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The Historical Decline in Real Interest Rates and Its Implications for CBO's Projections

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Abstract

The Congressional Budget Office's interest rate forecast is an important input into the agency's budget projections. In the United States and globally, real (inflation-adjusted) interest rates have trended downward since the early 1980s. Research on the factors leading to that decline points to demographic changes, such as slowing labor force growth and the aging of the populations; slower trend growth of real output; and a global saving glut. The policy responses to the financial crisis of 2007 to 2009 and the 2020 coronavirus pandemic also played a role in the downward movement in global interest rates. Additionally, over the past several decades, demand for safe liquid assets has markedly increased, driving down the interest rates on such assets in relation to the rates on risky assets. Many of the factors identified as causing interest rates to fall over the past four decades are expected to persist, albeit to a lesser extent. CBO's forecasts of interest rates over the medium term (10 years) and long term (30 years) are based on the factors identified in the research literature. CBO expects interest rates to rise over the coming decade but to remain below the historical average levels. That forecast is highly uncertain.

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Introduction

The Congressional Budget Office's forecast of interest rates on federal debt is an important input into its budget and economic projections. Understanding past movements in interest rates helps inform CBO's projections of interest rates over the next several decades. Over the past four decades, real (inflation-adjusted) risk-free interest rates have declined in the United States and globally. The extent and persistence of the decline was largely unanticipated by CBO and private forecasters alike. Researchers have identified several long-run structural factors responsible for that decline, and CBO's current forecasts of interest rates over the medium term (10 years) and long term (30 years) reflect those factors identified.

Cyclical forces have also played a role in interest rate movements over the past four decades. In early 2020, for example, interest rates declined as global economic activity slowed in the wake of the coronavirus pandemic. Monetary policymakers' response to the slowdown put further downward pressure on interest rates. CBO expects real interest rates to rise above their current level as the U.S. and global economies recover from the effects of the pandemic later in the decade; however, the agency expects interest rates to remain below their historical level for the next several decades because of the depressing effects of long-run structural factors. That forecast is highly uncertain.

The Importance of Interest Rates as an Input Into CBO's Budget Projections

Interest rates on federal debt affect the federal budget directly through net interest costs—the difference between what the federal government pays out and receives in interest payments.[1] CBO projects that net interest costs will rise to unprecedented levels over the next three decades. Under current law, net interest costs would, CBO projects, rise from 1.6 percent of gross domestic product (GDP) in 2020 to 2.2 percent in 2030 as debt accumulates and interest rates increase from their currently low levels. By 2050, net interest costs would equal 8.1 percent of GDP—higher than they have ever been before.[2]

The U.S. Treasury finances the deficits by issuing securities with maturities ranging from as short as four weeks to as long as 30 years. Longer-term securities tend to pay higher interest rates than shorter-term securities. In general, interest rates on Treasury securities of different maturities tend to move up and down together over time, and the downward trend in interest

[1] The federal government collects interest from various sources (for example, from interest on student loans and from states that pay interest on advances they received from the federal Unemployment Trust Fund when the balances of their state unemployment accounts were insufficient to pay benefits promptly). See Congressional Budget Office (2020b).

[2] The projected rise in net interest costs is due to projected increases in both interest rates and federal debt. The focus of this paper is on the interest rate portion of that projection. See Congressional Budget Office (2020a).

rates observed over the past four decades has occurred in interest rates on securities of all maturities. However, interest rates on longer-term Treasury securities (10-year Treasury notes, for example) have declined by a greater amount than interest rates on shorter-term securities (3-month Treasury bills). That difference reflects a decline in the term premium—the premium paid to bondholders for the relatively higher risk associated with holding longer-term bonds. The causes of that decline are discussed below. CBO projects that the premium on longer-term securities will rise in coming decades but remain below its historical average, thus implying a lower cost of borrowing through the issuance of longer-term securities than in the past.

An important distinction when discussing interest rates is the difference between nominal interest rates—the interest rates observed in financial markets, stated on loan contracts, and reported in the financial press—and real interest rates, which are nominal interest rates minus expected inflation. Both nominal and real interest rates have declined since the early 1980s (see Figure 1).[3] Nominal interest rates have declined by a greater amount, implying that some, but not all, of the decline in nominal interest rates is accounted for by the decline in expected inflation—the difference between the nominal and real rates. The rest of the decline, which is the primary focus of this paper, is in real interest rates and thus is attributable to factors that affect the real interest rate alone.

The Decline in Interest Rates

Real interest rates on U.S. government securities reached a post-World War II peak in the early 1980s (see Figure 2). The interest rate on U.S. 3-month Treasury bills and 10-year Treasury notes, both adjusted for inflation, averaged over 4.5 percent and 6.7 percent, respectively, between 1981 and 1985.[4] Those same rates have averaged −0.95 percent and 0.84 percent, respectively, over the 2013–2018 period—a decline of roughly 5.5 percentage points for short-term rates and 5.9 percentage points for long-term rates from the earlier sample period to the latter.

The decline in real interest rates has occurred in other countries as well. Figure 3 shows the average real short- and long-term interest rates on government securities from a selection of advanced economies from 1980 through 2018. The decline in the median real short-term interest

[3] Figures in this paper do not include the effects of the 2020 coronavirus pandemic, which pushed short- and long-term rates farther below their historical averages.

[4] The real interest rate is the nominal interest rate adjusted for expected inflation. The researchers cited in this paper have taken a number of different approaches to measuring expected inflation. Some authors use the expected inflation rate implied by Treasury inflation-protected securities (TIPS). Others use survey-based measures or simple time-series models, and because consistent measures of expected inflation are not always available, especially for comparisons among countries and across lengthy time periods, some authors use the realized inflation rate as a proxy for expected inflation. All of those various measures of expected inflation support the general conclusion that real global interest rates have declined over the past four decades. See Appendix A for more details on expected inflation.

rate over that period was 3.0 percentage points, and the decline in the median real long-term interest rate was 3.7 percentage points.

The data shown in Figure 3 are broadly consistent with the results reported in the literature. Rachel and Summers (2019) document a decline in global real long-term rates on government securities of roughly 3 percentage points between 1980 and 2018.[5] International Monetary Fund (2014), Council of Economic Advisers (2015), Bean et al. (2015), and Rachel and Smith (2017) report similar-sized declines in real rates since the early 1980s.

Policy actions by the Federal Reserve and other central banks complicate the interpretation of the change in real interest rates over time.[6] In the early 1980s, the Federal Reserve raised interest rates to rein in inflation, and more recently, the Federal Reserve and other central banks around the world have reduced rates to help stimulate aggregate demand in the wake of the 2020 coronavirus pandemic. The effects of those policy actions are hard to disentangle from other factors that affected interest rates. However, qualitatively, central bank actions most likely pushed interest rates above their equilibrium value in the early 1980s and below their equilibrium value more recently. Thus, the decline in real interest rates due to persistent, or long-lived, factors might be considerably smaller than the overall decline in real interest rates measured using raw data. Studies that attempt to measure trend movements in real rates by filtering out temporary highs and lows do tend to find smaller declines in rates since the early 1980s. For example, Johannsen and Mertens (2016), Laubach and Williams (2003, 2016) and Holston, Laubach, and Williams (2017) find that the neutral real rate—the risk-free rate of interest that would prevail when the economy was operating at full-employment—declined between roughly 1 percentage point and 3 percentage points from the early 1980s through early 2020.[7]

Evidence from a longer sample reinforces the view that the decline in global real rates on government and similar securities since the early 1980s is not a return to historical averages. Figure 4 shows the world real interest rate since the late 1800s. In this longer context, the decline in real rates since 1980 might at first appear to represent a return to a longer-run historical average. That is, real interest rates were also relatively low from the late 1940s through the late

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[5] Rachel and Summers' (2019) real world interest rate is based on the average of the real rates implied by inflation-protected sovereign debt in the G7 excluding Italy. Their real interest rate series is an extension of the real rate series constructed by King and Low (2014).

[6] Gerlach and Moretti (2014) argue that monetary policy responded to the drop in long-term rates, not the other way around. Their findings suggest that low rates were more likely the result of secular, as opposed to cyclical, forces in the decade prior to the global financial crisis. Justiniano and Primiceri (2010) reach a similar conclusion. They show that the stance of monetary policy when measured relative to the neutral rate of interest is better described as tight rather than loose in the early 2000s.

[7] Current and historical estimates of the natural rate of interest are available from the Federal Reserve Bank of New York, "Measuring the Natural Rate of Interest" (accessed November 20, 2020), www.newyorkfed.org/research/policy/rstar.

1970s, suggesting that the recent decline in interest rates could be seen as a return to normal following the restrictive monetary policy of the early 1980s. Bean et al. (2015) question that interpretation, however, arguing that the late 1940s through the late 1970s was a period of widespread financial repression—government policies artificially kept interest rates below their equilibrium level.[8] They argue that the drop in real rates observed since the early 1980s is unusual from the standpoint of the long-term average real rate in periods excluding wars and the period of financial repression. Looking at sub-sample averages provides some support for this explanation. Excluding the two world wars (1914 to 1918 and 1939 to 1945) and the period of financial repression (1946 to 1983), global real short- and long-term interest rates prior to the onset of the Great Moderation (1984) averaged 3.1 percent and 3.5 percent, respectively. Since that time, those rates have averaged 1.8 percent and 3 percent, respectively.

The decline in real interest rates since the early 1990s was largely unanticipated. Figure 5 shows the real interest rate on 10-year U.S. Treasury notes along with the five-year forecasts produced by private-sector forecasters as represented by the *Blue Chip* consensus. The consensus forecasts exhibited a smaller positive bias from 1984 to 1996 than they did from 1997 to 2014. From the first sample period to the second, the positive bias in the *Blue Chip* consensus forecast of the nominal 10-year interest rate increased, and the positive bias in the *Blue Chip* consensus forecast of inflation as measured by the consumer price index for all urban consumers (CPI-U) decreased. Those two diverging trends resulted in a larger positive bias in the real interest rate forecast over the latter period.

Explanations for the Long-Term Decline in Real Interest Rates

Most of the research explaining the trend decline in global real interest rates on government debt over the past four decades examines factors that have shifted the supply of and demand for saving. Researchers have identified several such long-run shift factors: the slowdown in trend real output growth, demographic forces such as slowing labor force growth and aging populations, a global saving glut, a shortage of safe assets, and secular stagnation. A handful of other explanations have been proposed including quantitative easing (that is, the large-scale purchase of financial assets) initiated by central banks in response to the global financial crisis and the 2020 pandemic as well as a shift in the perceived riskiness of the economy following those events. In addition to explaining the decline in global interest rates, other studies attempt to explain why relative demand has shifted away from more risky assets toward risk-free highly liquid assets—a shift that has resulted in an increase in the risk premium.

[8] Examples of such policies are limits on interest rates that financial institutions can pay on saving, limits on the flows of financial capital across borders, and, in some instances, requirements that force pension funds and financial institutions to lend to the government. In the presence of such policies, nonprice mechanisms, such as queuing, substitute for price rationing. See Reinhart and Sbrancia (2015) for evidence of financial repression over this period.

There is a large degree of overlap in those explanations. The slowdown in trend growth can be at least partly attributed to the slowdown in population growth and aging. The saving glut and shortage of safe assets are also somewhat related to demographic forces. Furthermore, demographic forces play a key role in models of secular stagnation as well.

Researchers have used a variety of methods to investigate why interest rates have declined. The most common method focuses on the determinants of the demand and supply of investment and saving. Some researchers focus on the link between trend growth and the real interest rate as implied by economic theory.[9] Others look at the reduced-form correlations between interest rates and factors that, according to economic theory, are expected to influence interest rates. Event studies have been the main method applied to analyze the effects of quantitative easing.

There is much overlap in those methods. The approaches taken by Laubach and Williams (2003, 2016) and Holston, Laubach, and Williams (2017), for example, are based on the relationship between the equilibrium real interest rate and trend growth. The demand and supply approach also recognizes the role of trend growth in determining interest rates but expands the list of covariates to include other demand and supply shifters. And the reduced-form approach looks at correlation between real rates and the factors suggested by demand and supply for saving and investment.

Slowdown in Trend Growth

One of the most widely cited explanations for the decline in real interest rates over the past four decades is the slowdown in trend real output growth (see Table 1). Economic theory predicts that the real interest rate is positively related to the trend growth rate of real output. Trend growth in real output has declined for advanced economies since the early 1980s. Figure 6 shows the trend growth rates for a selection of advanced economies as estimated by Holston, Laubach, and Williams (2017). The figure shows a clear slowdown in all of those economies since the early 1980s; according to economic theory, that slowdown implies a drop in the real interest rate, all else held constant. There are differing views on what will happen to trend growth in the future. Gordon (2016) sees trend growth remaining low over the coming decades. But others, including Brynjolfsson and McAfee (2014), project that trend growth will increase.

Other researchers have questioned the evidence supporting the tight link between growth and real interest rates suggested by economic theory. For example, Rachel and Smith (2017) show that growth in a broad cross-section of countries (advanced as well as emerging markets) remained fairly steady from the early 1980s through the early 2000s, averaging 2 percent to 4 percent. They conclude that past movements in trend output cannot explain the decline in real interest rates over the entire 1980–2019 period. However, they allow for the possibility that the

[9] Commonly referred to as the intertemporal optimizing condition for consumption, or the Euler equation.

decline in growth following the global financial crisis may have led to a reassessment of future trend growth and that some of the drop in interest rates over the past decade could therefore be attributable to the decline in trend growth. Furthermore, they argue that the global trend growth rate is likely to slow in the future, which would put downward pressure on global real rates.

Other researchers have found that the link between trend growth and the real rate of interest appears less robust over longer samples. On the basis of samples dating to the early 1800s, Lunsford and West (2019) and Hamilton et al. (2016) find that the correlation between real output growth and real interest rates on government debt is variable, weak, and sometimes of the wrong sign. Both studies find evidence that the correlation has been positive since the end of World War II, which is perhaps why approaches such as Laubach and Williams's (2003, 2016) and Holston, Laubach, and Williams (2017) find a role for trend growth in their estimates of the neutral real rate.[10] But a longer view suggests that a stable, reduced-form relationship does not exist.

Reduced-form correlations based on longer samples are more likely to be distorted by confounding factors, such as increased life expectancy. Hamilton et al. (2016) posit that increases in life expectancy since the early 1900s may have led to a lower rate of time preference, that is, as people expected to live longer, they began to place greater weight on consumption in the future. An earlier study by Clark (2005) argued that the decline in real rates of return before the start of the industrial revolution in England was also likely due to a decline in the rate of time preference. Nonetheless, the long sample results suggest that over the past 100 years, changes in trend growth have not been a dominant factor in movements in global real rates.

Aging Global Population

The world's population is getting older. The median ages of the U.S. and world populations have risen steadily since the early 1970s. According to the United Nations, both populations are expected to continue to age through 2100 (see Figure 7).

Aging populations affect interest rates mainly through two channels: shifts in people's desire to save and declining participation in the labor force. As individuals move from their early working years through middle age, their saving tends to rise. After retirement, saving tends to fall or become negative as assets are drawn down. Over the past four decades an increasing share of the world's population has moved into middle age, which has increased saving and pushed down the world interest rate. The second channel through which aging affects interest rates is through its effect on labor force participation. As the global population has aged labor force growth has

[10] There are exceptions. Clark and Kozicki (2005), for example, apply Laubach and Williams's (2003, 2016) technique to real-time data on real GDP and find "the quantitative link between the equilibrium rate and trend growth to be weak" (p. 403).

slowed. For a given capital stock, that slowing growth in the labor force has put upward pressure on the ratio of capital to labor, thereby lowering the marginal product of capital and putting downward pressure on real interest rates (Rachel and Smith 2015, 2017). Researchers estimate that together those factors account for roughly 100 to 200 basis points of the decline in global real interest rates since the early 1980s (see Table 2).

The continued aging of the population projected by the United Nations suggests that at some point over the coming decade, desired saving will begin to decrease and interest rates will begin to rise (Favero et al. 2016; Rachel and Smith 2017) as the bulk of the world's population shifts from high-saving middle age to retirement age. But Rachel, in a different paper co-authored with Summers (2019), sees increased life expectancy forestalling that shift toward dissaving, implying that aging will continue to put downward pressure on interest rates for several more years (see also, Carvalho et al. 2016; Gagnon et al. 2016; Krueger and Ludwig 2007).

Global Saving Glut

The global supply of saving increased sharply beginning in the early 2000s. The initial increase can be traced to the rise in saving relative to desired investment in emerging-market economies, many of which responded to the Asian financial crisis at the end of the 1990s by engaging in fiscal consolidation. Rising prices of oil and other commodities in the early 2000s led to increased saving by oil- and commodity-exporting countries. Faster growth in high-saving emerging-market economies—especially China—than in advanced economies also contributed to rising saving (International Monetary Fund 2014; see Figure 8).[11] The increase in the supply of saving relative to the demand for investment during that period, which has been termed the global saving glut, put downward pressure on global interest rates (Bernanke 2005, 2007).

A closely related explanation for the decline in global real interest rates over the past three decades is the so-called safe-asset shortage. The aforementioned glut of saving was not channeled to a well-diversified portfolio of assets; rather, it was channeled predominately into (mostly U.S.) assets that were perceived to be safe, that is, free of default risk. A consequence of that shift in the global portfolio is that interest rates on relatively safe assets, like U.S. Treasury securities, have declined by more than the return on risky assets, such as equities (Bernanke et al. 2011).

Several researchers have noted that when the demand for safe government-issued assets exceeds the supply, the private sector has responded by supplying assets that are perceived to be safe (Bernanke et al. 2011; and Gorton 2017). For example, in the decade before the global financial crisis, financial markets supplied apparently safe mortgage-backed securities in response to the demand for safe assets. The crisis led to a reassessment of the riskiness of mortgage-backed

[11] See Appendix B for a detailed discussion of China's role in the global saving glut.

securities, and thus to a decline in the global supply of safe assets, which put further downward pressure on interest rates on Treasury securities.[12] Coinciding with the reassessment of the riskiness of private assets, the demand for U.S. Treasury securities was rising as global investors sought a safe haven during the crisis. Further exacerbating the shortage of safe assets were large-scale purchases of such assets by the Federal Reserve and the central banks of Japan, the United Kingdom, and the European Union. In related research, the International Monetary Fund (2012) attributes some of the increased demand for safe assets to the Basel III regulations that increased the amount of safe assets that financial institutions are required to hold.

The portfolio shift toward safe assets has also been described as a rise in the convenience yield on Treasury securities. The convenience yield refers to the implicit return that investors receive from holding safe and highly liquid securities, such as Treasury securities and agency debt. The higher the convenience yield, the lower the observed yield on such securities. The increase in the spread between the rate of return on risky assets and safe assets over the past four decades is consistent with the rise in the convenience yield on safe assets (see Figure 9). Del Negro et al. (2017, 2018) present empirical evidence showing that increases in convenience yields over the past few decades have been a significant factor in explaining the decline in global real rates. Jordà et al. (2019) present corroborating evidence for that explanation by showing that the return on risky assets, and thus the marginal product of private capital, has been roughly stable over the past 40 years while safe asset returns have declined, which suggests that preferences for safe assets have increased.

Research on the saving glut and safe-asset shortage has provided some estimates of the contribution of those factors to the decline in interest rates on government securities over the past 30 years (see Table 3). Rachel and Smith (2017) estimate that the global saving glut accounts for roughly 25 basis points out of the nearly 4 percentage-point decline in global real interest rates since 1980. Warnock and Warnock (2009) estimate that increased foreign demand for U.S. Treasury securities decreased the 10-year Treasury note rate by .80 percentage points over the 1984–2005 period.

Most of the research on the saving glut and safe-asset shortage focuses on explaining past movements in global real interest rates. A few studies provide qualitative prognoses. The International Monetary Fund (2014), for example, expected the slowdown in emerging-market growth following the global financial crisis to reduce the saving rate in those countries and put upward pressure on real interest rates going forward. As the Council of Economic Advisers (2015) points out, however, the post-crisis reduction in saving in emerging-market economies was more than offset by the increased saving by advanced economies. Moreover, the council's

[12] Caballero and Farhi (2018) estimate that the supply of assets that were perceived to be safe fell from 32 percent of world GDP in 2007 to 18 percent in 2011.

report noted that if the increased saving in advanced economies is being driven by the prospect of slower growth and that slower growth is expected to persist, then the saving glut might continue to put downward pressure on interest rates over the next several years.[13]

Declining Investment

Also contributing to the downward trend in global interest rates was declining investment, which reduces the demand for loanable funds. According to Bean et al. (2015) and Rachel and Smith (2015), despite the drop in real interest rates, global investment as a share of GDP has remained roughly unchanged at 25 percent since the early 1950s, which suggests that there has been both an increase in the supply of saving and a decrease in demand for investment. As documented by Karabarbounis and Neiman (2012) and Rachel and Smith (2015), the relative price of capital goods has been declining since the 1950s. Most empirical studies find that the elasticity of investment with respect to the price of capital goods is less than 1 (Thwaites 2015) implying that it costs less (in real terms) to fund the same amount of investment today than in 1950. Thus, as the price of capital has declined, the investment rate has remained relatively constant as a share of GDP.

Other Explanations

Although most of the research has focused on the factors discussed above, some studies offer other explanations for falling interest rates. Several researchers point to rising income inequality as a factor pushing interest rates down over the past 40 years.[14] The share of total income received by higher-income households has increased over the past 40 years in the United States and worldwide. Higher-income households tend to save a greater proportion of their income, so the rise in the share of income received by higher-income households has led to an increase in the total amount of saving available for investment, which has put downward pressure on interest rates. Auclert and Rognlie (2020) estimate that rising inequality accounts for roughly one-fifth of the decline in the global real interest rate since 1980.

Researchers have also looked at the effect of increased life expectancy on the rate of time preference. Clark (2005) presents evidence that real interest rates before 1400 were greater than 10 percent per year, whereas current real rates on equivalent investments are 2 percent per year. Clark argues that increased life expectancy has led to a decline in the rate of time preference and thus to a decline in the equilibrium real interest rate.

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[13] Gourinchas and Rey (2016) provide a quantitative estimate of the effect of global saving on interest rates. Their empirical work implies global saving will depress real interest rates by −0.2 percent to 0 percent through 2021, which they characterized as an extended period of time in 2016. Those estimates are likely less relevant in the wake of the 2020 coronavirus pandemic.

[14] See Bean et al. (2015), Auclert and Rognlie (2020), Rachel and Smith (2017), Eggertsson et al. (2019), Lunsford and West (2019), and Rachel and Summers (2019).

In addition to declining real and nominal interest rates on securities of all maturities over the past 4 decades, there has also been a decline in the term premium on longer-term assets. Campbell et al. (2017) posit that the declining correlation between stock and bond returns accounts for that downward trend. They document that the covariance between stock and long-term bond returns was positive, on average, from the early 1950s through the early 1980s. Since then, the covariance has trended downward, and since the early 2000s, it has been persistently negative, implying that long-term bonds are now more valuable as a hedge against fluctuations in stock market returns. Those hedging properties have increased the demand for long-term bonds and pushed rates on those bonds down in relation to the rates on short-term bonds.

Other research finds that the reduction in inflation volatility since the early 1980s has also contributed to the decline in the term premium on long-term securities. As inflation volatility has declined, the risk that the real return on a long-term asset will change unexpectedly because of unanticipated movements in inflation has also declined. Thus, the term premium, which compensates investors for the risk of holding a long-term asset, has diminished as well. Research has identified changes in monetary policy—such as inflation targeting, which has increased the stability of expected inflation—as having contributed to the decline in the term premium (Kim et al. 2019; Clarida 2019).

Secular Stagnation

Secular stagnation describes an economy that persistently operates below its potential level of output because of insufficient aggregate demand. It is equivalently described as a condition in which desired saving exceeds desired investment, which pushes the equilibrium real interest rate below zero.

Much of the research on secular stagnation begins with the observation that the equilibrium real interest rate has fallen (often by citing the aforementioned literature on causes) and identifies the challenges those lower rates pose for achieving macroeconomic and financial stability.[15] In other words, most of the research focuses on the consequences rather than the causes of lower equilibrium real rates.

There are a few exceptions, however. Eggertsson et al. (2019), for example, provide a framework for identifying the sources of decline in the equilibrium real interest rate since the 1970s. The authors attribute most of the decline in the equilibrium rate since the 1970s to demographic and technological factors, and they estimate that the downward pressure on interest rates from those factors has been partially offset by increased government borrowing.

The factors identified by Eggertsson et al. (2019)—technology, demographics, and government borrowing—are not new to the research on the causes of the decline in interest rates. An

[15] See Summers (2014), for example.

important contribution of their work, however, is that they attribute low interest rates to persistent factors, which implies that central banks' interest rate policy will be constrained by the effective lower bound (ELB) more frequently than indicated by previous literature, which had mostly attributed the ELB to cyclical factors. The implication is that the ELB is likely to be a recurring problem as long as those long-lived factors continue to put downward pressure on interest rates.[16] Eggertsson et al. (2019) see the ELB as a continued risk given that the low interest rate environment is caused by factors that are highly persistent (demographics, for example) and not likely to be reversed quickly.

Rachel and Summers (2019) also find that slowing technological growth and aging populations have put downward pressure on global real interest rates over the past four decades. Their study accounts for the partially offsetting effects of rising government debt and social welfare programs (which have tended to reduce private saving rates). Their key finding is that over the past 50 years, increases in government debt (which, in the four countries considered, has tripled as a percentage of GDP) and in social welfare spending have put upward pressure on interest rates, partly offsetting the downward pressure from demographics, trend growth, and other factors. They conclude that without rising debt and social spending, the equilibrium real interest rate would have been negative, which implies that the world economy would have been in a persistent state of secular stagnation.

Improvements in technology might also contribute to secular stagnation. Thwaites (2015) presents an overlapping-generations model, in which advances in technology that generate a fall in the relative price of capital roughly in line with what has been observed in the data can generate persistently low interest rates and secular stagnation.

Factors Mitigating the Decline in Interest Rates

Although many factors have pushed down interest rates over the past three decades, other factors have exerted upward pressure on them. As noted above, Rachel and Summers (2019) estimate that real interest rates would have fallen further if not for rising federal debt relative to GDP, which stemmed, in part, from expanding social safety net programs.

Another factor putting upward pressure on interest rates over the past three decades has been the rise in the share of income paid to capital (and the corresponding reduction in the share paid to labor). All else constant, a rise in the share of income paid to capital will tend to put upward pressure on interest rates. Two prominent explanations for the rise in the capital share are

[16] The ELB is a constraint on nominal interest rates, whereas the secular stagnation hypothesis predicts that the equilibrium real interest rate will be negative. Therefore, as noted by Eggertsson et al. (2019), it could be possible to achieve a negative real interest rate by raising the inflation target. However, if the equilibrium rate is sufficiently negative, the inflation rate required to push the real interest rate to that level may be higher than policymakers are willing to accept.

changes in technology that have favored capital over labor (Grossman et al. 2017) and increasing market power, which has resulted in monopoly rents (Eggertsson et al. 2018). Those explanations also shed light on the possible causes of income inequality (Auclert and Rognlie 2020).

The Influence of the Global Financial Crisis and the Pandemic on Global Real Interest Rates

In addition to the long-term structural factors described above, the global financial crisis of 2007 to 2009 and the 2020 coronavirus pandemic put downward pressure on real interest rates. In both instances, saving (particularly in the form of safe assets) increased, investment demand collapsed, and central banks reduced short-term policy rates and engaged in large-scale purchases of assets. All of those actions reduced global real interest rates but are probably temporary (if highly persistent) in nature. Thus, as the economy recovers from the economic effects of the pandemic, global real interest rates are likely to recover as well but to levels that are lower than historical averages because long-term structural forces—forces that are unrelated to the global financial crisis and the pandemic—are expected to continue to put downward pressure on interest rates for the next several decades.

The Role of the Global Financial Crisis

The onset of the decline in real global interest rates predates the global financial crisis. But the immediate and lingering effects of the crisis, as well as the policy responses to it, played a role in pushing interest rates down over the past decade.

In response to the crisis, the Federal Reserve and other central banks around the world lowered short-term policy interest rates considerably (see Figure 10).[17] In addition, several central banks engaged in quantitative easing (see Figure 11), provided forward guidance indicating that policy rates would be low for a very long time, and, in some cases, set negative short-term policy interest rates. Quantitative easing policies are thought to affect long-term interest rates on government securities through two channels—signaling and the term premium. Signaling occurs when financial market participants perceive that quantitative easing signals a commitment on the part of the Federal Reserve to maintain low short-term interest rates for an extended period of time, reinforcing forward guidance (Krishnamurthy and Vissing-Jorgensen, 2011).

The second channel is the effect on the term premium. Quantitative easing mostly involved the Federal Reserve's purchasing long-term notes and bonds. To the extent that government securities of different maturities are not perfect substitutes, those purchases reduced the term premium—the premium paid on securities with longer maturities to compensate for the added

[17] Central banks lowered short-term policy rates and engaged in substantial amounts of quantitative easing following the onset of the 2020 pandemic. The effects of those policies are not included in Figure 10 or Figure 11.

risk of those securities.[18] Averaging estimates from a number of studies, Borio and Zabai (2016) estimate that the three quantitative easing episodes undertaken by the Federal Reserve after the global financial crisis pushed the yield on 10-year Treasury-notes down by roughly 100 basis points.

In addition to direct policy effects, the global financial crisis may also have depressed interest rates through other channels. For example, Kozlowski et al. (2018) develop a model with learning in which a large unexpected event—an event that had previously been perceived to be of very low probability—could lead to a large and highly persistent shift in beliefs about the probability that such an event would occur again in the future. Thus, the global financial crisis shifted investors' beliefs about the chances of another crisis, and as a consequence, those investors shifted their portfolios toward less risky and highly liquid bonds, which caused the real risk-free interest rate to fall. The authors argue that other events which happen more frequently might not affect investors' perception of risk.[19] The implication of their finding is that events like the global financial crisis and the pandemic can produce highly persistent shifts in preferences for safe assets.

The Role of the 2020 Pandemic

The 2020 pandemic put further downward pressure on global real interest rates. The pandemic led to a global recession as governments shut down large segments of their economies in an effort to slow the spread of the virus. Interest rates, which had been trending down for the reasons described above, fell further. Short-term interest rates fell as central banks reduced short-term policy rates. The Federal Reserve, for example, reduced the federal funds rate (that is, the interest rate that financial institutions charge each other for overnight loans of their monetary reserves) from 1.6 percent to near zero over a two-week span in early to mid-March. Long-term interest rates fell as well, as central banks, including the Federal Reserve, made direct purchases of long-term securities and instituted a number of lending programs aimed at maintaining the functioning of financial markets. Additional downward pressure on long-term interest rates came from private and official investors' shifting out of risky assets, such as equities, and into safe assets, such as U.S. Treasury securities. Rates were also held down by the fall in demand for investment as firms postponed and cancelled capital expenditure projects.

Fiscal policymakers also responded aggressively to the downturn caused by the pandemic. In the United States, legislation signed into law as of mid-April 2020 added an estimated $1.7 trillion to the projected debt over the coming decade. All else held constant, that increase in debt relative to GDP could eventually put upward pressure on interest rates. In addition, the unwinding of

[18] The notion that the government securities of different maturities are imperfect substitutes is called the preferred habitat hypothesis.

[19] Another way to describe the difference is that frequent shocks are drawn from a fixed-probability distribution, whereas infrequent shocks change investors' perception of that distribution.

cyclical forces could put upward pressure on interest rates. As the U.S. and world economies recover from recession, demand for borrowing will rise, central banks may begin to reduce the degree of accommodation, and investors will begin shifting back toward more risky assets. Those factors will most likely put additional upward pressure on risk-free interest rates beginning in the latter part of the coming decade as the economy approaches full employment and begins to recover and as central banks trim their monetary accommodation measures.

Despite the upward pressure from rising debt and the unwinding of cyclical forces, CBO expects interest rates to remain below historical averages because of the long-lived factors such as slowing trend growth and aging world populations.

Projected Trends in Real Interest Rates

Most of the studies summarized in Table 1, Table 2, and Table 3 focus on explaining past movements in real interest rates. A few studies provide forecasts, but the range of forecasts are quite wide, thus making it difficult to identify consensus estimates of the effect of each of the factors going forward. For example, Rachel and Smith (2017) expect demographic forces to push the real rate up by roughly 45 basis points over the coming decade, while Carvalho et al. (2016) forecast demographic forces to push real rates *down* by an additional 50 basis points through 2050 (see Table 2).

The other challenging aspect of much of the existing literature is that it is focused on a subset of factors. For example, Laubach and Williams (2003, 2016); Holston, Laubach, and Williams (2017); and Del Negro et al. (2018) investigate the role of trend growth in explaining the decline in real interest rates over the past several decades. Similarly, Carvalho et al. (2016), Gagnon et al. (2016) and Krueger and Ludwig (2007) investigate the role of demographics in explaining the decline in real interest rates over the past four decades. Those studies do not necessarily purport to offer a single explanation for the fall in real rates; in fact, Laubach and Williams (2003, 2016) and Holston, Laubach, and Williams (2017) allow for unknown factors to play a significant role as well. However, the narrow focus makes it difficult to assess how a combination of factors is likely to influence real interest rates going forward.

Several exceptions to the general rule that the literature focused on a subset of factors include Rachel and Smith (2015, 2017), Rachel and Summers (2019), International Monetary Fund (2014), Bean et al. (2015), Desroches and Francis (2006), Borio et al. (2017), and Council of Economic Advisers (2015). The general consensus among those studies is that most of the factors that have pushed real interest rate down over the past four decades—such as demographic forces, the slowdown in trend growth, and the various causes of the global saving glut and safe-asset shortage—are long-lived. As such, real interest rates are likely to remain below their historical average for the coming decade, and perhaps even beyond. Some of those studies provide quantitative estimates. Rachel and Smith (2015, 2017) forecast real interest rates to rise by roughly 50 basis points over the coming decade, whereas Rachel and Summers (2019) argue

that the equilibrium real rate of interest will most likely remain near its current low level for the next decade and well beyond.[20]

CBO's Interest Rate Projections for the Medium and Long Terms

CBO projects the real interest rate on 10-year Treasury notes to rise gradually over the next decade as the economy recovers from the economic fallout from the pandemic, monetary policy returns to a neutral stance, and federal debt continues to rise.

Although CBO expects interest rates to rise over the coming decade, the agency expects them to remain below their 1995–2004 average through 2050. CBO uses the years 1995 to 2004 for historical comparison because in those years monetary policy is estimated to have been neutral, on average; expected inflation was relatively stable; and the economy experienced relatively mild business cycle fluctuations.[21] The agency expects the long-lived factors, such as demographics and trend growth, to continue to put downward pressure on interest rates through 2050. CBO's method of forecasting interest rates over the medium and long terms is based on many of the factors identified in the academic literature. The agency's forecasts of interest rates over the medium and long terms are highly uncertain, in large part because forecasts of the underlying driving factors are uncertain.

Factors Underlying CBO's Projections

As reviewed in the previous section, the research literature has identified a number of factors that are likely to be important in determining the future path of interest rates. CBO's interest rate forecast takes those factors into account using projections of labor force growth, federal debt, private domestic and foreign saving, the growth rate of total factor productivity, the risk premium, and changes in the share of income paid to capital. As shown in Table 4, each of the factors that CBO projects is related to one or more of the factors identified in the research literature.

CBO's real interest rate forecast is based on comparisons of the underlying explanatory factors over a historical benchmark period—1995 to 2004—to those same factors over the forecast period. CBO estimates how the projected changes in each of the factors between the benchmark period and the forecast horizon are expected to affect interest rates by using a set of estimated impact parameters. CBO chose 1995 to 2004 as the benchmark period for comparison with the forecast periods because monetary policy is estimated to have been neutral, on average; expected

[20] Rachel and Summers (2019) project that the neutral real rate will remain near -2 percent through the next five decades.

[21] Monetary policy is neutral when the short-term risk-free rate of interest is equal to the rate that would prevail if the economy was in long-run equilibrium.

inflation was relatively stable; and the economy experienced relatively mild business cycle fluctuations.[22]

In CBO's assessment, many of the factors listed above are expected to put downward pressure on interest rates, and others are expected to put upward pressure on interest rates. For example, growth in labor hours is expected to be slower, on average, over the coming decades compared with such growth over the 1995–2004 period, putting downward pressure on interest rates. On the other hand, rising federal debt relative to GDP is expected to push interest rates up over the coming decades. In CBO's September 2020 baseline projections, the net effect of these various factors is negative, that is, real risk-free interest rates are expected to be lower on average over the 2031–2035 period than they were over the 1995–2004 period by roughly 1.8 percentage points. Over the longer run, 2046 to 2050, risk-free interest rates are lower in CBO's forecast than they were in the 1995–2004 period by roughly .6 percentage points, on average (see Figure 12).

Labor Force Growth. CBO expects the retirement of the baby boom generation to result in the labor force's growing at a slower rate than it grew over the 1995–2004 period. That slower growth in the number of workers would tend to increase the amount of capital per worker in the long term, thereby reducing the return on capital and, in turn, the return on government bonds and other investments.

Private Domestic and Foreign Saving. The retirement of members of the baby-boom generation and slower growth of the labor force will reduce the ratio of the number of workers in their prime saving years to the number of older people who are drawing down their savings, CBO projects. As a result, in CBO's estimates, the total amount of saving available for investment will be less than it otherwise would be (all else being equal), which tends to reduce the amount of capital per worker, thereby pushing up interest rates. CBO estimates that the effect will only partially offset the positive effect of increased income inequality on saving that results from changes in the distribution of income. CBO expects the share of total income received by higher-income households to be larger in the future than it was during the 1995–2004 period. Higher-income households tend to save a greater proportion of their income, so the difference in the distribution of income is projected to increase saving and reduce the real interest rate in relation to the 1995–2004 period.[23]

Foreign inflows of capital are an additional source of saving that CBO expects to affect interest rates in the medium and long terms. CBO anticipates that emerging-market economies will

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[22] Appendix C describes the details of this approach.

[23] Income inequality is not expected to further increase in the coming years in CBO's forecast. However, the agency expects the increased inequality that has occurred in prior years to remain roughly unchanged resulting in higher overall inequality than in the 1995–2004 period.

attract a greater share of foreign investment in coming decades than they did in the 1995–2004 period. As economic and financial conditions in those economies improve, they will become increasingly attractive destinations for foreign investment, thereby lessening the amount of foreign investment flowing into the United States. In addition, it is likely that household saving rates will decline as those economies continue to grow. As a result of those developments, CBO expects the downward pressure on U.S. real interest rates that results from foreign inflows of capital to diminish over the long term.

Total Factor Productivity Growth. Total factor productivity (TFP) is a key determinant of trend growth, which, as highlighted in several of the research studies described above, is an important factor in determining interest rates. As predicted by economic theory, trend growth and real interest rates are positively related. In CBO's forecasts, TFP grows more slowly in the future than it did from 1995 to 2004, thus putting downward pressure on real interest rates.

Debt-to-GDP Ratio. In CBO's baseline projections, federal debt is much larger as a percentage of GDP than it was over the 1995–2004 period—reaching 109 percent by 2030 and more than 200 percent by 2050. In the medium and long terms, as the economy reaches its historical relationship with potential output, greater federal borrowing is expected to crowd out private investment, thereby reducing the amount of capital per worker and increasing interest rates and the return on capital over time.

Risk Premium. CBO expects domestic and international investors' preferences for Treasury securities over riskier assets to remain higher than it was over the 1995–2004 period. As documented in the literature on the saving glut and safe-asset shortage, both domestic and international investors' appetite for risk began to diminish in the early 2000s, and the economic fallout from the financial crisis, the slow subsequent recovery, and financial institutions' response to increased regulatory oversight further increased the demand for low-risk assets. The 2020 coronavirus pandemic further shifted investors' preferences toward safe assets such as Treasury securities. The rise in demand for Treasury securities stemming from those events contributed to lower returns (that is, to lower interest rates).

CBO expects preferences for Treasury securities relative to riskier assets to gradually decline over the coming decades but to remain above their average levels from 1995 to 2004. In addition to the increased demand for Treasury securities resulting from a shift in investors' preferences, the Federal Reserve increased its purchases of Treasury and other securities in the wake of the pandemic. The increased purchases by the Federal Reserve put additional downward pressure on interest rates. In CBO's forecast, the Federal Reserve's holdings of Treasury and other securities measured as a percentage of GDP begins to fall after 2022. With that decline, CBO expects the downward pressure on interest rates resulting from the Federal Reserve's purchases to diminish over the latter half of the coming decade.

Capital Share of Income. The capital share of income—the percentage of total income that is paid to owners of capital—has been on an upward trend for the past few decades. That share is projected to remain higher than its average has been over recent decades. The factors that appear to have contributed to the rise in income for owners of capital (such as technological change and globalization) are likely to persist, keeping it above the historical average. In CBO's estimation, a larger share of income accruing to owners of capital would directly boost the return on capital and, thus, interest rates. However, that boost could be smaller if the rise in the share of capital income was a return to market power rather than to capital.

CBO's Medium-Term and Long-Term Forecasts of Real and Nominal Rates on 10-Year Treasury Notes

When forecasting interest rates over the medium term, CBO generally focuses on the latter half of the coming decade. Over that horizon, CBO typically projects that real output is near its long-run relationship to potential, the average inflation rate is close to the Federal Reserve's average inflation objective of 2 percent, and monetary policy is neutral, on average. In CBO's current forecast, however, the economy is still recovering from the 2020 recession over the 2025–2030 period. In those years, real output is expected to be below its historical relationship with potential output, on average, and the federal funds rate is expected to be below CBO's estimate of the rate consistent with neutral monetary policy.

For the purposes of preparing the baseline forecast published in September 2020, CBO therefore focused on the 2031–2035 period when forecasting interest rates over the medium term. The agency expects inflation to be close to the Federal Reserve's 2 percent average inflation objective and monetary policy to be neutral, on average, over that time period. CBO also expects real output to be at its long-run relationship with potential.

When forecasting interest rates over the longer-term, CBO focuses on the last five years of the long-term projection horizon—2046 to 2050 in the current forecast. That five-year period is far enough into the future to not be influenced by current economic conditions.

The main forces causing rates to be lower in the medium term are higher private domestic and foreign saving, slower growth in the labor force, slower growth in total factor productivity and a higher premium on risky assets compared with the 1995–2004 period. Those downward forces are expected to be partly offset by upward pressure from higher federal debt relative to GDP and a higher share of income paid to capital. The net result of those opposing forces is a real interest rate on 10-year Treasury notes that is 1.8 percentage points lower than the rate over the 1995–2004 period (see Figure 12, top panel). In the long term, the real rate on 10-year Treasury notes in CBO's forecast is 0.63 percentage points lower than it was during the 1995–2004 period (see Figure 12, bottom panel). The same forces putting downward pressure on real interest rates over the medium term are expected to continue to put downward pressure on real interest rates over the long term. However, CBO projects that the growth rate of the labor force will rise somewhat over the 2030–2050 period, which implies that there will be less downward pressure on real

interest rates over the long term than over the medium term. Weighing in the opposite direction, the projected increase in federal debt relative to GDP is also expected to put more upward pressure on the real interest rate over the long term than over the medium term.

CBO forecasts the nominal interest rate on 10-year Treasury notes by adding its forecast of the real interest rate to its forecast of the inflation rate as measured by CPI-U.[24] Table 5 shows the correspondence between the agency's forecasts of real and nominal interest rates.

Contributions of the Factors to Past Movements in Interest Rates

To understand the contributions of each of the factors to past movements in interest rates it is possible to use the forecast methods to analyze changes in interest rates over history. Figure 13 shows the estimated contributions of each of the factors to the decline in the real interest rate on 10-year Treasury notes between the historical benchmark period (1994 to 2005) and the past five years (2015 to 2019). Over that period, the real 10-year Treasury rate declined by roughly 3.0 percentage points (labeled "Total"). The factors in CBO's interest rate model explain roughly 1.8 percentage points of that decline. The remaining 1.3 percentage-point decline (labeled "Other" in the figure) is most likely attributable to cyclical factors. CBO estimates that the real federal funds rate was, on average, roughly 120 basis points below the estimated neutral rate over the 2015–2019 period.

Advantages and Challenges of CBO's Interest Rate Forecasting Method

CBO's method for forecasting interest rate has several advantages. First, it is based on factors that are part of the agency's macroeconomic forecast, ensuring consistency between the interest rate forecast and the forecast of the economy. Second, it attributes changes in interest rates in the past and over the forecast horizon to changes in factors identified by economic theory as having important effects on interest rates. And third, CBO's method allows the agency to track the sources of changes in its interest rate forecast from one forecast to the next. CBO regularly describes such changes in its interest rate forecasts in its major recurring reports on the budget and economic outlook.[25]

Modeling and forecasting interest rates also presents many challenges that contribute to the uncertainty about the path of interest rates, especially over the long term. Three challenges, in particular, contribute to the uncertainty of the projected path of interest rates over the next 10 to 30 years. The first challenge is that it is difficult to measure and forecast independent movements

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[24] CBO's September 2020 medium- and long-term forecasts for inflation as measured by the price index for personal consumption expenditures and CPI-U are 1.9 percent and 2.2 percent, respectively. Those estimates are consistent with CBO's forecast of an average gap between real output and potential output of −0.5 percent over the medium and long terms.

[25] See, for example, Congressional Budget Office, *The Budget and Economic Outlook: 2020 to 2030* (January 2020), p. 51, www.cbo.gov/publication/56020.

in the various factors affecting interest rates. For example, the research literature identifies demographic changes as an important factor in determining interest rates. But demographics (the aging population and increased life expectancy) affect interest rates through a number of different channels—the saving rate, the labor force participation rate, and possibly the rate at which people discount the future. Forecasting the independent influences of those channels is challenging and contributes to the uncertainty in interest rate forecasts.

A second challenge with forecasting interest rates over the next 30 years is that the ratio of debt to GDP in the United States is projected to rise to unprecedented levels (Congressional Budget Office 2020a). The peak ratio of debt to GDP over the past 100 years—120 percent—was reached just after World War II. In CBO's long-term budget projections, that ratio exceeds 200 percent. It is difficult to anticipate how the economy and financial markets might respond when the debt-to-GDP ratio reaches unprecedented levels. CBO's method for forecasting interest rates implicitly reflects the assumption that historical relationships between rising debt and interest rates will remain unchanged as debt rises to those unprecedented levels. But if the increase in debt leads to an erosion of confidence in the United States' ability to repay its debt or to an erosion of the dollar's status as an international reserve currency, real interest rates could increase more than CBO anticipates. The challenge of modeling how the economy will respond to rising debt as it reaches unprecedented levels adds to the uncertainty of CBO's interest rate forecast.

A third challenge with modeling and forecasting interest rates over the long term is separating temporary movements in interest rates from persistent or permanent movements. Over the past 150 years, real interest rates have been subject to sudden and persistent shifts (see Figure 4). A challenge with any forecasting method is to separate transitory from persistent shifts in interest rates. CBO addresses that challenge by choosing a historical benchmark period—1995 to 2004—over which the agency estimates monetary policy was neutral, on average.

The long-term decline in interest rates that occurred during the latter half of the benchmark period is interpreted as temporary rather than persistent and thus does not affect CBO's projections of interest rates. CBO expects that interest rates would be the same from 2046 to 2050 as they were on average from 1995 to 2004 if during that projection period the values of the factors that are inputs into CBO's projections equaled their averages over the 1995–2004 period. The difficulty in assessing whether omitted factors related to trends within the benchmark period would persist into the projection period contributes to the uncertainty of CBO's projections.

Summary and Conclusion

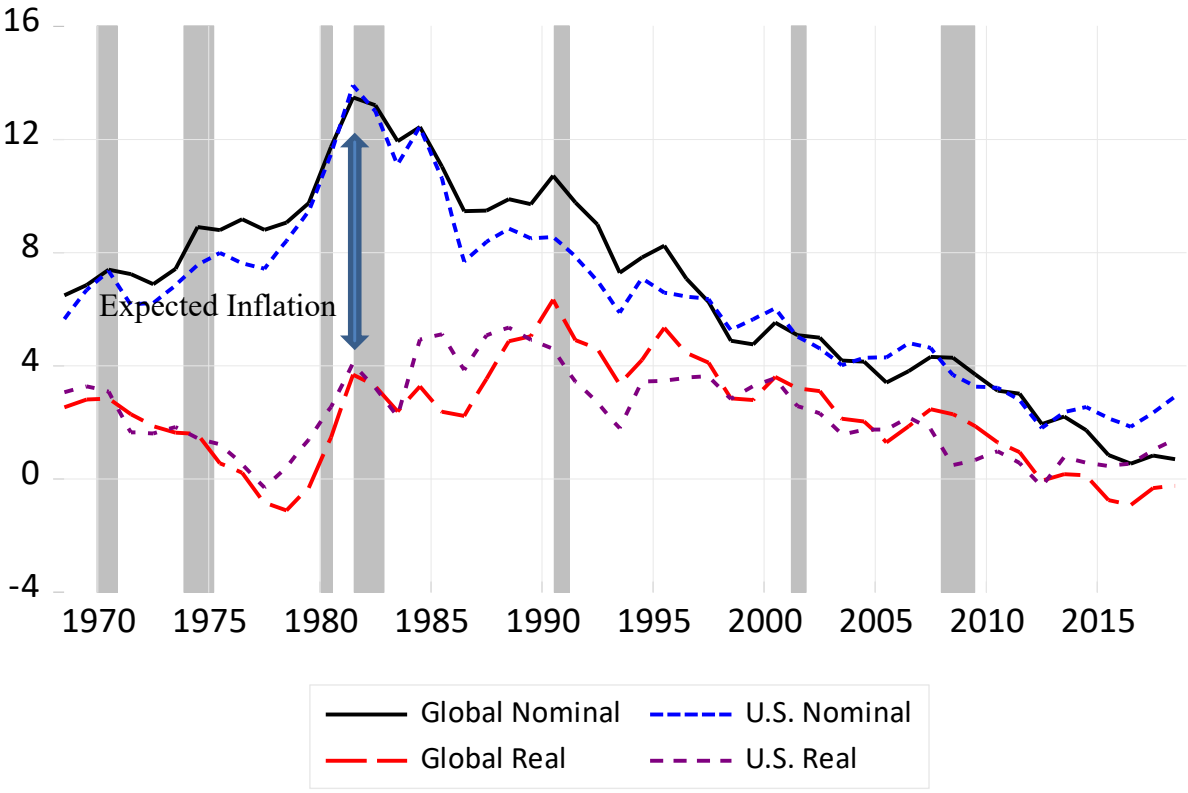
CBO's interest rate forecast is an important input into its budget and economic projections. Real interest rates have declined in the United States and globally since the early 1980s. Previous research attributes much of that decline to long-lived factors such as aging populations and slowing trend growth. CBO's forecast of the real interest rate on 10-year Treasury notes

incorporates many of the same factors identified in the research literature. CBO also projects that long-lived factors will continue to put more downward pressure on real interest rates through the medium term than they did over the 1995–2004 period. In CBO's long-term forecast, that downward pressure from long-lived factors continues but is largely, though not completely, offset by the effect of rising debt on interest rates. Interest rate forecasts over the medium and long terms are highly uncertain. That uncertainty has increased significantly since the large increase in government borrowing in the wake of the 2017 tax cuts and the 2020 coronavirus pandemic.

CBOs projections use extrapolations of behavior from the past few decades. But confidence in those projections are reduced by the expectation of unprecedented circumstances—peacetime levels of federal debt relative to GDP that have never before been reached. Projections of such levels of debt raise the possibility that rates could go much higher than CBO forecasts if investors began to have doubts about the ability or the willingness of the public to meet significantly higher debt-service obligations or of the Federal Reserve to keep inflation near its 2 percent target.

Figures

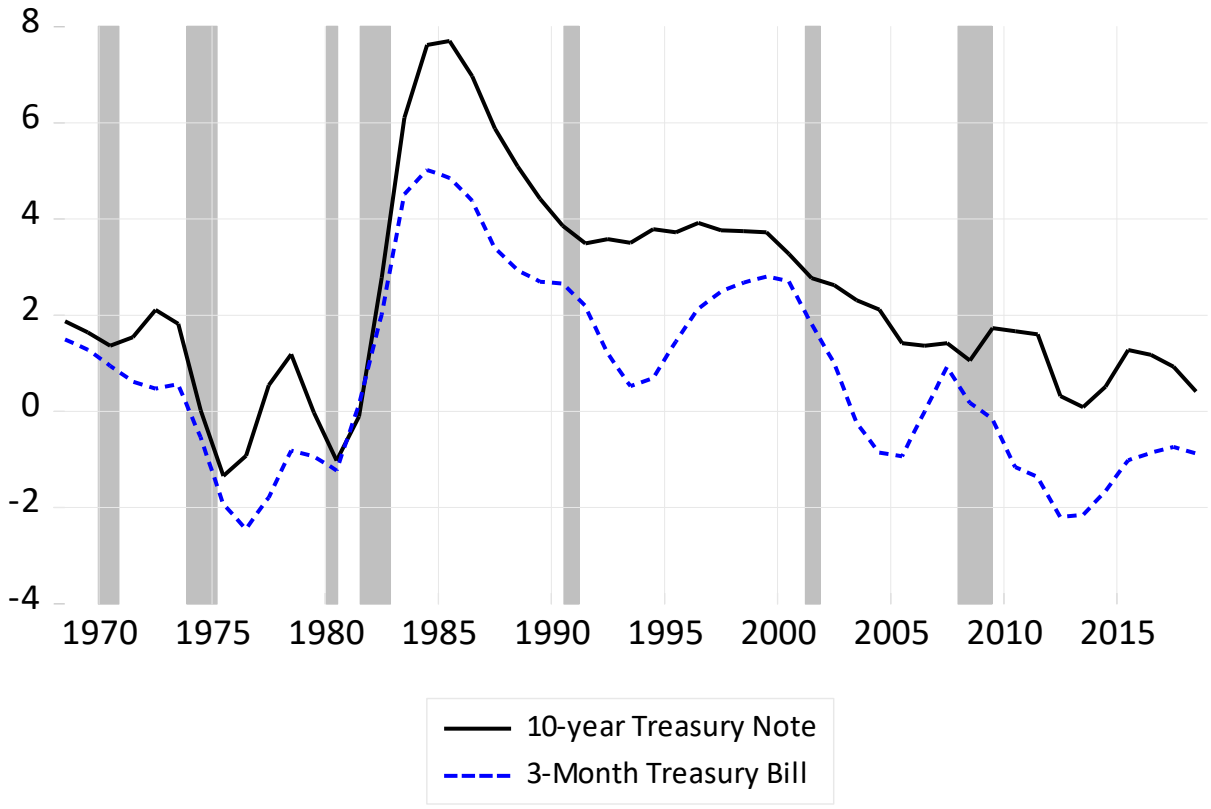
Figure 1.
U.S. and Global Long-Term Nominal and Real Interest Rates, 1968 to 2018
Percent



Data sources: Jordà et al. (2019) and author's calculations.

Real interest rates are the difference between nominal rates and the five-year unweighted moving average of inflation as measured by the consumer price index for all urban consumers. The long-term nominal interest rate is the interest rate on the 10-year Treasury note. The global interest rate is the average rate on long-term government securities from the following countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Figure 2.
Real Interest Rates on U.S. Treasury Securities, 1968 to 2018
Percent



Data sources: Bureau of Labor Statistics, Federal Reserve, and author's calculations.

Real rates are the three-year centered moving average of nominal rates minus inflation as measured by the consumer price index for all urban consumers.

Figure 3.
Average Annual Real Interest Rates for Advanced Economies, 1980 to 1985 and 2013 to 2018

Percent

Data sources: Jordà et al. (2019) and author's calculations.

Short-term real interest rates are calculated as the nominal interest rate on 3-month government securities minus the expected inflation. Long-term real rates are calculated as the nominal rate on 10-year government securities minus expected inflation. Expected inflation is measured as the unweighted moving average of the gross domestic product price index for the current and four previous years. The figure shows the average of the median real interest rate across a group of advanced economies for two sample periods—1980 to 1985 and 2013 to 2018—from the following countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Figure 4.
Global Real Interest Rates, 1876 to 2018
Percent

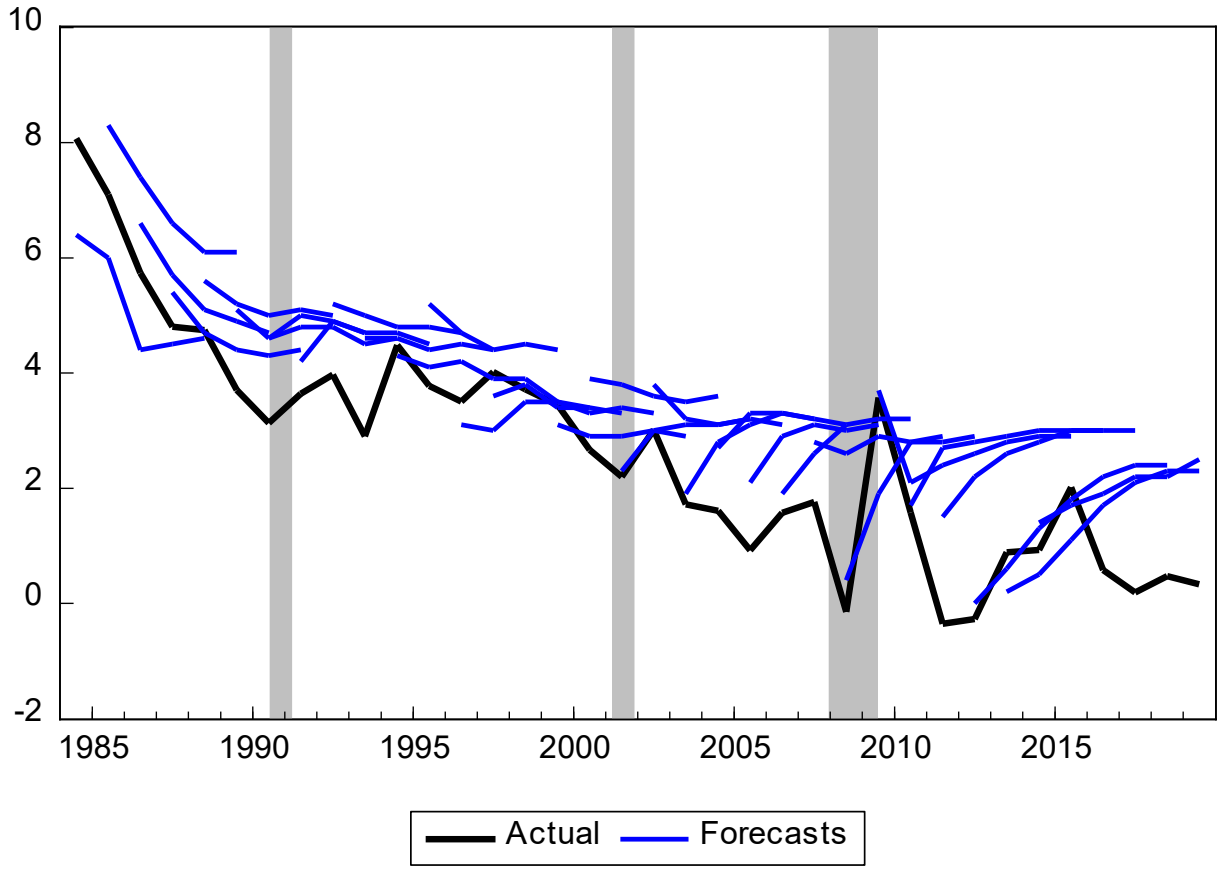
Data sources: Jordà et al. (2019) and author's calculations.

The real rate is calculated as the nominal 10-year rate on government securities minus expected inflation. Expected inflation is measured as the unweighted moving average of the gross domestic product price index for the current and four previous years). The median real rate among the following group of advanced economies is estimated for each year: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Averages are also shown on the graph for the following sub-samples: 1876 to 1916 (pre-World War I era), 1919 to 1938 (interwar period), 1946 to 1971 (Bretton Woods system), 1972 to 1983 (Great Inflation), 1984 to 2007 (Great Moderation), and 2010 to 2018 (post–global financial crisis period).

Figure 5.
Real Interest Rates on 10-Year Treasury Notes, Actual Values and *Blue Chip* Consensus Forecasts, 1985 to 2014

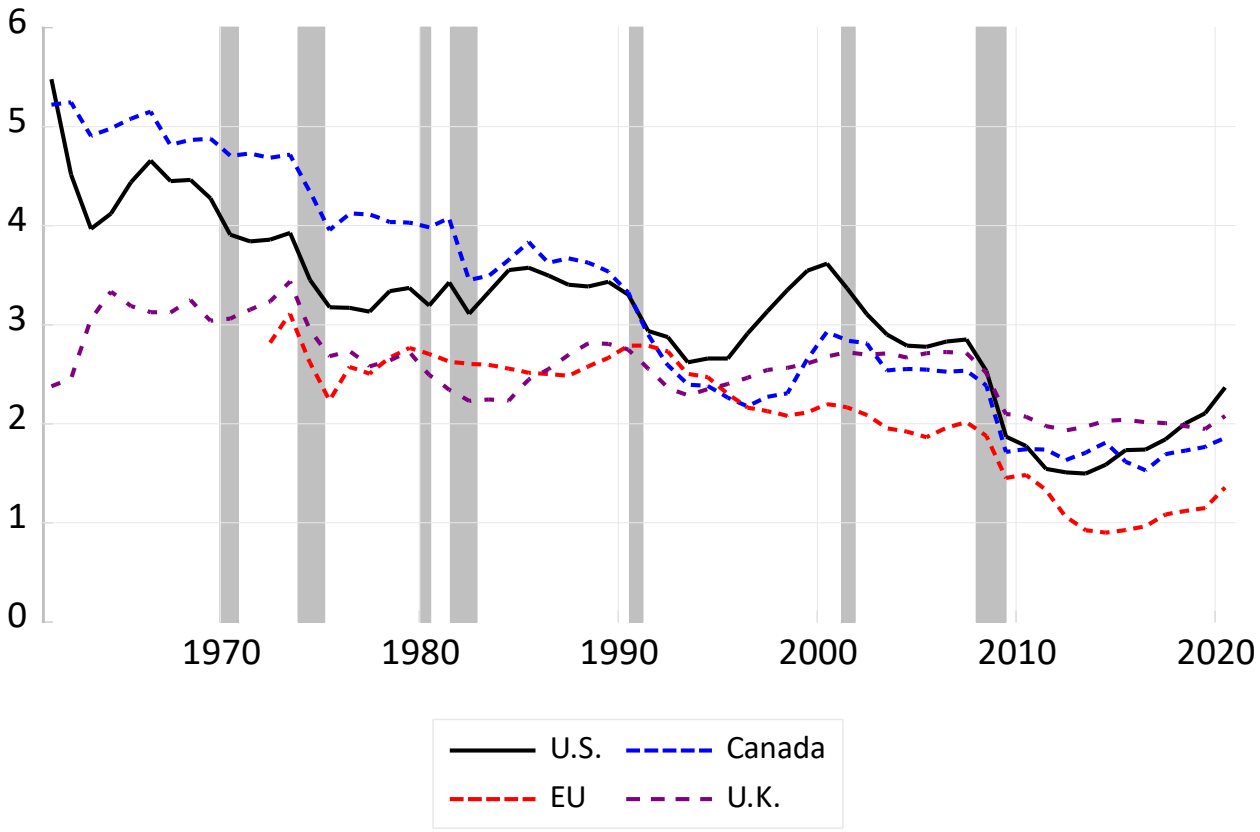
Percent



Data sources: Bureau of Labor Statistics, Federal Reserve, and Wolters Kluwer (publisher of the *Blue Chip* consensus).

The actual real interest rate is calculated as the difference between the nominal rate on 10-year Treasury notes and inflation as measured by the consumer price index for all urban consumers (CPI-U). The projected real interest rates are the differences between the projected nominal rates and the projected CPI-U inflation rates.

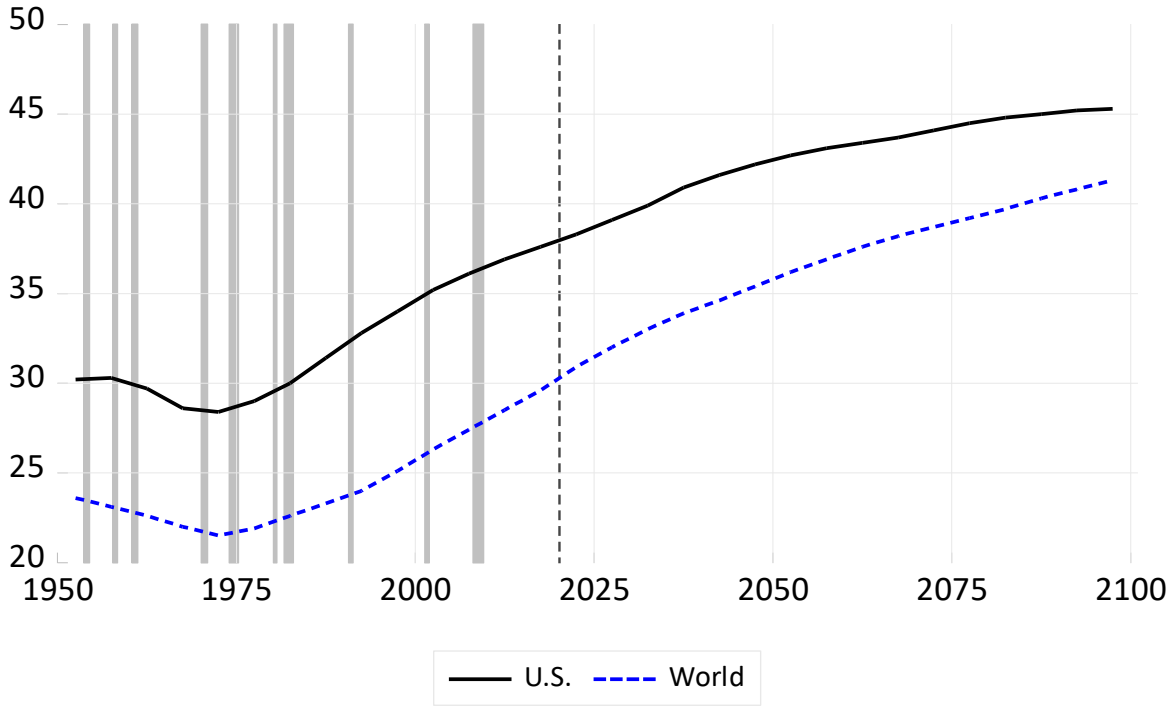
Figure 6.
Trend Real Output Growth, 1961 to 2020
Percent



Data sources: Holston et al. (2017) and Federal Reserve Bank of New York, "Measuring the Natural Rate of Interest" (accessed December 10, 2020), www.newyorkfed.org/research/policy/rstar.

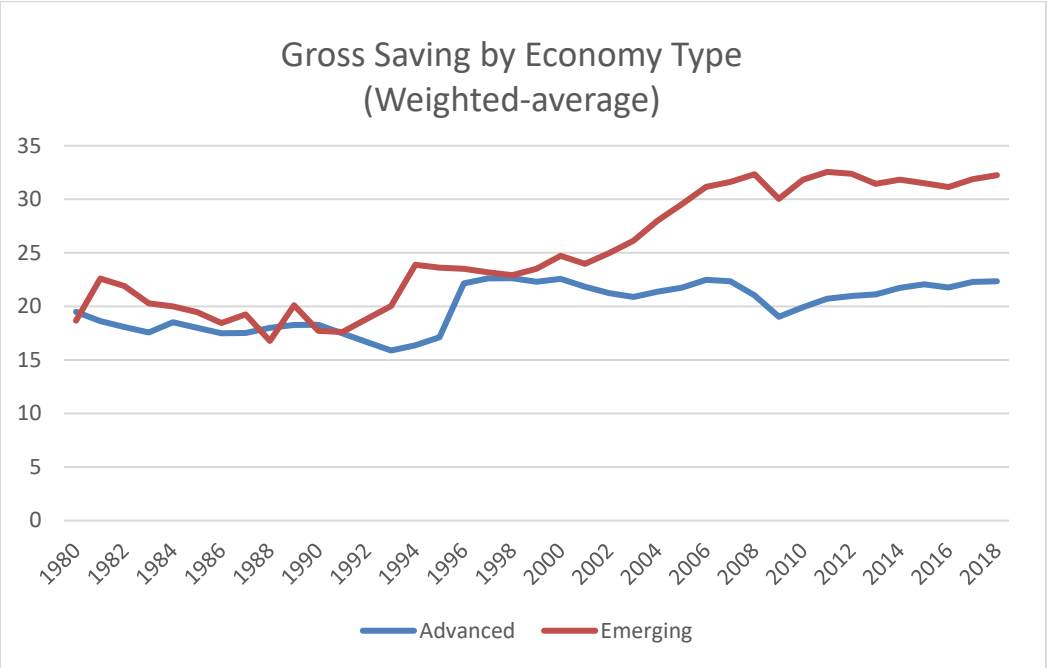
Data are annual averages.

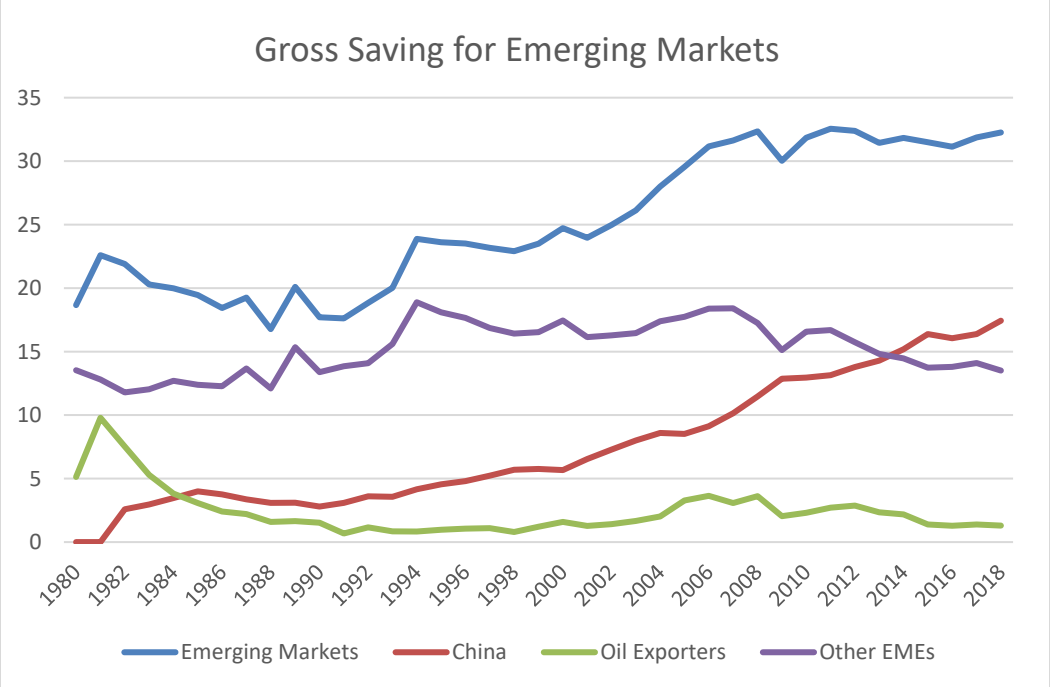
Figure 7.
Median Age of the World's and the United States' Population, 1950 to 2095



Data source: United Nations.

Figure 8.
Gross Saving Rates of Advanced and Emerging-Market Economies, 1980 to 2018
Percent

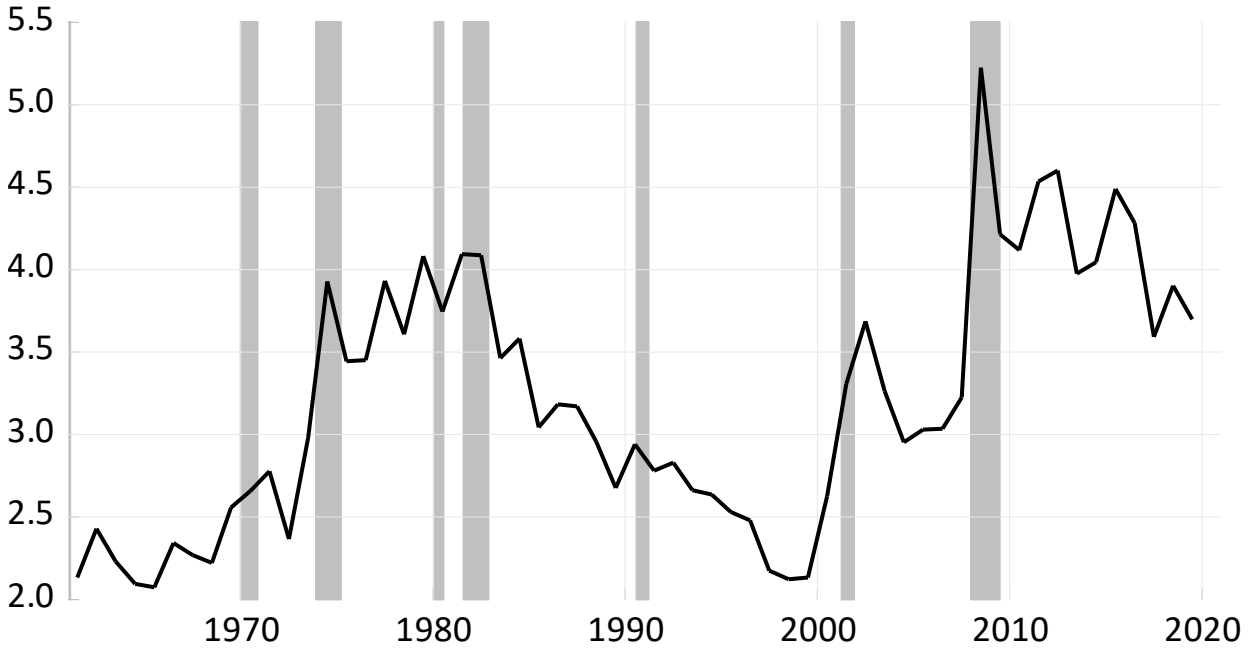




Data source: World Bank.

EMEs = emerging-market economies.

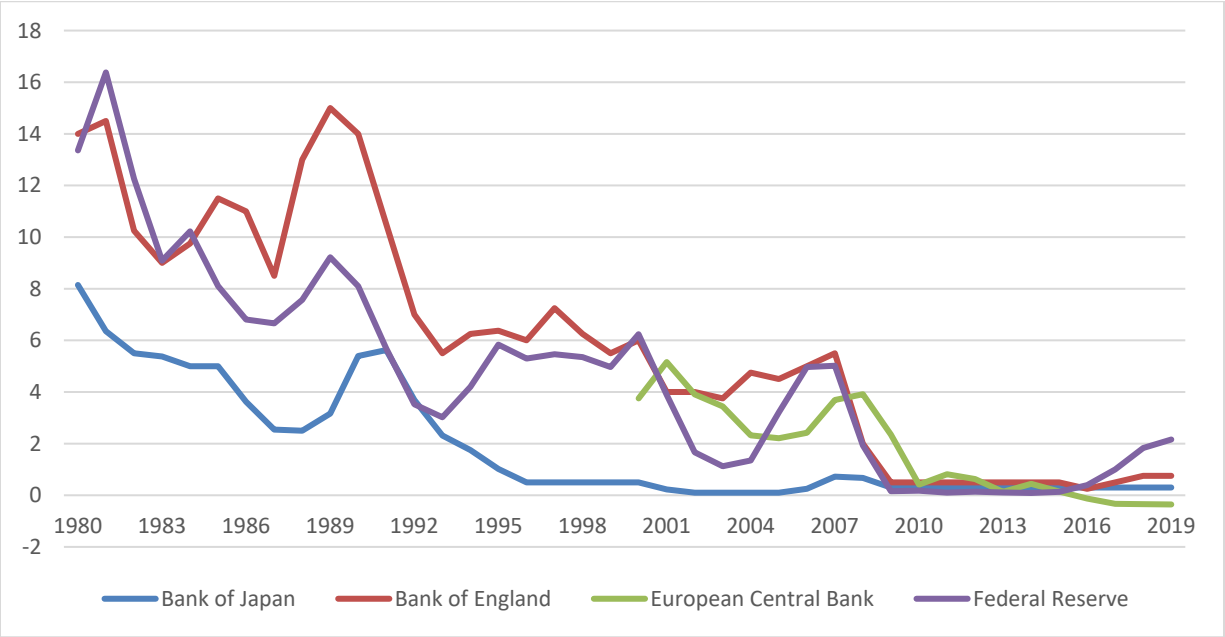
Figure 9.
Spread Between the Rate of Return on Risky and Safe Assets, 1961 to 2019
Percentage Points



Data source: Author's calculations, using data from Aswath Damodaran (http://pages.stern.nyu.edu/~adamodar/) and the Federal Reserve.

The spread between the rate of return on risky and safe assets is calculated as the weighted average of the equity risk premium and the spread between Moody's seasoned BAA-rated corporate bond yield and the yield on 10-year Treasury notes. Historical data on the equity risk premium are from Damodaran, and weights are based on the proportion of equities versus bonds held by households as reported in the Federal Reserve's *Financial Accounts of the United States*.

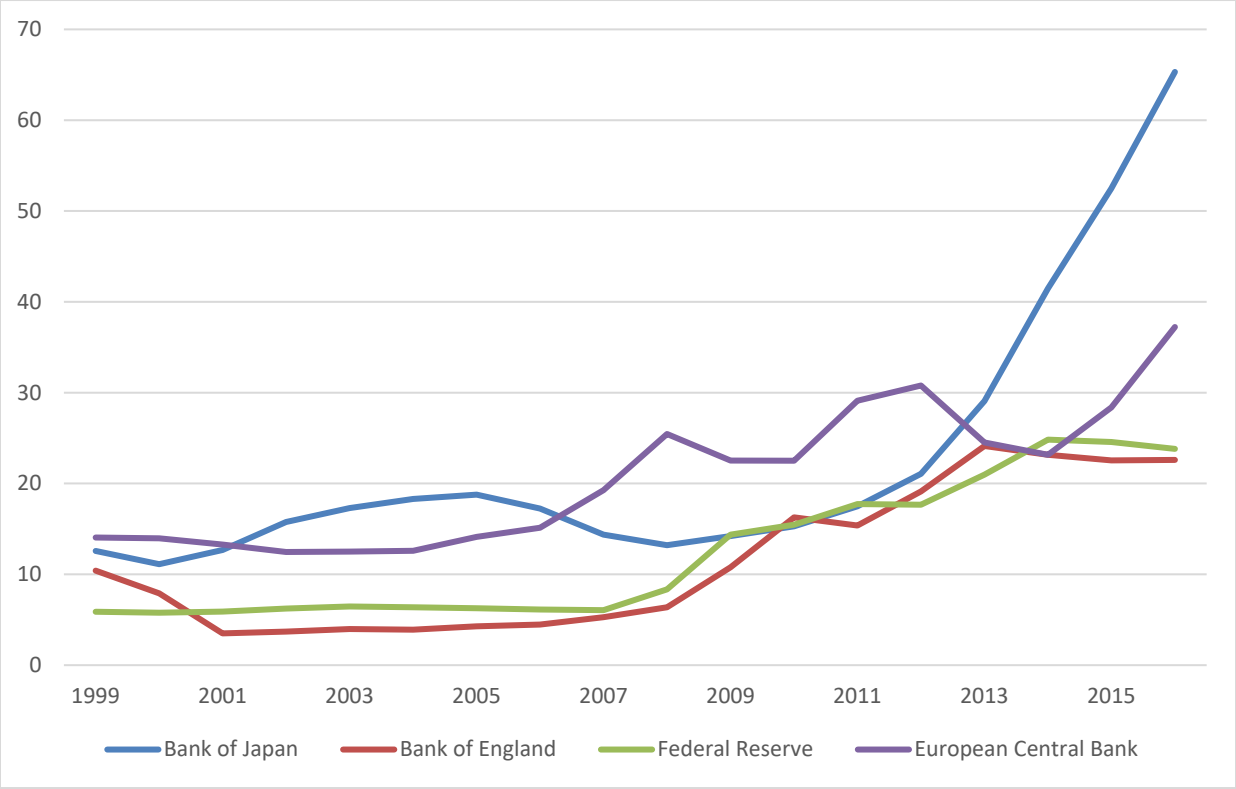
Figure 10.
Short-Term Policy Rates of Four Advanced Economies, 1980 to 2019
Percent



Data sources: Bank of England, Bank of Japan, European Central Bank, and Federal Reserve.

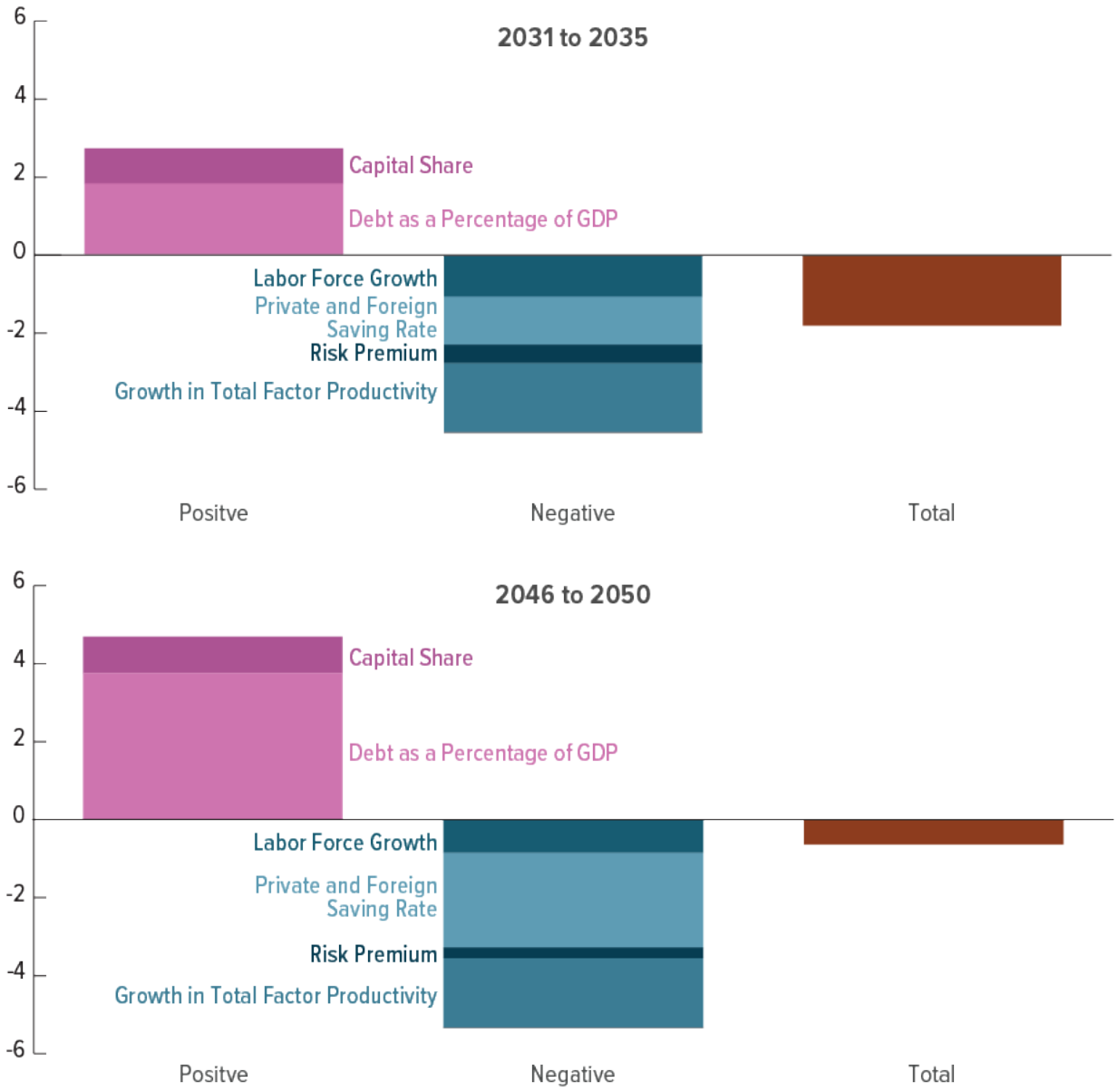
Figure 11.
Total Assets held by Central Banks Relative to GDP for Four Advanced Economies, 1999 to 2016

Percentage of Gross Domestic Product



Data sources: Bank of England, Bank of Japan, European Central Bank, and Federal Reserve.

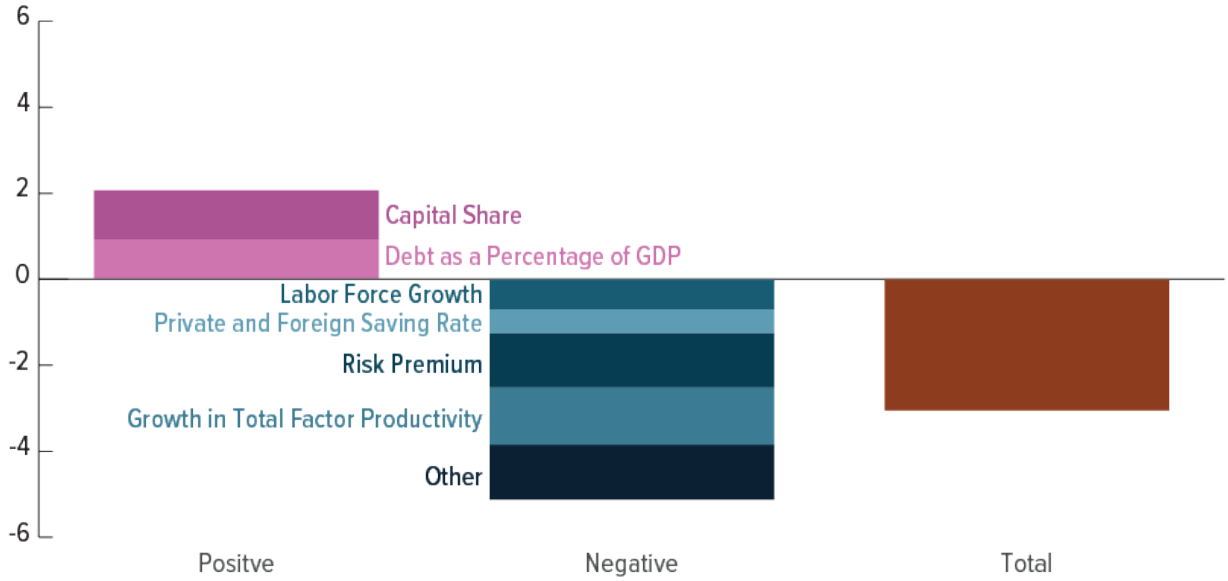
Figure 12.
Factors Affecting Projected Interest Rates Over the 2031–2035 Period and the 2046–2050 Period Measured Relative to the 1995–2004 Period
Percentage Points



Data source: Author's calculations, using data from the Congressional Budget Office.

Figure 13.
Factors Affecting Interest Rates Over the 2015–2019 Period Measured Relative to the 1995–2004 Period

Percentage Points



Data source: Author's calculations, using data from the Congressional Budget Office.

Tables

Table 1.
Literature Review: Key Estimates of the Effect of the Slowdown in the Trend Growth of Real GDP on Real Interest Rates

Study	Method	Estimate of Past Effect	Projected Effect
Laubach and Williams (2003); Holston, Laubach, and Williams (2017)	Kalman filter	-250 bps, mostly because of declining trend growth	n.a.
Clark and Kozicki (2005)	Laubach and Williams method with real-time data	Quantitative link between equilibrium rate and trend growth is weak	n.a.
Rachel and Smith (2015)	Investment and saving	-100 bps	Slight further depressing effects
Hamilton et al. (2016)	Examined correlations using annual data	Too noisy to draw conclusions	Even if trend growth slows, no reason to think real rate will fall given past correlations
Del Negro et al. (2017)	VAR, medium0scale DSGE model	-58 bps out of -150 bps decline since early 1990s	n.a.
Rachel and Summers (2019)	Laubach and Williams method applied to advanced economies as a whole; life-cycle model	Changes in trend growth explain very little of past decline in real interest rates; consistent with Hamilton et al. (2016)	Very little

bps = basis points; DSGE = dynamic stochastic general equilibrium; VAR = vector autoregression; n.a. = not applicable.

Table 2.
Literature Review: Key Estimates of the Effect of Changing Demographics on Real Interest Rates

Study	Method	Estimate of Past Effect	Projected Effect
Krueger and Ludwig (2007)	OLG	n.a.	-86 bps from 2005 through 2080
Rachel and Smith (2015, 2017)	Euler equation	-80 bps since 1980	-50 bps through 2030
Rachel and Smith, (2015, 2017)	Scatter plot dependency ratio; national saving rate	-90 bps since 1980	+45 bps through 2030
Carvalho et al. (2016)	OLG	n.a.	-50 bps through 2050
Favero et al. (2016)	Affine term structure model	n.a.	+100 bps through 2030
Gagnon et al. (2016)	OLG	Less than -2 bps since 1980	-10 bps by 2030
Aksoy et al. (2019)	Endogenous growth	n.a.	-50 bps to -70 bps through 2030
Rachel and Summers (2019)	OLG (Gertler 1999)	-180 bps since 1980	Additional downward pressure through 2070

bps = basis points; OLG = overlapping generations; n.a. = not applicable.

Table 3.
Literature Review: Key Estimates of the Effects of the Saving Glut and the Safe Asset Shortage on Real Interest Rates

Study	Method	Estimate of Past Effect	Projected Effect
Bernanke (2005); Bernanke et al. (2011)	Examination of international capital flows	n.a.	n.a.
Warnock and Warnock (2009)	OLG and error correction	-0.8 bps	n.a.
International Monetary Fund (2014)	Saving and investment	Increased global saving and decreased cost of capital	Saving and investment shifts unlikely to contribute to downward pressure on real rates; portfolio shift likely to continue to hold down rates
Gourinchas and Rey (2016)	VAR	n.a.	-2 percent to 0 percent through 2021
Rachel and Smith (2017)	Saving and investment	-25 bps since early 2000s	Effect will likely diminish
Del Negro et al. (2018)	VAR	Explains half of the decline since 1980; 60 percent of the decline since 1990	n.a.

bps = basis points; OLG = overlapping generations; VAR = vector autoregression; n.a. = not applicable.

Table 4.
Correspondence Between Factors in CBO's Interest Rate Model and Factors Cited in the Research Literature

Factors Underlying CBO's Interest Rate Projections	Factors Identified in the Research Literature
Labor force growth	Demographics
Private domestic and foreign saving	Changing distribution of income, domestic and global demographics, global growth, and global saving glut
Total factor productivity growth	Trend growth
Debt to GDP ratio	Federal borrowing and crowding out
Risk premium	Demand for safe assets, safe-asset shortage, and global saving glut
Share of income paid to capital	Share of income paid to capital

Table 5.
Parsing of CBO's Medium-Term and Long-Term Forecasts of the Interest Rate on 10-Year Treasury Notes
Percentage Points

CBO's Forecasts	2031 to 2035	2046 to 2050
Real Interest Rate on 10-Year Treasury Notes Over the Historical Benchmark Period, 1995 to 2004	2.96	2.96
Change in Real Rate	-1.81	-0.63
Real Interest Rate (Benchmark rate + change in real rate)	1.15	2.33
CPI-U Inflation Rate	2.23	2.23
Nominal Rate on 10-Year Treasury Notes (Real interest rate + CPI-U inflation rate)	3.38	4.56

Appendix A:
Measuring Expected Inflation

The real interest rate is the nominal interest rate adjusted for expected inflation. Expected inflation is not directly observed, but researchers have used various methods to approximate it. The basic stylized fact that is the focus of this paper—that the real interest rate in the United States and globally has fallen over the past four decades—is robust with respect to the various measures of expected inflation.

There are various methods for approximating expected inflation: surveys, Treasury inflation-protected securities (TIPS), and simple time-series methods (see Figure A-1).

Survey Methods. One way to approximate expected inflation is to survey forecasters, financial market participants, or households about what they think inflation will be over some period of time and then take the mean or median response as a measure of expected inflation. Figure A-1 shows two different survey measures—the Livingston Survey and the Survey of Professional Forecasters (SPF). Both measures are the median response of a group of professional forecasters. The Livingston Survey covers a longer period, but the measure of expected inflation is over the one-year ahead horizon. The SPF is a measure of long-term inflation expectations but covers a shorter period (1990 to 2019).

Treasury-Inflation-Protected Securities). Another way to approximate expected inflation is to use the information contained in TIPS. TIPS provide investors with an interest payment that is fixed in real terms. The difference between the interest rate on a standard (non-inflation-protected) Treasury note and the interest rate on TIPS can be used to approximate expected inflation. The TIPS-implied measure of expected inflation shown in Figure A-1 is based on the difference between the interest rate on the nominal 10-year Treasury note and the 10-year TIPS. The 10-year ahead TIPS measure of expected inflation is available only back to 2004.

Time-Series Methods. Some researchers use simple time-series approaches to measuring expected inflation. The idea behind such measures is that consumers and businesses might use fairly simple rules, such as a moving average of past inflation, when forming their expectations of future inflation. Figure A-1 shows the measure of expected inflation—labeled "5-Year Moving Average"—based on a moving average of the current and past 4 years of realized inflation. An advantage of this method over the other methods is that it can be used to measure expected inflation when survey and inflation-protected securities data are not available. As the figure illustrates, in those periods for which data for all the measures of expected inflation are available, the measures are all very highly correlated.

Figure A-2 shows the long-term real interest rate calculated as the difference between the nominal rate on 10-year Treasury notes and each of the various measures of expected inflation

described above. The figure shows that regardless of which measure of expected inflation is used to calculate the rate, the real interest rate has declined since the early 1980s.

Figure A-1.
Various Measures of Expected Inflation
Percent

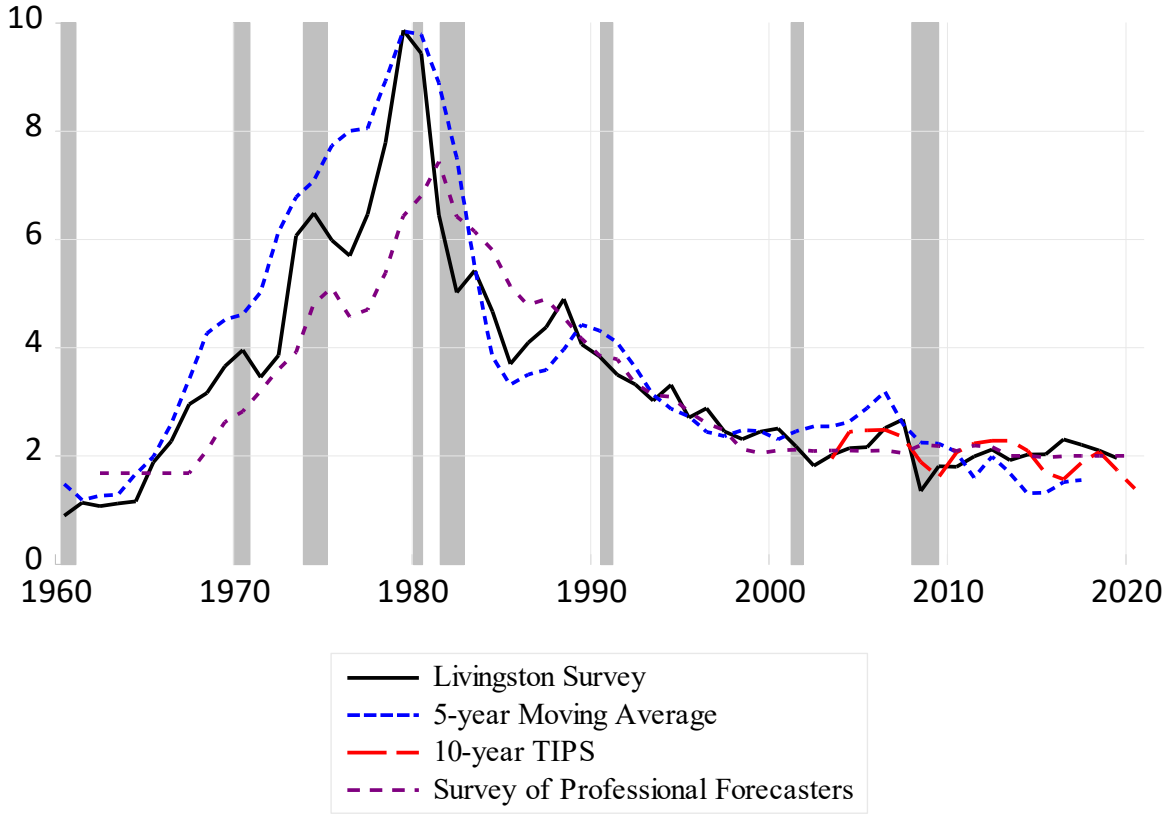
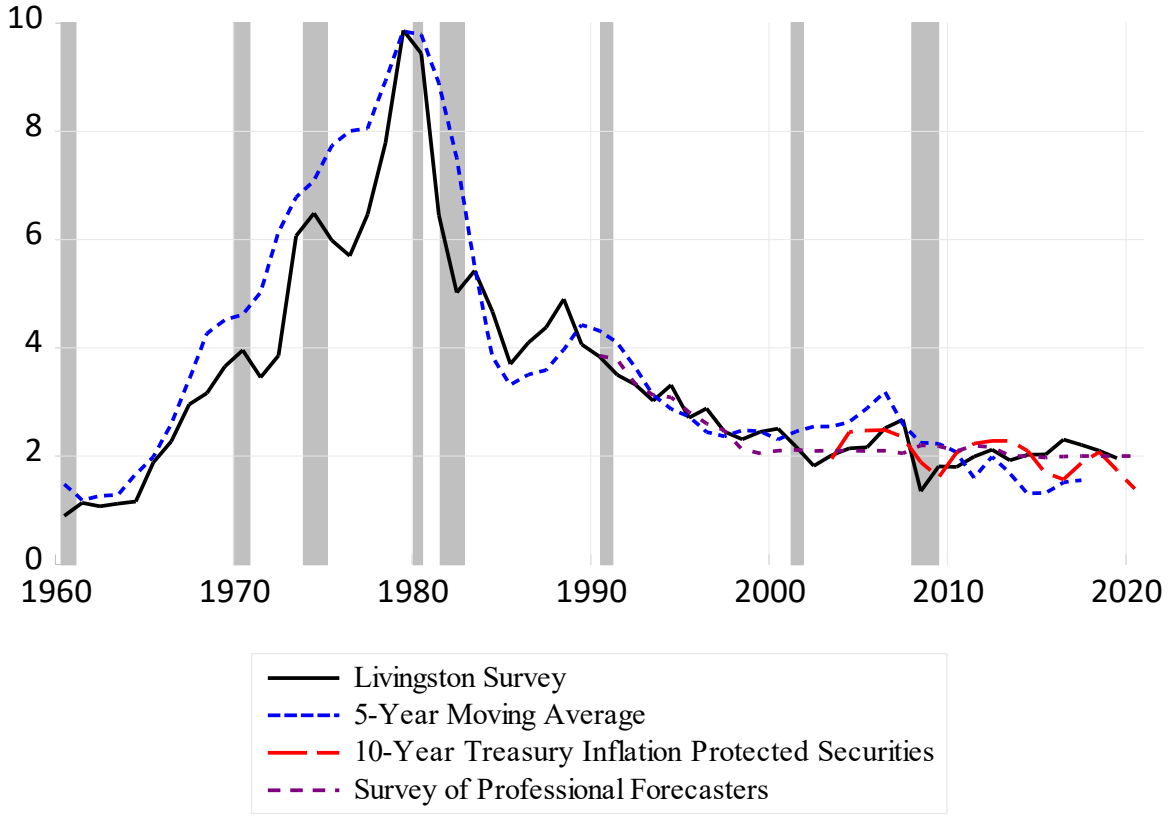


Figure A-2.
Real Interest Rates Based on the Various Measures of Expected Inflation

Percent



Appendix B:
China's Role in the Global Saving Glut

As shown in the bottom panel of Figure 8, China has contributed significantly to the increase in global saving since the early 2000s. Although China was not directly affected by the Asian financial crisis of the late 1990s, that crisis likely spurred an increase in China's saving as its government attempted to lessen its dependence on foreign lending. A larger factor in spurring the increase in China's saving, however, was its acceptance into the World Trade Organization in 2000, which gave it significantly greater access to export markets. Given China's broad macroeconomic policy goals as implemented through its fiscal, monetary, and exchange rate policies, the resulting export-led growth spurred greater saving, which China predominantly channeled into foreign assets, mostly U.S. Treasury securities (approximately $1.1 trillion during the 1995–2010 period). China's purchase of U.S. assets also had the effect of limiting the appreciation of the Chinese yuan relative to the U.S. dollar, which further fueled Chinese exports to the United States.

Most of the studies on the global saving glut estimate the aggregate effect on interest rates of increased *global* saving as opposed to the effect of any individual country's saving (see Table 3). An exception is Beltran et al. (2013), whose model implies that without China's purchase of roughly $1.1 trillion in U.S. Treasury notes and bonds between 1995 and 2010, the nominal interest rate on 5-year Treasury notes would have been 2 percentage points higher.

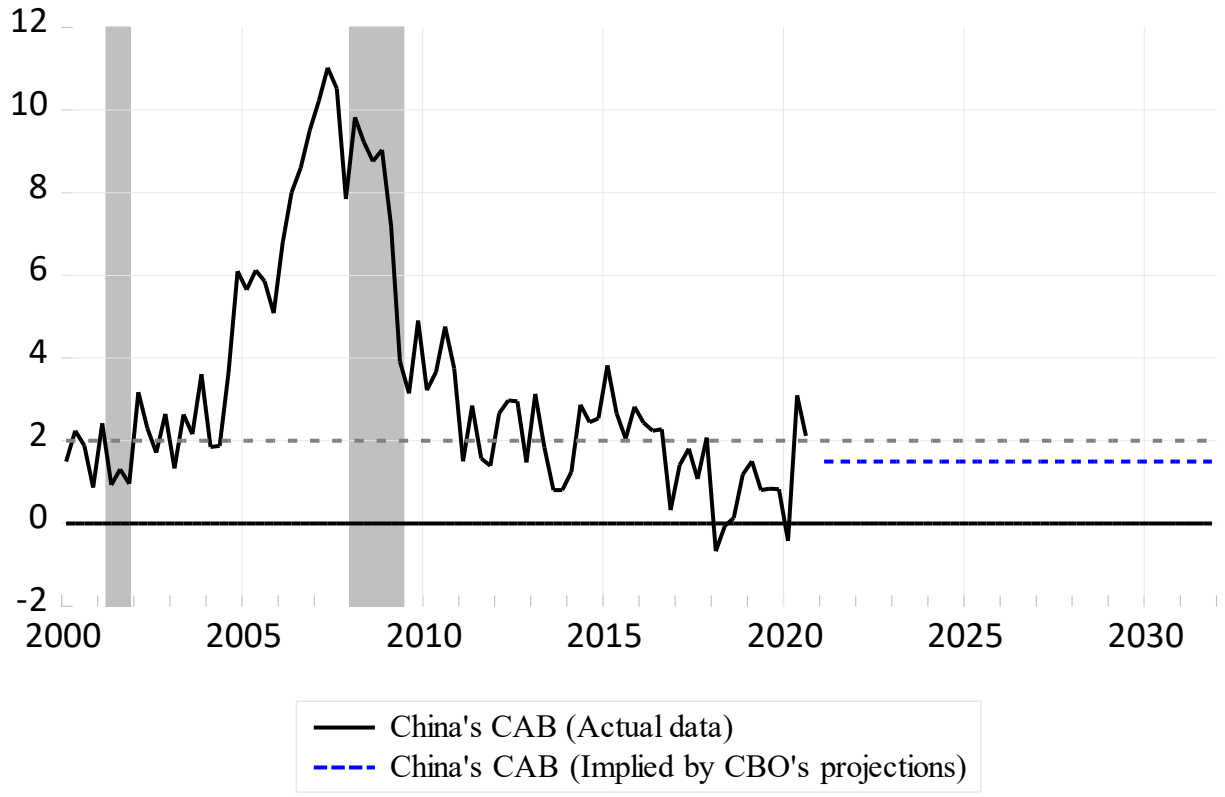
Several factors suggest that China's contribution to global saving will lessen over the coming decade. First, a large portion of the Chinese workforce is entering retirement age, those workers' retirement will likely suppress household saving. The International Monetary Fund expects the demographic transition to retirement to reduce China's household saving rate by 6 percentage points by 2030. Structural reforms—such as liberalizing markets, raising productivity, shifting supply toward consumer services, and improving social safety nets—could reduce net saving as well (Zhang et al. 2018).

It is reasonable to assume, therefore, that China's contribution to global saving will be lower over the next decade than it has been over the past two decades. In fact, the Congressional Budget Office's current baseline forecast of the rate on 10-year Treasury notes is consistent with a modest decline in China's current account balance from its average of 2 percent of gross domestic product (GDP) since 2011 to an average of 1.5 percent of GDP over the next decade.

An interesting counterfactual to consider is this: What would happen to rates on 10-year Treasury notes if China continued to run a current account balance of roughly 2 percent of GDP (see Figure B-1)? Using the estimated long-run effect from Beltran et al. (2013) and assuming that one-third of China's flow of saving to the U.S. is used to purchase private sector assets, CBO estimates that the impact on the 10-year rate in 2028 is roughly 12 basis points. That

estimate suggests that if China maintained a current account balance of 2 percent of GDP through 2028, the rate on 10-year Treasury notes would be roughly 12 basis points lower than it is in CBO's current baseline projections.

Figure B-1.
China's Current Account Balance as a Percentage of Its Economic Output
Percentage of Gross Domestic Product



Appendix C:
CBO's Method for Forecasting Interest Rates in the Medium and Long Terms

This appendix describes the details of the Congressional Budget Office's method for forecasting interest rates over the medium and long terms. The basic outline of the method is as follows: CBO identifies a historical benchmark period and a set of factors that economic theory has shown to be important in determining interest rates. The agency calculates the averages of those factors over the historical benchmark period as well as over the projection period of interest (2031 to 2035 and 2046 to 2050 in the examples presented here). CBO then uses a set of parameters derived from the Cobb-Douglas production function and research literature to estimate how the projected changes in each of the factors between the benchmark period and the projection period would affect interest rates.

The Historical Benchmark Period, 1995 to 2004

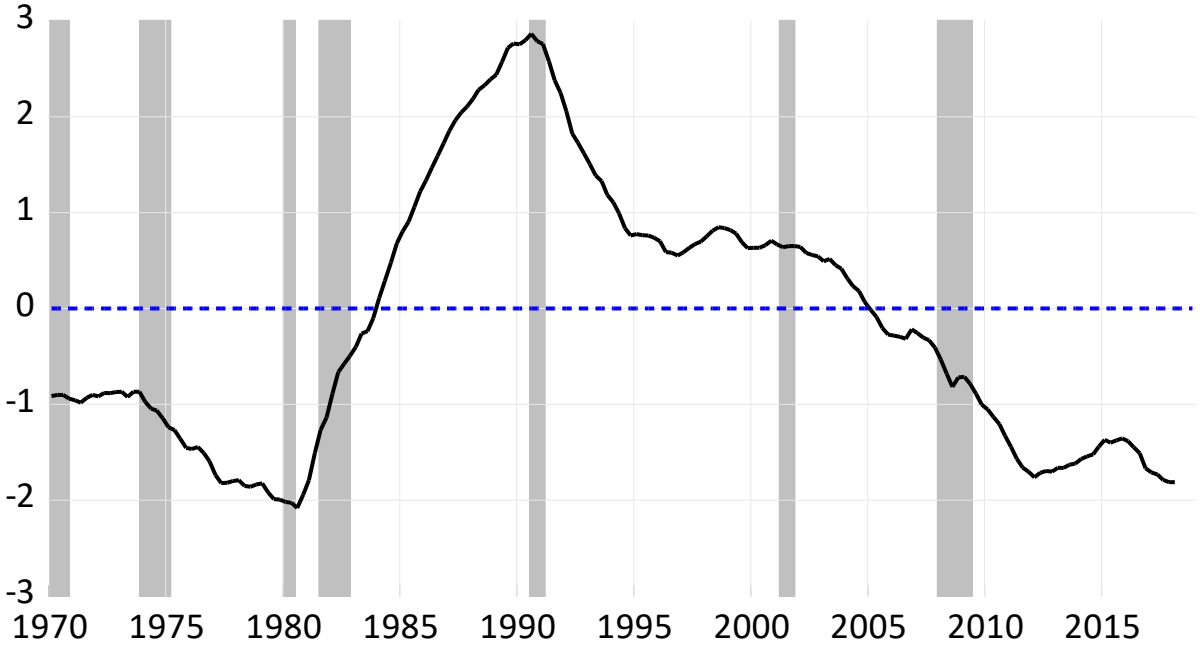
CBO projects real interest rates by comparing the projected average values of factors that affect interest rates over the medium and long term with their average values over the historical period that CBO has chosen as a benchmark—1995 to 2004. Over that 10-year period, monetary policy is estimated to have been neutral, on average, meaning it neither stimulated nor restrained economic activity. The neutral rate of interest—which is denoted r*—is defined as the short-term risk-free rate of interest that would prevail if the economy was in long-run equilibrium. CBO's estimate of r* is from Bauer and Rudebusch (2020) and is based on the average of nine separate r* series, which were estimated using a variety of methods.[26]

Figure C-1 shows the 10-year moving average of the difference between the real federal funds rate (r) and the average r*. The moving average of that difference crosses the horizontal axis at two dates—1983Q4 and 2004Q4—indicating that over the decade leading up to and including those quarters, monetary policy is estimated to have been neutral on average. CBO chose for its historical benchmark the latter of those two periods because output growth and inflation were much less volatile in that period than in the earlier one. In addition, changes in financial market regulations, as well as innovations in banking and finance, suggest that the period 1995 to 2004 is better suited for comparison with the medium-term and long-term forecasts.

[26] Those data are posted along with the article on the American Economic Association's website (www.aeaweb.org/articles?id=10.1257/aer.20171822).

Figure C-1.
10-Year Moving Average of the Real Federal Funds Rate Minus the Neutral Rate of Interest

Percent



Data source: Congressional Budget Office, using data from Bauer and Rudebusch (2020).

Forecasting Method

The first step in CBO's forecasting method is to calculate the value of the real interest rate, and of each of the factors that determine that rate, over the historical benchmark period, 1995 to 2004, and over the two forecast periods: 2031 to 2035 and 2046 to 2050. The second step is to calculate the projected change in each of the factors from the historical benchmark to the forecast period and then multiply each change by an impact parameter that reflects CBO's estimate of how changes in each of the factors are expected to affect the real 10-year interest rate. (Estimates of those impact parameters are detailed below.)

Table C-2 and Table C-3 show the values for the interest rate factors underlying the economic forecast that CBO published in September 2020; the only exception is the values for the private domestic and foreign saving rate. Those values have been adjusted to reflect the fact that a portion of the projected change in that rate is the endogenous response to rising debt relative to gross domestic product (GDP). CBO therefore includes an estimate of only the exogenous change in that saving rate, that is, changes that are not attributable to rising debt and interest rates. In CBO's current projections, half of the increase in private domestic and foreign saving is

assumed to be attributable to exogenous shifts, and the remaining half is assumed to be in response to rising debt relative to GDP.

The average real rate on 10-year Treasury notes in the benchmark period was 2.96 percent. From Table C-2, the projected change in that rate between the 1995–2004 period and the 2031–2035 period is −1.81 percentage points, resulting in a real rate in the medium term of 1.2 percent. Adding CBO's forecast rate of inflation as measured by the consumer price index for all urban consumers (CPI-U) to that projected real rate results in a projected nominal rate on 10-year Treasury notes of 3.4 percent over the 2031–35 period.

The projected change the real interest rate over the longer term is much lower (see Table C-3). That is primarily because of the large increase in the ratio of debt to GDP after 2030. Thus, the projected real interest rate over the 2046–2050 period is 2.3 percent, or .6 percentage points below the benchmark average. Adding CBO's forecast CPI-U inflation rate to that projected real rate results in a projected nominal rate on 10-year Treasury notes of 4.6 percent over the 2046–2050 period.

Data Sources for Interest Rate Factors

The data definitions and sources for the historical values of the interest rate factors used in CBO's interest rate forecasting model are shown in Table C-1.

Table C-1.
Definitions and Data Sources for Interest Rate Factors

Interest Rate Factor	Detailed Description and Source
Labor Force Growth	Growth rate of potential hours worked in the nonfarm business sector (BLS; CBO's estimate)
Private Domestic and Foreign Saving Rates	Private domestic saving is saving by households and firms (BEA); foreign saving is the negative of net foreign investment (BEA); both are measured relative to nominal GDP (BEA)
Total Factor Productivity Growth	Total factor productivity in the nonfarm business sector (CBO estimate; see www.cbo.gov/publication/53558)
Debt-to-GDP Ratio	Stock of federal debt (CBO's estimate) relative to GDP (BEA)
Risk Premium	Weighted average of the equity risk premium and spread between Moody's seasoned BAA-rated corporate bond yield and the yield on 10-year Treasury notes; historical data on the equity risk premium are from Aswath Damodaran (http://pages.stern.nyu.edu/~adamodar/); weights are based on the proportion of equities versus bonds held by households (Federal Reserve, *Financial Accounts of the United States*)
Capital Share of Income	The sum of the following (all measured as a share of gross domestic income): corporate profits with inventory valuation and capital consumption adjustments, rental income of all persons with capital consumption adjustment, proprietors' income, business transfer payments, and net interest and miscellaneous payments on assets (all from BEA)

BEA = Bureau of Economic Analysis; BLS = Bureau of Labor Statistics.

Table C-2.
Projected Changes in Interest Rate Factors From the Benchmark Period to the Medium-Term Forecast Period in CBO's September 2020 Baseline Projections

Variable	Average Value Over Historical Benchmark Period, 1995 to 2004 (Percent)	Projected Average Value in the Medium Term, 2031 to 2035 (Percent)	Change in Value (Percentage points)	Impact Parameter	Factor's Impact on Interest Rates (Percentage points)
Labor Force Growth	0.95	0.28	-0.67	**1.56**	-1.05
Private Domestic and Foreign Saving Rate	21.9	24	2.1	**-0.59**	-1.24
Total Factor Productivity Growth	1.86	1.11	-0.75	**2.37**	-1.78
Debt-to-GDP Ratio	38.18	111.8	73.62	**0.025**	1.84
Risk Premium	2.73	3.2	0.47	**-1**	-0.47
Capital Share of Income	33.2	35.26	2.06	**0.43**	0.89
Total					**-1.81**

Table C-3.
Projected Changes in Interest Rate Factors From Benchmark Period to Long-Term Forecast Period in CBO's September 2020 Baseline Projections

Variable	Average Value Over Historical Benchmark Period, 1995 to 2004 (Percent)	Projected Average Value in the Long Term, 2046 to 2050 (Percent)	Change in Value (Percentage points)	Impact Parameter	Factor's Impact on Interest Rates (Percentage points)
Labor Force Growth	0.95	0.41	-0.54	**1.56**	-0.84
Private Domestic and Foreign Saving Rate	21.9	26	4.1	**-0.59**	-2.42
Total Factor Productivity Growth	1.86	1.11	-0.75	**2.37**	-1.78
Debt-to-GDP Ratio	38.18	187.7	149.52	**0.025**	3.74
Risk Premium	2.73	3	0.27	**-1**	-0.27
Capital Share of Income	33.2	35.38	2.18	**0.43**	0.94
Total					**-0.63**

Where Do the Impact Parameters Come From?

The impact parameters in CBO's interest rate projection model come from a variety of sources. CBO used the expression for the real rate of return on private capital ($r^{private\ capital}$) derived from the Cobb-Douglas production function (equation C1) to derive estimates of the impact parameters for the growth rate of the labor force (n), the private domestic and foreign saving rate (s), the share of income paid to capital (α), and total factor productivity growth (g).

$$r^{private\ capital} = \frac{\alpha}{s}\left(\frac{g}{1-\alpha} + n + \delta\right) - \delta \qquad \text{(C1)}$$

The impact parameters are derived by differentiating this expression with respect to each of the interest rate factors. The rate of depreciation (δ) is assumed to be constant for these calculations.

Labor Force Growth. Calculated by differentiating the real rate of return on private capital with respect to the growth rate of the labor force:

$$\frac{\partial r^{private\ capital}}{\partial n} = \frac{\alpha}{s} \qquad \text{(C2)}$$

Private Domestic and Foreign Saving Rate. Calculated by differentiating the real rate of return on private capital with respect to the private domestic and foreign saving rate:

$$\frac{\partial r^{private\ capital}}{\partial s} = -\frac{\alpha}{s^2}\left(\frac{g}{1-\alpha} + n + \delta\right) \qquad \text{(C3)}$$

Total Factor Productivity Growth. Calculated by differentiating the real rate of return on private capital with respect to the growth rate of total factor productivity:

$$\frac{\partial r^{private\ capital}}{\partial g} = \frac{\alpha}{s}\left(\frac{1}{1-\alpha}\right) \qquad \text{(C4)}$$

Capital Share of Income. Calculated by differentiating the real rate of return on private capital with respect to the capital share of income:

$$\frac{\partial r^{private\ capital}}{\partial \alpha} = \frac{1}{s}\left[\frac{g}{(1-\alpha)^2} + n + \delta\right] \qquad \text{(C5)}$$

Table C-4 shows CBO's estimates of the production function inputs and the resulting impact parameters based on equations C2 to C5. Estimated values for the production function inputs n, g, and α are based on the averages of those variables in all years in the two samples under consideration. For example, the average growth of potential labor hours in the nonfarm business sector during the historic benchmark period (1995 to 2004) and the medium term (2031 to 2035) is calculated as (1 + .28)/2 = 0.62 percent. As noted above, the parameter δ is assumed to be

fixed at 5.5 percent, which is the average value in all years in the historic benchmark period and the medium- and long-term forecast periods. The saving rate s is set equal to the average investment–to-saving ratio over the historical benchmark period to reduce the bias attributable to endogenous responses of saving to changes in the debt-to-GDP ratio and interest rates.

Table C-4.
Production Function Inputs and Impact Parameters

Interest Rate Factor	Production Function Input	Medium-Term Forecast		Long-Term Forecast	
		Estimated Production-Function Input	Impact Parameter	Estimated Production-Function Input	Impact Parameter
Labor Force Growth	n	0.62	1.56	0.68	1.56
Private Domestic and Foreign Saving Rate	s	22	-0.59	22	-0.6
Total Factor Productivity Growth	g	1.49	2.37	1.49	2.37
Capital Share of Income	α	34.2	0.43	34.3	0.44

Debt-to-GDP Ratio. The impact parameter of .025 on the debt to GDP ratio is based on the empirical work by Gamber and Seliski (2019), who found that for each 1 percentage-point increase in CBO's projected debt-to-GDP ratio, real rates on 10-year Treasury-notes increased by 2 to 3 basis points. Gamber and Seliski's estimates are similar to estimates those of Gale and Orszag (2004), Engen and Hubbard (2004), and Laubach (2009).

Risk Premium. After using equation C1 to produce a forecast of the change in the real rate of return on private capital, CBO converts that change to a change in risk-free Treasury securities by subtracting the projected risk premium. The impact parameter of 1 indicates that, all else constant, an increase in the spread between the return on risky capital and risk-free Treasury securities has a one-to-one effect on the return on risk-free Treasury securities.

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