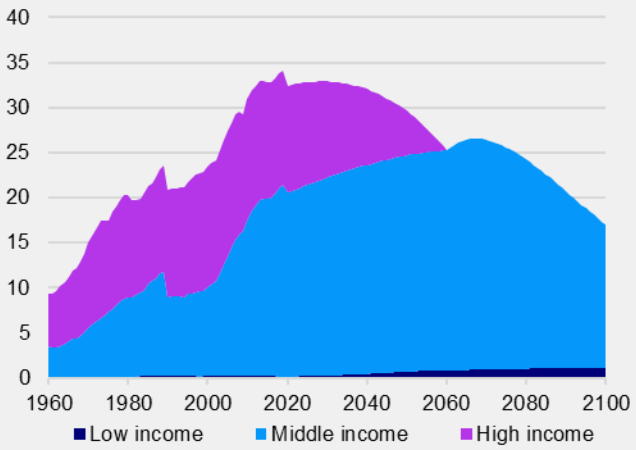


Figure 3b – CO2 emissions (optimistic, bn tonnes)



Notes: The charts show annual CO2 emissions in billions of tonnes from 1960 to 2100 for low, middle and high-income countries (as currently defined by the World Bank). World Bank historical emissions data is used from 1960 to 1989 and emissions are then estimated from 1990 to 2100. Emissions are calculated as a function of population, GDP per capita and the CO2 intensity of GDP (kg of CO2 per 2011 PPP US dollar of GDP). In all cases, population estimates are based on the UN's World Population Prospects 2019. Figure 3a (recent trends) uses recent trends in CO2 intensity of GDP and GDP per capita to forecast the future path of those variables, though convergence among income groups is assumed in later periods (see the appendix for full details). Figure 3b (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 – see the appendix for full details).
Source: Our World in Data, United Nations, World Bank, Refinitiv Datastream and Invesco

Figure 4 – Asset class total returns (%, annualised)

Data as at 20/08/2021		Current	Total Return (USD, %)					Total Return (Local Currency, %)				
	Index	Level/RY	1w	1m	QTD	YTD	12m	1w	1m	QTD	YTD	12m
Equities												
World	MSCI	723	-1.8	1.5	0.6	13.3	29.3	-1.4	1.7	1.2	15.0	29.3
Emerging Markets	MSCI	1221	-4.6	-6.6	-10.7	-3.9	15.5	-4.0	-5.9	-9.1	-1.8	13.8
China	MSCI	87	-7.8	-14.5	-20.4	-18.9	-8.9	-7.7	-14.3	-20.1	-18.6	-9.2
US	MSCI	4317	-0.6	2.7	3.4	18.8	34.0	-0.6	2.7	3.4	18.8	34.0
Europe	MSCI	2059	-2.5	4.2	1.9	14.4	29.5	-1.4	4.6	3.3	18.7	29.7
Europe ex-UK	MSCI	2612	-2.3	4.4	2.4	14.9	30.3	-1.4	4.9	3.7	20.4	31.9
UK	MSCI	1128	-3.3	3.7	0.2	12.8	26.5	-1.6	3.6	1.7	13.2	22.1
Japan	MSCI	3782	-3.8	-0.3	-2.2	-0.8	16.9	-3.8	-0.4	-3.3	5.5	21.2
Government Bonds												
World	BofA-ML	0.38	-0.2	0.0	1.2	-3.7	-1.7	0.3	0.2	1.6	-0.8	-0.6
Emerging Markets	BBloom	4.36	0.2	0.2	1.0	-1.0	2.9	0.2	0.2	1.0	-1.0	2.9
China	BofA-ML	2.79	0.0	0.4	1.4	4.9	11.7	0.2	0.7	2.0	4.2	4.9
US (10y)	Datastream	1.24	0.4	-0.2	2.1	-1.2	-3.3	0.4	-0.2	2.1	-1.2	-3.3
Europe	Bofa-ML	-0.16	-0.8	0.1	0.8	-5.2	-0.5	0.2	0.8	2.3	-0.7	0.9
Europe ex-UK (EMU, 10y)	Datastream	-0.54	-0.7	0.1	1.2	-4.7	-0.9	0.3	0.8	2.8	-0.1	0.5
UK (10y)	Datastream	0.62	-1.3	0.4	0.4	-3.1	1.1	0.4	0.3	1.8	-2.7	-2.4
Japan (10y)	Datastream	0.01	0.2	0.1	1.6	-5.5	-2.9	0.1	0.0	0.5	0.5	0.7
IG Corporate Bonds												
Global	BofA-ML	1.58	-0.2	-0.1	0.5	-1.2	2.2	0.2	0.1	1.1	0.2	2.4
Emerging Markets	BBloom	4.23	-0.1	-0.7	-0.4	0.7	6.8	-0.1	-0.7	-0.4	0.7	6.8
China	BofA-ML	3.63	-0.1	0.2	0.8	4.4	11.6	0.1	0.5	1.4	3.8	4.8
US	BofA-ML	2.07	0.2	-0.1	1.0	-0.1	2.3	0.2	-0.1	1.0	-0.1	2.3
Europe	BofA-ML	0.28	-0.9	-0.4	-0.3	-3.8	1.4	0.1	0.3	1.2	0.8	2.8
UK	BofA-ML	1.66	-1.4	0.6	0.7	-0.8	7.3	0.3	0.6	2.2	-0.4	3.6
Japan	BofA-ML	0.34	0.1	0.1	1.4	-5.3	-2.2	0.1	0.0	0.3	0.8	1.3
HY Corporate Bonds												
Global	BofA-ML	4.71	-0.4	-0.2	-0.5	2.0	9.1	-0.1	0.0	-0.1	3.0	9.3
US	BofA-ML	4.70	-0.1	0.1	-0.1	3.6	10.2	-0.1	0.1	-0.1	3.6	10.2
Europe	BofA-ML	2.84	-1.0	-0.1	-0.9	-1.0	7.5	0.0	0.6	0.6	3.7	9.0
Cash (Overnight LIBOR)												
US		0.08	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Euro Area		-0.59	-0.8	-0.8	-1.4	-4.6	-2.0	0.0	-0.1	-0.1	-0.4	-0.6
UK		0.04	-1.7	0.0	-1.5	-0.4	3.1	0.0	0.0	0.0	0.0	0.0
Japan		-0.10	-0.2	0.0	1.2	-6.0	-3.7	0.0	0.0	0.0	-0.1	-0.1
Real Estate (REITs)												
Global	FTSE	2038	-1.1	0.4	2.5	17.2	29.9	-0.1	1.1	4.0	22.7	31.7
Emerging Markets	FTSE	1732	-2.5	-4.0	-8.5	-9.1	-6.5	-1.5	-3.3	-7.1	-4.8	-5.2
US	FTSE	3522	-0.4	0.0	4.6	27.6	41.3	-0.4	0.0	4.6	27.6	41.3
Europe ex-UK	FTSE	4121	-1.6	4.6	8.1	12.7	28.3	-0.6	5.3	9.8	18.0	30.0
UK	FTSE	1634	-1.9	8.4	10.4	23.6	38.8	-0.2	8.3	12.0	24.1	34.0
Japan	FTSE	2829	-1.9	-1.4	-2.1	9.7	21.5	-1.9	-1.5	-3.1	16.7	25.9
Commodities												
All	GSCI	2417	-5.8	-3.3	-7.0	22.3	35.6	-	-	-	-	-
Energy	GSCI	352	-7.8	-5.5	-11.3	31.6	40.8	-	-	-	-	-
Industrial Metals	GSCI	1647	-4.1	-0.7	-1.6	17.7	32.3	-	-	-	-	-
Precious Metals	GSCI	2041	0.0	-2.3	-0.9	-7.2	-10.0	-	-	-	-	-
Agricultural Goods	GSCI	467	-5.0	-0.9	-2.0	16.8	51.1	-	-	-	-	-
Currencies (vs USD)*												
EUR		1.17	-0.8	-0.7	-1.3	-4.2	-1.4	-	-	-	-	-
JPY		109.82	-0.2	0.0	1.2	-6.0	-3.7	-	-	-	-	-
GBP		1.36	-1.7	0.0	-1.4	-0.4	3.6	-	-	-	-	-
CHF		1.09	-0.2	0.5	0.9	-3.5	-1.0	-	-	-	-	-
CNY		6.50	-0.4	-0.3	-0.7	0.4	6.4	-	-	-	-	-

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

Figure 5 – Global equity sector total returns relative to market (%)

Data as at 20/08/2021	Global				
	1w	**1m**	**QTD**	**YTD**	**12m**
Energy	**-1.7**	**-1.7**	**-6.1**	**-2.7**	**-7.1**
Basic Materials	**-4.4**	**-2.4**	**-3.0**	**-1.4**	**4.7**
Basic Resources	-7.1	-4.6	-5.7	-2.2	5.1
Chemicals	-0.8	0.6	0.6	-0.2	4.2
Industrials	**-0.2**	**0.0**	**0.7**	**2.0**	**5.3**
Construction & Materials	-0.1	2.9	3.6	4.9	8.7
Industrial Goods & Services	-0.2	-0.5	0.4	1.6	4.9
Consumer Discretionary	**-2.2**	**-4.0**	**-4.7**	**-7.3**	**-6.2**
Automobiles & Parts	-5.4	-3.0	-5.9	-5.7	11.4
Media	1.6	-0.1	-0.3	-7.5	-1.9
Retailers	-1.2	-6.1	-5.1	-9.1	-18.7
Travel & Leisure	-1.2	-2.8	-5.8	-11.1	-6.0
Consumer Products & Services	-3.2	-3.2	-4.2	-3.7	4.5
Consumer Staples	**1.4**	**-0.7**	**-0.3**	**-6.6**	**-11.1**
Food, Beverage & Tobacco	1.1	-1.2	-0.8	-5.4	-8.8
Personal Care, Drug & Grocery Stores	2.0	0.1	0.8	-8.9	-15.3
Healthcare	**2.9**	**2.9**	**4.7**	**1.6**	**-2.5**
Financials	**-0.3**	**2.9**	**1.3**	**5.7**	**10.4**
Banks	-0.9	2.5	-0.7	5.0	12.3
Financial Services	-0.1	2.8	3.3	9.3	13.8
Insurance	0.8	4.1	3.1	1.8	2.3
Real Estate	**1.0**	**-1.1**	**0.8**	**1.6**	**-2.4**
Technology	**0.9**	**0.4**	**1.6**	**4.5**	**3.7**
Telecommunications	**1.3**	**1.0**	**1.3**	**-1.9**	**-4.4**
Utilities	**3.0**	**3.7**	**5.3**	**-4.6**	**-4.6**

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

Figure 6a – US factor index total returns (%)

Data as at 20/08/2021	Absolute					Relative to Market				
	1w	1m	QTD	YTD	12m	1w	1m	QTD	YTD	12m
Growth	-0.1	4.0	16.1	26.3	49.0	0.4	1.1	3.3	5.8	11.9
Low volatility	0.8	3.3	11.4	15.8	23.9	1.3	0.4	-0.9	-3.0	-7.0
Price momentum	-3.4	2.9	4.9	10.9	22.8	-2.9	0.0	-6.7	-7.1	-7.8
Quality	-0.6	3.4	10.3	24.8	44.1	-0.1	0.5	-1.9	4.5	8.2
Size	-3.0	0.8	2.8	25.1	61.1	-2.4	-2.0	-8.5	4.8	20.9
Value	-3.1	2.1	4.3	30.3	68.4	-2.5	-0.8	-7.2	9.2	26.4
Market	-0.5	2.9	12.4	19.4	33.2					
Market - Equal-Weighted	-1.2	2.7	8.8	21.3	42.8					

Notes: 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. **Past performance is no guarantee of future results.**
Source: Refinitiv Datastream and Invesco

Figure 6b – European factor index total returns relative to market (%)

Data as at 20/08/2021	Absolute					Relative to Market				
	1w	1m	QTD	YTD	12m	1w	1m	QTD	YTD	12m
Growth	0.0	6.8	22.2	34.2	55.6	1.4	1.5	10.3	11.8	18.2
Low volatility	-0.2	5.2	14.6	21.0	27.5	1.3	0.0	3.4	0.8	-3.1
Price momentum	-2.8	6.5	10.0	16.3	28.6	-1.4	1.2	-0.7	-3.1	-2.2
Quality	-1.5	4.2	12.7	22.3	43.8	-0.1	-0.9	1.8	1.9	9.3
Size	-1.5	6.5	10.8	22.1	47.5	-0.1	1.2	0.1	1.7	12.1
Value	-2.7	7.1	8.1	27.2	59.4	-1.3	1.8	-2.4	6.0	21.2
Market	-1.4	5.2	10.8	20.0	31.6					
Market - Equal-Weighted	-1.5	5.3	10.7	19.8	36.9					

Notes: 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. **Past performance is no guarantee of future results.**
Source: Refinitiv Datastream and Invesco

Figure 7 – Model asset allocation

	Neutral	Policy Range		Allocation	Position vs Neutral
Cash Equivalents	**5%**	**0-10%**		**10%**	
Cash	2.5%			10%	
Gold	2.5%			0%	
Bonds	**40%**	**10-70%**		**22%**	
Government	25%	10-40%		**17%**	
US	8%			5%	
Europe ex-UK (Eurozone)	7%			4%	
UK	1%			1%	
Japan	7%			4%	
Emerging Markets	2%			3%	
China**	0.2%			0%	
Corporate IG	10%	0-20%		0%	
US Dollar	5%			0%	
Euro	2%			0%	
Sterling	1%			0%	
Japanese Yen	1%			0%	
Emerging Markets	1%			0%	
China**	0.1%			0%	
Corporate HY	5%	0-10%		5%	
US Dollar	4%			5%	
Euro	1%			0%	
Equities	**45%**	**25-65%**	↑	**51%**	
US	25%			18%	
Europe ex-UK	7%			12%	
UK	4%		↑	8%	
Japan	4%			5%	
Emerging Markets	5%			8%	
China**	2%			2%	
Real Estate	**8%**	**0-16%**		**16%**	
US	2%			4%	
Europe ex-UK	2%			4%	
UK	1%			1%	
Japan	2%			4%	
Emerging Markets	1%			3%	
Commodities	**2%**	**0-4%**	↓	**1%**	
Energy	1%		↓	0%	
Industrial Metals	0.3%			0%	
Precious Metals	0.3%			0%	
Agriculture	0.3%			1%	
Total	**100%**			**100%**	

Currency Exposure (including effect of hedging)					
USD	48%		↓	39%	
EUR	20%			22%	
GBP	7%		↑	11%	
JPY	15%			14%	
EM	9%			14%	
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

Figure 8 – Model allocations for Global sectors

	Neutral	Invesco	Preferred Region
Energy	**6.1%**	**Underweight**	**US**
Basic Materials	**4.4%**	**Neutral**	**Europe**
Basic Resources	2.5%	Neutral	Europe
Chemicals	1.9%	Neutral	US
Industrials	**13.0%**	**Neutral**	**US**
Construction & Materials	1.6%	Neutral	Europe
Industrial Goods & Services	11.3%	Neutral	US
Consumer Discretionary	**16.1%**	**Underweight ↓**	**EM**
Automobiles & Parts	2.7%	Underweight	Japan
Media	1.2%	Overweight	Europe
Retailers	5.9%	Underweight ↓	EM
Travel & Leisure	2.1%	Underweight ↓	EM
Consumer Products & Services	4.2%	Overweight	Japan
Consumer Staples	**6.2%**	**Overweight**	**Japan**
Food, Beverage & Tobacco	4.1%	Overweight	Japan
Personal Care, Drug & Grocery Stores	2.1%	Neutral ↑	Europe
Healthcare	**9.9%**	**Overweight ↑**	**Europe**
Financials	**14.5%**	**Underweight ↓**	**Europe**
Banks	7.3%	Underweight	Japan
Financial Services	4.6%	Underweight ↓	Europe
Insurance	2.6%	Underweight ↓	Europe
Real Estate	**3.5%**	**Overweight**	**EM**
Technology	**19.5%**	**Overweight**	**US**
Telecommunications	**3.8%**	**Neutral**	**Europe**
Utilities	**3.0%**	**Neutral**	**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

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 4

Sources: we source data from 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). The global rate is the average of the euro, British pound, US dollar and Japanese yen rates. The series started on 1st 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 Bank of America Merrill Lynch 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: Bank of America Merrill Lynch 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: Bank of America Merrill Lynch 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, 2b, 3a and 3b)
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 2019. 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 2018 for middle- and high-income countries and to 2016 for low-income countries, recent trends are used to estimate more recent years).

Two scenarios are imagined for future emissions (starting in 2021):

- "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 2018) and that GDP per capita continues to grow at the same rate as in the 10 years to 2019 (and not 2020, as that was an exceptional year due to Covd-19). For middle-income countries, it is assumed that CO2 intensity declines at the same rate as in the last 10 years (to 2018) 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 2019) 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 2018). Low-income GDP per capita is assumed to grow at the same rate as in the last 10 years (to 2019) until 2050 and thereafter to grow at the rate seen in middle-income countries in the last 10 years (to 2019).
- "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 2019), 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 2018) and GDP per capita is assumed to grow at the same rate as in the last 10

years (to 2019), 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 falling in line with it thereafter. Low-income GDP per capita is assumed to increase at the same rate as in the last 10 years (to 2019) until 2050 and to then grow at the same rate as in middle-income countries in the last 10 years (to 2019).

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