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A probability-based stress test of Federal Reserve assets and income[☆]

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ABSTRACT

To support the economic recovery, the Federal Reserve amassed a large portfolio of long-term bonds. We assess the Fed's associated interest rate risk—including potential losses to its Treasury and mortgage-backed securities holdings and declines in the Fed's remittances to the Treasury. In assessing this interest rate risk, we use probabilities of alternative interest rate scenarios that are obtained from a dynamic term structure model that respects the zero lower bound on yields. The resulting probability-based stress tests indicate that large portfolio losses or a cessation of remittances to the Treasury are unlikely to occur over the next few years.

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1. Introduction

The fundamental business model of many private financial institutions uses shorter-term liabilities to finance longer-term assets. The resulting balance sheet maturity mismatch implies that the financial institutions are bearing interest rate risk; namely, a financial exposure to adverse movements in interest rates. Accepting some interest rate risk is a natural part of financial intermediation and can be an important source of profitability; however, excessive interest rate risk can pose a significant threat to the earnings and capital base of a financial institution.

There are two separate, but complementary, perspectives commonly used for assessing interest rate risk exposure (e.g., [Basel Committee on Banking Supervision, 2004](#)). From the earnings perspective, the focus of analysis is on the effect of interest rate fluctuations on future firm cash flows. From the economic value (or capital) perspective, the focus of analysis is on the sensitivity of firm assets to fluctuations in interest rates, especially relative to the firm's capital base. Financial regulators have long cautioned financial institutions to avoid excessive interest rate risk from both perspectives. For example, recent supervisory guidance ([Board of Governors of the Federal Reserve System, 2010](#)) encourages financial institutions to forecast the effect of various interest rate scenarios on their future income statements and balance sheets. It is ironic then that many commentators have recently accused the Federal Reserve itself of taking on excessive interest rate risk along both dimensions. We consider such criticisms by examining forecasted probability distributions of the Fed's own income statement and balance sheet.

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In late 2008, in response to the severe financial crisis and recession, the Federal Reserve reduced its target for a key monetary policy rate—the overnight federal funds rate—to a range between zero and 25 basis points. To provide additional monetary stimulus to spur economic growth and avoid deflation, the Fed then conducted three rounds of large-scale asset purchases—commonly referred to as quantitative easing (QE). These purchases left the Fed's portfolio of longer-term securities several times larger than its pre-crisis level and greatly increased the Fed's liabilities in the form of bank reserves, which are commercial bank deposits with the Fed. Although the Fed's expanded securities portfolio carries essentially no credit risk, its market value will fluctuate over time, and its greater size and longer duration exposes the Fed to greater interest rate risk. The criticisms of the Fed's greater exposure to interest rate risk have generally taken either the standard earnings or economic value perspectives used for private financial institutions.¹ We label these two forms of interest rate risk as income risk and balance sheet risk, respectively, and they are the centerpieces of our analysis.

What we call income risk (also known in the literature as “carry” risk) is the risk that increases in *short-term* interest rates, notably the short-term interest rate that the Fed pays on bank reserves, will significantly increase the funding cost of the Fed's securities portfolio. Because the Fed's interest income is generated from fixed coupon payments on longer-maturity securities, rising short-term interest rates and increased payments on reserves would reduce the Fed's net interest income, which in turn would lower the Fed's remittances to the U.S. Treasury. For example, such worries were noted in the minutes of the March 20, 2013 Federal Open Market Committee meeting, which stated that “[s]ome participants were concerned that a substantial decline in remittances might lead to an adverse public reaction or potentially undermine Federal Reserve credibility or effectiveness.”²

What we call balance sheet risk (also known as “duration” risk) is the risk that increases in *longer-term* interest rates will erode the market value of the Fed's portfolio. For example, former Fed Governor Frederic Mishkin (2010) argued that “major holdings of long-term securities expose the Fed's balance sheet to potentially large losses if interest rates rise. Such losses would result in severe criticism of the Fed and a weakening of its independence.” Similarly, former Fed Vice Chairman Donald Kohn (2014) worried: “As long-term rates rise, the Federal Reserve will have mark-to-market losses on its balance sheet. These losses are not a threat to the Federal Reserve's ability to tighten nor do they have any economic significance, but losses could be used as a political weapon by those who seek to curtail the Federal Reserve's independence or limit its powers”.

To understand and assess the Fed's income and balance sheet risks, it is crucial to quantify them. Two recent papers—Carpenter et al. (2013) and Greenlaw et al. (2013), henceforth GHM—have made great progress in doing so. Both studies generated detailed projections of the market value and cash flow of the Fed's assets and liabilities under a few specific interest rate scenarios. In essence, their projections are akin to the “stress tests” that large financial institutions undergo to gauge whether they have enough capital to survive adverse economic scenarios.³ As is common, these stress tests do not place probabilities on the alternative interest rate scenarios but simply consider a few arbitrary scenarios including, say, shifting the level of the entire yield curve up or down from its baseline projection by 100 basis points. Clearly, it is also of great interest to know what probabilities should be attached to the range of considered outcomes.⁴ Attaching likelihoods to the alternative scenarios—or more generally, looking at the entire distributional forecast—results in what we term probabilistic or “probability-based” stress tests.

In this paper, we illustrate such a probability-based methodology by examining potential mark-to-market losses on the Fed's Treasury and mortgage-backed securities (MBS) holdings as well as the potential cessation of its remittances to the Treasury. Importantly, having information from the probability distribution of future interest rate scenarios enables us to assess the likelihood of certain events, such as the possibility that losses on the Fed's securities holdings will exceed a certain threshold or that net interest income will be negative for more than 1 year.

A key component of our probability-based stress test methodology is a dynamic term structure model that generates yield curve projections consistent with historical interest rate variation. Since nominal yields on Treasury debt are near their zero lower bound (ZLB), we use the shadow-rate, arbitrage-free Nelson-Siegel (AFNS) model class developed by Christensen and Rudebusch (2015) to generate the requisite, potentially asymmetric, distributional interest rate forecasts.⁵ Shadow-rate models are latent-factor models in which the state variables have standard Gaussian dynamics, but the standard short rate is replaced by a shadow short rate that may be negative, as in Black (1995). Since the short rate equals the shadow short rate

¹ Such balance sheet concerns have affected many central banks. For example, the Bank of Japan previously limited bond purchases from a fear that capital losses could tarnish its credibility (Bernanke, 2013); the Bank of England obtained an explicit indemnity from the British Treasury in advance of losses stemming from their QE (McLaren and Smith, 2013); and the Swiss National Bank faced a public referendum on the composition of its balance sheet. In response to these concerns, the literature on central bank financial accounting has recently grown in tandem with the latest expansion of central bank balance sheets and notably includes Bindseil et al. (2009), Archer and Moser-Boehm (2013), Hall and Reis (2013), and Del Negro and Sims (2015).

² See also Rudebusch (2011), Dudley (2013), and Goodfriend (2014).

³ Stress testing financial institutions, and the financial system more broadly, has taken on great importance in the wake of the financial crisis; see Schuermann (2013) and Borio et al. (2014). Our analysis is directly related to interest rate risk stress testing, which is discussed by Drehmann et al. (2010) and Abdymonunov and Gerlach (2014).

⁴ Berkowitz (2000) and Pritsker (2011) make a similar point regarding bank stress tests. In contrast, Borio et al. (2014) express the common view that stress tests should focus only on a few scenarios.

⁵ Recently, the ZLB has been shown to be somewhat elastic with some interest rates in Europe turning slightly negative. Christensen and Rudebusch (2013) extend our modeling structure to allow for possible non-zero lower bounds. For a Fed stress test, allowing U.S. interest rates to go slightly negative would notably allow short rates to push lower and raise the possibility of larger net interest margins and slightly more income for the Fed.

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