CHAPTER 2

LOW GROWTH, LOW INTEREST RATES, AND FINANCIAL INTERMEDIATION

Summary

Advanced economies have experienced a prolonged episode of low interest rates and low growth since the global financial crisis. From a longer-term perspective, real interest rates have been on a steady decline over the past three decades. Despite recent signs of an increase in long-term yields, particularly in the United States, the experience of Japan suggests that an imminent and permanent exit from a low-interest-rate environment need not be guaranteed. A combination of slow-moving structural factors, notably population aging and slower productivity growth common to many advanced economies, could conceivably generate a steady state of lower growth and lower nominal and real interest rates in these countries.

What would be the consequences for the financial sector of such a scenario? This chapter examines this question, abstracting from the role of monetary policy and from temporary effects. The chapter argues that the persistence of a prolonged low-interest-rate environment would present a considerable challenge to financial institutions. Over the long term, the scenario would entail significant changes to the business models of banks, insurers, and pension funds and the products offered by the financial sector.

In such an environment, yield curves would likely flatten, lowering bank earnings and presenting long-lasting challenges for life insurers and defined-benefit pension funds. If bank deposit rates cannot drop (significantly) below zero, bank profits would be squeezed even further. Smaller, deposit-funded, and less diversified banks would be hurt most, which could increase the pressure to consolidate. As banks reach for yield at home and abroad, new financial stability challenges may arise in their home and host markets. These hypotheses are supported by the experience of Japanese banks.

Low growth and aging populations would likely lower credit demand by households and firms and increase household demand for liquid bank deposits and transaction services. Consequently, in this scenario, domestic banking in advanced economies may generally evolve toward provision of fee-based and utility services.

Pension arrangements and the products and business models of life insurers would also likely change significantly in the long term. In this scenario, defined-benefit pension plans provided by employers would tend to become less attractive relative to defined-contribution plans, which offer more portability. Rising longevity would likely boost the demand for health and long-term care insurance. Demand for guaranteed-return, long-term savings products offered by insurers could be expected to weaken, while that for passive index funds offered by asset management firms would likely grow.

Policies could help ease adjustment to such an environment. Prudential frameworks would need to provide incentives to ensure longer-term stability instead of falling prey to demands for deregulation to ease the short-term pain. For banks, policies should help facilitate smooth consolidation and exit of nonviable institutions, while limiting excessive increases in risk taking and ensuring that the too-big-to-fail problem does not worsen. Implementing economic solvency requirements that encourage life insurers to undertake necessary adjustments to their business models would be vital. Surveillance and regulation of asset management activities would become more important as this industry's share in the financial sector grows.

Introduction

Advanced economies have been experiencing low real and nominal interest rates for several years (Figure 2.1). Interest rates have been less volatile and the yield curve has flattened considerably. Economic growth has also been persistently low over the past decade. Despite recent signs that longer-term yields are increasing, these developments have sparked interest in the question of whether they represent an unusually large and long deviation from a higher equilibrium level of economic growth or a new steady state with lower potential growth. Under the latter interpretation, interest rates at their prevailing low levels are equilibrium natural rates, and monetary policy simply mirrors underlying developments in the real economy.

The secular decrease in real interest rates across advanced economies since the mid-1980s suggests that natural rates may have fallen in response to slow-moving structural factors.[1] This decline may reflect lower steady-state growth and a drop in the investment-to-savings ratio in advanced economies. The combination of demographic changes and lower total factor productivity growth in these countries may represent important driving forces (Chapter 3 of the April 2014 *World Economic Outlook*; Gordon 2014; Bean and others 2015; Bernanke 2015). For example, waning population growth weighs directly on economic growth and may pull down real interest rates if it exerts a negative effect on the marginal productivity of capital. Rising longevity also puts downward pressure on real interest rates because households save more to prepare for longer retirement (Carvalho, Ferrero, and Nechio 2016). Gains in total factor productivity reflect, to an important degree, the pace of innovation, which may have slowed because of several factors (Summers 2014; Rachel and Smith 2015). Steadily rising savings and growing demand for advanced-economy financial assets in emerging market economies have also put pressure on interest rates in advanced economies over the past 15 years (Bernanke 2005).

It is important to understand how prolonged periods of low interest rates affect the provision of financial services. An efficient financial sector that supports growth and innovation is of particular significance in such an environment. The combination of structural factors that keep real interest rates low over a considerable length of time also underpins the impact on the financial sector. For example, population aging and rising longevity are likely to significantly affect asset allocation and the demand for banking and insurance services. Lower total factor productivity will weigh on the demand for credit and financial intermediation. If lower rates are accompanied by flatter yield curves, banks and life insurers are likely to suffer. Changes to the structure of the financial sector in such an economic scenario are also likely to have consequences for financial stability.

Previous studies have mainly examined the impact of *falling* interest rates. They have often focused on the short-term impact of monetary policy decisions, but not on the length of the low rate period and have not distinguished between the impact of falling short-term rates and that of the flattening yield curve itself.[2]

This chapter conducts a scenario analysis of prospects for financial intermediation in an economy in which nominal and real interest rates and growth are low and expected to remain low for the foreseeable future ("low-for-long economy").[3] Importantly, the chapter abstracts from the role of monetary policy and from the temporary effects of falling rates, lower rates, or both. Instead, it considers a hypothetical equilibrium with low growth and low interest rates, where expected returns on most financial assets are low.[4] The scenario should not be interpreted as a baseline or projection of most likely economic outcomes in the medium term, but as an exercise intended to illustrate some of the key associated issues.

This focus allows the chapter to address questions regarding the long-term impact of a steady state of low

Prepared by a staff team led by Jay Surti and composed of Jorge Chan-Lau, Qianying Chen, Gee Hee Hong, Mitsuru Katagiri, Oksana Khadarina, John Kiff, Frederic Lambert, Sheheryar Malik, Win Monroe, Nobuyasu Sugimoto, and Kai Yan, under the general guidance of Gaston Gelos and Dong He. Breanne Rajkumar and Annerose Wambui Waithaka provided editorial assistance.

[1]The concept of natural rates was introduced by Wicksell (1936). Holston, Laubach, and Williams 2016 present evidence of falling natural interest rates in a number of advanced economies.

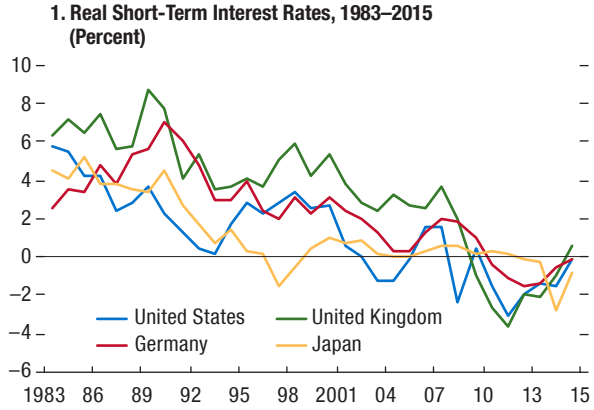
[2]European Systemic Risk Board 2016 also examines some of the issues discussed in this chapter in the European context.

[3]The assumption of low nominal rates does not follow directly from that of low real rates, but recent experience, particularly in Japan, has been marked by both low nominal and low real rates.

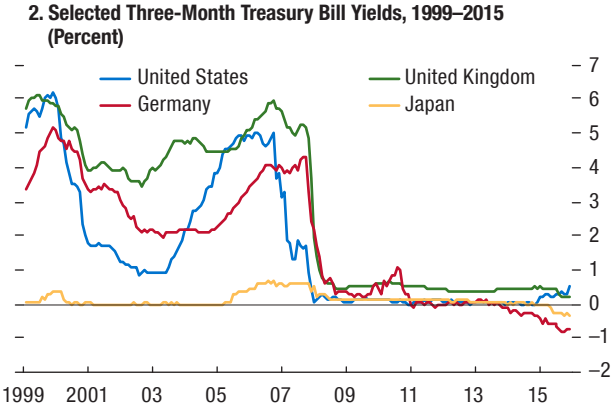
[4]Various other studies have examined the effects of temporary monetary policy measures under low interest rates. For a recent paper analyzing the effects of negative interest rate policies on monetary transmission and bank behaviors, see IMF 2017. The study finds that these policies have not had major side effects on bank profits, payment systems, and market functioning.

Figure 2.1. Interest Rates, Term Spreads, and Volatility in Advanced Economies

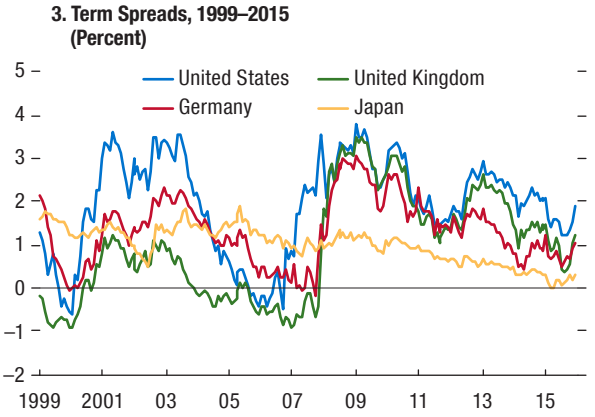
Real interest rates have been decreasing over the past three decades.



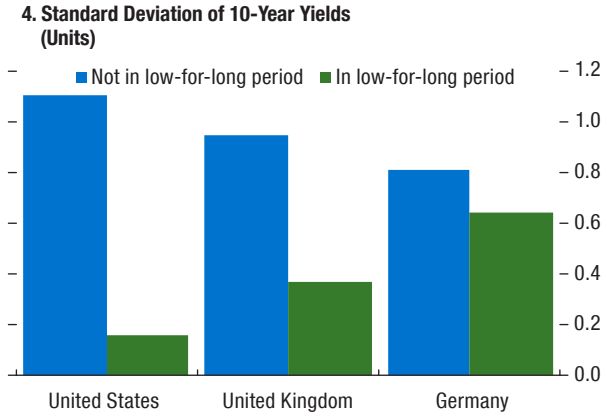
Nominal interest rates have fallen.



Yield curves have flattened.



Interest rate volatility has declined.



Sources: Thomson Reuters Datastream; IMF, World Economic Outlook database; and IMF staff calculations.
Note: Term spreads in panel 3 are defined as the difference in yield between a 10-year government bond and a three-month Treasury bill. Low-for-long periods in panel 4 are defined as those when the 10-year yield was less than 2 percent.

interest rates on financial intermediation and financial stability. What is the long-term impact on profits and solvency of financial institutions? How does it depend on their business models? Will the existing menu of financial products and services survive? How will these circumstances change the relative importance of banks, insurers, pension funds, and asset managers in the financial system? In taking this approach, the chapter seeks to examine the long-term implications of the proposed scenario and its underlying structural drivers for financial intermediation.

While not aiming to offer definitive and exhaustive answers to these questions, the chapter's novel contributions do shed light on them. First, it provides a new analytical framework to help understand the behavior of the term structure of interest rates in an equilibrium with low natural rates of interest. This is important given the relevance of the slope of the yield curve for the profits and solvency of different types of financial institutions. Second, it extends a standard model of bank profitability to such an equilibrium to assess the impact on banks according to their business models, and compares the insights with Japan's experience. Third, it empirically assesses the impact of low interest rates on banks' profits, distinguishing between situations when interest rates are expected to remain low

for a long time and other periods. Fourth, it discusses implications for insurers and pension funds, simulating alternative portfolio choices and discussing the viability of typical pension and insurance products in the low-natural-rate equilibrium. Fifth, it offers a discussion of how such a scenario affects households' asset allocations and the role of asset managers in financial intermediation. Sixth and last, it discusses potential implications for financial stability.

The main findings for this scenario are as follows:

- The yield curve would be flatter compared to an equilibrium with higher rates and growth.
- Although lower interest rates may boost banks' earnings in the short term, they hurt profitability in the steady state once they fall below a particular positive threshold. Smaller, geographically undiversified, deposit-funded banks would be hurt most in such a scenario.
- Tail risk exposure could increase.[5] Banks tend to adopt different strategies in reaching for yield, depending on their business models. Smaller, deposit-funded banks typically take on more interest rate risk by increasing the duration of bond portfolios. Large banks are likely to increase risk exposures in foreign countries that offer higher returns (in particular, emerging market economies) and rely more heavily on wholesale funding markets to do so.
- Life insurers and pension funds would face a long-lasting transitional challenge to profitability and solvency, which is likely to require additional capital. This challenge arises because some of them would find it difficult to meet cash outflows on large stocks of existing liabilities contracted in past periods of higher interest rates by only altering asset portfolios. Moreover, many of their other business lines may struggle to show profit in the tepid growth environment.

All of this would likely result in major changes in the long term to household demand for financial products and asset allocation, the menu of services the financial sector offers, and the relative role of institutions versus markets in financial intermediation.[6]

- To the extent that population aging and rising longevity are key forces behind the scenario, there are likely to be major changes to demand for banking and insurance products. Aging would likely reduce household demand for credit and increase demand for transaction services from banks. In combination with increased longevity, it would likely increase demand for health and long-term care insurance, with ambiguous implications for life annuities. Retail demand for asset management products would continue to grow, in particular for passive modes of index investing targeted at minimizing management fees.
- Pressure on smaller banks would lead them to consolidate among themselves or with larger banks. Credit demand would likely be lower in this scenario given an aging population and lower productivity growth. Domestic bank lending would likely shrink, focusing more on small businesses and less on households and large firms. Business models in advanced economies would tend to evolve toward fee-based and utility banking services.
- Insurers would likely cede some of their savings business to asset managers and banks over the long term. The reason for this shift is that, at low rates, their guaranteed products are relatively less attractive. Although insurers may respond, in part, by switching their focus to unguaranteed savings products, they could face tough competition from asset managers. Health and long-term care businesses would likely grow strongly as people age and live longer.
- The pooled management of household life cycle risks would likely decline more rapidly. Employers could be expected to increasingly move away from defined-benefit and toward defined-contribution pension plans, although the pace and extent of this transition may vary significantly across advanced economies.

The key policy challenge in this scenario would be to successfully balance multiple objectives, including the following:

- For banks, providing a legal and regulatory framework that facilitates smooth consolidation should go hand in hand with efforts to limit excessive risk taking in an environment with lower expected returns and avoid a worsening of the too-big-to-fail problem. This includes containing incentives to increase exposure to tail risk from widening maturity mismatches, higher wholesale funding, and foreign-

[5]Risk taking may arise due to competitive pressures, nominal return targets, or risk shifting in response to lower interest rates, among other factors.

[6]The discussion of the potential long-term impact of the scenario on financial intermediation seeks to take into account the interrelation across different sectors and key drivers. However, it is not based on a formal general equilibrium model, and does not aim to capture all potential accompanying factors, such as changes in labor supply (including changes in retirement ages), regulations, or social safety nets.

currency exposures. A similar challenge would be to reap benefits from banks' higher engagement in emerging market economies while containing potential new financial stability risks in home and host countries.

- Providing incentives to undertake necessary business model adjustments (life insurers) and contain "gambling for resurrection" (certain pension funds) would be key in this scenario. This would strengthen the case for implementing economic solvency requirements that ensure recognition of the costs of guarantees and options embedded in insurance and pension products.
- Surveillance and regulation of asset management activities would become even more important as this industry's share of the financial system grows. In particular, further strong growth of index investing could entail new financial stability challenges. Closing significant data gaps would also be essential to allow for effective macroprudential surveillance of this sector.

The Term Structure of Interest Rates

This section discusses the shape of the yield curve in an economy with very low natural rates. The slope of the yield curve is important for the financial system, since it affects all financial institutions that tend to have maturity mismatches between their assets and liabilities. The section summarizes insights from a new model that applies and extends the techniques of existing consumption-based asset pricing models to incorporate a zero lower bound on nominal interest rates.[7]

The spread between the yield on a longer-maturity bond and the short-term interest rate is the sum of two components. These are the market expectations of how the short rate will evolve between today and the maturity date of the longer-term bond, and the bond's term (risk) premium. Around a steady state in which the short rate is at its long-term equilibrium level, the slope of the yield curve is driven entirely by the sign and magnitude of (nominal) bond term premiums.

A simple way to understand the term premium on a long-term bond is that it reflects the degree to which bond returns provide insurance against shocks to other sources of an investor's income. If bond returns increase when economic shocks reduce other sources of income, investors would be willing to pay a premium to hold the bond (a negative term premium). If bond returns decline in tandem with other sources of income, investors require a premium to be paid to them (a positive term premium).

When the equilibrium rate of economic growth is high and nominal and real rates are not close to zero ("normal economy"), the model implies an upward sloping nominal yield curve (Figure 2.2, panel 1).[8] When inflation goes up, incomes fall and bond returns decline due to the central bank's policy response of raising interest rates. Because bonds worsen the impact of inflation shocks on incomes, bond term premiums are positive.

The key distinguishing feature of the low-for-long economy is a zero lower bound on short-term nominal interest rates. It is assumed that the central bank cannot, or will not, lower policy interest rates below zero, which prevents it from responding by cutting interest rates in response to negative (noninflationary) shocks to real income.[9] This means that bond returns remain resilient in the face of such shocks in a low-for-long economy compared with what happens in a normal economy, which results in lower term premiums and flatter yield curves (Figure 2.2, panel 2).

The decline in term premiums at the zero lower bound can also be interpreted as a consequence of investors perceiving a lower risk of holding long-term securities. Once short-term interest rates are near the zero lower bound and are expected to stay there for the foreseeable future, their sensitivity to macroeconomic news drops because central banks' reaction functions are constrained.[10] In such a situation, investors are more willing to hold long-term bonds, lowering the term premium.

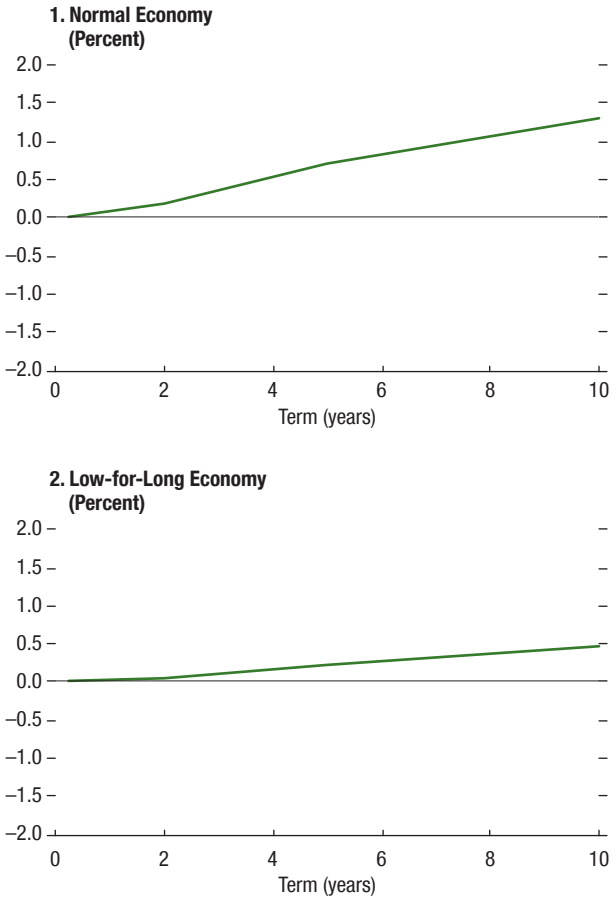
[7]Annex 2.1 contains details of the model and the literature.

[8]The results, as depicted in Figure 2.2, correspond to a parameterization of the model described in Annex 2.1. These results are robust to modeling endowment and inflation shocks as a joint process calibrated through a vector autoregression based on data from Germany, Japan, the United Kingdom, or the United States.

[9]Strictly speaking, it is sufficient for there to be an *effective*, possibly negative, lower bound on nominal short-term interest rates so long as it is close to zero. See Viñals, Gray, and Eckhold 2016 for a discussion of effective lower bounds for monetary policy rates.

[10]The flattening of yield curves due to compression in term premiums is a robust result across term structure models with a zero lower bound. Nakata and Tanaka (2016) and Gourio and Ngo (2016) investigate the term premium at the zero lower bound in a New Keynesian asset pricing model developed by Campbell, Pflueger, and Viceira (2012). In their models, however, the zero lower bound is a temporary phenomenon following a crisis rather than a persistent element of a low-for-long economy.

Figure 2.2. Term Premiums in Economies with Normal versus Low Natural Rates



Source: IMF staff calculations, based on the model described in Annex 2.1.

Banking with Low Natural Rates of Interest

This section augments the literature in two ways. First, it shows that with an unchanged yield curve, even permanently lower interest rates need not affect banks' earnings. Second, it clarifies how a zero lower bound on deposit rates generates pressure on bank interest margins and profits in an equilibrium with a low natural rate. These insights are applied to study the experience of Japanese banks since 2000 and the wider cross-country experience. The analysis also explains how the impact of this low-natural-rate equilibrium depends on bank business models.

Previous studies have clarified that negative interest rate shocks increase bank profits in the immediate future—but this favorable impact dissipates the longer interest rates remain low. Empirical studies covering banks in the United Kingdom (Alessandri and Nelson 2012) and the United States (English, van den Heuvel, and Zakrajsek 2012) show the existence of separate channels for short- and medium-term effects of interest rate changes on banks' interest margins, profits, and equity valuations. Banks tend to lose profitability from longer-lasting drops in interest rates in direct proportion to how much they engage in maturity transformation and make use of deposit funding. However, falling interest rates boost bank profits and equity values in the short term due to gains in the value of collateral, valuation gains on mark-to-market assets, and lower default risk on loans repriced to lower interest rates.[11] Banks appear to respond to falling rates by increasing risk taking through higher leverage.[12]

This literature does not provide guidance on several questions of interest in a low-for-long economy. What is the long-term impact on profits when banks operate in such an environment? Does this impact strengthen as interest rates go ever lower? Are some bank business models especially affected? Are significant changes to the market structure of the banking industry likely? This chapter addresses these issues using a three-pronged approach. First, the section provides a new theoretical model of banking in a low-for-long economy. Next, the insights of this model are applied to interpret the experience of Japanese banks over the past decade. The section concludes with an empirical examination of the impact on bank profitability and equity values and how these depend on banks' business models.

[11]Brunnermeier and Sannikov (2016) demonstrate that the adverse short-term impact of an increase in interest rates can be amplified through *liquidity spirals* (deteriorating net worth increases bank risk aversion, which lowers the market value of assets and lending volumes) and *disinflationary spirals* (the safe-asset value of cash increases).

[12]This is consistent with theoretical findings of Dell'Ariccia, Laeven, and Marquez (2014). Dell'Ariccia, Laeven, and Suarez (forthcoming) find that U.S. banks' risk taking responds similarly to changes in interest rates induced by monetary policy. Focusing on the impact of unconventional monetary easing in the United Kingdom, the United States, and the euro area in recent years, Lambert and Ueda (2014) find that it is associated with deterioration of bank credit risk and delayed balance sheet repair. Chodorow-Reich (2014) does not find evidence of increased risk taking by U.S. banks in response to unconventional monetary policies.

Insights from Theory

A simple model of banking is explored to show how bank profits evolve in a low-rate equilibrium.[13]

Bank profits fall significantly in a low-for-long economy if deposit interest rates are subject to a zero lower bound (Figure 2.3; Box 2.1).[14] Banks' interest margins are (almost) independent of the level of market interest rates if they can flexibly adjust loan and deposit rates in response to changes in steady-state market interest rates. Once deposit rates hit the zero lower bound, banks can no longer maintain spreads between loans and deposits, reducing net interest income under lower equilibrium market interest rates.

Several implications ensue for the business models of different types of banks. Banks able to operate internationally increase their exposure to countries where rates of return remain favorable, notably emerging market economies. They can be expected to increase reliance on wholesale funding in foreign currency (within existing regulatory limits) to finance this expansion. More generally, banks that raise a larger proportion of their funding from capital markets will be less susceptible to the squeeze in interest margins and incomes induced by the zero lower bound. Scale efficiencies in managing deposits would imply incentives for consolidation. At the same time, scale efficiencies in the costs of managing wholesale funding would mean that larger banks will be more inclined to seek this form of financing.

Lessons from Japan

The Japanese economy over the past decade provides the closest real-world approximation to a steady state with low growth and natural rates. The insights from the theoretical model can thus be weighed against the experience of Japanese banks over this period.[15] Japan has faced low interest rates for more than a decade. Short-term interest rates have been close to zero since the Bank of Japan adopted the zero interest rate policy in the early 2000s, with the exception of the extraordinary period of 2007–08. Long-term interest rates have also been low since the early 2000s and recently declined further, particularly after the Bank of Japan adopted policies of quantitative and qualitative monetary easing in 2013 and of negative interest rates in 2016.

Econometric analysis of the drivers of bank net interest margins supports the predictions of the theoretical model (Figure 2.4). An assessment of the behavior of Japanese banks' asset returns, funding costs, and market interest rates demonstrates that banks' interest margins have fallen primarily in response to the narrowing of funding spreads once deposit rates hit the zero lower bound in the mid-2000s.[16] Although market interest rates have remained close to zero since the 1990s, deposit rates first approached the zero lower bound in the mid-2000s. Bank net interest margins then gradually and steadily fell, particularly for regional and small regional cooperative financial institutions known as *shinkin* banks. Japanese banks have not introduced negative deposit rates or charged additional fees, such as account maintenance fees, on deposits even in the face of almost zero deposit spreads (Bank of Japan 2011).[17]

The relative performance of Japanese banks across business models also confirms the theoretical prediction that resilience to the low-for-long steady state improves with diversification (Figure 2.5). Smaller, domestically oriented, deposit-dependent regional and shinkin banks have sought to counter the compression of net interest margins primarily through expansion or adjustment of their domestic balance sheets. When benefits to this strategy declined, they engaged in cost cutting and consolidation. Large internationally active

[13]The model abstracts from the decrease in bank earnings due to yield curve flattening, focusing instead on a new mechanism that has not been explored in the existing literature. Brunnermeier and Koby (2016) explore a model with similar features to examine limits to monetary policy.

[14]The existence of an *effective* lower bound friction on deposit rates is sufficient to generate this result for interest rate levels around and below this lower bound.

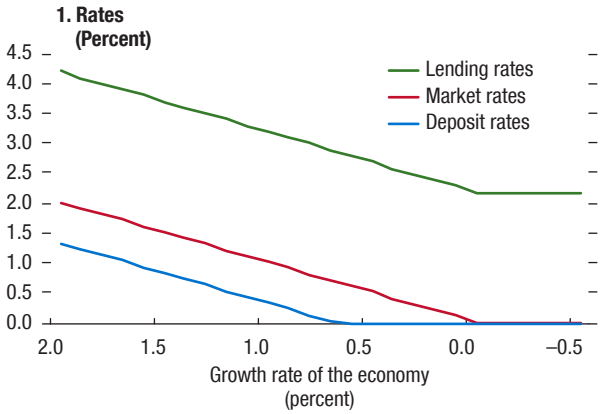
[15]Box 2.2 describes the experience of U.S. banks, which shares some, but not all, characteristics of Japanese banks' adaptation to the prolonged low-interest-rate environment.

[16]The analysis uses an error-correction model in the spirit of Gambacorta (2008). The model assumes that asset returns and funding costs are in a stable relationship with market interest rates in the long term, and that deviations from this relationship shrink gradually in the short term. Moreover, the long-term relationship changes depending on the level of market interest rates. The parameters governing the long-term relationship and the short-term dynamics are simultaneously estimated for a panel of Japanese banks.

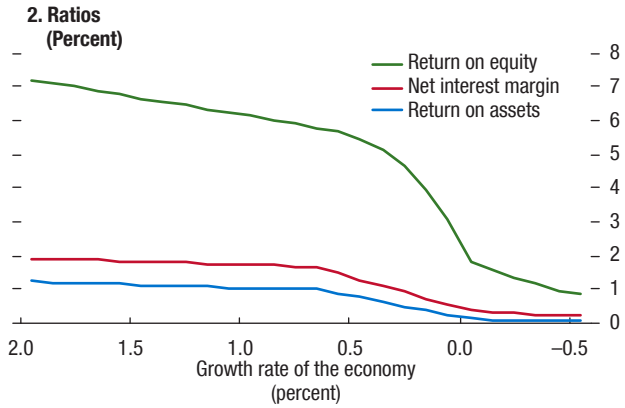
[17]It is important to focus on the past decade when examining the evolution of bank net interest margins and net interest income. First, deposit rates hit the zero lower bound only at the start of this period. Second, earlier hits to Japanese banks' profits in the period of low interest rates were the result of losses during the banking crisis, which had very different origins (Caballero, Hoshi, and Kashyap 2008).

Figure 2.3. Banking under Low Natural Rates: Theoretical Predictions

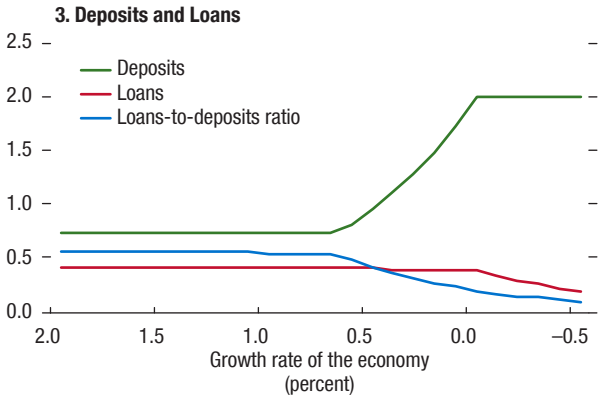
Deposit spreads are squeezed at low rates ...



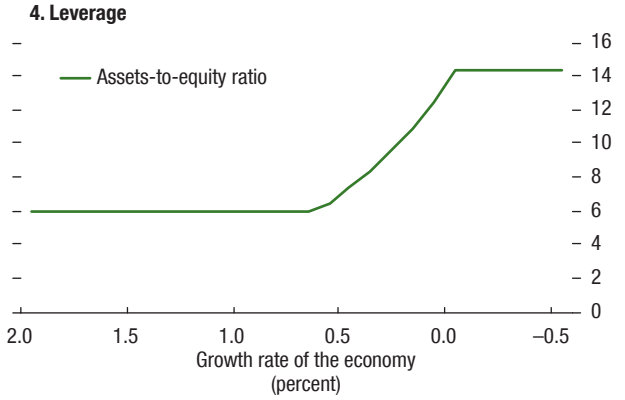
... compressing margins and profits.



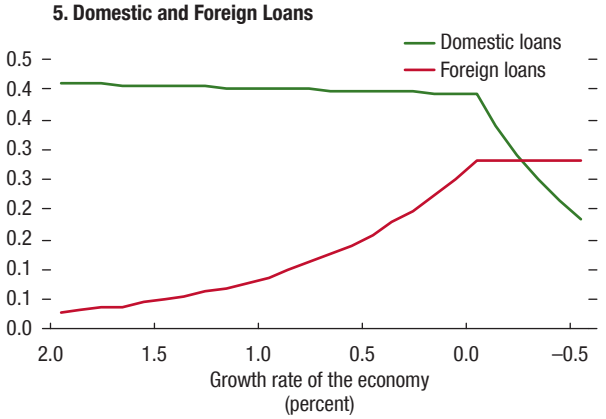
Deposit inflows invested in bonds ...



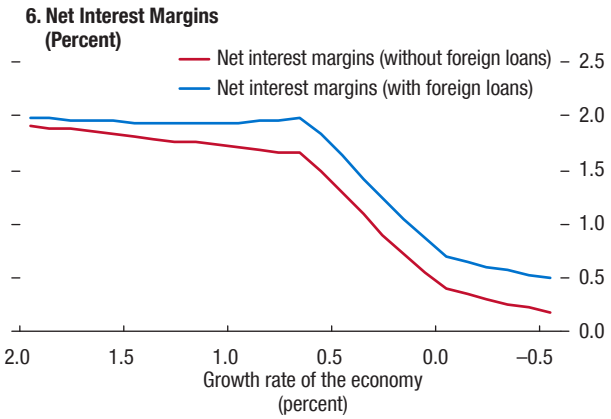
... raise bank leverage.



Banks respond by expanding lending abroad ...



... to maintain margins and profits.



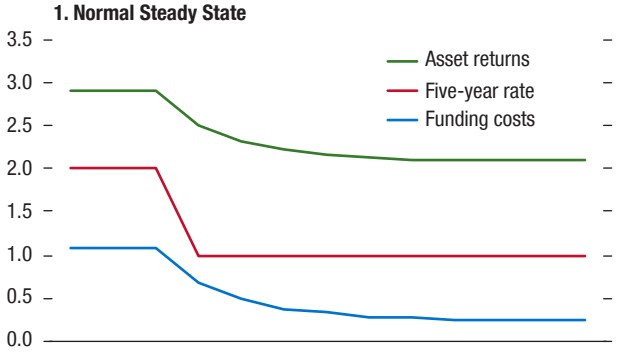
Source: IMF staff calculations (see Box 2.1).

banks, on the other hand, have sought to expand the diversification in their income sourcing. This strategy has been more effective, and these banks have faced little pressure to cut costs or to consolidate.

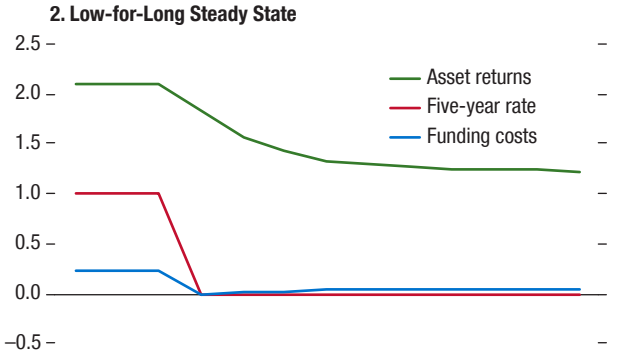
- *Assets and earnings:* Almost all the growth in the major banks' assets can be accounted for by the increase in international loans and securities, through both foreign branches and mergers with and acquisitions of foreign entities. The major banks have expanded their fee businesses outside Japan, including in emerging markets—for example, through the coordination of syndicated loans. Consequently, the share of income from international businesses has risen significantly, consistent with the model's predictions. The major banks have also been able to use their cross-product customer connections to increase noninterest income more effectively through fees and commissions on sales of investment trusts and life insurance products. By contrast, the smaller domestic banks have focused on growing their loan portfolios in urban centers (regional) and on expanding the maturity of their sovereign bond portfolios (regional and shinkin). Success has varied. Pursuing credit spreads has been more profitable, whereas the compression in term premiums has generated a relatively lower increase in returns to regional and shinkin banks from extending bond maturities.
- *Funding:* Major banks source about one-third of funding from capital markets. This has eased the consequences of the compression of domestic funding spreads around the deposit rate zero lower bound relative to regional and shinkin banks, whose deposits constitute over 90 percent of their nonequity financing.
- *Operational costs:* Regional and shinkin banks have cut these costs substantially by rationalizing their branch networks in the face of lower profitability. This is in contrast to the major banks, which have kept operational cost ratios almost flat for the past two decades.
- *Consolidation* has enhanced the effectiveness of strategies to maintain profits in the low-for-long environment. Consolidation can raise profitability by both cutting fixed operational costs and by increasing the banks' monopolistic power in deposit and loan markets. Recently, regional banks have pursued consolidation by forming financial groups to enhance their profitability.

Figure 2.4. Japan: Evolution of Bank Net Interest Margins in Normal and Low-for-Long Settings
(Percent)

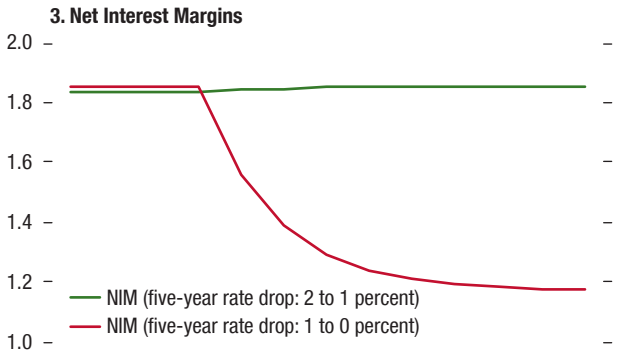
Asset returns and funding costs normally adjust proportionally as interest rates fall ...



... but asset returns fall significantly more once funding costs hit the zero lower bound ...



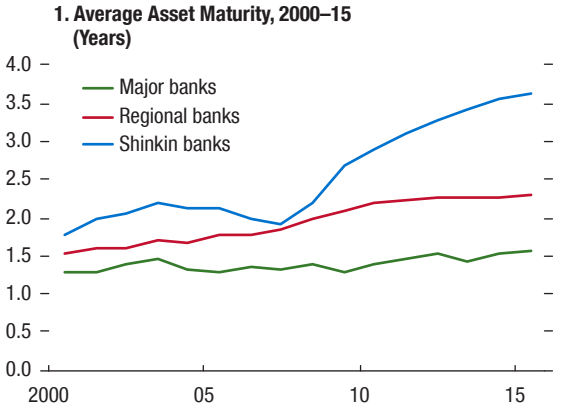
... compressing net interest margins in periods of prolonged low interest rates.



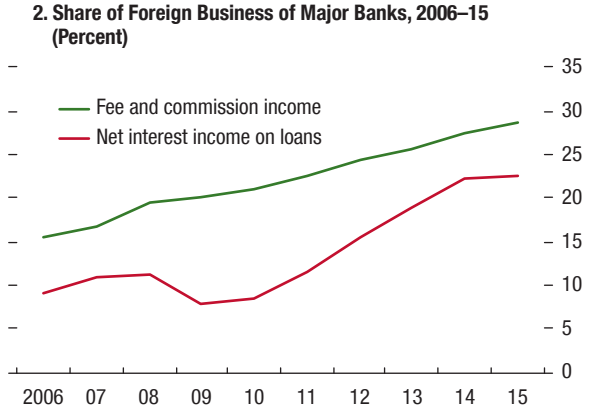
Sources: Fitch Connect; and IMF staff calculations.
Note: NIM = net interest margin.

Figure 2.5. Japan: Banks' Adaptation to the Deposit Rate Lower Bound Period

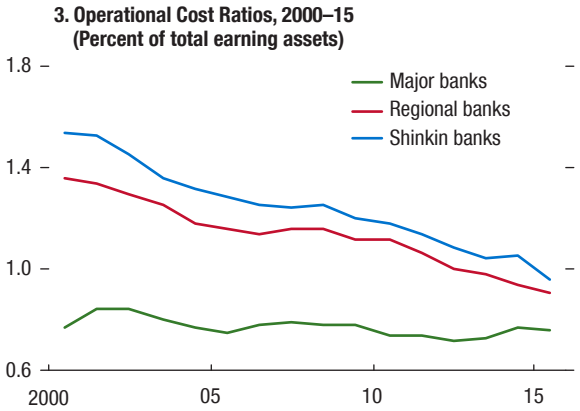
Smaller banks have taken more interest rate risk.



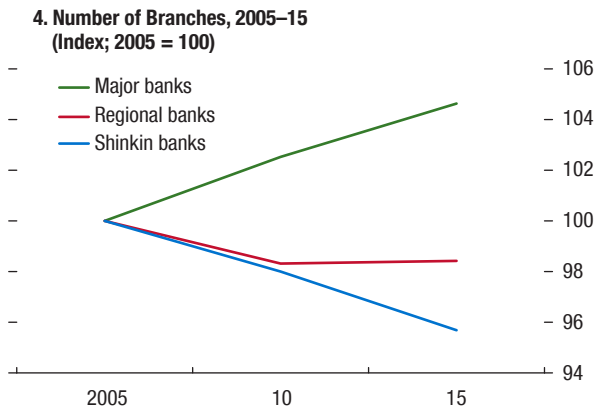
Large banks have expanded abroad.



Smaller banks have also cut costs ...



... in part, by closing branches.



Sources: Bank of Japan; Fitch Connect; Japanese Bankers' Association; and IMF staff calculations.

Alternative strategies have different risk implications. Major banks have maintained net interest margins and profits at the cost of higher cross-border market and counterparty risk. In particular, given the growing share of wholesale foreign currency funding used by major banks, the adverse impact of a tightening in these markets could be large (Chapter 1 of the October 2016 *Global Financial Stability Report* [GFSR]). Already, the costs of funding in this market have risen significantly due to market friction (Avdjiev and others 2016). Shinkin banks have increased interest rate risk by extending the average maturity of domestic bonds, but risk-adjusted returns have nonetheless increased modestly, given unusually low inflation and interest rate volatility during the past decade.

Cross-Country Experience with Prolonged Low Interest Rates[18]

Impact of Low-for-Long Episodes on Bank Profits

A cross-country analysis aims to compare, with other periods, bank profitability at times when interest rates are low *and* are expected to remain low for the foreseeable future. The approach uses a combination of criteria to demarcate these two types of periods. The first is that the short-term yield is below 1 percent. The second is that the "on-the-run," 10-year nominal bond yield is lower than the historical average of short-term policy

[18]Details of the empirical framework are in Annex 2.2.

Table 2.1. Classification of Bank Business Models

	Business Model 1 Wholesale funded, diversified geographically and by business line	Business Model 2 Deposit funded domestic credit intermediary	Business Model 3 Deposit funded, diversified by business line, domestic bank
Average Size (billions of U.S. dollars)	42	3	2
Average Loan-to-Asset Ratio (percent)	47	73	43
Average Deposit Funding Ratio (percent)	25	88	92
Average Share of Foreign Income (percent)[1]	17	2	4

Sources: Bloomberg L.P.; Fitch Connect; and IMF staff calculations.
[1]Data available for a significantly smaller subset of banks.

interest rates.[19] The reason for applying a double-threshold criterion is that it is typically satisfied only when both economic growth and nominal and real interest rates have been low for a considerable time—even if the dip in these measures initially resulted from an economic downturn or macro-financial instability.[20] The analysis also explores how the impact on profits depends on banks' business models (Table 2.1).[21]

Profits Are Lower in Periods of Prolonged Low Interest Rates

Prolonged periods of low interest rates are negatively associated with bank profitability (Figure 2.6, panel 1; Table 2.2). On average, sampled banks earn a 10½ percent return on equity, but in periods with prolonged low rates this falls to 7.8 percent. Consistent with previous literature, a drop in interest rates tends to increase bank profits in normal times. On the other hand, during periods of prolonged low interest rates, a 1 percentage point drop in three-month rates and in term premiums is estimated to reduce bank profits by 31 percent and 8 percent, respectively, below average estimated bank profits.[22]

[19]Some periods that are defined as having prolonged low interest rates under these criteria will not necessarily correspond to underlying economic conditions of low long-term equilibrium growth and interest rates. The results nonetheless provide valuable insights into the likely implications of such a scenario for the reasons cited in the text.

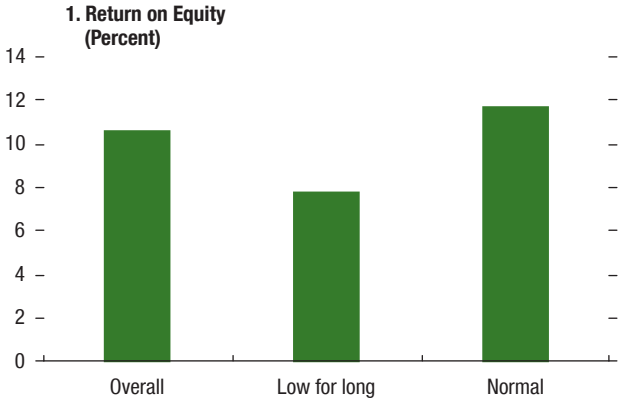
[20]Consequently, a significant proportion of temporary effects—near-term losses and balance sheet adjustments—have, arguably, already been worked out and the remaining effect on earnings is closer to the longer-term impact of prolonged low rates.

[21]The identification of business models relies both on several individual balance sheet indicators and on an approach in which a statistical model combines these multiple indicators to classify a bank's business strategy. The statistical (*clustering*) model is based on Roengpitya, Tarashev, and Tsatsaronis 2014.

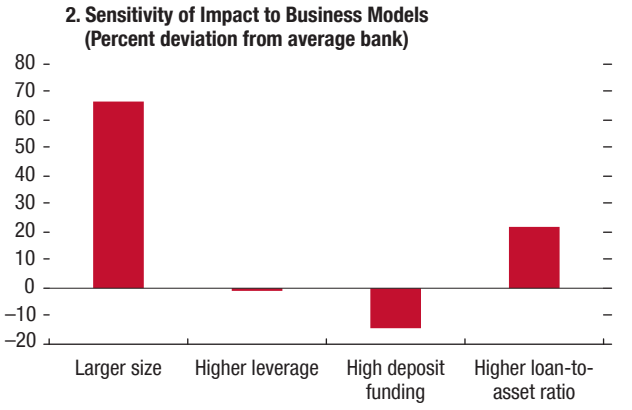
[22]Reported results are robust to controlling for the time-varying intensity of macroprudential policies, notably including enhanced prudential rules for banks in recent years. Stronger macroprudential policies are estimated to soften future profitability of banks but have an insignificant contemporaneous effect.

Figure 2.6. Prolonged Low Interest Rates and Bank Profits

Bank profits are significantly lower under prolonged low interest rates.[1]



The impact is very sensitive to bank characteristics.[2]



Sources: Bloomberg L.P.; Fitch Connect; IMF, *Monetary and Financial Statistics Manual*; Thomson Reuters Datastream; and IMF staff calculations.
[1]Profits in panel 1 are defined as the return on equity (ROE) averaged across all banks across all years in the sample horizon (overall) or for all years in periods with prolonged low and normal interest rates.
[2]Impact measures represent the deviations in ROE from the average bank ROE (in percent of average bank ROE) in periods of prolonged low rates after a one-standard-deviation change from the average value of each bank business model characteristic during such episodes. Only statistically significant results are shown.

Table 2.2. Bank Profitability and Equity Values in Periods of Normal and Prolonged Low Interest Rates

Dependent Variable: Return on Equity	Sign	Dependent Variable: Equity Price Return	Sign
Explanatory Variables		Explanatory Variables	
Prolonged-Low-Rate Period[1]	–		
Term Structure			
Three-Month Interest Rate	–		
Term Premium (normal period)	n.s.	Surprise on Monetary Policy Announcement Dates in Normal Times	–
Three-Month Interest Rate (prolonged low rates)	+		
Term Premium (prolonged low rates)	+	Surprise on Monetary Policy Announcement Dates in Prolonged-Low-Rate Periods	+
Bank Characteristics (prolonged low rates)[2]			
Size	+		
Leverage	–		
Deposit Funding Share	–		
Loan-to-Asset Ratio	+		
Controls		Controls	
Macro Controls		Macro Controls	
		Market Return	
Estimation Method	Bank FE, time FE	Estimation Method	Bank FE

Source: IMF staff calculations.
Note: The table shows the signs of the coefficients of regressors in the cross-country panel regressions of bank profits and daily equity returns that are statistically significant at least at the 10 percent level. Further details about regressions, variable definitions, and data sources are in Annex 2.2. FE = fixed effect; n.s. = not significant at the 10 percent level of significance.
[1]Periods of prolonged low interest rates are defined as described in the chapter.
[2]Denotes the sign and significance of bank business model characteristics in periods of prolonged low interest rates.

Resilience to Episodes of Prolonged Low Rates Depends Significantly on Banks' Business Models

Banks that are smaller, rely more on deposit funding, and have fewer lending opportunities tend to experience a significantly bigger dent in their profits (Figure 2.6, panel 2; Table 2.2). For example, a one-standard-deviation increase in the size of a bank's balance sheet significantly tempers the damage from prolonged low interest rates by raising bank profits an estimated 67 percent relative to the sample average for such periods. By contrast, a one-standard-deviation increase in the share of deposit funding and in the share of loans in the asset portfolio are associated, respectively, with estimated bank returns lower by 14 percent and higher by 22 percent than the sample average for such periods. Clustering the banks by business model confirms these results. Large, internationally more diversified, wholesale-funded banks tend to outperform other types of banks when interest rates are low for a long time. Their estimated average profit is 2.2 percentage points higher than that of deposit-funded domestic banks with small lending portfolios, which have the lowest estimated average profits during such episodes.

How Do Bank Equity Values Respond to Changes in Expectations Regarding a Low-for-Long Scenario?

Changes in stock returns are used to measure how changes in market expectations of future economic conditions affect banks' franchise values. A linear factor model is used to estimate the impact of changes in forward interest rates immediately following monetary policy announcements in periods of normal and prolonged low interest rates.[23] Daily stock returns around the dates of monetary policy decisions are analyzed to ensure that, to the extent possible, the equity price changes do not reflect the release of other relevant information on future economic conditions and bank profitability.

Monetary easing surprises affect bank equity returns differently in normal times compared with periods of prolonged low interest rates (Table 2.2). In normal times, unexpected monetary easing could generate expectations of higher economic activity and asset returns, fewer nonperforming loans, and higher spread income on fixed-rate assets—all of which increase expectations of future bank profits. Monetary easing surprises should, therefore, boost bank equity returns in normal times. During episodes of prolonged low interest rates, however, lower forward rates in response to monetary policy decisions are more likely to imply bad news for economic conditions and bank earnings.

[23]Monetary policy events are used only as exogenous shocks that provide new information about how long interest rates will remain low and hence about the impact on banks' future profits.

They should, therefore, lower equity returns.[24] Estimation results confirm this intuition.

Larger, more diversified, and more-wholesale-funded banks are less sensitive to monetary policy news during periods of prolonged low rates (Figure 2.7). This outcome may reflect the market's recognition of such banks' greater ability to adapt to changing domestic economic prospects—which corresponds both to theoretical prediction and to the experience of Japanese banks. In contrast, for smaller, deposit-funded, domestically oriented banks, the response of equity returns confirms their greater sensitivity to bad news about the domestic economy during prolonged low rates.

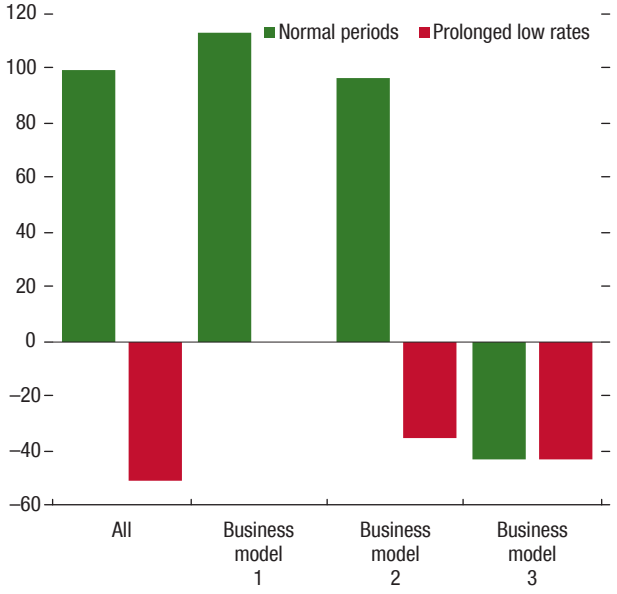
The Evolution of Banking over the Long Term

In a scenario of low natural rates, some consolidation in the banking industry is likely in the long term. Small deposit-funded banks that are less internationally diversified tend to suffer the largest hit to profitability. Eventually, consolidation could result through the merger of smaller banks or of midsize banks with smaller banks, and industry concentration could rise through the exit of nonviable institutions. Merged banks would have lower average operational costs, be more diversified, and have greater market power—all of which may mean less incentive to take excessive risks. The resulting industry structure could be more efficient and stable.[25]

Tail risk exposure is expected to increase. Over the medium term, banks, especially those that are smaller and less diversified, may actively seek longer maturities for their assets. Although less interest rate volatility in the scenario softens the risk implications of such a strategy, a large positive interest rate shock can mean significant losses. Banks would also feel pressure to increase, within regulatory limits, their share of wholesale funding, a more volatile source of financing than retail deposits. This would be particularly true for larger banks, because the low-for-long environment provides strong incentives to use capital market financing, especially for international expansion. Such a development may affect prospects for financial stability in their home and host countries, depending on the modality of expansion.[26]

Demographic factors, low productivity growth, and advances in financial technology will likely cause significant shifts in banks' business lines under this scenario. When the population ages, especially in a context of reduced income growth, demand for household loans falls, and deposits tend to rise (Imam 2013). Aging will also increase demand for transaction

Figure 2.7. Impact of Forward Rate Surprises on Bank Equity Returns
(Percent)



Sources: Bloomberg L.P.; Fitch Connect; IMF, *Monetary and Financial Statistics Manual*; Thomson Reuters Datastream; and IMF staff calculations.
Note: The figure depicts the estimated impact of a 1 percentage point surprise decrease in forward interest rates, occurring on monetary policy announcement dates, on the daily equity returns of banks relative to the estimated sample average impact of such surprises when interest rates are normal. For example, the far-left bar is the relative magnitude of the estimated impact on banks' daily equity return of forward rate surprises during normal periods, and is equal to 100 percent. Only statistically significant impact estimates are depicted as nonzero values. Business models are as defined in Table 2.1. Further details of the methodology are in Annex 2.2.

[24]More precisely, it would reflect the expectation of a lower net present value of future bank profits, even though the short-term impact of monetary easing could still be positive in such a period (though lower when deposit rates are at their zero lower bound).

[25]Some of the efficiency losses from consolidation, including higher funding costs for nonfinancial firms and reduced relationship banking for small and medium-sized enterprises, would be balanced by the gains from more rational branch networks and lower operational costs. Stability benefits may be significant, particularly if forces for consolidation are not strong for the large banks, preventing a worsening of the too-big-to-fail problem. In practice, bank mergers do not always achieve the desired scale economies, and can be fraught with difficulties in integrating participating banks' infrastructures and cultures.

[26]For a comparison of the stability implications of cross-border lending and expansion through subsidiaries, see Chapter 2 of the April 2015 GFSR.

services. However, if current trends in financial technology continue, the long-time preeminence of banks in payment services is not guaranteed. In addition, prospects for lending to domestic companies are also likely to be modest in this environment, because a shrinking population and low productivity imply fewer investment opportunities and lower loan demand. Finally, in a scenario of low rates, banks may lose market share in debt financing of larger companies, if financial technology allows nonbanks to price corporate credit risk, and low rates drive large firms to seek bond market funding. Consequently, business models of banks active in advanced economies may evolve toward fee-based and utility banking services even as fewer domestic lending opportunities motivate larger, internationally active banks to increase their exposure abroad, especially to emerging market economies.

Insurance and Pensions in a Low-Natural-Rate Economy

The life insurance and pension sectors face a formidable transitional challenge in a low-for-long economy. The large existing stock of liabilities offering guaranteed returns creates cash flow obligations over the medium term that are difficult to meet through investment income given lower interest rates and flatter yield curves. Therefore, in many cases, life insurers and defined-benefit pension plans may require additional capital. In the long term, the market for traditional savings products is likely to shrink, and insurers will focus more on protection products, particularly health insurance. Defined-contribution pension plans will probably continue to grow in importance because employees are likely to prefer these to employer-provided defined-benefit plans with benefit levels significantly lower than they are today.

Long-Term Implications for Insurance and Pension Business Models

In the low-for-long scenario, life insurers and sponsors of defined-benefit pension plans may have no choice but to significantly reduce benefits to policyholders and plan participants over the long term. With permanently low growth and interest rates, guaranteed rates of return are possible only if they are reset significantly lower.[27]

Pension Arrangements

A long-term transition from intergenerational collective risk sharing (defined benefits) to individual risk management (defined contributions) appears likely to continue. The combination of lower population growth, aging, and prolonged low interest rates will put pressure on retirement benefit levels. In such a situation, the long vesting periods of employer-provided defined-benefit plans mean that benefit cuts beyond a certain point could make them less competitive than defined-contribution plans, which offer more portability.[28] Portability makes defined-contribution plans attractive to younger employees, who value labor mobility. Over time, as the benefit differentials between the two types of plans dissipate under a low-for-long scenario, the balance will likely tip toward a labor market equilibrium in which defined-contribution plans play a larger role in the pension component of the benefits package. In the United Kingdom and the United States, where this transition is furthest along, the shift to defined-contribution corporate pension plans will likely accelerate due to the recent tightening of reporting and solvency standards. Other countries are attempting a hybrid approach, and their private pension systems embed features that may make for a slower and less extensive transition.[29] For example, multiemployer defined-benefit plans, such as the traditional industry-level arrangements in the Netherlands, will be more resilient in the face of such a scenario, since they offer built-in portability to beneficiaries within industries.

Life Insurers

The market for guaranteed-return life insurance savings products is likely to shrink under this scenario

[27]The remainder of this section does not aim to capture all factors that may be relevant to the long-term evolution of pension arrangements and insurance business models, such as changes to labor supply (including to retirement ages), and social safety nets.

[28]Administrative and actuarial valuation costs limit the portability of defined-benefit plans compared with defined-contribution plans. The traditional advantage of defined-benefit pension plans is superior risk sharing between sponsor and pensioner and across generations of beneficiaries; low asset returns under the scenario and the demographic changes underlying it reduce this advantage.

[29]The Netherlands has opted for a solution that reduces the retirement base salary from a high share of final salary to a lower career average share. Moreover, the system has removed the guarantee, but not the aspiration, to indexed pension payments. This allows for a collective approach to asset management, so that active participants can continue to benefit from equity investments suitable to their age and retirees continue to enjoy indexation and incur less risk of benefit cuts (Ponds and van Riel 2007).

with insurers focusing more on the unit-linked business segment.

- Population aging and rising longevity should raise the demand for life annuities, but countervailing forces may exist (Yaari 1965; Turra and Mitchell 2004; Davidoff, Brown, and Diamond 2005; De Nardi, French, and Jones 2010; Lockwood 2012). Where social safety nets are not sufficiently generous, longer life spans could increase demand for precautionary savings and liquid assets to cover out-of-pocket health expenses in retirement. At very low rates of interest, administrative costs of managing annuity portfolios may tip relative returns in favor of bonds and demand deposits.[30] Finally, a continuing switch from defined-benefit to defined-contribution pensions in such a scenario may also contribute to reducing annuity demand if very low take-up rates of voluntary annuitization (as in the United States) continued to prevail.[31] The combined effect of these forces on annuity demand is ambiguous.
- Life insurers may increasingly seek to expand into so-called unit-linked products on the savings side, where investors bear the risk of asset price volatility. These products make up a significant share of insurer business in such countries as Australia, Belgium, Canada, Ireland, Sweden, the United Kingdom, and the United States.

However, it is unclear what fundamental advantages insurers have in offering these products. Insurers' ability to compete for household savings through these products will increasingly depend on how they stack up against retail investments offered by asset managers. If the tax advantages currently enjoyed by unit-linked products disappear, a portion of household savings could shift over to funds offered by asset managers.

Demand for health and long-term care insurance and for new products may increase significantly. Koijen, Van Nieuwerburgh, and Yogo (2016) clarify that as households age, the value of life insurance progressively falls, the value of health insurance peaks only at a very advanced age, and that of long-term care insurance progressively rises. Population aging and increased longevity could, therefore, give a boost to new products that automatically replicate the life-cycle profile of an optimal package of insurance, eliminating the need for potentially costly active rebalancing by households.

[30]For example, demand for liquid assets has risen in Japan in a context of population aging and prolonged low interest rates (Suzuki 2005).

[31]The experience of Chile suggests that a transition to defined-contribution pensions may also increase voluntary purchases of deferred life annuities (Rocha, Morales, and Thorburn 2008). In Chile, pension reform resulted almost exclusively in defined-contribution plans starting in the early 1980s, and the annuity industry subsequently expanded as workers in the new system reached retirement age—about 60 percent of retired workers opt for an annuity instead of a phased withdrawal option.

A Difficult and Long-Lasting Transition

The challenge for insurers and pension funds is the medium-term impact of prolonged low interest rates on profits and solvency. Their assets are often of significantly shorter duration than their liabilities. Given the lower interest rates and flatter yield curves of the scenario, they will be forced to reinvest assets at significantly lower rates of return much earlier than their higher, fixed-rate obligations terminate. Can they, without assuming significantly greater risk, adjust their asset portfolios to meet cash flow obligations incurred in an environment of higher growth and interest rates? If not, what other options do they have to safeguard solvency?

Insurance Companies

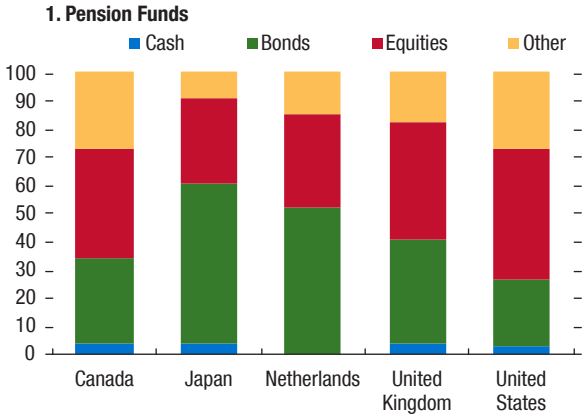
Not all insurers face this transitional challenge. Non–life insurance businesses, whose liability duration is short and whose main income source is profits from underwriting, are relatively unaffected. By contrast, long-term, guaranteed-payout businesses are especially vulnerable because when interest rates fall, a negative duration gap boosts the present value of a company's long-term liabilities much more than it boosts the present value of its assets. Other factors are options offered to policyholders that increase insurer losses when interest rates are low, and the difficulty of raising premiums due to competition and high price elasticity of demand for their savings products (Swiss Re 2012; Koijen and Yogo 2015).

Defined-Benefit Pensions

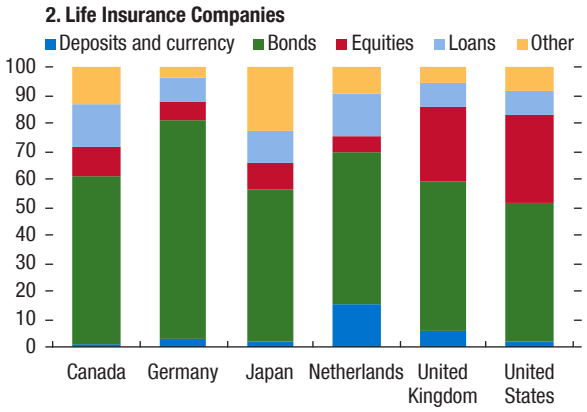
Defined-benefit pension funds with substantial vested obligations suffer most in a low-for-long environment. Because expected life spans after retirement are long, projected pension obligations can be seen as a large portfolio of long-term nominal bonds (real bonds, if the pension contract offers indexation) with coupon payments corresponding to normal interest rates. Pension plan sponsors would

Figure 2.8. Asset Allocation of Pension Funds and Insurers, 2015
(Percent)

Excluding Japan and the Netherlands, pensions place less than a third of funds in bonds.



Life insurers consistently invest a majority of their portfolios in bonds.



Sources: Bank of Japan; Centraal Bureau voor de Statistiek; Deutsche Bundesbank; GDV, Statistical Yearbook of German Insurance; Statistics Canada; U.K. Office of National Statistics; U.S. Federal Reserve; and IMF staff calculations.
Note: In panel 1, pension funds include defined-benefit and defined-contribution plans. In panel 2, for the Netherlands and the United Kingdom, the numbers exclude assets invested through mutual funds in separate accounts.

be hard-pressed to find a duration-matched risk-free bond portfolio to deliver the required cash flow in a low-for-long economy.[32]

[32]In contrast, sponsors of defined-benefit pension plans with a majority of actively employed, younger participants have several other options to actively manage the (future) accumulation of pension obligations. These options may render a smoother adjustment to such an equilibrium, including raising the retirement age and grandfathering current arrangements and subsequently reducing the replacement rate and removing indexation.

Can Existing Product Lines Be Maintained by Changing Asset Allocation?

Adopting a liability-driven investment strategy is recommended as an effective way for life insurers and pension funds to hedge against economic risks. For a life insurer or a mature or closed defined-benefit pension plan, liability-driven investment would entail finding a bond portfolio whose duration is similar to the bond-portfolio-like structure of its liabilities (Figure 2.8).[33]

Life insurers and defined-benefit pension plans tend to enter a period of low interest rates with reduced economic capital buffers (insurance companies) or a higher funding gap (pension funds).[34] This situation significantly complicates financial risk management for these institutions. On the one hand, portfolio decisions will need to continue to be guided by considerations of minimizing the adverse impact of market risk, in particular future interest rate volatility. This will call for an asset portfolio of bonds with cash flow characteristics to match cash outflows. On the other hand, given the wider funding gap, institutions have an incentive to generate returns on assets that exceed returns on liabilities in a sufficient amount to close the gap. This may call for riskier portfolios with a heavier weight on equities and alternative assets.

Can these institutions recover solvency margins and close funding gaps through changes to asset allocation, and, if so, how long would that take? A scenario simulation examines an underfunded defined-benefit pension fund faced with the choice of alternative portfolios of fixed-income and other assets; that is, evaluating the trade-off between the time it will take each portfolio to return it to fully funded status and the solvency risk entailed.[35]

Recovering adequate solvency margins by changing asset allocation appears feasible only by taking potentially unacceptable levels of risk (Box 2.3). The simulation shows that the volatility risk life insurers and defined-benefit pension funds would need to absorb is very high. This would either deter them from ven-

[33]The share of equity investments in the asset portfolios of pension funds may reflect the degree to which beneficiaries can rely on alternative sources of retirement income.

[34]The reason is the presence of significant negative duration gaps, as described earlier. A defined-benefit pension plan is said to have a *funding gap* when the present value of its assets is less than the present value of its projected benefit obligations.

[35]The simulation adapts the analytical approach of Leibowitz, Kogelman, and Bader (1995) and Leibowitz and Bova (2015).

Table 2.3. Capital Charges for Risky Investments by Insurers
(Percent)

	Solvency II (standard approach)	U.S. Risk-Based Capital Requirements	Japanese Solvency Margin Ratio
Listed Equity	22	15	20
Private Equity	49	30	20
Non-Investment-Grade Corporate Bonds	Up to 37.5 (five year)	30 (Class 6)	30
Real Estate	25	15	10

Source: Financial supervisory authorities in euro area, Japan, and the United States.

turing into such portfolios or entail the risk of falling afoul of regulatory constraints. For example, prudential regulation of insurers prevents significant reach for yield across broad asset classes or across risk categories within fixed income (Becker and Ivashina 2015). Many regulators' risk-based capital requirements for insurance companies comprise high capital charges for risky investments, including equity, non-investment-grade bonds, real estate, and alternative investments (Table 2.3). Expected returns on those assets may not compensate for the higher (regulatory) capital charge. This may explain why search for yield in the insurance sector so far has been moderate (Chapter 3 of the April 2016 GFSR). In the case of defined-benefit pensions, regulatory reform for corporate plans in the United States has resulted in tough penalties for underfunding, which also discourages excessively risky investment strategies. Public pension plans organized on a defined-benefit basis in the United States are an important exception: regulatory and accounting rules may encourage so-called gambling for resurrection incentives, especially in an environment of low returns on safe assets.[36]

The preceding analysis makes clear that asset allocation changes alone cannot adequately address the solvency challenge posed by negative cash flows on the current portfolio of liabilities. This means that, in the medium term, insurers and sponsors of defined-benefit pensions must find a way to capitalize their losses. A number of options are potentially available, including those discussed below. However, it seems likely that these institutions will have to make a fresh investment of equity capital to cover part of the loss.

- Insurers can attempt to expand the scale of their nonlife and protection businesses to generate earnings and cover some of the loss from their savings business. Other than health insurance, though, it is unclear whether, in the low-growth environment with an aging population, they can achieve the necessary business growth. The largest firms in the life insurance sector may gain market share if financial difficulties drive some of these insurers out of business.[37]
- Since many firms' defined-benefit pensions are mature or closed, and pension obligations are large relative to their businesses, the variation in the plans' net values due to market volatility increasingly drives companies' financial results. Transferring these pension obligations, or at least their financial risk, to insurers after recapitalizing the plans to close their funding gaps is an attractive option and has boosted growth of the market for pension risk transfers. At the level of the aggregate population, the mortality risk business provides insurers a natural hedge against longevity risk. Pension risk transfers may represent a market-efficient arrangement under which nonfinancial firms close out defined-benefit plans and sell them to insurers at actuarially fair prices. Regulation could play an important role in this area by facilitating such transactions.

The severity of the transitional challenge portends large business model adjustments in the life insurance industry's long-term-savings businesses in the medium term. Lower and less flexible guarantees on returns can be expected. Insurers may be given the option to

[36]This discussion presumes that current regulatory rules remain stable even under the chapter's scenario. The analysis does not formally examine the strength of gambling for resurrection incentives in a low-for-long economy highlighted in the literature (Antolin, Schich, and Yermo 2011) because such incentives reflect a more complex combination of regulatory and accounting factors. See, for example, Addoum, van Binsbergen, and Brandt 2010 for the case of U.S. corporate plans, and Andonov, Bauer, and Cremers 2016 for U.S. public plans.

[37]Japan's long experience with low interest rates has led to supervisory intervention in the case of seven insurers whose losses on existing stocks of guaranteed return liabilities proved impossible to absorb, even though the firms had reduced guarantee levels on new contracts.

adjust guarantees at regular intervals to reflect evolving market conditions. Regulation can play an important role in encouraging a switch to more sustainable business models. This switch will inevitably occur in part as a result of new regulatory and accounting regimes requiring economic valuation of portfolios and full recognition of the economic costs of long-term guarantees. Implementation or introduction of legal and regulatory requirements for reduction and adjustment of costly guarantees and options would support such a switch.

Asset Allocation, Market Finance, and Financial Stability

Households are likely to change their asset allocations in a low-for-long environment. First, demand for bank deposits should rise. Once deposit rates hit the zero lower bound, they become relatively more attractive as returns on other assets become very low—in particular, because bank deposits enjoy a liquidity premium and are usually guaranteed. Second, population aging may, under certain conditions, drive up the share of bonds in asset allocations at the expense of equities for several reasons. Various studies have pointed out that the equity risk premium tends to rise with age because older households have limited ability to earn labor income that can hedge effectively against wealth shocks from losses on equity portfolios (Jagannathan and Kocherlakota 1996).[38] For example, in the United States, older households have demonstrated a tendency to completely switch out of equities at the time of annuitization and withdrawals (Ameriks and Zeldes 2004).[39]

The share of asset managers in financial intermediation is also likely to increase for several reasons.

- Changes to pension arrangements may result in higher household demand for investment of retirement savings through asset managers. Investments of defined-contribution pension plans in the United States tend to be intermediated into both equities and bonds via mutual funds—more than for defined-benefit plans, in which direct investments are more common (Broadbent, Palumbo, and Woodman 2006).
- As discussed in the preceding section, insurers may lose clients to investment funds.
- Finally, as explained earlier, financial technology could drive up the share of market funding of nonfinancial firms, particularly large firms, with direct bank lending focusing more on small businesses.

How quickly such a development takes place could depend on how developed debt capital markets are. Countries with deep corporate bond markets and well-developed retail investment products (such as exchange-traded funds), like the United States, may make a quicker transition than other advanced economies.

Prolonged low rates may promote further growth in the average size of mutual funds and of the relative importance of index funds. Low asset returns under an equilibrium with low natural interest rates will combine with competitive pressure on mutual fund fees to make it increasingly difficult for smaller funds to survive, as has already happened in the money market fund sector in the United States (Chodorow-Reich 2014). The environment also puts active managers at a significant disadvantage relative to passive funds, such as exchange-traded funds, given that excess returns may no longer be high enough to justify fee differentials. Following already remarkable growth over the past two decades, this would place index funds front and center in financial markets in their share of assets both managed and traded (Figure 2.9).

The growth in index funds can present a challenge to financial market efficiency. Indexing promotes access to financial markets at lower cost and should facilitate portfolio diversification. However, as index investing through exchange-traded funds has become more prevalent, it appears to have increased the role of nonfundamental factors in determining both asset returns and their comovement.[40] A number of studies

[38]Such an outcome is very sensitive to the coverage and benefit levels promised by social insurance. Where these are generous, demand for risky assets such as equities can remain robust even in old age (Ang and Maddaloni 2005). However, generous social security benefits may be difficult to sustain fiscally with low long-term growth.

[39]The relationship between investment in equities and demographic structure is significantly richer (Goyal 2004). A higher dependency ratio would, all else equal, reduce investment in equities, but this would be attenuated or even reversed if the middle-age share of the population rose at the same time.

[40]For the price effects of inclusion into and deletion from the Standard & Poor's 500 index, see, for example, Chen, Norohna and Singal 2004; and Kasch and Sarkar 2011. Barberis, Shleifer, and Wurgler (2005) discuss the role of nonfundamental factors in driving market betas of stocks of firms included and deleted from the Standard & Poor's 500 index and quantitatively assess their relative significance.

have shown that widespread index investing could ultimately result in detachment of asset returns from information regarding fundamentals, hence thwarting price discovery (Barberis and Shleifer 2003; Wurgler 2010; and Sullivan and Xiong 2012).[41] Finally, benchmarking may have a detrimental impact on price discovery in additional ways. For example, it appears to motivate even sophisticated investors to overweight high-beta assets (Baker, Bradley, and Wurgler 2011).

Three important financial stability issues stem from the rising share of asset managers and index funds in financial intermediation in a low-for-long economy. First, as emphasized in earlier reports, stronger oversight of, and liquidity risk management by, mutual funds are needed, especially if investors continue to seek exposure to illiquid assets (Chapter 2 of the October 2015 GFSR). Second, the combination of larger fund sizes and increasing passive index investing carries potential new financial stability risks because of less diversity on the buy side and investors' greater proclivity to respond in the same way to shocks (Sullivan and Xiong 2012). Third, herd behavior among fund managers (which can be destabilizing) remains a concern (Chapter 3 of the April 2015 GFSR).

Policy Implications and Conclusions

Policies would help in the adjustment to a low-for-long environment. Prudential frameworks would need to provide incentives to ensure longer-term stability instead of falling prey to demands for deregulation to ease the short-term pain.

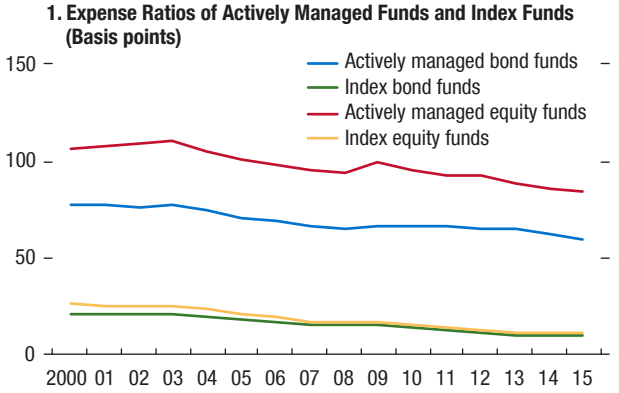
In a scenario of low interest rates and low growth, policymakers must help enable a smooth adjustment of financial institutions' business models. In the case of banks, this includes not hindering and, where feasible, actively facilitating consolidation for smaller institutions and liquidation of nonviable businesses where this is judged to be desirable from efficiency and financial stability perspectives (Chapter 1 of the October 2016 GFSR). For life insurers, a transition to the new contemplated regulatory and accounting regimes requiring more economic valuation is appropriate. These regimes encourage accurate recognition of the economic costs of long-term guarantees in the pricing of these products. Policymakers would do well to support efforts in this direction even in the face of competitive and political pressure.

Policy can play a vital role in guiding better financial planning by households in this scenario. Given the potential pressure on households' financial security in retirement, both through lower returns and less potential for collective risk sharing, encouraging more annuitization at retirement may be beneficial. Options include clearer delineation of its benefits and more

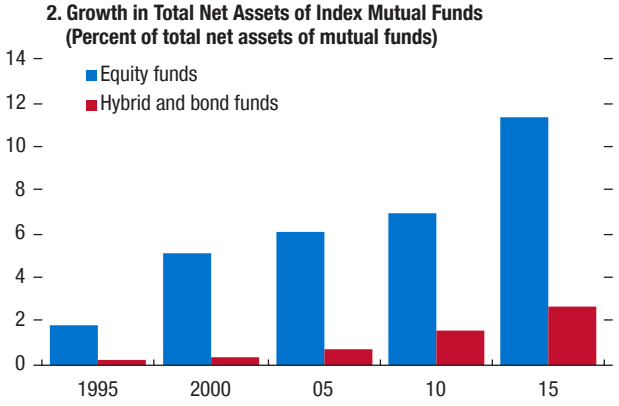
[41]Wurgler (2010) and Sullivan and Xiong (2012) also note that the rising prevalence of benchmarking active managers to indices and of overlap in constituent securities across multiple indices exaggerates the detachment problem.

Figure 2.9. U.S. Mutual Fund Expense Ratios and Growth of U.S. Index Funds

Fees charged by active funds are significantly higher than those charged by index funds.



The share of index funds has increased dramatically over the past two decades.



Sources: Investment Company Institute; and IMF staff calculations.
Note: The expense ratio is the annual fee charged by a mutual fund to its shareholders, defined as the percentage of assets deducted for fees and administrative expenses.

widely available options for automatic enrollment in employee defined-contribution plans.

Prudential authorities would need to contain incentives arising in a low-for-long scenario that may increase exposure to tail risk. Banks may respond to incentives in this environment with wider maturity mismatches, higher leverage, or more wholesale funding (within regulatory limits). Insurance and pension regulators that have not yet introduced economic solvency requirements would need to implement such regulations as soon as practical. Public pension funds in the United States are allowed to discount liabilities at expected rates of return on their asset portfolios. They have taken advantage of this opportunity by aggressively investing in risky assets, with negative financial results (Andonov, Bauer, and Cremers 2016). Aligning liability discounting rules with those for corporate pension plans in the United States would safeguard the solvency positions of these institutions from further erosion.

Surveillance and regulation of asset management activities will become even more important if this industry's share of the financial system continues to grow. Further strong growth of the sector can contribute to financial stability, but also entails new challenges. For example, if passive index investing becomes preeminent, price discovery could be hampered and markets could become more prone to swings in sentiment. More generally, as emphasized in earlier reports (Chapter 3 of the April 2015 GFSR; Chapter 2 of the October 2015 GFSR), closing significant data gaps and implementing adequate macroprudential rules to address risks, such as those related to liquidity mismatches, are essential for effective surveillance and to contain systemic risk.

Box 2.1. A Simple Model of Banking in a Low-for-Long Economy

In a model of a monopolistically competitive banking industry, equilibrium profits are reduced at very low interest rates in a low-for-long scenario if banks are unable to charge negative rates on deposits. In addition to lower profits, the model implies that bank leverage will increase in such a scenario. Banks may be able to attenuate this by expanding their international lending and investment activities.

The analysis builds on the Monti-Klein model, in which banks' profits reflect their market power in lending and deposit markets (Freixas and Rochet 2008, Chapter 3). In the model, lending and deposit rates adjust flexibly and instantaneously in response to the market interest rate.[1] The bank's assets consist of loans (L) and bonds (B); its liabilities consist of deposits (D), wholesale funding (W), and equity (E):

$$L + B = D + W + E.$$

The bank's profit (*before dividends*), π, is then defined as

$$\begin{aligned}\pi &= (R_L L + R_M B) - (R_D D + R_M W) - kL \\ &= (R_L - R_M - k)\mathrm{L} + (R_M - R_D)D + R_M E,\end{aligned}$$

in which R_L, R_D, and R_M are the loan rate, the deposit rate, and the market interest rate, respectively.[2] k is the marginal cost of lending. The bank's profit consists of the lending revenue, $(R_L - R_M - k)L$, and deposit revenue, $(R_M - R_D)D$.[3]

In the model, the bank optimally chooses the loan rate, R_L, and the deposit rate, R_D, so as to maximize its profit, π, subject to (1) the market rate, R_M; (2) the economic growth rate, g; (3) the balance sheet constraint; (4) the loan demand function; (5) the deposit supply function; and (6) market friction, namely, the zero lower bound on deposit rates. Because the economy is at, or close to, its steady state in the model, R_M can be set equal to g. Then, intuitively, loan demand is assumed to be a decreasing function of R_L relative to g. And deposit supply is assumed to be an increasing function, R_D, relative to R_M.[4] The zero lower bound for the deposit rate is introduced to account for the fact that banks find it difficult to charge negative rates to (retail) depositors, even at very low levels of $g = R_M$, when it is optimal to do so.[5]

As long as g is high and R_M is well above zero, the loan spread $R_L - R_M$ and the deposit spread $R_M - R_D$ as well as the loan and deposit volumes are (almost) independent of the market interest rate. As a result, lower market interest rates have a negligible effect on bank profits, and the excess return for bank shareholders, $\pi/E - R_M$, is nearly constant.

However, once g declines to levels at which the optimal deposit rate becomes negative, that is, the zero lower bound on deposit rates binds, lower R_M entails a negative effect on bank profits because of the compression in deposit spreads and, hence, in net interest margin. The narrowing deposit spread makes it more attractive to bank creditors to invest in deposits relative to other, market-based investment products at very low interest rates. This increases deposit inflows and bank leverage as R_M falls.[6] However, the negative effect of lower net interest margins on bank profits is stronger than the positive effect of rising balance sheet size and leverage because new deposits are invested in low-interest-earning bonds and not in higher-interest-earning loans in the low-growth environment.

Finally, when deposit rates are at their zero lower bound, if the economy contracts in equilibrium ($g < 0$), lending will contract and add to pressure on bank profits coming from compressed margins. This is because R_M, itself bounded below by zero, can no longer match the natural rate of interest (equal to g), resulting in lower demand for loans.

The author of this box is Mitsuru Katagiri.

[1]Consequently, the impact of an equilibrium with low natural rates on bank earnings does not ensue from differences in the average maturities of banks' assets and liabilities implied by maturity transformation.

[2]Banks are assumed to borrow and lend freely at the rate R_M. One of interpretations of R_M is the interbank market rate, but in countries where the loan-to-deposit ratio is far below 1, as in Japan, R_M can be interpreted as the rate of return on government bonds.

[3]Since profits are measured before dividend distribution, returns to equity are added back in.

[4]The assumption for loan demand is based on the fact that nonfinancial firms tend to increase their borrowing if the lending rate is low relative to the rate of economic growth. For deposit supply, on the other hand, the assumption implies that depositors decide on the amount of their bank deposits by comparing them with other market-based products, including money market funds. Positive deposit spreads reflect household liquidity needs. See Nagel, forthcoming.

[5]An alternative micro foundation for an effective lower bound on deposit rates is to introduce a preference for cash relative to deposits that is a function of their relative rates of return (Drechsler, Savov, and Schnabl 2016).

[6]In practice, leverage constraints will eventually force banks to raise capital or decline further deposit inflows.

Box 2.1 *(continued)*

Geographic diversification through businesses that operate internationally may mitigate the decline in banks' profitability under the low-for-long scenario. Under the assumption that economic growth in foreign countries is independent of that in the home country, the model implies that the lending spread for foreign loans is independent of R_M. Hence, under the low-for-long scenario, the bank can temper the decline in profitability of domestic businesses by increasing its portfolio of foreign loans.

Richer models are necessary to provide more comprehensive guidance on the implications of the low-natural-rates scenario for banks, for example, regarding risk taking in the steady state. This is an important area for future research.

Box 2.2. How Have U.S. Banks Reacted to the Low-Interest-Rate Environment?

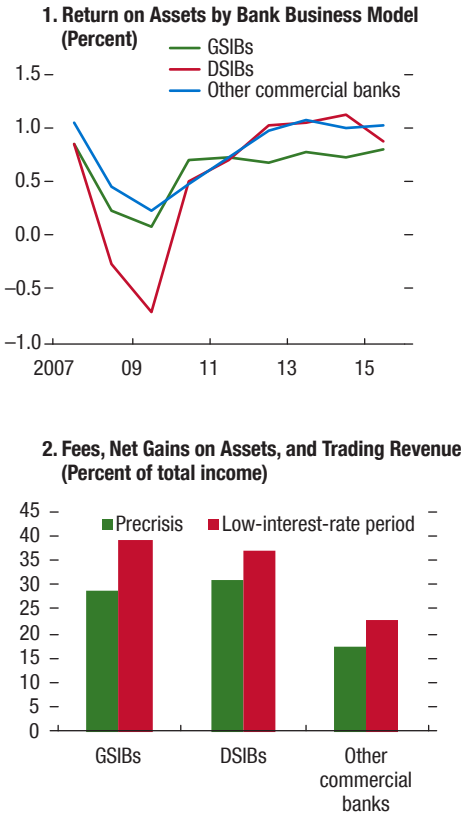
The recent experience of the United States does not lend itself to direct conclusions about the scenario considered here. Nonetheless, reviewing the response of U.S. banks to the prolonged period of very low interest rates may provide valuable additional insights into how banks may adapt to such circumstances.

After a significant dip around the Lehman Brothers bankruptcy, bank profitability in the United States has returned to precrisis levels (Figure 2.2.1, panel 1). A range of adaptation strategies are evident across banks of different sizes.

A common strategy is the increased focus on fee-based businesses and trading. The share of noninterest income in banks' total income has risen compared with the precrisis period (Figure 2.2.1, panel 2). The increase ranges from 5 to 10 percentage points depending on bank size and business model, with the largest increase observed for global systemically important banks. In particular, selected components of noninterest income, such as fees, net capital gains, and trading revenue, have grown significantly during the low-interest-rate period.

Banks have also increased the maturity of their assets, potentially seeking, as far as possible, to conserve interest margins from lending and bond investing.[1] Interestingly, banks that least successfully increased earnings from fees and trading are also the ones that most aggressively pursued this strategy. In

Figure 2.2.1. Bank Earnings and Noninterest Income since 2007



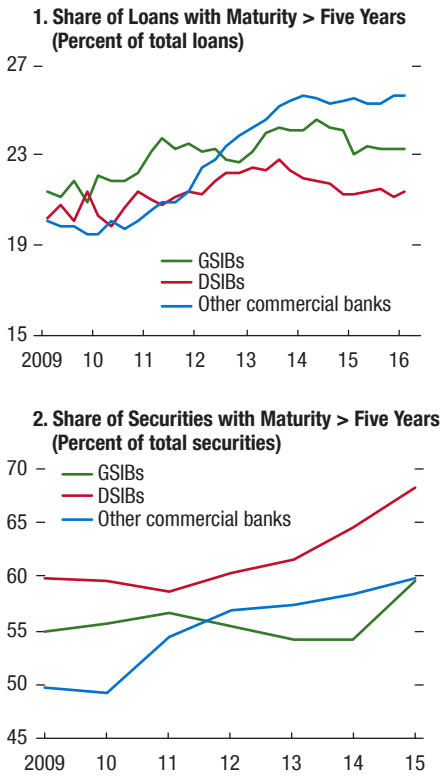
Sources: Call Reports of U.S. banks; and IMF staff calculations.
Note: "Fees, net gains on assets, and trading revenue" include service charges on deposits, net gains on loans and leases, net gains on sales of other assets, trading revenue, venture capital revenue, brokerage commissions, and investment banking advisory fees. DSIBs = domestic systemically important banks; GSIBs = global systemically important banks.

The authors of this box are Gee Hee Hong and Frederic Lambert.

[1]Low interest rates have increased demand for refinancing of residential mortgage loans into fixed-rate longer-maturity contracts, which also contributed to the lengthening of the average maturity of banks' asset portfolios. However, this does not explain why smaller banks have experienced a greater increase in average maturity of loans and securities.

Box 2.2 *(continued)*

Figure 2.2.2. Maturity Distribution of Bank Assets since 2007



Sources: Call Reports of U.S. banks; and IMF staff calculations.
Note: Securities include debt securities issued by the U.S. Treasury, U.S. government agencies and states, and political subdivisions in the United States; other nonmortgage debt securities; and mortgage pass-through securities. DSIBs = domestic systemically important banks; GSIBs = global systemically important banks.

smaller banks, the ratio of loans maturing in more than five years to total loans rose by more than 25 percent between 2011 and 2016 (Figure 2.2.2). In contrast, the average maturity of global systemically important banks' and domestic systemically important banks' loan portfolios has not changed significantly. In securities portfolios, both domestic systemically important banks and smaller banks have lengthened the average maturity of their portfolios by increasing the share of longer-term securities.

Box 2.3. Pension Fund Exit from Underfunding: Risk-Return Trade-off

The simulation analyzes how quickly pension funds can exit underfunded status, depending on asset allocation. Three strategies are considered: a high weight on bonds (*high bonds*), a high weight on equities (*high equity*), and a balanced portfolio strategy (*balanced*). Actual 2016 data are used to calibrate the risk-return profile of fixed-income and other assets (Table 2.3.1).[1] A fixed return of 4 percent is assumed for liabilities, consistent with the current discount rate implied by the Citi Pension Liability Index for U.S. corporate defined-benefit plans.

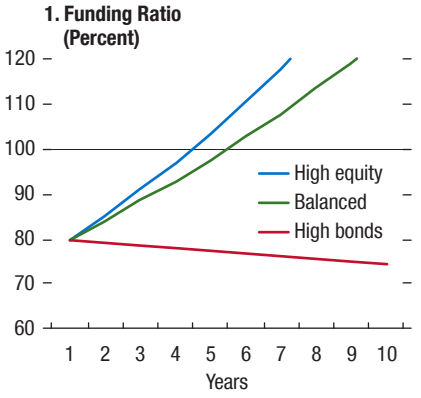
The initial funding ratio in present value terms is set at 80 percent, the current industry average for U.S. corporate defined-benefit plans.[2] Moving from fixed income and into other asset classes brings higher expected returns, but at a cost of greater return volatility, meaning that a fast exit from underfunded status depends on more volatility in the funding ratio.

For example, the low-risk, *high-bond* portfolio cannot help the fund achieve fully funded status. Even the portfolio allocation most tilted toward equity would require about four and a half years to reach full funding, with annual risk equal to 8 percent of the asset portfolio value a year (Figure 2.3.1, panel 1).

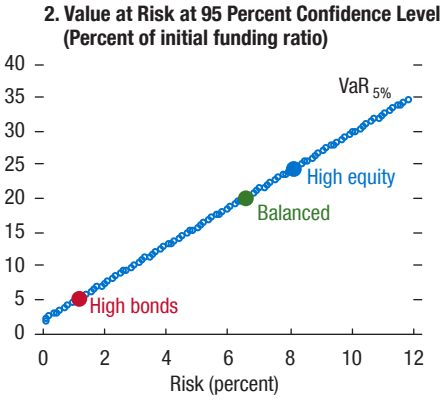
Potential losses from the *high-equity* strategy and from the *balanced* strategy can amount to up to 24 percent and 20 percent of market value of assets, respectively, in a single year at a 95 percent confidence level (Figure 2.3.1, panel 2). The expected time to fully funded status and the corresponding risk are highly sensitive to their initial underfunding. A fund with an initial funding ratio of 90 percent can achieve fully funded status in just two years with an asset portfolio whose return volatility is 7 percent a year, but would take more than four years with the same portfolio and a funding ratio of 80 percent.

Figure 2.3.1. Risk-Return Trade-off and Expected Times to Exit Underfunding

High-equity strategies can return a pension fund to solvency, but a high-bond strategy cannot.



High-equity strategies entail very high levels of risk, which can result in insolvency.



Sources: Bloomberg L.P.; Thomson Reuters Datastream; and IMF staff calculations.

The authors of this box are Sheheryar Malik and Jorge Chan-Lau.

[1]Specifically, the return on fixed-income assets corresponds to the annualized yield on monthly 10-year U.S. Treasury bonds; on other assets, it is the annualized monthly return on the Standard & Poor's 500 index. Both return measures are geometric averages. In general, other assets include alternative assets—real estate, private equity, and hedge funds, among others—other than equities. Since the analysis is illustrative, it is sufficient to focus on equities alone in characterizing the joint distribution of fixed-income and other asset returns and volatility. Long-term annual average equity returns calculated from the data are comparable to those in panel 1 of Table 2.3.1. The duration of liabilities is fixed at 12 years, and the duration of other assets is taken to be zero.

[2]The funding ratio (in present value terms) is the ratio of the present value of a pension fund's assets to the present value of its liabilities.

Box 2.3 *(continued)*

Table 2.3.1. Risk-Return Calibration and Portfolio Allocations

1. Baseline Calibration

	Fixed Income	Other
Assets		
Value (U.S. dollars)	36	44
Return (percent)	1.86	15.43
Risk (percent)	0.07	11.93
Covariance	0.005	–0.27
	–0.27	142.4
Liabilities		
Value (U.S. dollars)	100	
Return (percent)	4	
Duration (years)	12	

2. Selected Portfolio Allocations and Implied Fixed Income Durations under 50 Percent Hedge Ratio

	Fixed Income (percent)	Other (percent)	Implied Asset Duration (years)
High Equity	33	67	22.86
Balanced	45	55	16.66
High Bonds	90	10	8.33

Sources: Bloomberg L.P.; Citi; Thomson Reuters Datastream; and IMF staff calculations.

Annex 2.1. Term Premiums under a Low-for-Long Scenario[42]

This chapter's model derives from consumption-based asset pricing models, extending them to environments in which steady-state growth, inflation, and interest rates are very low and nominal interest rates are subject to a zero lower bound.[43]

An endowment economy model of asset pricing in the spirit of Deaton (1991) is adapted to accommodate an incomplete market with only nominal bonds, no borrowing constraints, an exogenous inflation process, an endowment process partially indexed to inflation, and nominal interest rates determined by a modified Taylor rule. The household receives an endowment Y_t at time t, which it may allocate to consumption C_t or savings through nominal bonds $B_{n,t}$, in which n,t denotes a term of n-periods at date t.[44] Subject to the period t budget constraint,

$$B_{t-1} + \sum_{n>1} Q_{n,t} B_{n,t-1} + Y_t = \frac{B_t}{R_t} + \sum_{n>1} Q_{n,t} B_{n,t} + P_t c_t,$$

households solve the following function:

$$V_t = max_{c_t} \left\{ c_t^{1-\sigma} + \beta E_t \left(V_{t+1}^{1-\alpha} \right)^{\frac{1-\sigma}{1-\alpha}} \right\}^{\frac{1}{1-\sigma}},$$

in which R_t, $Q_{n,t}$, and P_t are the nominal bond return, long-term bond price, and the price level, respectively, in period t; σ denotes the inverse of the intertemporal elasticity of substitution; and α the coefficient of risk aversion. The household optimization problem is situated in the context of exogenous inflation shocks described by

$$log\pi_t = \rho_\pi log\pi_{t-1} + (1-\rho_\pi) log\pi^* + \epsilon_{\pi,t},$$

and income shocks g_t around their steady-state values π^* and g^*. Households receive nominal endowments

$$\frac{Y_t}{Y_{t-1}} = \pi^{*\gamma} \pi_t^{1-\gamma} g_t$$

that are only partially indexed to inflation. Inflation shocks and income shocks are independently Gaussian, $\epsilon_{\pi,t} \sim N(0, \sigma_\pi)$ and $\log(g_t) \sim N(0, \sigma_g)$. The central bank's policy reaction function,

$$R_t = \max \left\{ \varphi_b (b_t - b^*) + \left(\frac{\pi_t}{\pi^*} \right)^{\varphi_\pi} \left(\frac{g_t}{g^*} \right)^{\varphi_g} R^*, \kappa \right\},$$

is subject to an effective lower bound, κ. The sensitivity of the central bank's policy response to growth and inflation shocks is $\varphi_g > 0$; $\varphi_\pi > 1$. A *fiscal risk premium*, φ_b, is assumed to be negative to ensure against explosive paths of capital accumulation by households. In particular, it is assumed that

$$R^* = \frac{\pi^* g^*}{\beta + \eta},$$

in which the value of η is chosen so that the average equilibrium value of real (government) debt outstanding is maintained at b^*. The model is solved following the approach of Caldara and others (2012).

A steady state with a low natural rate of interest close to the zero lower bound has flatter yield curves and compressed term premiums relative to a steady state with higher growth, inflation, and interest rates (Annex Figures 2.1.1 and 2.1.2).

In a normal economy, an inflation shock elicits a corresponding change in real rates because of the strong policy response of the central bank (Annex Figure 2.1.1). Moreover, inflation persistence, central bank policy reaction, and partial indexation of endowments ensure that real savings, real incomes, and expected lifetime utility move in a direction opposite from that of inflation and real interest rates, and hence in the same direction as bond prices. Accordingly, in this economy, households' lifetime utility moves positively with bond returns, which implies positive term premiums and a positively sloped yield curve.

In a low-for-long economy around the zero lower bound, central banks' constrained ability to respond to inflation shocks means that real rates now move in a direction opposite from that of inflation shocks. In turn, through the same transmission channels as above, this generates negative comovement of expected lifetime utility and bond returns, which lowers nominal and real term premiums in this economy relative to an economy with higher equilibrium levels of growth, inflation, and interest rates (Annex Figure 2.1.2).

[42]The author of this annex is Mitsuru Katagiri.

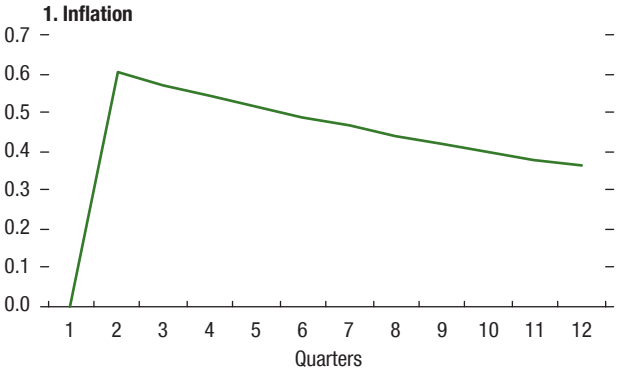
[43]Many factors play a role in determining the slope of the yield curve, including the covariation between household consumption growth and inflation (Piazzesi and Schneider 2007), the hedge provided by bonds against other asset returns (Campbell, Sunderam, and Viceira 2016), and the ability and willingness of arbitrageurs to execute risky, profitable trades in bond markets (Vayanos and Vila 2009; Greenwood and Vayanos 2010). The empirical literature on the measurement of term premiums has also advanced significantly, for example, based on the affine term structure models developed by Adrian, Crump, and Moench (2013) and Abrahams and others (2016) for the United States and applied by Malik and Meldrum (2016) for the United Kingdom.

[44]Uppercase letters denote nominal values, lowercase real values, and starred variables steady-state values.

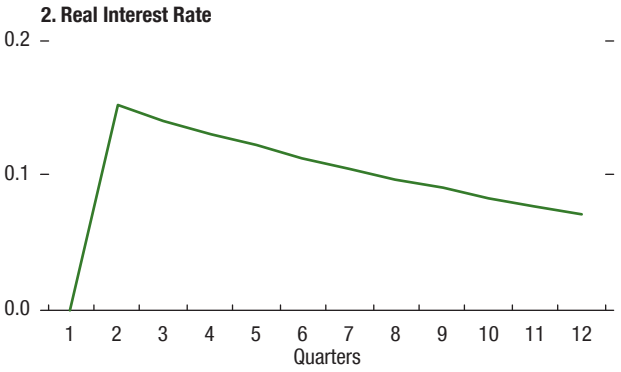
Annex Figure 2.1.1. Impulse Responses outside of a Low-for-Long Scenario

(Percentage points)

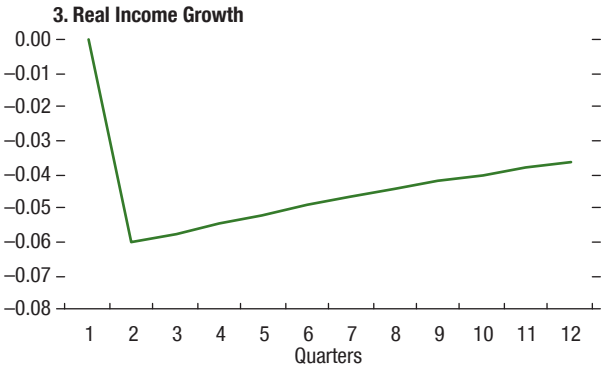
Under persistent inflation shocks ...



... real rates remain elevated ...



... and real incomes remain lower.

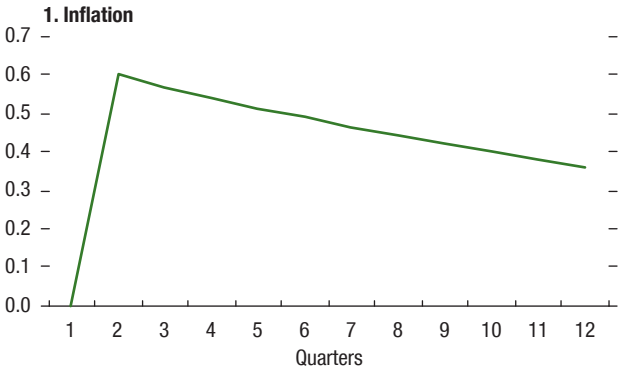


Source: IMF staff calculations.

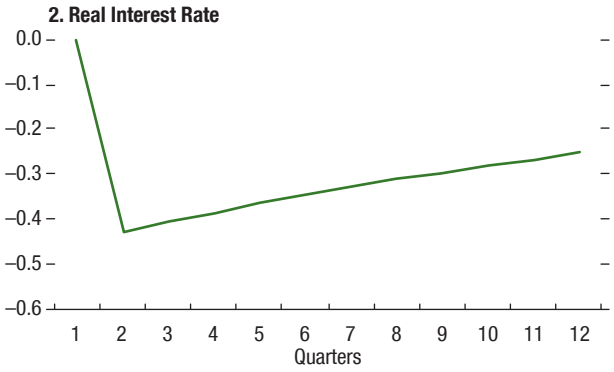
Annex Figure 2.1.2. Impulse Responses in Low-for-Long Economies

(Percentage points)

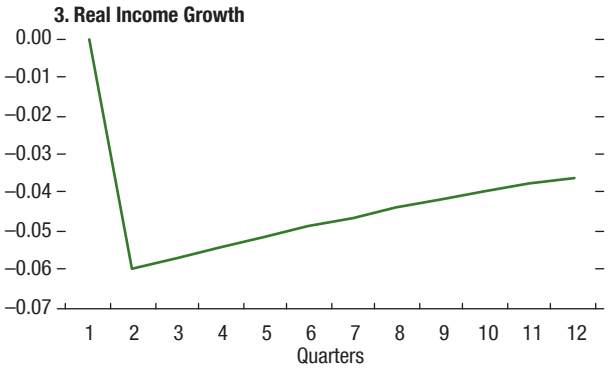
Under persistent inflation shocks ...



... real rates remain lower ...



... as do real incomes.



Source: IMF staff calculations.

Annex 2.2. Cross-Country Evidence of Prolonged Low Interest Rates' Impact on Banks[45]

This annex discusses the data and the empirical methodology used to analyze how periods of low interest rates affect bank profitability as measured by realized profits and expected future profits, as reflected in banks' equity price returns.

The Impact on Bank Profitability

Bank profits, typically measured by return on equity, are analyzed using the following regression (for bank *i* in country *j* in year *t*):

$$\begin{aligned} Profit_{ijt} = {} & \alpha_i + \beta\, Macro_{jt} + \theta\, low_{jt} + \gamma_1\, Shortrate_{jt} \\ & + \gamma_2\, Shortrate_{jt} \times low_{jt} + \gamma_3\, TP_{jt} \\ & + \gamma_4\, TP_{jt} \times low_{jt} + \phi_1\, Businessmodel_{ijt} \\ & + \phi_2\, Businessmodel_{ijt} \times low_{jt} + \varepsilon_{ijt}, \end{aligned}$$

in which *Profit* is measured by return on equity; *Macro* is a vector of macroeconomic control variables, such as consumer price index inflation, credit growth, and GDP growth; and *low* is a dummy for periods with prolonged low rates of interest, defined as years when the 10-year, on-the-run spot rate on government bonds is less than the historic in-sample average of the monetary policy interest rate, *and* the three-month government bond or bill interest rate is less than 1 percent. For Japan, the threshold for the 10-year spot rate is 2 percent;[46] *Shortrate* is the three-month interest rate; *TP* denotes the term premium, based on Wright 2011; and *Businessmodel* represents the indicators of banks' business models.

Two approaches are used to characterize banks' business models. First, several balance sheet indicators are considered individually, including size (total assets), leverage (assets-to-equity ratio), the deposit funding ratio, the loans-to-total-assets ratio, and the share of trading assets in total assets. Second, business models are constructed for each bank using a clustering method. The business models are defined by three features: size, deposit funding ratio, and loan-to-asset ratio.[47] Banks that are similar in these three dimensions are clustered into the same group, following Roengpitya, Tarashev, and Tsatsaronis 2014, and three group-types of business models are estimated and assigned one bank at a time.

The exercise covers an unbalanced panel of almost 17,000 banks in eight advanced economies, using annual data from 1990 through 2015. Only banks with end-of-year statements are included.[48] The estimation incorporates bank-level and time-level fixed effects.[49]

The baseline results are robust to a number of perturbations of this benchmark specification, including alternative definitions of bank profits (return on assets); inclusion of other bank business characteristics; alternative definitions of periods of prolonged low interest rates; lagged values of bank business model characteristics, controlling for the scope and intensity of macroprudential policies and for concentration in the banking industry; and incorporating a lagged dependent variable. A dynamic panel regression was initially implemented resulting in a finding of insignificant year-to-year persistence of bank returns, which argued for dropping the lagged dependent variable and reporting results of a cross-country panel regression.

The Impact on Bank Equity Price Return

The general specification can be written as follows:

$$\begin{aligned} & EquityPriceReturn_{ijt} \\ & = \alpha + \beta\, marketreturn_{jt} + \gamma_0\, surprise_{jt} + \gamma_1\, surprise_{jt} \\ & \quad \times MP\_normaltime_{jt} + \gamma_2\, surprise_{jt} \times MP\_low_{jt} \\ & \quad + \theta\, conditioningvariable_{jt} + \varepsilon_{ijt}, \end{aligned}$$

in which the dependent variable *EquityPriceReturn* is the daily change in equity prices (in logarithm); *marketreturn* denotes the daily change in country-specific stock market indices, capturing the overall market return (in logarithm); *surprise* denotes the unexpected change in market expectations of

[45]The authors of this annex are Qianying Chen and Kai Yan.

[46]Since Japan was in an environment of policy rates of less than 2 percent for most of the time in the sample, the historical average of policy rates is considered inappropriate for defining the ceiling of a period of low interest rates.

[47]Data on the geographic distribution of bank incomes could not be included because it was available only for a small subsample of banks and skews the country and size distributions relative to the overall sample of banks.

[48]Canada, Finland, France, Germany, Japan, the Netherlands, the United Kingdom, and the United States. The country coverage is subject mainly to data availability of the term premium.

[49]Incorporating country and time fixed effects eliminates, as expected, the effect of changes in the term structure of interest rates on bank profits in periods with prolonged low interest rates. However, the estimated sensitivity of the impact depending on bank business model characteristics is robust to inclusion of these fixed effects.

future short-term interest rates, defined as the change in the country-specific nine-year-ahead one-year-forward rate; *MP_low* is the dummy for monetary policy announcement dates in periods with prolonged low rates, while *MP_normaltime* represents the announcement dates in other periods. The period of prolonged low rates is defined as the time when the 10-year government bond yield is less than 2 percent, a level when the real rate adjusted by inflation target is at zero in many countries.[50]

The interaction terms $surprise_{jt} \times MP\_normaltime_{jt}$ and $surprise_{jt} \times MP\_low_{jt}$ measure the market surprises on the expected future short-term rate on the monetary policy announcement days. This is either the surprise triggered by the news about a change in the monetary policy stance or a correction of previous expectations when there is no change in the policy on that day. Assuming that there are no other major announcements on the same day, these interaction terms ensure the exogeneity of the interest rate shock.

The analysis relies on daily data spanning 2000 through 2016, covering banks in 16 advanced economies.[51] Details of variable definitions and data sources are provided in Annex Table 2.2.1. Only banks whose stocks are traded with sufficient frequency are included in the analysis.

Endogeneity may appear when including the surprise in the regression, because other economic news that changes the expectations of forward rates may also directly affect the equity price return. The missing variable of other news in the residual may be correlated with the surprise and result in biased estimation. Therefore, additional robustness checks are conducted. An event study regression was run, covering only the dates of the monetary policy announcements, and also a daily frequency regression with an alternative surprise measure extracting the component in surprise that is orthogonal to the market return, which is taken to represent news that affected interest rate expectations, but not the equity price return directly. Both of these checks confirm that the main results are robust.

[50]In defining periods of prolonged low rates, the second threshold applying to short-term interest rates (in the profit regression) was not applied in this regression to avoid the noise introduced by the volatile movement of daily short-term market interest rates. As part of robustness exercises, two alternative definitions were also examined—periods when the forward rate was less than the in-sample average of the monetary policy rate and when the shadow policy rate deviated from the actual policy rate. However, using the first of these alternative definitions does not work well with the Japanese data because interest rates were also low in the 1990s, and the second definition was problematic: it identified periods of prolonged low rates only with periods of negative interest rates.

[51]Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Annex Table 2.2.1. Data Sources

Variable	Description	Source
Low	Dummy for period with low interest rates, which is defined as the time when the 10-year government bond yield and the three-month short rate are below their corresponding thresholds. The threshold for the 10-year government bond yield of all countries except Japan is set to be the historical average of the country-specific policy rates (for Japan, it is set to be 2 percent) when the real rate adjusted by the inflation target is at zero. The threshold for the three-month interest rates is set to be 1 percent.	Thomson Reuters Datastream and IMF staff calculations
Surprise (9-year forward)	Daily change in the forward rate of the one-year government bond yield, based on a no-arbitrage assumption and the spot rate of the 10-year and 9-year government bond yield (from yield curve values for constant maturity).	Thomson Reuters Datastream and IMF staff calculations
Surprise (9-year-forward orthogonal)	Surprise that is orthogonal to market return, measured by the residual of the regression of surprise on market return.	IMF staff calculations
Monetary Policy in Low (2 percent)	Dummy for period in low period and with monetary policy announcements. The low period is defined as a period when the 10-year government bond yield is below 2 percent.	Thomson Reuters Datastream, central bank websites, and IMF staff calculations
Monetary Policy in Normal (2 percent)	Dummy for period in non-low period and with monetary policy announcements. The low period is defined as a period when the 10-year government bond yield is below 2 percent.	Thomson Reuters Datastream, central bank websites, and IMF staff calculations
Bank Characteristics		
Return on Equity	Earnings before interest and taxation divided by equity	Fitch Connect
Size	Logarithm of banks' total assets	Fitch Connect
Loan-to-Asset Ratio	Gross loans divided by total assets	Fitch Connect
Deposit Funding Ratio	Customer deposits divided by total liabilities	Fitch Connect
Trading Asset	Assets held for trading plus assets held at fair value	Fitch Connect
Trading Asset Ratio	Trading assets divided by total assets	Fitch Connect
Leverage Ratio	Total assets divided by equity	Fitch Connect
Macroeconomic		
Consumer Price Index Inflation	Year-over-year growth of consumer price index, percent	IMF, International Financial Statistics database
Credit-to-GDP Ratio	Private sector credit in percent of GDP	Bank for International Settlements
Real GDP Growth	Year-over-year growth of GDP, constant prices	IMF, World Economic Outlook database
Three-Month Interest Rate	Typically central bank bill/Treasury bill yield or interbank offered rate	Haver Analytics
Term Premium	Term premium estimated based on Wright 2011	IMF, *Global Financial Stability Report*, October 2016
Ten-Year Government Bond Yield	On-the-run 10-year government bond yield (from yield curve values for constant maturity)	Thomson Reuters Datastream
Monetary Policy Rates	Short-term interest rates represent the monetary policy stance in a country	Haver Analytics
Financial Market		
Equity Price Return	Log difference of equity prices	
Market Return	Difference of overall country-specific equity price indices	
VIX	Chicago Board Options Exchange Market Volatility Index	Bloomberg L.P.
Oil Price	West Texas Intermediate crude oil spot price	Bloomberg L.P.

Source: IMF staff.

References

Abrahams, Michael, Tobias Adrian, Richard K. Crump, Emanuel Moench, and Rui Yu. 2016. "Decomposing Real and Nominal Yield Curves." *Journal of Monetary Economics* 84: 182–200.

Addoum, Jawad M., Jules H. van Binsbergen, and Michael W. Brandt. 2010. "Asset Allocation and Managerial Assumptions in Corporate Pension Plans." https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1710902.

Adrian, Tobias, Richard K. Crump, and Emanuel Moench. 2013. "Pricing the Term Structure with Linear Regressions." *Journal of Financial Economics* 110 (1): 110–38.

Alessandri, Piergiorgio, and Benjamin Nelson. 2012. "Simple Banking: Profitability and the Yield Curve." Working Paper 452, Bank of England, London.

Ameriks, John, and Stephen P. Zeldes. 2004. "How Do Household Portfolio Shares Vary with Age?" Columbia University Graduate School of Business working paper, New York.

Andonov, Aleksandar, Rob Bauer, and Martijn Cremers. 2016. "Pension Fund Asset Allocation and Liability Discount Rates." Research Report. November. Global Risk Institute, Toronto, ON.

Ang, Andrew, and Angela Maddaloni. 2005. "Do Demographic Changes Affect Risk Premiums? Evidence from International Data." *Journal of Business* 78 (1): 341–80.

Antolin, Pablo, Sebastian Schich, and Juan Yermo. 2011. "The Economic Impact of Protracted Low Interest Rates on Pension Funds and Insurance Companies." *OECD Journal: Financial Market Trends* 1: 1–20.

Avdjiev, Stefan, Wenxin Du, Catherine Koch, and Hyun Song Shin. 2016. "The Dollar, Bank Leverage and the Deviation from Covered Interest Parity." Working Paper 592, Bank for International Settlements, Basel.

Baker, Michael, Brendan Bradley, and Jeffrey Wurgler. 2011. "Benchmarks as Limits to Arbitrage: Understanding the Low Volatility Anomaly." *Financial Analysts Journal* 67 (1): 40–54.

Bank of Japan. 2011. *Financial Stability Report*. Tokyo.

Barberis, Nicholas, and Andrei Shleifer. 2003. "Style Investing." *Journal of Financial Economics* 68: 161–99.

———, and Jeffrey Wurgler. 2005. "Comovement." *Journal of Financial Economics* 75: 283–317.

Bean, Charles, Christian Broda, Takatoshi Ito, and Randall Kroszner. 2015. "Low for Long? Causes and Consequences of Persistently Low Interest Rates." 17th CEPR-ICMB Geneva Report on the World Economy.

Becker, Bo, and Victoria Ivashina. 2015. "Reaching for Yield in the Bond Market." *Journal of Finance* 70 (5): 1863–902.

Bernanke, Ben S. 2005. "The Global Savings Glut and the U.S. Current Account Deficit." Sandridge Lecture, Virginia Association of Economists, Richmond, VA, April 14.

———. 2015. "Why Are Interest Rates So Low?" *Brookings Blog*.

Broadbent, John, Michael Palumbo, and Elizabeth Woodman. 2006. "The Shift from Defined Benefit to Defined Contribution Pension Plans—Implications for Asset Allocation and Risk Management." Working Group on Institutional Investors, Global Savings and Asset Allocation of the Committee on the Global Financial System, Bank for International Settlements, Basel.

Brunnermeier, Markus K., and Yann Koby. 2016. "The Reversal Interest Rate: The Effective Lower Bound of Monetary Policy." Unpublished, Princeton University, Princeton, NJ.

Brunnermeier, Markus K., and Yuliy Sannikov. 2016. "The I-Theory of Money." NBER Working Paper 22533, National Bureau of Economic Research, Cambridge, MA.

Caballero, Ricardo J., Takeo Hoshi, and Anil K. Kashyap. 2008. "Zombie Lending and Depressed Restructuring in Japan." *American Economic Review* 98 (5): 1943–77.

Caldara, Dario, Jesus Fernández-Villaverde, Juan F. Rubio-Ramirez, and Wen Yao. 2012. "Computing DSGE Models with Recursive Preferences and Stochastic Volatility." *Review of Economic Dynamics* 15 (2): 188–206.

Campbell, John Y., Carolin Pflueger, and Luis M. Viceira. 2014. "Monetary Policy Drivers of Bond and Equity Risks." NBER Working Paper 20070, National Bureau of Economic Research, Cambridge, MA.

Campbell, John Y., Adi Sunderam, and Luis M. Viceira. 2016. "Inflation Bets or Deflation Hedges? The Changing Risks of Nominal Bonds." Harvard University Working Paper, Cambridge, MA.

Carvalho, Carlos, Andrea Ferrero, and Fernanda Nechio. 2016. "Demographics and Real Interest Rates: Inspecting the Mechanism." *European Economic Review* 88 (September): 208–26.

Chen, Honghui, Gregory Noronha, and Vijay Singal. 2004. "The Price Response to S&P 500 Index Additions and Deletions: Evidence of Asymmetry and a New Explanation." *Journal of Finance* 59: 1901–29.

Chodorow-Reich, Gabriel. 2014. "Effects of Unconventional Monetary Policy on Financial Institutions." *Brookings Papers on Economic Activity* (Spring): 155–227.

Citi. 2016. *The Coming Pension Crisis*. Global Perspectives and Solutions, March.

Davidoff, Thomas, Jeffrey R. Brown, and Peter A. Diamond. 2005. "Annuities and Individual Welfare." *American Economic Review* 95 (5): 1573–90.

De Nardi, Mariacristina, Eric French, and John B. Jones. 2010. "Why Do the Elderly Save? The Role of Medical Expenses." *Journal of Political Economy* 118 (1): 39–75.

Deaton, Angus. 1991. "Saving and Liquidity Constraints." *Econometrica* 59 (5): 1221–48.

Dell'Ariccia, Giovanni, Luc Laeven, and Roberto S. Marquez. 2014. "Real Interest Rates, Leverage and Bank Risk-Taking." *Journal of Economic Theory* 149: 65–99.

Dell'Ariccia, Giovanni, Luc Laeven, and Gustavo A. Suarez. Forthcoming. "Bank Leverage and Monetary Policy's

Risk-Taking Channel: Evidence from the United States." *Journal of Finance*.

Drechsler, Itamar, Alexi Savov, and Philipp Schnabl. 2016. "The Deposit Channel of Monetary Policy." New York University working paper, New York.

English, William B., Skander J. van den Heuvel, and Egon Zakrajsek. 2012. "Interest Rate Risk and Bank Equity Valuations." Finance and Economics Discussion Series 2012–26, Board of Governors of the Federal Reserve System, Washington, DC.

European Systemic Risk Board (ESRB). 2016. "Macroprudential Policy Issues Arising from Low Interest Rates and Structural Changes in the EU Financial System." Frankfurt.

Freixas, Xavier, and Jean-Charles Rochet. 2008. *Microeconomics of Banking*. Cambridge, MA: MIT Press.

Gambacorta, Leonardo. 2008. "How Do Banks Set Interest Rates?" *European Economic Review* 52 (5): 792–819.

Gordon, Robert J. 2014. "The Demise of U.S. Economic Growth: Restatement, Rebuttal and Reflections." NBER Working Paper 19895, National Bureau of Economic Research, Cambridge, MA.

Gourio, Francois, and Phuong Ngo. 2016. "Risk Premia at the ZLB: A Macroeconomic Interpretation." Unpublished.

Goyal, Amit. 2004. "Demographics, Stock Market Flows, and Stock Returns." *Journal of Financial and Quantitative Analysis* 39 (1): 115–42.

Greenwood, Robin, and Dimitri Vayanos. 2010. "Price Pressure in the Government Bond Market." *American Economic Review: Papers and Proceedings* 100 (2): 585–90.

Holston, Kathryn, Thomas Laubach, and John C. Williams. 2016. "Measuring the Natural Rate of Interest: International Trends and Determinants." Working Paper 2016–11, Federal Reserve Bank of San Francisco, San Francisco, CA.

Imam, Patrick. 2013. "Demographic Shift and the Financial Sector Stability: The Case of Japan." *Journal of Population Ageing* 6 (3).

International Monetary Fund (IMF). 2017. "Negative Interest Rate Policies—Initial Experiences and Assessments." IMF Policy Paper, Washington, DC.

Jagannathan, Ravi, and Narayana R. Kocherlakota. 1996. "Why Should Older People Invest Less in Stocks than Younger People?" Federal Reserve Bank of Minneapolis, *Quarterly Review* (Summer): 11–23.

Kasch, Maria, and Asani Sarkar. 2011. "Is There an S&P 500 Index Effect?" Federal Reserve Bank of New York Staff Report 484, New York.

Koijen, Ralph S. J., Stijn Van Nieuwerburgh, and Motohiro Yogo. 2016. "Health and Mortality Delta: Assessing the Welfare Cost of Household Insurance Choice." *Journal of Finance* 71 (2): 957–1009.

Koijen, Ralph S. J., and Motohiro Yogo. 2015. "The Cost of Financial Frictions for Life Insurers." *American Economic Review* 105 (1): 445–75.

Lambert, Frederic, and Kenichi Ueda. 2014. "Effects of Unconventional Monetary Policy on Banking Sector Soundness." IMF Working Paper 14/152, International Monetary Fund, Washington, DC.

Leibowitz, Martin L., and Anthony Bova. 2015. "Pension Fund Flatlines and Recovery Rates." *Portfolio Strategy*, Morgan Stanley Research, December 8.

Leibowitz, Martin L., Stanley Kogelman, and Lawrence N. Bader. 1995. *Return Targets and Shortfall Risks: Studies in Strategic Asset Allocation*. Burr Ridge, IL: Irwin Professional Publishing.

Lockwood, Lee M. 2012. "Bequest Motives and the Annuity Puzzle." *Review of Economic Dynamics* 15 (2): 226–43.

Malik, Sheheryar, and Andrew Meldrum. 2016. "Evaluating the Robustness of U.K. Term Structure Decompositions Using Linear Regression Methods." *Journal of Banking and Finance* 67: 85–102.

Nagel, Stefan. Forthcoming. "The Liquidity Premium of Near Money Assets." *Quarterly Journal of Economics.*

Nakata, Taisuke, and Hiroatsu Tanaka. 2016. "Equilibrium Yield Curves and the Interest Rate Lower Bound." Board of Governors of the Federal Reserve System Finance and Economics Discussion Series 2016-085, Washington, DC.

Piazzesi, Monika, and Martin Schneider. 2007. "Equilibrium Yield Curves." In *NBER Macroeconomics Annual 2006*, Vol. 21, edited by Daron Acemoglu, Kenneth Rogoff, and Michael Woodford, 389–472. Cambridge, MA: MIT Press.

Ponds, Eduard H. M., and Bart van Riel. 2007. "The Recent Evolution of Pension Funds in the Netherlands: The Trend to Hybrid DB-DC Plans and Beyond." Working Paper 2007–9, Boston College Center for Retirement Research, Boston, MA.

Rachel, Lukasz, and Thomas Smith. 2015. "Secular Drivers of the Global Real Interest Rate." Bank of England Working Paper 571, London.

Rocha, Roberto, Marco Morales, and Craig Thorburn. 2008. "An Empirical Analysis of the Annuity Rate in Chile." *Journal of Pension Economics and Finance*, 7 (1): 95–119.

Roengpitya, Rungporn, Nikola Tarashev, and Kostas Tsatsaronis. 2014. "Bank Business Models." *BIS Quarterly Review* (December).

Sullivan, Rodney N., and James X. Xiong. 2012. "How Index Trading Increases Market Vulnerability." *Financial Analysts Journal* 68 (March/April): 70–84.

Summers, Lawrence H. 2014. "U.S. Economic Prospects: Secular Stagnation, Hysteresis and the Zero Lower Bound." *Business Economics* 49 (2): 65–73.

Suzuki, Wataru. 2005. "Determinants of the Upsurge in M1 Demand in Japan: Evidence from Household-Level Analysis." Tokyo Gakugei University Empirical Analysis of Economic Institutions Discussion Paper Series 81, Tokyo.

Swiss Re. 2012. "Facing the Interest Rate Challenge." *Sigma* 4.

Turra, Cassio M., and Olivia S. Mitchell. 2004. "The Impact of Health Status and Out-of-Pocket Medical Expenditures

on Annuity Valuation." University of Michigan Retirement Research Center Working Paper 2004–086, Ann Arbor, MI.

Vayanos, Dimitri, and Jean-Luc Vila. 2009. "A Preferred Habitat Model of the Term Structure of Interest Rates." NBER Working Paper 15487, National Bureau of Economic Research, Cambridge, MA.

Viñals, José, Simon Gray, and Kelly Eckhold. 2016. "The Broader View: The Positive Effects of Negative Interest Rates." https://blog-imfdirect.imf.org/2016/04/10/the-broader-view-the-positive-effects-of-negative-nominal-interest-rates.

Wicksell, Knut. 1936. *Interest and Prices*. English Translation of the 1898 manuscript, Royal Economic Society, London.

Wright, Jonathan. 2011. "Term Premia and Inflation Uncertainty: Empirical Evidence from an International Panel." *American Economic Review* 101 (4): 1513–44.

Wurgler, Jeffrey. 2010. "On the Economic Consequences of Index-Linked Investing." In *Challenges to Business in the Twenty-First Century: The Way Forward*, edited by W. T. Allen, R. Khurana, J. Lorsch, and G. Rosenfeld. Cambridge, MA: American Academy of Arts and Sciences.

Yaari, Menahem E. 1965. "Uncertain Lifetime, Life Insurance and the Theory of the Consumer." *Review of Economic Studies* 32 (2): 137–50.