# Uncommon truths
## The builder's guide to Bitcoin

**Looking at global stock indices, you wouldn't know there had been a global pandemic and recession during 2020. On the other hand, gold bears witness to the problems and Bitcoin has recently taken up the mantle. Applying our gold model to Bitcoin suggests a fair value closer to $9,000 than $19,000.**

Imagine you have just awoken from a deep sleep that began in January. Now look at the year-to-date performance data in **Figure 3**. MSCI World has produced a total return of around 14% in USD, so you could be forgiven for believing that 2020 has been another year of uneventful economic growth.

As we know, that is far from the truth, with a global pandemic resulting in the deepest global recession in living memory (the UK's Office for Budget Responsibility expects the 2020 recession to have been the deepest for more than 300 years, for example). The collapse in the oil price and the poor performance of real estate (see **Figure 3**) give a clue that something was untoward during the year.

Apart from the effect of central bank asset purchases (and the boost to US savings from generous fiscal support), the key contribution to the surprising performance of global equity indices has been the strength of the US market. This in turn is largely due to the performance of so-called FAANG stocks (the NYSE FANG Plus Index had produced a year-to-date total return of 84%, as of end-November, taking its market capitalisation to 22% of that of the S&P 500).

Indeed, the performance of that NYSE FANG Plus index has been so good that it looks like a bubble (see the comparison with our mania template shown in **Figure 1**). We first introduced this template in May 2019 (see The shape of a bubble). It shows the average performance of a range of assets across 15 previous manias, starting with the South Sea Bubble of the early 1700s (the appendices give more detail).

This does not prove the existence of a bubble about to burst but it is a warning. Of course, many components of that FANG Plus index have proven well suited to pandemic conditions but there is usually a kernel of truth behind all manias (and a generous supply of credit – see Why do bubbles and crashes occur?). Indeed, this index underperformed the S&P 500 during the end-October to mid-November stock market surge that was in part due to positive vaccine news.

Though FANG Plus has since outperformed a flatlining S&P 500, another asset would appear to have taken over as the "hot-money" favourite: Bitcoin. This cryptocurrency is up 175% year-to-date (as of November 30) and 206% since the end of March 2020 (yes, it has tripled in eight months!). It may not appear to fit the mania template shown in **Figure 1** but that is because the last three years includes the end of the bursting of the previous Bitcoin bubble (the mania template considers the three years before and after the peak of a mania). 2020 performance puts Bitcoin firmly in that category (especially the 69% gain in the last three months).



Figure 1 – Where are the bubbles (asset performance versus our mania template)?
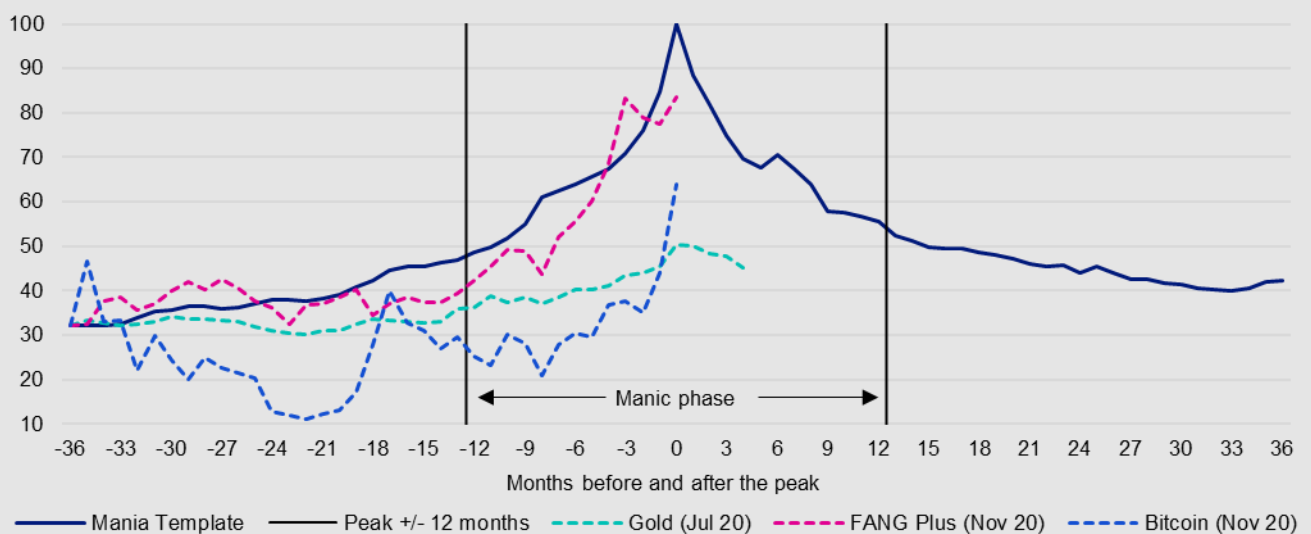
Note: based on monthly data. See appendix for construction methodology of "Mania template". "Bitcoin" and "FANG Plus" are constructed using the hypothesis that the 30 November 2020 level was the peak (month zero), while "Gold" uses 31 July 2020 as the peak. All assets are indexed to the same level as the Mania Template three years prior to the presumed peak (the Mania Template peaked at 100 in month zero). NYSE FANG Plus is an equally weighted price index designed to represent a segment of the US technology and consumer discretionary sectors. See appendix for further details of asset composition. Past performance is not a guide to future returns. Source: Refinitiv Datastream and Invesco.

I wouldn't normally concern myself with Bitcoin given its volatility and size (even at current prices, its market capitalisation is only $358bn, compared to $6.4trn and $31.7trn for the FANG Plus and S&P 500 indices, respectively). However, intellectual curiosity pushes me to understand the repeated boom and bust cycles (the November 2013 peak is the final component of our mania template and there have been three (smaller) surges since then – see **Figure 2**).

A few years ago, my builder explained to me why Bitcoin was a good investment (while also educating me about central banks). The builder's guide to Bitcoin would suggest that it serves many of the same purposes as gold: a perceived store of value and downside mitigation against disasters including inflation, banking system collapse, the effects of high government debt/central bank profligacy (though it would be interesting to see what happens if electricity generation and transmission systems collapse).

Taking what Warren Buffet said about gold in 2011, Bitcoin is a way of going long on fear. Hence, we shouldn't be surprised that it has done so well during 2020, as has gold. However, fear is always present and it hard to know when it will become an investment trigger and equally when it will dissipate. If we then add the lack of ability to put a value upon an asset (especially one that can be neither touched nor felt), bubbles become almost inevitable (fear drives up the price, which makes those fears seem even more credible, which builds more fear and creates "fear of missing out" momentum buying). I believe there is always a limit to such price movements but find it impossible to locate that limit in the case of Bitcoin.

However, the same can be said of gold. To better explain movements of the yellow metal, I have previously built an econometric model with three explanatory variables: real US 10-year treasury yield, US 10-year inflation breakeven yield (as a proxy for inflation expectations) and a trade-weighted US dollar index. To capture the effect of the Trump presidency, I have also introduced a dummy variable ("President Dummy") that was switched on in November 2016 (and radically improves the fit of the model). After the recent sell-off, gold is broadly in line with that model.

**Figure 2** shows my attempt to do the same for Bitcoin, using the same explanatory variables. It has an R-squared of 0.69, which is not bad but not as good as for gold (0.89). The explanatory variable coefficients are all in the same direction as for gold (negative correlation with real yields, inflation and the dollar; positive boost since President Trump was elected). However, in the case of gold, all coefficients are statistically significant, while for Bitcoin the relationship with the dollar is not. The other problem is that model suggests Bitcoin should have been negative at various times, which is not great. Unfortunately, excluding the dollar and other versions of the model give the same broad results.

Nevertheless, it is interesting to note that all versions of the model suggest Bitcoin should be around $9,000 (it is currently $19,000). This is up from around $7,300 at the start of 2020 when the market price was $7,200. **Figure 2** suggests that when the market and model diverge, it is usually the market that adjusts.

*Unless stated otherwise, all data as of 04 December 2020.*

**Figure 2 – Bitcoin versus model predicted value (USD)**
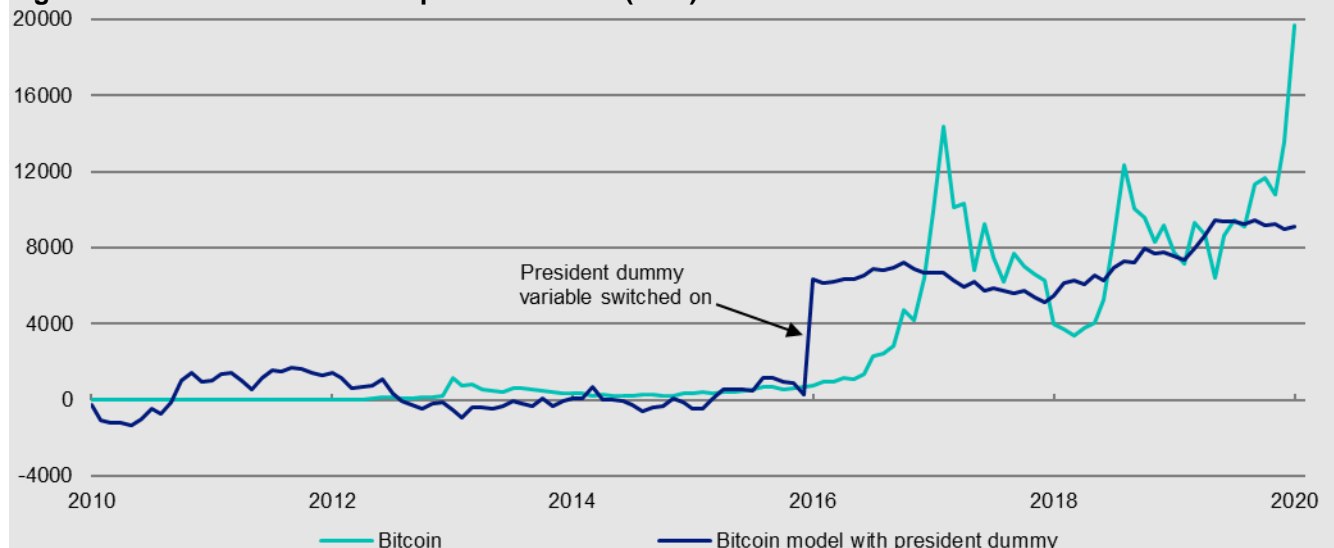
Note: Monthly data from November 2010 to November 2020 (as of 30 November 2020). Bitcoin is modelled as a function of real 10-year US Treasury yield, 10-year US inflation breakeven and trade-weighted USD. "President dummy" is a dummy variable that was set at zero prior to November 2016 (when President Trump was elected) and one thereafter. There is no guarantee that these views will come to pass. Past performance is not a guide to future returns. Source: Refinitiv Datastream and Invesco

## Figure 3 – Asset class total returns

| Data as at 04/12/2020 | Index | Current Level/RY | Total Return (USD, %) | | | | | Total Return (Local Currency, %) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1w | 1m | QTD | YTD | 12m | 1w | 1m | QTD | YTD | 12m |
| **Equities** | | | | | | | | | | | | |
| World | MSCI | 633 | 1.5 | 9.5 | 12.3 | 14.3 | 19.2 | 1.2 | 8.4 | 10.9 | 12.7 | 16.9 |
| Emerging Markets | MSCI | 1251 | 1.7 | 10.2 | 15.8 | 14.7 | 23.8 | 0.9 | 7.9 | 12.5 | 15.8 | 23.0 |
| China | MSCI | 106 | -1.6 | 1.3 | 9.5 | 27.7 | 39.7 | -1.7 | 1.0 | 9.0 | 26.3 | 37.6 |
| US | MSCI | 3601 | 1.7 | 8.1 | 11.0 | 19.0 | 23.7 | 1.7 | 8.1 | 11.0 | 19.0 | 23.7 |
| Europe | MSCI | 1808 | 1.9 | 12.8 | 13.5 | 4.0 | 8.6 | 0.5 | 9.0 | 9.4 | -2.5 | 0.5 |
| Europe ex-UK | MSCI | 2265 | 1.3 | 11.8 | 12.5 | 9.0 | 13.2 | -0.3 | 8.1 | 8.6 | 0.6 | 3.0 |
| UK | MSCI | 1034 | 3.9 | 16.3 | 17.1 | -10.3 | -4.9 | 3.0 | 12.2 | 12.3 | -11.8 | -7.5 |
| Japan | MSCI | 3749 | -0.7 | 10.3 | 12.0 | 11.6 | 13.1 | -0.5 | 10.0 | 10.6 | 7.0 | 8.3 |
| **Government Bonds** | | | | | | | | | | | | |
| World | BofA-ML | 0.26 | 0.0 | 0.8 | 1.2 | 8.0 | 8.0 | -0.5 | -0.6 | -0.5 | 4.3 | 3.8 |
| Emerging Markets | BBloom | 3.97 | 0.6 | 3.5 | 5.0 | 5.3 | 8.8 | 0.6 | 3.5 | 5.0 | 5.3 | 8.8 |
| China | BofA-ML | 3.26 | 1.0 | 2.6 | 4.4 | 8.4 | 10.8 | 0.2 | -0.2 | 0.1 | 1.7 | 2.4 |
| US (10y) | Datastream | 0.92 | -0.7 | -1.3 | -2.1 | 12.4 | 11.2 | -0.7 | -1.3 | -2.1 | 12.4 | 11.2 |
| Europe | Bofa-ML | -0.19 | 1.3 | 3.3 | 4.5 | 13.3 | 13.8 | -0.3 | -0.4 | 0.9 | 4.7 | 3.9 |
| Europe ex-UK (EMU, 10y) | Datastream | -0.54 | 1.2 | 2.7 | 3.7 | 12.2 | 12.2 | -0.4 | -1.0 | 0.1 | 3.7 | 2.4 |
| UK (10y) | Datastream | 0.37 | 0.5 | 2.4 | 3.2 | 7.0 | 7.3 | -0.4 | -1.2 | -1.0 | 5.2 | 4.4 |
| Japan (10y) | Datastream | 0.02 | -0.1 | 0.4 | 1.3 | 4.2 | 4.2 | 0.1 | 0.1 | 0.1 | -0.1 | -0.2 |
| **IG Corporate Bonds** | | | | | | | | | | | | |
| Global | BofA-ML | 1.50 | 0.3 | 2.2 | 3.1 | 9.2 | 9.9 | -0.2 | 1.0 | 1.8 | 6.9 | 7.1 |
| Emerging Markets | BBloom | 3.83 | 0.6 | 3.4 | 4.8 | 10.4 | 12.1 | 0.6 | 3.4 | 4.8 | 10.4 | 12.1 |
| China | BofA-ML | 4.19 | 0.9 | 2.7 | 4.8 | 9.4 | 11.6 | 0.1 | -0.1 | 0.5 | 2.5 | 3.1 |
| US | BofA-ML | 1.93 | -0.3 | 1.1 | 2.0 | 8.8 | 9.2 | -0.3 | 1.1 | 2.0 | 8.8 | 9.2 |
| Europe | BofA-ML | 0.34 | 1.6 | 4.5 | 5.4 | 10.9 | 12.3 | 0.0 | 0.8 | 1.8 | 2.5 | 2.5 |
| UK | BofA-ML | 1.61 | 0.9 | 5.0 | 6.4 | 8.7 | 10.2 | -0.1 | 1.2 | 2.1 | 6.8 | 7.2 |
| Japan | BofA-ML | 0.44 | -0.1 | 0.5 | 1.6 | 4.5 | 4.7 | 0.1 | 0.2 | 0.3 | 0.2 | 0.2 |
| **HY Corporate Bonds** | | | | | | | | | | | | |
| Global | BofA-ML | 4.98 | 1.2 | 4.4 | 6.2 | 6.7 | 8.8 | 0.9 | 3.6 | 5.4 | 5.1 | 6.9 |
| US | BofA-ML | 5.15 | 0.9 | 3.2 | 5.4 | 5.0 | 7.1 | 0.9 | 3.2 | 5.4 | 5.0 | 7.1 |
| Europe | BofA-ML | 3.16 | 2.3 | 8.1 | 9.0 | 11.0 | 13.5 | 0.7 | 4.2 | 5.3 | 2.6 | 3.7 |
| **Cash (Overnight LIBOR)** | | | | | | | | | | | | |
| US | | 0.08 | 0.0 | 0.0 | 0.0 | 0.4 | 0.5 | 0.0 | 0.0 | 0.0 | 0.4 | 0.5 |
| Euro Area | | -0.58 | 1.3 | 3.3 | 3.3 | 7.5 | 8.8 | 0.0 | 0.0 | -0.1 | -0.5 | -0.6 |
| UK | | 0.04 | 0.9 | 3.5 | 4.0 | 1.5 | 2.8 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 |
| Japan | | -0.12 | 0.0 | 0.3 | 1.2 | 4.2 | 4.4 | 0.0 | 0.0 | 0.0 | -0.1 | -0.1 |
| **Real Estate (REITs)** | | | | | | | | | | | | |
| Global | FTSE | 1773 | 1.2 | 10.7 | 12.1 | -9.8 | -7.9 | -0.4 | 6.8 | 8.2 | -16.6 | -15.9 |
| Emerging Markets | FTSE | 1978 | -1.6 | 7.9 | 7.6 | -16.7 | -8.7 | -3.2 | 4.1 | 3.9 | -23.0 | -16.6 |
| US | FTSE | 2837 | 2.2 | 10.9 | 13.3 | -9.4 | -9.7 | 2.2 | 10.9 | 13.3 | -9.4 | -9.7 |
| Europe ex-UK | FTSE | 3596 | 1.2 | 11.3 | 10.9 | -1.8 | 2.5 | -0.4 | 7.3 | 7.1 | -9.2 | -6.4 |
| UK | FTSE | 1337 | 5.6 | 15.3 | 19.1 | -14.1 | -8.2 | 4.6 | 11.1 | 14.2 | -15.6 | -10.6 |
| Japan | FTSE | 2580 | -0.5 | 7.1 | 6.4 | -11.5 | -12.0 | -0.3 | 6.8 | 5.1 | -15.2 | -15.7 |
| **Commodities** | | | | | | | | | | | | |
| All | GSCI | 1880 | 0.1 | 8.4 | 8.9 | -27.5 | -24.2 | - | - | - | - | - |
| Energy | GSCI | 255 | 0.8 | 14.6 | 11.5 | -48.8 | -46.3 | - | - | - | - | - |
| Industrial Metals | GSCI | 1415 | 1.8 | 9.6 | 15.1 | 16.1 | 20.3 | - | - | - | - | - |
| Precious Metals | GSCI | 2122 | 3.3 | -2.9 | -2.7 | 18.7 | 22.6 | - | - | - | - | - |
| Agricultural Goods | GSCI | 358 | -3.4 | 0.9 | 6.7 | 2.9 | 8.2 | - | - | - | - | - |
| **Currencies (vs USD)*** | | | | | | | | | | | | |
| EUR | | 1.21 | 1.3 | 3.4 | 3.4 | 8.1 | 9.4 | - | - | - | - | - |
| JPY | | 104.16 | 0.0 | 0.4 | 1.2 | 4.3 | 4.5 | - | - | - | - | - |
| GBP | | 1.35 | 1.0 | 3.7 | 4.2 | 1.7 | 2.8 | - | - | - | - | - |
| CHF | | 1.12 | 1.3 | 2.3 | 3.2 | 8.5 | 10.8 | - | - | - | - | - |
| CNY | | 6.53 | 0.7 | 1.9 | 4.0 | 6.6 | 7.9 | - | - | - | - | - |

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

| Data as at 04/12/2020 | Global | | | | |
|---|---|---|---|---|---|
| | 1w | 1m | QTD | YTD | 12m |
| **Energy** | **0.2** | **6.1** | **2.0** | **-30.8** | **-30.8** |
| **Basic Materials** | **2.2** | **4.9** | **4.2** | **5.7** | **5.7** |
| Basic Resources | 4.2 | 6.6 | 6.7 | 8.3 | 8.3 |
| Chemicals | -0.3 | 3.0 | 1.2 | 2.8 | 2.8 |
| **Industrials** | **-0.5** | **2.1** | **1.5** | **-0.8** | **-0.8** |
| Construction & Materials | -0.7 | 1.3 | 2.3 | -2.4 | -2.4 |
| Industrial Goods & Services | -0.5 | 2.2 | 1.4 | -0.6 | -0.6 |
| **Consumer Discretionary** | **-0.8** | **-0.8** | **-0.4** | **9.8** | **9.8** |
| Automobiles & Parts | -0.1 | 11.5 | 12.9 | 29.4 | 29.4 |
| Media | 2.3 | 4.8 | 3.7 | -0.1 | -0.1 |
| Retailers | -2.7 | -8.8 | -8.8 | 18.6 | 18.6 |
| Travel & Leisure | 1.2 | 7.3 | 6.0 | -13.6 | -13.6 |
| Consumer Products & Services | -0.3 | -0.1 | 2.1 | 10.5 | 10.5 |
| **Consumer Staples** | **-0.5** | **-2.8** | **-5.4** | **-7.2** | **-7.2** |
| Food, Beverage & Tobacco | 0.0 | -0.9 | -3.7 | -9.3 | -9.3 |
| Personal Care, Drug & Grocery Stores | -1.4 | -6.3 | -8.6 | -3.3 | -3.3 |
| **Healthcare** | **0.6** | **-5.6** | **-5.6** | **3.3** | **3.3** |
| **Financials** | **0.3** | **6.5** | **7.5** | **-15.1** | **-15.1** |
| Banks | 0.5 | 9.8 | 12.5 | -20.5 | -20.5 |
| Financial Services | 0.4 | 3.2 | 3.9 | -7.2 | -7.2 |
| Insurance | -0.3 | 4.5 | 2.9 | -13.3 | -13.3 |
| **Real Estate** | **-0.8** | **-2.1** | **-3.8** | **-16.1** | **-16.1** |
| **Technology** | **0.8** | **-2.6** | **-0.5** | **28.1** | **28.1** |
| **Telecommunications** | **-0.4** | **0.3** | **-1.9** | **-4.1** | **-4.1** |
| **Utilities** | **-2.3** | **-4.4** | **-2.5** | **-7.4** | **-7.4** |

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 5 – 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%** | ↓ | **20%** | |
| Government | 25% | 10-40% | | 15% | |
| US | 8% | | ↓ | 2% | |
| Europe ex-UK (Eurozone) | 7% | | ↑ | 4% | |
| UK | 1% | | ↑ | 2% | |
| Japan | 7% | | ↓ | 3% | |
| Emerging Markets | 2% | | | 4% | |
|   China** | 0.2% | | | 1% | |
| 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% | | ↓ | 4% | |
| Euro | 1% | | ↓ | 1% | |
| **Equities** | **45%** | **20-60%** | ↑ | **50%** | |
| US | 25% | | ↑ | 18% | |
| Europe ex-UK | 7% | | ↑ | 12% | |
| UK | 4% | | ↑ | 6% | |
| Japan | 4% | | | 6% | |
| Emerging Markets | 5% | | ↑ | 8% | |
|   China** | 2% | | | 3% | |
| **Real Estate** | **8%** | **0-16%** | ↑ | **16%** | |
| US | 2% | | ↑ | 3% | |
| Europe ex-UK | 2% | | ↑ | 4% | |
| UK | 1% | | | 3% | |
| Japan | 2% | | ↓ | 3% | |
| Emerging Markets | 1% | | ↑ | 3% | |
| **Commodities** | **2%** | **0-4%** | ↑ | **4%** | |
| Energy | 1% | | ↑ | 2% | |
| Industrial Metals | 0.3% | | ↑ | 1% | |
| Precious Metals | 0.3% | | | 0% | |
| Agriculture | 0.3% | | ↑ | 1% | |
| **Total** | **100%** | | | **100%** | |

| Currency Exposure (including effect of hedging) | | | | | |
|---|---|---|---|---|---|
| USD | 48% | | ↓ | 36% | |
| EUR | 20% | | ↑ | 23% | |
| GBP | 7% | | ↑ | 12% | |
| JPY | 15% | | ↓ | 13% | |
| EM | 9% | | ↑ | 15% | |
| **Total** | **100%** | | | **100%** | |

Notes: 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 6 – Model allocation for global sectors**

| | Neutral | Invesco | | Preferred Region |
|---|---|---|---|---|
| **Energy** | **6.0%** | **Neutral** | | **US** |
| **Basic Materials** | **4.1%** | **Neutral** | | **Europe** |
| Basic Resources | 2.2% | Underweight | | Europe |
| Chemicals | 1.9% | Overweight | | US |
| **Industrials** | **12.6%** | **Underweight** | | **US** |
| Construction & Materials | 1.6% | Neutral | ↑ | Europe |
| Industrial Goods & Services | 11.1% | Overweight | ↑ | US |
| **Consumer Discretionary** | **16.3%** | **Underweight** | | **Japan** |
| Automobiles & Parts | 2.3% | Underweight | | Japan |
| Media | 1.3% | Underweight | | US |
| Retailers | 6.9% | Neutral | | EM |
| Travel & Leisure | 2.0% | Underweight | | Japan |
| Consumer Products & Services | 3.9% | Neutral | | Japan |
| **Consumer Staples** | **7.0%** | **Overweight** | | **Europe** |
| Food, Beverage & Tobacco | 4.5% | Overweight | | Europe |
| Personal Care, Drug & Grocery Stores | 2.5% | Underweight | ↓ | US |
| **Healthcare** | **10.9%** | **Neutral** | | **Europe** |
| **Financials** | **12.8%** | **Neutral** | | **EM** |
| Banks | 5.8% | Neutral | ↓ | EM |
| Financial Services | 3.8% | Overweight | ↑ | US |
| Insurance | 3.2% | Underweight | | Japan |
| **Real Estate** | **3.7%** | **Overweight** | | **Europe** |
| **Technology** | **18.9%** | **Overweight** | | **US** |
| **Telecommunications** | **4.2%** | **Neutral** | | **US** |
| **Utilities** | **3.5%** | **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 3**

**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

**Methodology, data and benchmarks for Mania Template (Figure 1)**

The Mania Template is based on monthly data during 15 historical manias, sourced from Refinitiv Datastream unless stated otherwise. For each mania, the relevant asset price is indexed to 100 at the peak (month zero) and is shown over the three years before and after that point. The template shows the average of the 15 manias at each point in time. The 15 manias are (with peak month and source):

1) UK equities during the South Sea Bubble -- an index that is an unweighted average of the prices of Bank of England, East India Company and South Sea Company (Jun 1720, Global Financial Data);
2) UK equities -- an index of UK stocks (including industrials but excluding banks, insurance and bridge stocks) calculated by Hayek as provided by Rostow and Schwartz in The Growth and Fluctuation of the British Economy (Jul 1864, GFD);
3) US oil -- West Texas Intermediate oil price (US$/barrel), from The Derrick's Handbook of Petroleum (Sep 1876, GFD);
4) US oil -- West Texas Intermediate oil price (US$/barrel), from The Derrick's Handbook of Petroleum (Dec 1895, GFD);
5) US equities -- S&P Composite Index (Sep 1929, Robert Shiller);
6) US bank stocks -- S&P 500 Diversified Banks calculated by Standard & Poor's based on historical price data (Sep 1929, GFD);
7) US wheat -- US Wheat #2 Cash Price (US$/bushel) from The Chicago Board of Trade (Jan 1974, GFD);
8) Gold -- bullion price on the London Bullion Market (US$/ounce) provided by ICE Benchmark Administration Ltd. (Sep 1980);
9) Nikkei index (Dec 1989);
10) Greek bank stocks -- Datastream Banks Index for Greece (Sep 1999);
11) NASDAQ Composite (Feb 2000);
12) Miami house prices (Feb 2007, FHFA index);
13) China A-shares -- China A-DS Market Index calculated by Datastream (Oct 2007);
14) US oil -- West Texas Intermediate oil price (US$/barrel), 40-degree API, f.o.b. Cushing Oklahoma (Jun 2008, GFD);
15) Bitcoin -- USD to Bitcoin on the Bitstamp exchange, from Thomson Reuters (Nov 2013, data to Jul 2011 from Bloomberg).

"Bitcoin", "FANG Plus" and "Gold" are indexed to start at the same level as the "Mania Template" (i.e. in month -36) and are sourced from Refinitiv Datastream.

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