January 10, 2020

Monetary Policy Strategies and Tools: Financial Stability Considerations[1]

This memo examines potential interactions between financial stability and the monetary policy strategies and tools that the Committee is considering in its framework review. The memo also considers the role for macroprudential policy and supervisory tools in pursuing financial stability goals and discusses the limitations of these tools. Additionally, it explores issues related to reflecting financial stability considerations in monetary policy communications.

A stable financial system is resilient in the face of adverse shocks. An unstable system, by contrast, is characterized by vulnerabilities that may amplify adverse shocks and lead to substantial increases in unemployment or declines in inflation. Importantly, achieving the Federal Reserve's goals of full employment and price stability promotes financial stability, as such conditions support financial sector resilience.

A key concern, however, is that with a low equilibrium real interest rate, r*, a low policy rate will be necessary for the Federal Reserve to achieve its dual mandate goals. Indeed, a low r* implies that interest rates are likely to be low across any set of strategies and tools that achieves the Federal Reserve's objectives. In turn, these low rates may contribute to an increase in financial system vulnerabilities, including increased borrowing, financial leverage, and asset price pressures. The extent to which these benefits and costs arise may depend on the stage of the business cycle—intuitively, low rates in the middle of a recession could have different effects on financial vulnerabilities than during a long expansion, even while in both circumstances, the macroeconomic partial effects of low rates on inflation and employment are beneficial to financial system resilience.

As a result, the question for this memo is the extent to which the alternative strategies and tools on net enhance stability by improving economic performance and supporting inflation, or weaken stability by encouraging vulnerabilities such as elevated asset prices, excess borrowing, or excessive risk-taking by financial intermediaries. With the caveat that evidence is limited, our analysis suggests that there are typically significant macroeconomic and financial stability benefits of using these tools and strategies, but there are plausible situations in which the vulnerabilities are such that it would be desirable to limit the use of these tools and strategies.

[1] Jonathan Goldberg, Beth Klee, Ned Prescott and Paul Wood. Many thanks to our reviewers, Rochelle Edge, Michael Kiley, Larry Wall, and Min Wei. The authors thank Tyler Pike for expert research assistance and Caitlin Hesser for help editing the document.

The memo makes four points:

(1) Evidence on the link between low rates and financial vulnerabilities is limited and generally finds that interest rates, and most especially monetary policy, are not the primary contributor to financial vulnerabilities. That said, it is difficult to distinguish between the financial stability effects of low rates and the effects of accommodative policy. Indeed, available studies often do not make this distinction (section I).

(2) Possible financial vulnerabilities generated by makeup strategies and unconventional monetary policy tools are similar to those generated by traditional monetary policy, with vulnerabilities potentially growing when the economy is "running hot." Past experience is limited, particularly for times when the economy is at or close to full employment, but nonetheless suggests little evidence that unconventional monetary policy contributed significantly to financial vulnerabilities (section II).

(3) As previous communications by the Committee have stated, should vulnerabilities arise, they are often best addressed with macroprudential tools. That said, adjusting the settings of these tools or adjusting regulations in response to cyclical developments are relatively new strategies with practical limitations (section III).[2]

(4) A clear communications strategy likely supports achieving the Committee's goals of supporting economic growth and minimizing financial vulnerabilities when using makeup strategies and unconventional monetary policy tools, in part by avoiding large, destabilizing changes in the level of interest rates. Some jurisdictions have used financial stability "escape clauses" in conjunction with their monetary policy strategy (section IV).

I. Macrofinancial considerations

This section reviews characteristics of the current macrofinancial environment that will likely prevail regardless of the monetary policy strategies and tools used to achieve the Committee's goals. First, we focus on the general macrofinancial backdrop, and discuss possible implications for financial stability. Second, we discuss specific financial stability considerations connected to low interest rates and a flat yield curve.

A. The macrofinancial backdrop

The key feature of the macroeconomic backdrop is that standard estimates of r* have declined between 2 and 3 percentage points over the past two decades, with many estimates clustered around ½ percent. Low neutral rates are likely the result of persistent,

[2] See "Minutes of the Federal Open Market Committee," April 26-27, 2016.

structural factors such as productivity growth, demographic trends, and the reduced capital intensity of production. Therefore, it is unlikely that the decades-long decline in r* will reverse soon. A low neutral interest rate implies that achieving the dual mandate will require low interest rates in the future, regardless of the monetary policy strategies or tools chosen.

In this environment, the federal funds rate is likely to be more frequently at the effective lower bound, and the yield curve will likely be flatter relative to historical experience.[3] With the Committee's ability to provide accommodation limited to some extent by the ELB, macroeconomic risks are skewed to the downside. Consequently, recessions may become more likely and recoveries may be slower, which places pressure on financial system resilience. Additionally, well-anchored inflation expectations dramatically reduce the risk of the admittedly extreme situation of deflation, which can substantially damage household and firm balance sheets. As such, strategies that mitigate such risks likely support macroeconomic and financial stability.[4]

B. The link between low rates, a flat yield curve, and financial vulnerabilities

In the current environment with low r*, a key question is how monetary policy strategies and monetary easing affect financial vulnerabilities, such as elevated valuation pressures, excessive household and business borrowing, and excessive financial leverage. It seems reasonable that there would be a link: All else equal, low rates buoy asset prices, make borrowing for households and businesses cheaper, boost consumption and wealth, and increase incentives for leverage. Previous work has considered the effect of interest rates on a range of financial vulnerabilities, but more targeted research that distinguishes between the effects of alternative monetary policy strategies on financial vulnerabilities versus the effects of a decline in r* is limited to non-existent. Against this backdrop, we survey relevant analyses and consider the implications of this evidence for the more specific questions related to alternative strategies and tools.

(1) Asset valuations and investor risk appetite

Low rates are often intended to increase aggregate demand in part by boosting asset prices and spurring risk taking. However, taken to excess these can also increase financial vulnerabilities. For asset prices, there are two channels. First, low rates raise the value of future income streams by lowering the discount rate and hence raise asset

[3] As discussed below, the yield curve will likely be flatter than historical experience because of a lower real short rate, lower inflation expectations, and a lower term premium in a world in which bad economic outcomes are correlated with low inflation.

[4] See, for example, Chen, Engstrom and Grishchenko (2016).

prices. Second, low rates may compress risk premiums.[5] In the latter case, asset price "bubbles" may form, which could lead to heightened risks through outsized declines in asset prices and/or attendant forms of risk taking. This risk-taking could reflect rational behavior, but it might also reflect "animal spirits" or "irrational exuberance."[6] Of course, identifying bubbles in hindsight is easy; not so in real time. A particular concern would be rapid appreciation in real estate prices, as real estate has often been a factor in financial stability events.[7]

Estimating the relationship between changes in interest rates and changes in other asset prices is famously plagued by a host of econometric issues. As such, empirical estimates should be interpreted with an appropriate level of caution. Against this backdrop, the available empirical evidence suggests that asset prices increase when rates fall. Table 1 summarizes selected empirical evidence relating interest rates to asset valuations and risk premiums. Elasticity estimates across a range of models indicate that for every 100 basis points decline in the general level of interest rates, house prices increase roughly 2 to 4 percentage points over the course of several years, the stock market rises 4 to 5 percentage points, and corporate bond spreads decline by 20 basis points. The size of the house and equity prices changes is notable, and, indeed, the response of asset prices is an important channel of monetary policy transmission. Nonetheless, these elasticities are modest in magnitude relative to the overall variation in house and equity prices. For example, between 2000 and 2006, house prices increased between 40 and 70 percent, depending on the house price measure used.

Some recent literature shows that a considerable portion of the response of asset prices to monetary easing reflects lower risk premiums.[8] Empirical estimates suggest that a 100 basis points easing in the general level of interest rates leads to a decline in the 10-year nominal Treasury term premium of about 10 basis points and a decline in the excess corporate bond premium of about 15 basis points. Of note, the magnitudes of the estimated changes in term premiums and the excess corporate bond premium are almost as large as the *total* changes in Treasury yields and corporate bond spreads, suggesting that monetary policy affects asset prices to a significant extent through risk premiums.[9]

---

[5] See, for example, Borio and Zhu (2012) and Coimbra and Rey (2019).

[6] Theory suggests that asset price bubbles can obtain when market participants are rational (Tirole, 1985; Martin and Ventura, 2019), but might also be driven by "animal spirits" or "irrational exuberance" (Bordalo et al., 2018). The presence of irrational traders can lead rational traders to try to "time the market" or "ride the bubble" (Abreu and Brunnermeier, 2002).

[7] See, for example, Kindleberger (2015).

[8] See, for example, Bernanke and Kuttner (2005).

[9] Gertler and Karadi (2015) present evidence that unexpectedly accommodative monetary easings are associated with sizable declines in the long-term nominal term premium and the excess corporate bond

Relatedly, there is a range of evidence showing that banks and other intermediaries "reach for yield" when rates are low; selected works are summarized in table 2.[10] Reach for yield comes in a variety of forms; a typical example is holding assets with lower credit quality or less liquidity to earn a higher yield.[11] For example, banks often loosen credit standards in response to lower rates, which can also boost asset valuations. While some of this represents the risk-taking channel of monetary policy and is the intended result of policy easing when the economy needs support, this can go too far when economic activity strengthens, leading to weak standards and terms and potential outsized credit losses in a subsequent downturn.

Despite this evidence, the longer-run effect of low rates on financial vulnerabilities is uncertain. Some part of reach for yield may be temporary, as financial intermediaries such as pension funds and insurers that made long-term commitments to pay high nominal rates face pressure to reach for yield. This incentive should fade as old commitments mature and new commitments are made at lower nominal rates. In addition, a strand of recent research has pointed to a channel through which lower rates might contribute to *lower* vulnerabilities, partly reflecting that lower rates reduce the migration of intermediation to outside the banking system.[12]

(2) Household and business leverage

Borrowing and bank credit has long been linked to monetary policy; traditional bank credit models made this link explicit.[13] More modern investigations of the relationship between monetary policy and borrowing focus on other ideas, such as the financial accelerator of monetary policy or the response of business borrowing to monetary policy surprises.

Additional debt likely increases the system's vulnerability to an unexpected adverse shock. Of course, high rates make borrowing expensive; low rates make it

---

premium. Gilchrist, López-Salido, and Zakrajšek (2015) show that easings were associated with modest declines in the term premium during the pre-crisis period, but much larger ones post-crisis.

[10] Daniel et al. (2018) presents evidence of "reach-for-income" by dividend-seeking retail investors when interest rates decline, but the magnitude of portfolio reallocations (to high yielding equities and mutual funds) is fairly modest. Using incentivized laboratory experiments with students and others, Lian et al. (2018) show that students make moderate shifts toward riskier assets when the risk-free rate is lower, even when risks and risk premiums remain the same.

[11] On reach-for-yield in the corporate bond market, see Becker and Ivashina (2015) and Chen and Choi (2019).

[12] See Dreschler et al. (2017, 2019), and Driscoll and Judson (2013).

[13] For example, the 1977 Federal Reserve Reform Act, which forms the basis of the dual mandate, directs the Federal Reserve to "maintain long run growth of the monetary and credit aggregates commensurate with the economy's long run potential to increase production, so as to promote the goals of maximum employment, stable prices, and moderate long-term interest rates."

cheap. With cheap debt comes more borrowing, which can be too much of a good thing if it creates financial vulnerabilities. Empirically, most financial instability events, in the United States and abroad, are characterized by large, debt-financed increases in asset prices that are followed by a sharp drop in asset prices.[14] Reflecting this, some empirical evidence shows that debt growth increases vulnerabilities, and significantly affects the probability of an ensuing financial crisis.[15] As has been the case in the U.S., mortgage debt in particular appears linked to boom and bust cycles; effects can be magnified by interactions with liquidity supply.[16]

One way to gauge the importance of debt growth on financial vulnerabilities is the effect on the probability of a crisis. Empirically, the effect of debt growth on the probability of a crisis is not large. For example, the median of a range of estimates of the response of mortgage credit to monetary policy suggests that a 100 basis point policy rate easing leads to only a 30 basis point increase in the probability of a crisis.[17]

(3) Financial leverage and funding risk

Financial leverage and its connection to the level of the short rate has been cited not only as an important channel of monetary policy transmission, but also as a potential source of financial vulnerabilities.[18] Just as with businesses and households, low rates make borrowing cheap for intermediaries. As such, institutions such as dealers that rely on market funding can do so at lower cost when rates are low, and then lend on these funds to other financial intermediaries or real investors. That said, some of the profitability of this trade depends on a reasonably steep yield curve. In a low r* environment, the yield curve may be flatter than historically was the case, which could dampen vulnerabilities stemming from this channel.

More narrowly, an often-cited risk of low interest rates is related to the franchise value of banks and other institutions engaged in maturity transformation.[19] Bank profits depend partly on net interest margins. Because retail deposit rates are generally constrained at the effective lower bound, and so would likely not fall as much as rates on

[14] The three most significant financial instability events in the United States, at least since the Federal Reserve was founded, are the stock market crash of 1929, the S&L and banking and thrift crises of the 1980s, and the Global Financial Crisis of 2008-2009. All three episodes were characterized by a large fluctuation in asset prices, high leverage, as well as extensive maturity transformation.

[15] See Jordà, Schularick, and Taylor (2013) and Krishnamurthy and Muir (2018).

[16] Mian, Sufi, and Verner (2017), Goldberg (forthcoming).

[17] Jordà, Schularick and Taylor (2016), Musso et al. (2011), Kiley (2018). These estimates may be subject to small sample problems; estimates should be interpreted accordingly.

[18] See Adrian and Shin (2010).

[19] See BIS (2018) for a detailed discussion of the effect of low rates on banks, insurance companies, and pension funds. On declines in franchise value and risk taking by banks in the 1980s, see Keeley (1990).

loans, net interest margins could narrow. As a result, banks' future profitability could decline, thus negatively affecting capital levels and reducing franchise value. The erosion of capital levels could leave banks vulnerable to shocks. Furthermore, as discussed earlier, lower franchise value could lead to reach for yield and increased risk appetite, exposing the financial system further to the vulnerabilities described above.

While low rates may lead to reach-for-yield behavior, they may also reduce incentives to engage in liquidity and maturity transformation because the yield curve will be flatter due to low real rates and low expected inflation.[20] Consequently, that particular source of financial vulnerability may decline. Which effect is quantitatively more important is not clear and may vary over time.

II. Financial stability implications of strategies and tools

This section reviews the potential financial stability implications of several of the strategies and tools reviewed in earlier memos.[21] It also discusses macroprudential and supervisory tools. With the caveat that the analysis is subject to a great deal of uncertainty, while use of these strategies and tools could entail some financial stability risks, these potential costs are likely small relative to the economic and financial stability benefits. Of course, there is likely a range of costs and benefits of using these strategies; prudent risk management suggests weighing the degree of accommodation against the potential for increased vulnerabilities. Relatedly, although monetary policy stimulates the economy in part by encouraging risk taking, excessive risk taking may be a greater or lesser concern at different points of the business cycle.[22]

We discuss makeup strategies, forward guidance, balance sheet tools, and macroprudential and supervisory tools reviewing the costs and benefits of each.

A. Makeup strategies

We first focus on "makeup strategies," or alternative monetary policy strategies that aim to offset, at least in part, past misses of inflation from its objective.

If makeup strategies generate financial stability vulnerabilities, intuition suggests these would most likely become salient during the makeup period, although experience with these strategies is minimal. In particular, makeup strategies may require accommodative monetary policy and thus low rates well into economic recoveries, possibly generating overly optimistic macroeconomic expectations and excessive risk taking and leverage. Should leverage or other vulnerabilities become elevated, a drop in asset prices or other shock may lead to financial instability. In addition, if financial institutions acquire low-yielding assets during the low inflation period, they may

[20] See Woodford (2016).

[21] Board of Governors of the Federal Reserve System (2019a,b).

[22] See Chodorow-Reich (2014).

experience losses on these assets during the higher-inflation period. These risks could be important; however, we have little relevant experience with these conditions.

In addition, concerns about rising debt and excessive risk taking should be evaluated in light of how much interest rates will be lower under makeup strategies than under the current framework. Makeup strategies may have modest effects on the level of interest rates over the business cycle. At the same time, scenario analysis suggests that interest rates would be lower than under the current framework over significant portions of an expansion. As shown in exhibit 1, following a mild recession under an average-inflation-targeting rule, the real 10-year yield deviates from the baseline path by up to 50 basis points during the recovery.[23] As shown in exhibit 2, forward guidance that promises to delay departure from the ELB only after the economy returns to 2 percent inflation leaves rates lower for a protracted period: The real 10-year Treasury yield is 50 basis points below the baseline, on average, during the decade after the recession ends.

These lower yields would likely support a stronger recovery, and they could also generate additional borrowing and financial leverage. The magnitudes of the increases in vulnerabilities would likely be moderate relative to the types of credit booms that have preceded financial instability. As a result, such conditions do not seem to suggest makeup strategies should be avoided. However, they point to the potential value of escape clauses should vulnerabilities materialize in unexpected ways, as discussed below.

Makeup strategies may affect financial stability in the opposite manner—by succeeding "too much," and generating an unwelcome rise in inflation that requires a sharp tightening in policy and potentially abrupt shifts in expectations and financial markets. One longer-term financial stability risk from a makeup strategy could arise if during the high inflation period, inflation expectations became unanchored and drifted significantly above 2 percent.[24] The probability of a high inflation outcome depends heavily on the credibility of the Committee; with credibility, the probability of inflation expectations becoming unanchored is likely small.

Even with these potential concerns, it is important to recognize that makeup strategies may contribute positively to financial stability. Forgoing a makeup strategy could result in low nominal rates for even longer, perhaps reflecting a drift down in inflation expectations or subdued growth. Lower inflation expectations and a weak

[23] Exhibit 1 reproduces analysis in the memo to the Committee, "Alternative Strategies: How do they work? How might they help?" August 30, 2019. Exhibit 2 reproduces analysis of Chung et al. (2019). Of note, there are several differences between the scenarios and models studied in Exhibits 1 and 2. The purpose here is provide an assessment of the potential quantitative effects of these alternative strategies, rather than to compare the effects of threshold-based forward guidance and AIT strategies.

[24] The high inflation of the 1970s combined with the prevailing set of financial regulations (Regulation Q, for example) was a major factor in the financial instabilities of the 1970s and early 1980s.

economy can be problematic for financial stability through a number of channels, including debt deflation or weaker intermediary and borrower balance sheets. [25]

B. Monetary policy tools

We next turn to the unconventional monetary policy tools that could be used to achieve the goals of a makeup strategy, once the policy rate has reached the effective lower bound, and discuss the implications of their use for financial stability. Broadly, a number of these tools support the goals of the strategy by affecting the level of interest rates and the slope of the yield curve. Whether these tools affect financial vulnerabilities depends on whether the changes to interest rates are large enough to affect asset valuations and financial intermediaries' balance sheets. Consequently, an overarching question is "Are potential changes in the level or slope of the yield curve large enough to affect asset values or financial institution balance sheets?" The available empirical evidence suggests those changes are not large enough to contribute materially to financial vulnerabilities. That said, there are a few potential exceptions, which we review below.

(1) Forward guidance at the ELB

Forward guidance at the ELB intends to reduce uncertainty about the future path for the federal funds rate and drive expectations of the private sector towards the announced path. By doing so, forward guidance can provide additional policy accommodation, despite the ELB constraint. In turn, this accommodation supports the economy, which is a force for reducing financial stability concerns.

With forward guidance leaving rates low for long at the ELB, financial institutions may come under pressure to "reach for yield," which raises the concerns discussed above regarding low interest rates. Some evidence suggests that U.S. money funds apparently responded to forward guidance by extending into riskier assets, holding less diverse portfolios, reducing fees, and exiting the market.[26]

Another concern is that low uncertainty about monetary policy can lead to muted financial market volatility and a build-up in leverage. One channel identified in a pre-crisis context for this to occur is through value-at-risk considerations. Specifically, the ratio of value at risk to equity is observed to be relatively constant over the business cycle. Should market volatility decrease, this has the effect of both decreasing value at

[25] Sheedy (2014) argues that nominal GDP targeting, which, in part, is a makeup strategy, improves the functioning of financial markets because most debt is nominal. Koenig (2012) highlights the connection between nominal GDP targeting and a traditional Taylor rule. Gomes, Jermann, and Schmid (2016) present evidence that debt deflation is an important channel for the transmission of shocks.

[26] See Di Maggio and Kacperczyk (2017).

risk and increasing the value of equity. In turn, intermediaries lever up to bring the ratio back towards its steady state value.[27]

Formal empirical evidence regarding the financial stability effects of forward guidance at the effective lower bound is scant. In broad terms, however, the federal funds rate was held at the lower bound for nearly seven years, with a number of episodes of forward guidance used to communicate to the public information regarding the FOMC's reaction function and views regarding the future path of policy. While pockets of vulnerabilities appeared during this period—most notably in leveraged lending—overall vulnerabilities were assessed to be moderate. A caveat to this episode is that the economy was recovering from the financial crisis for the bulk of that period, and so some of the excesses that could be associated with an economy "running hot" would be less likely to materialize. Furthermore, this was during a period in which bank supervision and regulation was being tightened which limited banks' ability to take additional risk until they could identify new gaps in the rules.

(2) Balance sheet tools

Balance sheet policy is a tool that the Committee could use to provide monetary policy stimulus in situations in which the federal funds rate is at or near its ELB. Balance sheet policy has been used only during a few episodes of the Federal Reserve's history, leading to limited empirical evidence of its effects.[28] However, this evidence, plus some theory, has identified a number of costs and benefits of balance sheet policies.[29]

Balance sheet policies reduce longer-term interest rates. Because many businesses and households borrower long term, quantitative easing (QE) might encourage borrowing disproportionately more than changes to short rates. In addition, the reduction in longer-term interest rates can flatten the yield curve. A flatter yield curve can disrupt the business models of financial institutions (such as pension funds and life insurance companies) that depend on positive long-run returns. Although a relatively flat yield curve has not, to date, constrained the Committee's actions much, it has constrained the aggressiveness of the Bank of Japan's asset purchases.

[27] See Adrian and Shin (2010). The Basel Accords have replaced value at risk with expected shortfall but both measures are sensitive to decreases in market volatility.

[28] The three major episodes that used balance sheet policies were Large Scale Open-Market Operations during the Great Depression, Operation Twist in the 1960s, and the Large Scale Asset Purchases during the Global Financial Crisis.

[29] See "Issues in the Use of the Balance Sheet Tool," Memo to the Committee, October 11, 2019.

At the same time, a flatter yield curve can lessen the quantity of maturity transformation. Because the interest rate spread between longer-term assets and shorter-term liabilities narrows, intermediaries find it less profitable to engage in this activity.[30]

Likely related to the flat yield curve, there is some evidence that QE leads to reach for yield behavior and narrowing of risk premiums, both for Treasury securities and other instruments.[31] Some empirical research suggests that banks most affected by QE eased lending standards and made riskier loans. Other evidence suggests that corporate bond portfolios move towards riskier instruments.[32] While this risk-taking channel is one way in which monetary policy can be effective, that same channel can generate financial vulnerabilities. The evidence on excessive risk-taking by financial and non-financial firms during QE suggests that while some reaching-for-yield may have occurred, it did not pose a serious concern.[33]

There are some financial stability benefits from QE. The increase in reserves from QE boosts bank liquidity. Furthermore, in past experience, much of the rise in reserves occurred at the largest banks and at foreign branches, the institutions with the largest impact on financial stability. In addition, and on net, overall private sector duration risk is reduced by balance sheet policies.[34] The provision of safe assets by the central bank through reserves and reverse repos has the potential to "crowd out" unstable private sector money creation.[35] And finally, many of the possible financial stability concerns that were raised in advance of the implementation of QE did not materialize.

(3) Yield curve control tools

Yield curve control tools are a subset of balance sheet tools, which can be used in conjunction with forward guidance tools, and can be used at either the short or long end of the yield curve. Financial stability concerns for yield curve control tools are similar to those for balance sheet tools. One difference is the extent to which preferred habitat motives coincide with financial stability concerns. For example, pension funds and other institutional investors reportedly prefer specific maturities—if they did not, balance sheet policies generally and yield curve control tools specifically would be less effective. To the extent that these institutions were unable or unwilling to switch to assets of similar

[30] Of course, maturity transformation has its plusses, too—maturity transformation is one of the principal activities of banks, and this activity supports economic growth.

[31] See Kashyap and Seigert (2019), Li and Wei (2013), and Gagnon et al (2011).

[32] Chen and Choi (2019) demonstrate that yields on bonds that were more likely to be subject to "reach for yield" behavior reacted more to LSAP announcement effects than bonds that were not.

[33] See Kuttner (2018).

[34] See Woodford (2016).

[35] See Greenwood, Hanson, and Stein (2016). Gorton and He (2016) offer a caveat: if QE is concentrated in Treasury securities, safe collateral is removed from the market and investors will create risky alternatives to satisfy collateral needs.

safety but different maturity, and instead substituted assets with less safety and similar maturity, yield curve control could have financial instability implications.

The most salient evidence regarding yield curve control comes from recent Bank of Japan operations. There, the commitment to target 10-year bond yields created some operational and liquidity problems due to the dominance of the Bank of Japan in market segments where purchases were concentrated. In addition, the flat yield curve led pensions and life insurance companies to take on somewhat greater risk by purchasing foreign bonds and super-long Japanese government bonds.

(4) Negative interest rates

Financial stability risks from negative interest rates are similar to those from low rates, but with a few additional concerns. For example, the implementation of negative interest rates in the U.S. could cause some problems for the operation of money markets. Evidence from the CCAR stress tests and from experience abroad suggests that negative interest rates reduce bank profitability at exposed institutions. [36] Negative rates squeezed banks' profit margins as their lending rates declined more than their funding costs, because retail deposit rates generally stayed above zero. That effect was partly offset by improved bank balance sheets, as asset values increased and non-performing loans were contained.[37] However, with these positive effects likely transitory, there is concern that bank profits would come under greater pressure as negative rate regimes persist.[38]

III. Macroprudential and supervisory tools

The Federal Reserve and other regulatory agencies have a range of regulatory and supervisory tools to build financial resilience and mitigate financial vulnerabilities. Tools to build resilience include capital and liquidity requirements, along with requirements that banks make structural changes to facilitate resolution. Tools for addressing cyclical vulnerabilities include the countercyclical capital buffer (CCyB), the CCAR stress tests,

[36] Regarding Euro-area banks, Heider, Saidi, and Schepens (2019) provide evidence that the introduction of negative policy rates by the European Central Bank in mid-2014 lead to increased risk-taking (and less lending) with a greater reliance on deposit funding. However, Arce, García-Posada, Mayordomo, and Onega (2019) find that banks with net interest income that are adversely affected by negative rates take less risk and adjust loan terms and conditions to shore up their risk weighted assets and capital ratios. Ampudia and Van den Heuvel (2017) find that accommodative monetary policy shocks, on average, boost bank equity prices, but this effect is reversed when interest rates are already low. Regarding the U.S., Arseneau (2017) finds the effect of negative rates depends importantly on bank business type.

[37] In general, negative rates have modest profitability effects on banks that rely relatively more on activities that generate fee income. See Arseneau (2017).

[38] Brunnermeier and Koby (2018) and Eggertsson, Juelsrud, Summers, and Wold (2019) argue that negative interest rates can lead to a contraction in lending and output through negative effects on bank profitability. They use the term "reversal rate" to refer to the (negative) level of the interest rate at which these contractionary effects on bank lending outweigh the stimulative effects through other channels.

bank supervisory guidance and changes to margin requirements. The CCyB in particular can be activated to boost capital during good times when vulnerabilities build, and released when the economy weakens to promote continued lending.

The appeal of using macroprudential and supervisory tools rather than monetary policy to address financial vulnerabilities is twofold. First, it reduces potential conflicts with macroeconomic monetary policy goals. Monetary policy is already tasked with maximum employment and price stability and trying to meet a third goal may require sacrifices to other goals even if it was effective at dealing with financial vulnerabilities. Second, macroprudential tools can be more narrowly tailored towards a set of vulnerabilities than monetary policy tools can be. For example, in the wake of the financial crisis, regulators raised capital requirements for the largest, most interconnected institutions. In addition, in 2006, supervisory guidance was used to limit banks' commercial real estate exposures as valuations increased and terms weakened. This guidance was reiterated in late 2015 and is widely viewed as helping to tamp down commercial real estate prices.[39,40] In addition, the 2016 money market reform appears to have eliminated much of the run risk associated with these institutions.

As the Committee has noted previously, there are, however, limits to the effectiveness of macroprudential and supervisory tools, which may be a justification for using monetary policy to address financial vulnerabilities. The first is that many of them, such as bank capital rules or supervisory guidance, only affect banks. Consequently, the effect on vulnerabilities may be limited if the vulnerabilities stem from or can migrate to the nonbank sector. In contrast, monetary policy affects all lenders. As former Governor Stein observed, "while monetary policy may not be quite the right tool for the job, it has one important advantage relative to supervision and regulation--namely that it gets in all of the cracks."[41]

The second limit is that many of these tools require coordination with other agencies and some delay in implementation. For example, changing banking regulations usually requires some coordination and agreement among the three federal bank regulators. In addition, the Administrative Procedures Act requires that regulations go through a public process of rule proposal and public comment that, by construction,

[39] See Glancy and Kurtzman (2018), Basset and Marsh (2017), and Glancy et al. (2019).

[40] For details, see https://www.federalreserve.gov/supervisionreg/srletters/sr1517.htm

[41] Stein (2013). In addition, the Committee has previously debated potential situations in which monetary policy could be used to address financial vulnerabilities; many of the limitations of macroprudential tools were raised on that occasion. See Board of Governors (2016).

easily lasts six months or longer.[42] The primary exceptions to these processes are the CCyB and the Dodd-Frank stress tests where the stress scenario can be tailored to focus on emerging vulnerabilities, subject to the Board's framework for scenario design.

A third limit is that in the U.S., unlike those in some other countries, there cannot be underwriting standards that apply to borrowers, regardless of lender. Examples include minimum down payment requirements on a mortgage or limits on corporate debt service ratios.[43] Here, the problem is that if regulators try to impose such limits indirectly, by restricting lending terms used by a bank, lending can migrate to a non-bank, and potentially less prudentially regulated, entity.

IV. Communication strategies

The effects of monetary policy on financial stability will depend importantly on the expectations of households and firms about economic and policy variables. Communication about monetary strategies and tools can help shape those expectations and thus influence the impact on financial stability. More narrowly, if markets do not understand how monetary policy will respond to changing economic conditions, they may position themselves in ways that make them vulnerable to interest rate changes. Thus, clear communication of the monetary policy strategy is important to reduce surprises that could lead to financial instability. Of course, certainty poses risks as well. In particular, if policymakers remove too much uncertainty regarding the expected policy path, financial intermediaries could take on positions that then lead to outsized losses with broader knock-on effects if the strongly expected path does not come to pass.[44]

A. International experience

Some foreign central banks have incorporated financial stability issues into their monetary policy communications to varying degrees. Although most foreign central banks have a primary mandate for price stability, many also have financial stability among their secondary mandates. For example, the ECB Treaty requires it to "… contribute to the smooth conduct of policies pursued by competent authorities relating to the prudential supervision of credit institutions and the stability of the financial system," and the Bank of Japan Act says one of its purposes "… is to ensure smooth settlement of funds among banks and other financial institutions, thereby contributing to the maintenance of stability of the financial system."

[42] For more detailed descriptions of these tools and their limitations see the discussions of the two tabletop exercises undertaken by the Conference of Presidents Committee on Financial Stability (Adrian et al., 2017, and Duffy et al., 2019).

[43] The Federal Reserve Board has had the authority to set margin requirements on purchases of equities since 1934, but has not used this power since the early 1970s. This may be because these requirements were viewed to be ineffective, e.g., Hsieh and Miller (1990).

[44] See De Pooter et al. (2018).

Central banks have varied in terms of how they sought to promote financial stability. Some, such as the Bank of England, have a separate financial policy committee with authority over macroprudential tools, leaving the monetary policy committee to focus on macroeconomic objectives. Other central banks, such as the Swedish Riksbank and the Norges Bank, have at times incorporated financial stability considerations into how they conduct and communicate about monetary policy. In particular, both of those central banks went through periods during the past decade when they kept monetary policy tighter than consistent with their inflation goals in order to lean against perceived financial stability risks from rapidly rising house prices and household debt. That experience is generally seen as problematic, because the monetary policy stance could not be explained based on the inflation-targeting framework, and those central banks provided insufficient guidance on how they would balance their inflation and financial stability goals. Most foreign central banks have stated that they would use monetary policy as a response to perceived financial stability risks only if they believed that macroprudential and supervisory tools would be inadequate.

B. Financial stability "escape clauses"

The foreign experience also provides insights regarding the use of financial instability "escape clauses." Because the evolution of financial vulnerabilities may be uncertain, the escape clause allows the central bank to deviate from a monetary policy strategy or rule if financial vulnerabilities become significant. An example of an escape clause was the Bank of England's 2013 forward guidance linking interest rates and asset purchases to a threshold for the unemployment rate. That guidance had a "knockout" saying that such a link would cease to hold if the BOE's Financial Policy Committee judged that the stance of monetary policy posed a significant threat to financial stability that could not be contained through macroprudential and supervisory tools. Specifically, the Bank of England indicated that the forward guidance would cease to hold if one of three conditions were breached, including if: "the Financial Policy Committee (FPC) judges that the stance of monetary policy poses a significant threat to financial stability that cannot be contained by the substantial range of mitigating policy actions available to the FPC, the Financial Conduct Authority and the Prudential Regulation Authority in a way consistent with their objectives."

References

Abreu, Dilip and Markus K. Brunnermeier (2002). "Synchronization Risk and Delayed Arbitrage," *Journal of Financial Economics*, vol. 66 (Nov), pp. 341-360.

Adrian, Tobias, Patrick de Fontnouvelle, Emily Yang, and Andrei Zlate (2017). "Macroprudential Policy: A Case Study from a Tabletop Exercise," Federal Reserve Bank of New York, *Economic Policy Review*, vol. 23 (February), pp. 1–30.

Adrian, Tobias, and Hyun Song Shin (2010). "Liquidity and Leverage," *Journal of Financial Intermediation*, vol. 19 (July), pp. 418–37.

Ampudia, Miguel, and Skander Van den Heuvel (2018). "Monetary Policy and Bank Equity Values in a Time of Low Interest Rates," ECB Working Paper No. 2199. Frankfurt: European Central Bank, November, https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2199.en.pdf.

Antolín-Díaz, Juan, Ivan Petrella and Juan F. Rubio-Ramírez (2019). "Structural Scenario Analysis with SVARs." London Business School working paper, May.

Arce, Óscar, Miguel García-Posada, Sergio Mayordomo, and Steven Ongena (2018). "Adapting Lending Policies When Negative Interest Rates Hit Banks' Profits," Banco de España Working Paper No. 1832. Madrid: Banco de España, September, https://www.bde.es/f/webbde/SES/Secciones/Publicaciones/PublicacionesSeriadas/DocumentosTrabajo/18/Files/dt1832e.pdf.

Arseneau, David M. (2017). "How Would U.S. Banks Fare in a Negative Interest Rate Environment?" Finance and Economics Discussion Series 2017-030. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2017.030.

Bank for International Settlements (2018). "Financial Stability Implications of a Prolonged Period of Low Interest Rates," Committee on the Global Financial System Papers No. 61. Basel: BIS, July, https://www.bis.org/publ/cgfs61.pdf.

Bassett, William F., and W. Blake Marsh (2017). "Assessing Targeted Macroprudential Financial Regulation: The Case of the 2006 Commercial Real Estate Guidance for Banks," *Journal of Financial Stability*, vol. 30 (June), pp. 209–28.

Becker, Bo, and Victoria Ivashina (2014). "Cyclicality of Credit Supply: Firm Level Evidence," *Journal of Monetary Economics*, vol. 62 (March), pp. 76–93.

Bernanke, Ben, Michael Kiley, and John Roberts (2019). "Monetary Policy Strategies for a Low-Rate Environment," Finance and Economics Discussion Series 2019-

009. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2019.009.

Bernanke, Ben S., and Kenneth N. Kuttner (2005). "What Explains the Stock Market's Reaction to Federal Reserve Policy?" *Journal of Finance*, vol. 60 (June), pp. 1221–57.

Board of Governors of the Federal Reserve System (2016). "Minutes of the Federal Open Market Committee, April 26–27, 2016," press release, May 18, https://www.federalreserve.gov/newsevents/pressreleases/monetary20160518a.htm.

Board of Governors of the Federal Reserve System (2019). "Alternative Strategies: How Do They Work? How Might They Help?" memorandum to the Federal Open Market Committee, August 30.

Board of Governors of the Federal Reserve System (2019). "How Robust Are the Alternative Strategies to Key Alternative Assumptions?" memorandum to the Federal Open Market Committee, August 30.

Bordalo, Pedro, Nicola Gennaioli, and Andrei Shleifer (2018). "Diagnostic Expectations and Credit Cycles," *Journal of Finance*, vol. 73 (Feb), pp. 199-227.

Borio, Claudio, and Haibin Zhu (2012). "Capital Regulation, Risk-Taking and Monetary Policy: A Missing Link in the Transmission Mechanism?" *Journal of Financial Stability*, vol. 8 (January), pp. 236–51.

Brunnermeier, Markus K. and Yann Koby (2018). "The Reversal Interest Rate," NBER Working Paper Series 25406. Cambridge, Mass.: National Bureau of Economic Research, December, https://www.nber.org/papers/w25406.

Caldara, Dario, and Edward Herbst (2019). "Monetary Policy, Real Activity, and Credit Spreads: Evidence from Bayesian Proxy SVARs," *American Economic Journal: Macroeconomics*, vol. 11 (January), pp. 157–92.

Chen, Qianwen, and Jaewon Choi (2019). "Reaching for Yield and Bond Returns," University of Illinois Urbana-Champaign Working Paper, November.

Chen, Andrew Y., Eric C. Engstrom, and Olesya V. Grishchenko (2016). "Has the Inflation Risk Premium Fallen? Is It Now Negative?" FEDS Notes. Washington: Board of Governors of the Federal Reserve System, April 4, https://dx.doi.org/10.17016/2380-7172.1720.

Chung, Hess, Etienne Gagnon, Taisuke Nakata, Matthias Paustian, Bernd Schlusche, James Trevino, Diego Vilán, and Wei Zheng (2019). "Monetary Policy Options at the Effective Lower Bound: Assessing the Federal Reserve's Current Policy Toolkit," Finance and Economics Discussion Series 2019-003. Washington:

Board of Governors of the Federal Reserve System, January, https://doi.org/10.17016/FEDS.2019.003.

Coimbra, Nuno, and Hélène Rey (2019). "Financial Cycles With Heterogeneous Intermediaries," working paper, January, http://www.helenerey.eu/Content/_Documents/Financial%20Cycles%20with%20Heterogeneous%20Intermediaries.pdf.

Daniel, Kent, Lorenzo Garlappi, and Kairong Xiao (2018). "Monetary Policy and Reaching for Income," NBER Working Paper Series 25344. Cambridge, Mass.: National Bureau of Economic Research, December, https://www.nber.org/papers/w25344.

De Pooter, Michiel, Giovanni Favara, Michele Modugno, and Jason Wu (2018). "Monetary Policy Surprises and Monetary Policy Uncertainty," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, May 18, 2018, https://doi.org/10.17016/2380-7172.2176.

Del Negro, Marco, and Christopher Otrok (2007). "99 Luftballons: Monetary Policy and the House Price Boom across U.S. States," *Journal of Monetary Economics*, vol. 54 (January), pp. 1962–85.

Dell'Ariccia, Giovanni, Luc Laeven, and Gustavo A. Suarez (2017). "Bank Leverage and Monetary Policy's Risk-Taking Channel: Evidence from the United States," *Journal of Finance*, vol. 72 (March), pp. 613–54.

Di Maggio, Marco, and Marcin Kacperczyk (2017). "The Unintended Consequences of the Zero Lower Bound Policy," *Journal of Financial Economics*, vol. 123 (January), pp. 59–80.

Dokko, Jane, Brian M. Doyle, Michael T. Kiley, Jinill Kim, Shane Sherlund, Jae Sim, and Skander Van Den Heuvel (2011). "Monetary Policy and the Global Housing Bubble," *Economic Policy*, vol. 26 (April), pp. 237–87.

Drechsler, Itamar, Alexi Savov, and Philipp Schnabl (2017). "The Deposits Channel of Monetary Policy," *Quarterly Journal of Economics*, vol. 132 (November), pp. 1819–76.

——— (2019). "How Monetary Policy Shaped the Housing Boom," NBER Working Paper Series 25649. Cambridge, Mass.: National Bureau of Economic Research, March, https://www.nber.org/papers/w25649.

Driscoll, John C., and Ruth A. Judson (2013). "Sticky Deposit Rates," Finance and Economics Discussion Series 2013-80. Washington: Board of Governors of the Federal Reserve System, October, https://www.federalreserve.gov/pubs/feds/2013/201380/201380pap.pdf.

Duffy, Denise, Joseph G. Haubrich, Anna Kovner, Alex Musatov, Edward S. Prescott, Richard J. Rosen, Thomas D. Tallarini, Jr., Alexandros P. Vardoulakis, Emily Yang, and Andrei Zlate (2019). "Macroprudential Policy: Results from a Tabletop Exercise," Federal Reserve Bank of Cleveland Working Paper 19-11. Cleveland: FRB Cleveland, May, https://doi.org/10.26509/frbc-wp-201911.

Eggertsson, Gauti B., Ragnar E. Juelsrud, Lawrence H. Summers, and Ella Getz Wold (2019). "Negative Nominal Interest Rates and the Bank Lending Channel," NBER Working Paper Series 25416. Cambridge, Mass.: National Bureau of Economic Research, January, https://www.nber.org/papers/w25416.

Gagnon, Joseph, Matthew Raskin, Julie Remache, and Brian Sack (2011). "The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases," *International Journal of Central Banking*, vol. 7 (March), pp. 3–43.

Gertler, Mark, and Peter Karadi (2015). "Monetary Policy Surprises, Credit Costs, and Economic Activity," *American Economic Journal: Macroeconomics*, vol. 7 (January), pp. 44–76.

Gilchrist, Simon, David López-Salido, Egon Zakrajšek (2015). "Monetary Policy and Real Borrowing Costs at the Zero Lower Bound," *American Economic Journal: Macroeconomics*, vol. 7 (January), pp. 77–109.

Glancy, David, and Robert Kurtzman (2018). "How Do Capital Requirements Affect Loan Rates? Evidence from High Volatility Commercial Real Estate," Finance and Economics Discussion Series 2018-079. Washington: Board of Governors of the Federal Reserve System, November, https://doi.org/10.17016/FEDS.2018.079.

Glancy, David, John Krainer, Robert Kurtzman, and Joseph Nichols (2019). "Intermediary Segmentation in the Commercial Real Estate Market," Finance and Economics Discussion Series 2019-079. Washington: Board of Governors of the Federal Reserve System, November, https://doi.org/10.17016/FEDS.2019.079.

Goldberg, Jonathan (forthcoming). "Liquidity Supply by Broker-Dealers and Real Activity," *Journal of Financial Economics*.

Gomes, João, Urban Jermann, and Lukas Schmid (2016). "Sticky Leverage," *American Economic Review*, vol. 106 (December), pp. 3800–28.

Gorton, Gary, and Ping He (2016). "Optimal Monetary Policy in a Collateralized Economy," NBER Working Paper Series 22599. Cambridge, Mass.: National Bureau of Economic Research, September, https://www.nber.org/papers/w22599.

Greenwood, Robin, Samuel G. Hanson, and Jeremy C. Stein (2016). "The Federal Reserve's Balance Sheet as a Financial-Stability Tool," in *Designing Resilient Monetary Policy Frameworks for the Future*, proceedings of the 2016 Economic Policy Symposium held in Jackson Hole, Wyo. Kansas City: Federal Reserve Bank of Kansas City, pp. 335–97.

Hsieh, David A. and Merton H. Miller (1990). "Margin Regulation and Stock Market Volatility," *Journal of Finance*, vol. 45 (March), pp. 3-29.

Jarociński, Marek, and Frank R. Smets (2008). "House Prices and the Stance of Monetary Policy," Federal Reserve Bank of St. Louis, *Review*, vol. 90 (July/August), pp. 339–65.

Jermann, Urban, and Vincenzo Quadrini (2012). "Macroeconomic Effects of Financial Shocks," *American Economic Review*, vol. 102 (February), pp. 238–71.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina (2014). "Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk-Taking?" *Econometrica*, vol. 82 (April), pp. 463–505.

Jordà, Òscar, Moritz Schularick, Alan M. Taylor (2013). "When Credit Bites Back," *Journal of Money, Credit and Banking*, vol. 45 (s2), pp. 3–28.

_____ (2016). "Macrofinancial History and the New Business Cycle Facts," *NBER Macroeconomics Annual*, vol. 31 (2016), pp. 213–63.

Heider, Florian, Farzad Saidi, and Glenn Schepens (2019). "Life Below Zero: Bank Lending under Negative Policy Rates," *Review of Financial Studies*, vol. 32 (October), pp. 3728–61.

Hsieh, David A., and Merton H. Miller (1990). "Margin Regulation and Stock Market Volatility," *Journal of Finance*, vol. 45 (March), pp. 3–29.

Kang, Johnny, and Carolin E. Pflueger (2015). "Inflation Risk in Corporate Bonds," *Journal of Finance*, vol. 70 (January), pp. 115–62.

Kashyap, Anil, and Caspar Seigert (2019). "Financial Stability Considerations and Monetary Policy," paper presented at the Conference on Monetary Policy Strategy, Tools, and Communications Practices, held at the Federal Reserve Bank of Chicago, June 5.

Keeley, Michael (1990). "Deposit Insurance, Risk, and Market Power in Banking," *American Economic Review*, vol. 80 (December), pp. 1183–1200.

Kiley, Michael (2018). "What Macroeconomic Conditions Lead Financial Crises?" Finance and Economics Discussion Series 2018-038. Washington: Board of Governors of the Federal Reserve System, May, https://doi.org/10.17016/FEDS.2018.038.

Kindleberger, C. (2015). *Manias, Panics, and Crashes*. Palgrave Macmillian; 7th edition.

Koenig, Evan F. (2012). "All the in Family: The Close Connection between Nominal-GDP Targeting and the Taylor Rule," Federal Reserve Bank of Dallas Staff Papers 17. Dallas: FRB Dallas, March, https://www.dallasfed.org/~/media/documents/research/staff/staff1202.pdf.

Krishnamurthy, Arvind, and Tyler Muir (2017). "How Credit Cycles across a Financial Crisis," NBER Working Paper Series 23850. Cambridge, Mass.: National Bureau of Economic Research, September, https://www.nber.org/papers/w23850.

Kuttner, Kenneth N. (2018). "Outside the Box: Unconventional Monetary Policy in the Great Recession and Beyond," *Journal of Economic Perspectives*, vol. 32 (Fall), pp. 121–46.

Li, Canlin, and Min Wei (2013). "Term Structure Modeling with Supply Factors and the Federal Reserve's Large-Scale Asset Purchase Programs," *International Journal of Central Banking*, vol. 9 (March), pp. 3–39.

Lian, Chen, Yueran Ma, and Carmen Wang (2019). "Low Interest Rates and Risk-Taking: Evidence from Individual Investment Decisions," *Review of Financial Studies*, vol. 32 (June), pp. 2107–48.

Maddaloni, Angela, and José-Luis Peydró (2011). "Bank Risk-Taking, Securitization, Supervision, and Low Interest Rates: Evidence from the Euro-Area and the U.S. Lending Standards," *Review of Financial Studies*, vol. 24 (June), pp. 2121–65.

Martin, Alberto and Jaume Ventura (2018) "The Macroeconomics of Rational Bubble: A User's Guide," NBER Working Paper Series 24234. Cambridge, Mass.: National Bureau of Economic Research, January, https://www.nber.org/papers/w24234.

Mian, Atif, Amir Sufi, and Emil Verner (2017). "Household Debt and Business Cycles Worldwide," *Quarterly Journal of Economics*, vol. 132 (November), pp. 1755–1817.

Musso, Alberto, Stefano Neri, and Livio Stracca (2011). "Housing, Consumption and Monetary Policy: How Different are the U.S. and the Euro Area?" *Journal of Banking and Finance*, vol. 35 (November), pp. 3019–41.

Paligorova, Teodora, and João A. C. Santos (2017). "Monetary Policy and Bank Risk-Taking: Evidence from the Corporate Loan Market," *Journal of Financial Intermediation*, vol. 30 (April), pp. 35–49.

Stein, Jeremy C. (2013). "Overheating in Credit Markets: Origins, Measurement, and Policy Responses," speech delivered at "Restoring Household Financial Stability After the Great Recession," a symposium sponsored by the Federal Reserve Bank of St. Louis, February 7, https://www.federalreserve.gov/newsevents/speech/stein20130207a.htm.

Swanson, Eric T. (2017). "Measuring the Effects of Federal Reserve Forward Guidance and Asset Purchases on Financial Markets," NBER Working Paper Series 23311. Cambridge, Mass.: National Bureau of Economic Research, April, http://www.nber.org/papers/w23311.

Taylor, John B. (2009). "Economic Policy and the Financial Crisis: An Empirical Analysis of What Went Wrong," *Critical Review*, vol. 21 (July), pp. 341–64.

Tirole, Jean (1985). "Asset Bubbles and Overlapping Generations," Econometrica, vol. 53 (Nov), pp. 1499-1528.

Woodford, Michael (2016). "Quantitative Easing and Financial Stability," NBER Working Paper Series 22285. Cambridge, Mass.: National Bureau of Economic Research, May, https://www.nber.org/papers/w22285.

Table 1: Estimated effects of 100 basis points monetary policy shock (unexpected easing) on asset valuations	
Measure and source	Effect
Corporate bond spread	
Caldara and Herbst	20 bps
Excess corporate bond premium	
Gertler and Karadi	15 bps
Stock prices	
Bernanke and Kuttner	4.7%
Swanson	3.6%
House prices	
Del Negro and Otrok	3.3%
Jarociński and Smets	4.4%
Kiley	2.0%
Musso et al.	1.5%
10-year Treasury yield	
Gertler and Karadi	16 bps
Gilchrist, López-Salido, Zakrajšek	14 bps
10-year Treasury term premium	
Gertler and Karadi	16 bps
Gilchrist, López-Salido, Zakrajšek	7 bps

The estimates in this table are from models using a range of identification methods (including changes in futures prices around FOMC announcements, VARs using such changes as external instruments, and VARs using sign restrictions), use different sample periods and definitions of monetary policy shocks, and are estimated with some imprecision. Some papers measure monetary policy shocks as unexpected changes in the one-year or two-year Treasury yield; where possible, these estimates are adjusted so that the estimated effect shown in the table can be interpreted as the effect of a 100 basis point unexpected decline in the federal funds rate. The estimates in this table are most reasonably applied to policy interventions that do not represent a large deviation from historical practice (Antolín-Díaz, Petrella, Rubio-Ramírez (2019)).

Table 2. Connections between interest rates, vulnerabilities, and vulnerability-related measures

	This paper studies the effect of….	This paper studies the effect on these vulnerability-related measures	Studies specifically low rate environment	Findings
Banking system vulnerabilities				
Jiménez, Ongena, Peydró, and Saurina (2014)	Changes in interest rates, controlling for unobserved time-varying characteristics of firms and banks. Data is from Spain.	Lending approval rate, lending amount, collateral requirements, default propensity, for loans to "risky" firms (firms that have defaulted recently). Focuses on how lowly capitalized banks respond differently than highly capitalized banks.	No	Lower interest rates increase risk taking; relation is *more* pronounced for low-capitalized banks. Following a 1 percent decrease in overnight rate, loan approval rate for risky borrowers increases by 3 percentage points more for poorly capitalized banks than for well capitalized banks (mean approval rate is 36 percent). Following a decline in interest rates, poorly capitalized banks reduce collateral requirements and make more loans that lead to default, relative to well capitalized banks.
Dell'Ariccia, Laeven, and Suarez (2017)	Changes in interest rates. US.	Internal ratings on loans to businesses, from the Survey of Terms of Business Lending	No	Lower interest rates modestly increase risk taking; relation is *less* pronounced for low-capitalized banks. Following a 1 percent decrease in overnight rate, loan risk ratings for new loans rise by 0.1 standard deviations.

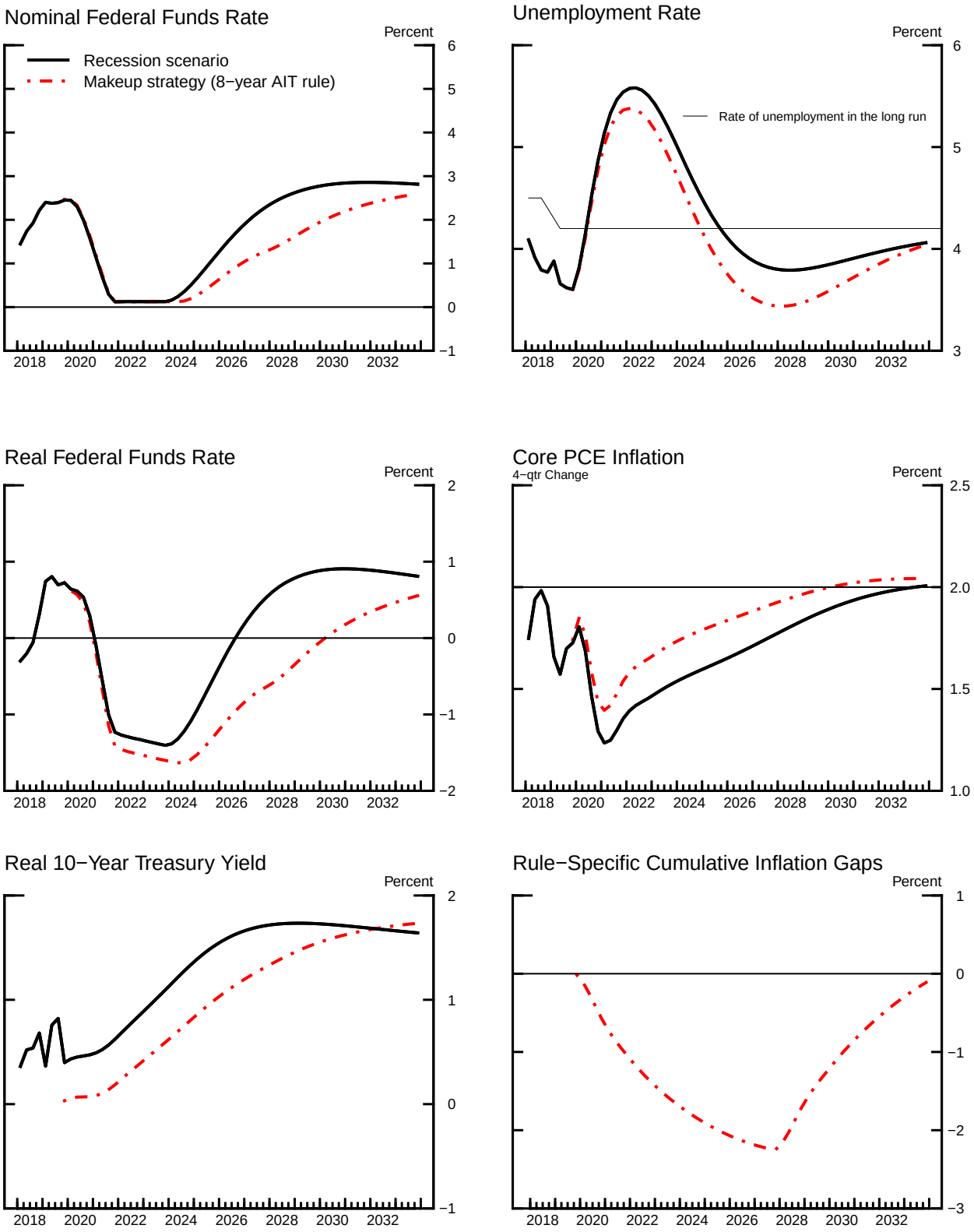
Short term funding / maturity transformation

Di Maggio and Kacperczyk (2018)	Five FOMC announcements from 2008 and 2012 at which "lower-for-longer" forward guidance or the federal funds rate target was lowered. US	Prime money market funds' maturity transformation and portfolio composition	Yes	When close to the ELB, lower-for-longer announcements led to higher risk taking by MMFs. A reduction in the federal funds rate from 1 percent to 0 percent increases the spread over T-bills for prime money market funds by 57 basis points; weighted average maturity increases by 1.7 days.
Dreschler, Savov, Schnabl (2019)	Changes in deposit rates driven by 2003-2006 hikes in the federal funds rate. US	Rate hikes don't pass one-for-one into deposit rates, thereby leading investors to shift from deposits into shadow banks, and ultimately leading to a shift in the composition of mortgage finance.	No	Hikes in the federal funds rate between 2003-2006 caused aggregate deposits to shrink by 12 percent, leading to a 13 percent decline in bank real estate loans, and a corresponding 10 percent increase in loans through private-label securitization

Investor risk appetite

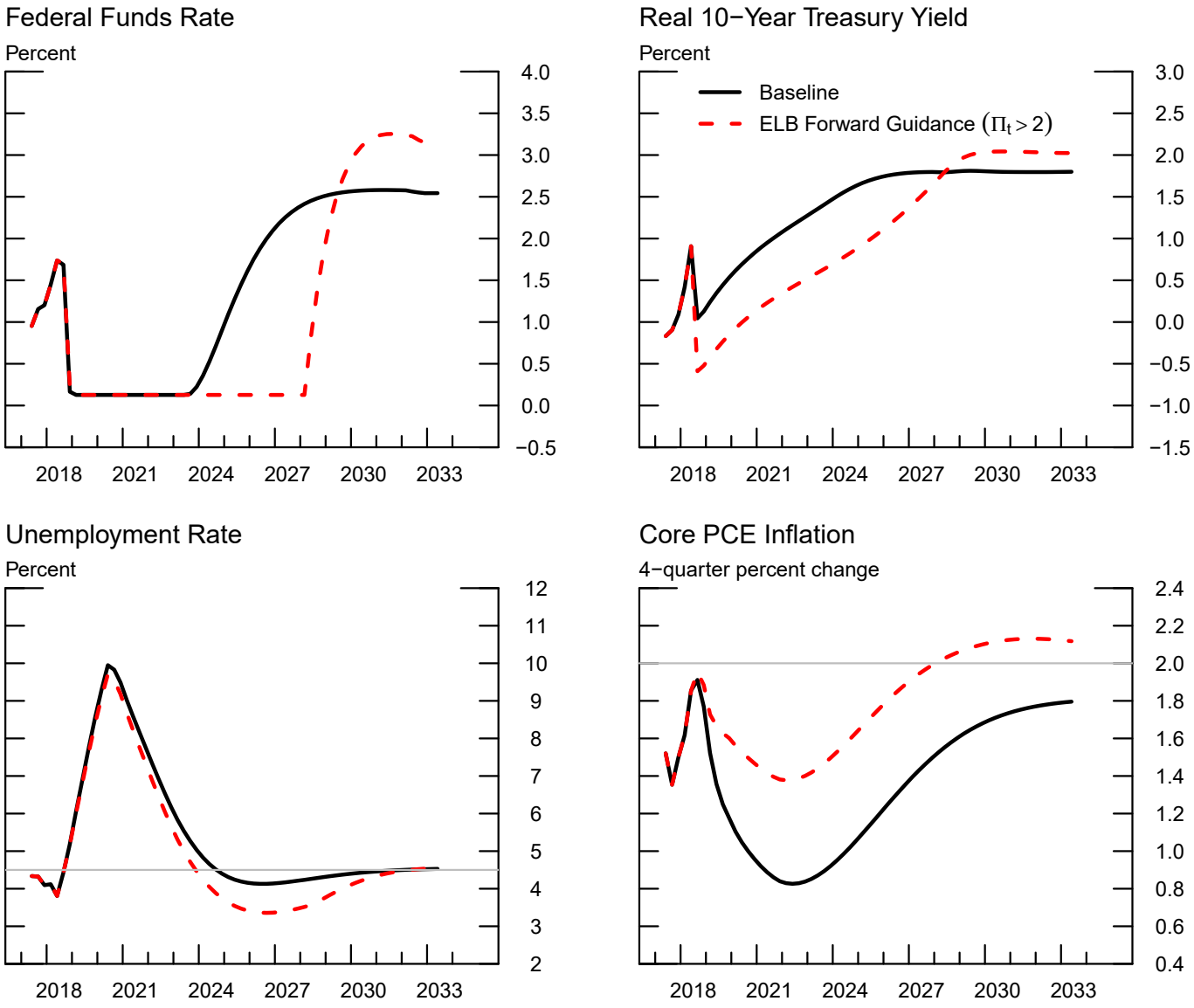
Lian, Ma, Wang (2019)	Lower risk-free rates, using an incentivized lab experiment. The lab experiment participants are Harvard Business School (HBS) students and others. Lab experiments offer very clean identification but raise questions of applicability in real-world settings.	The share of a hypothetical portfolio that HBS students allocate to risk assets.	Yes	In the lab, HBS students demonstrate stronger preference for risky assets when the risk-free rate is low. Keeping risk premiums and risks the same but reducing the risk-free rate from 5 percentage point to 1 percentage point, HBS students increase allocation to the risky asset by 9 percentage points.
Daniel, Garlappi, Xiao (2018)	Local deposit rates. US	Allocation to high dividend stocks for individual investors	No	Lower interest rates are associated with modest changes in aggregate retail investor allocations. A 1 percent decrease in the Federal Funds rate leads to a 1 percent increase in holdings of high dividend stocks and a 5 percent increase in AUM for high-income equity mutual funds. Effects more pronounced for retirees.

Exhibit 1: An average−inflation−targeting rule in a recession scenario



Source: Board of Governors of the Federal Reserve System (2019). "Alternative Strategies: How Do They Work? How Might They Help?" memorandum to the Federal Open Market Committee, August 30.

Exhibit 2: Forward guidance with an inflation threshold in a recession scenario



Source: Chung et. al (2019). Monetary Policy Options at the Effective Lower Bound: Assessing the Federal Reserve's Current Policy Toolkit, Finance and Economics Discussion Series 2019−003.