

The Policy Perils of Low Interest Rates

Well before central banks slashed rates to fight the Great Recession, long-term market rates began slipping. With no reversal in sight, will policymakers lose their main recession-fighting tool?

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BY LUKASZ A. DROZD

The primary tool that central banks have to fight recessions is to cut interest rates so as to encourage enough borrowing and spending to return the economy to full employment. But as we experienced during the Great Recession, there is a natural limit to how low interest rates can go: It is known as the *zero lower bound*—or the *effective lower bound*. When the interest that banks pay on deposits reaches zero, lowering rates further means depositors earn a negative return—in other words, they must actually pay to deposit their money—making it more attractive to stuff cash in a mattress. At that point, monetary policymakers are left without their most tested method of stimulating demand.¹

The Great Recession marked the first time in the postwar era that the zero lower bound became a relevant constraint for monetary policymaking worldwide.² Unable to lower rates any further, the Federal Reserve and central banks in Europe and other developed countries struggled to deliver the additional monetary policy stimulus needed to counteract the deepest economic contraction since the 1930s, finally resorting, as I will discuss, to less proven, unconventional tools such as *forward guidance* and *quantitative easing*. Nine years on, economists are still debating the extent to which the lack of the primary monetary policy instrument contributed to the severity of the recession.

Why Can't Central Banks Simply Set Rates Below Zero?

Contrary to the common perception, central banks do not set interest rates across the economy. Most rates are determined by supply and demand forces in financial markets, and central banks influence these forces to move rates to the desired level.

The Federal Reserve, for example, targets the interest rate at which banks lend to each other overnight, the so-called federal funds rate. This market rate is determined by the supply of and demand for funds in the interbank market, where banks borrow and lend overnight to ensure they are never holding too little or too much in required reserves based on daily fluctuations in their assets and liabilities. The Fed targets this particular market and this particular rate because it can most directly influence it and at the same time tightly control the availability of funds in the banking sector, which is under its supervision. Since the current and future cost of funds is the key determinant of how much banks charge their customers for loans, when the fed funds rate moves or is expected to move, interest rates across the economy move as well, and so does aggregate demand.³

When the zero lower bound is not an issue, the Fed can lower the fed funds rate by, in essence, printing money to purchase government bonds from primary broker-

dealers, which are bank subsidiaries or deal with banks and carry out the transaction through their accounts with the Fed. The Fed credits the broker-dealer's account with an electronic deposit equal to the payment for the bonds. The recipient banks may ultimately lend these funds to firms and households, but since it takes time to find such long-term customers, banks typically look to earn interest in the meantime by lending the funds in the fed funds market. Because this activity increases the supply of funds in the interbank market, their price—the fed funds rate—declines.

While the Fed can increase the supply of funds at will, it cannot induce the fed funds rate to fall much below zero. In principle, the Fed could “tax” banks’ cash, prompting them to lend their excess to other banks, even at negative interest. But banks would ultimately have to pass on the cost of such a tax by charging their customers for making deposits—in other words, imposing a negative rate on deposits. Since depositors can just as well stuff money in their mattresses, there is a limit to how much banks can charge for deposits. Hence, there is a limit to how low rates can go before they hurt bank profits and credit conditions across the economy, which would work against the Fed’s goal during a recession of stimulating aggregate demand by driving down rates.

Today, the Great Recession is long over. Economic output and employment have recovered, and the Federal Reserve has hiked its policy target rate several times, causing market rates across the economy to begin rising again, to the relief of savers. Yet, to policymakers, the problem of the zero lower bound remains a major concern. What alarms them is that beyond cyclical, policy-induced fluctuations, market interest rates have been trending downward for years, starting long before the last recession, and bringing the zero lower bound ever closer. If this trend has continued through the crisis and current expansion, and many economists believe it has, then policymakers could face the next major recession without a monetary remedy, as occurred with dire results in the Great Depression. Even a mild recession could compel policymakers to turn to the kind of extraordinary interventions employed during the latest crisis, only this time without the extra margin of first responding by cutting rates.

As I will discuss, the nature of the forces behind the decline in interest rates gives little hope for a reversal in the foreseeable future. As I will also discuss, this outlook is prompting study and debate over whether a low-rate environment calls for a fundamentally different approach to monetary policy and to how central banks will fight recessions in the future.

The Global Decline in Interest Rates

Today's exceptionally low interest rates are often blamed on the Great Recession and the economic malaise that lingered in its aftermath. But the picture that emerges from an analysis of the average interest rate across countries shows that the decline very much predates the Great Recession. Accordingly, the low rates prevailing currently may have less to do with the crisis and more to do with the secular global decline in long-term interest rates.

To pinpoint the beginning of this decline, economists follow the evolution of the average inflation-adjusted yield on long-term bonds issued by governments of major world economies that are fiscally sound and open to international capital flows. Averaging long-term government bonds helps filter out forces that are expected to reverse course such as business cycle fluctuations or monetary policy interventions to fight recessions.⁴ Tracking the average world interest rate also helps identify the trend because it focuses on movements driven by forces that are common across countries and hence unlikely to be canceled out by international capital flows, which tend to equalize returns across countries in the long run. In addition, tracking the average world interest rate removes the effect of expected (real) currency exchange rate movements, which can cause interest rates to diverge from the actual return that global investors earn after taking into account differences in the rate of return on currencies implied by exchange rates.⁵ The estimated average world interest rate suggests that long-term rates have been declining since at least the 1990s.⁶ The real interest rate paid on 30-year U.S. Treasury Inflation Protected Securities has followed a remarkably similar downward path, highlighting the relevance of global trends for the evolution of U.S. interest rates (Figure 1).

The global secular decline in long-term rates—alongside aggressive interest rate cuts during the Great Recession—is a key reason why economists believe that even though central banks

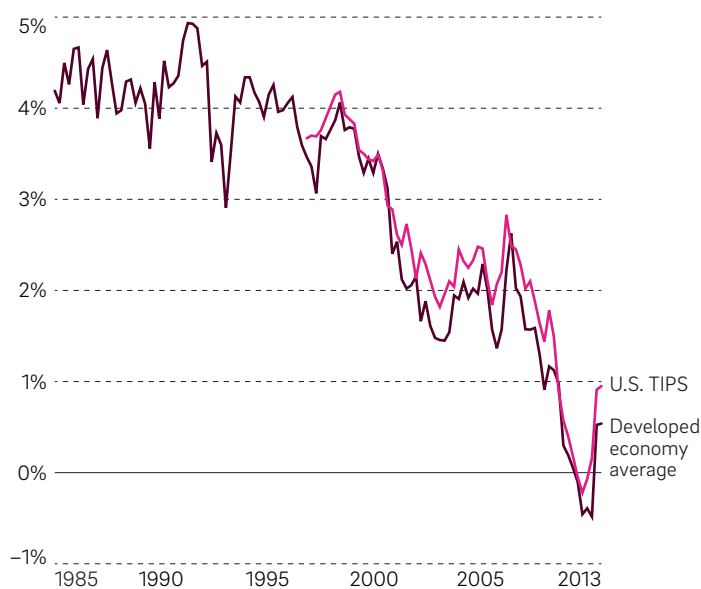
have begun raising their policy rate targets, they might still be operating close to the zero lower bound. What reinforces these concerns is the fact that, as the economic recovery has gained momentum around the globe, both inflation and interest rates remain exceptionally low. While central banks can act to move interest rates across the economy to stimulate spending, if they hope to ensure low and stable inflation they must over the long run respect the supply and demand forces generated from within the economy that drive interest rates. Keeping rates below the natural level implied by these forces, known as the *neutral* interest rate—also called the *natural* rate or *r-star*—eventually leads the economy to a state of full employment.⁷ But at that point, further stimulation no longer prompts firms to increase employment; rather, it makes them raise prices to meet the excess aggregate demand implied by below-neutral rates, ultimately leading inflation to rise out of control.⁸

While today's lower rates may reflect the still-accommodative stance of monetary policy, economists attribute much of the secular decline in policy rates since the 1990s to the global decline in the neutral rate (Figure 2). What leads them to this conclusion is the long period in question—a period that includes both economic expansions and recessions—and the remarkably stable rate of inflation during this time.

This assessment is confirmed by econometric studies that aim to estimate the neutral rate using empirical data. The best known among them, by Thomas Laubach and John C. Williams, finds the neutral rate to be below zero.

FIGURE 1
Interest Rates Have Been Falling Since the 1990s

Average inflation-adjusted interest rate in developed economies, 1985–2013, and 30-year U.S. Treasury Inflation Protected Securities yield, 1998–2013.



Sources: King and Low (2013) and Treasury Department.

Note: Inflation-adjusted interest rate as estimated by Mervyn King and David Low using inflation-protected long-term government bonds issued by G-7 countries, minus Italy, 1985–2013. Inflation-adjusted yield earned on 30-year U.S. Treasury Inflation Protected Securities held to maturity.

While finding slightly higher estimates, two other studies confirm these findings using a different methodology.⁹ A third, more recent, analysis¹⁰ yields a markedly higher estimate by allowing for investor preferences to shift toward safe U.S. bonds, but it also suggests the neutral rate has fallen to an alarmingly low level, below 100 basis points.¹¹

Forces at Play for the Foreseeable Future

Adding to concerns that today's low rates may complicate the conduct of monetary policy in the future are model-based studies that see demographic trends—and to a lesser extent, slower productivity growth—in developed countries as the main culprits. Since these changes are persistent, the models predict that rates will remain depressed for the foreseeable future. How do the forces identified by the models shape interest rates, and how will they evolve in the future?

Three model-based studies that focus solely on demographics forecast that

interest rates will continue to decline until at least 2050 given projected global demographic trends, even absent any productivity slowdown.¹² A recent detailed study for the U.S. economy confirms the forecast for demographics, while finding that the productivity slowdown will also play a role in depressing interest rates.¹³

All of these studies seek to understand the principal driving forces behind the demand for and supply of funds in financial markets, where interest rates are determined. The models derive the supply of funds from household net saving for retirement, while the demand comes from firms that seek funds to invest in capital to produce goods and services, with interest rates balancing demand with supply by falling whenever demand rises or supply falls.

Demographics

What makes demographic trends play a crucial role in the models is that saving and working vary predictably over a person's lifetime. The average lifecycle

profile of a household exhibits a remarkably similar pattern across countries (Figure 3). That is, minors have little income, as they supply little labor, yet they consume out of the income of their parents, on net subtracting from the savings of the household sector as a whole. Similarly, retirees live off their accumulated savings, supply little labor, and also subtract from the savings of the household sector. The bulk of household savings and labor supply come from working-age individuals, so their share of the population is a crucial determinant of how much households overall save.

Demographic forces matter not only for households' saving behavior but also for firms' demand for funds to invest in capital, because when demographics change, so does the supply of labor. Models assume that labor and capital are complementary inputs in the production of goods and services: As less labor is employed in production, capital inputs become less productive, meaning that the size of the labor force affects the amount of capital investment and hence

FIGURE 2

Estimated Neutral Rate Has Likewise Plummeted

The Laubach and Williams estimate of the neutral U.S. interest rate, 1985–2017.

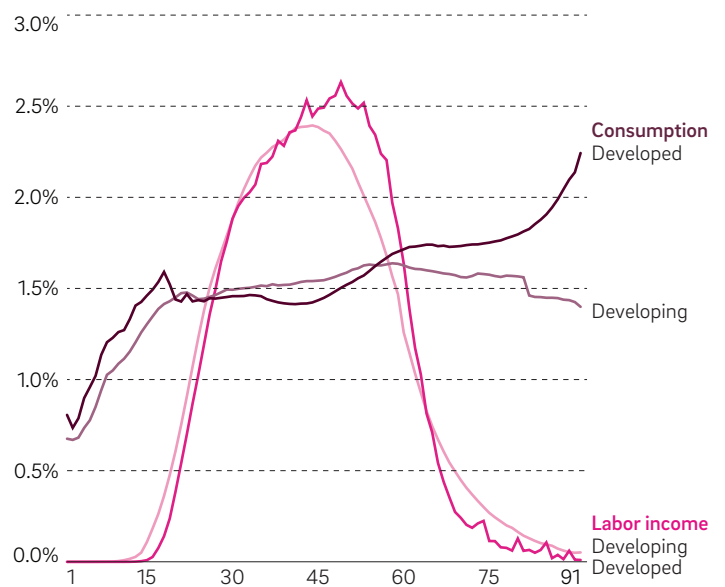


Source: Laubach and Williams (2003), online data set as of July 28, 2017, www.frbsf.org/economic-research/files/Laubach_Williams_updated_estimates.xlsx.

FIGURE 3

Propensity to Earn and Save Varies Predictably by Age

Average consumption and labor income over the lifecycle in developed and developing economies.



Source: Lee and Mason (2011), selected data from www.ntaccounts.org.

Note: Average earnings and consumption by age. Developed economies: Canada, France, Germany, Italy, Japan, United Kingdom, United States. Developing economies: Brazil, Chile, China, Philippines, Hungary, India, Indonesia, Mexico, Peru, South Africa, South Korea, Thailand, Turkey.

firms' demand for funds. This assumed complementarity between labor and capital is consistent with the remarkable stability across time and countries of the share of an economy's total income that goes to wages and salaries. Although it has declined somewhat globally for about the past 15 years, labor's share of income had remained stable despite a major decline in prices of capital goods and interest rates, which absent the assumed complementarity between labor and capital would not have happened to this extent, according to the models.¹⁴

Both key demographic trends that according to these models have affected interest rates—slower population growth due to lower fertility and longer life expectancies (Figure 4a), and declining labor supply due to aging and the resulting rise in the share of retirees in the population (Figure 4b)—are projected to continue, and at a faster pace than in the past.

The basic mechanism that makes these trends relevant for the evolution of interest rates around the globe is that lower fertility implies that the working-age population saves more on net, as there are fewer minors. Similarly, longer life expectancy implies that workers in midlife save more to afford longer retirements. Although the growing share of retirees in the population has the opposite effect and tends to reduce the net savings of the household sector, it also reduces labor supply and hence the demand for capital and investment due to the complementarity of capital and labor, for an attenuated or even opposite net effect on interest rates.

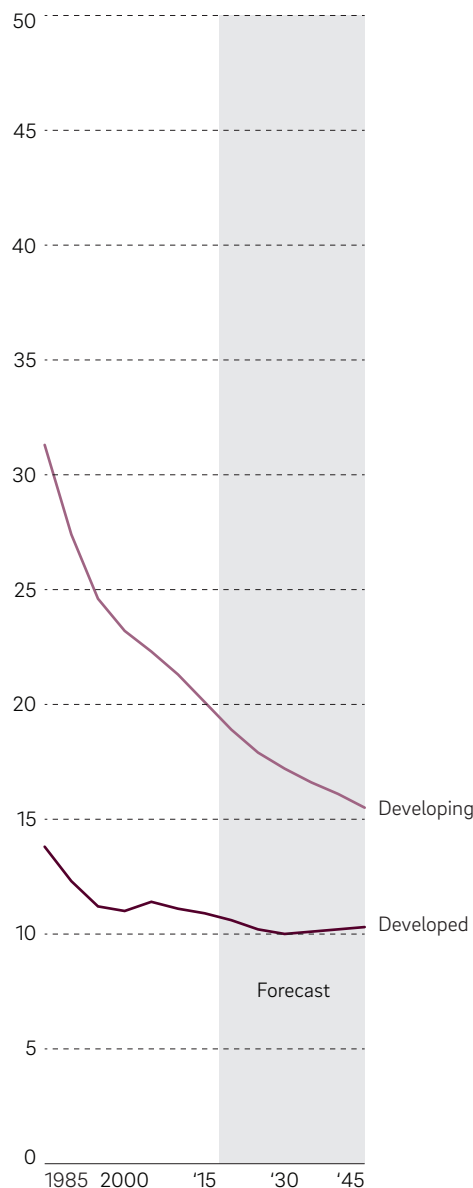
Productivity

Productivity in developed countries, and also globally, has been rising more slowly in recent years, leading to projections of slower income growth.¹⁵ What makes the rate of productivity growth important is that future income depends on labor productivity growth; if slower growth is expected, the working-age population may be encouraged to save more of what they earn so they will be able to maintain their targeted level of consumption in the future. Not all studies take the productivity slowdown into account, but those

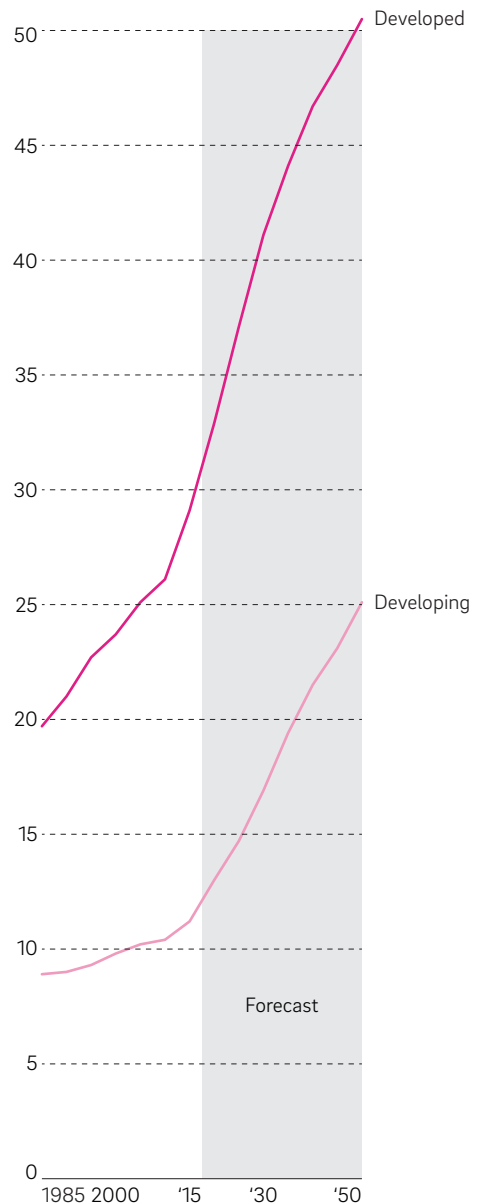
FIGURE 4

Global Demographic Trends Likely to Continue

4a: World birth rate per 1,000 population in developed and developing regions. Percent



4b: Old-age dependency ratio. Number of people age 65 and older to the number age 20–64, percent



Source: United Nations Department of Economic and Social Affairs, Population Division, World Population Prospects: The 2017 Revision. Custom data from <https://www.un.org/development/desa/publications/world-population-prospects-the-2017-revision.html>.

that do conclude that it is a force to be reckoned with.

A comprehensive study of U.S. interest rates that analyzed the effect of not only demographics but also productivity growth, government debt, and capital goods prices found that, had it not been for the offsetting effect of rising U.S. government debt, the productivity slowdown would have depressed interest rates

further. Productivity growth is difficult to forecast, and initially reported growth rates are sometimes substantially revised. However, the analysis—by Gauti Eggertsson, Neil Mehrotra, and Jacob Robbins—suggests that productivity would have to grow at trend rates not seen in the postwar period to undo the effect of demographic forces.

Other Forces

Two other factors that model-based studies do not take into account might also have affected the evolution of interest rates around the globe.¹⁷ Commentators have recently emphasized a potential role for rising income inequality within countries and China's unusually high national saving rate.

Income inequality has been rising in most countries, especially in developed ones, raising the question of how this trend might have affected interest rates.¹⁸ Because the rich generally save a larger fraction of their income, inequality within a country tends to raise the net savings of its households overall.

Lukasz Rachel and Thomas D. Smith shed light on this issue by showing that within-country inequality is correlated with cross-country net savings. Based on this fact, they estimate that income inequality accounts for about one-tenth of the decline in interest rates and argue that if inequality rises further, interest rates will fall further.¹⁹

By focusing on averages, economic models also do not take a full account of idiosyncratic differences among countries. For example, China's high saving rate has been quite an outlier given that nation's level of economic development. China's consumption profile is well below even lower-income countries (Figure 7). Today, China is actively moving toward a more consumer-oriented rather than export-oriented economy, which opens up the possibility that its saving rate may decline in the future, alleviating the downward pressure that its growing economy exerts on world interest rates. However, there are important caveats to this reasoning. One, this

How Do Demographic Forces Affect Interest Rates?

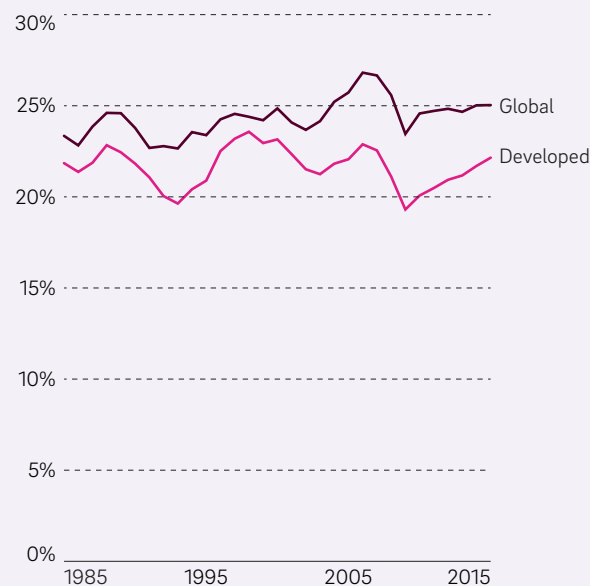
Demographics lower interest rates by affecting both the supply of and demand for funds in financial markets. In Figure 5, the upward sloping blue line represents the supply of funds. It rises as interest rates rise because higher interest rates encourage saving. The downward sloping red line represents the demand for funds. It falls as interest rates rise because higher rates make loans more costly, thereby discouraging borrowing. The equilibrium interest rate balances out the demand for funds with the supply of funds where the two lines intersect. **1** In recent decades, falling birth rates and rising longevity have increased net household savings, increasing the supply of funds in global financial markets. **2** But rising life expectancy has also increased the share of retirees in the population, for an attenuated effect on the net supply of savings and interest rates. **3** Yet, it appears that rates have continued to decline because the rising share of retirees has also reduced the size of the labor force and hence the demand for capital and funds.

A remarkable feature of the dynamic illustrated here is that it is consistent with little change in the global saving rate. This observation is broadly consistent with the evidence.¹⁶ While the saving rate in the U.S. and other advanced economies has been declining, for the world as a whole it has remained remarkably constant as rates have fallen (Figure 6).

FIGURE 6

Lower Rates Have Not Spurred a Rise in Global Saving

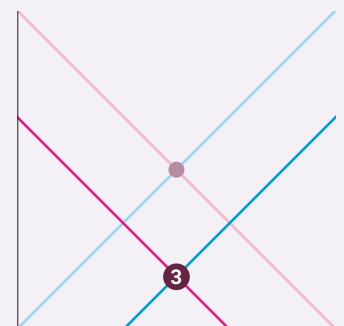
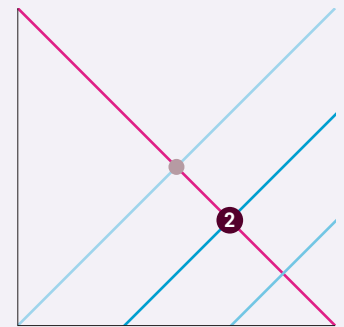
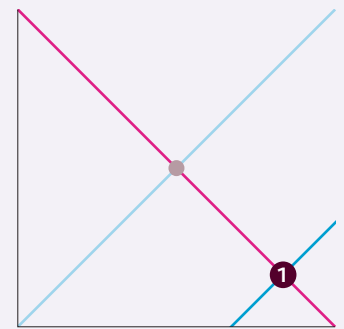
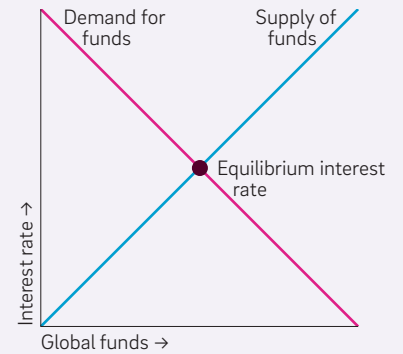
Gross savings (gross national income less total consumption) as a fraction of GDP.



Source: World Bank, World Development Indicators; custom data from <https://data.worldbank.org/indicator/NY.GNS.ICTR.ZS>

FIGURE 5

How Demographics Have Lowered Interest Rates



process will take time. Two, as the gap narrows, China's rising share of world income will continue to depress interest rates until its saving rate is no longer above the world average.

An Uncertain Future for Monetary Policymaking

With the normalization of policy rates well under way but market rates persistently low, policymakers may soon face an important question: What is the best way to respond to recessions given the projected low interest rate environment? Two types of options are being debated: Central banks can accept that whenever they need to stimulate the economy, they will have to resort to employing unconventional instruments within the existing monetary policy framework to lower the effective long-term interest rate that households and firms pay. Or they can work around the zero lower bound by creating a new monetary policy framework to restore the effectiveness of their most proven tool, cutting rates.²⁰

Unconventional Tools: Balance Sheet Policy and Forward Guidance

The primary unconventional instrument

designed to work within the existing framework is *forward guidance*. The basic idea behind forward guidance is that merely by publicly announcing how interest rates will be set in the future, a central bank can alter the public's expectations about future short-term rates. Since long-term rates are tied to expectations about short-term rates, long-term rates will decline after such an announcement.²¹

Unlike traditional U.S. monetary policy, which aims to influence rates throughout the economy by moving overnight interbank rates, forward guidance aims to achieve the same goal by announcing how future rates will be set. Banks and other financial intermediaries price the long-term loans they make today based on their expected cost of funds in the future, as such loans must be financed over an extended period. So, in principle, if a central bank's forward guidance is credible, lenders will raise or lower the interest they charge on long-term loans accordingly. And in fact, the evidence so far is quite compelling that forward guidance was effective in lowering long-term rates during the crisis.²²

The second type of unconventional instrument is balance sheet policy, in which a central bank purchases riskier assets from banks and other lenders so

they will be in a stronger position to bear risk and hence more willing to lend to firms and households, thereby stimulating the economy. To implement this tool, the central bank either changes the composition of its own balance sheet by selling safer assets or buying riskier assets, or both, or it expands its balance sheet by, in essence, printing money to buy more risky assets.

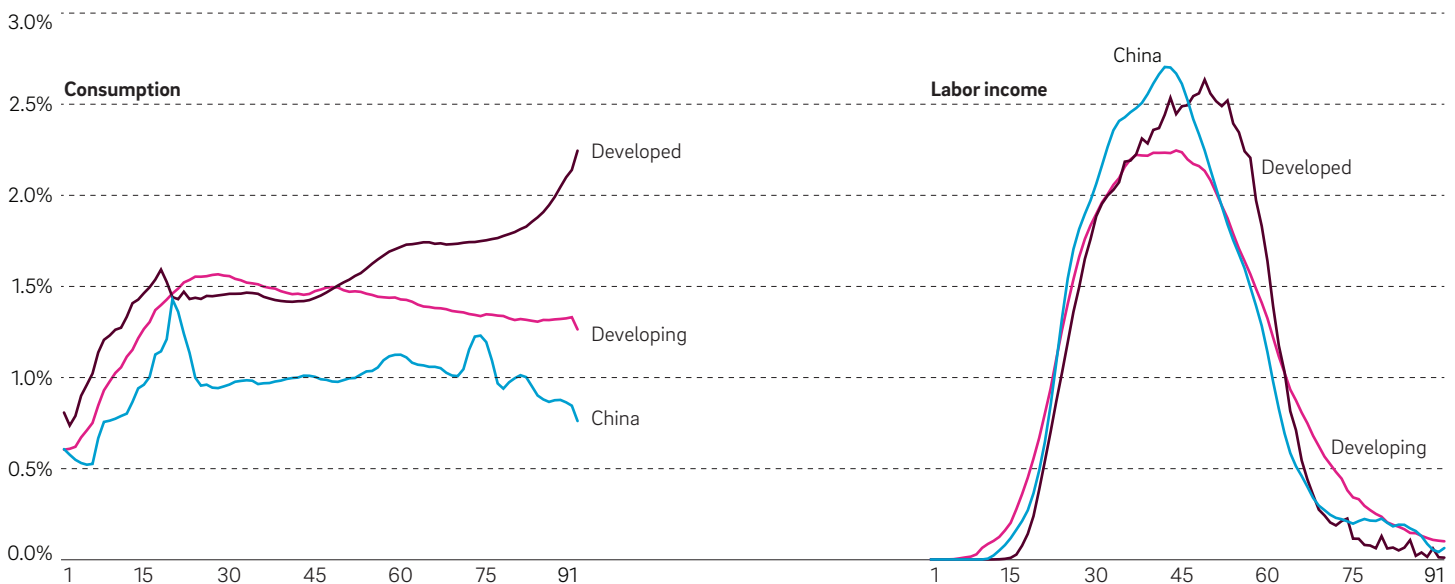
Proponents also argue that purchasing large amounts of long-term assets amplifies the effect of forward guidance. Such large-scale purchases, known as *quantitative easing*, boost the credibility of the forward guidance by signaling the central bank's commitment to making good on its announcements about reducing long-term rates and, in principle, creating room to drive them even lower.²³ Also, by making it easier for financial intermediaries to shed their riskier assets, these purchases lower the *risk premiums* that lenders charge borrowers in the form of higher interest rates as compensation for bearing risk.

Opponents, however, question whether unconventional tools would be effective under any conditions, especially in a deep recession with rates already at or near the zero lower bound. They point out the theoretical limitations of forward guidance

FIGURE 7

China's Saving Rate Likely to Keep Down Interest Rates

Average per capita labor income and consumption rates by age, China vs. developed vs. developing countries.



Source: Lee and Mason (2011), selected data from www.ntaccounts.org.

Note: Developing economies: Cambodia, Ethiopia, Ghana, Indonesia, Jamaica, Kenya, Mozambique, Nigeria, Philippines, Senegal, Vietnam.

and the somewhat mixed evidence regarding the effectiveness of quantitative easing.²⁴ They also emphasize that the economy's reaction to these less-tested policies is less predictable, requiring them to be deployed more slowly in order to monitor their effectiveness and guard against unintended consequences.

A chief concern regarding forward guidance is that, at the zero lower bound, central banks may not always be able to influence the public's expectations of how future policy rates will be set. At least in theory, neutral rates may fall to zero perpetually, invalidating the effectiveness of any forward guidance that requires the public to believe that rates will eventually lift off the zero lower bound.²⁵ Also, forward guidance may conflict with central banks' mandate to keep inflation low and stable. That is, central banks may find themselves having to convince the public that they will keep rates low even after the economy is expanding again—letting it “run hot” for a while—possibly undermining their commitment to low inflation. At the very least, policymakers may need to rethink inflation targeting as a means to signal their commitment to price stability and replace it with a more flexible target that better accommodates forward guidance.²⁶

As a stark warning of how difficult it may be to escape the zero lower bound once it becomes binding, skeptics of unorthodox tools cite Japan, which has remained at the zero lower bound for decades now, despite repeated unconventional policy interventions by the Bank of Japan.²⁷ Indeed, while the evidence suggests that unconventional tools can stimulate demand, Japan offers a cautionary tale. In 1999, the Bank of Japan introduced a zero interest rate policy in which the overnight rate was targeted “as low as possible.” In 2001, the central bank introduced quantitative easing and an early form of forward guidance. All these efforts largely failed to stimulate the economy and raise inflation. In 2013, the Bank of Japan introduced its most aggressive quantitative easing. Inflation rose briefly above the targeted rate but soon fell back below target, where it remains today, suggesting that Japan has been locked in a holding pattern at the zero lower bound for almost two decades now.

It remains an open question whether the policies Japan deployed were simply too small in scale or duration, or whether its experience highlights the limited effectiveness of unconventional monetary policy under the kind of extreme circumstances afflicting Japan.

A New Monetary Policy Framework

Modifying the standard monetary policy framework might well give policymakers enough effective tools to ensure that they can still precisely tailor policy to the state of the economy in a recession. Among the proposals that have attracted the most attention, increasing the inflation target tops the list. Targeting higher inflation was first proposed soon after the Great Recession,²⁸ and more recently, former Federal Reserve Chair Janet Yellen deemed the issue “one of the most important questions facing monetary policy around the world in the future,” and called for more research.²⁹

Inflation can remedy the problem of the zero lower bound because nominal interest rates compensate for the expected rate of inflation. That is, higher inflation raises people's expectations of more inflation, prompting them to borrow and spend more at a given nominal interest rate, causing rates to rise from the zero lower bound.³⁰

The main objection to raising the inflation target is that inflation is costly. A 2011 analysis of the costs of inflation using modern economic models suggested that even moderate inflation may result in significant misalignments of prices,³¹ although a 2017 study of actual price dispersion during a period of high inflation in the U.S. questions this assessment,³² suggesting rather low costs. Nonetheless, convincing the public that more inflation is needed may prove too high a hurdle, as inflation remains deeply unpopular. In addition, there is a practical concern that central banks may not yet be capable of raising inflation, which could cost them credibility if they failed to deliver on the new higher target.

A more radical proposal than raising inflation calls for replacing paper currency with digital currency that could be “taxed”—that is, whenever the economy needed a monetary stimulus, the central bank could make the virtual currency more costly to discourage savers from hoarding cash when bank deposit rates turn negative.³³ The main advantage of such a solution is that the inflation target could stay at the current level or even be lowered, since central banks would have no problem driving interest rates below zero in any inflation environment.³⁴ However, maintaining two parallel currencies or abolishing cash would mean entering uncharted waters for central banks, as such a solution has never been tried, and while appealing in theory, in practice there could be challenges.³⁵

As a last resort, policymakers could pursue dismantling the separation between monetary policy and fiscal policy to allow central banks to finance government spending by, in effect, printing money.³⁶ Although *helicopter drops* of money, as they've been called, could give central banks more power to stimulate the economy, breaking the separation between monetary policy and fiscal policy is a controversial proposal. A central bank that ventured into fiscal policy would likely find itself under pressure from the private sector, financial markets, and the government to use its balance sheet to relax fiscal constraints in the short run at the risk of undermining the stability of the monetary system.³⁷

Concluding Remarks

Interest rates have been declining globally for years and may not rise in the foreseeable future, according to current projections. The experience of the Great Depression cautions that a major recession without an adequate monetary or fiscal accommodation can have disastrous consequences for the economy. How central banks will adapt to this “new normal” is still unclear. What is clear, however, is that the zero lower bound will likely remain at the top of central banks' agendas, as sooner or later a major recession will come along to test whatever tools are available to fight it. 

Notes

- 1** Because there are costs to storing large amounts of cash, in practice central banks may be able to drive interest rates below zero. So, for all practical purposes, the effective lower bound occurs at whatever rate results in cash hoarding. Negative interest rates have been implemented in Europe and Japan to extend the scope of conventional monetary policy. See “[Why Can't Central Banks Simply Set Rates Below Zero?](#)” on p. 1 for details.
- 2** The first country after the Great Depression to experience the zero lower bound was Japan, as I discuss later.
- 3** While the actual operating procedures differ across central banks, the basic principle of the transmission mechanism outlined here remains similar.
- 4** Governments can borrow for the long term by issuing either long-term bonds or short-term bonds in a staggered fashion so that the proceeds from current short-term issuances can be used to pay investors who purchased prior issuances, thereby effectively borrowing for the long term. Hence, governments will pay significantly higher yields on long-term debt only if they expect borrowing costs for short-term bonds to rise persistently, which is not the case with transient forces.
- 5** Averaging interest rates across a large number of countries eliminates the effect of expected exchange rate movements because exchange rates are reciprocal: If one currency is expected to strengthen, others are therefore expected to weaken, for an offsetting effect on interest rates around the globe and an attenuated effect on the average interest rate.
- 6** As estimated by Mervyn King and David Low, 2013.
- 7** Full employment does not imply no unemployment—as at any given time a certain number of workers are always between jobs—only that there is no unemployment caused by a cyclical deficiency of aggregate demand, as occurs in a recession. The unemployment rate that occurs at full employment is known as the natural rate of unemployment.
- 8** Amid rising prices, workers demand higher wages, leading firms to further increase prices to cover their rising labor costs, leading workers to demand still higher wages, and so on.
- 9** See the work by Jens H.E. Christensen and Glenn D. Rudebusch and by Benjamin Johannsen and Elmar Mertens.
- 10** See the study by Marco Del Negro, Domenico Giannone, Marc P. Giannoni, and Andrea Tambalotti.
- 11** James Hamilton, Ethan Harris, Jan Hatzius, and Kenneth West show that from the long-term international perspective, these estimates are more uncertain.
- 12** See Dirk Krueger and Alexander Ludwig’s paper as well as the study by Etienne Gagnon, Benjamin Johannsen, and David Lopez-Salido. The paper by Carlos Carvalho, Andrea Ferrero, and Fernanda Nechio suggests similar findings, although it does not offer a long-term forecast.
- 13** See the work of Gauti Eggertsson, Neil Mehrotra, and Jacob Robbins, who include the productivity slowdown among other factors.
- 14** For more details on the labor share, see Roc Armenter’s *Business Review* article. The analysis by Eggertsson and his coauthors concludes that although labor’s declining share of U.S. income has contributed to interest rate declines, it has been a secondary factor.
- 15** For an accessible discussion, see Mike Dotsey’s *Economic Insights* article. Robert Gordon has been the most prominent advocate of the hypothesis that the productivity slowdown in the U.S. and other developed countries is here to stay. For a contrarian and more optimistic view of what the future may bring, see the book by Erik Brynjolfsson and Andrew McAfee.
- 16** An alternative hypothesis put forth by Charles Bean, Christian Broda, Takatoshi Ito, and Randall Kroszner to explain the remarkable stability of the world saving rate holds that either demand or supply is insensitive to rates, implying that one of the lines in Figure 5 is vertical. Microeconomic studies suggest that both investment and saving respond to interest rates. See the discussion in the paper by Lukasz Rachel and Thomas Smith.
- 17** See, for example, the blog post by former Federal Reserve Chairman Ben Bernanke on the global savings glut.
- 18** The rise in the income distribution in this case is measured by the Gini coefficient, which ranges from 0, in which all households in a country would have the identical income, to 1, in which a single household would earn all the income and the rest earn nothing.
- 19** Krueger and Ludwig point out that part of the rise in inequality may be explained by aging and show that their model in part captures the increase in inequality measures in the data.
- 20** See former Federal Reserve Chair Janet Yellen’s 2016 speech outlining the future of U.S. monetary policy. See also Bernanke’s 2017 discussion paper.
- 21** See Edison Yu’s *Economic Insights* article for an accessible explanation of how short-term rate expectations affect long-term rates.
- 22** See Michael Woodford’s discussion of the effectiveness of unconventional monetary policy instruments deployed during the crisis.
- 23** See the work by Leonardo Melosi.
- 24** Yu’s *Economic Insights* article also explores the theoretical challenges and evidence regarding quantitative easing.
- 25** See the work by Eggertsson and his coauthors.
- 26** In this context, price-level targeting is often considered a better alternative to inflation targeting to signal a central bank’s commitment to price stability and to communicate its intentions without compromising the effectiveness of forward guidance. For a recent proposal along these lines, see the discussion paper by Bernanke.

27 An overview of the evidence on the effectiveness of long-term asset purchases and quantitative easing can be found in, for example, Woodford's discussion paper.

28 See the work that Olivier Blanchard did with Giovanni Dell'Ariccia and Paolo Mauro while Blanchard was research chief at the International Monetary Fund. Also see the work by Laurence Ball as well as Stephen Cecchetti and Kermit Schoenholtz.

29 See page 14 of the transcript of former Chair Yellen's press conference of June 14, 2017, at <https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20170614.pdf>. The open letter that prompted the question can be found at <https://populardemocracy.org/news-and-publications/prominent-economists-question-full-inflation-target>.

30 Say you want to take out a loan and expect that by the time you need to pay it back both wages and prices will have accelerated. The dollars you will repay your debt with will purchase less than the dollars you borrow, and you will have to work less to repay your debt. So, at any fixed nominal interest rate, the expectation of higher inflation will make the lender want to lend less but will encourage you to borrow more.

31 See the work by Olivier Coibion, Yuriy Gorodnichenko, and Johannes Wieland.

32 See the study by Emi Nakamura, Jon Steinsson, Patrick Sun, and Daniel Villar.

33 See "Why Can't Central Banks Simply Set Rates Below Zero?" on p. 1 for an explanation of how "taxing" cash could help break through the zero lower bound.

34 Ruchir Agarwal and Miles Kimball argue that a partial phase-out of paper currency to roll out a parallel electronic currency would suffice to overcome the zero lower bound. The tax could be imposed only when the zero lower bound became a problem.

35 See the discussion paper and book by Kenneth Rogoff for a detailed discussion of key practical considerations underlying a complete or a partial phaseout of paper currency.

36 For a discussion of a policy proposal along these lines, see the paper by Adair Turner.

37 For a detailed discussion of these risks, see, for example, the essay based on the speech by former Federal Reserve Bank of Philadelphia President Charles Plosser.

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