Unwind of negative bond risk premium to underpin rising yields

Leo Krippner, 28 March 2022

A. The evolution of bond yields is largely determined by the Expected Policy Interest Rate (EPIR) and the Bond Yield Risk Premium (BYRP). Quantifying these components provides a useful perspective for interpreting the historical movements of fixed interest yields and assessing their scope for future movements.

B. Figure 1 below illustrates that the recent rise in global bond yields (as proxied by a weighted-average of 5-year yields for the G4 countries) is mostly due to increases in the EPIR. This reflects the market anticipation, and subsequent delivery, of central banks withdrawing COVID-related monetary policy stimulus in response to elevated inflation pressures.

C. Figure 1 also shows that the BYRP for global bond yields remains just off its lowest levels in the sample period. An influence on the BYRP over 2020-21 has been purchases of government bonds by central banks, which also influenced the shift to a negative BYRP after 2008. A longer-term factor contributing to the persistent BYRP decline over the sample period was market confidence that central banks would maintain low and stable inflation.

D. The EPIR and BYRP suggest that bond yields still have much scope to move higher. That is, despite the G4 EPIR having reverted to the nominal Long-horizon Natural Interest Rate (LNIR), a level of restraint somewhat above the LNIR will likely be required to curtail prevailing inflation pressures. The upside scope is higher for the BYRP, due to the reversals of central bank government bond purchases and rising inflation uncertainty.

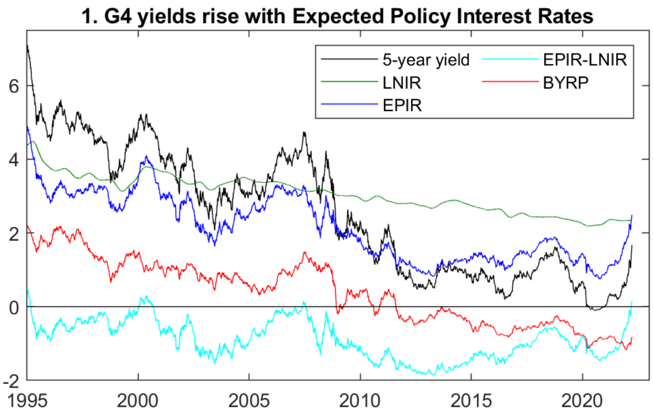

Figure 1: The G4 5-year yield and the underlying LNIR, EPIR, and BYRP components. These are all GDP weighted-averages of the United States, the Euro Area, Japan, and the United Kingdom.

1 Introduction

In this note I discuss the decomposition of bond yields, or more generally the nominal yield curve of fixed interest securities, into the components of the Expected Policy Interest Rates (EPIR) and the Bond Yield Risk Premium (BYRP, a term I will use even when the fixed interest rate may be for securities other than a bond). Section 1 first outlines the key concepts underlying any such decomposition, and section 2 provides an overview of the framework I use to estimate the EPIR and BYRP components. I present results in section 3 for the economies I regularly apply the framework to, i.e. the G4 economies (the United States, the Euro Area, Japan, and the United Kingdom) and the dollar-bloc economies (Canada, Australia, and New Zealand). In light of those results, I discuss the historical evolution of bond yields in section 4, and then in section 5 the outlook for bond yields from the perspective of the decomposition framework and results.

2 Policy interest rates, risk premiums, and the yield curve

The evolution of bond yields, or fixed income interest rates in general, is largely determined by the EPIR and the BYRP. For a given bond, the EPIR component reflects the alternative return that an investor would expect from a compounding investment in short-maturity interest rates over the bond's lifetime. That is, investors can choose between: (1) a longer-maturity investment in a bond at the prevailing market yield to maturity; or (2) rolling a series of short-maturity money-market investments, with yields close to the expected path of the Policy Interest Rate (PIR), up to the same maturity as the bond. The Expectations Hypothesis (EH) simply equates the two returns, thereby implicitly ignoring any risk premiums, and so predicts that a bond yield will essentially be determined by the average of expected short-maturity interest rates up to the bond's maturity.

The BYRP component reflects factors other than PIR expectations that may be associated with the bond. One example is the liquidity/safety benefits from government bonds, and another is the effect of central bank purchase programs specific to some classes of interest rate securities and not to other asset classes. More fundamental factors are the risk/return characteristics of bonds, and the potential benefit that bonds offer for diversification within portfolios of financial assets. I will expand on each of these four points in section 5.3.

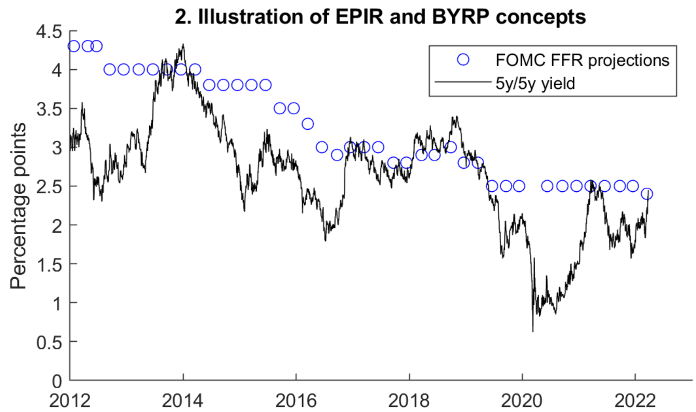

Figure 2: Federal Open Market Committee (FOMC) longer-term projections of the Federal Funds Rate (FFR), and the 5-year government bond yield five years' forward (5y/5y).

To illustrate the concepts discussed above, I refer to figure 2. It plots the median of the Federal Open Market Committee (FOMC) members' longer-term Federal Funds Rate (FFR) projections, which have been made publicly available from January 2012. I have also plotted the 5-year forward 5-year (5y/5y) government bond yield, which is calculated using the EH and 5- and 10-year bond yields,[1] to show the implied 5-year government bond yield in five years' time. A negative BYRP premium is the most plausible explanation for the 5y/5y yield usually being materially and persistently below the FOMC longer-term FFR forecasts over this period. A possible alternative but less plausible explanation is that the market nearly always factored in a materially lower average longer-term expected FFR than the FOMC over the past decade.

[1] That is 5y/5y=(10×10y–5×5y)/5. The 5y/5y is commonly used in various contexts to indicate longer-horizon expectations (e.g. for inflation swaps), but being based on the EH it omits any risk premium considerations.

3 A framework for estimating yield curve components

While a bond may be considered conceptually in terms of EPIR and BYRP components, neither of those components are observable in practice. However, they may be estimated using a theoretical model for the yield curve and applying it to a yield curve dataset (plus other relevant data, as discussed further below). Below I summarize my approach to this process (which I have used since 2015; e.g. see Krippner and Callaghan 2017), placing it in the context of the associated yield curve literature, and then discuss the output.

The yield curve model I use is an Arbitrage-free Nelson-Siegel Model (ANSM) for the shadow yield curve, within my shadow/lower-bound (LB) framework detailed in Krippner (2011, 2013, 2015c).[2] A shadow/LB model is appropriate given that the yield curve datasets for all of the economies I analyze have been subject in one or more periods to the near-zero constraint for interest rates. I estimate the shadow/LB model using the iterated extended Kalman filter. These choices are well-established in the literature. Examples of applying the ANSM are Krippner (2006, 2015b) and Christensen, Diebold, and Rudebusch (2009). Examples of using the ANSM as the shadow yield curve within the Krippner (2011-2015c) shadow/LB framework are Krippner (2015c), Christensen and Rudebusch (2015a), and Carriero, Mouabbi, and Vangelista (2016). These references and those in the following paragraph, except Bauer and Rudebusch (2020), use some version of the Kalman filter for estimation.

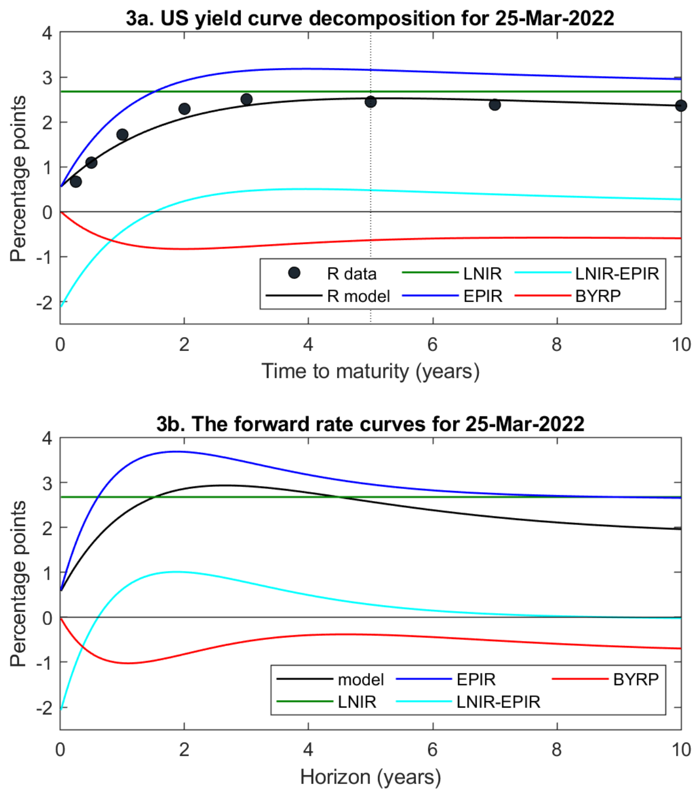

Figure 3: Panel (a) contains an example of yield curve data (R data) from 25 March 2022, and the results obtained from the estimated shadow/LB yield curve model. Panel (b) contains the forward curves associated with the estimated yield curve.

Regarding the yield curve dataset, the top panel of figure 3 below contains an example of the yield curve data that I use to estimate my model. These are Overnight Indexed Swap (OIS) rates

[2] The framework is specified in continuous time. Wu and Xia (2016) and Bauer and Rudebusch (2016) are examples of the analogous framework in discrete time.

for 25 March 2022, the last day of my yield curve dataset. OIS rates are for the fixed interest rate leg of derivatives that settle against the realized return from the PIR over the lifetime of the OIS contract, and so they are more precisely connected to expected PIR settings than rates on government securities. Otherwise the OIS yield curve has properties, characteristics, and behaviors very similar to the government bond yield curve.[3] The times to maturity for the yield curve data used in my estimation are 0.25, 0.5, 1, 2, 3, 5, 7, 10, and 30 years (the 30-year rate is omitted in figure 3 to better illustrate the shape of the yield curve for shorter times to maturity), and the yield curve dataset is daily from 3 January 1995. The literature often uses yield curve data with maturities out to only 10 years, but I prefer using the additional information in the 30-year benchmark maturity. Christensen and Rudebusch (2015b) and Christensen, Lopez, and Mussche (2018) are examples that use data out to 30 years to estimate shadow/LB models.

I also use survey data in two respects when estimating the model. First, to compliment the yield curve data, I use survey data for analysts' expectations of 3-month and 10-year interest rates for future horizons ranging from three months to 10 years (according to their availability). As discussed in Kim and Orphanides (2005, 2012) and Kim and Wright (2005), using such survey data improves the estimates of the expected path of the short-maturity rate, which otherwise tends to be estimated with low precision if only yield curve data is used for the estimation. Second, I use long-horizon survey data for interest rates, growth in Gross Domestic Product, and/or inflation, according to their availability, to estimate a time-varying nominal Long-horizon Natural Interest Rate (LNIR), in the sense of Wicksel (1898). Using surveys in this manner follows Kim and Orphanides (2005, 2012), Kim and Wright (2005), Bauer and Rudebusch (2020), and practice I am aware of for yield curve modeling at the European Central Bank. As explained in Bauer and Rudebusch (2020), their r^* (analogous to my LNIR) provides an anchor for the equilibrium value of the EPIR, and its time-variation reflects changes to the natural interest rate over time.

Panel (a) of figure 3 provides an example of the yield curve results obtained from the estimated model for 25 March 2022, along with the yield curve data as previously mentioned (the black dots "R data" in the top panel). The black line "R model" is the yield curve produced by the estimated model for 25 March 2022. As illustrated in figure 3, the differences between R data and R model are small, and the differences over the sample are small and not persistent (which is not surprising given that the model is estimated to provide the best fit of the shadow/LB model to the yield curve dataset). Therefore it is valid to treat the decompositions underlying R model as also applying to R data, which I do for the remainder of this note.

Figure 3 also shows the EPIR and BYRP components that are available from the estimated yield curve, R model = EPIR + BYRP. I typically re-express the EPIR component as EPIR = LNIR + [EPIR–LNIR], i.e. the LNIR plus what I will hereafter refer to as the EPIR gap, which therefore gives the following decomposition:

$$\text{R model} = \text{LNIR} + [\text{EPIR–LNIR}] + \text{BYRP}$$

Re-expressing EPIR as the LNIR and the EPIR gap is useful because it provides a gauge for whether the EPIR component is stimulatory or restrictive (i.e. a negative or positive EPIR gap, respectively) relative to natural interest rates that can change over time.

Panel (b) of figure 3 contains the equivalent information to the top panel, but expressed as forward interest rates by their forward horizon, rather than as interest rates by their time to maturity. The forward rate perspective is not required for the yield curve decomposition, but it helps with the intuition of the EPIR gap results and hence the discussion in sections 5.2 and 6.2. Specifically, the

[3]Indeed, I use government bond yields as a close proxy for OIS rates when OIS rates are not available (which, depending on the economy, is usually for earlier years in the sample and for longer times to maturity).

EPIR component for the forward rate curve is essentially the expected path of the PIR (to within a minor convexity term). The EPIR component for a given time to maturity in the yield curve representation is the average level of the expected path of the PIR up to the horizon equal to the time to maturity. For example, the EPIR component for the 5-year yield that I discuss in the following paragraph is the average of the expected path of the PIR for the next five years.

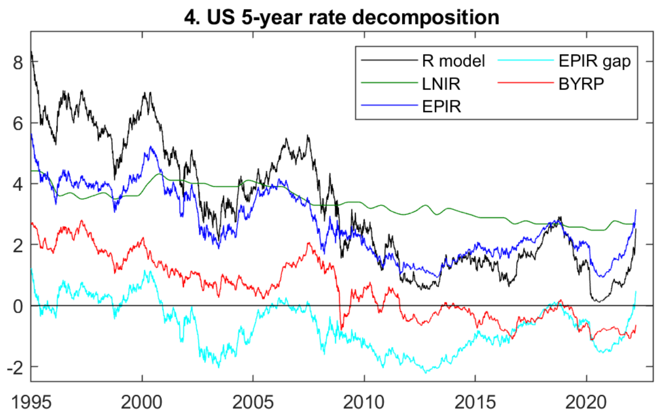

Figure 4: The time series of the US 5-year rate decomposed into its estimated components of the EPIR and BYRP, which may be equivalently expressed as LNIR, EPIR gap, and BYRP components.

The model will produce results like figure 3 for each day from the start to the end of the sample.[4] From the set of results for each point in time of the sample, the time series of the yield for any time to maturity may be decomposed into a time series of the LNIR, the EPIR gap, and the BYRP components. I routinely produce decompositions for maturities of 2-, 5-, 10-, and 30-years, which covers the short-, mid-, and long-maturity parts of the yield curve.

For this note, I will use just the decomposition for the 5-year yield as a single representative mid-maturity yield, which avoids any potential confusion with other times to maturity. Figure 4 plots the 5-year results for the US as an example of the decomposition for a single economy. To put these time-series results in context, the last points plotted for each series in figure 4 correspond to the 5-year results from panel (a) of figure 3 (i.e. where the vertical dotted line at the 5-year time to maturity intersects each of the respective curves).

4 G4 and dollar-bloc 5-year decomposition results

Figure 5 plots the decomposition results individually for each of the economies I routinely apply the framework to, i.e. the G4 (i.e. the United States [US], the Euro Area [EA], Japan [JP], and the United Kingdom [UK]) and the dollar-bloc (i.e. Canada [CA], Australia [AU], and New Zealand [NZ]). These are all from 1995, and the G4 results are a weighted-average of the US, the EA, JP, and the UK, by their respective GDP at market value converted to US dollars.[5] Note that I have used the same scale for all economies for comparability.

Figure 6 collects the results from figure 5 together by the LNIR, EPIR gap, and BYRP categories. For comparability, the 5-year rates and LNIR components are plotted on the same scales, and the EPIR gap and BYRP are plotted on the same scales. Figure 6 turns out to be the more insightful way to view the results because it shows that the components from each economy have typically followed fairly common trends (aside from Japan). This is most apparent for the LNIR, where there are usually

[4]Results are also produced for non-trading days. One benefit of estimating the model with the Kalman filter is that it provides model-consistent results even when yield curve data is missing or unavailable.

[5]The average weights over the sample period are US 44%, EA 33%, JP 16%, and UK 7%.

only small fluctuations, but it is also notable for the BYRP. And even the EPIR components among the different economies tend to cycle together. I will discuss these aspects further in the following section, and also mention why Japan is an exception.

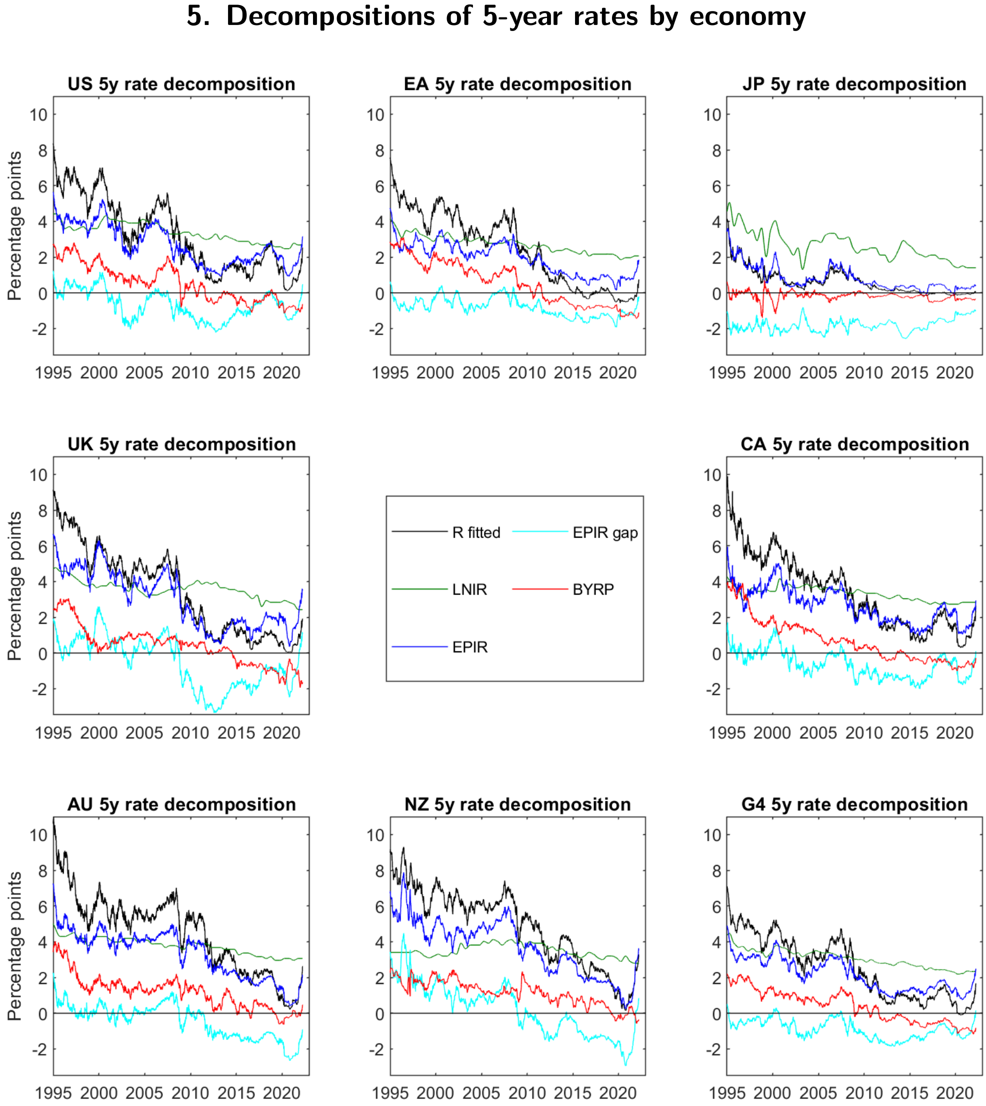

Figure 5: The time series of the 5-year yields for each economy decomposed into its estimated components of the EPIR and BYRP, which may be equivalently expressed as LNIR, EPIR gap, and BYRP components.

Figure 7 contains what I will refer to as the long US decomposition, which is possible to obtain due to the longer history of appropriate data for the US. The long US results provide an important perspective for the shorter results in figures 5 and 6, as I discuss in the following section. The results prior to 1995 are from an earlier estimate of the model with monthly data from June 1961 to November 2018, and I have plotted those monthly results to December 1994 spliced with the daily results thereafter.

The results from any model estimation will, of course, be influenced by the specification of the model and data used to estimate it, which is a point I highlighted in Krippner (2015a, 2020) in the context of Shadow Short Rate (SSR) estimates. Fortunately, yield curve decompositions are less sensitive to model and data choices than SSR estimates, in that my EPIR and BYRP results in figure 6 are broadly similar to those from Kim and Wright (2005) and Adrian, Moench, and Crump (2014), i.e. the respective models regularly updated by the Federal Reserve Board and the Federal Reserve

Bank of New York, and Bauer and Rudebusch (2020). The main differences of those models to my approach are that they use yield curve datasets with maturities out to 10 years, and they do not include a lower-bound mechanism for interest rates. Adrian, Moench, and Crump (2014) also does not use survey data.

6. Decompositions of 5-year rates by category

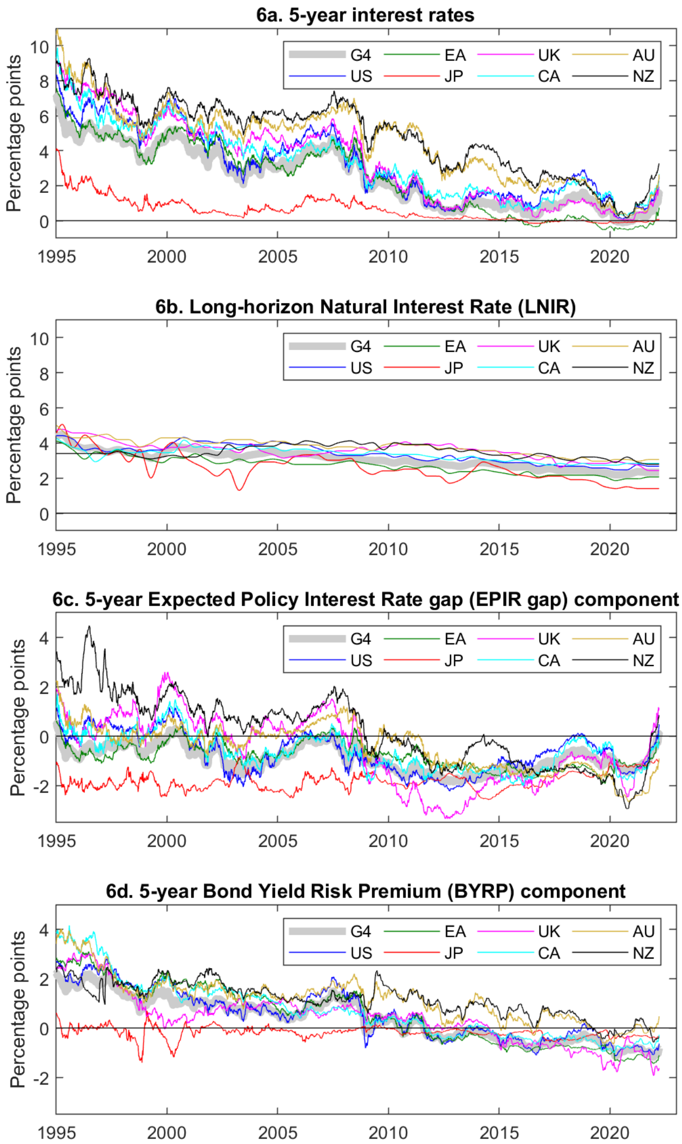

Figure 6: The time series of 5-year yields for each economy, and their decomposition into EPIR and BYRP components, which may be equivalently expressed as LNIR, EPIR gap, and BYRP components.

5 A component perspective on the history of 5-year bond yields

The 5-year rate has had an obvious downward trend down since 1995 for all economies, e.g. from 7.0% to a 2020 low of -0.1% for the G4 average, punctuated with occasional peak-to-trough reversals of in the order of several percentage points. The longer history for the US shows that the downward trend began well before 1995, i.e. from a peak of 14.8% in 1981 to a low of 0.1% in 2020, and 2.5% at present. Prior to the 1981 peak, the US 5-year rate trended up from 3.8% at the beginning of the sample in 1961.

The three components of the LNIR, EPIR gap, and BYRP provide a useful perspective for assessing the historical evolution of 5-year rates noted in the previous paragraph. In the following three subsections, I discuss each of these components in turn. In each case, I begin by discussing the longer history for the US because it helps to put the shorter history for the US and the other economies in context. In particular, I note up-front an important point indicated by the US results: i.e. the common downward trends for the LNIR and BYRP components for the economies I analyze may be related to common developments in the global inflation environment.

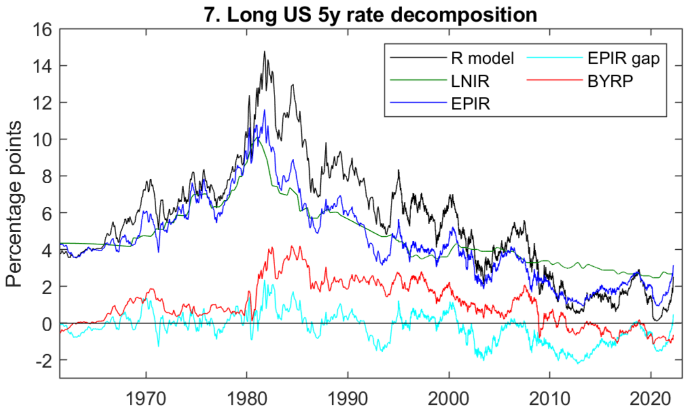

Figure 7: The time series of 5-year yields from 1961 for the US, and its decomposition into EPIR and BYRP components, which may be equivalently expressed as LNIR, EPIR gap, and BYRP components.

5.1 History of the LNIR

The LNIR for the long US decomposition shows a trend up from a level of 4.3% at the start of the sample in 1961 to a peak of 10.1% in 1980, and then follows a trend decline down to the present level of 2.7%. The relatively low volatility in the LNIR reflects the mechanics of its construction from long-horizon survey data that itself moves slowly. From an economic perspective, the long-horizon survey data reflects analysts' estimates of fundamental quantities inherent to the economy, such as the longer-horizon interest rate, longer-horizon GDP growth, and the central bank inflation target along with the perceived credibility of delivering it on average.

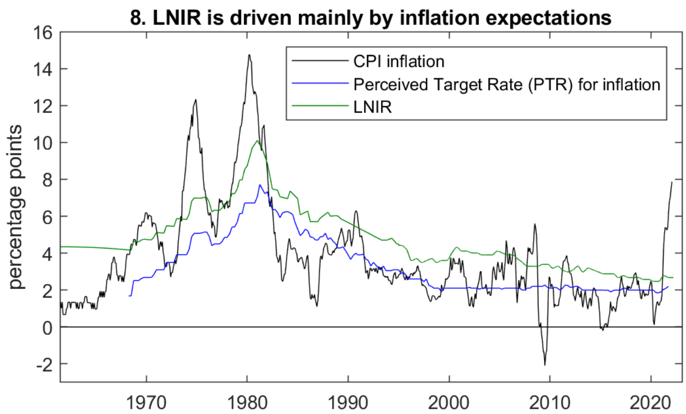

Figure 8: The long US LNIR plotted with CPI inflation and the Perceived Target Rate (PTR) for inflation used in the FRB/US model.

The profile for the long US LNIR is attributable predominantly to the long-horizon inflation expectations that I have used in its construction. To illustrate this, I have plotted the long US LNIR with one of the measures I use to construct it, i.e. the Perceived Target Rate (PTR) for inflation from the Federal Reserve FRB/US model. As noted in Bauer and Rudebusch (2020), the PTR is mostly based on inflation survey data. The part of the LNIR not attributable to inflation expectations, which may be gauged as the difference between the LNIR and the PTR, remains in a much narrower range of 0.5-2.5% over the sample period.

In brief, for the purposes of this note and the discussion below, the rising PTR from 1961 to the early 1980s occurred in an environment of persistently rising inflation, illustrated in figure 8 with a plot of ex-ante annual CPI inflation (the two peaks reflect the effects from the 1973 and 1979 oil shocks). The decline in the PTR followed the Volcker-led Federal Reserve tightening of monetary policy in 1979 with the aim to reduce inflation, which subsequently occurred from the early 1980s. The PTR continued to decline until the late 1990s when it reached a level of 2%, consistent with the Federal Reserve's implicit target since the mid-1990s, and announced explicitly in 2012.

The LNIR components for the other economies I analyze, with the exception of JP to be discussed below, have been similar to the US since 1995, and for similar reasons. That is, the LNIRs have trended lower over the shorter sample periods with relatively modest peak-to-trough reversals, and the main influence has been the decline in long-term inflation expectations driven by the focus of central banks to achieve low and stable inflation. Indeed, following NZ in 1989, inflation targets were adopted by the central banks of the UK, CA, and AU prior to 1995, and for the EA on its inception in 1999.

The LNIR for Japan shows a similar downward trend since 1995 as the other economies, but it differs in the other aspects. First, the LNIR for JP shows material variation over short periods of time, particularly around the year 2000. These results are mainly due to the variation of long-horizon survey results for inflation.[6] Second, the decline in JP inflation expectations occurred amidst doubts that economic policy would escape its low inflation environment. Indeed, the later adoption of explicit inflation objective of 1% in February 2012, raised to 2% in January 2013, were part of efforts to raise inflation expectations and inflation.

5.2 History of the EPIR gap

Figure 7 below plots the EPIR gap for the long US decomposition, and it is apparent that it has no obvious trend. That is, the series starts and finishes near zero, and it also averages zero over the sample. However, it is apparent from figure 7 that the EPIR gap has made the largest contribution to the routine cyclical variation in US 5-year rates since 1961.

The cyclical nature of the EPIR gap reflects that it is driven by monetary policy cycles, i.e. central bank actions and associated communication, plus market anticipation of those aspects depending on the markets' assessment of the central bank's reaction function. To illustrate the relationship between the EPIR gap and monetary policy for the US, figure 9 plots the FFR (monthly average to August 1982) spliced with the Federal Funds Target Rate (FFTR, available from September 1982) to represent conventional monetary policy (CMP). To represent unconventional monetary policy (UMP), once the FFTR had been set to the effective LB (the range of 0-0.25% for the US from December 2008 to December 2015 and then March 2020 to March 2022), I have also plotted my estimates of the Shadow Short Rate (SSR) and the Expected Time to Lift-off (ETL).

One notable monetary policy cycle example for the US is the tightening (and subsequent easing) of monetary policy in the late-1970/early-1980s to bring inflation down. This is evidenced by the record level of the Federal Funds Rate (FFR) in figure 9, and it was associated with the most positive EPIR gap over the sample, i.e. up to 2.4%. Other examples are the monetary policy easings (and subsequent tightenings) associated with the "dotcom" equity market downturn in the early 2000s,

[6] Some refinement to my fairly mechanical method of calculating the LNIR for all economies, to ensure comparability, might be worthwhile for JP. The LNIR results for NZ should arguably be higher in the early part of the sample.

the Global Financial Crisis (GFC, often referred to as the Great Recession in the US) in 2008, and the COVID economic disruption of 2020. The "dotcom" easing was achieved with CMP, i.e. by lowering the FFTR, while easing in the GFC and COVID cases was achieved with a combination of CMP (i.e. lowering the FFTR to near zero) and UMP (i.e. QE/LSAPs and forward guidance on how long the FFTR would likely remain near zero).

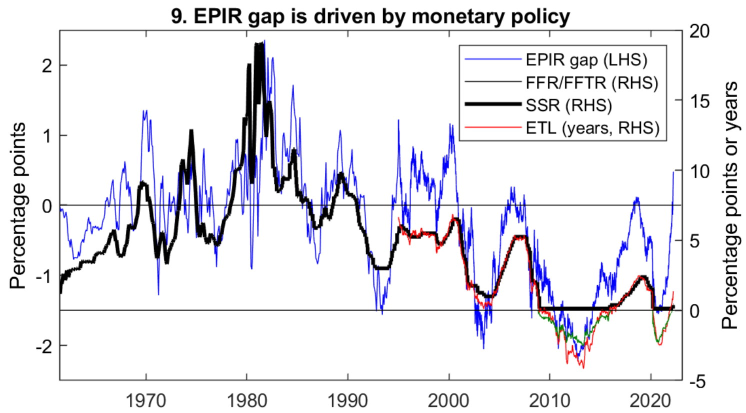

Figure 9: The long US EPIR gap (left-hand side) plotted with (on the right-hand side) the Federal Funds Rate or Federal Funds Target Rate (FFR/FFTR), Shadow Short Rate (SSR), and the Expected Time to Lift-off (ETL).

The EPIR gaps for other economies over the shorter sample period from 1995 also vary according to the monetary policy cycles in those respective economies. For example, episodes common to all economies (except the EA and JP) are the central bank easings in the wake of the GFC and again for the COVID economic disruption. JP was already in a LB environment when the GFC occurred, and both the EA and JP had not exited their LB environments before the COVID disruption. The EPIR gaps for the EA and JP therefore have a muted decline for the GFC and the COVID disruption relative to the other economies.

5.3 History of the BYRP

The BYRP for the long US decomposition went through a minor cycle from 1961 to the early 1980s, peaking at 1.9% in 1970. In the early 1980s, the BYRP rose quickly to levels of up to 4.2% (in 1982, 1984, and 1985), then settled into a range around 2% from the mid-1980s to the early 2000s. Since then, the BYRP has trended lower to the level of -1.1% in April 2020 and December 2021. However, there have been several marked cycles against the trend, most notably to a peak of 2.1% in 2007 and a peak of 0.2% in 2018.

The economic reasons underlying the BYRP movements noted above are more complex than for the EPIR gap. The latter has a well-identified economic driver, i.e. the EPIR relative to the slow-moving LNIR (albeit with both quantities themselves based on a variety of underlying factors), while the BYRP is in some respects a catch-all for everything else. I will therefore discuss the history of the long US BYRP using the perspective of four influences that have been discussed in commentaries and the literature, i.e.:[7] (1) the safety/liquidity effect of US government securities in times of US and/or global financial market uncertainty;[8] (2) the Federal Reserve's Quantitative Easing (QE) and

[7]For example, Ben Bernanke mentions all four of these aspects in the 2015 blog "Why are interest rates so low, part 4: Term premiums"; see https://www.brookings.edu/blog/ben-bernanke/2015/04/13/why-are-interest-rates-so-low-part-4-term-premiums.

[8]Even though I use OIS rates rather than government bond yields for my estimations, the former move closely with the latter.

Large Scale Asset Purchase (LSAP) programs; (3) the inflation environment; and (4) bond/equity correlation.

To introduce the first two influences, figure 10 plots the BYRP along with Federal Reserve total assets (available from December 2002). The dotted vertical lines indicate the following events on the given dates: (a) 15 September 2008, the Monday immediately after Lehman Brothers declared bankruptcy over the weekend, which was followed with liquidity provisions; (b) 22 May 2013, QE3 tapering first raised by FOMC Chair Bernanke; (3) 14 June 2017, FOMC announces intended balance sheet normalization; (d) 15 March 2020, Federal Reserve cuts the FFTR to zero and re-introduces LSAP programs; (e) 22 September 2021, FOMC statement first mentions tapering; (f) 19 February 2022, release of January 2022 FOMC meeting minutes first mentions balance sheet normalization.

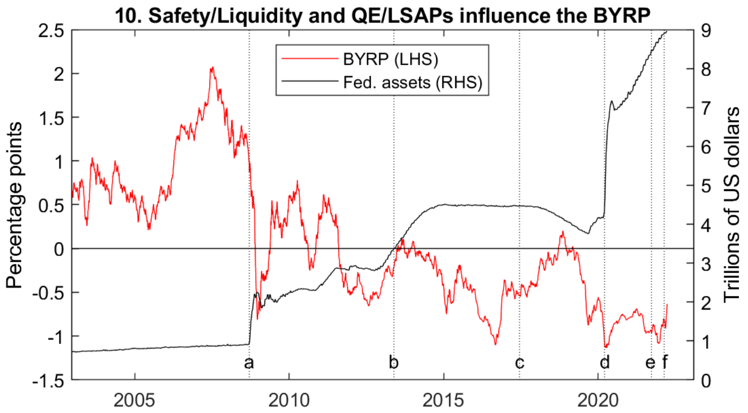

Figure 10: The US BYRP (left-hand side) and the total assets of the Federal Reserve (right-hand side). The dotted vertical lines denote the dates of events as explained in the paragraph above.

The large decline in the BYRP around the Lehman/GFC event, from 1.3% to -0.8%, is the best example of a flight to the safety of US government securities. Such events are typically short-lived, and in this case the BYRP rose quite quickly once financial markets settled from mid-December 2008.

The Federal Reserve's QE/LSAP programs had a less immediate but more pervasive effect on the BYRP. That is, excluding the safety/liquidity effect discussed above, the decline in the BYRP from around 0.5% in mid-2009 to negative levels and then to new lows coincided with the Federal Reserve's balance sheet expansion from September 2008, initially through liquidity provisions in response to the Lehman Brothers' bankruptcy and then through several rounds of QE/LSAP programs to offset the economic downturn from the GFC. The sharpest rise in the BYRP occurred once the Federal Reserve began a series of increases in the Federal Funds Rate (beginning with a range of 0.50-0.75% in December 2016) and announced an intention to reduce the size of its balance sheet from 2017 to 2019 (foreshadowed in June 2017).

The inflation environment is a fundamental driver of the more persistent trends in the long US BYRP. To be clear up-front, what I outline below is not simply a form of "higher bond yields are required to compensate for higher inflation"; while true, this is an expected return consideration that would be reflected in a rising LNIR and/or EPIR. The BYRP connection to inflation is a separate channel that follows from considering risk premiums in general with respect to a fundamental foundation from asset pricing theory. The foundation is best outlined by quoting from Cochrane (2005), page 13:[9]

[9]See the "Risk Corrections" section of Cochrane (2005) chapter 1 for further related discussion.

"... an asset's price is lowered if its payoff covaries positively with consumption. Conversely, an asset's price is raised if it covaries negatively with consumption. Why? Investors do not like uncertainty about consumption. If you buy an asset whose payoff covaries positively with consumption, one that pays off when you are already feeling wealthy, and pays off badly when you are already feeling poor, that asset will make your consumption stream more volatile. You will require a low price to induce you to buy such an asset."

As Cochrane (2005) subsequently notes, paying a low price for a given expected return is simply an alternative expression of the well-used finance adage that a high risk asset (in the covariance sense noted above) needs to provide a high return. A well-diversified equity portfolio is the most familiar example of a high risk/high return asset, and the fundamental reason from asset pricing theory is because equities tend to perform poorly in economic downturns (as expected earnings tend to decline).

For bonds, unanticipated changes in inflation should in principle result in bond payoffs that covary positively with consumption. That is, larger unanticipated increases in inflation are associated with larger increases in bond yields, therefore larger decreases in bond prices, and the latter represents a lower payoff from owning bonds. At the same time, the higher-than-anticipated level of inflation reduces the spending power of income and wealth available for consumption, relative to the spending power based on the previously anticipated level of inflation.

11. Inflation uncertainty figure from D'Amico and Orphanides (2014)

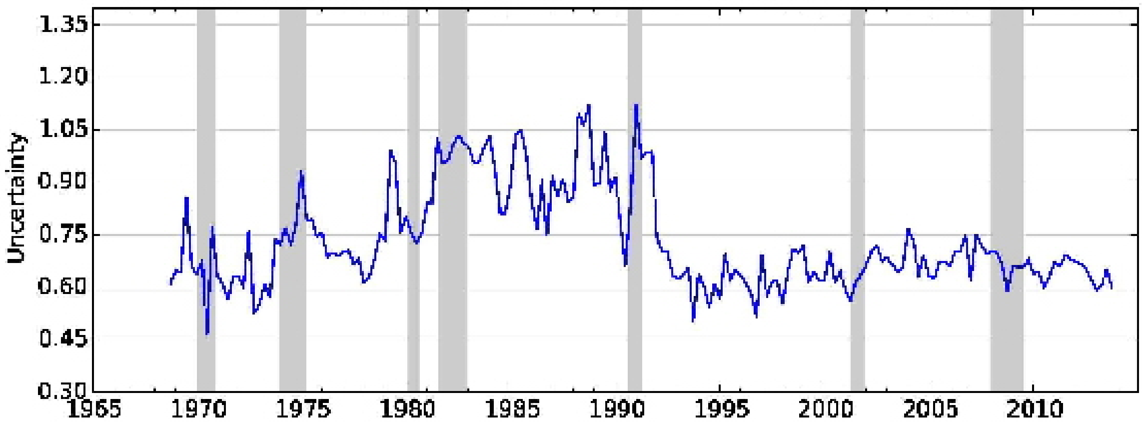

Figure 11: In the absence of the numerical data being available, I have reproduced the second panel of figure 1 from D'Amico and Orphanides (2014), which plots the direct measure of inflation uncertainty estimated for the US in that paper.

In summary then, the BYRP should rise (fall) as the inflation outlook becomes more (less) uncertain, so the BYRP should in principle be positively correlated with inflation uncertainty. This relationship may be checked empirically given a direct measure of inflation uncertainty, but long histories of such data are unfortunately not readily available. One imperfect proxy is CPI inflation itself, based on the Friedman–Ball theory that inflation uncertainty increases with the level of inflation (which has empirical support in the literature). A direct measure of inflation uncertainty is produced in D'Amico and Orphanides (2014), and figure 11 reproduces the relevant figure from that paper (the underlying data are not available). Another direct measure is the 5-year inflation uncertainty index from Binder (2017), which is on a 0-100% scale that I have rescaled in figure 12 to approximately match the level and range of annual CPI inflation. However, the Binder (2017) 5-year data are only available sporadically from 1980 to 1990, and are then monthly from April 1990 to May 2021.

Figure 12 indicates a positive correlation of the BYRP with CPI inflation.[10] The BYRP relationship also appears positive with the partial 5-year inflation uncertainty data, and with the profile of the of inflation inflation uncertainty measure reproduced in figure 11. Indeed, D'Amico and Orphanides (2014) establishes a positive relationship with the term premium measure used in that paper, and Wright (2011) is another example that establishes the same result.

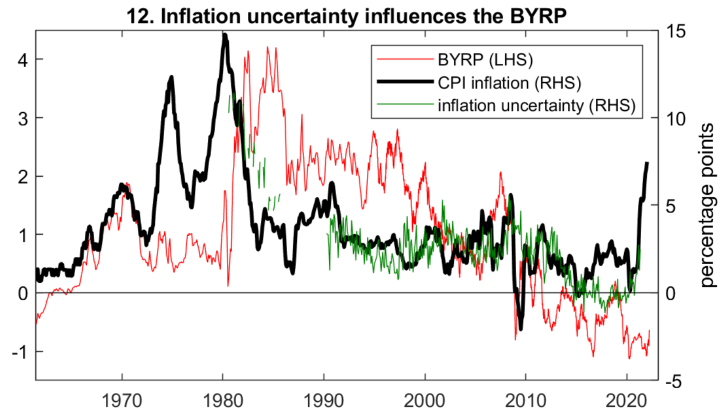

Figure 12: My estimated BYRP plotted with CPI inflation and the rescaled 5-year inflation uncertainty measure from Binder (2017).

Moving to the bond/equity correlation, this is another fundamental aspect associated with asset pricing theory. Essentially, investors should in principle be prepared to pay more for asset classes that offer greater diversification benefits, i.e. that enhance overall return relative to risk, within an overall financial portfolio. Bonds are one such asset class relative to equities, in that there will always be some diversification benefit but more so if/when bonds provide some degree of hedging for equities.

The hedging benefits of bonds relative to equities may be gauged from the rolling correlation of their respective price changes. Figure 13 plots the rolling one-year correlations of the daily returns on the Standard and Poor's 500 Stock Composite Index with negated daily bond yield changes. Negating the bond yields change puts both equity and bond returns on a price basis, which is clearest for discussing the correlations. That is, a positive correlation indicates that bond prices tended to increase (decrease) when equity returns were positive (negative), while a negative correlation indicates that bond prices tended to increase (decrease) when equity returns were negative (positive). It is worthwhile mentioning, which I will return to in section 6.3, that the economic environment is the underlying reason for the changes in correlation. For example, from the abstract of Ilmanen (2003): "Growth and volatility shocks tend to push stocks and bonds in opposite directions, while inflation shocks tend to cause common discount rate variation across asset classes."[11]

The diversification benefits of bonds relative to equities are lowest when the bond/equity correlation is most positive, and investors would be expected to pay a lower price for bonds during such periods. Translating this back into yields, investors would only invest if bond yields offered a positive BYRP. Conversely, the diversification benefits of bonds relative to equities are highest when the bond/equity correlation is most negative, resulting in a higher price for bonds, which translates to a positive BYRP.

[10]The relationship is highly significant, with a t-statistic of 2.94 (adjusted for heteroskedasticity and autocorrelation using the Newey-West method and a window length set to 12, where the latter allows for the moving average effect from using monthly CPI data to calculate annual inflation).

[11]A longer list of potential drivers is contained in https://www.vanguardinvestments.se/documents/the-stock-bond-correlation-eu-en-pro.pdf.

Figure 13 shows empirically that the in-principle relationship between the BYRP and the bond/equity correlation holds in practice.[12] That is, the BYRP is generally higher when the bond/equity correlation is more positive, and the BYRP is lower when the bond/equity correlation is more negative.

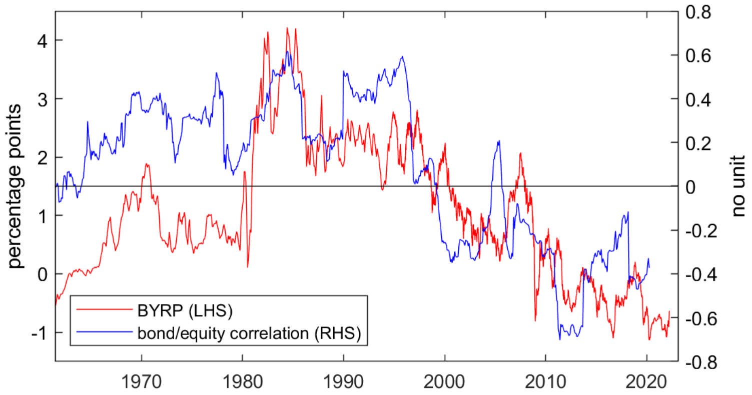

Figure 13: The long US BYRP plotted with the bond equity correlation over the

The BYRP for the other economies, apart from JP which has been relatively flat over the whole sample, also show a distinct downward trend in the sample period from 1995. The reasons are fairly similar to those given for the US. The main points in common are the influence of moderating inflation and therefore lower inflation uncertainty on the BYRP, and the generally lower BYRP over the period/s of QE/LSAP programs (from 2008/09 except for AU and NZ that only implemented UMP actions from 2020). And while I haven't calculated bond/equity correlations, the influence of US bonds and US equities on their global counterparts makes it likely that bond/equity correlations have followed a similar pattern in all of the economies I analyze. The safety/liquidity effect is the main point of difference, which is unsurprising given the typically specific demand for US bonds in such circumstances. Hence, this effect was muted in most economies around the GFC, and the BYRP for AU and NZ initially rose.

6 A component perspective on the outlook for 5-year bond yields

Having introduced the 5-year rate decomposition components and their historical evolution in the previous sections, in this section I discuss the outlook for 5-year rates based on the LNIR, EPIR gap, and the BYRP and their drivers. As previously, I will generalize for all of the economies analyze, but I will leave aside JP given its particular circumstances already discussed in section 5.

6.1 Outlook for the LNIR

As discussed in section 5.1, the main driver of movements in the LNIR is long-horizon inflation expectations. This in turn depends on the central bank's inflation target and the credibility that the market has in the central bank achieving the target on average over time. The latter point and the current elevated level of inflation provides an element of upside to the LNIR. That is, as was the case in the 1970s, long-horizon inflation expectations are likely to rise if inflation remains elevated, in which case markets may question how tightly central banks intend to adhere to their target. At present, surveys of US inflation are for 6.6% and 3.0% for 2022 and 2023 respectively, following the 4.9% outcome for 2021 (all annual average percent changes).

[12]The relationship is highly significant, with a t-statistic of 4.09 (adjusted for heteroskedasticity and autocorrelation using the Newey-West method and a window length set to the correlation window). The relationship and its statistical significance is robust to changes in the length of the window used to calculate the correlation.

Two other aspects, albeit qualitative and speculative respectively, that have potential to skew inflation and long-horizon inflation expectations to the upside are:

- The prevailing global supply environment, including geopolitical considerations, is arguably the least conducive to globalization and the benefits that it has had on productivity and prices over the past three decades or more. In particular, the importance of securing the supply of key components has shifted ahead of seeking the least cost factors of production.
- Central banks may adopt higher inflation targets. The case was raised after the GFC that central banks could adopt higher inflation targets, 4% was suggested, to provide more scope for real interest rate decreases without hitting the near-zero LB for nominal interest rates. Central banks could use the prevailing inflation environment to adopt modestly higher inflation targets that could be attained without as restrictive a monetary policy stance being required for current targets.

6.2 Outlook for the EPIR gap

Beginning with the outlook for central bank PIR settings, the case for increases is clear given the environment of elevated inflation, economic activity at or close to capacity, and particularly because real PIRs are historically low. The latter is due to the combination of near-zero or low nominal PIRs and inflation at multi-decade highs, which figure 14 illustrates for the US. Whether using ex-ante CPI or PCE ex-FE inflation, the real FFR/FFTR is slightly below their lows of 1980 and 1975, respectively. This perspective suggests some urgency in raising PIRs. While some central banks have already started to deliver (in the US, UK, CA, and NZ), there is obviously still quite a way to go to get real PIRs back to neutral and then restrictive to offset prevailing inflation pressures.

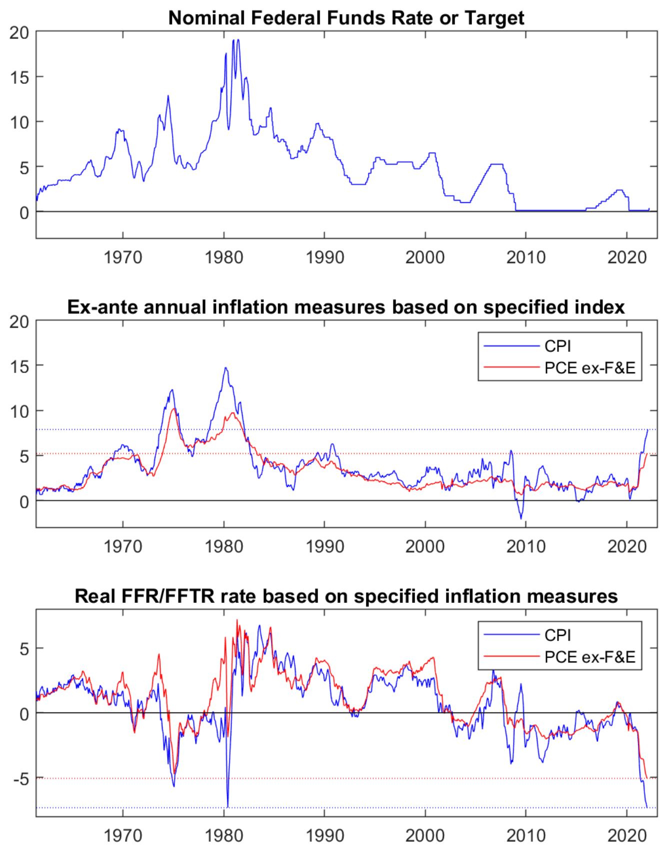

Figure 14: Real FFR/FFTR calculated from ex-post annual inflation based on the Consumer Price Index (CPI) and on the index for Personal Consumption Expenditure excluding Food and Energy (PCE ex-F&E).

However, the EPIR gaps show that markets have already factored in a series of PIR increases. Specifically, with the exception of the EA and AU (and the previously noted special case of JP), 5-year EPIR gaps have risen to near zero or more in all economies. Referring to the example in figure 3, a zero 5-year EPIR gap in the top panel essentially implies that the expected path of the PIR over the following five years will equal the LNIR. Hence, given there is an initial period of the expected path of the PIR being below the LNIR, a longer-horizon period of the expected path of PIR being above the LNIR must already have been factored into 5-year rate. This is illustrated in panel of figure 3 for the US, but for a 5-year EPIR gap of 0.48% rather than zero. That is, the expected path of the PIR rises above the LNIR of 2.7% at the horizon of 0.63 years, peaks at 3.7% at the horizon of 1.9 years, and then declines to 3.0% at the horizon of 5 years. The average of this expected PIR path is 0.48%, which is the PIR gap for the 5-year time to maturity in panel (a) of figure 3.

Nevertheless, most economies typically have the 5-year EPIR gap in the order of 0.5-1% in anticipation of or during a tightening cycle. Hence, there will likely be some further movement higher in the EPIR gap for all economies. A related consideration is that central banks have, to-date, been relatively sanguine about the emergence and persistence of inflation pressures, and the timing and magnitude of their policy responses to offset it. That is, after initially hoping that rising inflation would prove transitory, central banks all brought forward their PIR lift-offs from their prior indications,[13] but indicated that PIR increases would be at a gradual pace. Now there is now increased scope for another shift in central bank considerations, as already hinted at by the US and NZ, of a faster pace of PIR increases. Finally, if the prevailing period of elevated inflation leads to more persistent inflationary outcome that then requires a disinflationary period, then the monetary policy response would be larger again. The longer history for the US for such a period in the late 1970s/early 1980s shows that the EPIR gap peaked at 2.1%.

6.3 Outlook for the BYRP

Like the historical narrative for the BYRP, the outlook for the BYRP is the combination of its larger number of potential influences. I will therefore discuss in turn the four influences introduced in section 5.3, i.e. (1) safety/liquidity; (2) QE/LSAP programs; (3) the inflation environment; (4) and bond/equity correlation.

The main safety/liquidity consideration at present is any possible effects arising from losses associated with lending to Russia, given the sanctions imposed after the Ukraine invasion. These would likely fall predominately within the Euro Area. However, this aspect has already been known to the market for several weeks, and it only resulted in a mild fall in the BYRP during the first week of March. Indeed, the longer-term consideration from a safety/liquidity perspective issue is the potential for some diversification of foreign reserves away from the US dollar as countries consider the implications of Russia recently being cut off from its foreign reserves.

Regarding QE/LSAP programs, central banks have now at least indicated bringing them to a close (aside from JP), and several have already indicated a reversal of their expanded balance sheets built up since 2020. The former includes the EA and AU, and the latter includes the UK, CA, NZ, and most notably the US. In particular, aside from a 0.25% increase in the FFTR, the 16 March 2022 Federal Open Market Committee (FOMC) statement included the line: "In addition, the Committee expects to begin reducing its holdings of Treasury securities and agency debt and agency mortgage-backed securities at a coming meeting." Furthermore, the minutes of the January 25-26 FOMC meeting indicate that the reversal will be quicker than the post-GFC pace, i.e. from page 11: "While participants agreed that details on the timing and pace of balance sheet runoff would be determined at upcoming meetings, participants generally noted that current economic and financial conditions

[13] The exception is the special case of JP, where no indications of lift-off have been given (and the ETL implied from the yield curve has remained fairly steady).

would likely warrant a faster pace of balance sheet runoff than during the period of balance sheet reduction from 2017 to 2019. Participants observed that, in light of the current high level of the Federal Reserve's securities holdings, a significant reduction in the size of the balance sheet would likely be appropriate."

The US provides the only post-GFC precedent for the potential effect of central bank security holding reductions on the BYRP, over 2017 to 2019. Based on that period, a reversal of the US BYRP to the 2018 peak (0.2%), would be an increase of about 0.8 percentage points from the latest US value of the BYRP (-0.6%). However, the reduction in holdings from 2017 to 2019 was based on not re-investing the proceeds from maturities. A faster reduction, as indicated by the FOMC above, would likely occur via outright security sales. This might see the BYRP return to the levels that prevailed prior to any QE/LSAP actions in 2008, i.e. about 1%. Another consideration is that another G4 central bank (the UK) has indicated security holding reductions (as have CA and NZ), while the EA will at least cease its security purchases. Hence, the resulting net flows from central banks has the potential to push the BYRP even higher.

Regarding the effect of the inflation environment on the BYRP,[14] the main consideration based on the discussion in section 5.3 is how inflation uncertainty will evolve. There are two immediate reasons to expect it to remain elevated, and therefore contribute to a higher BYRP. The first reason is the level of inflation itself, i.e. it is at a 40-year peak for the US, and analysts' surveyed expectations are for it to remain elevated over 2022 and 2023. A second and related reason is that an up-to-date direct measure of inflation uncertainty, i.e. the standard deviation of expected inflation from surveys has been rising steadily. That is, for the US at the start of 2021, the standard deviation of surveyed inflation expectations for 2022 was 0.3%. As at March 2022, the standard deviation is now 0.7%.

Turning to bond/equity correlations, the least disruptive outcome that could be hoped for with respect to the BYRP would be that the correlations return to the average negative levels that prevailed from the late 1990s. That would therefore justify the existing holdings of bonds relative to equities in financial portfolios. But without that best outcome, the mechanical calculations of fund managers will at some point, depending on their given rolling windows, produce the less negative bond/equity correlation and translate that to reduced bond holdings when undertaking their portfolio risk/return optimizations, thereby increasing the BYRP. The economic environment suggests that the best outcome is unlikely at present, given that elevated inflation is more consistent with the bond/equity correlation being less negative.

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[14]That is, apart from the potential effect of inflation on the LNIR and EPIR, which have already been discussed respectively in sections 6.1 and 6.2.

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