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FUNDAMENTAL DRIVERS OF ASSET RETURNS

DISCUSSION NOTE

In this note, we decompose equity and bond returns into their fundamental drivers based on expected cash flows, inflation, real interest rates and risk premiums.

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SUMMARY

- Asset returns are driven by changes to their expected future cash flows and the corresponding discount rates. In this note, we use this idea to identify the fundamental drivers of equity and bond returns based on expected cash flows, expected inflation, real interest rates and asset-specific risk premiums.
- Certain fundamental drivers are common across equities and bonds, most importantly real interest rates. The level of real interest rates is a key driver of the long-run returns on multi-asset portfolios, in large part due to the long duration of equities. To accurately capture the economic forces driving real rates, our decomposition splits real rates into a transitory component, dominated by the monetary policy cycle, and a persistent component that reflects secular developments in the economy.
- We use our framework to examine the properties of fundamental drivers of equity and bond returns over the last few decades, where the real rate components have played a significant role. In addition, we highlight the fundamental drivers during 2020 – a year dominated by the global pandemic and the subsequent policy response to it. The large drop in equity prices in the first quarter was caused by both lower cash flow expectations and a sharp increase in the equity risk premium. The fall in equity prices was partly offset by a combination of easier monetary policy and a decline in the persistent component of real rates.

1. Introduction

Strategic asset allocation is usually determined by a combination of global equity and fixed income indices. These indices are broadly diversified, which means that broad market developments will determine their long-term real returns. There are fundamental drivers underlying these broad asset class returns, and investors need to identify these drivers to understand the types of risks they are exposed to through their strategic asset allocation.

In this note, we outline a return decomposition framework that allows us to identify the fundamental drivers of equity and bond returns. The framework is based on the well-known identity that expresses asset prices in terms of the expected cash flows from holding the asset, and the corresponding rates at which the cash flows are discounted. The discount rates that are applied to both equity and bond cash flows can be split into distinct components, including expected inflation, real interest rates and asset-specific risk premiums.

The implementation of our decomposition puts emphasis on two important aspects that are relevant for long-term investors in equities and bonds. Our framework captures common fundamental exposures across equities and bonds through their respective discount rates. Real rates, in particular, impact the real returns on both equities and bonds. This exposure is accentuated by the long duration of equities, making the level of real interest rates a potential key driver of the long-term returns on multi-asset portfolios. To accurately capture the economic forces driving real rates, our decomposition splits real rates into a transitory component, dominated by monetary policy, and a persistent component that reflects secular developments in the economy.

Our framework distinguishes between persistent and transitory return drivers. Certain fundamental drivers are more persistent, and may therefore impact returns over years and potentially even decades. Naturally, persistent return drivers are more important for understanding performance over the long term. This distinction is especially important for the real interest rate, which is a common driver of equity and bond returns.

We use our decomposition framework to examine the properties of fundamental drivers of equity and bond returns over the last few decades, where the real rate components have played a significant role. In addition, we highlight the fundamental drivers during 2020 – a year dominated by the global pandemic and the subsequent policy response to it. Our decomposition shows that the large drop in equity prices seen in the first quarter of 2020 was caused by both lower cash flow expectations and a sharp increase in the equity risk premium. While large in magnitude, both these shocks mainly impacted short-term expectations and turned out to be transitory in nature. The fall in equity prices was partly offset by a combination of easier monetary policy and a decline in the persistent component of real rates – both of which contributed to the positive bond returns seen over the same period.

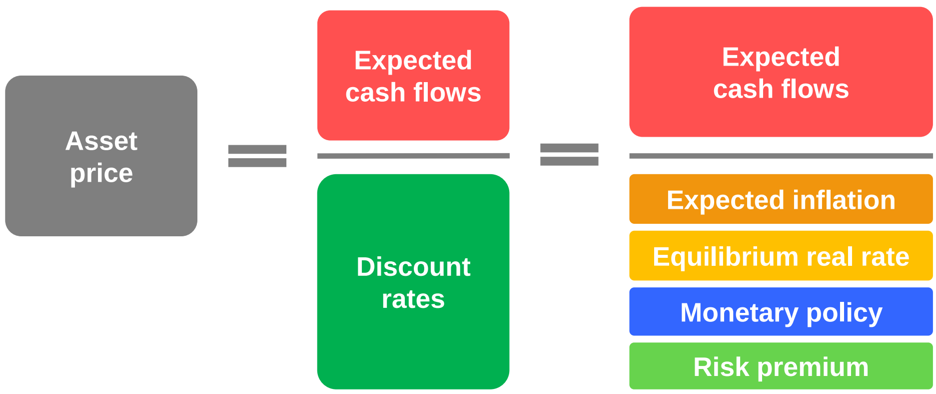
The pandemic has underscored the importance of obtaining accurate and timely estimates of expected equity cash flows and their corresponding risk premiums. This note focuses on the joint modelling of equity and fixed income returns with an emphasis on the role of persistent and transitory components of real rates. In a separate Discussion Note (NBIM, 2021), we focus exclusively on the modelling of equity market term structures with the help of dividend futures.

The note proceeds as follows. In Section 2, we outline our decomposition framework and describe our methodology for defining the fundamental drivers of equity and bond returns. Section 3 explains how we empirically implement the decomposition. In Section 4, we briefly summarise the estimation results. Section 5 concludes.

2. Fundamental Drivers of Returns

A key concept in understanding asset or portfolio returns is that they are claims on future cash flows (dividends or coupons). This idea is captured through an identity, shown in Figure 1, that tells us that these cash flows are discounted at rates that in general reflect their riskiness and expected future interest rates. Taken together, the discount rate reflects the expected future return on the asset. This identity applies to all assets and is a cornerstone of financial modelling.

Figure 1: Illustration of cash flow and discount rate components



Changes in asset prices can be caused by either changes in expected future cash flows or changes in the rates at which those cash flows are discounted. The distinction between expected cash flows and discount rates is important: while a change in either of the return drivers has an immediate impact on asset prices, their long-run portfolio implications differ.

To understand how this difference arises, consider the following example. A fall in cash flow expectations immediately leads to lower prices because it lowers the present value of the asset's future payouts. This leaves the investor unambiguously worse off than before the price drop. An increase in discount rates also causes prices to drop by lowering the present value of the asset. However, while the investor is worse off today, the higher discount rate means that they can expect to earn a higher return on the asset going forward, thus offsetting the initial price drop over time.

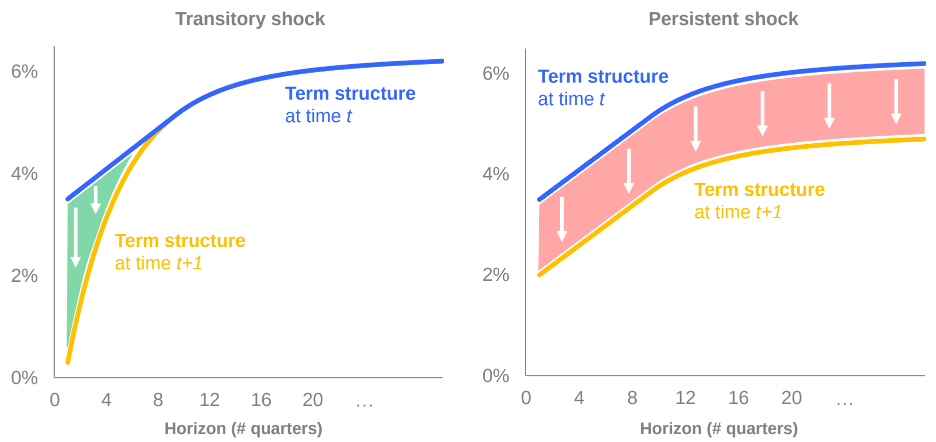
In practice, this simple illustration is complicated by two important features of financial markets. First, many assets pay cash flows that stretch far into the future. This means that each of the cash flow and discount rate components in Figure 1 represents the sum of all their expected future values over the lifetime of the asset. The expected values from today out to some future point in time are known as the *term structure* of expectations for each return driver. These term structures extend to infinity for equities and to a finite maturity date for bonds.

Second, these term structures are constantly changing due to aggregate capital flows and the steady release of various forms of news, including company-specific announcements and macroeconomic data releases. These term structure shifts can be either transitory or persistent, regardless of whether they are related to cash flows or discount rates.

To illustrate the distinction between transitory and persistent shocks, Figure 2 shows two hypothetical downward shifts of a generic term structure of expectations. The left panel illustrates the effect of a transitory shock that shifts parts of the term structure down from time *t* (blue line) to *t+1* (orange line). While the shock impacts near-term expectations, it largely dissipates after around eight quarters, leaving long-run expectations unchanged.

The persistent shock in the right panel, on the other hand, shifts the entire term structure downwards from time *t* to *t+1*. The shock therefore impacts all future expectations, including those that lie in the distant future. The magnitude of these persistent shifts does not need to be very large to have a meaningful impact on returns. This is the case because all future cash flows are being affected, either directly or through discount rates. In this example, the price impact of the persistent shock, which is indicated by the red shaded area, is considerably larger than the price impact of the transitory shock (green area), despite the transitory shock to short-term expectations being almost twice as large as the persistent shock.

Figure 2: Illustration of transitory and persistent shocks to asset fundamentals



Components of Discount Rates

The total discount rate comprises several components, as shown in Figure 1. Empirical evidence suggests that some components, in particular expected inflation and the equilibrium real rate, appear to be more persistent than the others.[1] This implies that we need to model the distinct components that make up total discount rates individually. As shown on the right-hand-side of Figure 1, we therefore go one step further and break down discount rates into separate parts reflecting: 1) expected inflation, 2) the equilibrium real rate, often referred to as "r-star", 3) the cyclical part of real rates, which as we explain below is most naturally labelled as monetary policy, and 4) asset-class-specific risk premiums.

Together with expected cash flows for equities and bonds, these components represent the fundamental drivers of returns in our framework. In the next two sub-sections, we describe in detail how we decompose fixed income and equity returns into their fundamental drivers. We focus on aggregate bond and equity returns measured in their local currencies.

Decomposing Fixed Income Returns

This section presents the methodology for decomposing nominal risk-free government bonds. We are ultimately interested in the fundamental drivers of broadly diversified bond portfolios which are usually represented by benchmark indices such as the Bloomberg Global Aggregate Index. Such bond indices include different types of coupon-bearing bonds issued by governments, corporations and other entities. While all these various bond types can be decomposed using our approach, we focus on government bonds, which represent the largest bond segment and drive the majority of the return variation in broad bond portfolios.[2]

To assess the relative importance of the return drivers outlined in Figure 1, we decompose an n-period zero-coupon bond.[3] We can think of this bond as a proxy for a portfolio consisting of nominal government bonds, free of any credit risk and with a market-value-weighted duration of n periods. The holding period log return on this bond, $r_{t+1}^{(n)}$, is given by:[4]

$$\underbrace{r_{t+1}^{(n)}}_{\text{return}} = \underbrace{n y_t^{(n)} - (n-1)\, y_{t+1}^{(n-1)}}_{\text{change in yield } y \text{ from period } t \text{ to } t+1 \text{, scaled by duration } n} \qquad (1)$$

[1] In their recent research, Bauer and Rudebusch (2020) show that long-horizon expectations about inflation and the equilibrium real rate jointly account for most of the variation in long-term bond yields. Similarly for equities, Lettau and Nieuwerburgh (2008) and Monache, Petrella, and Venditti (2020) argue that shifts in long-horizon expectations about dividend growth and expected returns can account for a significant fraction of changes in equity valuations.

[2] As at 31 December 2020, nominal government bonds made up 61 percent of the Bloomberg Global Aggregate Index (excluding securitised debt).

[3] The maturity n is given in months/quarters, depending on the frequency of the data. For example, when working with monthly data, a ten-year bond would have n = 120 months.

[4] Log return on an n-period zero-coupon bond realized at time $t+1$ is defined as $r_{t+1}^{(n)} = \log P_{t+1}^{(n-1)} - \log P_t^{(n)}$ where $P_t^{(n)}$ refers to the bond price at time t. We use log returns for convenience: log bond prices can be expressed as the negative of their yields scaled by duration, as in equation (1).

The equation states that bond investors earn a positive return if yields decline and vice versa. Equation (1) suggests that to understand the drivers of bond *returns*, a natural starting point is to decompose bond *yields* into their fundamental drivers. We can decompose the yield on an n-period nominal government bond, denoted as $y_t^{(n)}$, into its components:

$$\underbrace{y_t^{(n)}}_{\text{yield}} = \underbrace{\frac{1}{n}\sum_{i=1}^{n} E_t\left(\pi_{t+i}\right) + \frac{1}{n}\sum_{i=1}^{n} E_t\left(rr_{t+i-1}\right)}_{\text{expected avg. short rate } y_t^{(1)} \text{ (inflation + real rate)}} + \underbrace{\frac{1}{n}\sum_{i=1}^{n-1} E_t\left(ex_{t+i}^{n-i+1}\right)}_{\text{term premium } tp_t^{(n)}}, \tag{2}$$

where π_t represents inflation, rr_t refers to the real interest rate and $ex_t^{(n)}$ denotes the log excess return. The latter is defined as $ex_{t+1}^{(n)} = r_{t+1}^{(n)} - y_t^{(1)}$. If we take the average of the expected excess returns over the lifetime of the bond, we get the so-called term premium $tp_t^{(n)}$. The term premium is the compensation an investor receives for being exposed to duration risk, which refers to uncertainty around the future evolution of short rates. The premium also reflects yield moves driven by temporary fluctuations in aggregate demand for safety and liquidity, often referred to as the convenience yield.

Empirical evidence suggests that the term premium is a key driver of *short-term* fluctuations in bond yields (Bauer and Rudebusch, 2020; Feunou and Fontaine, 2021). Over longer horizons, however, bond yields are predominantly driven by persistent yield curve trends that tend to evolve over decades. Two such yield curve trends have been emphasised in the empirical literature: slowly evolving long-horizon inflation expectations π_t^* and the equilibrium real rate r_t^* (both shown in Figure 3 below).

Naturally, these persistent return drivers are particularly important for long-term investors. Motivated by this empirical evidence, we isolate trend components of inflation expectations and the real rate, and highlight their dominant role in yield curve variation. We rewrite equation (2) as follows:

$$\underbrace{y_t^{(n)}}_{\text{yield}} = \underbrace{i_t^*}_{\text{yield curve trends}} + \underbrace{\frac{1}{n}\sum_{i=1}^{n} E_t\left(\pi_{t+i} - \pi_t^*\right) + \frac{1}{n}\sum_{i=1}^{n} E_t\left(rr_{t+i-1} - r_t^*\right) + tp_t^{(n)}}_{\text{transitory variation}}, \tag{3}$$

where i_t^* is the nominal equilibrium policy rate defined as the long-run expectation of future nominal short-term interest rates.[5] Following the Fisher equation, the nominal equilibrium rate consists of two yield curve trends:

$$\underbrace{i_t^*}_{\text{long-run expected nominal rate}} = \underbrace{r_t^*}_{\text{long-run expected real rate}} + \underbrace{\pi_t^*}_{\text{long-run expected inflation}} \tag{4}$$

We define the transitory part of the ex-ante real rate as $rr_t^c \equiv rr_t - r_t^*$. We refer to this part of real rates as "monetary policy" because it largely captures changes in the overall monetary policy stance.[6] To visualise the importance

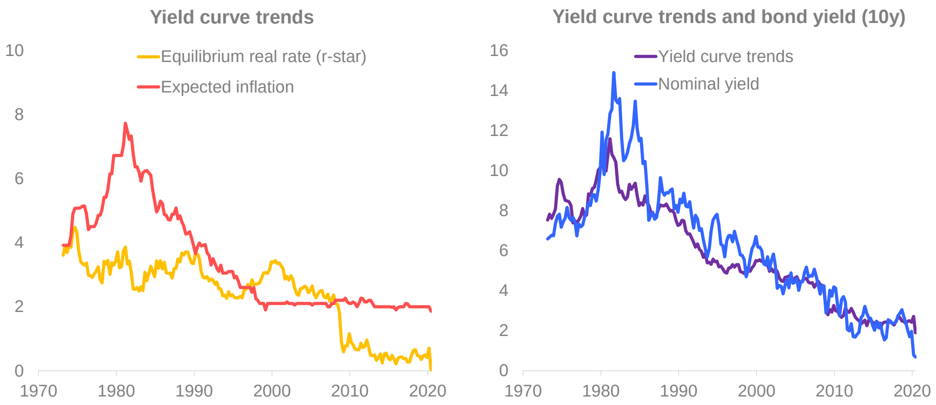
[5] Formally, i_t^* is defined as the expected short rate at the infinite horizon: $i_t^* \equiv \lim_{j\to\infty} E_t y_{t+j}^{(1)}$.

[6] Labelling transitory variation in the ex-ante real rate as "monetary policy" deviates from the academic literature that aims to isolate pure monetary policy shocks. Our goal is to distinguish between the persistent structural forces driving the equilibrium real rate (potential output growth, persistent safety and liquidity effects) and cyclical drivers of the ex-ante real rate (business cycle

of yield curve trends, the left panel of Figure 3 plots estimates of both return drivers going back to the early 1970s.

To highlight their combined level, the right panel of Figure 3 shows the combined impact of the two drivers, labelled "yield curve trends", together with the yield on a ten-year bond. Note that both these drivers enter the denominator in Figure 1. The combined yield curve trends series in Figure 3 therefore refers to the sum of the two return drivers. Comparing the combined yield curve trends to bond yields, we can see how closely the persistent trends have tracked historical bond yields. Ignoring short-term fluctuations, the yield curve trends account for most of the persistent decline in nominal yields since the early 1980s.

Figure 3: Persistent drivers of US nominal bond yields



Note: The left panel shows estimates of the equilibrium real rate from Holston, Laubach, and Williams (2017) and long-horizon inflation expectations from the FRB US model maintained by the Federal Reserve Board. The right panel superimposes the nominal ten-year US Treasury yield with "yield curve trends" which is the sum of inflation expectations and the equilibrium real rate. The sample period is Q1 1973 to Q2 2020.

If we subtract the yield curve trends from the level of bond yields, we are left with a relatively small gap between the purple and blue lines in the right panel of Figure 3. Based on the decomposition outlined in equation (3), this gap must be driven by a combination of the transitory component of the real rate and inflation, and the term premium. Rather than a persistent wedge, the gap seems to arise as bond yields fluctuate around their long-term trend. These temporary moves, however, are neither persistent nor large enough to materially impact the long-term properties of bond yields.

Empirical evidence suggests that the shape of the term structure of inflation expectations does not show much variation: it remains mostly flat around the current level of inflation, see e.g. Crump, Eusepi, and Moench (2018). Motivated by this evidence, we assume that the transitory component of inflation expectations plays a negligible role in determining the term structure of inflation expectations. Instead, we focus on the persistent component as a sole driver of inflation expectations.

variation in output growth and monetary policy).

Taken together, equations (3)-(4) identify four term structures that drive nominal bond returns:

1. Inflation expectations;
2. Equilibrium real rate;
3. Transitory real rate expectations (monetary policy);
4. Expected excess bond return (the term premium).

Decomposing Equity Returns

Next, we proceed to outline a framework for understanding the fundamental drivers of equity returns. The accounting identity in Figure 1 suggests that high equity prices can be due to elevated cash flow expectations, low discount rates, or a combination of the two. Similar to the decomposition of bond returns, our methodology for decomposing equities starts with the basic definition of the one-period returns on a broad equity index:

$$\underbrace{R_t^{eq}}_{\text{return}} = \frac{\overbrace{S_{t+1} + D_{t+1}}^{\text{index value and dividends at time } t+1}}{\underbrace{S_t}_{\text{index value at time } t}} \tag{5}$$

where S_t is the index value at time t, and D_{t+1} denotes the index dividend paid out between t and $t+1$. Unlike bonds of fixed maturities, however, a large part of the value of the equity index comes from cash flows occurring in the distant future.

The long-duration nature of equities implies that long-horizon dividend growth expectations, together with the interest rates and risk premiums at which those dividends are discounted, play a crucial role in determining their prices. To identify these drivers and assess their relative importance, we need to decompose R_t^{eq} further. To this end, we follow Lettau and Nieuwerburgh (2008) and log-linearise the one-period return given by equation (5) as follows:

$$\underbrace{r_{t+1}^{eq}}_{\text{return}} = \underbrace{\kappa_t}_{\text{linearisation term}} + \underbrace{\Delta d_{t+1}}_{\text{real dividend growth}} + \underbrace{\rho_{t+1} \times pd_{t+1} - pd_t}_{\text{valuation changes}}, \tag{6}$$

where r_t^{eq} refers to the one-period log equity return, κ_t is a linearisation term, Δd_t represents log dividend growth, ρ_t is a linearisation term close to one and pd_t is the log of the price-dividend ratio. Intuitively, this component of the equity return can account for most of the volatility in equity returns, an observation that goes back to the seminal work in Shiller (1981). We further decompose the log of the price-dividend ratio into:

$$\underbrace{pd_t}_{\text{equity valuation}} = \underbrace{\overline{pd}_t}_{\text{persistent valuation drivers}} + \underbrace{\sum_{i=1}^{\infty} \rho_t^{i-1} \left[E_t\left(\Delta \tilde{d}_{t+i}\right) - E_t\left(rr_{t+i}^c\right) - E_t\left(\tilde{e}_{t+i}\right)\right]}_{\text{transitory valuation drivers}}, \tag{7}$$

where $\overline{pd}_t$ is long-term (steady state) equity valuations that vary over time.

Similar to the fixed income decomposition in equation (3), we distinguish between persistent and transitory changes in equity valuations and highlight their fundamental drivers. Persistent changes to equity valuations $\overline{pd}_t$ are driven by long-horizon expectations about dividend growth: $\bar{d}_t \equiv \lim_{j\to\infty} E_t \Delta d_{t+j}$, real interest rates: $r_t^* \equiv \lim_{j\to\infty} E_t rr_{t+j}$ and the expected excess return on equity (the equity risk premium): $\bar{e}_t \equiv \lim_{j\to\infty} E_t e_{t+j}$. These long-horizon expectations can be interpreted as shifting steady states. Combining them, we can express steady-state equity valuations in logs as:

$$\underbrace{\overline{pd}_t}_{\text{long-run valuation}} = \underbrace{\bar{d}_t}_{\text{long-run growth}} \underbrace{- \log\left(\exp\left(r_t^* + \bar{e}_t\right) - \exp\left(\bar{d}_t\right)\right)}_{\text{long-run discount rate - long-run growth}}. \tag{8}$$

The equation tells us that long-horizon expectations about real dividend growth and discount rates are the two fundamental drivers of long-run equity valuations.[7] According to equation (8), elevated equity valuations can be sustained in the long run by a positive long-term growth outlook, persistently low discount rates, or a combination of the two. Equation (8) also suggests that if the equilibrium real rate co-moves perfectly with long-horizon expectations about real dividend growth, it will not have any impact on equity valuations. It is therefore the gap between these two that drives shifts in equity valuations.

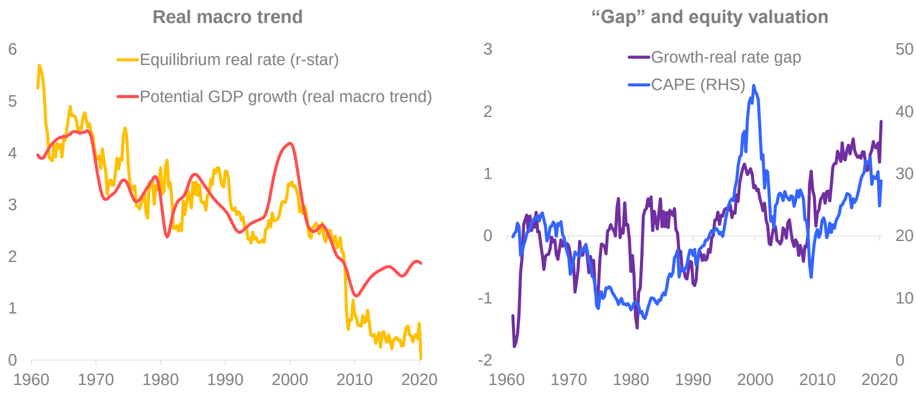
Transitory changes to equity valuations in equation (7) are driven by transitory variation in dividend growth $\Delta\tilde{d}_{t+i} = \Delta d_{t+i} - \bar{d}_t$, real rates $rr^c_{t+i} = rr_{t+i} - r_t^*$ and the equity risk premium $\tilde{e}_{t+i} = e_{t+i} - \bar{e}_t$.

While the equity discount rate can be depressed by any of its underlying components, only its persistent drivers have the potential to impact discount rates over long horizons. Recent empirical evidence suggests that the equilibrium real rate is the key driver of persistent shifts in discount rates, while the persistent component of the equity risk premium has remained relatively stable (Monache, Petrella, and Venditti, 2020). Persistent changes to long-run real rates and expected cash flows are therefore key drivers of equity returns in the long run.

To visualise their importance, the left panel of Figure 4 plots estimates of both return drivers for the US equity market going back to the early 1960s. Note that the long-horizon expectations about equity cash flow growth are approximated by the estimate of the growth rate of potential output, towards which aggregate cash flows must eventually converge if the labour share is stable. The right panel of Figure 4 shows the combined impact of the two long-term components together with equity valuations represented by the cyclically adjusted price-to-earnings ratio (CAPE). Note that cash flows enter the numerator in Figure 1, while real rates impact equities as a part of discount rates in the denominator. To the extent that the two return drivers co-move, their impacts on equity valuations will potentially offset each other, at least partially. The "gap" series in Figure 4 therefore refers to the difference between the two return drivers.

[7] We provide more details on the derivations of equations (6)-(8) in Appendix B.2.

Figure 4: Persistent drivers of US equity valuations



Note: The left panel shows estimates of the equilibrium real rate from Holston, Laubach, and Williams (2017) and a real growth rate of potential GDP from the Congressional Budget Office (CBO) which we label "real macro trend". The right panel superimposes the cyclically-adjusted price-earnings ratio (CAPE) with the "gap", which represents the difference between potential GDP growth and the equilibrium real rate. The sample period is Q1 1961 to Q2 2020.

There are good theoretical reasons to believe that equilibrium real rates are closely related to long-horizon expectations about real output growth. The high degree of co-movement between the two drivers visualised in the left panel of Figure 4 indicates that this is also the case empirically. Nevertheless, there are prolonged periods of divergence between the two series, the last of which started during the Global Financial Crisis and is still ongoing.

Equation (8) indicates that such gaps in long-run expectations about growth and real rates should lead to persistent changes in equity valuations. The co-movement between equity valuations and the gap, as shown in the right panel of Figure 4, suggests that this has largely been the case over the last six decades. While valuations fluctuate around the gap, the overall level seems to track the gap between the long-run growth and real rates.

As with fixed income, we split the ex-ante real rates into the long-run component r_t^* and the transitory component rr_t^c. We do not split the equity risk premium into persistent and transitory components. This modelling choice is motivated by the evidence suggesting that the persistent component of the equity risk premium varies less than the equilibrium real rate. This means we split the equity discount rate into the following three components:

$$\underbrace{E_t r_{t+i}^{eq}}_{\text{equity discount rate}} = \underbrace{E_t e_{t+i}}_{\text{risk premium}} + \underbrace{E_t rr_{t+i}^{c}}_{\text{transitory real rate}} + \underbrace{r_t^*}_{\text{equilibrium real rate}} . \tag{9}$$

For long-term investors holding both equities and bonds, long-run real rates are particularly important as they are shared across both asset classes, thus accentuating their total portfolio impact. Binsbergen (2021) highlights the role of persistent variation in real interest rates by showing that, on a duration-matched basis, equities and bonds delivered broadly similar returns over the last 50 years.

As we discuss in more detail below, we use survey-based estimates of real output growth to approximate the term structure of real dividend growth. This modelling choice complicates the identification of the transitory and persistent components of dividend growth expectations. For this reason, we work with real dividend growth expectations as a single return driver.

Taken together, we identify four fundamental drivers of equity returns, changes in the term structures of:

1. Real dividend growth expectations;
2. Equilibrium real rates;
3. Transitory real rate expectations (monetary policy);
4. Equity risk premium.

3. Implementing the Return Decomposition

The return drivers outlined in the previous section are not directly observable and need to be estimated. In this section, we construct the term structures and their shifts over time, and link these fundamental drivers to equity and bond returns. For both asset classes, we focus on the four largest markets: Japan, the euro area, the UK and the US. As a group, we refer to these four markets as the "G4".

There are a variety of methods to produce estimates of the term structures described in the previous section. The most common approach is to use dynamic models such as Vector Autoregressions (VAR), see e.g. Campbell and Shiller (1988); Campbell (1991); Campbell and Ammer (1993). These models specify short-run dynamics for a small number of variables and infer long-horizon expectations by extrapolating their short-run behaviour over the long term. The variables included in the VAR are usually realised asset returns and the corresponding predictors of these returns. Cash flow news is often identified as a residual.

However, due to frictions in the expectations formation process,[8] small-sample bias,[9] and the sensitivity of results to which predictors of returns are included, the identification of return drivers using VARs has proven to be challenging in practice. We therefore explore an alternative implementation of our return decomposition with the goal of avoiding the challenges mentioned above. We model term structures of expectations explicitly for all return drivers, each of which is explained in more detail below.

Our approach is similar in spirit to the most recent literature on decomposing asset returns, which emphasises the role of professional surveys and asset

[8]Decomposing asset returns with the help of VARs assumes that the full-information rational expectations hypothesis holds. This assumption implies that investors have full knowledge of the economy and, as a result, there is no wedge between the real-time and full-sample analysis.

[9]The key issue in representing long-term dynamics using VARs is the small-sample bias in parameter estimates driving persistent dynamics. As a result, some return drivers will be spuriously less persistent than they actually are, see e.g. Bauer, Rudebusch, and Wu (2012). The existence of regime shifts, such as the high-inflation environment of the 1970s and early 1980s in the US or the introduction of the euro, further complicates the modelling using VARs.

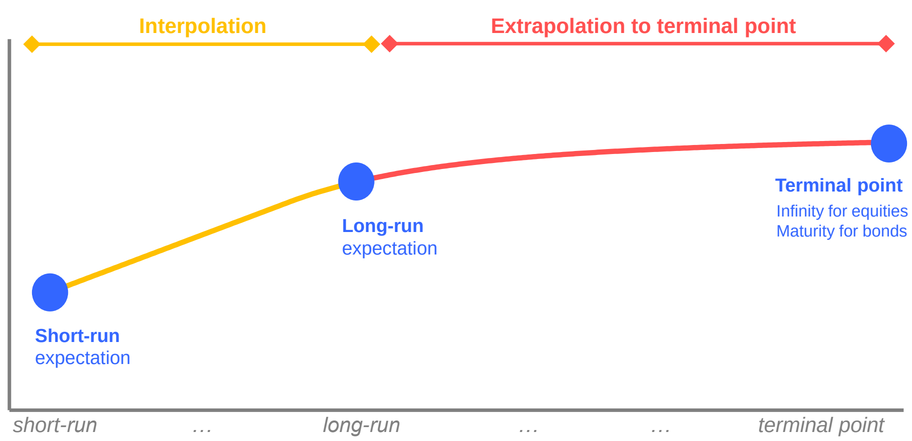
prices, see e.g. De La O and Myers (2021); Knox and Vissing-Jorgensen (2021). In this section, we focus on the most important modelling choices that separate our implementation from other approaches, and defer more technical details to the appendix. Across these drivers, our decomposition emphasises long-horizon expectations as the most important component determining the returns on long-duration assets such as equities and bonds. How we model these long-horizon expectations is therefore particularly important.[10]

Building Term Structures of Expectations and Risk Premiums

We first describe the term structures and then proceed to evaluate how well their changes explain asset returns. When constructing term structures, we model short- and long-run expectations separately. The expectations themselves are proxied by a combination of survey-based forecasts and market-implied expectations from traded assets. By relying on surveys and market prices, we ensure that we only use data that are available to investors in real time. This is an important feature because empirical evidence suggests that differences between full-sample and real-time analysis can be both sizeable and persistent.[11]

Figure 5 illustrates how we represent the term structure of expectations. From left to right, the blue dots represent horizon-specific expectations pertaining to short-run, long-run and terminal points. Based on these points, we approximate term structures in two steps. First, we interpolate between the short- and long-run expectations (the orange line in Figure 5). Then, we extrapolate the long-run expectations out to infinity for equities and to some finite maturity date for bonds.

Figure 5: Illustration of term structures of expectations



[10] We refer to long-horizon expectations as the limiting conditional expectations about return components as specified in the previous section.

[11] Empirical studies suggest that there is a non-negligible wedge between ex-post full-sample and real-time analysis, see e.g. Coibion and Gorodnichenko (2015); Cieslak (2018). This wedge is generated by errors investors make when forming expectations about macroeconomic variables, earnings and monetary policy. Any analysis that ignores these errors tends to wrongly attribute them to risk premiums.

For fixed income, we construct the following term structures:

- Inflation expectations;
- Equilibrium real rates;
- Transitory real rate expectations (monetary policy);
- Term premium.

We model these term structures out to the ten-year maturity point. We construct term structures of inflation expectations using survey-based short- and long-term inflation forecasts from the Consensus Economics panel.[12] Short- and long-term expectations are represented by the one- and ten-year-ahead forecasts, respectively.

Our estimates of the equilibrium real rate follow Holston, Laubach, and Williams (2017) and Han (2019).[13] We assume that the term structure of equilibrium real rates is flat, i.e. the short- and the long-run expectations in Figure 5 coincide. This means that movements in the equilibrium real rate generate a level effect that has an equal impact on yields across all maturities.

The basis for building the remaining two term structures is nominal forward rates, for which we have richer data that allow us to specify full term structures at three-month maturity intervals.[14] We subtract maturity-matched inflation expectations and equilibrium real rates from their corresponding nominal forwards. This gives us a residual yield component that reflects a combination of the transitory parts of ex-ante real rates and the term premium. To disentangle these two drivers, we rely on the fact that their relative importance varies across maturities and assume that term premium variation can be represented by a single factor. This allows us to use term premium estimates in combination with loadings that vary between zero (one-year maturity) and one (ten-year maturity) to extract the cyclical part of real rates. Term premium estimates are obtained following the methodology outlined in Cieslak and Povala (2015).

For equities, we construct the following term structures:

- Dividend growth expectations;
- Equilibrium real rates;
- Transitory real rate expectations (monetary policy);
- Equity risk premium.

In the case of equities, the terminal point in Figure 5 refers to infinity. We construct term structures of expected dividend growth using survey-based short- and long-term forecasts of real output growth from the Consensus Economics panel.[15] Short- and long-term expectations are represented by the

[12] See Appendix A.1 for more details.
[13] See Appendix A.2 for more details.
[14] See Appendix A.3 for more details.
[15] See Appendix A.1 for more details.

one- and ten-year-ahead forecasts, respectively.[16] The terminal point is also represented by the survey-based forecast of real output growth at the ten-year horizon.

The construction of both components of the term structure of real rates is identical to fixed income, except for the terminal point. We use the ten-year nominal forward rate to represent the terminal point for nominal yields. Assuming that the term structure of the equilibrium real rate is flat allows us to use the estimate of the equilibrium real rate to represent all three points depicted in Figure 5.

We use two distinct modelling approaches for constructing the short- and long-run estimates of the equity risk premium. The short end of the term structure is approximated using option-based estimates of the equity risk premium following the methodology outlined in Martin (2017).[17] The option-based estimates are available for maturities of up to three years. The availability of multiple points on the term structure allows us to use a non-linear interpolation between the short- and the long-run estimates depicted in Figure 5. The non-linear interpolation helps us ensure that the short-term estimate converges towards the long-term estimate at a speed that is in line with the data, see e.g. Knox and Vissing-Jorgensen (2021).

The long end of the term structure is approximated by real-time estimates of the equity risk premium from restricted predictive regressions studied in Campbell and Thompson (2008). Specifically, we work with a version that uses the dividend yield in combination with expected cash flow growth.[18] In contrast to the volatile short-horizon estimates extracted from equity index options, the long-horizon estimates are relatively stable. Hence, most of the variation in the equity risk premium is concentrated at the front end of the term structure.

Linking Term Structures to Returns

As indicated in equation (1) for fixed income and in equations (6)-(7) for equities, asset returns are driven by changes in the term structure of expectations and risk premiums. These changes in market expectations are sometimes referred to as "news terms" in the literature (Campbell, 1991). We create news terms using the estimated term structures. For each term structure, we sum over all points along the curve, from today out to infinity for equities or to some finite maturity date for bonds. The news term is then the difference between the discounted sums at times $t + 1$ and t.

[16] The volatility of revisions to real output growth is lower than the volatility of revisions to earnings growth, a result that holds across horizons. We partially address this issue in the implementation discussed below.

[17] In our own empirical analysis, we verify that option-based estimates of the equity risk premium predict the excess equity returns at horizons ranging between one and 12 months.

[18] Appendix C.2 provides more details on the construction of long-run estimates of the equity risk premium.

Starting with fixed income, we split realised bond returns into their expected and unexpected parts using the yield components:

$$\overbrace{r_{t+1}^{(n)}}^{\text{return}} = \overbrace{E_t r_{t+1}^{(n)}}^{\text{expected return}} \overbrace{\underbrace{-N_{\pi,t+1}^{(n)}}_{\text{cash flow news}} \underbrace{-N_{r^*,t+1}^{(n)} - N_{rr^c,t+1}^{(n)} - N_{tp,t+1}^{(n)}}_{\text{discount rate news}}}^{\text{unexpected return}}, \tag{10}$$

where $E_t r_{t+1}^{(n)}$ refers to the one-period expected fixed income return. The various components that make up the unexpected part of bond returns are driven by changes to their respective yield components. These are converted to returns by scaling yield changes by their duration n, as indicated in equation (1). For example, changes to the equilibrium real rate are reflected in $N_{r^*,t+1}^{(n)}$ and are given by $(n-1)\,\Delta r_{t+1}^*$. An increase in the equilibrium real rate leads to a negative unexpected return whose magnitude depends on duration.

Note that the illustration in Figure 1 shows components of *nominal* returns. Investors, however, ultimately care about the real returns on their investment. Bondholders receive regular payments in the form of fixed nominal coupons and a principal at the bond's maturity date. The real value of these cash flows is determined by changes to inflation expectations. Changes to inflation, captured by $N_{\pi,t+1}^{(n)}$, therefore represent "cash flow news" in equation (10). The remaining components of unexpected returns are collectively referred to as "discount rate news". We provide expressions and derivations of all news terms in equation (10) in Appendix B.1.

The corresponding decomposition of equity returns is given by:

$$\overbrace{r_{t+1}^{eq}}^{\text{return}} = \overbrace{E_t r_{t+1}^{eq}}^{\text{expected return}} \overbrace{\underbrace{+N_{d,t+1}}_{\text{cash flow news}} \underbrace{-N_{r^*,t+1} - N_{rr^c,t+1} - N_{e,t+1}}_{\text{discount rate news}}}^{\text{unexpected return}}, \tag{11}$$

where $E_t r_{t+1}^{eq}$ refers to the one-period expected equity return, and the remaining components refer to the various news terms that make up the unexpected part of equity returns. We provide expressions and derivations for all news terms in equation (11) in Appendix B.2.

Finally, we construct empirical proxies for expected returns. The expected asset return can be split into the return on a safe asset, such as the Treasury-bill, and the expected excess return that represents the compensation investors require for holding risky assets. The proxy for expected excess return on government bonds is the estimate of the term premium scaled by the duration of the bond portfolio. The option-based estimate of the equity risk premium serves as a proxy for expected excess return on equities. We provide more details on how we construct expected excess return proxies and news terms in Appendices C.1 and C.2.

With estimates of expected excess returns and news terms at hand, we regress realised returns for each asset class on the corresponding set of return drivers. The accounting identities presented above provide strong guidance on signs and magnitudes of betas in these regressions.[19]

[19] A consistent way of imposing these priors is to use Bayesian methods, which we use to estimate

Fixed Income

To decompose fixed income returns, we apply equation (10) to quarterly excess returns on nominal government bonds. Using bond indices from Bloomberg, we focus on local-currency government bond returns in excess of the returns on three-month Treasury bills, denoted as $ex_t^{fi,(n)}$. We estimate the following regression for each bond market:[20]

$$\overbrace{ex^{fi,(n)}_{t+1}}^{\text{excess return}} = \overbrace{\beta_{ex}\hat{E}_t ex^{fi,(n)}_{t+1}}^{\text{expected excess return}} + \overbrace{\underbrace{\beta_\pi \hat{N}^{fi,(n)}_{\pi,t+1}}_{\text{expected inflation}} + \underbrace{\beta^{fi}_{r^*}\hat{N}^{fi,(n)}_{r^*,t+1}}_{\text{r-star}} + \underbrace{\beta^{fi}_{rr^c}\hat{N}^{fi,(n)}_{rr^c,t+1}}_{\text{monetary policy}} + \underbrace{\beta_{tp}\hat{N}^{fi,(n)}_{tp,t+1}}_{\text{term premium}}}^{\text{unexpected excess return / news terms}} + \varepsilon^{fi}_{t+1} \quad (12)$$

Table 1 shows the regression results. Equation (10) offers some intuition on how to interpret the regression results. If our estimated term structures are perfectly accurate, we would observe: 1) a beta of one for the expected return component, 2) betas of minus one for all news terms, and 3) an R^2 of one for the regression.[21]

Table 1: Drivers of G4 fixed income returns

	US	DE	UK	JP
Expected return	0.24 *	0.49 *	0.62 *	0.38 *
	(0.03)	(0.06)	(0.07)	(0.05)
Expected inflation	−0.61 *	−0.69 *	−0.72 *	−0.55 *
	(0.03)	(0.05)	(0.06)	(0.04)
Equilibrium real rate	−0.64 *	−0.6*	−0.62 *	−0.52 *
	(0.03)	(0.04)	(0.08)	(0.05)
Monetary policy	−0.59 *	−0.58 *	−0.65 *	−0.53 *
	(0.02)	(0.03)	(0.04)	(0.04)
Term premium	−0.32 *	−0.46 *	−0.67 *	−0.52 *
	(0.02)	(0.06)	(0.07)	(0.04)
N	108	90	108	108
adj. R^2	0.96	0.94	0.87	0.88

*Note: Quarterly data. Sample period is Q1 1994 (Q3 1998 for DE) to Q4 2020. "Monetary policy" represents the transitory variation in the ex-ante real rate. Robust standard errors are reported in parentheses, * indicates significance at p < 0.05.*

both equity and fixed income regressions. Note that the usual definition of R^2 as the variance of the predicted values divided by the variance of the data does not apply in the Bayesian setting, as the numerator can be larger than the denominator. For this reason, we report a version of R^2 that is adjusted so that it is bounded at unity, following the standard definition.

[20] The realized return on a safe asset from time t to $t+1$ coincides from the expected return at time t. This allows us to recast equations (10) and (11) in terms of excess returns by subtracting the return on safe asset from both sides of the equation. This means that using total returns and excess returns is equivalent. Our choice to implement the decomposition using excess returns is motivated by convenience.

[21] Note that our approach does not deliver an R^2 of one, as opposed to the VAR-based implementation of the Campbell-Shiller decomposition. A key step in the VAR-based implementation is to back out the cash flow component as a residual. This is usually justified by the assumption that the residual captures a return driver that is thought to be difficult to model explicitly. This stands in contrast to our approach, where we don't force the valuation to hold exactly, but rather model each return driver explicitly. While both approaches end up with a residual return component, the VAR-based implementation gives this residual a label, ensuring that returns are always fully decomposed with an R^2 of one and the valuation holds exactly.

The regression results are broadly in line with this intuition. First, all news terms have their expected negative signs – i.e. an increase in expected inflation, tighter monetary policy, higher equilibrium real rates and a positive shock to the term premium all lead to negative unexpected bond returns. Second, the R^2 is high and close to one for all G4 markets. Overall, this indicates that our return drivers capture most of the variation in bond returns.

Equity

To decompose equity returns, we apply equation (11) to quarterly excess returns. We use equity returns in excess of the returns on three-month Treasury bills, denoted as ex_t^{eq}. Like the fixed income implementation, the regression breaks excess returns into their expected ($E_t ex_{t+1}^{eq}$) and unexpected return driver components, as outlined in equation (11). We estimate the following regression for each equity market:

$$\overbrace{ex_{t+1}^{eq}}^{\text{excess return}} = \overbrace{\beta_{ex}\hat{E}_t ex_{t+1}^{eq}}^{\text{expected excess return}} \overbrace{+\underbrace{\beta_d \hat{N}_{d,t+1}^{eq}}_{\text{cash flows}} + \underbrace{\beta_{r^*}^{eq}\hat{N}_{r^*,t+1}^{eq}}_{\text{r-star}} + \underbrace{\beta_{rr^c}^{eq}\hat{N}_{rr^c,t+1}^{eq}}_{\text{monetary policy}} + \underbrace{\beta_e \hat{N}_{e,t+1}^{eq}}_{\text{equity risk premium}}}^{\text{unexpected excess return / news terms}} + \varepsilon_{t+1}^{eq}, \quad (13)$$

Table 2 shows the results for the regression given in equation (13). Similar to the fixed income estimation, we have strong priors from the relationships laid out in equation (11). The closer the estimated loadings on expected returns and cash flows are to one, the more accurate our implementation is. A similar logic applies to all remaining news terms, whose loadings should converge to *minus* one. The goodness of fit, as measured by the adjusted R^2, is an equally important measure of the accuracy of our implementation.

Table 2: Drivers of G4 equity returns

	US	Euro area	UK	JP
Expected return	0.96 *	0.9*	0.81 *	0.97 *
	(0.23)	(0.23)	(0.24)	(0.23)
Expected cash flows	0.9*	0.86 *	0.74 *	0.83 *
	(0.09)	(0.10)	(0.09)	(0.09)
Equilibrium real rate	−0.59 *	−0.53 *	−0.54 *	−0.94 *
	(0.15)	(0.16)	(0.18)	(0.16)
Monetary policy	−0.46 *	−0.49 *	−0.25 *	−0.28 *
	(0.11)	(0.12)	(0.10)	(0.12)
Equity risk premium	−1.16 *	−0.91 *	−0.86 *	−0.72 *
	(0.13)	(0.09)	(0.10)	(0.11)
N	92	92	92	92
adj. R^2	0.55	0.59	0.58	0.52

*Note: The estimates are obtained using a Bayesian estimation. Data are quarterly and the sample period is Q1 1998 to Q4 2020. "Monetary policy" represents transitory variation in the ex-ante real rate. * indicates significance at p < 0.05.*

Based on these priors, all estimates have the correct signs and magnitudes. The explained variation is lower than in the case of fixed income returns, which is to be expected given that equity returns are known to be notoriously difficult to explain in terms of economic variables. There are several potential explanations for the less than perfect fit. First, our cash flow proxies, which are based on survey data about real output growth, are imperfect. Second, a two-stage modelling of the term structures outlined in Figure 5 might be too simplistic for capturing all relevant variation in equity returns. Finally, excluding the dot-com period (1998-2001), where equity returns are hard to relate to fundamentals, significantly improves the fit.[22]

4. Properties of Return Drivers

This section discusses the properties of the fundamental drivers of equity and fixed income returns. To conserve space, we focus on the US market and mention other markets where appropriate. We start by exploring volatility estimates and the correlation structure of fundamental return drivers, which together determine the risk characteristics of both asset classes.

Figure 6 summarises the covariance structure of bond return drivers. Volatility estimates are shown along the diagonal, and all off-diagonal numbers refer to correlations between individual return drivers.

Despite its transitory nature, the monetary policy component has been the largest contributor to the volatility of bond returns over this sample period. The other components are less volatile, with the volatility ranging between 2.3 and 2.7 percent. When combined, the two components of the real rate drive more than half of the variation in fixed income returns.

Figure 6: Volatility and correlation statistics for US bond return drivers

	Expected inflation	Monetary policy	Equilibrium real rate	Term premium
Expected inflation	2.7%			
Monetary policy	-0.64	3.9%		
Equilibrium real rate	0.37	-0.56	2.3%	
Term premium	0.24	0.18	0.15	2.3%

Note: Items on the diagonal report the annualised volatility of return drivers. The items below the diagonal are the pair-wise correlations of return components. The sample period is from Q1 1994 through Q4 2020, quarterly data. "Monetary policy" represents the transitory variation in the ex-ante real rate.

[22] For example, the adjusted R^2 for the US (the euro area) returns increases to 0.61 (0.70).

The correlations across return drivers add more nuance to this picture. Both inflation expectations and long-run real rates are negatively correlated with the monetary policy component, which reduces the overall bond volatility. The negative correlation tends to intensify when the overall level of interest rates is close to the lower bound. The variation in the term premium, on the other hand, is only weakly related to the other return components, making it particularly important for the short-term variation in bond returns.

It is worth highlighting that periods in which the effective lower bound is binding usually lead to changes in the correlation structure of fixed income return drivers. At different points in our sample, policy rates in all G4 markets have reached levels at which conventional monetary policy was constrained. When interest rates are at or close to their lower bound, the negative correlation between monetary policy and inflation expectations becomes even more negative than the full-sample estimate reported in Figure 6. Under such scenarios, falling inflation expectations automatically translate into higher ex-ante real rates and thus tighten the overall monetary policy stance. Not being able to lower their policy rates further, central banks are left unable to counteract weak inflation by deploying conventional monetary policy tools.

To explore how our estimated return fundamentals contribute to the volatility of equity returns and how they relate to each other, Figure 7 summarises the volatility and pair-wise correlations of equity return drivers. The volatility of individual return drivers is reported along the diagonal, while the off-diagonal items report correlations between individual return drivers.

Our decomposition suggests that fluctuations in the equity risk premium make up the largest contributor to equity return volatility, followed by the cash flow component. However, the combined contribution of real interest rates – monetary policy and the equilibrium real rate – to equity volatility is comparable to equity risk premium shocks. As with bonds, real interest rates thus play an important role in driving the variation in equity returns.

Figure 7: Volatility and correlation statistics for US equity return drivers

	Expected cash flows	Monetary policy	Equilibrium real rate	Equity risk premium
Expected cash flows	6.2%			
Monetary policy	0.10	5.6%		
Equilibrium real rate	0.11	-0.55	4.7%	
Equity risk premium	-0.46	0.06	-0.31	10.6%

Note: The matrix diagonal shows the volatility of return drivers. The items below the diagonal are the pair-wise correlations of return components. The sample period is from Q1 1998 to Q4 2020, quarterly data. "Monetary policy" represents the transitory variation in the ex-ante real rate.

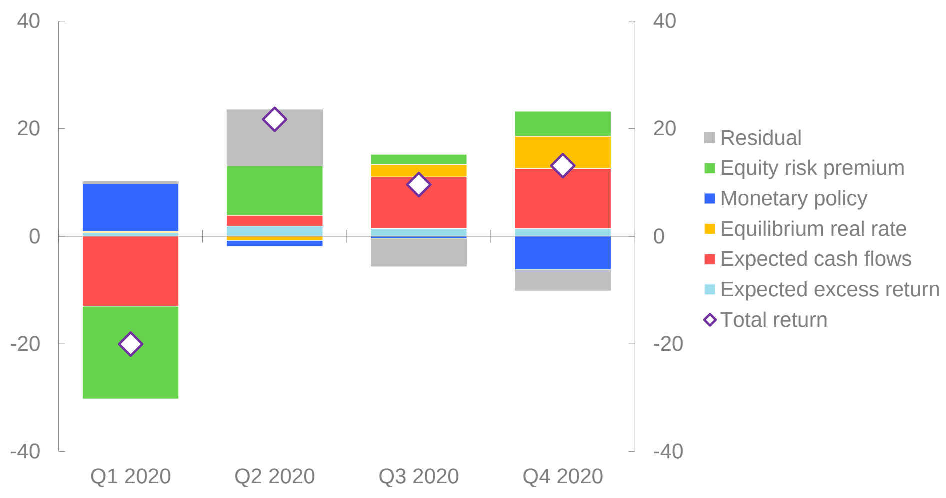
Intuitively, the correlation between cash flows and the equity risk premium is negative – where a downward revision to expected equity cash flows coincides with an increase in the equity risk premium. This means that the equity risk premium tends to amplify cash flow shocks. There are, however, offsetting effects within the discount rate that tend to dampen the volatility of equity returns, such as the negative correlation between the equity risk premium and the equilibrium real rate.

Decomposing Returns during 2020

In this section, we use our return decomposition framework to understand the fundamental drivers of equity and bond returns during 2020 – a year dominated by the global pandemic and the subsequent policy response.[23]

Figure 8 shows the return drivers and their contribution to US equity returns in each quarter of 2020. The US equity market dropped by around 20 percent in the first quarter of 2020. Cash flow expectations fell sharply and were a large contributor to the negative equity returns. In fact, the negative return contribution from the fall in expected cash flows is the largest quarterly drop in our sample, significantly exceeding that seen during the 2008 financial crisis. In line with the estimates presented in Figure 7, the decline in expected cash flow growth expectations coincided with a sizeable upward move in the risk premiums. The increase in the equity risk premium further exacerbated equity losses. According to our estimates, the spike in the equity risk premium contributed minus 15 percentage points to the equity return and was thus the largest contributor to the equity drawdown during the first quarter of 2020.

Figure 8: Decomposition of US equity returns in 2020, quarterly returns (percent)



Note: The chart decomposes US equity returns in excess of the three-month Treasury bill. Estimates are obtained using equation (13). The sample period is Q1 2020 to Q4 2020.

[23] To present the results in this section, we use the model estimated over the entire sample period. However, for robustness, we also estimated a model excluding 2020 data which produced very similar results.

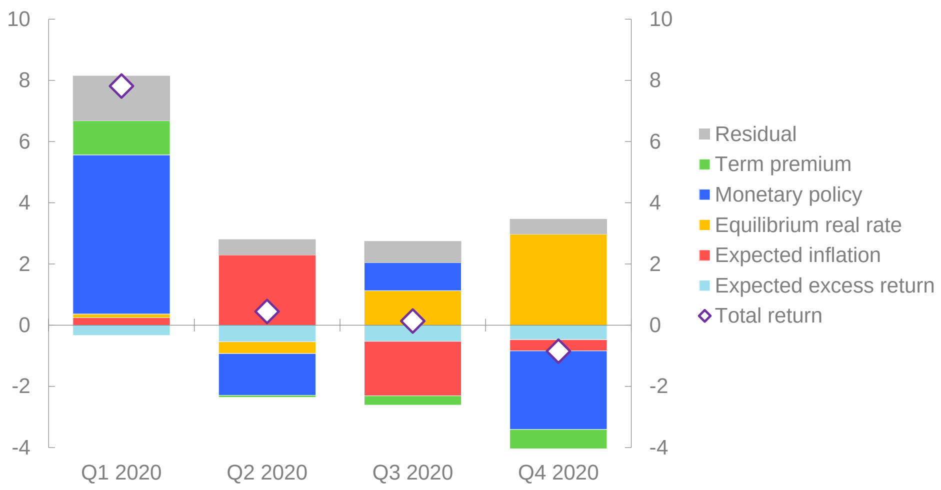
The deteriorating economic and market conditions were met with a swift policy response. In particular, the monetary policy response helped offset the negative impact of expected cash flows and risk premiums.[24] Our estimates suggest that the contribution of monetary policy to equity returns in the first quarter of 2020 was close to ten percentage points.

The picture started improving significantly in the second quarter of 2020. Helped partly by the policy response, both shocks to cash flows and risk premiums turned out to be more transitory than investors initially priced them to be during the first quarter of 2020. Indeed, over the remaining quarters of 2020, a series of positive shocks to the risk premium and cash flow expectations helped to more than offset their initial negative contributions from the first quarter of the year.

Figure 9 shows the decomposition of quarterly US bond returns in 2020. The first quarter of 2020 was dominated by monetary policy easing, which lowered real rates and resulted in a sizeable positive return. Importantly, monetary policy easing also helped offset the drop in equity prices by lowering the transitory part of real interest rates.[25]

In the second half of 2020, declines in the equilibrium real rate contributed positively to both equity and fixed income returns. The significant contributions from both components of real interest rates in 2020 highlight the importance of drivers that are common across equity and fixed income returns.

Figure 9: Decomposition of US fixed income returns in 2020, quarterly returns (percent)

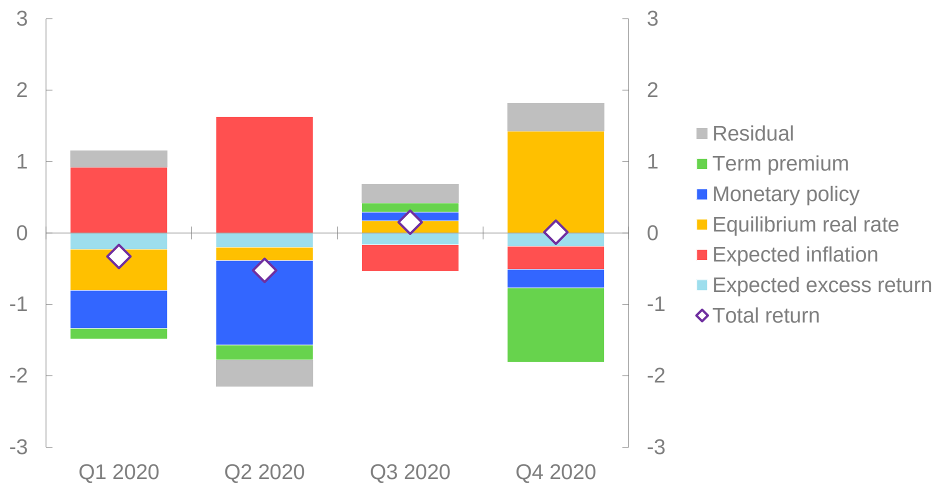


Note: The chart decomposes returns on US government bonds in excess of the three-month Treasury bill. Estimates are obtained using equation (12). *The sample period is Q1 2020 to Q4 2020.*

[24] Vissing-Jorgensen (2021) provides a detailed overview of the policies deployed by the Federal Reserve in the spring 2020 and the corresponding reactions of asset markets to them.

[25] The label "monetary policy" in Figure 8 refers to the transitory component of the ex-ante real interest rate, and as such does not capture the full extent of the monetary policy impact on asset prices – in particular the non-conventional measures deployed during 2020. To the extent such measures work mainly through risk premiums, they are captured in the equity risk premium.

Figure 10: Decomposition of Japanese fixed income returns in 2020, quarterly returns (percent)



Note: The chart decomposes returns on Japanese government bonds in excess of the three-month Treasury bill. Estimates are obtained using equation (12). *The sample period is Q1 2020 to Q4 2020.*

While the Federal Reserve was able to lower the policy rate in early 2020, other major central banks were more constrained in terms of conventional monetary policy tools. Fixed income returns in Japan, presented in Figure 10, highlight this constraint. Focusing on the first quarter of 2020, Japanese fixed income returns were marginally negative which is in stark contrast to fixed income returns for the US. In addition to the lack of ability to lower the policy rate, inflation expectations in Japan decreased in the first two quarters of 2020, which led to higher real rates and thus a tighter conventional monetary policy stance.

Fixed income returns in the US and Japan over the last three quarters of 2020 also illustrate the importance of decomposing returns into their fundamental drivers. While overall fixed income returns were close to zero in each of these quarters, meaningful changes in bond fundamentals underlie the headline return numbers. Although these shifts did partially offset each other, it is important for investors to understand the movement in each individual return driver to extract the right signals from the market.

5. Summary

We outline a framework that allows us to identify the fundamental drivers of equity and bond returns. Our framework emphasises the role of real interest rates, a driver that is common to equities and bonds. To accurately capture the economic forces driving real rates, our decomposition splits real rates into a transitory component, dominated by the monetary policy cycle, and a persistent component that reflects secular developments in the economy.

A key feature of our implementation is that we explicitly model the term structure of expectations for each return driver. These term structures help us to distinguish between persistent and transitory return drivers. While persistent drivers, such as expected inflation and the equilibrium real rate, determine returns on long-duration assets such as equities and bonds, transitory drivers often dominate return variation over shorter periods.

We use our framework to examine the properties of fundamental drivers of equity and bond returns over the last few decades, where the real rate components have played a significant role. Using our model, we highlight the drivers of equity and bond returns in 2020. During the first quarter, the economic fallout from the pandemic triggered a sharp selloff in global equity markets, driven by a combination of lower cash flow expectations and a spike in the equity risk premium. At the same time, government bonds delivered strongly positive returns, in particular US Treasury bonds. This was largely driven by monetary policy easing, which lowered real interest rates.

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Appendix A: Data

This appendix provides additional details on the data used to decompose equity and fixed income returns.

Appendix A.1 Consensus Economics Surveys

We use survey data from the Consensus Economics panel to construct the term structures of expected inflation and real output growth. The survey data are available from April 1990.

The short end of the term structure is represented by forecasts for the current and the next calendar year, both of which are available at a monthly frequency. We use these two forecasts to create constant-maturity one-year-ahead forecasts of inflation and real output growth. Before 2015, we use a mean estimate from a full panel of forecasters, updated once a month. From 2015 onwards, we use a more responsive estimate which is based on a moving average of qualified *changed* forecasts. This measure enables us to better capture sudden changes in forecasts such as coronavirus-induced recalibration of expectations in the first quarter of 2020.

Long-horizon forecasts are available at a quarterly frequency from 2014 onwards. Prior to 2014, long-horizon forecasts were available at a semi-annual frequency. In months where a long-horizon forecast is not available, we carry forward the latest available long-horizon forecast. For long-term forecasts, we use the mean estimate based on a full panel of forecasters.

Appendix A.2 Equilibrium Real Rate

We splice estimates of the equilibrium real rate for G4 markets from two sources. Before Q2 2017, we use the estimates of equilibrium real rates maintained by the New York Federal Reserve. These estimates are based on the methodology outlined in Holston, Laubach, and Williams (2017). The estimates are available for the US, the euro area and the UK. For Japan, we use the estimates provided by Fei Han of the International Monetary Fund. These estimates are based on the methodology outlined in Han (2019). From 2017 onwards, Consensus Economics publishes long-horizon (ten-year-ahead) forecasts for the Treasury bill yield for a panel of countries that includes the G4. Starting from Q2 2017, we approximate the equilibrium real rate by subtracting the mean long-horizon inflation forecast from the corresponding forecast of the Treasury bill yield.

Appendix A.3 Interest Rate Data

We source estimates of zero-coupon spot yields and forward rates from ICE Indices (formerly BofA Fixed Income Indices). The data are sampled at a monthly frequency and are available at three-month maturity steps between three and 360 months.

Appendix A.4 Equity Index Options

We estimate the equity risk premium using European options on major equity indices: the EURO STOXX 50, S&P 500, FTSE 100 and Nikkei 225. We source the option data and the corresponding risk-free interest rates from OptionMetrics. Options are available on the EURO STOXX 50 from January 2002, the S&P 500 from January 1996, the FTSE 100 from March 2002, and the Nikkei 225 from June 2009. To estimate the equity risk premium, we follow the methodology outlined in Martin (2017). More details on processing equity index option data are provided in a separate Discussion Note (NBIM, 2021).

Appendix B: Return Decomposition – Derivations

This appendix provides additional details on derivations of the return decomposition presented in Section 2 of the note.

Appendix B.1 Fixed Income

To obtain equation (10), we plug the definition of the nominal zero-coupon yield given by equation (3) into the definition of bond returns given by equation (1) to get:

$$
\begin{aligned}
r_{t+1}^{(n)} = & \underbrace{i_t^* + E_t\left(\pi_{t+1} - \pi_t^*\right) + \left(rr_t - r_t^*\right) + E_t ex_{t+1}^{(n)}}_{\text{expected return}} - \\
& \underbrace{-\left(n-1\right)\Delta i_{t+1}^* - N_{\pi^c,t+1}^{(n)} - N_{rr^c,t+1}^{(n)} - N_{tp,t+1}^{(n)}}_{\text{unexpected return – revisions to macro drivers}},
\end{aligned}
$$

where $\Delta i_{t+1}^* = \Delta\pi_{t+1}^* + \Delta r_{t+1}^*$ captures changes in the inflation target and the equilibrium real rate from time t to time $t+1$. The news terms are defined as follows:

$$
N_{\pi^*,t+1}^{(n)} = \left(n-1\right)\Delta\pi_{t+1}^* \tag{14}
$$

$$
N_{r^*,t+1}^{(n)} = \left(n-1\right)\Delta r_{t+1}^* \tag{15}
$$

$$
N_{\pi^c,t+1}^{(n)} = \sum_{i=1}^{n-1} E_{t+1}\left(\pi_{t+1+i} - \pi_{t+1}^*\right) - \sum_{i=1}^{n-1} E_t\left(\pi_{t+1+i} - \pi_t^*\right) \tag{16}
$$

$$
N_{rr^c,t+1}^{(n)} = \sum_{i=1}^{n-1} E_{t+1}\left(rr_{t+i} - r_{t+1}^*\right) - \sum_{i=1}^{n-1} E_t\left(rr_{t+i} - r_t^*\right) \tag{17}
$$

$$
N_{tp,t+1}^{(n)} = \sum_{i=1}^{n-1} E_{t+1} ex_{t+i}^{n-i+1} - \sum_{i=1}^{n-1} E_t ex_{t+i}^{n-i+1}. \tag{18}
$$

Appendix B.2 Equity Returns

Starting with the gross equity return in equation (5), we define the steady-state gross rate of dividend growth at time t denoted as $\overline{D}_t$ and the steady-state expected gross return at time t denoted as $\overline{R}_t$. These two components imply a steady state for the price-dividend ratio $\overline{PD}_t$:

$$\overline{PD}_t = \frac{\overline{D}_t}{\overline{R}_t - \overline{D}_t} \quad \text{and in logs:} \quad \overline{pd}_t = \overline{d}_t - \log\left(\exp\left(\overline{r}_t\right) - \exp\left(\overline{d}_t\right)\right),$$

where $\bar{r}_t = r^*_t + \bar{e}_t$. We assume that the equilibrium real rate, steady-state log excess returns, log dividend growth rates and the steady-state valuations are unpredictable, i.e. $E_t\left[r^*_{t+i}\right] = r^*_t$, $E_t\left[\bar{e}_{t+i}\right] = \bar{e}_t$, $E_t\left[\overline{d}_{t+i}\right] = \overline{d}_t$ and $E_t\left[\overline{pd}_{t+i}\right] = \overline{pd}_t$. Log-linearising equation (5) around the steady states above and iterating forward, we get:

$$pd_t = \overline{pd}_t + \sum_{i=1}^{\infty} \rho_t^{i-1} \left[E_t\left(\Delta\tilde{d}_{t+i}\right) - E_t\left(\tilde{r}^{eq}_{t+i}\right)\right], \tag{19}$$

where $\rho_t = \frac{\exp\left(\overline{pd}_t\right)}{1+\exp\left(\overline{pd}_t\right)}$. For more details on derivations, see Lettau and Nieuwerburgh (2008). Equation (6) is obtained by rearranging the terms in a log-linearisation of equation (5) at time $t+1$. Linearisation term κ_t is defined as $\kappa_t = -\log\left(\rho_t\right) - \left(1-\rho_t\right)\log\left(1/\rho_t - 1\right)$.

Appendix C: Implementing the Return Decomposition

This appendix provides details on the implementation of the return decomposition outlined in the body of this note.

Appendix C.1 Fixed Income Returns

To estimate the regression given by equation (12) we construct empirical proxies for the expected excess return and all four news terms. We assume that the duration of the fixed income portfolio is ten years, i.e. n = 120 months.

We extract the expected excess returns from the yield curve in three steps. First, we subtract both yield curve trends from yields across all maturities to get yield cycles. Second, we take a cross-sectional average of the cyclical parts of yields with maturities above one year. Finally, the term premium is a residual from the univariate regression of this cross-sectional average on a one-year yield cycle. The expected excess return is the term premium scaled by duration, which we assume to be ten years.

To obtain fixed income news terms, we decompose yields with maturities between three months and ten years. To do this, we follow equation (3) with one modification: we do not split inflation expectations into persistent and transitory components. This is motivated by the empirical evidence that suggests that the shape of the term structure of inflation expectations does not show much variation in our sample period. We approximate the term structure of inflation expectations using the one- and ten-year-ahead mean forecasts from the Consensus Economics panel and interpolate linearly between these two points.

Equation (3) suggests that r^*_t, which is part of i^*_t, loads equally on all yields across the term structure. This allows us to simply subtract the estimate of the equilibrium rate and maturity-matched estimates of inflation expectations from all yields we consider. This leaves us with a combination of the cyclical part of the ex-ante real rate and the term premium. We use the fact the relative importance of the term premium varies with the yield maturity and assume that the variation in the term premium moves on one factor. This allows us to use our estimate of the term premium in combination with loadings that vary between zero (one-year maturity) and one (ten-year maturity) to extract the cyclical part of the real rate. Once we have the term structures, we construct the news terms following equations (14)-(18).

Appendix C.2 Equity Returns

Section 2 identifies five drivers of equity returns. Due to data limitations, we do not split the expectations about real dividend growth into transitory and persistent components, which reduces the number of return drivers to four.

We implement the decomposition of G4 equity returns in the sample period Q1 1998 to Q4 2020. The start of the sample period is determined by data availability constraints.

We approximate the term structure of expected real dividend growth in each region through a simple term structure of expected real output growth obtained from the Consensus Economics panel. We interpolate between survey-based forecasts of real output growth at a one-year and a ten-year horizon. To build the term structure to infinity, we extrapolate the ten-year forecast.

We use the following two estimates of expected excess returns on equities to build a term structure for the equity risk premium:

- Option-based estimates of the equity risk premium following the methodology outlined in Martin (2017) (short end). US option data are available throughout the sample period. Euro area and UK option data are available from 2002, while Japanese option data start in 2009. In the early part of the sample period for which we do not have option data in the euro area, the UK and Japan, we approximate the short-term estimate of the equity risk premium with an estimate of expected volatility. Specifically, we fit an AR(1) model to two-month realised volatility for the indices that underlie the option-based approach. We find this measure to be highly correlated with the option-based estimates in the overlapping period.
- Estimates based on a restricted predictive regression following Campbell and Thompson (2008), which we use to approximate the long-horizon expectations about the equity risk premium. Specifically, we estimate a real-time version of the following predictive regression:

$$\widehat{ERP}_{DP} = \frac{D}{P} + \left(1 - \frac{D}{E}\right) ROE. \tag{20}$$

We interpolate between these two points on the term structure and extrapolate the long-horizon estimate to infinity to construct the term structure of expected excess returns. Option-based estimates of the equity risk premium also serve as a proxy for expected excess return in equation (13).

Once we have all four term structures, we construct the news terms by cumulating points on the term structure between the shortest maturity and infinity. For maturities between three months and ten years, we add up all the points discounted by ρ_t. For maturities above ten years, we create a "perpetuity" term using the longest available maturity. The news terms are obtained as a difference between the cumulated terms at times t and $t+1$.

We estimate the regressions in equations (12) and (13) using Bayesian methods, which allows us to impose priors on the magnitude of betas. We work with normal priors for all parameters. Compared to implementing the decomposition of fixed income returns, imposing priors is relatively more important for equities.