CHAPTER 2

THE NATURAL RATE OF INTEREST: DRIVERS AND IMPLICATIONS FOR POLICY

The natural rate of interest—the real interest rate that neither stimulates nor contracts the economy—is important for both monetary and fiscal policy; it is a reference level to gauge the stance of monetary policy and a key determinant of the sustainability of public debt. This chapter aims to study the evolution of the natural rate of interest across several large advanced and emerging market economies. To mitigate the uncertainty that typically surrounds estimates of the natural rate, the chapter relies on complementary approaches to analyze its drivers and project its future path. Common trends such as demographic changes and productivity slowdown have been key factors in the synchronized decline of the natural rate. And while international spillovers have been important determinants of the natural rate, offsetting forces have resulted in only a moderate impact on balance. Overall, the analysis suggests that once the current inflationary episode has passed, interest rates are likely to revert toward pre-pandemic levels in advanced economies. How close interest rates get to those levels will depend on whether alternative scenarios involving persistently higher government debt and deficit or financial fragmentation materialize. In major emerging market economies, natural interest rates are expected to gradually converge from above toward advanced economies' levels. In some cases, this may ease the pressure on fiscal authorities over the long term, but fiscal adjustments will still be needed in many countries to stabilize or reduce debt-to-GDP ratios.

Introduction

In 1979, the Federal Reserve hiked interest rates from about 10 percent at the start of the year to almost 14 percent by the year's end, which in real terms—after taking account of inflation—amounted to a rate of interest of about 5 percent.[1] Even at the time this was viewed as likely insufficient to tame rapidly rising inflation.[2] And so it proved to be. Inflation continued to rise, peaking at nearly 15 percent the following year, requiring even higher interest rates and a prolonged recession before the situation was brought under control.

Nearly three decades later as the world faced the global financial crisis of 2008, the Federal Reserve—along with central banks worldwide—slashed interest rates to as close to zero as they thought possible in nominal and real terms. This time around, however, commentators and policymakers raised concerns that interest rates were not low enough to boost demand and inflation. Once again, these concerns proved well-founded, with inflation remaining stubbornly low for much of the next 10 years.

These two contrasting examples raise an obvious question. How can it be that in the same country a real interest rate of 5 percent is sometimes too low but at other times a real interest rate of zero is too high?

Most answers rely on the idea that a given real interest rate does not have the same macroeconomic effects at all times. Instead, the impact is relative to some reference level. When real interest rates are below that level, they are stimulatory, boosting demand and inflation. And when above it, they are contractionary, lowering output and inflation. If this reference level moves over time, then the same real interest rate can be too high or too low at different times.

Macroeconomists call this reference interest rate the "real natural rate of interest."[3] The "natural" part means that this is the real interest rate that is neither stimulatory nor contractionary and is consistent with output at potential and stable inflation. Lowering the real rate below the natural rate is akin to stepping on the macroeconomic accelerator; raising it above is like hitting the brake. The natural rate is usually thought of as independent of monetary policy and instead driven

The authors of this chapter are Philip Barrett (co-lead), Christoffer Koch, Jean-Marc Natal (co-lead), Diaa Noureldin, and Josef Platzer, with support from Yaniv Cohen and Cynthia Nyakeri. The authors thank John Williams for very helpful comments.

[1]When comparing interest rates, it is important to take account of inflation. Savings invested at 5 percent when inflation is 2 percent will buy the same thing as an investment at 3 percent when inflation is zero.

[2]See Goodfriend and King (2005).

[3]In many discussions, the "real" part is dropped; this approach is followed in the chapter. Some economists use the terms "neutral" and "natural" interchangeably, and some do not. For clarity, this chapter uses only "natural."

by real phenomena such as, for instance, technological progress, demographics, inequality, or preference shifts for safe and liquid assets.[4]

As the preceding discussion suggests, the natural rate is important for the conduct of monetary policy. Policymakers need to know the level of the natural rate in order to gauge the likely impact of their policies and so assess the stance of monetary policy. The natural rate also has a critical influence on fiscal policy. On average over the long term, monetary policy is typically neither inflationary nor contractionary. And so the natural rate is also an anchor for real rates over long periods of time. Because governments typically pay back debts over long time spans (both through long-maturity debt and by rolling over short-term debt), the natural rate is essential in determining the overall cost of borrowing and the sustainability of public debts.

Given the importance of the natural rate for both monetary and fiscal policy, it is not surprising that the recent surge in inflation and government debt worldwide has led to renewed interest in this topic. Real rates have increased a bit as monetary policy has become tighter in response to higher inflation. But the uptick remains modest compared with the late 1970s. Whether central banks have raised rates enough to return inflation to target depends critically on the level of the natural rate. Similarly, the natural rate will determine how much of a burden the present-day high levels of debt will be for governments (see Chapter 3).

In light of these concerns, the chapter seeks to answer the following questions:

- How has the natural rate evolved in the past across different economies?
- What has driven this evolution?
- What is the outlook for these drivers and natural rates in the near and medium term?
- How will this outlook affect monetary and fiscal policies?

To shed light on these issues, the chapter first reviews the main stylized facts that characterize real interest rate trends at different maturities and across different countries. It then sets out to measure the natural rate. To mitigate the unavoidable uncertainty associated with estimations of the natural rate, the chapter will follow a two-pronged approach. Beginning with a simple model (Laubach and Williams 2003)—one that lets the data speak—it moves to a tighter theoretical structure that imposes more restrictions on the data but allows a deeper understanding of the underlying drivers of the natural rate (Platzer and Peruffo 2022). Comparing estimates from different models provides independent validation. In addition, alternative scenarios covering a range of plausible future developments for the main underlying drivers of the natural rate are considered for robustness. These projections provide a long-term anchor for monetary policy and a crucial input to analyze debt sustainability in the largest advanced and emerging market economies.

The main findings of the chapter are as follows:

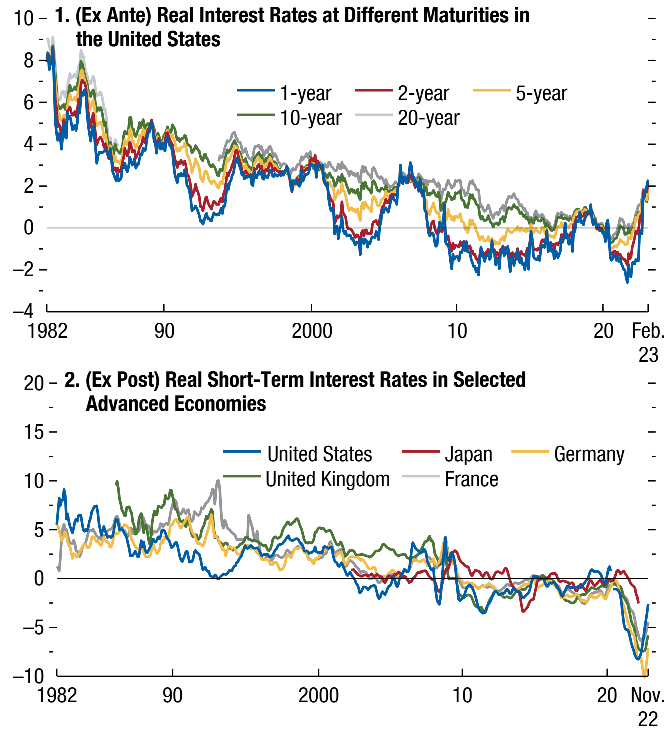
- *Common trends have played an important role in driving real interest rates down.* The natural rate has declined over the past four decades in most advanced economies and some emerging markets. While idiosyncratic factors can explain cross-country differences, common trends underlying demographic transitions and productivity slowdowns are key to understanding the synchronized decline.
- *Global drivers have also been important determinants but on balance have had a limited impact on net capital flows and corresponding natural rates in advanced and emerging market economies.* As global capital markets opened and fast-growing emerging market economies entered the scene in the 1980s and 1990s, foreign factors increasingly shaped long-term trends in interest rates. High growth in emerging markets has tended to drive up interest rates in advanced economies while producing a glut of savings in emerging markets. These excess savings—in their quest for safe and liquid assets—have tended to flow back to advanced economies, pushing natural interest rates back down. On balance, these forces seem to have had broadly offsetting effects on capital flows and a moderate impact on natural rates over the past half-century.
- *Country-specific natural rates of interest are projected to converge in the next couple of decades.* Based on conservative assumptions on demographic, fiscal, and productivity developments, it is anticipated that natural rates in large emerging market economies will decline, gradually converging toward the low and steady levels expected in advanced economies.
- *As inflation returns to target, the effective lower bound on interest rates may become binding again.* Post-pandemic increases in interest rates could be

[4]In line with a long tradition in monetary economics, monetary policy is here assumed to be neutral, meaning that it does not affect real variables over the long term. Borio, Disyatat, and Rungcharoenkitkul (2019) present an alternative view and implications for the natural rate.

protracted until inflation is brought back to target (Chapter 1). However, long-term forces driving the natural rate suggest that interest will eventually converge toward pre-pandemic levels in advanced economies. How close to those levels will depend on whether alternative scenarios involving persistently higher government debt and deficit or financial fragmentation materialize. Because nominal rates cannot fall far below zero (the effective lower bound constraint), this could limit central banks' ability to respond to negative demand shocks. Thus, debates about the appropriate level of target inflation at the effective lower bound could reemerge. Even the central banks in some emerging market economies may eventually need to adopt unconventional policy tools similar to those used by advanced economies in recent years.

- *Despite increased fiscal space, many countries will have to consolidate.* While low natural rates may ease pressure on fiscal policy, they do not negate the need for fiscal responsibility. Important government support during the pandemic has strained public accounts, requiring some budget consolidation to ensure long-term debt sustainability. Various paths to deficit reduction are open, but delaying action will only make the required steps more drastic: Larger public debt tends to crowd out private investment and erode the appeal of safe and liquid government debt.

Figure 2.1. Real Interest Rate Trends
(Percent)



Sources: Federal Reserve Economic Data; and IMF staff calculations.
Note: In panel 1, the real interest rates are computed as the difference between the US Treasury rate at each horizon and the Cleveland Federal Reserve measure of inflation expectations over the same horizon. In panel 2, the real interest rates are the difference between the three-month interbank rates and the average of the realized inflation measured by the consumer price index in the next three months for each country. Japan's three-month interbank rates are spliced with rates for certificates of deposit from 1979 to 2002. Online Annex 2.1 provides details on data sources and calculations for the figure.

Trends in Real Rates over the Long Term

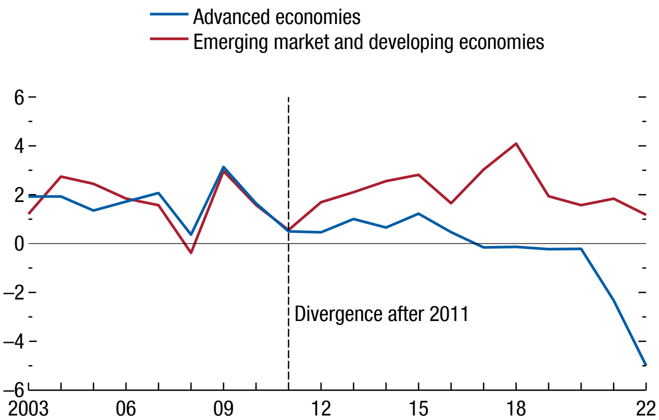
This section lays out some basic facts about how real interest rates have evolved over the long term. Because the natural rate is an anchor for real interest rates, long-term trends in real interest rates are potentially informative signals about the natural rate itself.

Figure 2.1, panel 1, starts the inquiry by comparing five different measures of the ex ante real interest rate for the United States.[5] Different maturities from 1 year up to 20 years are considered. Despite differences at high frequencies—the short-horizon measures are unsurprisingly much more volatile—all these measures share a common long-term trend. Looking through cyclical fluctuations and term premiums, real rates have fallen steadily, by about 5 percentage points over the last four decades across all maturities. Given that the natural rate of interest is a long-term attractor for real rates, this suggests that the natural rate of interest has also fallen, at least in the United States.

To get a sense of whether these developments have been mirrored elsewhere, Figure 2.1, panel 2, compares historical ex post real rates in five advanced economies over a similar period, in this case using three-month real rates. The broad pattern is the same, with real rates declining steadily from highs in the 1980s. Interestingly, the common international component seems at first glance to have become more important over time, with countries' real rates seeming to converge gradually.

[5]Ex ante measures of the real interest rate use actual measures of inflation expectations, which are either extracted from financial markets or based on surveys, to deflate the nominal interest rate. Ex post real interest rates rely instead on realized inflation. Over long periods of time, ex ante and ex post real interest rates tend to coincide, but there can be large discrepancies when surprise inflation is expected to be temporary, as in the most recent episode. Unfortunately, inflation expectation measures are not always available for long time series, emerging markets, or both.

Figure 2.2. (Ex Post) Real Interest Rates in Advanced and Emerging Market and Developing Economies
(Percent)



Source: IMF staff calculations.
Note: The sample comprises 34 advanced economies and 25 emerging market and developing economies, aggregated using market-exchange-rate-based GDP weights. Maturity of the bonds is greater than one year. Nominal interest rates are deflated using consumer price inflation.

Figure 2.2 contrasts developments in advanced and emerging market economies. A shared trend at the start of the 2000s decoupled later on as real rates continued to decline in advanced economies but stabilized at their 2005 level in emerging markets.

Overall, this first look at the data suggests that the natural rate has likely declined in the past four decades or so in advanced economies. This downward trend seems to be increasingly common across countries and points to some global drivers. The picture is different in emerging markets, where natural rates have remained broadly stable over the past 20 years on average. Because emerging market and advanced economies' current accounts are broadly balanced, the divergence in long-term rates points to remaining frictions preventing a stronger convergence between advanced and emerging market economies (Obstfeld 2021).[6] Yet this analysis leaves many important issues unaddressed. The data, although suggesting that the natural rate has declined in many advanced economies, cannot explain why this decline occurred and fail to distinguish the impact of secular and cyclical factors. The following sections tackle these concerns.

Measuring the Natural Rate

This section relies on well-known macroeconomic empirical models to try to estimate the natural rate of interest. Because the natural rate is an unobserved, latent variable, any measurement requires some theory. The approach here is to use a minimal amount of theory, drawing on simple macroeconomic relationships between aggregate supply and demand, interest rates, and inflation. Approaches based on aggregate relationships are a good starting point for developing a more informed measure of the natural rate because they are transparent and straightforward. Subsequent sections use a richer framework based on more extensive microeconomic theory and so speak more to the underlying drivers of the natural rate.

Single-Country Estimates of the Natural Rate

The first approach is an application of the widely used Laubach-Williams model (Holston, Laubach, and Williams 2017; hereafter HLW). This model assumes a set of relationships between supply, demand, interest rates, and prices consistent with perhaps the most standard macroeconomic view of the world, the New Keynesian model.[7] In this setting, the natural rate is driven by a variety of shocks, including trend output growth. Here, it is defined as the real interest rate that will return output to potential and inflation to target, once purely transitory shocks to aggregate supply or demand have dissipated. The intuition for this is that central banks tend to think about returning inflation to target in the medium term, because trying to offset every temporary shock would lead to undue volatility in interest rates and output.[8]

[6]Beyond market frictions, weak institutions and lack of investor protection in recipient countries may also explain the lack of convergence. An alternative explanation, which is likely to be particularly relevant for the United States, is that following the global financial crisis, emerging market debt was not considered safe, pushing down the real interest rate for the main provider of safe and liquid assets.

[7]See Online Annex 2.2 for a formal description of the model. All online annexes are available at www.imf.org/en/Publications/WEO.

[8]In this framework, financial shocks affect the natural rate only if they affect potential output. A persistent increase in precautionary saving or preference for safe and liquid assets would qualify, whereas purely transitory variation in risk aversion, for example, would not (Barsky, Justiniano, and Melosi 2014; Gourinchas, Rey, and Sauzet 2022). This definition of the natural rate is consistent with the one implicit in the theoretical framework of the next section, because it emphasizes low-frequency movements of the real interest rate in a world without nominal friction (where output is at potential).

The model is first estimated from data for one country at a time. As part of the estimation, the model attempts to figure out what were the most likely values for several key unobserved variables, including potential output and the natural rate of interest, given the (relatively standard) New Keynesian view of the macroeconomy. This framework also offers a basic decomposition of changes in the natural rate into two components: one due to changes in the long-term growth trend, and one due to other factors, which can in principle include domestic and foreign drivers. One drawback, however, is that the HLW model is designed to apply principally to advanced economies, for which data can be reasonably described by the New Keynesian model over a long enough time period. The richer structural model in the next section has more to say about emerging markets.

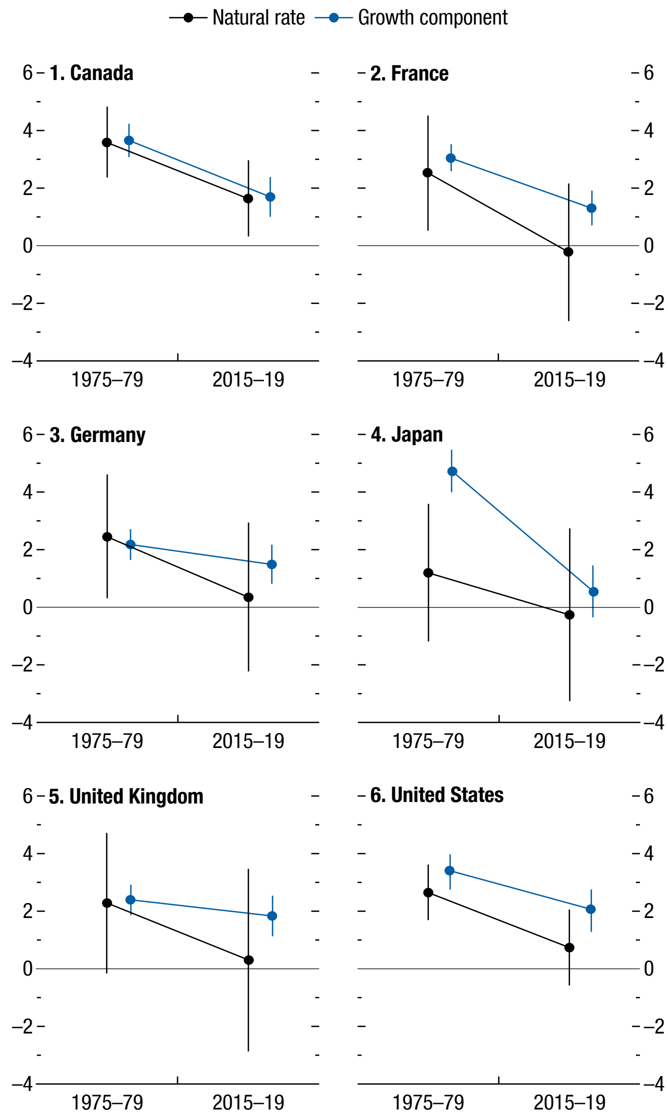
Figure 2.3 summarizes the results from estimating the HLW model on a sample of six advanced economies for which sufficient quarterly data exist. It shows estimates of the natural rate, as well as the part due to trend growth, for two five-year periods: one covering the end of the 1970s, the other for the late 2010s. These estimates broadly confirm the intuition presented so far in this chapter: that the natural rate of interest has declined across advanced economies in the past 40 years. Despite some variation in the level of the rate across countries, the magnitude of the decline has been broadly similar, at a little over 2 percentage points in most countries. This is much smaller than the overall decline in real interest rates over the same period (of about 5 percentage points), which likely also reflected the change in the monetary policy stance, particularly tight at the beginning of the 1980s as central banks fought historically high inflation.

However, the uncertainty over the estimates of the natural rate is very large, with the 90 percent confidence interval for the United States ranging from zero to about 3 percent in the second half of the 2010s. Uncertainty is a common feature of all estimates of the natural rate[9] and arises because the estimated relationships between interest rates and the output gap, and the output gap and inflation, are both relatively weak. As a result, fluctuations in output and inflation provide little information about the overall level of the natural rate. Yet at least one part of the natural rate is well estimated: the trend growth component, for which confidence intervals are much smaller. This is because data for output are directly informative about trend growth.

One interesting feature of these results is that the decline in the natural rate is so similar across advanced economies *despite* such differing trend growth components. With the exception of Japan, the natural rate dropped more than implied by the change in growth rates over the same period. This suggests that some forces other than domestic growth may be inducing

[9]See Arena and others (2020) for a related exercise applied to European countries.

Figure 2.3. Kalman Filter Estimates of the Natural Rate of Interest for Selected Advanced Economies
(Percent)



Sources: Holston, Laubach, and Williams (2017); and IMF staff calculations.
Note: The ranges show 90 percent confidence intervals.

common movements in the natural rate. That estimated natural rates are more similar across countries now than 40 years ago is perhaps consistent with the idea that capital market integration has progressed, at least among advanced economies. This possibility motivates an extended version of this model, which allows for explicit international spillovers through either real or financial channels (and is explored in the section "Multicountry Estimates of the Natural Rate").

The Natural Rate during the COVID-19 Pandemic

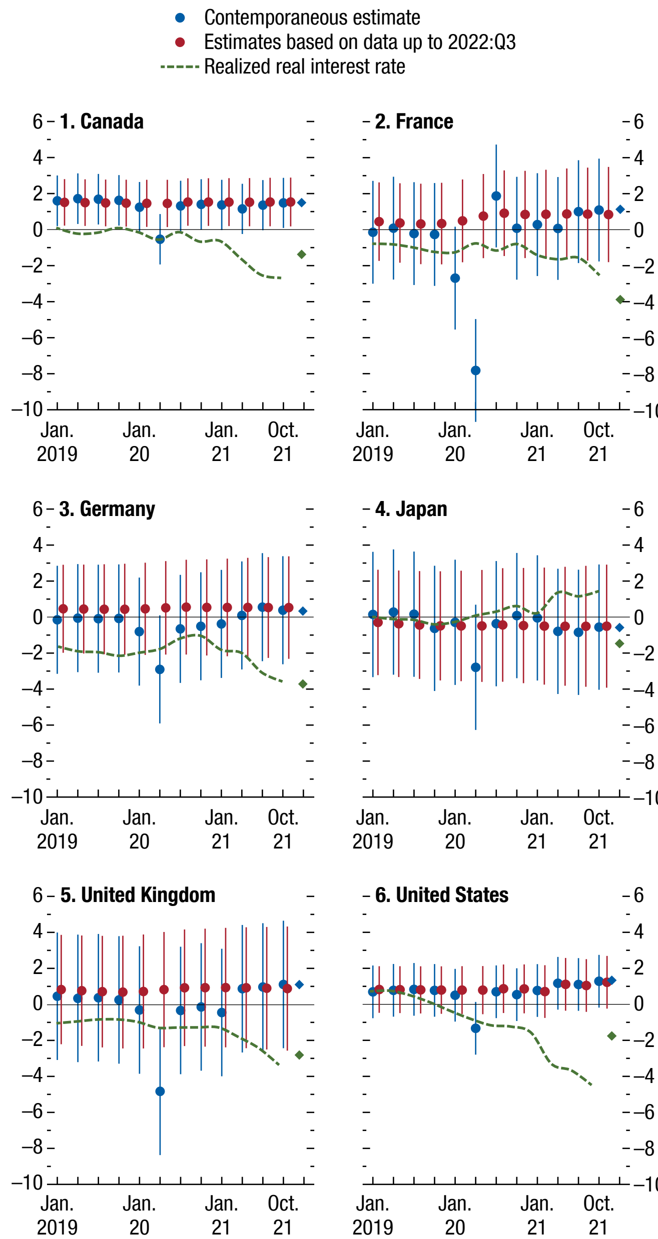
Despite its limitation, the closed economy model is a useful benchmark for addressing two questions that have gained attention during the post-pandemic inflationary episode in many advanced economies. That is: How much did policymakers stimulate during the pandemic? And how fast did they tighten afterward?

One concern when answering these questions is that any conclusions may unduly rely on the benefit of hindsight. What now might appear to be policy mistakes may have been perfectly reasonable decisions for policymakers without the benefit of perfect foresight.

To illustrate the challenges, Figure 2.4 shows different vintages of measures of the real and natural rates. The gap between the two is a summary measure of whether monetary policy is tight (when the realized real rate is higher than the natural rate; the gap is positive) or loose (when the gap is negative). The measures differ in the data they use. The full-sample estimate (in red) uses data up to the third quarter of 2022 and so approximates the current best guess of what the natural rate was at each point in time. This helps provide an assessment of the monetary policy stance with the benefit of hindsight. In contrast, contemporaneous estimates (in blue) are computed by repeatedly running the model, extending the data sample by one quarter each time. This aims to approximate how the real rate gap might have been assessed at the time.

Early in the pandemic, the two measures differed, often considerably and usually with the contemporaneous estimate presenting a much tighter view of monetary policy. This is consistent with the idea that the shocks seen when the pandemic hit were highly unusual, with both supply and demand moving far and fast. Faced with contemporaneous data, this model viewed supply shocks as having a large permanent component, generating an exceptionally low natural rate and thus a tight stance for monetary policy.

Figure 2.4. Real Rates and Natural Rates: Contemporaneous and Current Estimates for Selected Advanced Economies
(Percent)



Sources: Holston, Laubach, and Williams (2017); and IMF staff calculations.
Note: The ranges show 90 percent confidence intervals. Parameters are estimated on pre-COVID data. The diamonds represent contemporaneous estimates at 2021:Q4 and realized real interest rates at 2022:Q4 for each country.

Subsequent data helped correct this misperception, with the sharp change in the natural rate early in the pandemic progressively revised away. A reasonable interpretation is that policymakers looked through the immediate crisis, applied their judgment in a way that a model cannot, and so delivered moderately stimulatory policy.[10]

Later in the pandemic, however, policy became looser. And although the natural rate did rise a little in most places, looser policy largely came about through inflation eroding real policy rates. In contrast to the early pandemic period, the red and blue dots are generally very close. This says that subsequent data do not tell us much that was not known at the time. And so, while policymakers may have had good reasons not considered here for conservatism in adjusting rates, the HLW model suggests that policy was loose for a long time in some countries (October 2022 *Global Financial Stability Report*).

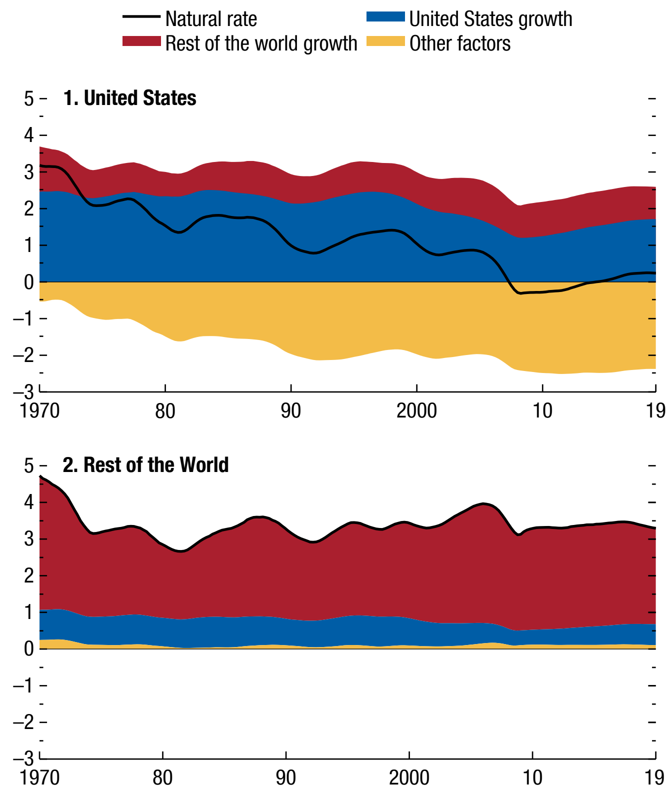
Multicountry Estimates of the Natural Rate

One drawback of the HLW approach is that it involves a closed-economy model; it can only estimate the natural rate for one country at a time. This is not an issue when the goal is only to estimate the level of the natural rate in a particular country. However, the approach cannot be used for counterfactual analysis that would try to assess something like the impact of a decline in foreign potential growth on the domestic natural rate.

One way to address this is to use an explicitly international model. Wynne and Zhang (2018) proposed one such framework that allows for two-way interactions between two independent regions using an empirical approach very similar to HLW. The framework features an important general equilibrium aspect of the determination of the natural rate via international spillovers. This is in line with international macroeconomic theory that stipulates that when capital is internationally mobile, the determination of natural rates entails a global dimension (Clarida, Galí, and Gertler 2002; Galí and Monacelli 2005; Metzler 1951; Obstfeld 2020). This also implies that if there are spillovers from one country to another, then it stands to reason that those effects might spill back over to the originator.

Specifically, the natural rate is now allowed to be affected not just by domestic growth but also by foreign growth. The intuition is that if foreign growth increases, so do foreign rates of return, necessitating greater compensation for domestic investors and driving up the domestic natural rate. Of course, changes in the domestic natural rate affect domestic growth,

Figure 2.5. Measuring the Natural Rate: The Role of International Spillovers
(Percent)



Sources: Wynne and Zhang (2018); and IMF staff calculations.
Note: "Rest of the world" comprises Australia, Austria, Belgium, Brazil, Canada, China, Finland, France, Germany, Greece, India, Ireland, Italy, Japan, Korea, The Netherlands, Norway, Portugal, Russia, South Africa, Spain, Sweden, Switzerland, and the United Kingdom.

which then spills back to the foreign natural rate through a similar channel.

Figure 2.5 presents the results from such a model, with the United States and the rest of the world as the two regions.[11] As before, this setting suggests that the natural rate in the United States has declined by about 2 percentage points in the past 50 years or so. In contrast, the estimated natural rate in the rest of the world has been more stable, at least since the mid-1970s. Two factors are responsible. First, as might be expected, domestic growth rather than foreign growth is more important for each (relatively closed) region. Second, secular slowdown in many advanced

[10]See Holston, Laubach, and Williams (2020) for a discussion on how to adapt the HLW model to capture the pandemic.

[11]It is important to exercise caution when interpreting the quantitative implications of this analysis. The estimation is not disciplined by current account data, and so the decomposition may lump various effects together. Moreover, large confidence bands suggest that inference is highly imprecise.

economies is offset by the rise of high-growth emerging market and developing economies, such as China, propping up growth in the rest of the world. These elements working together have led to a higher and more stable natural rate outside the United States.

Nevertheless, international spillovers are significant and important for determining the level of the natural rate. The analysis suggests two offsetting channels. The first operates through overseas growth (in red), which has helped support the natural rate in the United States. The other channel is shown by the increasing and negative impact of "other factors" (in yellow). That this has had a long-lasting and negative effect on the natural rate in the United States is consistent with the idea that increased foreign demand for safe and liquid US assets has depressed returns (Bernanke 2005; Caballero, Farhi, and Gourinchas 2008, 2016, 2017b; Pescatori and Turunen 2015), especially since the global financial crisis. Note that the converse effect in the rest of the world is smaller, which reflects the relative sizes of the two regions.

Overall, this analysis suggests that foreign developments likely have had two offsetting effects on natural rates in the United States. Sustained growth in emerging markets has driven up the US interest rate while simultaneously producing a glut of savings that pulled it down again as foreign investors increasingly demanded safe and liquid US government debt.

While more general than a closed economy model, this framework still has an important drawback. It has little to say about the true drivers of the changes in the natural rate: What causes growth, either foreign or domestic? What is behind "other factors"? The next section tackles some of these questions.

Drivers of the Natural Rate

The aggregate macroeconomic models of the preceding sections can offer a very simple explanation for why the natural rate has declined: While *other factors* do play a role, *growth*—both foreign and domestic—seems to be the most important factor. But this is not very satisfying. "Growth" is a result of different macroeconomic forces, not a primary force itself. For example, while both demographic forces and productivity growth could be responsible for the secular decline in growth, each could have potentially very different implications for the natural rate. Moreover, these deeper forces may have offsetting effects not fully captured by this simple decomposition.

Some Theory

Many possible economic mechanisms have been proposed to explain variations in the natural interest rate. Their importance can vary at different frequencies, with "macroeconomic" forces more likely to drive long-term trends and "financial" forces more likely to be important in the short to medium term, reflecting risk aversion and leveraging cycles.[12] Of course, this distinction is somewhat artificial because financial forces may drive secular shifts in behavior that determines saving rates.[13]

Macroeconomic Drivers

- *Productivity growth:* The simplest macroeconomic theories dictate that the interest rate is pinned down by growth in aggregate productivity. The idea is that the rate of interest paid by a borrower must compensate the lender for giving up on alternative use of those funds, known as their "opportunity cost." Higher productivity growth increases the marginal product of capital and drives up savers' opportunity cost, necessitating a higher interest rate to induce them to lend (Cesa-Bianchi, Harrison, and Sajedi 2022; Mankiw 2022; Solow 1956).
- *Demographics:* Changes in fertility and mortality rates have complex and time-varying effects on the natural rate. Demographic forces have implications for the economy's growth rate, its dependency ratio, and aggregate desired saving for longer retirement (Auclert and others 2021; Carvalho, Ferrero, and Nechio 2016; Gagnon, Johannsen, and López-Salido 2021; see Online Annex 2.3).
- *Fiscal policy:* Increased government borrowing can lead to higher interest rates because more saving is required to meet the increased demand for funds. However, the extent to which this occurs also depends on how much private investment is displaced by the additional public debt (Eggertsson, Mehrotra, and Robbins 2019; Rachel and Summers 2019).
- *Market power and the labor share:* The impact of increased market power on the natural rate is ambiguous. Increased market power typically depresses future production and investment demand, weighing down on interest rates. But it also reroutes dividends from laborers to capital owners, with the impact on the

[12]See also Rogoff, Rossi, and Schmelzing (2021) for an analysis of real rate dynamics over the past 700 years.

[13]See Eggertsson, Mehrotra, and Robbins (2019) and Mankiw (2022) for recent reviews and Online Annex 2.3 for detailed description of the theoretical channels.

natural rate depending on the distribution of these dividends across cohorts (Ball and Mankiw 2021; Caballero, Farhi, and Gourinchas 2017b; Eggertsson, Mehrotra, and Robbins 2019; Mankiw 2022; Natal and Stoffels 2019; Platzer and Peruffo 2022).

- *Other reasons:* These include the effect of government taxation on the profile of private consumption and saving (Eggertsson, Mehrotra, and Robbins 2019; Platzer and Peruffo 2022), rising inequality increasing the overall supply of savings because rich people tend to save more than poor people (Mian, Straub, and Sufi 2021a, 2021b, 2021c), and potential interactions between different channels.

Financial Drivers

- *International capital flows and the scarcity of safe assets:* International spillovers from the integration of global capital markets may have been powerful drivers of the natural rate. Two main mechanisms are at work. On one hand, high-growth emerging markets provide alternative investment opportunities, resulting in capital outflows and raising the natural rate in advanced economies (Clarida, Galí, and Gertler 2002; Galí and Monacelli 2005; Obstfeld and Rogoff 1997; Obstfeld 2021). On the other hand, the supply of safe and liquid assets, primarily US government bonds, has not kept pace with fast-rising demand, especially from emerging markets. Their ensuing scarcity may have driven up their price and lowered their return (Bárány, Coeurdacier, and Guibaud 2018; Bernanke 2005; Caballero, Farhi, and Gourinchas 2008, 2016, 2017a, 2017b, 2021; Del Negro and others 2017; Krishnamurthy and Vissing-Jorgensen 2012).
- *Risk aversion and leverage cycles:* The quality attributed to particularly safe and liquid assets (for example, government bonds in advanced economies) gives rise to a *convenience yield*, which is variable and likely to increase when global stress leads to deleveraging (Gourinchas, Rey, and Sauzet 2022). Given the safe haven property of the US dollar, this is especially the case for US Treasurys whose value increases in periods of stress, providing protection to risk-averse international investors (Gourinchas, Rey, and Govillot 2017).

A New Theoretical Framework

To compare the quantitative impact of these different forces, this chapter relies on a macroeconomic model (PP) based on Platzer and Peruffo (2022). This is an important novelty with respect to earlier literature because the PP model includes in one unified framework many of the mechanisms discussed in the previous section and so can explain how the contributions from each of the corresponding economic forces change the natural rate. This approach avoids double-counting and having to infer the importance of each driver from different models calibrated separately.[14]

PP is a "real" macroeconomic model, in the sense that it abstracts from nominal and financial frictions that typically underlie cyclical fluctuations. Similarly, for tractability, uncertainty is assumed away. While these are reasonable assumptions for the study of medium- to long-term trends in the real interest rate, the model is ill-equipped to analyze the impact of the financial drivers discussed earlier.[15] Nonetheless, PP still allows for foreign developments to affect domestic interest rates through their implication for *net* international capital flows.

PP is calibrated to represent eight major global economies: the United States, Japan, Germany, the United Kingdom, France, China, India, and Brazil. These are the five largest advanced economies and the three largest emerging market and developing economies, which cover some 70 percent of global GDP. Demographic developments, the age-earning profile, the share of income going to the richest 10 percent, productivity trends, the retirement age, average pension replacement rates, labor share, government debt, and public expenditure inform the country-specific calibrations.

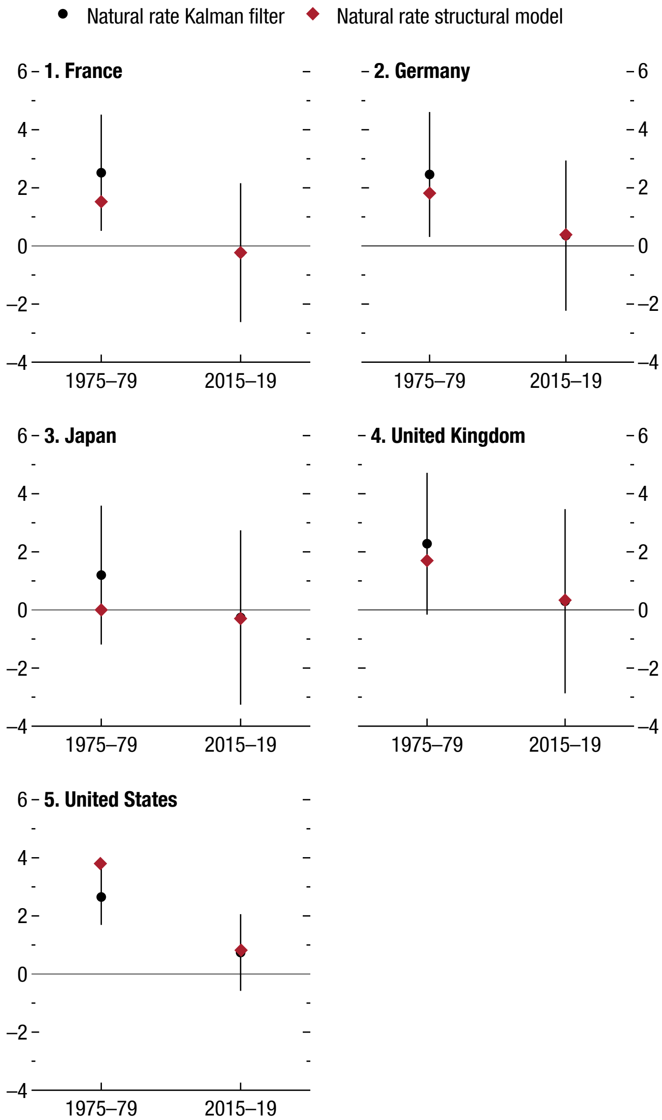
Before turning to detailed model simulations, Figure 2.6 compares the overall decline in the natural rate implied by the PP and HLW frameworks. The striking similarity between the results obtained with two very different approaches is reassuring. This mitigates the uncertainty surrounding HLW point estimates while bolstering confidence in the microeconomic structure of the PP framework.

The first exercise for this model is to understand *why* the natural rate has declined in the past several decades. Figure 2.7 presents the estimated change in the natural rate and its attribution to the different fundamental forces for each of the eight countries.

[14]Full details of the model are in Platzer and Peruffo (2022). A description of specific calibration and simulations is in Online Annex 2.3.

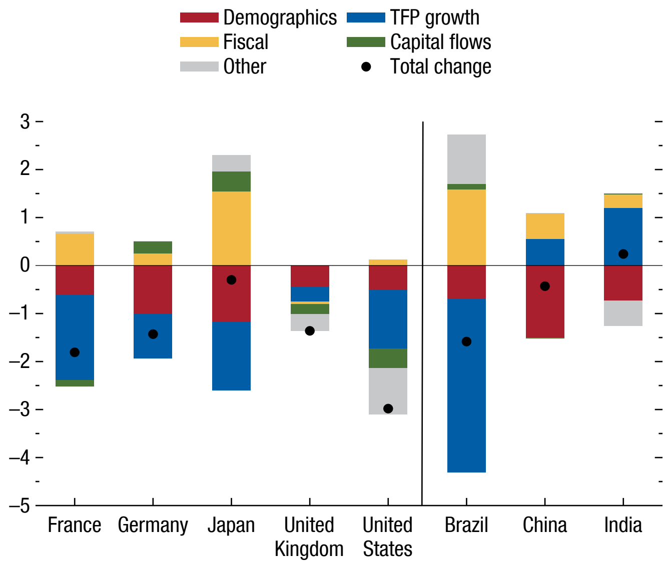
[15]See the section "Alternative Scenarios" for quantification of the impact of variations in the convenience yield.

Figure 2.6. Natural Rate Estimates: Model Comparison
(Percent)



Sources: Holston, Laubach, and Williams (2017); Platzer and Peruffo (2022); and IMF staff calculations.
Note: The Kalman filter estimates are based on Holston, Laubach, and Williams (2017). The estimates from the structural model are based on Platzer and Peruffo (2022). The values from the structural model for 2015–19 are calibrated to overlap with the Kalman filter estimates. The ranges show 90 percent confidence intervals.

Figure 2.7. Drivers of Natural Rate Changes from 1975–79 to 2015–19 for Selected Economies
(Percentage points)



Sources: Platzer and Peruffo (2022); and IMF staff calculations.
Note: TFP = total factor productivity.

While no factor clearly dominates over the past 40 years, a set of common forces has driven the natural rate, explaining part of the international comovement. All eight countries in the sample experienced *population aging* contributing negatively to the change in the natural rate. This effect was particularly large in China, Japan, and Germany. Growth in *total factor productivity* (TFP) declined in all advanced economies, at times explaining far more than the final decline in the natural rate. *Fiscal policy* is an important offset in all economies, particularly Japan and Brazil. In Japan, public debt increased by more than 200 percent of GDP, lifting the natural rate by more than the negative contributions from TFP growth or demographics. In Brazil, it is mainly the large increase in public consumption, financed by taxation, that explains the positive contribution of the fiscal driver, even though the increase in public debt also plays a role. The contribution of *net international capital flows*, which summarizes the net impact of global forces through international spillovers (discussed in the context of Figure 2.5), is significant but smaller and goes in the expected direction.[16] The largest net negative effect is found in the United States, potentially reflecting that stockpiling of safe assets by emerging markets more than offsets capital outflows drawn to attractive investment opportunities abroad. In contrast, in Japan, capital outflows seem to dominate, lifting the country's natural rate as excess domestic savings are invested in faster-growing economies abroad. The picture is more mixed in the three large emerging markets displayed

[16]Note that while *gross* capital flows have increased over time as capital accounts have liberalized, both in- and outflows have surged since the 1970s.

here (Box 2.3 analyzes the importance of international spillovers for smaller emerging market and developing economies).[17]

The Outlook for the Natural Rate

So far, this chapter has focused on understanding *what has happened* to the natural rate and *why*. While interesting, this is perhaps less relevant for policy today than a slightly different issue: *What will happen* to real rates in the future?

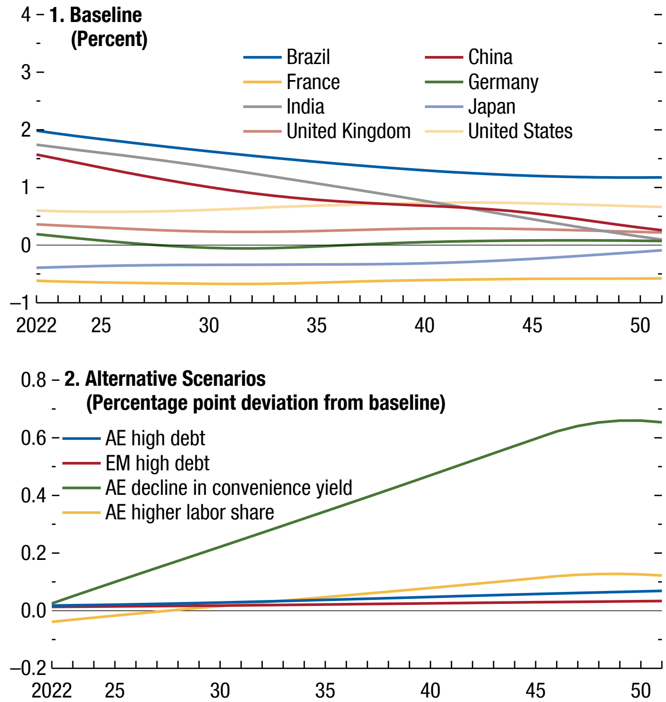
The Baseline

The same framework used to understand the drivers of the natural rate can also be used to convert assumptions about those underlying drivers into predictions for the natural rate. The baseline projection presented in Figure 2.8, panel 1, relies on conservative assumptions for the main drivers: (1) predicted demographic trends follow United Nations population projections, (2) public debt follows *World Economic Outlook* (WEO) projections until 2028 (and remains constant thereafter), and (3) all other drivers are assumed fixed at their 2015–19 levels. In emerging markets, (4) TFP growth is assumed to converge to the advanced economies' average over the long term, as would be expected as countries get closer to the technology frontier.

The simulation suggests that natural interest rates are likely to stay close to pre-pandemic levels in *advanced economies*. Because the demographic transition is already well underway, the residual negative impact of further aging is expected to be moderate. At the same time, higher public debt acts as a counterweight, pushing up the natural rate. In *emerging markets*, in contrast, the prognosis is for a significant decline in natural rates. This is the consequence of slowing productivity growth and an aging population; in many emerging market economies, the demographic transition should accelerate in the decades ahead. In China, for example, a steady decline in the natural rate by about 1.5 percentage points within the next 30 years is projected, bringing it to about zero in 2050.

[17]There are also country-specific forces that drive idiosyncratic movements in the natural rate. For example, the rise in inequality during the past half-century has had a large negative impact on the natural rate in the United States, even more than demographic changes. Rising inequality is also relevant in India and Japan. The change in market power is significant for India, which has experienced a large decline in the labor share over recent decades, implying a corresponding rise in market power in this chapter's model. Online Annex 2.3 provides further explanation.

Figure 2.8. Simulated Path for Natural Rate of Interest: Baseline and Scenarios



Sources: Platzer and Peruffo (2022); and IMF staff estimates.
Note: AEs are France, Germany, Japan, United Kingdom, and United States. EMs are Brazil, China, and India. The lines in panel 2 represent the difference between the scenarios and the baseline. The decline in convenience yield is simulated in a version of the model with a positive convenience yield; see Online Annex 2.3.
AE = advanced economy; EM = emerging market economy.

These projections assume that some degree of segmentation remains between the capital markets of advanced economies and emerging markets (see Figure 2.2 and the analysis in Obstfeld 2021) and that the balance of capital inflows and outflows stays as it was in 2019.

Departures from these assumptions are used to craft alternative scenarios.

Alternative Scenarios

The outlook for a given scenario is highly uncertain. Many shocks could cause the natural rate to depart from the baseline paths. And so these paths should be thought of as illustrative, with a distribution of future outcomes around them. Within this uncertain outlook, some specific *alternative scenarios* stand out as particularly germane to the current post-pandemic conjuncture. (1) Government debt could drift higher, (2) enthusiasm for holding safe and liquid public debt could wane, (3) workers' bargaining power could increase, (4) deglobalization forces could intensify, and (5) the energy transition could have important implications for global saving, investment, and the natural rate. These alternative scenarios are reported in Figure 2.8, panel 2, and in Boxes 2.1 and 2.2 and are described briefly here. All in all, deviations are expected to be relatively modest, spanning a range of about 120 basis points centered on the baseline scenario. Of course, more sizable effects could be envisioned should combinations of these scenarios happen simultaneously.

- *Higher government debt:* As households struggle to keep up with rising energy expenses and the ongoing impact of the pandemic, governments may opt to provide greater financial assistance. Allowing public debt to increase by 25 percent of GDP above the baseline by 2050 would increase demand for private savings and lift the natural rate; however, the impact should not exceed 5 to 10 basis points for most countries.[18]
- *Erosion of the convenience yield, leading to higher borrowing costs for government in advanced economies:* If investors were to perceive advanced economies' government debt as less safe and less liquid than in the past (for example, if the US Congress failed to raise the debt ceiling), then the premium they pay for holding this particular type of asset would erode as portfolios are rebalanced; in this scenario, it is assumed that the premium would return to pre-2000 average levels.[19] This decline in the convenience yield over the next three decades would bring up natural rates in advanced economies (and lower corporate bond yields) by about 70 basis points.[20]
- *Higher labor shares in advanced economies:* Markups have increased in the past several decades, raising the share of income going to capital owners at the expense of workers (Akcigit and others 2021). As workers' bargaining power continues to improve following the post-pandemic transformation of the labor market, a return to labor shares prevailing in the mid-1970s in advanced economies would raise the natural rate by 6 to 19 basis points by 2050.
- *Energy transition:* Transitioning to a cleaner and more sustainable global economy by 2050, as laid out in the 2015 Paris Agreement on climate change, would push global natural rates lower in the medium term because higher energy prices bring down the marginal productivity of capital and investment demand. For reasonable scenarios based on the October 2020 WEO, the effects are expected to be relatively modest: By 2050, natural rates are expected to decline by 50 basis points along a hump-shaped trajectory. If large investment in low-emission capital and technology is financed through budget deficits, natural rates could temporarily climb by 30 basis points (Box 2.1).
- *Deglobalization:* With increasing geopolitical tensions, the risk of some form of international trade fragmentation—higher trade barriers, sanctions, and the like—is elevated. Lower international trade would push down global output and desired investment. The effect on the natural rate would vary across regions, reflecting the shortening of global value chains. The risk of trade fragmentation is compounded by the risk of financial fragmentation (April 2023 *Global Financial Stability Report*), whose effect on real interest rates will depend on countries' initial external position: Deficit countries will find it more difficult to finance their current accounts, while surplus countries will repatriate excess savings, bringing down the natural

[18]The only channel modeled here is the effect of higher demand for loanable funds from the public sector lifting the equilibrium interest rate. Higher public debt could in principle also erode the convenience yield, with a significant effect on sustainability. This is considered explicitly in the next section, "Policy Implications."

[19]By considering yield spreads between safe and liquid government bonds and the highest-quality corporate bonds, the chapter focuses here on the spread that most closely reflects the notion that the convenience yield measures the unique safety and liquidity characteristics of a government bond (Del Negro and others 2017). Other possibilities include yield spreads with lower-quality corporate bonds or the equity risk premium (Caballero, Farhi, and Gourinchas 2017b).

[20]The model does not capture the endogenous response of capital flows to a change in preferences for government bonds by foreign investors. However, this effect could be sizable for safe asset providers such as the United States. To get a sense of the possible magnitude of the effect, it is useful to look at gross foreign portfolio investments in the United States, which increased by about 79 percent of GDP (US Bureau of Economic Analysis) from their average level before 2000. Were these flows to reverse, simulations show that this could result in an increase in the natural rate of roughly 100 basis points in the United States by 2050.

interest rate. Effects are between a 40 basis point decline and a 20 basis point increase, depending on the region. For trade fragmentation, the effects are expected to be smaller (Box 2.2).

Policy Implications

Overall, the simulations previously discussed indicate that natural rates will likely remain at low levels in advanced economies, while in emerging market economies, they are expected to converge from above toward advanced economies' levels. These patterns will have important implications for both monetary and fiscal policy.

Monetary Policy

Once inflation is brought back to target over the coming years, which may require a protracted period of high interest rates (Chapter 1), the implication for monetary policy seems clear: Long-term forces suggest that natural rates will remain low (in advanced economies) or decline further (in emerging markets), which may limit the ability of central banks to ease policy by lowering nominal interest rates. As a result, monetary institutions may have to resort to the same strategies they employed in the decade before the pandemic, such as balance sheet policy and forward guidance. In addition, if deflationary dynamics take hold, many economies may become trapped for an extended period in a suboptimal equilibrium characterized by low growth and underemployment (Summers 2014). To address these challenges, a larger stabilization role may have to be assigned to fiscal policy, and coordination between fiscal and monetary policy might even be necessary. Reopening the debate about the appropriate level of inflation targets, weighing the cost of permanently higher inflation against the benefit of enhanced monetary policy space, may also be warranted (Blanchard 2023; Galí 2020; IMF 2010; Chapter 2 of the April 2020 WEO).

Fiscal Policy

Concerns about debt sustainability have recently resurfaced due to the sharp increase in government debt following the onset of the COVID-19 pandemic and the simultaneous rise in policy rates to combat high inflation. In this context, the key factor for debt sustainability analysis is the difference between the real rate of interest (r) and the growth rate of the economy (g). If growth is higher than the real interest rate, governments may be able to sustain higher primary budget deficits without necessarily compromising debt sustainability.

The PP model used earlier in the chapter considered the impact of the fiscal policy stance on the natural rate, given that public debt issuance increases demand for loanable funds. This section studies the implications of secular movements in the natural rate for debt sustainability. The analysis relies on a partial equilibrium framework based on recent work by Mian, Straub, and Sufi (2022).[21] This framework takes the natural interest rate and growth projections from the PP model as given and assesses debt dynamics under different scenarios for the eight advanced and emerging market economies presented in the preceding section.

The framework assumes that savers prefer to hold government debt due to its liquidity and safety features or due to regulatory requirements. This means government debt enjoys a premium in financial markets relative to comparable assets, known in the literature as the "convenience yield," which effectively translates into a discount extended to the government on its borrowing costs (Krishnamurthy and Vissing-Jorgensen 2012; Wiriadinata and Presbitero 2020). However, as the public sector accumulates more debt, government securities become less attractive to savers, and the borrowing costs for the government increases: The convenience yield gets eroded. Because the interest rate increases with the debt level in this framework, there is a limit to the size of the primary deficit governments can sustainably run in the long term.[22] The sensitivity of interest rates to debt is important in this context, and its implications are discussed at the end of this section.

[21]Online Annex 2.4 describes the framework in detail. Further references can be found in Chapter 2 of the April 2022 WEO and Caselli and others (2022). A framework in which both channels are mutually operable would be ideal, but it would add a significant layer of complexity to an already very detailed framework.

[22]Of course, stabilizing the debt ratio is only one criterion for debt sustainability. Furman and Summers (2020) and Blanchard (2023) discuss stabilizing the debt service ratio, or debt service costs as a percent of GDP, as an alternative. Chapter 2 of the October 2021 *Fiscal Monitor* discusses the merit and limitations of this approach. In a long-term steady state in which borrowing costs are pinned down by the natural rate of interest, stabilizing the debt-to-GDP ratio would also stabilize the debt service ratio. The two measures would, however, diverge over the business cycle, especially if interest rates and growth rates move in opposite directions, as is often the case in emerging markets.

The projections from the PP model and the elasticity of the convenience yield to the level of the debt-to-GDP ratio are used to identify the long-term debt-stabilizing primary balance for each level of debt. Given current primary balances, the amount of fiscal consolidation needed is computed under the baseline and two of the scenarios presented earlier (high debt and 1970s labor share). Table 2.1 shows the amount of fiscal consolidation needed for the United States and China, the single largest representative of each country group in our sample.[23]

For the United States, consolidation of about 3.7 percentage points of GDP is needed under the baseline. In the higher-debt scenario, more consolidation is required, at about 3.9 percentage points of GDP. Under the higher-labor-share scenario, the difference between the natural rate and long-term growth becomes less favorable, so that slightly greater consolidation is required relative to the baseline. For China, the needed consolidation is much greater. A deficit reduction of about 7.6 percent of GDP is required to stabilize the debt-to-GDP ratio over the long term. The large consolidation reflects China's sizable primary deficit of about 7.5 percent of GDP in 2022. In all scenarios, it is assumed that fiscal adjustment can be undertaken either in the near term or over the medium term; the smaller the primary deficit in 2022, the smaller the fiscal cost of waiting.[24]

Inference about the fiscal space available to governments is of course uncertain. One important dimension of uncertainty relates to the sensitivity of interest rates to debt. An increase in the sensitivity of interest rates to debt essentially lowers the debt threshold at which primary surpluses are required for sustainability and thus erodes the fiscal space available to governments. Online Annex 2.4 conducts robustness analysis around this parameter that highlights the importance of building safety margins to account for changing market conditions and investors' risk perceptions (Caselli and others 2022).

[23]This exercise is repeated for the other six large advanced and emerging market economies in Online Annex 2.4.

[24]As noted earlier, this is a partial equilibrium exercise. Fiscal consolidation is bound to be more difficult if the effect of deficit reduction on real GDP is taken into account. Also, for China, the chapter uses the definition of public debt in the World Economic Outlook database, which uses a narrower perimeter of the general government than IMF staff estimates in China Article IV reports. See the 2022 Article IV report on China for a reconciliation of the two estimates and a debt sustainability assessment based on the broader perimeter of the general government.

Table 2.1. Required Fiscal Adjustment under Different Scenarios

(Changes in primary deficit, percentage points of GDP)

		Scenarios	
	Baseline	Higher Debt	1970s Labor Share
Near-Term Adjustment			
United States	–3.71	–3.94	–3.75
China	–7.63	–7.69	–7.63
Additional Consolidation Needed for Medium-Term Adjustment (three years)			
United States	–0.17	–0.18	–0.17
China	–0.47	–0.49	–0.47
Additional Consolidation Needed for Medium-Term Adjustment (five years)			
United States	–0.29	–0.32	–0.29
China	–0.87	–0.93	–0.87

Source: IMF staff calculations.

Note: The required fiscal adjustment is the difference from the long-term debt-stabilization level, calculated as the difference between the 2022 primary deficit from the World Economic Outlook database and the model-based estimate of the primary deficit that stabilizes debt to GDP at the long-term rates given projections for the natural rate of interest and growth.

Conclusion

Following four decades of steady decline, real interest rates appear to have increased in many countries in the wake of the pandemic. While this uptick clearly reflects recent monetary policy tightening, this chapter's analysis seeks to understand whether the long-term anchor—the natural rate—has also shifted. This is of key importance for the pricing of all assets (housing, bonds, equities) and for monetary and fiscal policy. All else equal, higher natural rates typically decrease fiscal space—that is, higher primary surpluses (smaller deficits) are required to stabilize debt ratios. But they also free up some monetary policy space. Higher natural rates imply higher nominal rates over the long term, providing central banks with more space to react to negative demand shocks without hitting the effective lower bound.

The chapter suggests that recent increases in real interest rates are likely to be temporary. When inflation is brought back under control, advanced economies' central banks are likely to ease monetary policy and bring real interest rates back toward pre-pandemic levels. How close to those levels will depend on whether alternative scenarios involving persistently higher government debt and deficit or financial fragmentation materialize. In large emerging markets, conservative projections of future demographic and productivity trends suggest a gradual convergence toward advanced economies' real interest rates.[25]

[25]Of course, structural policies that boost potential growth and diminish inequalities, for example, will tend to lean against these secular trends.

This means that the issues associated with the "effective lower bound" constraint on interest rates and "low (interest rates) for long" are likely to resurface.[26] Unconventional policies through active management of central bank balance sheets and forward guidance may become standard stabilization tools, even in emerging markets. Debates about the appropriate level of inflation target may also reemerge as countries weigh the social cost of higher inflation against the constraint of ineffective stabilization due to the effective lower bound. In addition, permanently lower real interest rates also increase fiscal space—all else equal—and allow fiscal authorities to take a more active role in stabilizing the economy, provided fiscal sustainability is ensured (Chapter 2 of the April 2020 WEO). In this case, it is crucial to clarify the scope and responsibilities of fiscal and monetary authorities to avoid long-term damage to the credibility of central banks.

[26]As discussed at length in Eggertsson and Woodford (2003) and Adrian (2020).

Box 2.1. The Natural Rate of Interest and the Green Transition

Policy responses to a transition to a carbon-neutral world will induce significant structural transformation that will affect the natural rate (r^*) via a number of channels. This box highlights the crucial role of two channels: the design of climate policies and the level of international participation in their implementation.

A comprehensive and global policy package intended to achieve net zero emissions by 2050 serves as a benchmark, as simulated in Chapter 3 of the October 2020 *World Economic Outlook*.[1] Carbon taxes—aimed at achieving net-zero emissions by 2050—are imposed globally, starting at between \$6 and \$20 a metric ton of CO_2 (depending on the country) and reaching \$40 a ton in 2030 and between \$40 and \$150 a ton in 2050. The package is fully financed by the carbon tax revenues—25 percent recycled toward social transfers, up to 70 percent for green public infrastructure investment, and the rest as subsidies to renewable energy sectors—making the policy budget-neutral.[2] Maintaining budget neutrality helps isolate the impact of the green transition on r^* absent debt-financed green investments. Although they are subject to uncertainty and intended to be largely illustrative, the results from simulating the policy package yield several insights into how climate policies can be expected to affect r^*.

Different climate mitigation policies affect r^* *differently.* Acting alone, carbon taxes depress overall investment and hence r^* (Figure 2.1.1, panel 1). This is because the carbon tax increases the overall cost of energy, a complement in production to physical capital. As a result of frictions, the associated decline in carbon-intensive activities exceeds the investment in renewable sources of energy and low-emission production methods—especially in countries where

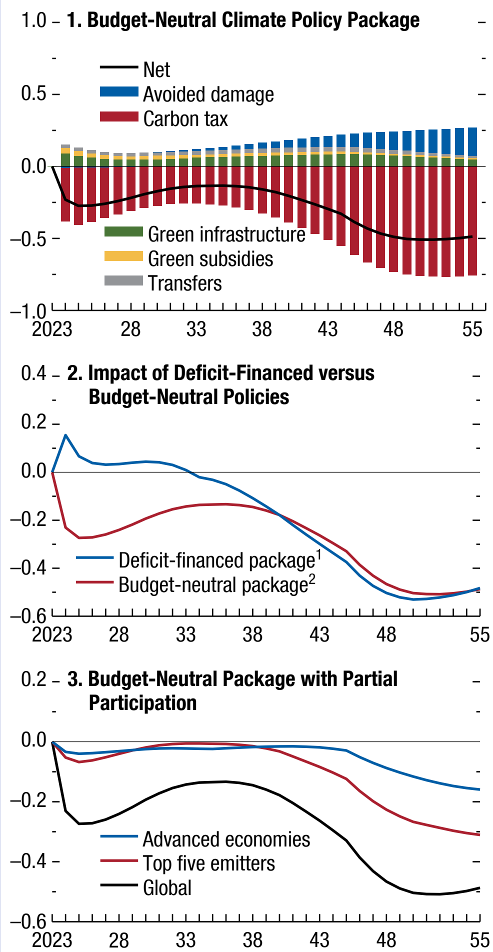
The authors of this box are Augustus Panton and Christoph Ungerer.

[1]Simulations are computed with the G-Cubed model, an open-economy, multicountry macroclimate model (see Liu and others 2020; McKibbin and Wilcoxen 1999).

[2]The scenario differs from the investigation in Chapter 3 of the October 2020 *World Economic Outlook* in two ways. First, it assumes a budget-neutral design rather than deficit financing. Second, given the large uncertainty surrounding the impact of green public investment on output, the simulations take a conservative approach and do not assume any direct productivity gains from green public investment. Of course, any amount of progress in total factor productivity would tend to lift the natural rate.

Figure 2.1.1. The Global Natural Rate of Interest and the Green Transition

(Global average, percentage point deviation from baseline)



Sources: G-Cubed model, version 164; and IMF staff calculations.

[1]The deficit-financed package is based on Chapter 3 of the October 2020 *World Economic Outlook* (WEO) but is agnostic on total factor productivity effects: front-loaded and deficit-financed green public investment of 1 percent of GDP in the first 10 years, 80 percent green subsidies to renewable sectors, carbon tax revenues recycled to households (1/4), and public debt reduction (3/4).

[2]Budget-neutral package uses carbon tax revenues to finance green public investment, green subsidies, and household transfers in the same proportion as in Chapter 3 of the October 2020 WEO, but with a much smaller revenue envelope.

Box 2.1 *(continued)*

production is carbon intensive. In contrast, public investment in green infrastructure and subsidies to renewable energy positively affect investment, pushing up r^*. It is also worth noting that climate mitigation helps avoid climate-change-related damages, boosting productivity growth with respect to a business-as-usual baseline and raising r^*.

The net impact on r* *depends on the associated overall fiscal impulse.* Panel 2 of Figure 2.1.1 shows an alternative policy package that includes a temporary deficit-financed and front-loaded green investment push. Unlike the budget-neutral policy package, which depresses r^* along the entire transition path, this simulation suggests that a deficit-financed fiscal stimulus—because it increases demand for private savings—could have a positive impact on r^*.

The macroeconomic impact of the green transition depends on the number of participating countries. In Figure 2.1.1, panel 3, the climate policy package is simulated under three different configurations, depending on whether all countries, only the five biggest emitters (China, European Union, India, Japan, United States), or only advanced economies participate. Not surprisingly, partial participation in the program leads to a significantly more muted impact on r^*.

Overall, the short- to medium-term impact of the green transition on r^* depends on the balance of several effects. But over the long term, r^* would converge to its pre-climate-policy steady state as economies become greener and climate policy applies to a shrinking share of economic activity.

Box 2.2. Geoeconomic Fragmentation and the Natural Interest Rate

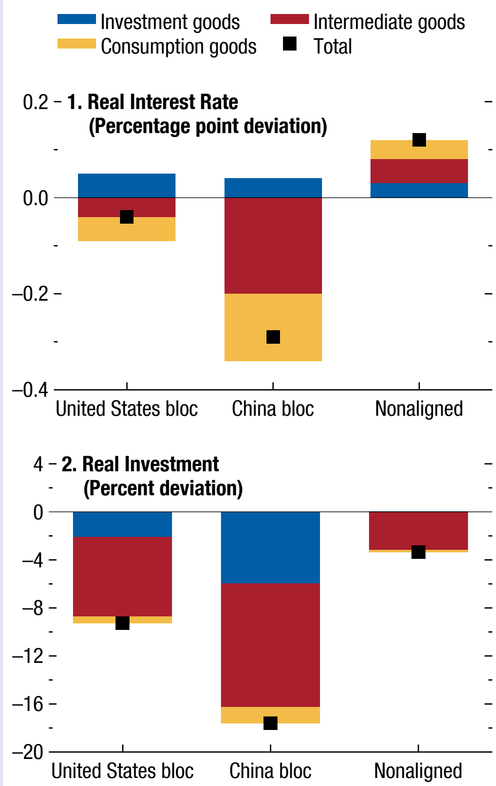
Geoeconomic fragmentation impacts regional economies through different channels, in particular, trade, technology diffusion, cost of external financing, international factor mobility, risk, and provision of global public goods (see Aiyar and others 2023). This box uses the IMF's Global Integrated Monetary and Fiscal (GIMF) Model[1] to analyze two scenarios of *trade* and *financial* fragmentation between the "US bloc" (United States, European Union, other advanced economies) and the "China bloc" (China, emerging Southeast Asia, remaining countries group).[2]

To understand the impact of trade fragmentation on the natural rate, it is necessary to grasp its impact on saving and investment in the US and China blocs (both deflated by the consumption price index for comparison). The imposition of nontariff trade barriers—which are assumed to increase by 50 percent over 10 years—affects saving in two main ways. First, trade restrictions tend to increase import prices for all goods, whether intermediate, investment, or consumption. Second, higher import prices for crucial production inputs act as a negative productivity shock and reduce output. Thus, by increasing the price of consumption (the price of imported consumption goods increases by about 5 percent to 25 percent depending on the region) and reducing output, trade barriers tend to reduce saving and push up the natural rate. Two opposite forces also determine how trade restrictions impact investment. First, higher input prices along the global value chain lower the profitability of production in all regions, including the "nonaligned bloc," and depress the volume of investment demand (see Figure 2.2.1, panel 2). At the same time, trade restrictions directly increase the relative price of investment goods (from their higher import share compared with consumption goods), increasing the demand for loanable funds, all else equal.

Overall, higher trade barriers between the US and China blocs will reduce trade between the two regions. This reduction is partially offset by larger trade within blocs and with the nonaligned, but the net effect is a shortening of the global value chain and less global trade (–19 percent) and output (–6 percent). Given the structure of trade, real investment in the China bloc declines the most due to reshoring (Figure 2.2.1, panel 1).

The impact on real interest rates is modest and varies across regions (Figure 2.2.1, panel 2). Real interest rates are expected to fall by about 30 basis points in the China bloc as investment demand declines more than saving does. In the United States, the positive impact of lower saving on the natural rate and the negative impact as a result of the decline in investment broadly balance each other out. In the nonaligned bloc, trade diversion implies that investment demand declines by less than desired saving, which raises the real interest rate by about 10 basis points.

Figure 2.2.1. Regional Impact of Trade Fragmentation Scenario



Sources: IMF, Global Integrated Monetary and Fiscal (GIMF) Model; and IMF staff calculations.
Note: The fragmentation scenario is a gradual increase in nontariff barriers between the US bloc and the China bloc for all types of traded goods (intermediate, investment, and consumption) over 10 years. The real interest rate is the average over 10 years, whereas real investment is after 10 years. See Online Annex 2.5 for the country composition of the blocs.

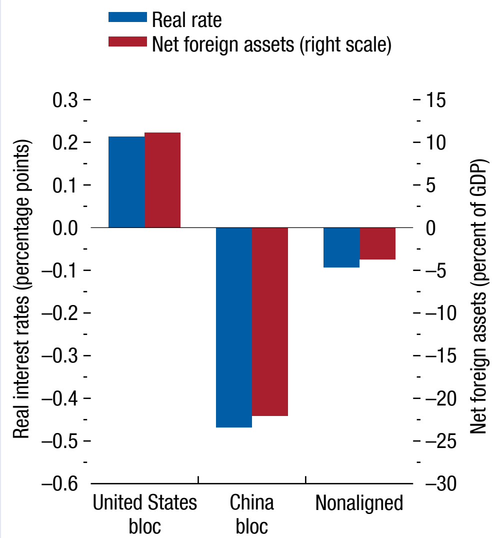
The authors of this box are Benjamin Carton and Dirk Muir.
[1]See Kumhof and others (2010) for a description of the GIMF Model.
[2]See Chapter 4 and Online Annex 4.4 for the modification to the GIMF Model to introduce explicit value chains and the calibration for eight regions grouped in three blocs: the US bloc, the China bloc, and the nonaligned bloc. The GIMF Model is also calibrated so that intermediate inputs (in value chains) and capital are complements in production.

Box 2.2 *(continued)*

Geoeconomic fragmentation also has implications for capital markets. In recent decades, and especially since the end of the 1990s, capital market integration has allowed advanced economies—and in particular the United States—to benefit from low borrowing costs. Savings from emerging markets have increasingly sought the safety and liquidity of US government bonds. This has helped bring down the natural rate of interest in the United States while lifting it in surplus countries in Asia and the Middle East (Bernanke 2005; Caballero, Farhi, and Gourinchas 2008, 2016, 2017a, 2017b, 2021). As this process reverses, the natural rate is likely to increase in the United States and other advanced economies while decreasing in emerging markets. In the extreme example of a full shutdown of capital markets, regional natural rates would converge to levels that reflect only domestic drivers such as demographics and productivity.

Figure 2.2.2 presents the macroeconomic impact of a financial fragmentation scenario assuming the China bloc reduces its exposure to the US bloc's Treasury bonds; it is modeled by reducing the premium paid by foreigners on US Treasury bonds. The China bloc disposes of net foreign assets, which pushes down their domestic interest rate by 40 basis points. In the US bloc, the interest rate increases by 20 basis points and the net foreign asset position improves by 10 percent of GDP. The nonaligned countries experience slight net capital inflows from the China bloc, as investors look for returns, reducing their interest rates by about 10 basis points.

Figure 2.2.2. Regional Impact of Financial Fragmentation Scenario
(Deviation from baseline)



Sources: IMF, Global Integrated Monetary and Fiscal (GIMF) Model; and IMF staff calculations.
Note: The fragmentation scenario is a permanent 100 basis point premium on one bloc's assets held by the other bloc's economic agents. The real interest rate and the net foreign asset position are reported after 10 years. See Online Annex 2.5 for the country composition of the blocs.

Box 2.3. Spillovers to Emerging Market and Developing Economies

Do movements in the natural rate of interest in advanced economies impact real interest rates in emerging market and developing economies? And if so, at what horizon? How strong are such associations, and what determines their strength?

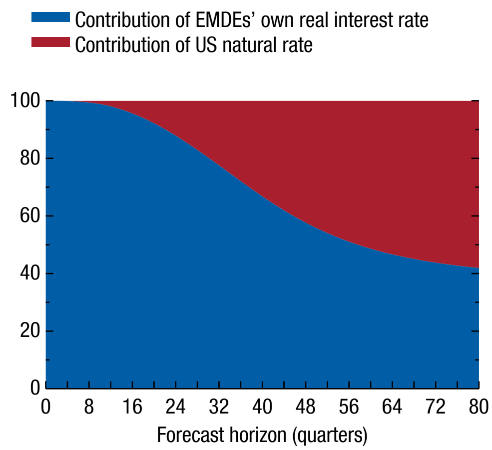
Many emerging market economies have adopted inflation targeting—orienting monetary policy toward domestic stabilization goals. Yet policymakers in those countries may be unable or unwilling to closely track global natural rates in the short term. Thus, for emerging market and developing economies, real rates' short-term dynamics may appear disconnected from global forces (Figure 2.2 and Obstfeld 2021). Arslanalp, Lee, and Rawat (2018) examine real interest rates in the Asia and Pacific region and find that a country's capital market openness is a key factor for linking domestic and global *long-term* real rates.

This box's analysis focuses instead on *short-term* real rates that pertain directly to the monetary policy stance and are less likely to be swayed by fluctuations in risk or term premiums.[1] The importance of global natural rates to individual countries' real interest rate dynamics is measured by the contribution of the US natural rate to emerging market economies' individual forecast error variance decomposition.

The authors of this box are Christoffer Koch and Diaa Noureldin.

[1]This box uses quarterly short-term deposit rates adjusted for ex post realized inflation. The data are from the first quarter of 2020 to the fourth quarter of 2022, although coverage is uneven, particularly toward the end of the sample. The primary data source is the IMF's International Financial Statistics database. For countries with short-period gaps, the data are supplemented with data from Haver Analytics. The emerging market and developing economies sample consists of Algeria, Bangladesh, Bolivia, Brazil, Cambodia, Cameroon, Chile, China, Colombia, Costa Rica, Côte d'Ivoire, Hungary, India, Indonesia, Jordan, Malaysia, Mexico, Nigeria, Peru, South Africa, Thailand, Türkiye, and Uganda. To avoid spurious regression, the deciding selection factor is whether each emerging market and developing economy rate series is cointegrated with the US rate series. The Phillips-Perron test is used for stationarity of the residual of the regression of emerging market and developing economy interest rates on the US natural rate, allowing for up to four lags. Forecast error variance decomposition is computed based on bivariate vector autoregression models including the US natural rate and individual countries' real interest rates.

Figure 2.3.1. Natural Rate Spillovers at Different Horizons
(Percent)



Source: IMF staff calculations.
Note: Forecast error variance decomposition contributions for each horizon are weighted by GDP weights adjusted for purchasing power. EMDEs = emerging market and developing economies.

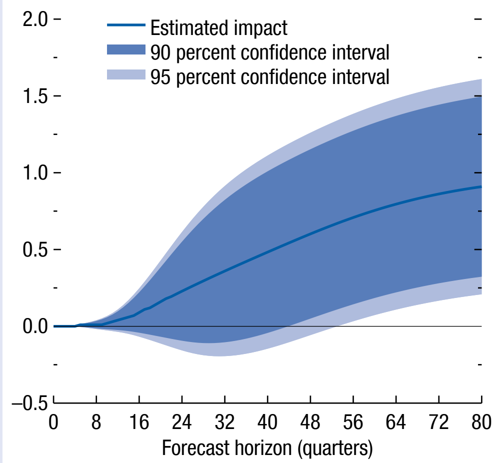
Figure 2.3.1 shows that at business cycle horizons of less than five years, domestic real rates dominate. At horizons beyond a decade, spillover from the US natural rate matter just as much. This weighted aggregation masks substantial variation across countries at longer horizons. The contribution from the US natural rates tends to be larger for East Asian and Latin American countries. In large emerging market economies, such as China and India, about 30 percent of real rate variation is explained by US natural rates after a decade. After two decades, spillovers are somewhat stronger in China than in India. Spillover effects to African countries, such as Cameroon, Côte d'Ivoire, and Uganda, are minor, with less than a 10 percent contribution from US natural rate spillovers.

What is the role of capital account openness in explaining this substantial variation across countries? To gauge its importance, de facto capital openness—the sum of foreign assets and liabilities as a percent of GDP (IIPGDP)—is regressed on the cross-country variation in magnitude of US natural rate spillovers

Box 2.3 *(continued)*

to emerging market and developing economies at 80 quarterly horizons. Figure 2.3.2 shows that the effect of capital account openness becomes significant only gradually after about a decade. Quantitatively, a 1 percentage point increase in the gross international investment position as a share of a country's GDP raises the importance of the US natural rate in explaining the share of movements in emerging market and developing economies' real interest rates by half a percentage point after a decade and by 0.9 percentage point after two. So for a country like Brazil, with an IIPGDP of about 40 percent, 20 percent of the forecast error variance decomposition of Brazilian real interest rates is attributable to US spillovers after a decade, and about 36 percent after two decades. This implies sizable spillovers but at fairly low frequency.

Figure 2.3.2. Estimated Impact of Capital Openness on Strength of US Spillovers
(Percent)



Source: IMF staff calculations.
Note: Each point on the solid blue line is the estimate of the coefficient from a cross-section regression of the forecast error variance decomposition share of the US real natural rate on the emerging market and developing economies' capital openness at the displayed forecast horizon from 1 to 80 quarters.

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