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NATURAL AND NEUTRAL REAL INTEREST RATES: PAST AND FUTURE

Maurice Obstfeld

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ABSTRACT

Monetary theory posits a critical real rate of interest below which the monetary policy setting is inflationary and above which it is deflationary. For roughly a decade after the Great Financial Crisis (GFC), many economists linked deflationary pressures to the difficulty central banks encountered in attaining sufficiently low policy interest rates after decades of global decline in real market rates. In contrast, some ascribe the recent global upsurge in inflation to central banks' tardiness in raising real policy rates high enough to place a sharp brake on demand. This paper surveys the decline in real interest rates in advanced and emerging economies over the past several decades, linking that process to a range of global factors that have operated with different force in different periods. The paper argues that estimates of the long-run equilibrium real rate, which I call the natural rate ($\bar{r}$), may not always furnish an accurate guide to the rate appropriate for short-term monetary policy, which I call the neutral rate (r^*). It suggests that monetary policymakers should consider not only equilibrium in the market for domestic goods, but also the current account balance, financial conditions (including gross capital flows), and imperfect policy credibility. According to market indicators, expected long-term real interest rates have now risen to around the levels that prevailed just before the GFC. However, some of the main underlying factors that pushed real interest rates down after the 1980s and 1990s (notably demographic shifts, lower productivity growth, corporate market power, and safe asset demand relative to supply) may remain relevant. The big open question is whether recent developments including geopolitical tensions, bigger government deficits, deglobalization, and possible productivity gains from generative AI will overpower other ongoing trends to produce a further durable rise in global real interest rates. If not, low equilibrium interest rates may well continue periodically to bedevil monetary policy and financial stability. But if so, fiscal crises become a bigger risk.

Maurice Obstfeld
Peterson Institute for International Economics
1750 Massachusetts Avenue, NW
Washington, DC 20036
and NBER
obstfeld@econ.berkeley.edu

Over decades, real interest rates have fallen across the globe from the heights reached during the disinflation of the 1980s. The world has taken a remarkable journey from Blanchard and Summers (1984) – "Perspectives on High World Real Interest Rates" – through Summers (2015) – "Have We Entered an Age of Secular Stagnation?" – to Blanchard (2023) – "Secular Stagnation is Not Over" – and Summers (2023) – "My guess is that we'll not return to the era of secular stagnation ..." Meanwhile, Rogoff, Rossi, and Schmelzing (2024) contextualize the high real interest rates of the Volcker era as well as the low rates following the Great Financial Crisis (GFC) as mere blips around a relentless downward trend of global long-term real rates since the early fourteenth century.[1]

This evolution and its likely future have a range of implications for macroeconomic and financial policymaking, as well as for the intergenerational distribution of income. One set of questions centers on monetary policy. For roughly a decade after the GFC, many economists linked deflationary pressures to the difficulty central banks encountered in attaining sufficiently low real interest rates across the maturity structure of credit instruments. In contrast, some ascribe the recent global upsurge in inflation to central banks' tardiness in perceiving the need for real policy rates of interest high enough to place a sharp brake on demand. What benchmark, however, should guide the monetary policy rate toward a stance restrictive enough to reduce inflation on an acceptable time scale, but not so restrictive as to generate deep recession? The most common answers refer to the "natural" or "neutral" policy rate of interest.

The conclusion of this paper will not surprise anyone. There are no easy answers, no off-the-shelf recipes for monetary policy that apply in all circumstances. (Even the iconic Taylor rule depends on an intercept term that represents an unknown equilibrium real rate of interest.) As unsatisfying as it may be, we largely remain in the situation described in the 1930s by John H. Williams (1931), as quoted by Athanasios Orphanides and John C. Williams (2002):

> The natural rate is an abstraction; like faith, it is seen by its works. One can only say that if the bank policy succeeds in stabilizing prices, the bank rate must have been brought in line with the natural rate, but if it does not, it must not have been.

A statement by Federal Reserve Chair Jerome Powell echoes the preceding one (Powell 2023, p. 11):

> [W]e understand that it's a real rate that will matter and that needs to be sufficiently restrictive. And, again, I would say, you know ... "sufficiently restrictive" only when you see it .... [I]t's not something you can arrive at with confidence in a model or ... in various estimates ....

Past data can potentially illuminate what the price-stabilizing rate "must have been." However, extrapolating that learning into the future is riskier. I will also argue, however, that the drivers of global real interest rates are multiple and changing and that many of the empirical frameworks used to guide monetary policy are incomplete owing to failures to account for shifting policy credibility, financial conditions, and global forces. These factors make it especially perilous to forecast future real interest rates, but I will nonetheless try to identify relevant factors.

[1] Rogoff, Rossi, and Schmelzing (2024) cite an average 1.6 basis point per year decline in the global long-term real rate over their eight-century data sample. Like their finding, the Council of Economic Advisers (2015) found an average 2 basis point per year decline in the United States real long-term rate since the late nineteenth century.

The paper is in eight sections. Section 1 draws a distinction between the neutral or non-inflationary policy rate of interest (r^*) and the natural or long run flexible-price equilibrium rate ($\bar{r}$). Here, "long run" means "after all sticky prices (and other state variables) have had time to adjust." Section 2 reviews the recent behavior of real government bond interest rates in advanced economies, while section 3 compares that experience with that of emerging and developing economies (with special attention to Asia). Section 4 reviews the basic determination of world real rates in terms of global saving and investment and examines how global saving and investment patterns over the past three decades may have affected rates. Then section 5 considers shifts in relative demand for safe assets as a determinant of real government bonds rates and presents some evidence. Section 6 brings these strands together to identify distinct phases of global real interest rate decline since the early 1990s, driven by somewhat phase-specific factors. The role of neutral and natural interest rates in monetary policy is the subject of section 7, which emphasizes the determination of the natural rate in open economies. Closed-economy predictions are modified in that setting. Finally, section 8 considers whether a substantive rise in real interest rates is in store considering demographic, economic, political, and geopolitical trends and shocks. I conclude that different answers to this question presage different policy challenges.

1. The Natural Rate and the Neutral Rate

Economists usually cite Wicksell (1898) for the insight that a real central bank policy rate set below a benchmark real market rate of interest will be inflationary, whereas the opposite setting will be deflationary (Woodford 2003). However, the idea goes much further back, at least to Henry Thornton at the start of the nineteenth century. Hayek (1939, p. 50) described the link to Wicksell in his introduction to Thornton's 1802 classic, *An Enquiry into the Nature and Effects of the Paper Credit of Great Britain.* Hayek's edition includes two summaries of speeches in the House of Commons debate over the Bullion Report of 1810, in which Thornton lays out with clarity his view that a policy interest rate set below the market rate will lead to excessive credit issuance and inflation:

> This subject, of the rate of interest, was one to which he wished to call the attention of the House; it seemed to him to be a very great and turning point. If the principle adopted by the Bank [of England] was that which they professed, of lending to the extent, or nearly to the extent, of the demand made upon them by persons offering good mercantile paper, the danger of excess was aggravated in proportion to the lowness of the rate of Interest at which discounts were afforded, and one cause, as he conceived, of the somewhat too great issues of the Bank, during the present war, had been the circumstance of their lending at five per cent., when rather more than five per cent. might in reality be considered as the more current rate paid by the merchants.[2]

Thornton does not describe exactly how a central bank would ascertain "the more current rate [of interest] paid by merchants" or what Hayek (1939, p. 50) calls the "mercantile rate" of interest. Wicksell (1898, p. 102) was more specific, defining the natural rate as the rate at which the demand and supply of capital would be in equilibrium in a non-monetary economy – basically, the equilibrium return on capital under full employment and flexible prices. Woodford (2003, p. 9) identifies the natural rate with "the equilibrium real rate of interest in the case of flexible prices and wages, given current real factors." Laubach and Williams (2016) add another proviso that gives their definition more of a long-run flavor, "the real short-term interest rate consistent with the economy operating at its full potential once

[2] Hayek (1939, p. 335).

transitory shocks to aggregate supply or demand have abated." Even after one chooses one of these conceptual definitions, there is still the question of what empirical manifestation of the long-run equilibrium rate of return can serve as a benchmark for central bank policy – for example, the rate on treasury debt or the marginal product of capital (Reis 2022).

In recent decades, monetary policymakers pursuing inflation targets have focused increasingly on the natural-rate framework to guide policy interest rates. Borio (2021) shows that the number of central bank speeches mentioning the natural or neutral interest rate first moved into double digits in 2015 – the year of the Federal Reserve's initial "lift off" from zero nominal rates following the GFC – and has only been higher since then. That official focus is encouraged by modeling such as that of Neiss and Nelson (2003), Barsky, Justiniano, and Melosi (2014), and Cúrdia, Ferrero, Ng, and Tambalotti (2015). In Barsky, Justiniano, and Melosi (2014), for example, a monetary policy tracking "the natural real interest rate ... that would have prevailed in an economy with neither nominal rigidities nor price and wage markup shocks ... would have significantly stabilized the output and [employment inefficiency] gaps while also decreasing the variability of price and wage inflation."

Because the central bank policy rate is a nominally risk-free rate, the most logical benchmark for its real value is the equilibrium rate on a government bond. There is now a huge empirical literature on real government bond interest rates that documents and attempts to explain their long decline and the implications for monetary policy implementation. Much of this literature uses the terms "natural" and "neutral" real interest rate interchangeably, but I will find it convenient to distinguish between them – even though these rates are closely related conceptually and are positively correlated with each other over time. By *natural rate*, I will mean the real rate of interest prevailing in a long-run equilibrium where price rigidities are no longer relevant and other expected economic adjustments have taken place – one might denote this rate as $\bar{r}$ (r-bar). By *neutral rate,* typically labeled r^* (r-star), I will mean the real policy rate of interest that eliminates inflationary or deflationary pressures (see also Platzer, Tietz, and Lindé 2022). I will argue that $\bar{r}$ and r^*– while closely related and even identical within some stylized modeling frameworks – are not necessarily the same in real-world economies.

I focus on these two interest rates because r^* is central to the conduct of monetary policy in the short run, whereas a broad set of methodologies seeks to estimate some variant of $\bar{r}$. However, one could define a time profile of $\bar{r}$ values at various intermediate horizons i, with $\bar{r}_{t+i}$ defined as the short-term rate of interest that would prevail in a hypothetical flexible-price model i periods in the future from date *t*, where $i = 0, 1,2,3, \ldots$. One forecasting methodology of the Federal Reserve Bank of New York staff produces Dynamics Stochastic General Equilibriun (DSGE) model predictions of $\bar{r}_{t+i}$ at the 5-, 10-, and 30-year horizons *i*, as well a "short-run r^*" defined as the immediate flex-price equilibrium interest rate of the model, $\bar{r}_t$ (see Baker et al 2023a and 2023b). Their "30-year *r**," $\mathbf{E}_t\{\bar{r}_{t+30}\}$, corresponds conceptually (in intent) to my notion of the natural rate $\bar{r}$, which could be defined for any date *t* by $\lim_{i\to\infty}\mathbf{E}_t\{\bar{r}_{t+i}\}$.

In empirical methodologies to measure $\bar{r}$, the standard implicit or explicit assumption is that the influence of current nominal rigidities and various temporary shocks and disequilibria can be expected to disappear at long-horizons, making some sort of long-run forecast of a time-series or structural model a reliable guide to the steady-state, flexible-price, no-shock equilibrium. In practice, therefore, most approaches to measuring $\bar{r}$ conflate the long-run elimination of nominal frictions with the potential predicted convergence of other economic state variables unrelated to rigidities (such as capital or foreign asset stocks) to stationary-state values. This is yet another reason to be wary of equating most measures of $\bar{r}$ with r^*.

Indeed, I will argue that both $\bar{r}$ and r^* reflect international forces and can depend on factors such as domestic or international financial conditions and the national current account balance. The last dependencies are especially important: much analytical and empirical research on natural or neutral interest rates fails to account for economic openness, despite the manifest comovements of all measures of international interest rates. A good starting point for my discussion, then, is on the behavior of international real interest rates and the importance of global factors.

2. Real Interest Rates across Advanced Economies and Time

Observed market real rates of interest should converge in expectation to natural or long-run equilibrium rates. Observed rates thus have direct implications for understanding natural and neutral rates.

Real short-term government bond interest rates for the United States have declined since the mid-1980s, reaching a peak in mid-1984 following the Volcker disinflation. Figure 1 illustrates the evolution of short-term real rates in a longer perspective for both the United States and the United Kingdom. Short-term real rates in both countries averaged around 2 percent throughout the 1960s but then entered negative territory as inflation accelerated in the early 1970s, with no strong pushback from central banks. At the end of the 1970s disinflation became a priority: both the U.S. and U.K. monetary authorities pivoted to strongly restrictive policies. Those policies pushed real interest rates to postwar highs from which they have declined, albeit not monotonically. Rates turned sharply negative in 2021-23

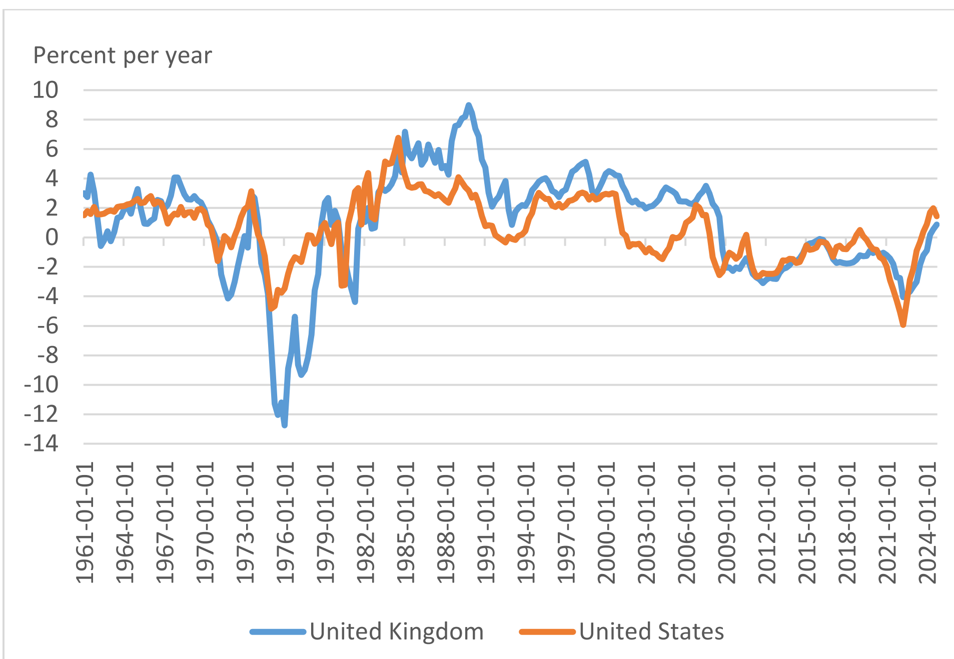

Figure 1: Short-term real interest rates in the United States and the United Kingdom, 1961-2024

Source: FRED and author's calculations.

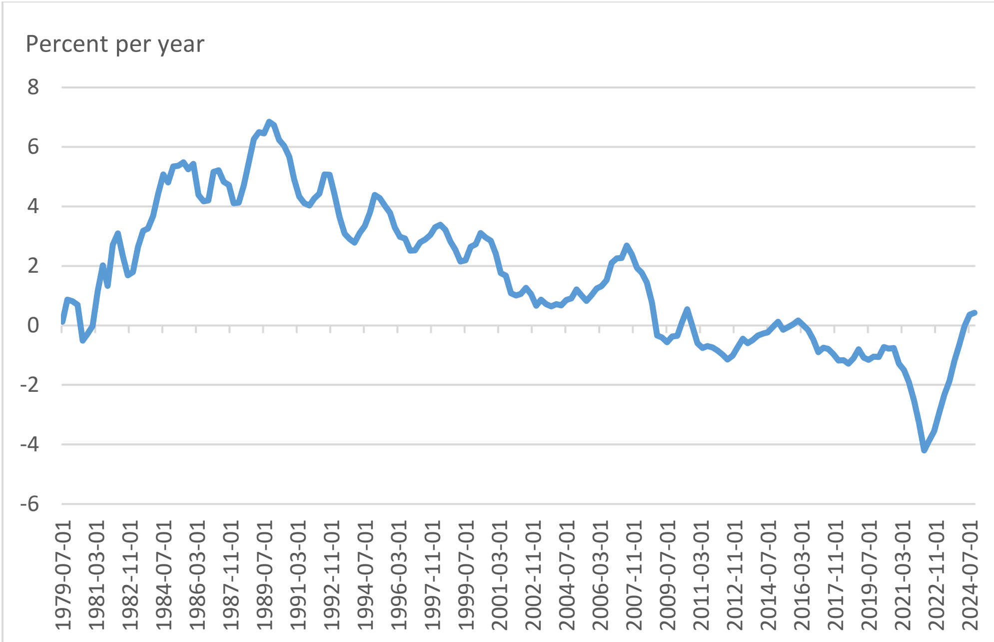

Figure 2: Average of short-term real interest rates in twelve advanced economies, 1979-2024

Source: Simple (unweighted) average based on data from FRED and author's calculations.

in the face of high inflation and slow central-bank responses, but subsequently rose to positive levels.[3]

The patterns are similar for other advanced economies. Figure 2 summarizes by showing the unweighted average of quarterly real interest rates since 1979 for 12 advanced economies.[4] For this broad average (as for the United Kingdom), the real rate peaks in late 1989 or early 1990, later than in the United States. Real short rates (which are largely ex post rates in the figure) become quite negative in 2021-23 as worldwide inflation surges unexpectedly, but have since risen as in the U.S. and U.K. cases.

These data reflect both natural and neutral short-term real rates and should trend similarly to them over long periods. But they can diverge considerably in the short run if the economy is out of equilibrium and central banks are trying to engineer more or less inflation as a result. The bulge in the U.K. short real rate in figure 1, which is quite divergent from the U.S. rate, illustrates the divergence. Real short rates rose so sharply in the United Kingdom in part to support sterling's October 1990 entry into the European Exchange Rate Mechanism (ERM). ERM membership obliged Britain to peg sterling to the deustche mark just as German reunification, with its accompanying massive fiscal expenditures by the Federal Republic, was getting underway. Other ERM members faced similar challenges, and the 1992 European currency

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[3] The nominal interest rate series underlying figure 1 (and figure 2, which follows) are quarterly 3-month interbank or treasury borrowing rates. I subtract expected CPI inflation from nominal rates to obtain real rates. To compute short-term real rates, I proxy expected inflation for quarter t, π_t^e, by $\pi_t^e = \left(\frac{1}{1.75}\right)[\pi_t + (0.75)\pi_{t-4}]$, where $\pi_t = 100\left(\frac{P_t - P_{t-4}}{P_{t-4}}\right)$ and P_t is the date-t CPI. Below, I use a slightly different expected inflation formula to calculate the real return on a long-term nominal bond. As my proxy formula is unlikely to capture market expectations exactly, it should be thought of as an intermediate based on both ex ante and (mostly) ex post real interest rates.

[4] The countries are Australia, Canada, France, Germany, Italy, Japan, New Zealand, Spain, Switzerland, Sweden, the United Kingdom, and the United States.

crisis resulted (Corsetti, Hale, and di Mauro 2023). Figure 1 also shows how the Fed (unlike other advanced-economy central banks) drove short real rates negative in the early 2000s as it experimented with "low for long" forward guidance. The GFC followed (Obstfeld and Rogoff 2010).

Real *long-term* interest rates may be less sensitive to short-run monetary policies and therefore could provide more information about long-run equilibrium rates, although these rates, too, are likely to differ from natural or neutral rates, perhaps considerably. Figure 3 returns to the longer sample of U.S. and U.K. data, reporting the real rate on 10-year treasury bonds.[5]

U.S. and U.K. long real rates move more tightly together, as one would expect given the surprisingly high general correlation of different countries' nominal long rates (Obstfeld 2015), but they show the same broad longer-term pattern as the short rates in figure 1: they are generally lower after the mid-1980s and eventually reach negative values after the GFC. The downward trend is clearest after the mid-1990s. Even for the long rates, the imprint of Britain's inflationary crisis in the middle 1970s is evident.

The average of long real rates for twelve advanced economies also displays a strong downward trend after the mid-1990s (see figure 4). As this figure suggests, the international coherence of long real rates extends beyond just the United States and United Kingdom, although there is more national variation and greater cross-country differences than between the U.S. and U.K. rates. Figure 5 displays the downward path of real long rates for all twelve advanced economies in my sample. However, it also shows considerable dispersion, partly reflecting shocks with disproportionate effects in some regions.

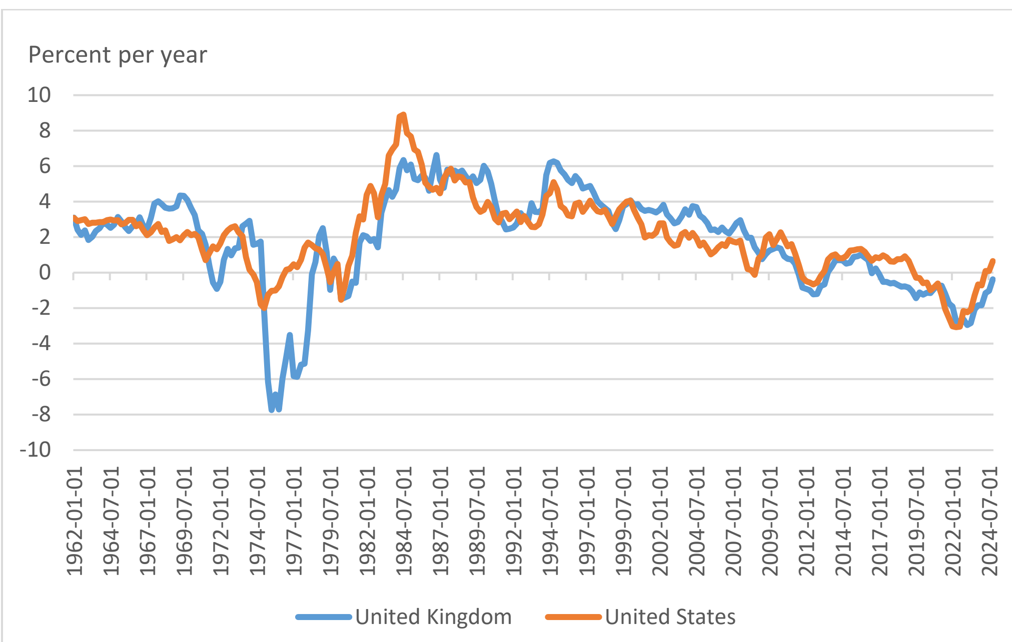

Figure 3: Long-term real interest rates in the United States and United Kingdom, 1962-2024

Source: FRED and author's calculations.

[5] For long-term real rate estimates, the expected inflation proxy is $\pi_t^e = \left(\frac{1}{2}\right)[\pi_t + (0.67)\pi_{t-4} + (0.33)\pi_{t-8}]$.

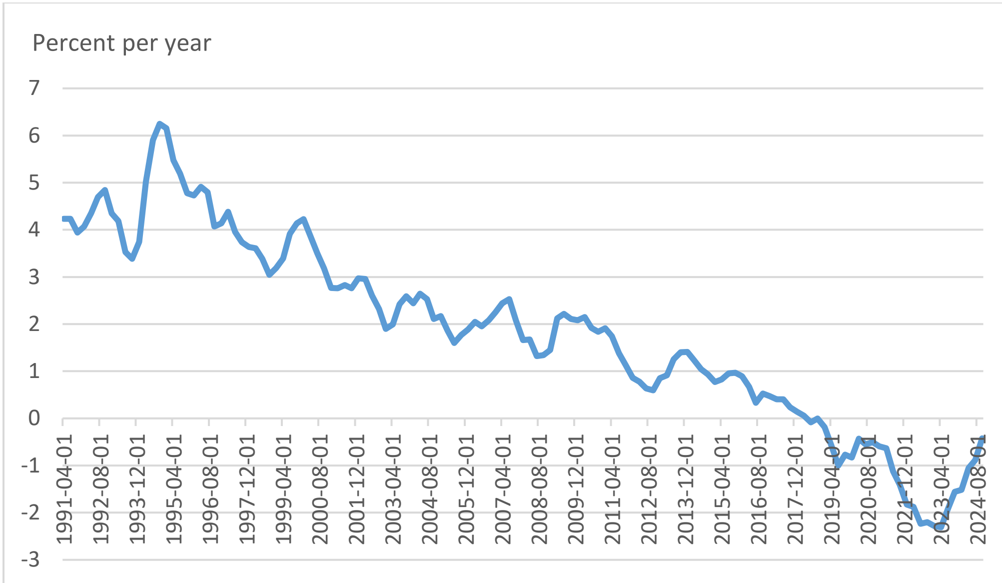

Figure 4: Average of long-term real interest rates in twelve advanced economies, 1991-2024

Source: Simple average based on data from FRED and author's calculations.

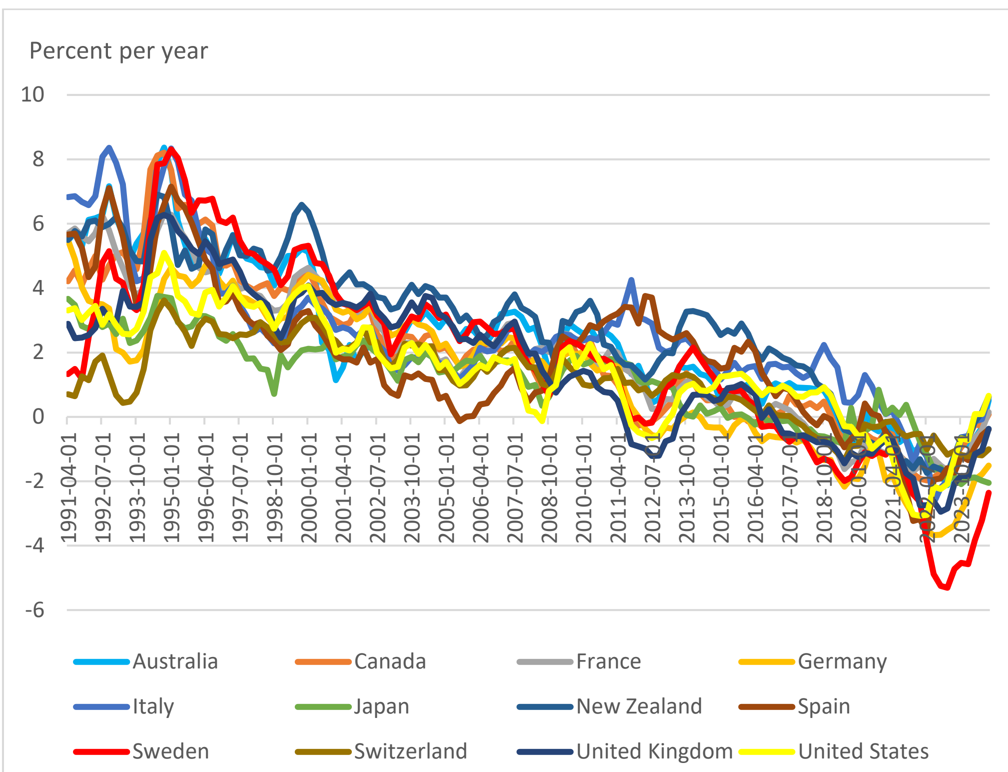

Figure 5: Long-term real interest rates in twelve advanced economies, 1991-2024

Source: FRED and author's calculations.

The upward jump in the Italian yield during the 1992 ERM crisis is one such idiosyncrasy – the market attack on the Italian lira's ERM peg coincided with a domestic debt crisis. Japan's real long yield dips during the 1997-98 Asian financial crisis owing to regional safe haven flows into JGBs. Spain's real yield drops sharply in the mid-2000s as capital flows to the European periphery, encouraged by the elimination of currency risk in the euro zone. These fund inflows spark a housing boom and inflation – all while nominal long yields stay near German levels (Hale and Obstfeld 2016).[6] Not long after (2011-12), Italian and Spanish yields spike up in the euro crisis because of default fears. Evidently, short-term movements in risk premia can move long-term real interest rates considerably, even though long rates are often assumed to be heavily dependent on longer-term expectations of future short rates and thus less sensitive to temporary market developments. The very low real rates measured in 2021-23 come from the global shock of surprisingly high inflation.

One way to gauge the evolution of long-rate dispersion among advanced economies is to plot the difference between the highest and lowest real rates on every date. Figure 6 reports this calculation. After declining in the 1990s, dispersion has been essentially flat during this millennium, other than a big jump during the euro crisis and a somewhat smaller jump during the recent inflation surge.

3. Trends in Emerging and Developing Economies

Data on real interest rates for emerging and developing economies (EMDEs), including some newly industrialized economies, are spottier but still informative. As examples, Figure 7 shows long-term real rates of interest for eight Asian economies. Although some of the series are relatively short, patterns

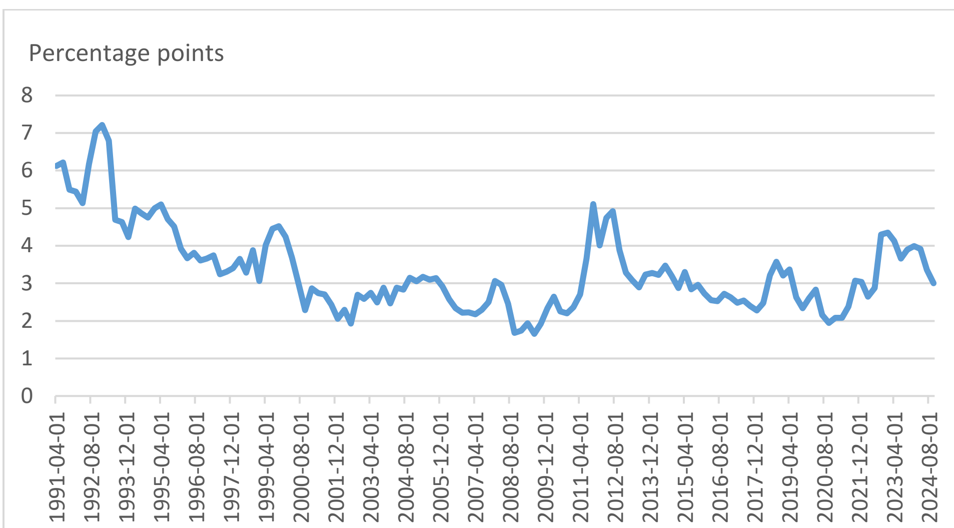

Figure 6: Dispersion: Maximum less minimum long-term real interest rates in twelve advanced economies, 1991-2024

Source: FRED and author's calculations.

[6] Gopinath et al. (2017) show how these capital flows led to resource misallocation in Spain, Italy, and Portugal during 1999-2012.

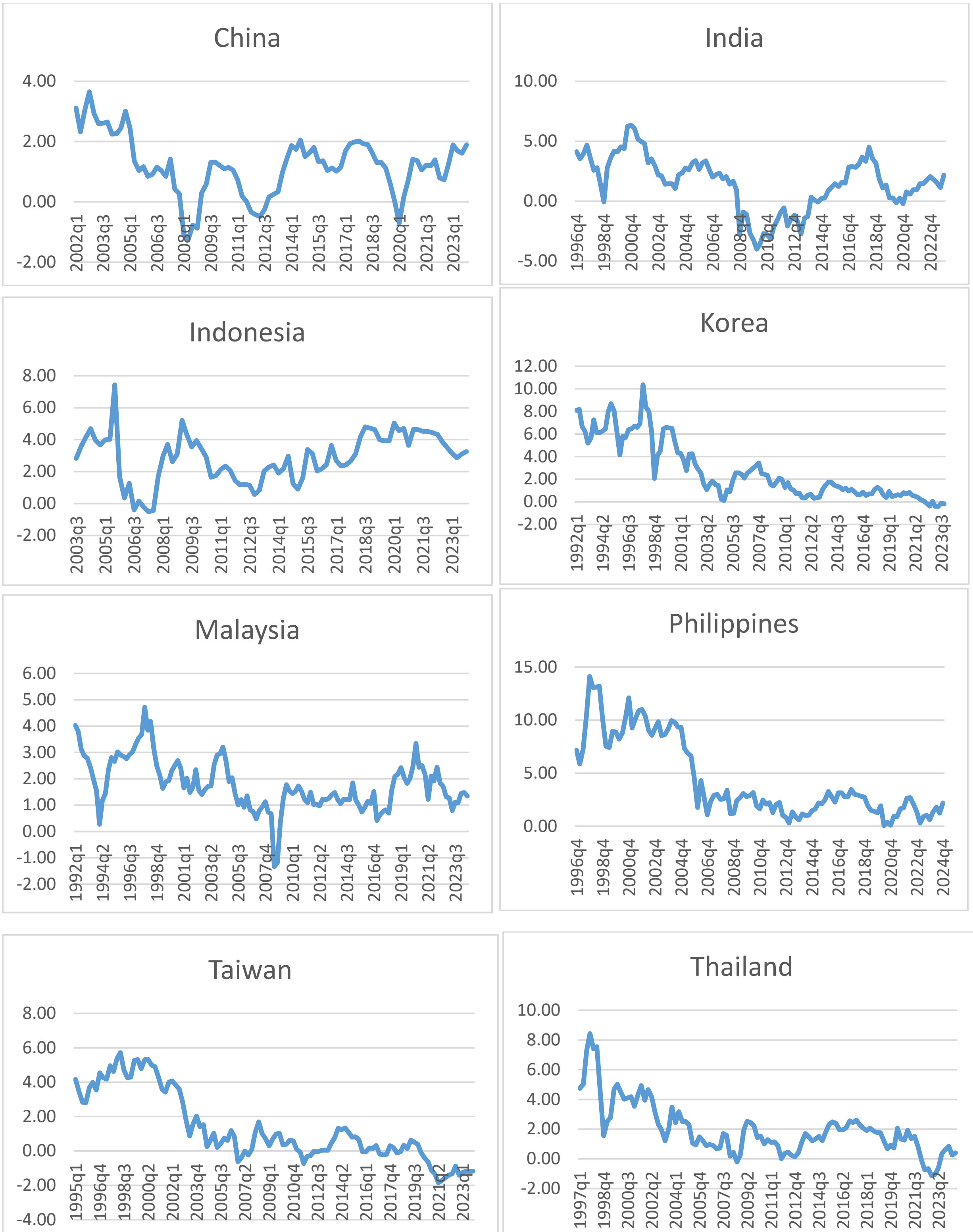

Figure 7: Long-term real interest rates for eight Asian economies

Source: IMF, *International Financial Statistics*, national central banks, and author's calculations.

emerge. In most cases there is some decline in real interest rates from higher levels in the late 1990s or early 2000s. Korea and Taiwan, which are high-income industrialized economies, show patterns of real interest rate decline broadly like those in the more longstanding high-income economies. China, India, Indonesia, and Malaysia show more of a U-shaped pattern, with real interest rates falling but then heading upward again (with varying delays) after the GFC. The Philippines and Thailand are intermediate cases, showing strong declines until about 2012, followed by upward bumps that lose steam as the COVID-19 crisis erupts.

Figure 8 compares the unweighted average of real interest rates across the AE and EMDE groups, starting in the early 2000s when the bulk of EMDEs achieve more stable inflation.[7] The two unweighted group averages track each other quite well until around the last quarter of 2010. Then, average EMDE real rates then remain at roughly 2 percent until 2019, before dropping in the pandemic and subsequent (substantially unanticipated) inflation. However, the EMDE-AE gap persists. Forbes (2019) and International Monetary Fund (2023) show similar pictures of the post-GFC divergence between EMDE and AE long-term real interest rates.[8]

Hamilton et al. (2016), Del Negro et al. (2019), Jordà and Taylor (2019), Kiley (2020a), and International Monetary Fund (2023) all document the importance of common global components in the behavior of a range of advanced economy real interest rates. According to figure 8, that conclusion seems also to apply to EMDE rates through around 2010-11, but afterward there is a notable divergence. One hypothesis would center on higher financial flow barriers between rich and less prosperous countries, a possibility consistent with existing de jure and de facto measures of international financial integration. However, gross flows between the two country groups are substantial compared with overall current account imbalances, as are gross flows among the EMDEs themselves (Broner et al. 2022), which have shown rapid growth in this millennium. Another relevant point in evaluating this evidence is that even among advanced economy currencies, traditional arbitrage relationships that held well before the GFC, such as covered interest parity, have not been re-established afterward – financial markets in general appear in several respects more constrained and less liquid (Du and Schreger 2022). The financial frictions separating advanced markets likely apply with even more force to flows across EMDE borders. Complementary to this observation, quantitative easing policies that advanced, but not emerging economies, implemented (at least prior to the COVID-19 crisis) may also have played a role in opening a wedge between the two country groups' real bond rates. Also, as International Monetary Fund (2023) suggests, higher safe asset demand after the GFC may have widened the wedge between AE and EMDE sovereign bond yields. EMDE sovereign bonds, even when denominated in home currencies, doubtless carry higher and more variable term premia (Kalemli-Özcan 2019).

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[7] The 23 countries in my EMDE sample are: Brazil, Bulgaria, Chile, China, Colombia, the Czech Republic, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Romania, Russia, South Africa, Taiwan, Thailand, and Turkey.

[8] Those alternative charts display GDP-weighted averages of long real rates with possibly different debt instruments and different country samples, but the impression they give is remarkably consistent with figure 8 above. For example, the IMF chart (p. 48) is based on 34 AEs and 25 EMDEs, reports ex post real interest rates, and uses GDP shares evaluated at market exchange rates to weight different countries. That weighting can impart considerable volatility to the country shares (which is why the IMF elsewhere uses PPP weighted GDP shares or three-year averages of market exchange rate weighted shares), whereas the unweighted average can give individual countries undue weight.

The EMDE average in figure 8 masks considerable variation across countries. Looking at the dispersion of interest rates, Figure 9 shows a comparison of the maximum minus minimum numbers for EMDEs and the AEs (the latter already shown in figure 6). On this metric, EMDE rate dispersion nearly always exceeds that of AEs. It drops over time only to jump up in 2018 and then contines to rise owing to the COVID-19 pandemic and the subsequent global inflation surge.

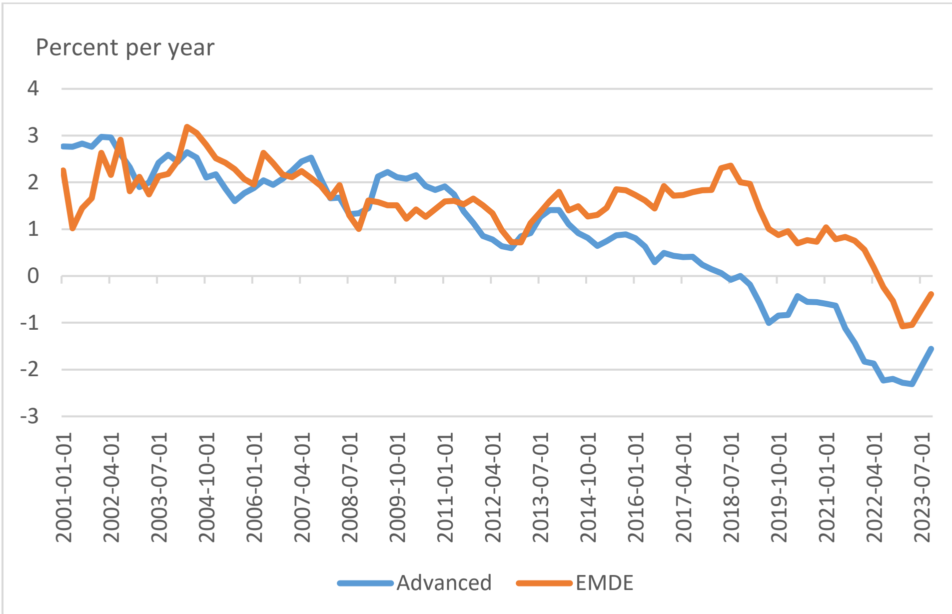

Figure 8: Long-term real interest rate averages for AEs and EMDEs, 2001-2023

Source: FRED, IMF, *International Financial Statistics*, Eurostat, and national central banks. Country sample varies over time.

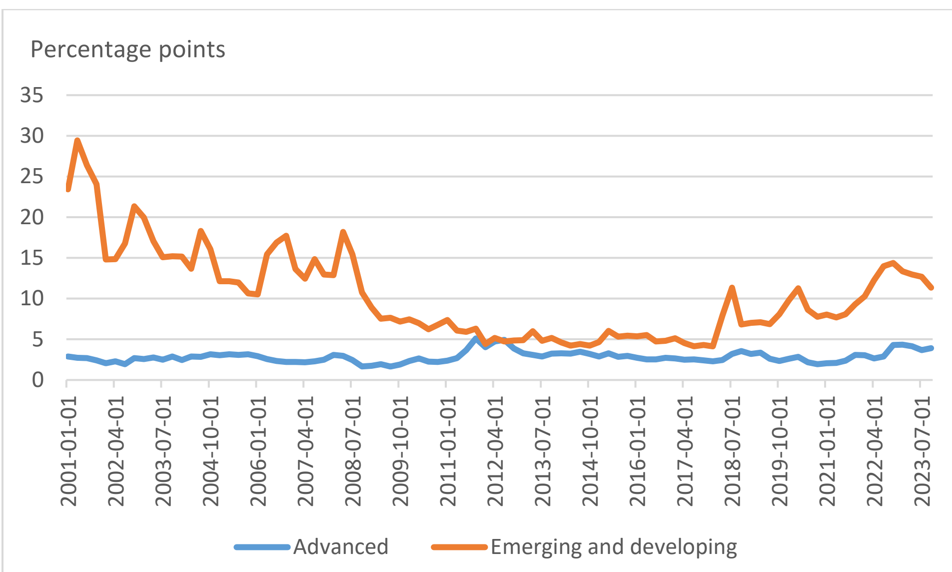

Figure 9: Long-term real interest rate dispersion for AEs and EMDEs, 2001-2023

Source: Sample maximum less minimum rates from FRED, IMF, *International Financial Statistics*, Eurostat, and national central banks. Country sample varies over time.

4. Saving, Investment, and Global Real Interest Rates

In theory, expected real government bond yields can differ across countries due to expected changes in real exchange rates, risk premia, liquidity premia, default premia, an array of tax policies, or nontax barriers between domestic and foreign financial markets. The data in figures 1 through 9 suggest that, notwithstanding the potential relevance of all of these factors, there is a strong co-movement among real long-term interest rates, indicative of either common global shocks, some degree of capital-market integration, or both. The variable and sometimes large divergences in the figures, however, caution against any simplistic account based on assuming perfect capital mobility or asset-market arbitrage among countries. Even if one interprets figures 8 and 9 as evidence that impediments to cross-border capital movements are especially important for EMDEs, those impediments still leave EMDEs quite open to import global financial shocks – and to export them as well.

It therefore useful to abstract temporarily from the frictions just listed to recall the most basic model of real interest-rate determination in a world devoid of uncertainty or market frictions, that of Metzler (1968). From there, one can add complications if needed; but in general, the Metzler model will predict correctly the qualitative effects of shifts in world saving and investment. The model also captures the reality that real interest rates are determined globally, not nationally. More nuanced models can examine changes that differentially affect riskless and risky assets, and the extent to which those are empirically relevant for guiding monetary policy. Such models could allow shifts in asset preferences – for example, a tilt in demand toward safe assets – to affect government bond rates. But I will leave this topic aside until later.

Figure 10 shows how a unique global world real interest rate is determined in a world of two countries, Home and Foreign, with saving and investment schedules that depend positively and negatively, respectively, on real interest rates. In the picture, Home's autarky rate of interest r_H^{aut} exceeds Foreign's r_F^{aut}, and so in the global capital-market equilibrium, Home, which has the higher autarky rate, runs a current account deficit – its saving falls short of its investment – whereas Foreign has a surplus – its saving exceeds its investment. In the equilibrium, the interest rate $r^* = r_H^* = r_F^*$ that clears the world capital market also sets Home's desired external deficit equal to Foreign's desired external surplus. If we identify $r^*$with the natural or neutral real rate of interest, then it is apparent that it must respond to global shifts in saving and investment, wherever they occur.

Figure 10, with the United States in the role of Home, is at the heart of Bernanke's (2005) famous account of the "global saving glut." He held it largely accountable for the very low U.S. real interest rates of the early to mid-2000s (figures 1 and 3). In his telling, higher Asian saving after the regional crisis of 1997-98, along with a rise in energy exporters' incomes, shifted the Foreign saving curve to the right, raising the Foreign current account surplus, depressing world interest rates, and raising the deficit of Home. Figure 11 shows the result. Lower post-crisis Asian investment (a leftward shift in Foreign's investment schedule) pushed in the same direction.

The data I have reviewed raise two immediate questions about a theory based on higher saving by poorer countries. First, the decline in real interest rates in advanced economies began well before the Asian crisis, no later than the early 1990s. In addition, the saving rate of the major oil exporters declined

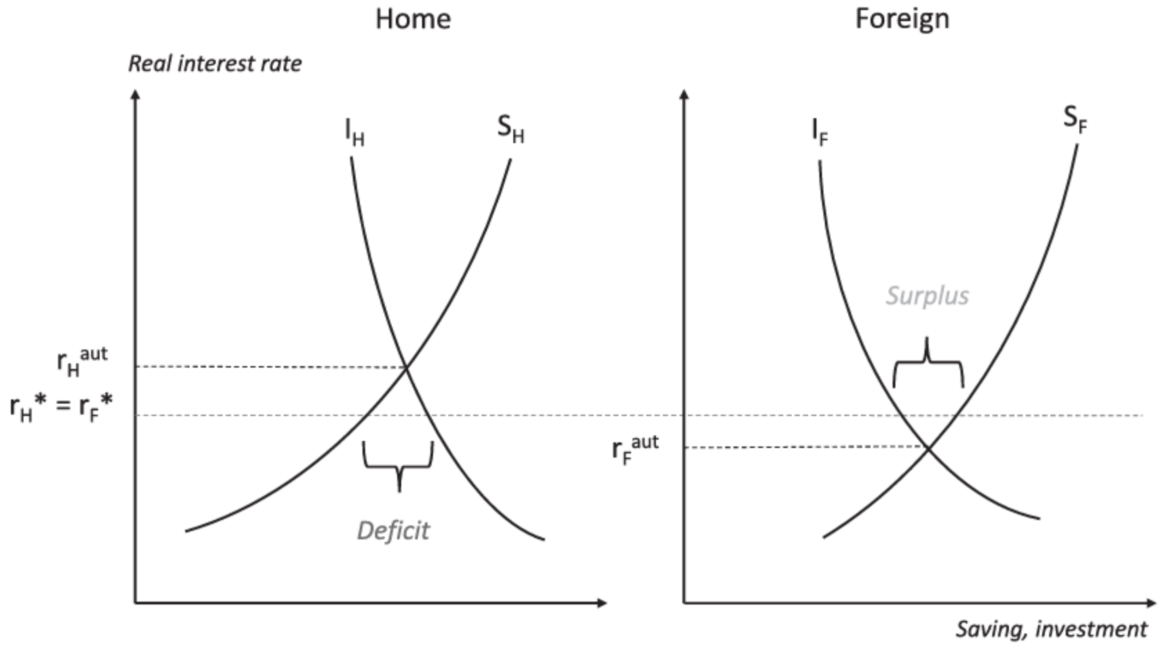

Figure 10: Global real interest rate determination in a simplified model

Source: Metzler (1968).

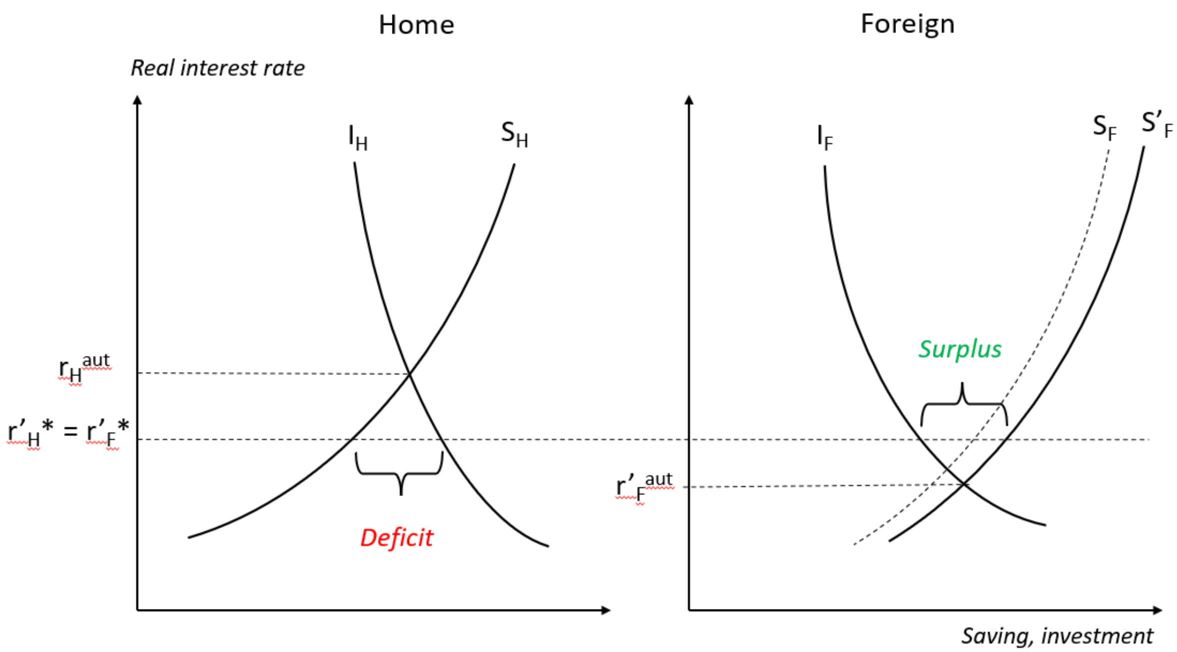

Figure 11: Effect of a rise in Foreign saving on the global equilibrium

Source: Metzler (1968).

from 24.7 percent in 1990 (the year Iraq invaded Kuwait) to 17.9 percent in 1998. Second, the fall in real interest rates in advanced economies endured and intensified well past any plausible legacy of the Asian crisis and through many ups and downs of energy prices. These questions have led researchers to focus on other negative influences on global real interest rates, such as lower population growth and aging, diminished productivity growth, growing income inequality, lower prices for investment goods, chronically deficient demand resulting in "secular stagnation," debt deleveraging, excess demand for "safe assets," corporate market power, fiscal policy (including low public investment), and regime shifts in monetary policy (see International Monetary Fund 2014, 2023; Council of Economic Advisers 2015; Bean et al. 2015; Yi and Zhang 2016; Rachel and Smith 2017; Brand, Bielecki, and Penalver 2018; Rachel and Summers 2019).[9] All of these explanations have plausibility and some empirical backing, but leave unanswered questions. What seems likely is that over more than three decades of falling real interest rates, different factors have dominated at different times, and a grasp of these time patterns is necessary for forecasting the future of real interest rates. As Hamilton et al. (2016) conclude,"[T]he determinants of the equilibrium rate are manifold and time varying."

Sorting out the causes of falling real interest rates requires a more granular focus on the saving and investment trends in particular country groups than has been common in most of the literature. A first pass at such an analysis gives some perspectives on existing literature. A natural starting point, inspired by Bernanke (2005), is to consider global saving patterns.

Figure 12 shows global saving patterns over time for the world, advanced economies, and EMDEs.[10] From the early 1980s to 2000, saving rates rise very slightly, with the EMDE rate generally somewhat

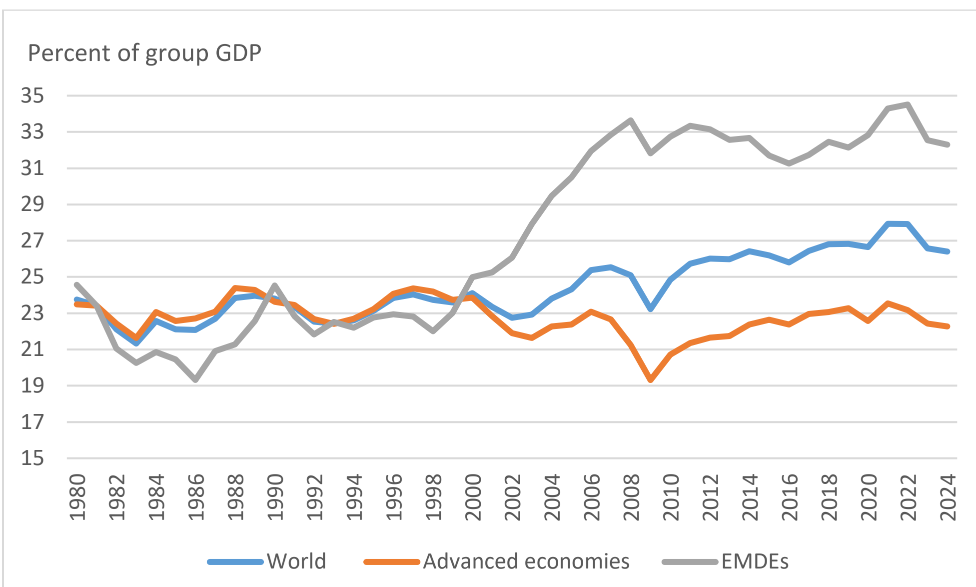

Figure 12: Gross saving rates according to country group

Source: IMF, World Economic Outlook database, October 2024 (forecast for 2024).

[9] Eggertsson, Mehrotra, and Robbins (2019) present a closed-economy model including many of these elements.
[10] For similar pictures, see Bean et al, (2015, p.19) and Blanchard (2022, p. 37).

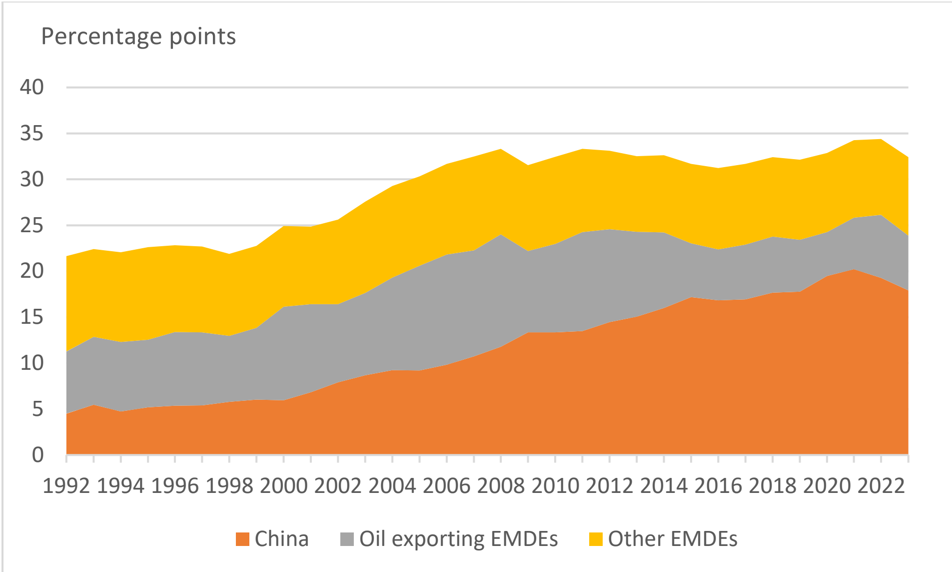

Figure 13: Contributors to the EMDE saving rate

Source: IMF, World Economic Outlook database, October 2023 (forecast for 2023), and author's calculations.

below the world average. Starting in 2000, however, the EMDE saving rate starts a sharp ascent, leveling off at around 33 percent of GDP in 2007. Advanced economy saving falls after 2000 but rises back toward its initial level by the late 2010s. In an accounting sense, it is the surge in saving by poorer countries that dominates global saving measures after the 2000s. This development also coincides with a broadly-based surge in EMDE growth (i.e., including but reaching beyond China).

Which EMDEs primarily contribute to the rise in the EMDE saving rate? Figure 13 decomposes the EMDE saving rate into the contributions due to China, oil exporting EMDEs, and other EMDEs.[11] The portion of the saving rate due to oil exporters surges temporarily in the years leading up to the GFC, but the aggregate weight of oil EMDEs has declined since then. China's importance rises starting in the early 1990s. By 2022, China alone accounted for most of EMDE saving. Accordingly, any explanation of the sharp rise in EMDE saving is closely tied to factors specific to China.

The same is true of world saving, as figure 14 shows. In 2023, the world saving rate estimated by the IMF was 26.3 percent, of which EMDEs contributed 13.5 percentage points – more than half (at market exchange rates) – and China alone 7.5 percentage points. The share of world saving for which advanced economies account has shrunk over time, owing to relatively low average growth and a comparatively low average saving rate.

Even in 1980, China's saving rate was a very high 32.6 percent. This rate reflected, among other things, the absence of social safety nets, financial repression, and the government's focus on investment over consumption.[12] Over subsequent years, however, China's saving rate rose dramatically as its rapid

[11] Each colored area measures the country or country group's GDP-weighted saving rate. The oil exporting EMDEs included are Algeria, Angola, Azerbaijan, Brazil, Brunei Darussalam, Colombia, Ecuador, Iran, Iraq, Kazakhstan, Kuwait, Libya, Mexico, Nigeria, Oman, Qatar, Russia, Saudi Arabia, United Arab Emirates, and Venezuela.

[12] The copious literature on China's saving includes Modigliani and Cao (2004), Yang (2012), and Curtis, Lugauer, and Mark (2015).

growth simultaneously raised China's weight in the world economy. The rate climbed to 42.3 percent in 2003, peaking at 51.6 percent in 2008 before falling back to the mid-40s as China's GDP growth simultaneously also slowed from a peak of over 14 percent in 2007.

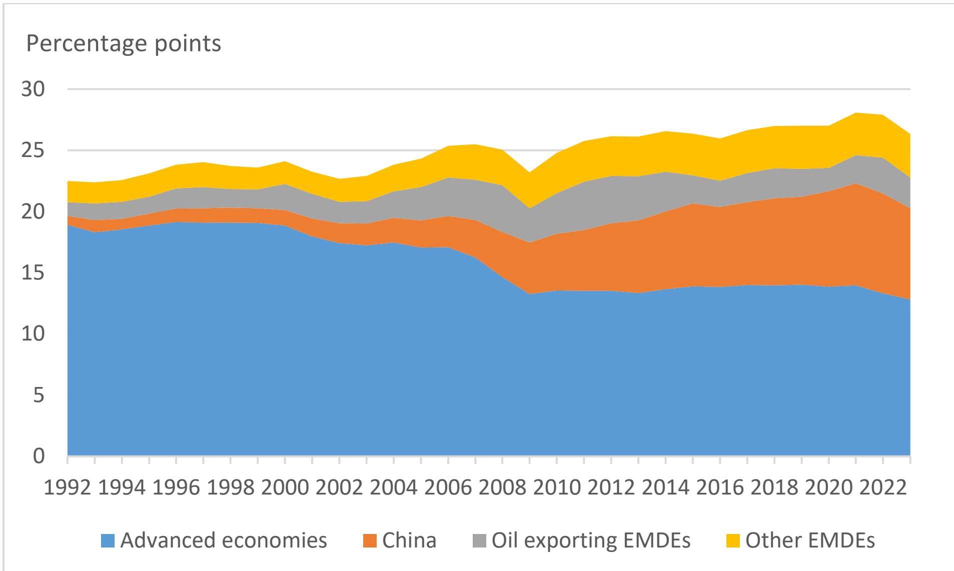

Figure 14: Contributors to the world saving rate

Source: IMF, World Economic Outlook database, October 2023 (forecast for 2023), and author's calculations.

A sizable part of understanding the evolution of world saving since 2000 therefore is to understand China's saving.

Not only has China's saving rate been relatively high, so has its investment rate. China's net impact on the global capital market, in the Metzler (1960) model of figures 10 and 11, is reflected in its current account balance. Figure 15 shows the evolution of global current account imbalances, measured on a balance of payments basis, from the early 1980s. beginning

A striking aspect of this chart is the rapid widening of imbalances that began at the end of the last millennium. The advanced economy deficit rises to a historical record, largely driven by the United States. However, a large "missing surplus" in the global accounts prevents definite identification of the balance of payments counterpart elsewhere in the world. There is some fall in the "other EMDE" deficits starting with the Asian crisis, as Bernanke (2005) claimed, but it is only after that process ends that oil exporters' surpluses begin to rise and even later (around 2004) that China's surplus begins its ascent. At around the same time, the global "missing deficit" becomes a global "missing surplus." There is a compression in global imbalances in the crisis year 2008, but they widen afterward. To some degree, the "baton" of the dominant surpluses has passed over time from China and oil exporters in the middle 2000s to advanced economies (mostly in Europe) more recently. While China's continuing high level of saving relative to investment continues to help keep world real interest rates down, rich countries' saving-investment imbalance had a comparable or bigger weight in world GDP in the past few years.

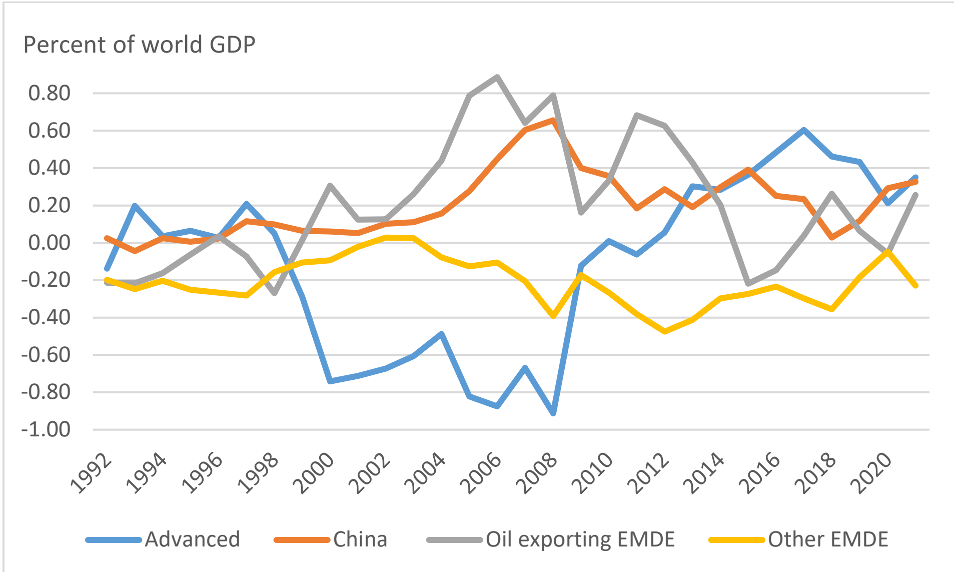

Figure 15: Net global current account imbalances, 1992-2021

Source: World Bank (for China's current account balance, 1992-1996), IMF, World Economic Outlook database, October 2022, and author's calculations.

5. Beyond the Metzler Model: Gross International Financial Flows

Rachel and Summers (2019, p. 6) opine that "the decline in neutral real interest rates can be understood through the balance between desired saving and investment." However, changes in asset preferences – such as a heightened desire for safe assets on the part of investors – can move rates of return (and therefore ex post saving and investment flows), although shifts in the saving and investment schedules themselves may not be the root cause of those developments (Obstfeld 2020).[13] The question is how quantitatively important such preference shifts have been in moving real government bond rates.

In principle, for example, demographic shifts that change overall saving will move not only riskless returns but risky returns, such as the return on equity, and can do so even if perfectly foreseen (Abel 2003; Geanakoplos, Magill, and Quinzii 2004). Thus, a widening gap between the returns on government bonds and equities could indicate preference shifts toward safer and more liquid assets. Caballero (2006), Caballero, Farhi, and Gourinchas (2017a, 2017b), Del Negro at al. (2019), Krishnamurthy (2019), and Ferreira and Shousha (2022), among others, have made the case that such a shift has been a dominating feature of global asset markets in the 2000s.[14]

[13] In general, of course, portfolio and saving decisions are not separable and we would expect the investment schedule to depend on the cost of capital, not the return that savers expect to earn on optimally allocated wealth.
[14] Some authors view the safety and liquidity characteristics of an asset as distinct and have proposed empirical approaches for identifying the associated return premia in practice (for example, Krishnamurthy and Vissing-Jorgensen 2012 in the case of U.S. Treasury obligations). Conceptually, however, an asset that is "safe" but not entirely liquid may find its liquidation value impaired in some states of the world – in which case it is not truly safe. Safety raises liquidity and liquidity raises safety. Even U.S. Treasury debt is information-insensitive, but subject to

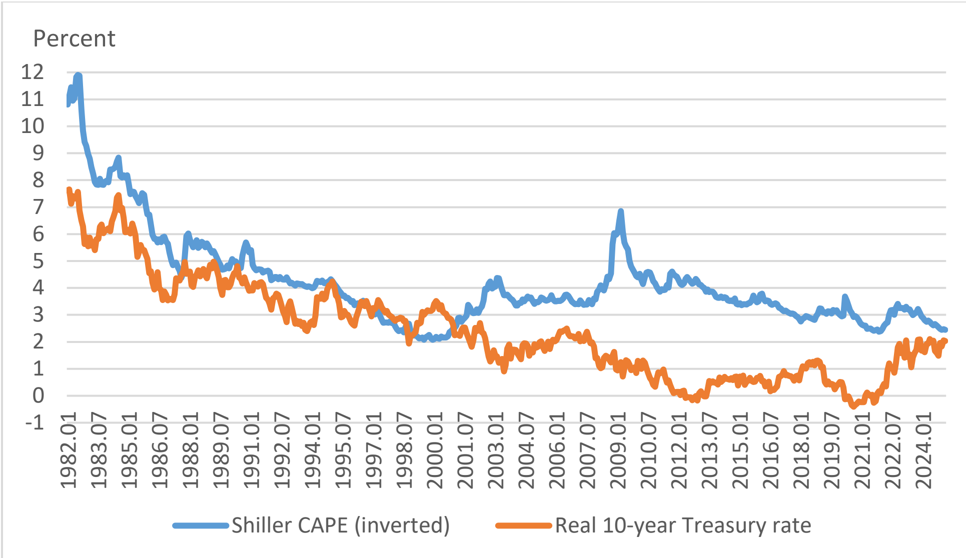

Figure 16: Long-term U.S. real Treasury rate and cyclically adjusted equity earnings-to-price ratio

Source: FRED (series REAINTRATREARAT10Y) and inverse cyclically adjusted S&P 500 total return price-earnings ratio from Robert Shiller's online data website at http://www.econ.yale.edu/~shiller/data.htm.

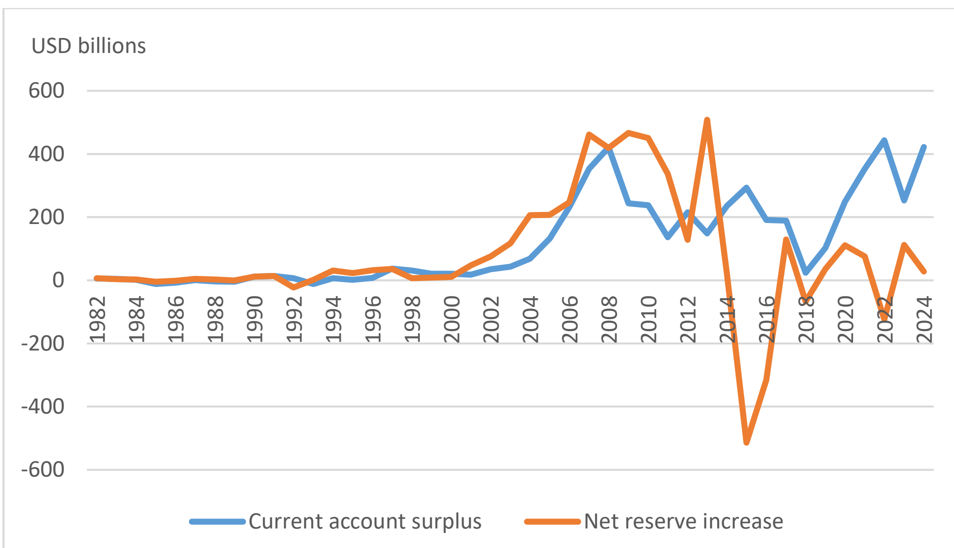

Figure 17: China's current account balance and change in foreign exchange reserves, 1982-2024

Source: FRED, World Bank, and IMF World Economic Outlook database, October 2024 (2024 current account from Xinhua, reserve change for 2024 only through November).

Figure 16 shows one possible indicator of equity returns, the inverse of the price-earnings ratio as calculated by Robert Shiller. Over 1980s and 1990s, this measure moves in parallel with the expected

episodic illiquidity and therefore not entirely safe. For relevant discussions, see Benmelech and Bergman (2018) Dang, Gorton, and Holmström (2020), and Duffie et al. (2023).

real long-term U.S. Treasury yield, as calculated using a model from the Cleveland Fed. However, a sizable gap began to open in 2001. In the two decades after, the real bond rate continued its decline until spiking up very recently, while the earnings yield fell more slowly.[15] This return comparison supports the hypothesis that part of what drove real government-bond interest rates down after 2000 was a worldwide shift in preferences toward relatively safe assets.[16] (Corporate market power also has likely played a role, as is discussed below.) Since the pandemic, the gap between the earnings-to-price ratio and the real Treasury yield has narrowed substantially. If this pattern is sustained, it could indicate that "safe-asset" demand for Treasuries has fallen.

The two returns in figure 15 begin to diverge around the turn of the millennium, when global imbalances also begin to diverge widely (figure 15). These developments are connected: Not only did emerging market current account surpluses rise in the early 2000s, emerging market authorities stepped up purchases of international foreign exchange reserves (mostly U.S. dollars, but increasingly euros) after the Asian crisis in the late 1990s. (Japan, struggling with deflation, was also a participant.) Econometric evidence suggests that these purchases gave a significant downward push to U.S. Treasury rates (Krishnamurthy and Vissing-Jorgensen 2012; Ahmed and Rebucci 2024).[17] In turn, lower U.S. safe rates would have shifted portfolio demands toward other potential reserve assets, reducing their yields.

To underline the point that EMDE reserve demand was a force distinct from EMDEs' contribution to global current account imbalances, Figure 17 shows China's purchases of international reserves compared with its current account surplus, in billions of U.S. dollars. In most years through 2014, reserve purchases far outstripped the current account surplus. China experienced private capital inflows (often circumventing controls), forcing it to purchase dollars in the FX market in the face of yuan appreciation pressures. Capital inflows thus added to China's balance of payments surplus, raising its rate of reserve accumulation above what its current account surplus otherwise would have implied. (At other times, reserves have fallen as the current account surplus has risen.)

An estimate of China's downward push on global interest rates based on its contribution to the global saving-investment balance alone would therefore miss the additional downward pressure due to the government's strong preference for safe government-guaranteed securities, which both differed from the preference of the average global investor and in fact often led to reserve buys exceeding the current account surplus. During and after the GFC, these interventions supported the Fed's quantitative easing. Only in 2014 did China move into a weaker phase of dollar accumulation – and indeed massive disgorgement of dollars in 2015 and 2016 when a stock-market meltdown led to the yuan's devaluation and subsequent market turbulence. China spent about a quarter of its roughly $4 trillion reserves to finance massive capital outflows amid depreciation pressures that unbleashed a disruptive global risk-off episode.

[15] This graph of U.S. asset prices informs about *global* trends considering the worldwide ownership of U.S. stocks and Treasury obligations. Caballero, Farhi, and Gourinchas (2017a), Rachel and Summers (2019), and Reis (2022) present similar pictures, although Rachel and Summers (2019) draw different implications from mine.
[16] The divergent behavior of equity returns and real interest rates since 2000 contrasts with empirical discussions of real interest rates from several decades ago, such as Blanchard and Summers (1984) and Barro and Sala-i-Martin (1990), which viewed higher equity returns as possibly predicting upward shifts in the world investment schedule.
[17] Bernanke (2005) noted the rise in reserve purchases by EMDE central banks, notably in Asia.

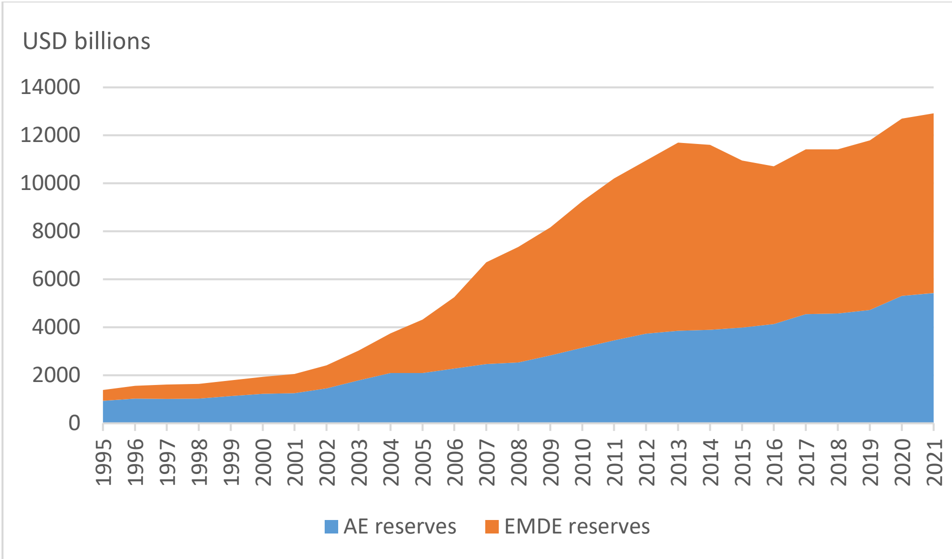

Figure 18: Foreign exchange reserve stocks of advanced and EMDE countries, 1995-2021

Source: IMF COFER database and IMF *Annual Report 2022* (appendix 1.1, https://www.imf.org/external/pubs/ft/ar/2022/downloads/appendix.pdf).

China's reserve purchases (and those of other emerging markets) likely helped to lower global real interest rates in the years from the late 1990s through the end of the euro crisis in 2012. Figure 18 shows how reserves rose from the mid-1990s, the increase largely due to acquisitions by EMDEs. Global and EMDE reserves began to rise again after China's capital-account crisis abated in 2016, but at a slower rate than during the peak of accumulation in the decade 2002-12.

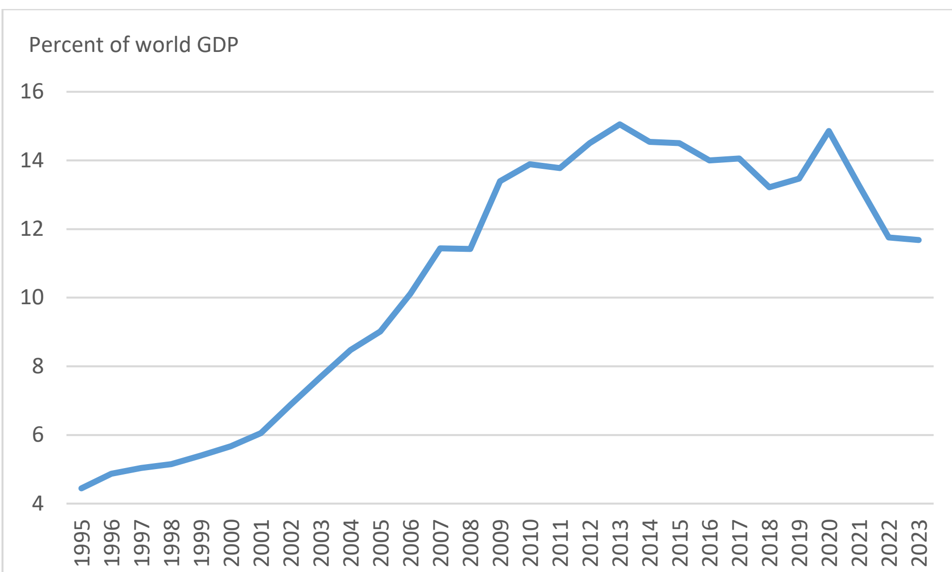

Figure 19: Global foreign exchange reserves as a fraction of global GDP, 1995-2023

Source: IMF World Economic Outlook database, October 2024 and IMF COFER database.

To gauge the impact of these reserve transactions for global bond markets, I scale world reserves by world GDP in figure 19. Global foreign exchange reserves rose to a peak of 15 percent of world GDP in 2013 and have since fallen below 12 percent. At the same time, outstanding gross government debt stocks of the main issuers, net of central bank holdings, have risen relative to GDP. While reserveaccumulation by EMDEs played a role in driving down global interest rates in the 2000s through the early 2010s, it seems to have played a smaller role in the decline of global interest rates afterward through the pandemic. Private safe asset demand may have persisted, though.

6. Three Phases of Interest-Rate Decline

Caballero, Farhi, and Gourinchas (2017a) argue persuasively that interest rates have declined over the past four decades in three main phases, with differing primary drivers over those phases. My discussion adds support to their narrative and adds some further dimensions, although I will consider the decline in rates as definitively starting in the early 1990s after the U.S. disinflation of the 1980s was mostly complete. Nonetheless, my phases are roughly coincident with those described by Caballero, Farhi, and Gourinchas. Identifying the different drivers over these periods is a key prerequisite for predicting future real rates.[18]

Figure 20 illustrates three stages of global long-term interest-rate decline: a first from the early 1990s to the turn of the millennium, a second from then until the GFC, and a third from the GFC to 2018. I deem the period of the COVID-19 pandemic and recovery to be unusually disrupted; the U.S. Trump administration has administered further structural shocks since January 2025. At the end of the paper, I speculate on the ultimate implications for equilibrium rates, but here I examine the past. For each chart, the horizontal red line shows the average rate for the six quarters centered on the year indicated in the legend. Over the entire period, the fall in global real interest rates is roughly 450 basis points.

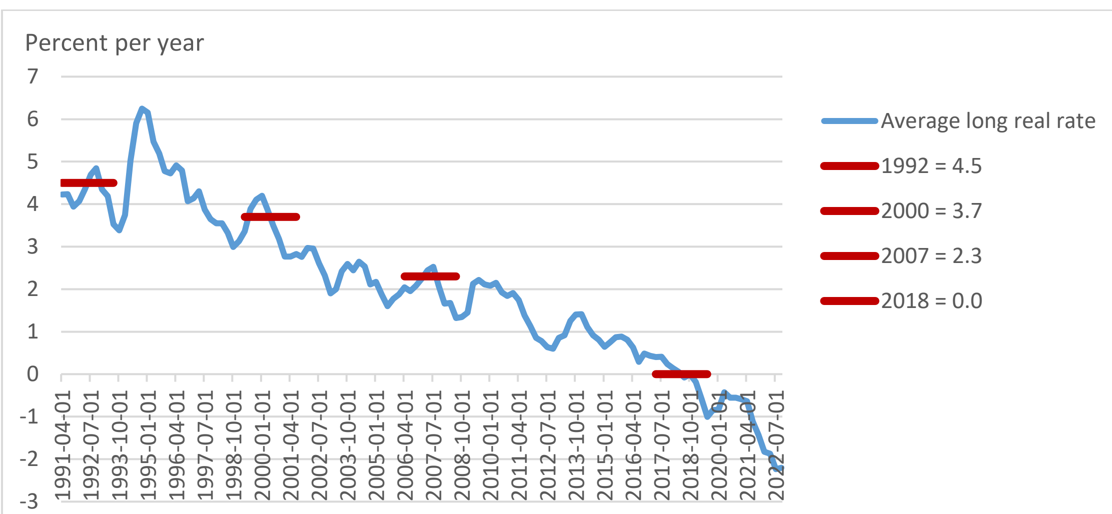

Figure 20: Three phases of real interest rate decline between 1991 and 2018

Source: Long-term real government bond rates from figure 4 and author's calculations.

[18] The starting point is somewhat arbitrary, and could well have been the mid-1990s instead, which would result in a considerably bigger real interest rate drop over the period considered. The average advanced economy real interest rate in 1995 is about 150 basis points above its value in 1992.

As Caballero, Farhi, and Gourinchas (2017a) observe, the 1992-2000 span seems characterized by higher global saving and possibly a leftward shift of the Metzlerian investment schedule, but not by a detectable ex ante shortage of safe assets.[19] Key driving factors include:

- On the saving side – demographics, notably high baby-boom saving in advanced economies (see Carvalho, Ferrero, and Nechio 2016; Gagnon, Johannsen, and López-Salido 2019; Goodhart and Pradhan 2020).
- Also on the saving side – growing inequality following the political ascent of more market-led economic approaches after the late 1970s (for example, Rachel and Smith 2017; Auclert and Rognlie 2017, 2020; Goodhart and Pradhan 2020; Mian, Straub, and Sufi 2021). [20]
- On the investment side – rapidly falling prices of investment goods (see Karabarbounis and Neiman 2014; Sajedi and Thwaites 2016; Lian et al. 2019), leading to lower investment needs when the capital-labor substitution elasticity is below unity (as historical estimates have suggested).
- Also on the investment side – greater market power by firms in product and labor markets, as well as a growing market share of firms with more market power, such that firms can generate higher profits with less investment and substitute labor for capital (see De Loecker, Eeckhout, and Unger 2020; Díez, Malacrino, and Shibata 2022; Mankiw 2022).[21] Corporate market power could be another factor behind the long stretch of high earnings ratios in Figure 16.
- A final plausible factor is the end of the Cold War and expectations of lower military expenditures worldwide. Notable as well, the U.S. Federal budget deficit disappeared.

While most of the trends evident over 1992-2000 continue, figure 15 also suggests that one clue to understanding the behavior of real interest rates in the 2000-07 period is the bigger dispersion of external balances, and particularly the emergence of the very large U.S. deficit. This period is characterized by extremely easy financial conditions worldwide, promoted in part by the ongoing expansion in the depth, breadth, and freedom of global financial activity that began in the 1990s, with growing participation by emerging markets. If there is a rising demand for safe assets in this period, it is coming mainly from the official and not the private sector. Emerging central banks are building up their reserves (figures 18 and 19), but the risk tolerance of the private sector, on the contrary, is high and yields are compressed, the situation in the euro area being one notable example that would end in tears later on (Shin 2012; Hale and Obstfeld 2016). As a group, nonoil emerging markets apart from China run bigger current account surpluses until 2002 but then go more deeply into deficit after 2003.

In this environment of high global liquidity (Hume and Sentance 2009; Bracke and Fidora 2012), energy prices escalate and oil exporter's surpluses swell as their aggregate consumption fails to keep up with income growth. A similar dynamic is seen in China, where rapid income growth, itself supported by FDI

[19] However, there was a slowdown in upward debt supply pressures in the 1990s owing to the Clinton-Rubin fiscal policies in the United States and European attempts – sometimes cosmetic – to slow public debt issuance in compliance with Maastricht entry requirements. Nonetheless, the U.S. equity premium became quite compressed by around 2001 (Caballero, Farhi, and Gourinchas 2017a).

[20] Figure A1 reports time series of the Gini index for the United States, China, Germany, Russia, and the United Kingdom, to cite just one possible measure of income inequality.

[21] Growing market power of firms would also have affected saving by raising income inequality, thereby pushing interest rates lower still. However, a higher present value of firm profits increases the market values of equities; this rise in asset supply could exert some upward pressure on interest rates, as in Auclert and Rognlie (2020).

inflows and unequally distributed across households, raises the saving rate and China's current account surplus, while also magnifying China's impact on total global saving (figure 14).[22] One more driver of easy global financial conditions in the early 2000s was likely the Fed's very loose monetary stance in that period (Obstfeld and Rogoff 2010). However, U.S. financial conditions failed to tighten quickly even after the Fed embarked on a two-year interest-hike cycle starting at the end of June 2004 (figure A2 shows the Chicago Fed's financial conditions indexes).

The third phase in Figure 20 (2007-18) begins with the GFC but is quickly followed by the related euro area crisis (2010-12). Euro fiscal consolidation is a factor. Over this long period, much of which covers recovery from crises, private risk aversion and therefore the private demand for safe assets is likely higher, as Caballero, Farhi, and Gourinchas (2008) suggest. As those authors also suggest, safe asset supplies grow more slowly or shrink, and the persistence of the ELB as a policy factor is likely both an effect and a cause of economic uncertainty. Also, political uncertainty rises globally.

Earlier trends in demographics, inequality, and investment-goods prices continue, albeit in some cases at more moderate paces. Aging and slower-growing work forces inhibit investment, although a rise in global saving from about 25 percent to nearly 27 percent of world GDP suggests that saving increases could be an even more important factor over this period. As noted, the foreign exchange reserve accumulation that helped keep interest rates low in the 2000s slows after the early 2010s.

Even though this third period is comparatively long, the global real interest rate decline of 230 basis point is big. Indeed, the Federal Reserve was raising interest rates between December 2015 and December 2018 (which marked the end of that hiking cycle), yet between 2015 (the year of the working paper version of Rachel and Smith's forensic decomposition of low interest rates, Rachel and Smith 2015) and 2018, the global long-term real rate declined by a further 80 basis points to reach zero. Even though output growth seems to have little explanatory power for real interest rates over longer horizons, it seems likely that lower growth has been a factor after the GFC. Lower growth may well affect saving asymmetrically compared with higher growth because of borrowing constraints, and will certainly discourage investment. Fernald (2015) and Cette, Fernald, and Mojon (2016) document that

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[22] Rachel and Summers (2019) point to the possibility of rapid income growth raising rather than decreasing saving, even when the growth seems likely to persist. This effect runs counter to the intuition from representative-agent intertemporal models that higher expected income growth should lead to reduced saving. Carroll and Summers (1991) present relevant evidence. Of course, much depends on how persistent a growth increase is expected to be. If Chinese savers expect a surge like China's in the 2000s to be somewhat temporary, they might well use much of their higher income to provision for the future, especially the lengthier old age implied by increasing longevity. Several studies (for example, Hamilton et al. 2016 and Lunsford and West 2019) fail to find a robust connection between output growth (or output growth per capita) and the real interest rate, contrary to what one might expect from a simple Euler equation approach. For several reasons, this may not be surprising. The Euler prediction depends in part on individuals being able to raise consumption immediately in response to future expected income growth, but borrowing constraints likely impede that response. Even so, the income growth relevant for consumption decisions is at cohort level, not the aggregate level (Blanchard 2022). Finally, in a world of integrated capital markets, global income growth matters more than national growth. On the investment side, however, higher growth could also come with a higher productivity of capital, which shifts the *I* schedule upward, but empirically, this channel too is hard to identify. In contrast to the results just mentioned, Del Negro et al. (2019) find a role for lower growth in explaining the last three decades' fall in trend real interest rates in a sample of seven advanced economies. See also Davis et al. (2023). Other studies likewise conclude that higher output or productivity growth raises real interest rates.

U.S. and European productivity growth began to fall even before the GFC, and growth in EMDEs has been notably weaker after the GFC.

Another factor likely at work in this third period is the need for debt deleveraging after the debt buildups that led up to the GFC and euro area crisis. Lo and Rogoff (2015) argue that debt overhang is an important contributor to low post-GFC growth, and possibly, therefore, to low real interest rates.[23] Gourinchas, Rey, and Sauzet (2022) suggest that wealth collapses can forecast lower real interest rates going forward. However, short- and long-term real interest rates implied in the 1870-2015 data set of Jordà et al. (2019) show no clear tendency for low rates to follow crisis dates, even when the post-2007 data are included, consistent with findings of Laubach and Williams (2016). Financial regulatory changes (notably Basel III) could have played a role.

An instructive exercise is to use estimated elasticities of global saving and investment with respect to the real interest rate – the elasticities of the curves in figure 10 – to quantify the macro shifts necessary to generate observed equilibrium changes in global real interest rates and saving.[24] In a sense, this approach inverts the experiments done by Rachel and Smith (2017). While they ask about the extent to which various shocks may have shifted the saving supply and investment demand schedules, inferring the outcome for interest rates, I will use the equilibrium outcomes for interest rates and saving to infer the magnitude of saving and investment shocks.

Rachel and Smith (2017) consider saving supply elasticities in the interval [0.3, 0.7] and investment demand elasticities in the interval [−0.5, −0.7]. Using the "cautious" values that Rachel and Summers (2019) posit, one can write the changes implied by the curves in figure 10 as:

$$\frac{dS}{S} = 0.3\frac{dr}{r} + \varepsilon_{S,}$$

$$\frac{dI}{I} = -0.5\frac{dr}{r} + \varepsilon_{I}.$$

With a global ratio *S/Y* of about 0.25, the 49 percent fall in the interest rate (from 4.5 percent to 2.3 percent) and rise in *S/Y* = *I/Y* (from 22.5 percent to 25.5 percent, implying a 12 percent rise in saving) over 1992-2007 imply that $\varepsilon_S = 26.7$. This amounts to a rightward shift in the saving schedule of about $\left(\frac{S}{Y}\right)\varepsilon_S = 6.7$ percent of world GDP. The same numbers imply that the shift in investment as a share of world GDP was $\left(\frac{I}{Y}\right)\varepsilon_I = -3.1$ percent, a leftward shift.

The corresponding shifts for the period 2007-18 are a rise in *S/Y* from 25.5 to 27 percent and a fall in the interest rate of 100 percent. Based on the previous elasticities, these translate into a 6 percent increase in *S* = *I*, and thus into a $\left(\frac{S}{Y}\right)\varepsilon_S = 9$ percent of world GDP rightward shift in the saving schedule. The corresponding shift in the investment schedule (leftward) is implied to be equivalent to $\left(\frac{I}{Y}\right)\varepsilon_I = -11$ percent. The implication would be that saving shifts were about twice as important as investment shifts in depressing global interest rates over 1992-2007, but both curves have continued to shift, with the negative horizontal shift in investment after the GFC somewhat more important.

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[23] Eggertsson and Krugman (2012) offer a formal model.

[24] Auclert et al. (2021) provide a micro-foundation for this type of analysis.

However, the shifts just calculated for the second subperiod are certainly far too large. It is implausible to assume that a constant saving or investment elasticity would persist for interest rates much lower than the historical averages that underlie the estimates that Rachel and Smith (2017) list. It is more likely that at very low interest rates, the elasticities are lower, implying smaller shifts in the saving and investment schedules. Because equilibrium world saving and investment rise relatively little over 2007-18 in the face of a very large decline in the real interest rate, however, it is reasonable to conclude that if the saving function remains comparatively inelastic at low interest rates, then a sizable leftward shift in the investment schedule also did occur.

7. Implications for Monetary Policy

The logic of Thorton and Wicksell implies that to achieve a target level of inflation, the central bank should set the nominal policy rate of interest with reference to the economy's equilibrium real rate. Difficulties emerge, however, once monetary economists try to define exactly what that equilibrium benchmark is, how to measure it, and how to determine precisely where the nominal policy rate should stand relative to the benchmark rate to achieve price stability.

Estimating Natural and Neutral Rates

Earlier I defined the natural real rate of interest $\bar{r}$ as the economy's long-run flexible-price equilibrium rate, and the neutral rate r^* as the rate the central bank should set to neither stimulate nor hold back the economy. The two concepts are closely related, if not necessarily identical. Economists have tried empirically to estimate both as guides to central banks, deploying methods that alternatively come closer to one or the other concept. There are four fundamental approaches:

1. Estimating long-horizon forecasts or trends by nonstructural time series methods (e.g., the time-varying vector autoregression (VAR) of Lubik and Matthes 2015 or the latent trends VAR of Del Negro et al. 2019). The basic hope is that cyclical factors and price rigidities are not reflected in the estimated trends or long-run forecasts.
2. Extracting information on the expected long-horizon real interest rate from a bond pricing model (e.g., Christensen and Rudebusch 2019 and D'Amico, Kim, and Wei 2018, or DKW). Again, it is hoped that the long-horizon interest rate forecast is insensitive to intervening price stickiness and other temporary factors.
3. Solving for the flexible-price equilibrium rate within a calibrated structural model (e.g., Cúrdia et al. 2015 or Del Negro et al. 2017 within DSGE models or Platzer and Peruffo 2022 within an overlapping generations model).
4. Semi-structural (such as Laubach and Williams 2003 and Holston, Laubach, and Williams 2017). Kiley (2020a) offers a blend of time series, asset-pricing, and semi-structural approaches, applied to an international dataset.

As noted, the first of these approaches presumes that the estimated trend value or long-horizon forecast of a time series model corresponds to a flexible-price equilibrium interest rate – effectively, the natural rate, $\bar{r}$. The second extracts a forecast of long-run future $\bar{r}$ from an asset pricing model and thus is vulnerable to model misspecification (of term and liquidity premia). However, this class of models can be implemented at high frequency, giving the bond market's real-time read on long-run rates if one accepts the model's identifying assumptions. The third, structural, approach is if anything even more sensitive to specification error, though it can yield a rich account of the drivers of natural rates. In some

DSGE applications, e.g., the DSGE model in Del Negro et al. (2017), the model is used to extract an estimate of a longer-run equilibrium rate that conceptually resembles $\bar{r}$, whereas the short-run equilibrium real rates implied by standard versions of these models bear a more direct but complex relationship to the stance of monetary policy (see box 1). Of all these approaches, the semi-structural approach of Laubach and Williams seems closest to targeting an estimate of the *neutral* rate of interest r^*– which enters the model as a latent variable governing whether the monetary policy stance is accommodative or contractionary. However, this approach, too, is vulnerable to specification error, and can yield imprecise estimates (Kiley 2020b).[25]

In principle, different measurement approaches may take different stands on the statistical stationarity of real interest rates. Rogoff, Rossi, and Schmelzing (2024) survey research on this question and argue that for now-advanced economies, seven centuries of data reveal trend stationarity in real rates. The answer is certainly relevant for forecasting purposes, but given the high persistence in macro data, different approaches to estimating natural rates may give similar results regardless of stationarity assumptions (e.g., see the comparison of long-run VAR and DSGE forecasts in Del Negro et al. 2017).

Figure 21 shows natural or neutral rate estimates for the United States using three methodologies:

1. The Lubik-Matthes natural rate, which is a five-year-ahead VAR forecast.
2. The DKW five-year forward average expected real short rate, estimated via a term-structure model that allows for both term and liquidity premia in TIPS yields.
3. Current model estimates of the Holston-Laubach-Williams (HLW) r^* reported by the Federal Reserve Bank of New York.

These estimates follow the general downward trend of U.S. long-term market real rates, but with some divergences among the three measures. Based on revised data, the HLW r^* was relatively high from the late 1990s to the GFC, and substantially higher than the Fed's real policy rate in the early 2000s. During those years, global liquidity surged, the American housing market bubbled, and the dollar weakened. The new HLW estimates unveiled in May 2023, as updated to 2024 Q4, place r^*slightly below its pre-pandemic level, at 78 basis points (Holston et al. 2023). The LM natural rate starts to rise at the start of 2017, dropping only briefly in the COVID outbreak quarter 2020 Q2 before rebounding strongly. The 2024 Q4 estimate stood at 2.5 percent. The DKW five-year forward natural rate estimate has generally been equal to or below the other estimates for three decades. After turning negative in March 2020, it rose sharply to about 1.3 percent at the end of 2024.

The three estimates are generally rather close from mid-2009 through about the end of 2014, so the recent divergences are striking. Interestingly, a divergence has also emerged between the DSGE 30-year forward estimates and the trend-VAR estimates that had tracked closely together in the data sample

[25] Davis et al. (2023) explore a ten-country sample using an approach that merges the time series and asset-pricing methodologies by postulating that persistent trends in inflation and the natural rate are key pricing factors for bonds. Like the two methodologies upon which it builds, this approach also is geared to uncover estimates of $\bar{r}$. Bofinger and Haas (2023) suggest an alternative methodology to Laubach-Williams based on actual output gap and inflation outcomes viewed through a new-Keynesian lens.

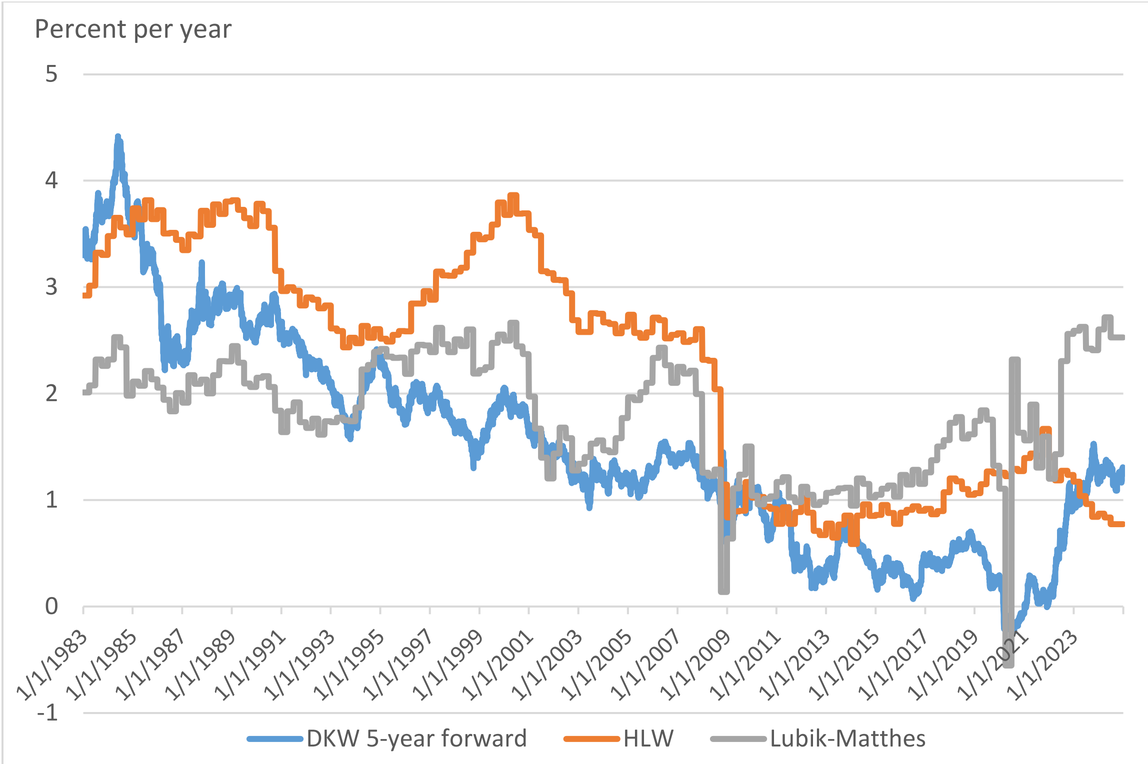


Figure 21: Alternative estimates of natural or neutral real interest rates

Source: Federal Reserve Bank of Richmond, Kim, Walsh, and Wei (2019), and Federal Reserve Bank of New York (updated to September 29, 2023).

analyzed by Del Negro et al. (2017). In August 2023, the former stood at about 1.75 percent while the latter was around 0.5 percent – a 125 basis point spread (Baker et al. 2023a). The corresponding forecasts at the end of 2024 were, respectively, around 2.4 percent (Cho et al. 2024) and 1.2 percent (close to the DKW estimate).[26] Both are higher than in August 2023 but are separated by a similar gap.

Implementation Challenges for Monetary Policy

Even if a central bank could identify with some precision the natural rate of interest, pinning down the neutral rate remains challenging. In simple models with rational expectations and a credible monetary rule, it may be true that simply guiding the policy interest rate with reference to the natural rate eliminates price instability or achieves a desired point on the short-run inflation-unemployment tradeoff. In general, however, this view of the world is overly simplistic.

One problem, already mentioned, is that financial conditions may diverge from the monetary policy setting, adding a factor that is absent from models like the original Laubach-Williams, but which may call for a more or less aggressive interest rate response to inflation (Borio 2021). One example would be a divergence between the movement in policy and long-term interest rates. The movement of the exchange rate is also relevant to overall financial conditions, especially in smaller open economies, and

[26] Personal communication from Sophia Cho and Marco Del Negro.

Box 1: The short-run equilibrium real rate and inflation in a basic New Keynesian model

New Keynesian (NK) DSGE models may be used to compute a short-run flexible-price real interest rate that "summarizes the real forces driving the movements in interest rates, abstracting from the influence of monetary policy decisions" (Del Negro et al., 2017, p. 236). For example, denoting this hypothetical interest rate by $\bar{r}(0)$ (and using overbars to denote flexible price, and efficient, values in general), a standard simple closed-economy representative-agent model without capital might imply $\bar{r}_t = \left[\frac{\beta E_t u'(\bar{y}_{t+1})}{u'(\bar{y}_t)}\right]^{-1} - 1$, where y_t is output on date t and $u'(y)$ is the marginal utility of consumption. This definition corresponds to the New York Fed's "short-run r^*" for date *t.*

The relationship between $\bar{r}_t$ and r_t^* is not simple in this model, however. In the NK model, inflation depends on the entire future path of policy rates relative to the future path of $\bar{r}_{t+i}$, and $\bar{r}_{t+i}$ can be quite volatile, making it hard to track in practice. Even if it were practical to use $\bar{r}_t$ reliably to guide monetary policy, the standard model implies that setting $r_t^* = \bar{r}_t$ yields inflation stabilization only in special (unrealistic) cases.

In the standard model (e.g., Galí 2015), the NK *IS* curve (written in terms of deviations from the flexible-price equilibrium) takes the form

$$y_t - \bar{y}_t = \mathbf{E}_t(y_{t+1} - \bar{y}_{t+1}) - \sigma(r_t - \bar{r}_t)$$

Assuming that the economy converges to the flexible-price path quickly enough as the horizon $i \to \infty$, this equation may be iterated forward to give

$$y_t - \bar{y}_t = -\sigma \mathbf{E}_t \left[\sum_{i=0}^{\infty} (r_{t+i} - \bar{r}_{t+i})\right].$$

Thus, the date-*t* output gap depends not just on contemporaneous $r_t - \bar{r}_t$, but on the entire expected future path of the gap between the actual and flex-price real rates. A sufficient (but not necessary) condition for it to be zero is that the interest-rate gap is zero on every future date.

The linearized Calvo pricing model for inflation (also written in terms of deviations from the flex-price equilibrium, where I assume that the inflation target $\bar{\pi} = 0$ on every date) implies

$$\pi_t = \kappa \mathbf{E}_t \left[\sum_{i=0}^{\infty} \beta^i (y_{t+i} - \bar{y}_{t+i} + s_{t+i})\right],$$

where $\beta \in (0,1)$ is the subjective discount factor and $\{s_{t+i}\}_{i=0}^{\infty}$ is a sequence of cost-push or supply shocks (as in, e.g., Clarida 2018). Combining the last two equations shows how the inflation gap depends on the expected future path of real interest gaps and supply shocks:

$$\pi_t = -\kappa\sigma \mathbf{E}_t \left[\sum_{i=0}^{\infty} \frac{1-\beta^{i+1}}{1-\beta} \left(r_{t+i} - \bar{r}_t(i)\right)\right] + \kappa \mathbf{E}_t \left[\sum_{i=0}^{\infty} \beta^i s_{t+i}\right].$$

Problematically for the model, this expression implies that future expected interest rate gaps have an influence over today's inflation that *rises* as the gap recedes further into the distant future. As the horizon $i \to \infty$, the impact coefficient converges to the possibly very large number $1/(1-\beta)$, for example, to 50 if β = 0.98. No one believes that the impact of the policy rate in a thousand years is 50 times stronger than its impact today. The "intuitive" (but implausible) reason is that in the model the far distant interest rate affects equally every output gap from today into the distant future.

The problem is a reflection of the "forward guidance puzzle." The literature suggests several fixes: a precautionary saving motive (McKay, Nakamura, Steinsson 2016), demographics based on finite lifetimes (Del Negro, Giannoni, and Patterson 2023), or cognitive discounting (Gabaix 2020). However, these

Box 1 (continued)

modifications should be accounted for in the computation of $r^*$and its relationship to the flexible-price path of interest rates.

One can implement a simple version of Gabaix's approach by assuming that consumers have an "inattentiveness factor" $\mu \in (0,1)$ such that the *IS* curve becomes:

$$y_t - \bar{y}_t = \mu \mathbf{E}_t(y_{t+1} - \bar{y}_{t+1}) - \sigma(r_t - \bar{r}_t).$$

The inflation equation is unchanged, assuming that producers are not inattentive. Substituting the *IS* relation into the inflation equation yields

$$\pi_t = -\kappa\sigma\mathbf{E}_t\left[\sum_{i=0}^{\infty}\mu^i\left(\frac{1-(\beta/\mu)^{i+1}}{1-(\beta/\mu)}\right)(r_{t+i} - \bar{r}_{t+i})\right] + \kappa\mathbf{E}_t\left[\sum_{i=0}^{\infty}\beta^i s_{t+i}\right]$$

If $\beta \neq \mu$, the weights on the future interest gap $\to 0$ as $i \to \infty$. (If $\beta = \mu$, the forward guidance puzzle remains.)

The preceding expression has several implications.

First, zero inflation requires a path for the policy rate such that

$$\sum_{i=0}^{\infty}\mu^i\left(\frac{1-(\beta/\mu)^{i+1}}{1-(\beta/\mu)}\right)r_{t+i} = \sum_{i=0}^{\infty}\mu^i\left(\frac{1-(\beta/\mu)^{i+1}}{1-(\beta/\mu)}\right)\bar{r}_{t+i} + (1/\sigma)\sum_{i=0}^{\infty}\beta^i s_{t+i}\,.$$

If supply shocks are absent, committing to the policy path $r_{t+i} = \bar{r}_{t+i}$ for all *i* is a dynamically consistent strategy if the sole policy goal is zero inflation. Other paths for the policy rate could be consistent with zero inflation on date *t* but generally would not be if continued from date *t* + 1. However, there is a range of possible neutral rate settings r_t^* today if the central bank forgoes zero inflation later. A central bank cannot, in a dynamically consistent way, "borrow" a low interest rate today with a promise of a higher rate tomorrow, while keeping inflation constant at zero. Related, there is no constant level of the neutral policy rate that can credibly be promised to hold inflation at zero unless the flexible-price rate is constant.

Second, if a central bank takes as the neutral rate $r_t^* = \bar{r}_t, r_t^*$ need not equal the long-run natural rate $\bar{r} = \lim_{i\to\infty}\mathbf{E}_t\{\bar{r}_{t+i}\}$ that many empirical approaches seek to measure and often identify with r_t^*.

Third, if there are supply shocks, then setting $r_{t+i} = \bar{r}_{t+i}$ no longer guarantees zero inflation. In such a setting, generally one with no "divine coincidence," a neutral interest rate (one that sets inflation to zero) depends on more than simply the short-term flexible-price real interest rate.

Fourth, an additive shock to the *IS* curve could represent an additional financial friction. That shock would further attenuate the direct link between the flexible-price short-term real interest rate and the neutral rate. It would also introduce a direct channel through with the attentiveness parameter μ could influence the neutral real interest rate.

exchange rates are driven by additional financial factors alongside monetary policy (see Obstfeld and Zhou 2022 for a survey and evidence). Indeed, changing inflation and financial conditions can change households' and firms' effective costs of consumption and production, with implications for the neutral rate of interest.[27] DSGE models more recently have incorporated financial frictions (e.g., Del Negro at al. 2017 assume a liquidity value of Treasuries as well as a Bernanke-Gertler-Gilchrist financial accelerator). Recent practical evidence of temporary financial conditions affecting the neutral rate comes from countries that saw the effectiveness of monetary tightening reduced owing to long-term borrowing at low fixed interest rates during the pandemic.[28] Box 1 suggests how a financial friction in the form of a household Euler-equation "wedge" could make the neutral rate deviate from a flexible-price rate. Supply shocks can also operate in this way too, as the box shows. Other recent work focuses on the inverse problem to the effect of financial conditions on price-stability policy, namely, the effect of the monetary policy stance on financial stability (Akinci et al. 2023).

Simple theoretical analyses of monetary rules often assume that fiscal or other policies have eliminated sources of dynamic consistency in monetary policy (as I also assume in box 1), but this elegant theoretical construct doesn't apply in reality. The game between policymakers and markets is much more complex, all the more so when inflation expectations become unanchored. In a situation where private agents forecast inflation to be persistently above target, the nominal neutral rate may need to be considerably above the nominal natural rate (calculated as the real natural rate plus private inflation expectations) if the central bank wishes to drive expectations back to target.

The need for the central bank to assess private expectations introduces its own perils. If the central bank lowers the policy rate after a market-based or survey indicator of expected inflation drops, agents may take the move as indicating less resolve to quell inflation and adjust their expectations back upward. Yet, to assess the real policy rate implied by its nominal policy rate setting, the policymaker must take a view of the public's inflation expectations. Bernanke and Woodford (1997) analyzed the possibility of indeterminacy when central banks base policy entirely on inflation expectations indicators. They recommended that the central bank base decisions on a broader set of economic indicators.

Alongside these issues, there is conceptual disagreement about the asset market most appropriate to be the "thermostat" for the monetary policy rate. Reis (2022) argues that the return on private capital is a more appropriate benchmark for the neutral rate than the bond rate: Hayek's "mercantile rate" (to quote another LSE scholar) should effectively be the marginal product of capital. However, the average return on capital over a long enough period also reflects compensation for risk, as stressed by Vissing-Jorgensen (2022), and that equity premium rose after the GFC in an environment that until 2021 was characterized by persistent deflation pressures (at least in advanced economies). Thus, the return on capital seems like too high a benchmark for the central bank's risk-free overnight interest rate, although there could be circumstances where the risk-free government bond rate is too low a benchmark.

Added to all this, there is the fundamental empirical problem that estimates of the natural or neutral rate come with wide standard error bands (for example, see Kiley 2020b).

[27] Models that analyze a "cashless limit," in which transactions in markets do not require the intermediation of any financial instruments, rule out this type of effect by assumption. For different accounts of such channels, see Obstfeld (1985) and Canzoneri, Cumby, and Diba (2015).
[28] For evidence on the U.S. mortgage market, see Berger, Milbradt, Tourre, and Vavra (2021).

The Natural Real Rate in Open Economies: External Shocks and External Balance

I explained in Obstfeld (2020) that with global determination of real interest rates, measurement methodologies based on closed-economy models may mislead. One main point can be put simply – an approach based on the closed-economy equality between saving and investment, or between domestic expenditure and full employment output, cannot be right when domestic saving and national investment need not be equal, or equivalently, when the country can run a net export surplus or deficit for goods and services.[29]

Beyond shifts in domestic saving and investment, purely financial external shocks to asset preferences – for example, capital inflow or outflow surges – can move domestic financial conditions including interest rates, as discussed above, with implications for monetary policy. Think of a typical emerging market economy that faces capital inflows driven by risk-on sentiments in global asset markets – an upturn in the global financial cycle. This could lower the domestic natural rate of interest, but unless there is a currency appreciation strong enough to choke off inflationary pressures, the neutral setting of the policy interest rate may rise, even as long-term government bond yields fall. Which outcome occurs is an empirical matter, and Corsetti, Dedola, and Leduc (2022) present a detailed analysis of possibilities in a model where "news shocks" drive capital flows.[30] The decline in U.S. safe asset interest rates in the 2000s, driven as it partly was by asset-preference shifts in the foreign official sector, arguably included a component that would have warranted a rise rather than a fall in the Fed's neutral-rate target.

Even in a flexible-price model with no financial frictions or asset-preference shocks, "the" natural interest rate cannot be defined without reference to the external balance of payments. Goods can be exported or imported: the market for traded goods need not clear domestically. The real domestic interest rate that clears the market for nontraded goods depends on planned consumption of traded goods, which need not equal domestic production.

To see this point concretely within a special context, consider figure 22, which shows the classic "dependent economy" or Australian model of Salter, Swan, and Corden. In this model, the economy is dependent in that it takes the price of tradables as exogenously fixed by world markets (it has no market power over its exports or imports). So, the real exchange rate depends exclusively on $p \equiv P_N/P_T$, the relative price of nontradables in terms of tradables. In equilibrium A, where the representative consumer's indifference curve is tangent to the production possibilities frontier, the economy's consumption just equals its production of both goods, $\boldsymbol{C}_{\mathrm{A}} = \boldsymbol{P}_{\mathrm{A}}$, and therefore net exports are zero a at the same time, disequilibrium price pressures are absent. Importantly, the economy's resources also remain fully employed, with no pressure for price changes, in equilibrium B. There, total expenditure exceeds income – the economy has a trade deficit – and so the consumption point $\boldsymbol{C}_{\mathrm{B}}$ differs from the production point $\boldsymbol{P}_{\mathrm{B}}$. However, the relative price of nontradables *p* is higher, inducing the economy to produce the extra nontradables it wishes to consume. The excess demand for tradables, beyond what the economy produces, is met through imports, without inflationary pressure.

[29] Clarida (2018) develops a new Keynesian model whose analytical solutions show how global forces feed into the flexible-price interest rate. But special features in that model imply that trade imbalances can never arise in equilibrium, so the model cannot throw light on its role in influencing the real interest rate.

[30] They also show that an optimal monetary response may allow higher inflation, depending on policymaker preferences and the economy's structure.

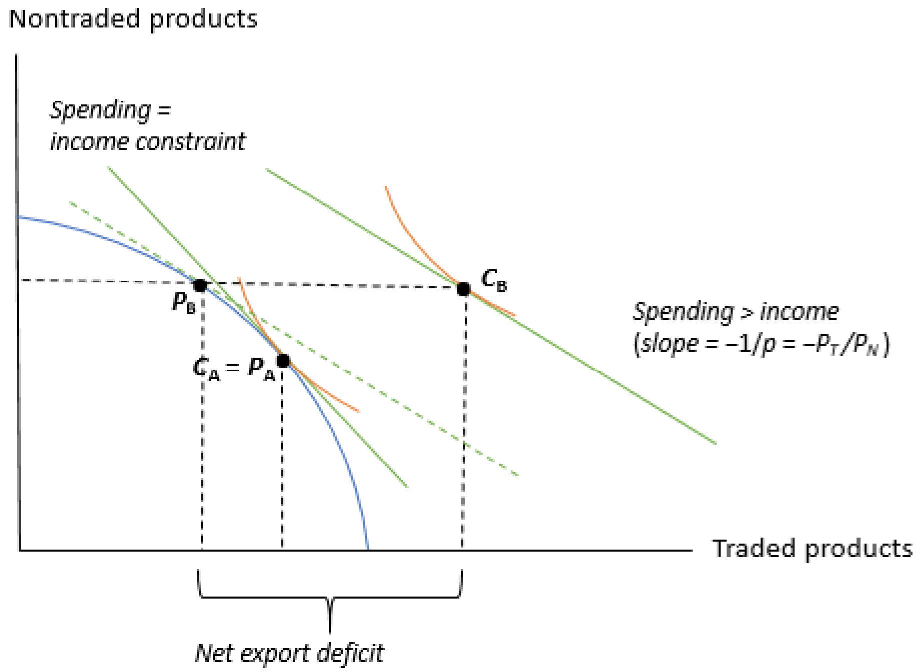


Figure 22: Alternative full-employment equilibria in the Australian open-economy model

Note: Equilibria A and B both are consistent with full employment, but at different domestic real interest rates.

To see the relevance for the domestic real rate of interest, consider a representative consumer who can borrow or lend in the international capital market at an interest rate of *r* (in terms of tradable goods) and maximizes

$$\sum_{t=0}^{\infty} \beta^t u(C_t)$$

where $0 < \beta < 1, u(C) = \frac{C^{1-\frac{1}{\sigma}}}{\left(1-\frac{1}{\sigma}\right)}$, and *C* depends on consumption of tradables and nontradables (C_T and C_N) according to

$$C = \left[\gamma^{\frac{1}{\theta}} C_T^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} C_N^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}.$$

The optimal path for total real consumption in this model follows the (Euler) difference equation

$$C_{t+1} = \beta^{\sigma} \left[\frac{(1+r)}{P_{t+1}/P_t}\right]^{\sigma} C_t,$$

where the exact consumer price index is $P = \left[\gamma + (1-\gamma)p^{1-\theta}\right]^{\frac{1}{1-\theta}}$ and $r_t^C = \left[\frac{(1+r)}{P_{t+1}/P_t}\right]$ is therefore the real (CPI-based) interest rate (Dornbusch 1983; Obstfeld and Rogoff 1996, section 4.4). Assume for simplicity that the economy's endowments of tradables and nontradables, Y_T and Y_N, are exogenous. If net exports (of tradables, of course) are denoted by NX, then consumer optimization implies that

$$p_t = \left[\frac{(1-\gamma)(C_{T,t})}{\gamma C_{N,t}}\right]^{\frac{1}{\theta}} = \left[\frac{(1-\gamma)(Y_{T,t} - NX_t)}{\gamma Y_{N,t}}\right]^{\frac{1}{\theta}}.$$

It follows that the equilibrium path of expected inflation, P_{t+1}/P_t, and hence, of the real interest rate, $r_t^C = \left[\frac{(1+r)}{P_{t+1}/P_t}\right]^{\sigma}$, depends on the expected path of net exports. Different paths of net exports could be driven by different expectations about the evolution of the tradables endowment, for example, and would imply different flexible-price domestic real rates of interest. Combining the equations above shows that, other things equal, a higher export surplus NX_t implies lower demand for nontraded as well as traded goods, a lower equilibrium relative price of nontraded goods p_t, a lower CPI (in terms of traded goods) P_t, and so higher expected inflation and a lower real consumption interest rate r_t^C.[31]

The relevance of openness is that the natural real interest rate must be consistent not only with internal balance (full employment and price stability) but with external balance (national intertemporal solvency). An attempt to read the natural rate off of the full-employment Euler equation cannot work without information on the "natural" net export balance, which (it is fair to say) is quite hard to ascertain conceptually. Here, the real exchange rate plays a key role. Both the real exchange rate and real interest rate paths must align to ensure a domestic expenditure level consistent with the optimal trade balance as well as full employment.

To grasp the mechanisms at work in a simple case, suppose there are only two periods, *t* and *t* + 1, and, without loss of generality, that the economy starts out with zero net foreign assets on date *t.* The economy's intertemporal budget constraint shows the linkage between net exports on dates *t* and *t* + 1:

$$NX_t + \frac{NX_{t+1}}{1+r} = 0.$$

Accordingly, while p_t is still given by the expression above, p_{t+1} must equal

[31] In an extension of this model with production of nontradables and nominal wage rigidities, such as Schmitt-Grohé, Uríbe, and Woodford (2022), the real interest rate consistent with full employment would also depend on net exports. Of course, net exports are endogenous and reflect deeper factors that will be the ultimate determinants of the natural rate in an open economy. But the dependence likely will take a different form than in standard closed-economy models. Another way frame the issue is to observe that in the simplest closed-economy NK models (as in box 1), consumption equals output and the IS curve, $y_t - \bar{y}_t = \mathbf{E}_t(y_{t+1} - \bar{y}_{t+1}) - \sigma(r_t - \bar{r}_t)$, follows directly from the consumer Euler equation, $c_t - \bar{c}_t = \mathbf{E}_t(c_{t+1} - \bar{c}_{t+1}) - \sigma(r_t - \bar{r}_t)$. In an open economy, however, $y - c \neq 0$: the gap reflects the trade balance and therefore depends on international relative price variables, among other factors. So, setting $r_t = \bar{r}_t$ on every date will not always ensure zero output gaps and zero (GDP deflator) inflation. A relevant model in this vein is Ferrero, Gertler, and Svensson (2009).

$$p_{t+1} = \left[\frac{(1-\gamma)\left(Y_{T,t+1}+(1+r)NX_t\right)}{\gamma Y_{N,t+1}}\right]^{\frac{1}{\theta}}.$$

An increase in NX_t lowers r_t^C as before, but by more, because NX_{t+1} must fall simultaneously. Full employment equilibrium and price stability require, not the equality of saving and investment or of domestic demand and supply, but instead, that r_t^C, p_t, and p_{t+1} (the real interest rate and real exchange rates) occupy a configuration in which the market for nontradables clears and the economy respects its intertemporal budget constraint. Only two of these prices are independent, but if the central bank gets only one of them right, disequilibrium will ensue. How would a shock to domestic saving, for example a rise in impatience (fall in β) play out? Households would wish to consume more today and less tomorrow, which would lower today's net export surplus, in turn lowering expected inflation and raising the natural real interest rate. This is an intuitive outcome. Essential to equilibrium adjustment, however, are a real appreciation on date *t* and a real depreciation on date *t* + 1. The exchange rate movements ensure that national expenditure is consistent with market clearing in nontradables on both dates.

In models with financial frictions that cause deviations from uncovered interest parity, foreign exchange intervention might be available and also necessary as a policy tool complementing monetary policy. Analyses of optimal monetary policy in open economy settings, in addition to the paper by Corsetti, Dedola, and Leduc (2022), include Ferrero, Gertler and Svensson (2009), Gopinath and Itskhoki (2022), and Itskhoki and Mukhin (2022).

In the simple Australian model above, of a small country facing a fixed global real interest rate, a higher trade deficit is associated with a higher natural interest rate. The reason is that, given the special assumptions of the model, deficits are driven by domestic demand. In other settings, for example, where export demand is finitely price elastic, a rise in the home deficit could be associated with a fall in the home real interest rate. For example, if a temporary increase in capital inflows induces a sharp currency appreciation and domestic recession with unchanged home monetary policy, the home natural and neutral real interest rates could fall, as in the model of Corsetti, Dedola, and Leduc (2023).

In the open economy, any estimated steady-state equilibrium real interest rate presumably would reflect the anticipated adjustments in the trade balance that assure national solvency. All the more reason for standard estimates of $\bar{r}$ to diverge from r^*, which is the rate meant to stabilize prices in the short run despite trade-balance shocks.

Open-Economy Estimation Approaches

Several studies have attempted to incorporate external factors into estimates of natural or neutral interest rates. Rachel and Summers (2019) recognize the shortcomings of closed-economy analyses and treat the OECD members as a single closed bloc. While it is true that the advanced economies' aggregate current account balance has been smaller as a share of group GDP than the balances of many group members as a share of their own individual GDPs (see figure 1 in their paper), imbalances of the magnitude shown in figure 15 above have arguably had significant repercussions for global interest rates. The approach has two other shortcomings. First, even when net flows are small ex post, shifts in gross asset demands and supplies can have sizable impacts on rates. Second, estimates derived based on the Rachel-Summers assumption would be problematic for assessing the effects of counterfactual experiments that in equilibrium would result in a widening of the group current account balance.

Wynne and Zhang (2018) develop a two-country Laubach-Williams model in which the U.S. and Japanese neutral rates are estimated jointly within a framework where each country's rate depends on foreign as well as domestic growth. Their findings suggest a significant impact of foreign growth on the domestic neutral rate. Del Negro et al. (2019) and Kiley (2020) implement time series approaches that extract global trends from samples of seven and 13 advanced economies, respectively. These types of estimates can throw some light on the global correlates of global trends, but do not explicitly model the channels of interaction among economies.

In a paper on the U.S. real interest rate, Platzer and Peruffo (2022) introduce net capital inflows as a positive exogenous shock to saving (a transfer of foreign saving) and estimate the effect on the U.S. real rate.[32] International Monetary Fund (2023) extends this approach to a sample of eight advanced and emerging economies. The effect of net capital flows on natural real interest rates is found to be small, but generally in line with the prediction of the Metzler model that net inflows depress countries' natural rates, provided the flows are driven by supply rather than demand, i.e., a rise in the ex ante foreign saving-investment gap rather than a decline in the home ex ante saving-investment gap.

Finally, representing a hybrid of time series and structural modeling approaches, Cesa-Bianchi, Harrison, and Sajedi (2022) use a common trends framework to estimate the trend global natural real rate and global trends for five observable drivers of the rate. Simulations of a calibrated overlapping generations model for their sample of 31 high-income economies, assumed to constitute the world economy, suggest that lower productivity growth and increased longevity are principal drivers of the last few decades' decline in global real rates.

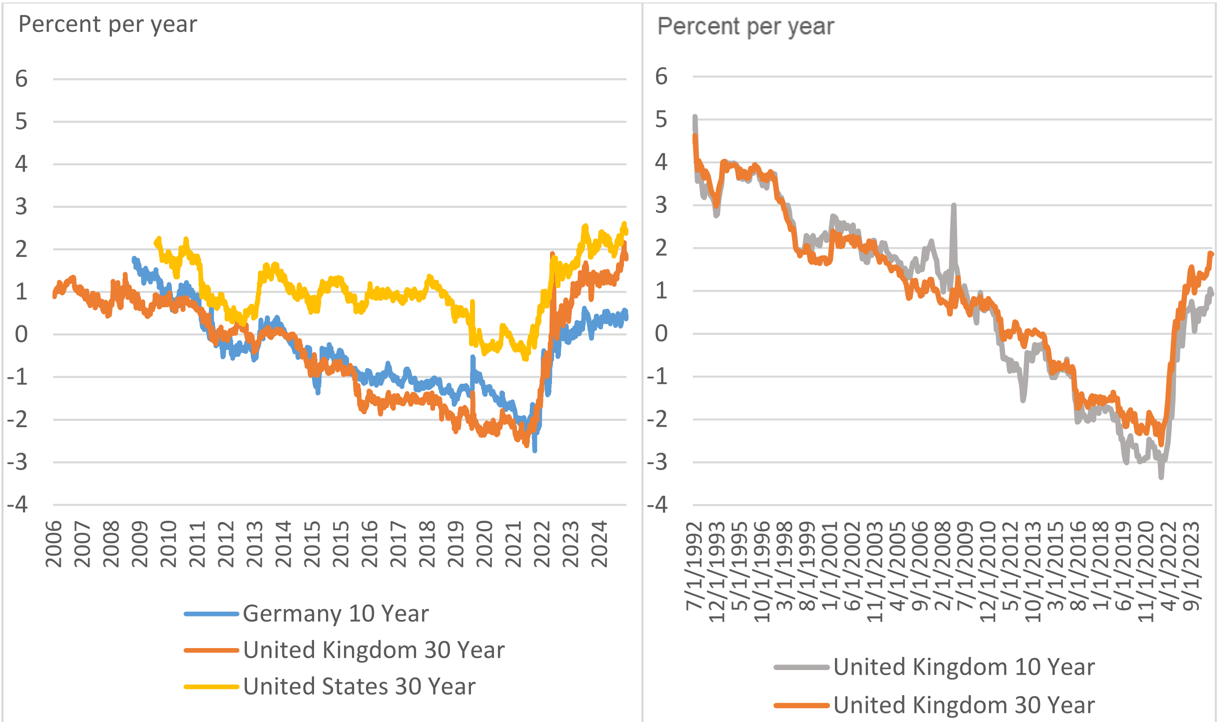
8. The Future of Global Real Interest Rates

> [T]he long-term trends in global saving and investment that contributed to low rates in the past will reverse in the decades ahead. The primary reason is that developing economies are embarking on one of the biggest building booms in history. At the same time, aging populations and China's efforts to boost domestic consumption will constrain growth in global savings. The world may therefore be entering a new era in which the desire to invest exceeds the willingness to save, pushing real interest rates up.... We project that by 2020, global investment demand could reach levels not seen since the postwar rebuilding of Europe and Japan and the era of high growth in mature economies.

McKinsey Global Institute, *Farewell to Cheap Capital? The Implications of Long-Term Shifts in Global Investment and Saving* (December 2010)

Following the natural, economic, and geopolitical disruptions of the last few years, predictions that the era of low real interest rates is over have increased in frequency and plausibility. Even before recent events, Goodhart and Pradhan (2020) made a detailed case that real interest rates (as well as inflation) would be higher in the future, but as the MGI quotation above shows, such predictions are not new. Will they prove accurate this time?

[32] The empirical modeling takes the fall in the U.S. NIIP as a proxy for the capital-inflow shock. However, much of the NIIP change comes from asset-price changes rather than capital flows as captured in either the balance of payments statistics or NIPA, and so the proxy measure of saving flows is conflated with portfolio shocks that alter asset prices.



(a) Germany, United Kingdom, and United States (b) U.K. 10- and 30-year maturities

Figure 23: Inflation-linked long-term bond yields for Germany, United Kingdom, and United States

Source: Bloomberg (updated to February 4, 2025).

The inflationary surge of 2021-22 took many forecasters by surprise and pushed long-term *ex post* real interest rates lower even as it raised long-term nominal rates. The previous charts reflect this development; I have downplayed those recent data because they may not be indicative of longer-term real rate expectations. To focus on the possibility that we have entered new territory, I first show in figure 23 some (limited) data on very long-term inflation indexed bond yields, which could provide a better read on market expectations of far-future natural interest rates.[33]

These yields all show sharp upward jumps since the first half of 2022 coincident with monetary tightening. However, higher rates persisted even after central banks began to cut policy rates in the second half of 2024. The increases likely indicate upwardly revised market expectations of future real natural rates.[34] For the United States (panel (a)), the 30-year TIPS yield has risen to surpass its values in early 2011; as of early 2025, it stood at around 250 basis points – about 120 basis points above the DKW estimates for the five-year forward real short rate in January 2025, but close to the 2024 Q3 Lubik-

[33] For the United States, ex ante long-term real bond yields computed using survey data on expected inflation yield similar recent patterns (International Monetary Fund 2023).

[34] The DKW estimates for end-January 2025 suggested that for U.S. 10-year TIPS, the real term risk premium was about 53 basis points, while the inflation risk premium was negligible. The liquidity premium was estimated at around 30 basis points. (See https://www.federalreserve.gov/econres/notes/feds-notes/DKW-updates.csv.) Christensen, Mouabbi, and Paulson (2025) estimate that interest rates on German inflation-linked bonds average 33 basis points lower than comparable market rates owing to a safety/liquidity premium. These excess returns indicate the need for caution in inferring longer run real rate expectations from market yields.

Matthes estimate. German and U.K. indexed yields have risen more than long-term TIPS yields since 2021, from levels below –200 basis points, but those yields still fall short of the index-linked U.S. Treasury yield. To some degree, the expected real rate changes reflect recovery from perhaps overly pessimistic expectations during the COVID-19 recession and constitute a more dramatic reversal in Europe than in the United States, where indexed yields remained relatively high (averaging about 100 basis points) from mid-2013 to mid-2019 and became only moderately negative during the pandemic. For the United Kingdom, the recent increases return real rates approximately to the levels of the mid-2000s, still about 200 basis points below the levels of the early 1990s. Will this interest-rate recovery endure and perhaps even intensify? Or will the "secular stagnation" scenario, with the attendant challenges for monetary policy, re-emerge?

It is not straightforward either to pinpoint the key elements that have driven real interest rate trends in the past, or to forecast those drivers' future evolution. Nonetheless, the weight of statistical and modeling evidence suggests that several likely relevant factors would be in play.

Growth

Figure 24 shows global rates of growth as calculated by the IMF, with projections starting 2024.

One potential driver of a real interest rate recovery would be a surge in global investment that would likely be associated with higher productivity and output growth. The forecasts in figure 24 suggest that this is not in the cards in the near term. New technologies, for example, those based on generative artificial intelligence, could lead private investment to rise temporarily or longer term, and even increase the secular growth rate, but those predictions are contested and speculative at this point. Public or government-supported investment could rise owing to the needs of the green transition. Given the uncertainty unleashed by the new U.S. administration's seeming weakening of the U.S.-European

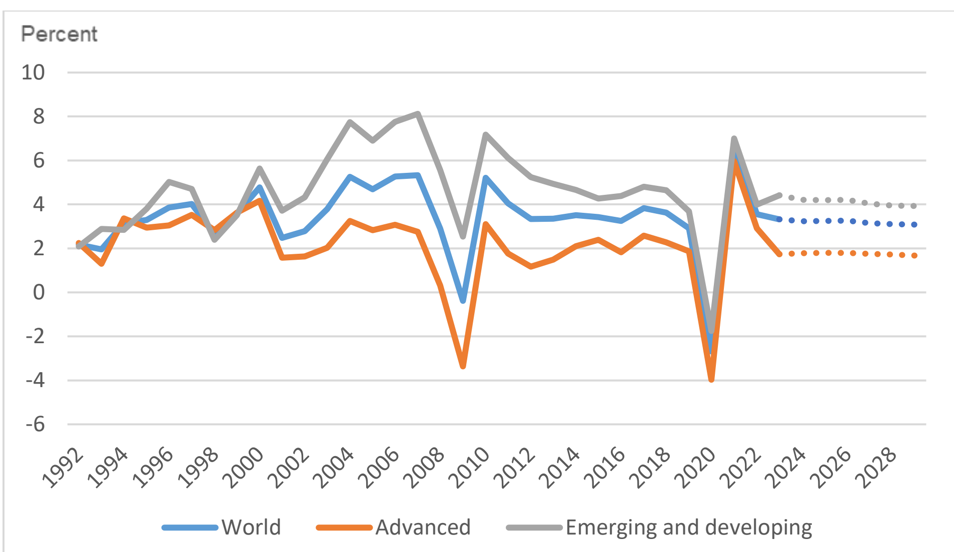


Figure 24: Output growth rates for the world and country groups, 1992-2029

Source: Growth rates with PPP weights from IMF, World Economic Outlook database, October 2024 (projections starting in 2024).

alliance, substantial increases in military expenditures – for example EU investments in defense industries and in a missile defense shield – seem likely. Geopolitical uncertainties may well propagate this trend worldwide, reversing further some of the favorable developments at the end of the Cold War.

The quotation from MGI at the start of this section suggested that higher investment demand in less prosperous countries would be the key to higher global interest rates worldwide. Those investment needs, especially in the infrastructure realm, are certainly high. For this channel to operate, however, investment funding must be free to flow from richer to poorer countries, yet the net transfer of capital between the two country groups has been limited, perhaps due to financial frictions (Chari and Rhee 2000) or the riskiness of investment in the destination economies (David, Henriksen, and Simonovska 2016).

Using Penn World Table data, Monge-Naranjo, Sánchez, and Santaeulàlia-Llopis (2019) document a tendency for marginal products of capital in rich and poorer countries to converge over time as capital intensity rises in poorer countries. Importantly, however, they also document that higher capital intensity in those countries has been driven mostly by higher domestic saving and only minimally by net capital inflows, reminiscent of the pattern documented by Feldstein and Horioka (1980). Bai and Zhang (2010) demonstrate the potential for certain financial frictions to rationalize the Feldstein-Horioka regularity, although good-market frictions, which allow real interest rates to diverge across countries, also play a role (Obstfeld and Rogoff 2001; Eaton, Kortum, and Neiman 2016). With the rise of U.S.–China tensions and tensions over Russia's aggression in Ukraine and developments in the Middle East, intensifying global economic fragmentation will further discourage rich-to-poor capital flows – through financial as well as goods-market channels.

Bilateral official investment initiatives like China's BRI and the Partnership for Global Infrastructure and Investment announced at the 2021 G7 leaders' summit – and now likely a dead letter – can raise global public investment in middle- and low-income countries but would have their biggest potential effects by raising marginal returns to private investments and catalyzing further capital accumulation. The same is true of the AIIB's Climate Action Plan, announced in September 2023, and the World Bank's recent efforts to expand its balance sheet (also possibly over for now). In any case, as precursors to subsequent private investment, the recent track record of these types of public investment is unclear.

One important factor that will influence the investment landscape also has big implications for saving – demographic trends – but these are not obviously favorable for higher real interest rates.

Demographic Trends and Their Implications for Saving and Investment

With the baby boom generation well into retirement, there are several other salient facts about global demographics going forward. Fertility will continue to fall, population growth will slow, old-age dependency rates will rise, and lifespans will continue to lengthen. Figure 25 shows United Nations projections for global population growth and average life expectancy from birth. The UN projects that population growth will turn negative in the 2080s and that average life expectancy, currently around 73, will reach nearly 82 by the end of this century.

Goodhart and Pradhan (2020) predict that increased lifespans will lead to lower global saving as the old draw down their wealth over a longer retirement. Blanchard (2022) has questioned the prediction on theoretical grounds. In fact, simple steady-state closed-economy examples without growth like

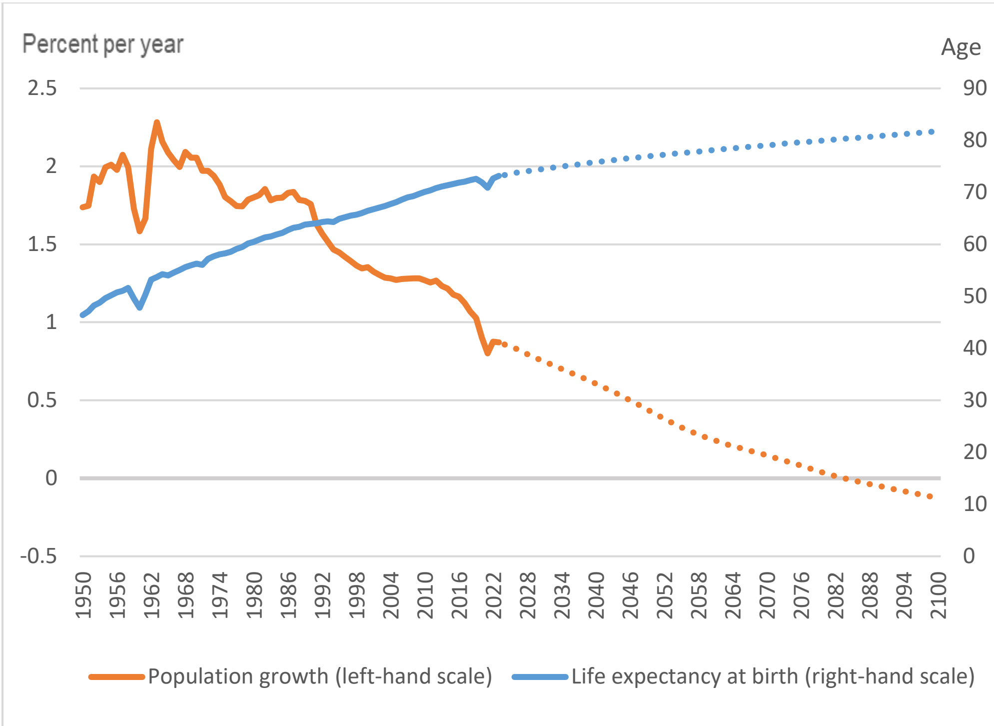


Figure 25: World population growth and average life expectancy

Source: United Nations, *World Population Prospects 2024* (projections starting in 2024).

Blanchard's imply that net saving is always zero: dissaving by the old exactly offsets saving by the young, consistent with zero net investment and a constant stock of capital. Blanchard's focus, as in the analysis of Auclert et al. (2021), is on *savings* rather than saving – the economy's accumulated capital level in its steady state. A higher capital stock, in turn, means a lower marginal product of capital, and a lower real interest rate (abstracting from uncertainty). If a collection of such national economies constitutes a global economy and a common demographic shock raises each country's desired autarky desired capital stock, the general equilibrium result will necessarily be a higher global capital stock and a decline in global interest rates.

The issues can be clarified by a simple example. Start with an overlapping generations economy that faces a global real interest rate of $r^* = 0$. Each individual works for T_y periods, earning output of *Y* per period of work, and is retired for T_o periods, earning 0 per period of retirement. At birth, individuals maximize the lifetime utility function

$$\sum_{t=0}^{T_y+T_o} u(C_t)$$

subject to

$$\sum_{t=0}^{T_y+T_o} C_t = T_y Y,$$

giving a flat level of desired consumption,

$$C_t = \bar{C} = \frac{T_y Y}{T_y + T_o}, \forall t.$$

Importantly, in this stationary economy, the total population on any date is $T_y + T_o$, if we assume that there is one representative worker per generation.

It is simple to calculate aggregate wealth in a steady state by summing wealth over the generations. An active (or "young") worker who has been working for $n \leq T_y$ years has (end-of-period) wealth of $n(Y - \bar{C})$. A retired (or "old") worker who is $n \leq T_o$ years into retirement has remaining wealth $T_y(Y - \bar{C}) - n\bar{C}$. After substituting the previous optimal consumption function, we find that wealth-to-GDP ratios for the young and old generations, are proportional to

$$W_y = \frac{T_y T_o (T_y + 1)}{2(T_y + T_o)}, \quad W_o = \frac{T_y T_o (T_o - 1)}{2(T_y + T_o)},$$

respectively, implying an aggregate wealth level proportional to

$$W \equiv W_y + W_o = \frac{T_y T_o}{2}.$$

This expression summarizes demographic predictions, but it is important to use it carefully. For example, increasing T_o above raises post-retirement longevity, but given the model's assumptions, it also raises total population, contrary to current demographic projections, which could be misleading.

An arguably more conservative way to evaluate the Goodhart-Pradhan longevity hypothesis holds total population constant while increasing the ratio of retirement to working years. In that setup, if total lifespan and population $T_y + T_o = N$ are fixed, total wealth becomes proportional to

$$W = \frac{(N - T_o) T_o}{2}.$$

The economy's wealth is maximized when half of life is spent in retirement, $T_y = T_o = \frac{N}{2}$. Provided this is not yet the case, $\frac{dW}{dT_o} = N - 2T_o > 0$ and a longer retirement period unambiguously raises steady-state wealth (though not by as much as in the example of Blanchard 2022), implying a depressing effect on interest rates.[35]

[35] The example is over-stylized of course, but it does serve to illustrate the limits of the Goodhart-Pradhan argument as a predictor of interest rates. For relatively long initial periods of working life, greater provisioning for old age raises steady-state wealth as T_o rises. But there is another force at work, too: if T_o rises with *N* constant, the economy is poorer – GDP is lower – and so there will naturally be less wealth. For $T_o < N/2$, the saving effect on wealth dominates in this example. But when $T_o > N/2$, the effect of general impoverishment dominates even though saving is very high.

This result does not capture a dynamic in which lower fertility and a shrinking population lead to a growing proportion over time of old dissavers in the economy. Unlike in my simple example, lifespans are rising globally at the same time as population growth is slowing. However, realistically calibrated dynamic global life-cycle models have tended to support the hypothesis that demographic trends will depress real interest rates further in this century. Auclert et al. (2021), Cesa-Bianchi, Harrison, and Sajedi (2022), and Lisack, Sajedi, and Thwaites (2021) find that demographic projections overall, including longevity projections and the effects of demographics on the demand for capital investment, imply further declines in interest rates far into the future. One important empirical element that these models incorporate is that many retirees save much more than simple life-cycle models predict, often in positive amounts, perhaps for bequest or precautionary reasons. (For the United States, there is a range of supporting studies stretching from Kotlikoff and Summers 1981 to De Nardi et al. 2025, Lockwood 2018, and Nakajima and Telyukova 2025.) Consistent with the theoretical results is the empirical finding of Grigoli, Platzer, and Tietz (2023) for 16 advanced economies since the 1870s that a higher old-age dependency ratio is associated with lower r^*. Of course, the past and predicted life-cycle asset holding patterns built into the calibrated dynamic models could fail to be accurate in the future.

Despite the evolution of private saving by households and corporates, higher levels of public debt going forward could crowd out capital and push interest rates higher. Demands on the public purse will include not only the possible military expenditures mentioned earlier, but health and pension costs from aging populations. Public debts spiked during COVID-19, especially in richer countries. The unexpected inflation that followed temporarily reduced debt ratios to GDP, but even before the recent geopolitical shifts generated by the new U.S. administration, the IMF was predicting gross general government debt levels for 2029 equal to or (for emerging markets and especially China) much higher than the immediate post-pandemic levels. (See figure 26, where group averages are weighted by GDP). Government borrowing rates may need to rise to persuade investors to add these public debts to their portfolios.

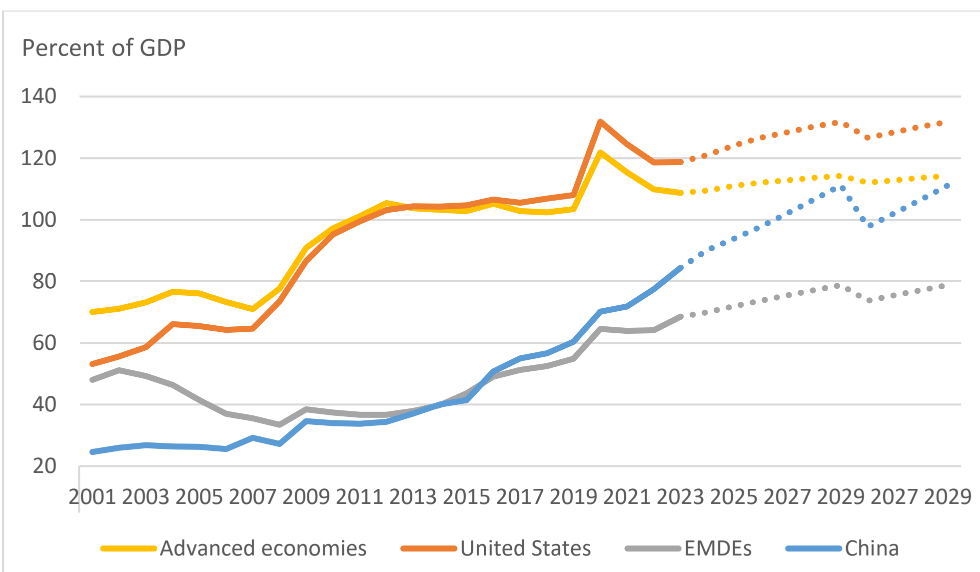


Figure 26: Gross general public debt levels relative to GDP

Source: IMF, World Economic Outlook database, October 2024 (projections starting 2024).

I have discussed demography's impact private and public saving but it also has critical implications for investment. In general, a slower-growing, aging population will deter investment by reducing the labor force. Beyond this, it could also discourage R&D, productivity growth, and investment because, as in endogenous growth models, the sunk costs of R&D must be recouped through a stream of monopoly profits, and more slowly growing consumer markets mean lower profits. This channel was suggested in Council of Economic Advisers (2015). It is formally modeled by Askoy et al. (2019). Jones (2022a) sets out an extreme case in which negative population growth (which the UN forecasts for the world by the late 2080s, see figure 25) causes a total collapse in innovation and growth.[36]

Fragmentation and Uncertainty

Greater fragmentation in the world economy can hamper long-term global growth by impeding the diffusion of new ideas and technologies (Bekkers and Góes 2023; Cerdeiro et al. 2023). Greater uncertainty, driven by political, geopolitical, and natural tremors, is another headwind to growth. Since the GFC, events that once seemed to be remote "tail risks" – financial collapse, pandemics, climate disasters, territory seizures by large countries including the United States, even nuclear war – now seem more probable. The tails are fatter (Kozlowski, Veldkamp, and Venkateswaran 2019). Even short of disaster risks, trade policy uncertainty has taken a ratchet step upward. Such developments discourage investment in plant, equipment, and R & D. Ultimately, higher uncertainty could raise precautionary saving and encourage demand for safe assets, pushing interest rates down. However, the range of assets deemed to be truly safe could shrink markedly – which could add higher default premia to government bond rates. Despite growing risks, financial markets remain remarkably ebullient as of early 2025, as indicated by the strength of demand for portfolio equities despite higher bond rates (figure 16). But financial gravity will reassert itself quickly if investor sentiment sours.

Countervailing Forces

Goodhart and Pradhan (2020) observe that the entry of China and the former Soviet countries into the world economy, along with India's reforms around the same time, constituted a massive increase in the world's effective labor force, which was bound to reduce relative wages worldwide. The increase in inequality may have shifted the world saving curve to the right over time, pushing down interest rates.

However, those effects had well worked themselves out by 2010 or so, yet real interest rates continued to fall. Considering the rise of corporate market power, it is hard to see a meaningful redistribution of income toward labor, which Goodhart and Pradhan predict will lower world saving. The current global trend toward economic fragmentation, replete with industrial policies and renewed attachment to "national champion" firms, does not bode well for an internationally competitive environment conducive to lower corporate rents. Technological trends – the possibility that robots and Gen AI render many current jobs obsolete – do not unambiguously support a narrative of lower future inequality either. However, as noted above, those factors could boost productivity growth (and incomes for some in the economy), barring adverse climate or geopolitical shocks.

[36] Jones (2022b) stresses demographic factors in a broader survey of long-term growth prospects.

Assessment

Growth and investment prospects, ever-more radical uncertainty, predictable forces of demographics, higher military spending, and higher government debts are likely to be the dominant factors determining global real interest rates over the next decade. The recent rate run-up evident in government bond markets is not necessarily a peak, and as inflation proves more persistent than central banks expected, rates could stay higher for longer and perhaps even rise.

Real interest rates now are roughly at pre-GFC levels; but they seem unlikely to return durably to their levels of three decades ago absent global growth well above current IMF forecasts. If interest rates were to decline, that would be an advantage for fiscal policy space, if not driven entirely by lower growth. Given current inflation targets, however, it would leave the effective lower bound as a recurring challenge for monetary policy. Financial instability also would remain a present threat, and several financial-sector business models will be challenged.

However, if higher government spending and faster public debt issuance drives real interest rates up in an environment of tepid growth, fiscal crises could result. Cuts to social insurance programs owing to other fiscal needs might force higher household saving, but they could as easily lead to political backlash and social disorder. Ultimately, whether higher real interest rates are beneficial or destabilizing will depend on their cause. If they are not due to higher productivity and growth, the triad of higher government debt, permanently higher government borrowing rates, and fiscal sustainability could well prove mutually inconsistent.

Appendix: Supplementary Charts

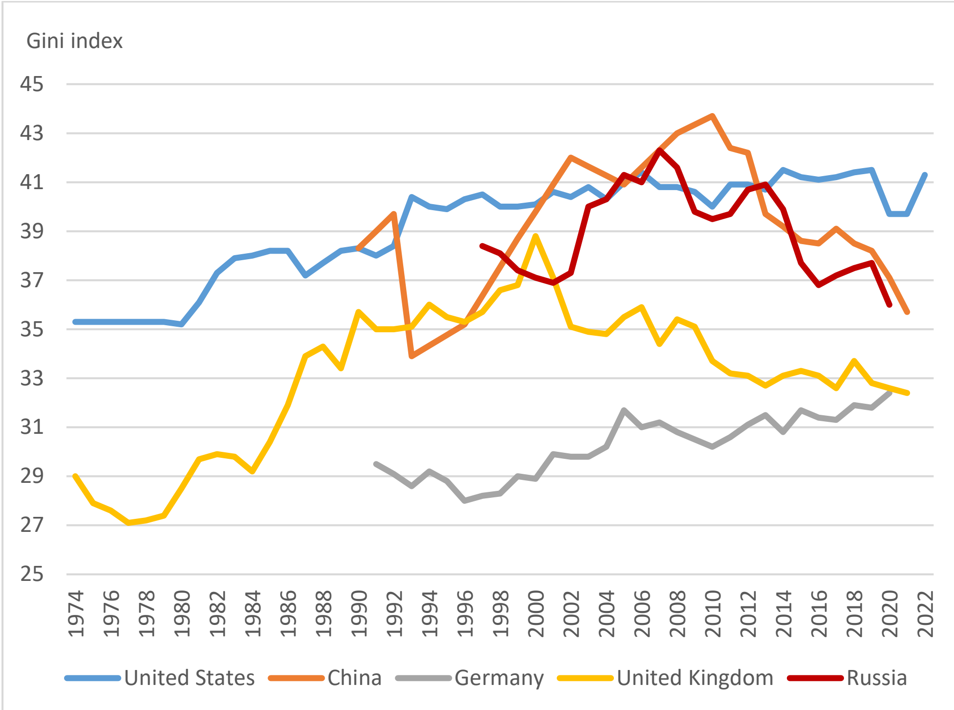


Figure A1: Gini coefficients for the United States, China, Germany, and the United Kingdom

Source: FRED, with some missing years interpolated for the United States and China.

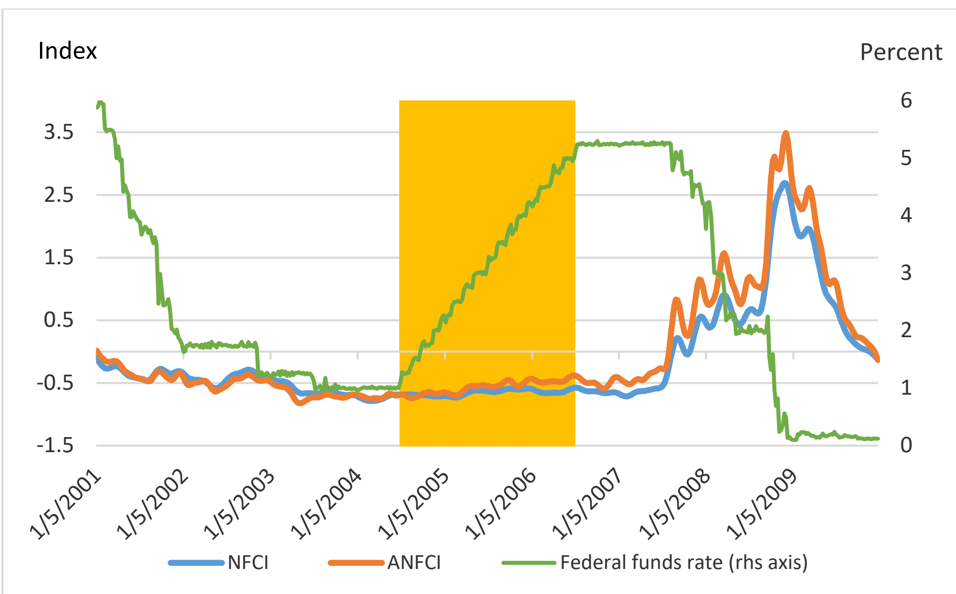


Figure A2: U.S. financial conditions amid the Fed's June 2004 – June 2006 hiking cycle

Source: Effective federal funds rate from FRED, Federal Reserve Bank of Chicago national financial conditions index (NFCI) and adjusted NFCI (ANFCI), from https://www.chicagofed.org/research/data/nfci/current-data.

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