March 3, 2017

Changing the FOMC's Reinvestment Policy: Approaches and Considerations

Staff of the Board of Governors and the Federal Reserve Bank of New York[1]

1 Introduction /Executive Summary

As the process of lifting the federal funds target range continues, focus is shifting to questions about managing the balance sheet, and specifically the questions of when and how the Committee plans to reduce the size of the securities portfolio. The accompanying memo "The Macroeconomic Effects of State-Contingent Ending of Reinvestment" looks at issues and tradeoffs related to the timing of ending reinvestments. This memo considers four approaches the FOMC might follow in normalizing the balance sheet. For each approach, the memo discusses implications for the Federal Reserve's balance sheet and income, interactions with the Committee's longer-run operating framework, potential market reactions, and consequences for market functioning.

The FOMC has provided broad guidance on its approach to reinvestment. In particular, the Policy Normalization Principles and Plans (PNP&P) note that securities holdings will be reduced in a "gradual and predictable manner" by ceasing reinvestments (also referred to as redemptions herein) and that in the longer-run, the portfolio will consist of "primarily Treasury securities" to "minimize the effect" on the "allocation of credit across sectors of the economy." As part of the July 2015 FOMC discussion on reinvestment, the minutes noted that policymakers expressed a preference for beginning the process of redemptions based on a qualitative assessment of economic conditions and the outlook. Views on the operational approach were mixed, with most participants favoring an approach to wind down reinvestments in a way that would result in a smooth decline in the balance sheet, while others favored ceasing reinvestments all at once. Finally, the current FOMC statement language notes that reinvestments will continue until normalization of the level of the federal funds rate is "well under way." By maintaining reinvestments until the federal funds rate is well away from the zero lower bound, the Committee is better positioned to respond to an adverse shock through traditional interest rate cuts.

There are several key decisions that need to be made before implementing a change to the reinvestment policy. Below we use the four illustrative scenarios to highlight a range of considerations that might guide policymakers in their decisions about the reinvestment policy. These scenarios are illustrative and draw attention to trade-offs involved with different approaches; in practice, many variations are possible.

[1] Board: Michele Cavallo, Erin Ferris, Jane Ihrig, Don Kim; FRBNY: Brian Greene, Frank Keane, Deborah Leonard, Julie Remache, Brett Rose, Lisa Stowe. Sam Schulhofer-Wohl contributed to Section 4 and provided helpful comments throughout. The appendix was written by Courtney Demartini, Jeff Huther, Laurie Krmpotich, Laura Lipscomb, Luke Pardue, Mary-Frances Styczynski, Manjola Tase, and Heather Wiggins. We thank Stefania D'Amico and Andrew Meldrum for work on the MBS analysis; James Trevino and Wei Zheng for their outstanding technical support; and Grant Carney, Khalela Francis, Jamie Grasing, and Gabe Herman for excellent research assistance. We also thank Jim Clouse, Josh Frost, Thomas Laubach, Lorie Logan, Simon Potter, and Nate Wuerffel for valuable feedback.

The first scenario assumes a full and immediate cessation of reinvestments in all securities at the point when redemptions are initiated. Policymakers may prefer this approach as it achieves the most rapid reduction in the balance sheet. Among the four scenarios, it achieves the greatest reduction in interest rate risk of the portfolio (and hence the risk to the Federal Reserve's remittances to the Treasury). This approach also moves toward minimizing the effect of Federal Reserve holdings on the allocation of credit across sectors of the economy by redeeming MBS as they come due, and this approach is fairly straightforward to communicate. On the other hand, respondents to the Desk's surveys view it most likely that the Committee will phase out reinvestments over a period of time, so without further communication, this approach might be somewhat of a surprise.[2] In addition, the full and immediate cessation of MBS reinvestments could lead to a widening of the MBS-Treasury basis, if the market takes some time to adjust to the additional flow of these securities to the public after the Fed has been a large and consistent buyer for many years. The volume of Treasury redemptions under this option is also significant—more than $400 billion in 2018 and nearly $400 billion in 2019. Moreover, there is considerable month-to-month variation in maturing Treasuries—some upcoming months have redemptions of over $50 billion. The runoff of the Federal Reserve's Treasury portfolio could occur against the backdrop of considerable uncertainty about the fiscal outlook and the possibility of large net new financing requirements.

The second scenario is very similar to the first except that it caps the total monthly amount of Treasury redemptions to reduce the month-to-month volatility. While the cap could be set at any level, the scenario shown in the memo assumes a relatively high cap of $30 billion so that it addresses only the largest spikes in Treasury redemptions, which are associated with maturities during the months in which the Treasury holds its mid-quarter refunding auctions. Policymakers may prefer this approach as it has many of the same benefits as the first scenario and reduces the risk that large and lumpy SOMA redemptions could adversely affect Treasury market functioning or have outsized effects on interest rates.

The third approach assumes the FOMC adopts a policy to gradually phase out both Treasury and MBS reinvestments.[3] This approach is in line with current market expectations for a taper, and provides time for the Treasury and other market participants to adjust to market dynamics without regular reinvestments by the Federal Reserve.[4] Policymakers might prefer this approach if they are concerned about the possibility for disorderly conditions or temporary interest rate increases or MBS spread widening arising from full redemptions. Tapering was used to conclude prior asset purchase programs and, though it is not clear whether the approach can be credited with helping to avoid such conditions, it may still be viewed as providing some "insurance" against undesirable outcomes. On the other hand, a taper could be more complicated to design and to communicate. The Committee would need to

[2] On average, respondents to the Desk's January Surveys of Primary Dealers and Market Participants assigned a roughly 70 percent probability to reinvestments being phased out over time.

[3] In practice, the Committee could instead phase out only one asset class while using another approach for the other asset class. In that case, the benefits and drawbacks would apply to that asset class alone.

[4] The average respondent to the Desk's January surveys put a high probability on phasing out reinvestments of both Treasury securities and MBS, but the survey offers no additional insight as to the rationale of respondents nor how the phase out would be implemented. The March survey (forthcoming) includes a qualitative question about the form of a phase out, which may offer additional perspective.

decide whether to define an approach that would adjust automatically over time—in fixed quantities or percentages—or if it would actively adjust the taper over time.

Finally, the fourth scenario assumes that principal payments on the Federal Reserve's MBS holdings are redeemed in full, while Treasury reinvestments are maintained. Policymakers might prefer MBS redemptions only if they are willing to reduce the balance sheet more slowly, but wish to still minimizing the effect of Federal Reserve holdings on the allocation of credit across sectors of the economy. Such a strategy would avoid any possible pressures of redemptions in the Treasury market and could avoid what would otherwise be seen as a temporary reduction in Treasury holdings that would need to be reversed once the balance sheet is normalized. On the other hand, this approach could be somewhat unexpected, and given that MBS would be allowed to redeem in full, there could yet be some risk of market functioning concerns in that market, similar to the first two scenarios. At the same time, this approach would prolong the time to reach a normalized size of the balance sheet by several years relative to the other scenarios, which would increase the Federal Reserve's exposure to interest rate shocks and could result in a larger balance sheet than desired in a potential zero lower bound episode.[5] However, some of these risks could be mitigated if policymakers reinvested at least part of the Treasury maturities into Treasury bills or shorter-dated Treasury coupon securities.

As noted, these strategies are illustrative and are intended to highlight some basic tradeoffs. There are many other variations and hybrid approaches that are possible.[6] The analysis below suggests that there are only very small differences in the macroeconomic implications across the strategies along the baseline economic outlook. The differences among the first three strategies for the Federal Reserve's balance sheet and income over time are also relatively modest. All of these strategies normalize the size of the balance sheet at about the same time and there are only minor differences in the implications of these strategies for Federal Reserve remittances. In contrast, the fourth strategy has a somewhat lower modal path for Federal Reserve income in the next several years and has the potential for greater variability in Federal Reserve income over time.[7]

We also discuss the potential market responses to these redemption policies. We consider effects that are captured by our model (such as the stock effect on the 10-year Treasury term premium) as well as

[5] Respondents to the Desk's January surveys assigned an average probability of about 20 percent of there being no end to Treasury reinvestments. Four (of 53) respondents indicated a modal expectation of no end to Treasury reinvestments while MBS reinvestments are ceased.

[6] All four scenarios assume an eventual full cessation of MBS reinvestments. The Committee might consider continuing some amount of reinvestment-related purchases of agency MBS. In fact, some small amount might be desired to maintain operational readiness. Purchases motivated by operational readiness could be viewed as incidental and therefore not necessarily in contrast to policy directives related to overarching balance sheet objectives.

[7] Income issues for the U.S. government as a whole, however, are most likely modest because those situations that would dampen Federal Reserve remittances would also boost tax receipts for the Federal government. Following earlier work by Clouse et al. (2013) on the broader fiscal implications of large-scale asset purchases, Cavallo and Malin (2016) used the FRB/US model to evaluate the broader fiscal effects of alternative balance sheet configurations and stressed two main takeaways. First, the broader fiscal implications of different balance sheet configurations are substantially larger than the corresponding implications for remittances, and second, larger balance sheets produce, on average, substantial net fiscal benefits, even though they produce somewhat lower remittances.

additional factors (such as the convexity hedging). In general, any announced redemption policy that does not deviate too much from market beliefs is expected to have a modest market reaction. That said, a substantial market response, reminiscent of the 2013 taper tantrum, is possible, particularly if the market sees the announcement of a relatively aggressive policy of reducing the size of the balance sheet as also signaling a possible steeper trajectory for the path of the federal funds rate. Clear communication is therefore essential in helping to mitigate such an outcome. The memo also examines the potential for market functioning issues from the size of Treasury and MBS redemptions. On the Treasury side there is uncertainty associated with issuance needs for future fiscal spending, but there does seem to be room for sizable SOMA redemptions. On the MBS side there is uncertainty with regards to who will absorb the securities that run off the Fed's balance sheet, but the market has been quite resilient since the end of LSAP3. The memo concludes with a discussion of a few communication issues that policymakers will need to decide if they want to unveil information about their reinvestment intentions to the public ahead of a change in policy.

2 Background Factors

Figure 1 provides the projected principal receipts from maturities and MBS paydowns (that is, scheduled and unscheduled MBS principal payments) from securities held in the SOMA portfolio. Looking out over the next several years, the overall volume of Treasury securities maturing (red bars) is large and totals $426 billion in 2018 and $387 billion in 2019. In addition, the pattern of those redemptions is uneven with very large maturities in the months in which the Treasury conducts its mid-quarter refunding auctions. For example, in 2018, the amount maturing from the Fed's SOMA Treasury portfolio is on average about $35 billion per month, but during the refunding months (Feb, May, Aug and Nov) redemptions spike to average about $50 billion. The largest redemption is in August 2019, with $70 billion rolling off. MBS paydowns (blue bars) are relatively smaller and are projected to decline as rates are expected to rise in coming years, totaling about $160 billion per year in 2018 and 2019 and averaging about $15 billion per month. However, maturing principal and principal payments associated with MBS are uncertain since the pace of prepayments depends on the path of interest rates.[8]

Some aspects of the approach to normalizing the size of the balance sheet may depend on policymakers' views about the appropriate long run size and composition of the balance sheet. For example, the time required to "normalize" the size of the balance sheet depends importantly on the level of reserves required in the long-run policy implementation framework. Should the Committee decide to remain in a floor system, the supply of reserves should be sufficiently large to remain safely on the flat part of the demand curve. As discussed in detail in the appendix, this level will take into account the quantity of reserves needed to operate on the interest elastic portion of the demand curve (with a buffer to accommodate unanticipated declines in reserves resulting from temporary, exogenously-driven shifts in other liability items such as currency in circulation, the Treasury General Account, foreign repo pool, or account balances held by designated financial market utilities). While the level of reserve balances

[8] Most of the prepayment uncertainty is associated with situations where interest rates are lower than in the baseline, implying a possibility for higher prepayments and a quicker reduction in reserves and the size of SOMA than in the baseline. See "Confidence Interval Projections of the Federal Reserve Balance Sheet and Income," FEDS Notes by Ferris, Kim, and Schlusche for an example of confidence bands around SOMA and MBS holdings.

needed for such an operating framework is difficult to determine at present, staff has estimates in the range of $300 billion to $1 trillion, much smaller than the current level of $2.2 trillion. Given the large range of uncertainty around the estimates, the baseline level of longer-run reserve balances used in the analysis in this memo is $500 billion.[9]

The longer-run level of reserve balances has implications for the ultimate size of the balance sheet. The appendix discusses how key liabilities, such as currency in circulation, along with other assets and liabilities and the desired level of reserve balances drive the overall size of the balance sheet and the level of the SOMA portfolio. Assuming $500 billion in reserve balances and currency growth of about 5 percent per year, SOMA holdings might be $2.6 to $3.2 trillion and total assets $2.8 to $3.3 billion, when the balance sheet reaches its normalized size.[10] At that point, staff assumes that rollovers of maturing Treasury securities resume and that additional purchases of Treasury securities are conducted to offset the ongoing runoff of agency debt and MBS holdings and to support currency-driven balance sheet growth.

The process of normalizing the balance sheet also will have implications for the composition of the balance sheet over time. For example, in terms of the composition of the SOMA portfolio, staff assumes that the Committee intends to run down the MBS portfolio through full redemptions. Under this assumption and the projected pace of paydowns, MBS holdings are estimated to be around $1.3 trillion at the end of 2020 and $500 billion at the end of 2030. Even twenty years from now, MBS are expected to compose 7 percent of the SOMA domestic securities portfolio. The Committee therefore has time to decide whether to hold a small portfolio of MBS over the long run to help maintain operational familiarity with transacting, settling and accounting for MBS holdings.

Finally, the Treasury portfolio currently includes a large proportion of longer-dated securities, which is reflected in a weighted average maturity (WAM) of almost 100 months, significantly longer than both the pre-crisis WAM (40 months) and the WAM of the outstanding Treasury universe (70 months). Any policy which involves continued Treasury reinvestments nonetheless allows for the possibility to move from the current policy of reinvesting at auction proportionally to new issuance to one of reinvesting in Treasury bills or short-dated Treasury coupon securities.[11] These shorter-dated purchases would

[9] The scenarios in the memo incorporate the staff's standard assumptions about the future level of non-reserve liabilities. To the extent that these assumptions understate such liabilities, the $500 billion and $1 trillion level of reserve balances can be viewed as a proxy more generally for liabilities in excess of currency. The portfolio effects of one liability versus another are the same; however, higher liability shares of reserves result in lower levels of income, assuming reserves remain a relatively more costly liability item.

[10] The ranges depend on many assumptions, including the pace of redemptions, the growth rate of currency, and levels for other liabilities like the Treasury General Account and FIMA Repo. See Domestic Open Market Operations during 2015 chart 29 for how the growth rate in currency affects the timing of normalizing the balance sheet and size of the SOMA portfolio.

[11] If policymakers wanted to add Treasury bills to the portfolio, this would most likely involve secondary market purchases since the Federal Reserve can only participate in Treasury auctions when maturing funds come due on the same day that new Treasury securities are issued. Since the portfolio only contains Treasury coupon securities which mature either on mid-month or month-end dates, participation in auctions for Treasury bills would be limited to days in which those maturity dates occur on Thursdays when the Treasury issues new bill securities.

reduce the WAM of the portfolio and the interest rate risk associated with the portfolio, and could add flexibility for how to use the portfolio in future zero lower bound episodes. [12]

With this background in mind, we now turn to the illustrative redemption scenarios to see tradeoffs for the Fed's balance sheet and income.

3 ILLUSTRATIVE REDEMPTION SCENARIOS

In this section, we review four illustrative balance sheet scenarios that include different redemption strategies to evaluate trade-offs in terms of balance sheet and income metrics.[13] Of course, policymakers could choose an alternative strategy, which may include some variation of a few of these scenarios. The scenarios and their pattern of redemptions are as follows:

- "Immediate cessation." As shown in figure 2.a, all maturing and prepaying securities redeem starting in 2017:Q4 without a phase out. This scenario results in the shortest time to normalize the size of the balance sheet without using asset sales.
- The "Capped Treasury" redemption strategy is shown in figure 2.b. In this scenario, MBS reinvestments cease completely but redemptions of Treasury securities are limited to no more than $30 billion in months with outsized maturities—concentrated in mid-quarter Treasury refunding months.
- "2-year phase out" redemptions are reported in figure 2.c. Redemptions (reinvestments) start small (large) and gradually build up to full redemptions (i.e., zero reinvestments) over the course of a 2-year period.[14]
- "MBS redemptions only," as shown in figure 2.d, has redemptions of MBS paydowns but Treasury securities continue to be rolled over in full at auction. This scenario results in the longest time to normalize the size of the balance sheet while still rolling off MBS holdings.

With these four strategies, we discuss some tradeoffs between these alternative redemption policies with respect to key balance sheet and income measures under the Tealbook baseline projection as well as through the outcomes of stochastic simulations. These simulations use the Federal Reserve Board's SOMA model along with FRB/US.[15] Overall, these metrics are one way to evaluate the tradeoffs across

[12] A strategy to pursue bill purchases under the capped and phase out scenarios would be effective if those investments were maintained through ongoing reinvestments of these holdings even when other Treasury coupon securities were being redeemed.

[13] In all scenarios it is assumed that the change in reinvestment policy is triggered when the federal funds target range is between 1¼ and 1½ percent, starting in 2017:Q4, as in the January Tealbook.

[14] Based on responses to the Desk's December Survey of Primary Dealers, the assumption of a 2-year phase out lies near the 75th percentile of the distribution of expectations regarding the likely length of a phase-out period.

[15] For each of our four scenarios, these simulations are based around deterministic paths for financial and macroeconomic variables that are consistent with the January 2017 Tealbook projection and all assume the redemption policy is effective in 2017:Q4. Importantly, the deterministic paths in the simulations differ across scenarios because the configuration of the different redemption strategies influences the term premium, which in turn affects the rest of the economy. That said, the shocks around the deterministic paths are the same across scenarios. The immediate cessation scenario differs from "Evaluating the Macroeconomic Effects of Fixed versus Flexible Reinvestment Policies" by Chung, Doniger, Fuentes-Albero, Lopez-Salido, and Schlusche because in that

reinvestment policies. Policymakers will want to also consider how markets may respond to such a policy and evaluate the ability of private investors to absorb the projected redemptions; these additional considerations are covered in detail in subsequent sections.

3.1 Balance Sheet Considerations

There are a few balance sheet metrics one can evaluate each of the redemption scenarios against: the date at which the size of the balance sheet is normalized, the share of MBS in the portfolio, the composition of Treasury holdings, and the expected size of the balance sheet in the event of returning to the zero lower bound.

Figure 3 shows the evolution of the size of the SOMA portfolio, conditional on standard projections for the balance sheet and an assumed longer-run level of reserve balances of $500 billion.[16] As shown by the black line, the "immediate cessation" scenario, which features the fastest pace of redemptions, results in the size of the balance sheet being normalized in 2021:Q1. Under this scenario, monthly redemptions of Treasury and MBS average $29 billion and $13 billion (lines 2 and 3 in Table 1), respectively. Under both the "capped Treasury" and the "2-year phase out" scenarios, the slower pace of decline in the size of the portfolio results in the size of the balance sheet being normalized in 2021:Q4, three quarters later than in the "immediate cessation" scenario.[17] The "indefinite Treasury" scenario has the slowest pace of decline, extending the time necessary to reach the longer-run balance sheet size to 2027:Q4, 7 years later than the "immediate cessation" scenario.

As indicated above and in the appendix, there is uncertainty about the level of reserve balances that will be associated with the long-run policy implementation framework. If instead of assuming a $500 billion level, these balances were $100 billion or $1 trillion, the implied date of normalization will shift out or in. For those scenarios that redeem both Treasury securities and MBS—the immediate cessation, capped Treasury, and 2-year phase out options above--the date of normalization would shift out or in by roughly five quarters if the long-run level of reserves is $100 billion or $1 trillion, respectively. Under the "MBS redemptions only" scenario, the normalization date would shift out or in by three years if reserves were $100 billion or $1 trillion.

Across the four scenarios, the differences in the paces of decline for Treasury and MBS holdings lead the relative share of MBS to vary, as shown in figure 4. Under the "immediate cessation" scenario, the relative share of MBS rises from the current level of 41 percent to 50 percent (line 4 of Table 1); below

---

memo the start of redemptions is triggered by when the federal funds rate rises above the threshold level of the federal funds rate.

[16] The evolution of the various line items on the balance sheet are the same assumptions staff uses in the balance sheet projections reported in Tealbook B.

[17] There is uncertainty over some balance sheet items which would lead to uncertainty in the timing of normalization. For instance, if MBS prepayments are faster, the size of the balance sheet could normalize sooner. Estimates from the stochastic simulations around the "immediate cessation" scenario suggest normalization could occur up to 6 months earlier or three months later based on the 90 percent confidence intervals. Similarly, currency-in-circulation growth estimates suggest normalization could occur 3 months earlier or later. Overall, the simulations lead to a 90 percent confidence interval for the timing of normalization for the third quarter of 2020 through the first quarter of 2021.

the 54 percent peak recorded in 2010.[18] The "capped Treasury" scenario would lead to a slightly smaller increase in the portfolio share of MBS relative to the "immediate cessation" scenario, while the "2-year phase-out" scenario would lead to a slightly higher maximum share. The "MBS redemptions only" scenario is the only one in which the share of MBS declines over the entire projection period.

Regarding the composition of the Treasury portfolio, we consider the evolution of the weighted average maturity (WAM) of SOMA Treasury holdings to illustrate the differences across the four scenarios. Figure 5 illustrates that under the "immediate cessation", "capped Treasury", and "2-year phase-out" scenarios, the WAM increases over the redemption period, as maturities of short-dated securities results in a portfolio that is more concentrated in longer-maturity securities.[19] In contrast, under the "MBS redemptions only" scenario, the WAM remains comparatively lower through 2020 as Treasury reinvestments maintain the WAM near current levels. In all scenarios, the WAM declines once the size of the balance sheet is normalized and Treasury bill purchases resume.

These projections assume the current practice of reinvesting the proceeds of maturing Treasury securities in proportion to new Treasury issuance at auction. Alternatively, if bills were purchased instead, it would reduce the WAM and perhaps mitigate some of the concerns associated with the larger balance sheet. For example, in the MBS redemptions only scenario, if maturing Treasury securities were reinvested into bills, more than $800 billion could be directed to very short-dated securities by the end of 2019, resulting in approximately 1/3 of the Treasury portfolio holdings being in short-dated securities. One could pursue a similar strategy under the capped and phase-out scenarios directing reinvestment purchases towards Treasury bills; however the effect will be muted because the cap and the phase out period would imply less reinvestments. While the balance sheet is larger with reinvestments than without, it does provide some optionality to sterilize or conduct a MEP if policymakers faced the zero lower bound in this circumstance. In addition, if this adjustment in the composition of SOMA Treasury securities does not affect what is privately held, then the LSAP term premium estimated under each scenario would not be affected. However, policymakers may prioritize reducing the size of the balance sheet through the medium term and see communications associated with explaining a change in reinvestment complicated and not necessary at this time, and they may be comfortable delaying an increase in bills until after normalizing the size of the portfolio.

An additional consideration is the likelihood of returning to the zero lower bound as well as the size of the balance sheet at that time, evaluating the degree to which each scenario preserves the flexibility to expand the size of the balance sheet in the future. In stochastic simulation analysis, all four scenarios had similar probabilities, ranging from 10 percent to 14 percent, of having the policy rate return to the zero lower bound before the end of 2030. Figure 6 reports the distribution of the size of the SOMA holdings at the onset of the zero lower bound under each scenario. The key takeaway is that the immediate cessation scenario, that has the fastest runoff of securities, has a wide distribution of the size of SOMA holdings when the policy rate returns to the zero lower bound; whereas, the redeem MBS only scenario, that reinvests Treasury securities, has a distribution skewed to the larger side.

[18] If agency debt is included along with MBS, the peak agency securities percent is 62 percent.

[19] The capped scenario has about $100 billion in Treasury securities that are reinvested in each 2018 and 2019. These reinvestments are assumed to be proportional to the Treasury's offerings. An alternative is to reinvest all these funds into bills, which could bring down the WAM slightly.

3.2 Income Considerations

One can also evaluate the scenarios against a few income metrics, such as the contour of remittances, the volatility of remittances, and the probability of recording a deferred asset. While the contour of remittances is largely similar across all four scenarios, results of stochastic simulations suggest that the risk of low income is notably larger in the "MBS redemptions only" scenario.

Using the interest rates paths from the January 2017 Tealbook, projected remittances to the Treasury are similar across all four scenarios. As shown in figure 7, remittances decline over the next few years, primarily as interest expense associated with elevated levels of reserve balances rises along with increases in the federal funds rate. From 2021, remittances increase through the remainder of the projection horizon, mainly reflecting the recovery in interest income driven by the purchases of new securities at higher prevailing market yields needed to keep up with currency growth. Compared to the other three scenarios, and reflecting the interest expense associated with higher levels of reserve balances, remittances decrease to their trough at a slightly lower level in the "MBS redemptions only" scenario. Specifically, remittances decrease to their trough at approximately $30 billion in 2020, $6 billion less than under the "immediate cessation" scenario. If this scenario rolled into bills, instead of the current policy of proportional rollovers across issuances, then remittances may be even lower if bill rates lie below IOER.

Policymakers, however, may also care about the risks associated with remittances falling to zero. Across the four options presented, the risks of this event differ. Table 1 reports summary statistics related to remittances from stochastic simulations for each balance sheet scenario.[20] The average dollar value of remittances is roughly comparable across all four scenarios, which is an outcome that could be expected given the similar paths of projected remittances across all scenarios, as noted above. Turning to the variability of remittances, it is fairly similar across the "immediate cessation," the capped Treasury," and the "2-year phase-out" scenarios, while it is the highest for the "MBS redemptions only`" scenario which features the largest balance sheet. This outcome mostly reflects the higher variability of interest expense implied by a larger balance sheet size. Prior to the resumption of asset purchases (which occurs at different times for different scenarios), the variability of remittances mirrors that of interest expense because the variability of interest income is essentially zero and, therefore, so is the covariance.[21]

[20] Summary statistics from the simulations are obtained following the approach outlined in two 'Long-Run Framework" memos. See Cavallo and Malin (2016) "Implications of the Size and Composition of the Balance Sheet for Remittances: Results from Model Simulations" as well as Bi, Cavallo, Del Negro, Frame, Malin, and Rosa (2016) "Fiscal Implications of the Size and Composition of the Central Bank's Balance Sheet." The summary statistics on remittances include both the average and standard deviation (across simulations) of annual remittances, expressed in dollar values and also relative to the size of the balance sheet (expressed in percentage points). We first calculate the average and standard deviation across simulations within each year and then take the mean across years.

[21] Interest income displays essentially no variability across interest rate paths and scenarios prior to balance sheet normalization because income mostly reflects the coupons of assets purchased in the past. The dispersion in interest expense, on the other hand, reflects variability across simulations in both short-term interest rates and the quantity of interest-bearing reserves. The latter–i.e., for a given variance in short-term interest rates, a larger quantity of reserves implies more variable interest expense–is most important for explaining the variation across scenarios in dispersion of interest expense.

In addition to showing the dollar value of the average and standard deviation of remittances, Table 1 reports these statistics per balance sheet dollar. These statistics provide one measure of the rate of return on balance sheet assets as well as of the variability of that return. As reported, the rate of return decreases with the size of the balance sheet. As additional assets held in the larger balance sheet scenarios are funded by interest-bearing reserves, the average rate of return on the portfolio diminishes. Meanwhile, the variability of the rate of return varies little across scenarios.

Table 1 also reports summary statistics on deferred assets for each scenario, including the likelihood of recording a deferred asset (i.e., the fraction of simulations that produce negative net earnings in at least one quarter), the maximum (across periods) of the 95th percentile of its size (across simulations), the maximum realized spell length (in quarters), and the average size of the balance sheet when a deferred asset is recorded for the first time.[22] The "MBS redemptions only" scenario has the highest likelihood of recording a deferred asset and the longest period of time until returning to positive remittances.

Looking across all the various income risk metrics, one can conclude that there is higher risk to net income falling below zero in the "MBS redemptions only" scenario than in the other cases. A policy to shift the portfolio towards bills would, as noted, likely lower the overall trajectory of income, however, it may also lessen the volatility of income since the yield on bills would track more closely to changes in the level of IOR. More analysis would be needed to assess how such an approach would affect the likelihood of a deferred asset.

3.3 Macroeconomic Considerations

Finally, one can evaluate how the scenarios perform with respect to macroeconomic variables by looking at how the staff's Tealbook projection would change if one of the alternative redemption scenarios was used instead of the staff baseline.[23] Overall, the 10-year Treasury term premium effects of the first three scenarios are quite similar, and the MBS redemptions only scenario has a contemporaneous term premium that is only about 10 basis points more negative than the others. As a result, the macroeconomic outcomes and paths for the federal funds rate are very similar for the three scenarios that allow for some type of redemptions in Treasury securities.[24] The results in the "MBS redemptions only" scenario, however, indicate that the unemployment rate would be 0.1 percentage point lower in 2021 than in the Tealbook baseline and the other scenarios, with no noticeable effect on

[22] The size of the deferred asset as measured by the 95th percentile of the distribution can be loosely interpreted as a "value at risk" measure for the Federal Reserve. Value at Risk (VaR) is a measure of the risk of a given portfolio over a set horizon. For example, a one-day five percent VaR of $1 million means there is a five percent probability that the portfolio will fall in value by more than $1 million over a one-day period. One study that uses a probabilistic approach to analyze the interest-rate risk of the SOMA portfolio is that by Christensen, Lopez, and Rudebusch (2015), "A Probability-Based Stress Test of Federal Reserve Assets and Income," Journal of Monetary Economics, vol. 73 (April), pp. 26–43.

[23] The staff baseline is the "immediate cessation" scenario.

[24] The staff assumes that the Treasury replaces the financing lost from SOMA reinvestments by issuing across the maturity distribution. If, instead, the Treasury issued mostly shorter or longer-term securities, there would be implications for interest rates. Specifically, if Treasury issued bills (longer-bonds) then the federal funds rate would most likely rise more (less) steeply over the next few years than in the staff projections, and then remain persistently higher (lower). For more details, see Erin Ferris, "The Interaction of Monetary and Debt Management Policy when Reinvestment of Treasury Securities Ceases," Briefing Memo to the Board of Governors, May 4, 2016.

inflation. The path for the federal funds rate would be a touch steeper, with about one more rate hike relative to the other scenarios by 2022.[25]

Table 1: Scenario Implications for Change in Reinvestment Policy

(2017-2030, Billions of $, unless otherwise noted)

	Immediate Cessation	Capped Treasury	2-Year Phase-Out	Ongoing Treasury Reinvestment
Balance Sheet				
1. Normalization Date *	Q1-2021	Q4-2021	Q4-2021	Q4-2027
2. Avg. Monthly Treasury Redemptions 2018-2020	29	22	25	0
3. Avg. Monthly MBS Redemptions 2018-2020	13	13	9	13
4. Max MBS Share **	49	44	50	42
5. Cumulative Treasury Reinvestments During Normalizaton***	0	279	248	1112
Income Risk Measures				
Avg. Remittances				
7. Dollar Values	57	57	57	56
8. Per Balance Sheet Dollars **	1.73	1.70	1.68	1.56
Std. Dev. Remittances				
9. Dollar Values	10	10	11	14
10. Per Balance Sheet Dollars **	0.30	0.30	0.31	0.36
Deferred Asset				
11. Probability of Incurring **	8	11	14	26
12. 95th percentile of Size	1	5	9	26
13. Maximum Realized Spell ****	20	22	23	29
14. Avg. Balance Sheet Size *****	3679	3749	3925	4105
Macroeconomic Conditions				
15. Federal Funds Rate ** 2021:Q4	4.01%	4.06%	4.06%	4.21%
16. Ten-Year Treasury Yield ** 2019:Q3	3.90%	3.85%	3.86%	3.73%

* Longer-run Reserve Balances = $500 Billion

** Expressed in Percentage Points

*** Excludes rollovers of securities issued after the cessation of reinvestments

**** Expressed in Quarters

***** At the time the first deferred asset is recorded

[25] The changes in the paths for the federal funds rate are not large enough in the short-term to imply different timing for the cessation of reinvestments.

4 Discussion of Market Responses to Redemption Policy

Each of the illustrative scenarios would likely come as a modest surprise to market participants along at least some dimensions. All of the scenarios envision beginning redemptions somewhat sooner than market participants now expect: In January, the median respondent to the Desk's Surveys of Primary Dealers and Market Participants indicated that the most likely timing of a change to reinvestment policy was roughly 14 months forward, in 2018:Q2 and that the most likely level of the target FFR is expected to be 1.375 percent.[26] An abrupt end to reinvestments would also surprise some investors: On average, respondents attached a roughly 70 percent probability to reinvestments being phased out over time, and the median respondent indicated that the most likely length of a phase out period was 12 months.[27]

The most prominent channel by which a surprise change in SOMA holdings can affect interest rates is the portfolio rebalancing channel or "stock effect", which implies that an increase in the private sector's security holdings stemming from the reduction in the expected level of SOMA holdings leads to an increase in the underlying term premiums and, in the case of MBS, an additional increase in the spread between MBS and Treasury yields. The term premium effect is embedded in the staff's LSAP 10-year term premium model (Li and Wei, 2013). Overall, comparing the illustrative redemption scenarios to the expected reinvestment path, the model predicts that the 10-year Treasury yield term premium may move up or down by at most 10 basis points at the announcement of the new policy.[28,29] On one side, under the "MBS redemption only" scenario, the term premium would become 10 basis points more negative, primarily reflecting the larger size of the Treasury portfolio compared with what markets currently expect. And on the other side, a complete cessation of reinvestments, as in the "immediate cessation" scenario, would push securities out to the market a bit sooner and faster than expected, causing a narrowing of the term premium by about 10 basis points.

So-called convexity hedging could amplify any rise in yields in response to reinvestment changes as estimated here. Higher long-term interest rates reduce homeowners' incentive to refinance, thus

[26] There is some dispersion across the respondents. Some respondents did not expect a change in policy until roughly 3 years forward; and, the average respondent attached a roughly 20 (13) percent probability to no change in the reinvestment policy for Treasuries (MBS).

[27] The expectation for the most likely length of a phase out period is drawn from the Desk's December Primary Dealer survey, which is the last time this question was asked. At that time, the question was only asked of the dealers and not of the buy side. Other figures come from the Desk's January surveys.

[28] In estimating these effects, we assume market expectations for the length of the phase out period is 12 months and that this phasing out starts in July 2018. These assumptions are taken from the Desk's December and January Dealer surveys.

[29] Under a policy in which MBS are redeemed, if rates move unexpectedly, then the path of MBS prepayments will change, which will affect the term premium estimate as well as the difference between MBS and Treasury rates (the MBS basis). For example, if rates increase unexpectedly after reinvestments end, refinancing activity will decrease relative to expectations and SOMA paydowns will decline commensurately. Lower realized SOMA paydowns relative to expectations would reduce the amount of MBS shifting to the private sector and thus reduce the upward pressure on the 10-year Treasury yield through the term premium and MBS basis. Conversely, if rates did not rise as much as expected, SOMA agency MBS paydowns would likely increase relative to expectations and in turn, the amount of securities shifting to the private sector would be higher. This dynamic would be expected to put additional upward pressure on rates and the MBS basis. Simulation results suggest this could have a small effect on yields. A memorandum to research directors discusses this issue in more detail.

slowing prepayments and extending the duration of MBS. Some market participants who seek to hedge the interest rate risk of their MBS portfolios then have to sell long-term fixed-income securities ("convexity hedging"), leading to a further rise in long-term yields. This hedging reportedly was among several factors that played a role in the 2013 "taper tantrum," when the 10-year Treasury yield rose by 82 basis points over the months of May and June and MBS duration extended significantly amid FOMC communications about plans to reduce asset purchases. However, staff estimates that a 100 basis point interest rate shock today would generate the same duration extension in private MBS holdings as a 50 basis point shock generated in the taper tantrum, because significantly fewer outstanding MBS today are at interest rates high enough to make refinancing a desirable option for homeowners. In addition, amplification from convexity hedging is likely to be a smaller factor today than in the past because a larger share of agency MBS are now held by investors that do not engage in this hedging, such as the Federal Reserve, commercial banks and foreign official investors. Perli and Sack (2003) estimated that convexity hedging amplified an initial yield shock by 16 percent to 28 percent in 2003; staff believes that the amplification today would be at the lower end of that range based on changes in the universes of MBS and of investors.

Although models of the stock effect and convexity hedging suggest small impacts, other effects left out of these estimates could prove important. In particular, if a surprise policy action (in terms of either the timing or the abruptness of the end of reinvestments) is interpreted by market participants as a signal of a significantly less accommodative monetary policy stance going forward, it could lead to a substantial rise in interest rate uncertainty, herd-like selling behavior, and outflows from bond funds. The taper tantrum provides an example of such an event. The stock effect and convexity hedging are viewed as explaining only a fraction of the sharp rise in yields at that time.[30] Market participants during that episode also appeared to substantially re-price the path of the policy rate, despite the FOMC's communications that forward guidance and asset purchases were separate instruments. Similarly, there may now be some potential for the FOMC's choices about reinvestment policy to affect market participants' beliefs about interest rate policy; such an interaction could produce larger impacts on interest rates from the Committee's reinvestment decision. Overall, the taper tantrum experience underscores the importance of clear communication and possibly argues for advance notification so that market agents can prepare for the change in supply arising from the portfolio reduction. In general, credibility would likely be enhanced by a reinvestment policy that is clearly understood, and that may include some discussion of how the policy may respond to evolving economic conditions.

Finally, the "flow effect," by which changes in Federal Reserve purchases affect market liquidity, could also put some upward pressure on yields and may not be captured by standard pricing models.[31] The research of D'Amico and King (2013) indicates that the flow effect has been relatively small in the Treasury market during past Federal Reserve purchase programs. In the MBS market, anecdotally, the

[30] Though the mechanism behind the taper tantrum remains not well understood, a significant steepening of the policy rate path resulting from the perception among some investors of asset purchases and funds rate policy (forward guidance) as a "single" instrument, as well as amplification effects due to "market dynamics," are generally viewed as having contributed to sharp yield movements. See, for example, the July 2013 FOMC memo "Recent Interest Rate Developments."

[31] Readers may have different definitions of the "flow effect". Here, "flow effect" is intended to mean the transitory effect that occurs through actual operations (purchases), originating from market-microstructural effects.

impact of the flow of purchases by the Federal Reserve has, at times, supported market functioning, and at other times, it has created strain. [32] In general, the risk of flow effects that drive up yields is likely somewhat larger for MBS, given the usually lower liquidity of MBS than Treasuries.[33] The next section discusses the market's capacity to absorb a higher flow of Treasuries and MBS.

5 Market Absorption Issues

A key consideration for determining the timing and size of redemptions is to understand how markets might handle the flow of securities that must be absorbed by private investors as a result of redemptions. In this section we provide context for thinking about the flow of securities associated with redemptions which may highlight impact policymakers' decisions as to how they want to plan their Treasury and MBS redemptions.

5.1 Treasury considerations

Given the substantial amount of SOMA Treasury securities maturing over the next few years and the concentration of Treasury roll offs at mid-quarter refunding dates, policymakers may want to consider how both the size and variability of Treasury roll offs affect market functioning in the Treasury market. In particular, pushing "too many securities too fast" into the private market could cause Treasury auction yields to vary significantly from fair value, risk an unanticipated move in the term premium, or push up other money market rates more than may be desired.[34]

There are two ways to think about "too many too fast": one is in terms of monthly flow and the other in terms of annual volume. If monthly flow is a concern, then a capped redemption policy can be put in place. In principle, this policy could be maintained as the portfolio is reduced over time and would limit surges in the flow of securities to private investors, which would accommodate the Treasury's refunding months throughout the projection period. A phase-out strategy could also temper the effects of large

[32] During the crisis period, large amounts of MBS purchases by the Federal Reserve were reportedly seen as helping market functioning as the presence of the Fed as a major player in the MBS market was viewed as stabilizing. During the later period of asset purchases (e.g., LSAP3), the Fed's MBS purchases did at times appear to contribute to specialness in certain TBA contracts, though market functioning was generally viewed as orderly.

[33] Hancock and Passmore (2011, 2014)'s model of the nominal MBS-Treasury spread, estimated with an updated sample that includes the taper tantrum period, suggests an increase in this spread from changes in redemption policy. In addition, their estimate would include the effect of a possible "surprise announcement" of ending reinvestments. This model includes direct supply effects of Federal Reserve MBS and Treasury securities holdings (as a share of the market) on the MBS-Treasury spread, flow effects, as well as announcement effects.

[34] Increased Treasury issuance to the private investors, which replaces funding lost through SOMA redemptions, could place upward pressure on Treasury GC rates as the aggregate supply of Treasury collateral in private hands grows. The extent of any increase in general Treasury collateral in the repo market will depend on whether the substitute auction purchasers are dealers, levered money, or real money. If Treasury replaces SOMA redemptions with increased bill issuance, increases in bill supply could cause bill rates to rise. Greenwood, Hanson, and Stein (http://onlinelibrary.wiley.com/doi/10.1111/jofi.12253/pdf) find that a 1% increase in the bill-to-GDP ratio ($180 billion in added bill supply) is associated with a cheapening of bill rates relative to coupon rates (at the 10-week maturity) of 5.2-6.5 basis points.

monthly redemptions, at least in the near term. But, by construction, the effectiveness of this approach to reduce spikes in maturity amounts would be more limited, diminishing over time as the volume of redemptions increases as the phasing out of reinvestments progresses.

Turning to the annual volume, table 2 reports the annual redemptions in each of the four scenarios in the next few years, with Row 1 presenting the size of full redemptions.[35] The next two scenarios dampen roll offs a bit, while the final scenario has no roll offs.

Table 2 – Annual SOMA Treasuries redeemed in each of the scenarios ($, billions)

	2018	**2019**	**2020**
Immediate cessation	426	387	243
Capped Treasury Redemptions	331	271	175
2-yr phase out	246	358	297
MBS redemptions only	0	0	0

To provide some guidance about whether these annual redemptions could be absorbed by the private sector with limited impact on market pricing, one can look at the Treasury's most recent primary dealer auction size survey, which asks dealers to estimate the maximum auction size for each of the existing maturity points that would not cause a "significant yield deviation" from fair value.[36] These survey results are instructive in measuring potential capacity considerations within the existing structure of Treasury debt issuance (although it is also is possible the Treasury could auction securities at additional maturity points). Using the current maximum auction sizes along with the maturity structure of existing Treasuries and the incremental change to auction sizes indicated by the survey, staff estimates that the private Treasury coupon securities outstanding could increase by about $1,200 billion in both 2018 and 2019—suggesting sufficient room to absorb maximum SOMA redemptions of $426 billion and $387 billion in those years, respectively.[37] Of course, there is some uncertainty about how quickly the private market could adapt to absorb a large increase in Treasury issuance.[38] And, this analysis excludes any impact of new net borrowing requirements to finance increased deficit spending.

One can try to account for the additional Treasury supply needed for deficit financing, though details are unknown at this time. The Tealbook has again included a placeholder that the new Administration will implement adjustments to fiscal policy that increase the annual "primary" budget deficit by 1 percent of GDP, resulting in total annual deficit financing of roughly $800 billion in 2018 and 2019.[39] Using this estimate, the increase in privately-held Treasury coupon securities under an "immediate cessation"

[35] The values reported in Table 2 include expected redemptions as implied by SOMA holdings projected through 2020.

[36] The most recent primary dealer auction survey recommendations (collected in October 2016) are as follows (https://www.treasury.gov/resource-center/data-chart-center/quarterly-refunding/Pages/dealer-agenda-survey.aspx).

[37] Roll offs in 2017:Q4 amount to about $45 billion and could be offset by increased bill issuance, with coupon issuance ramped up subsequently.

[38] Over two years, gross debt issuance to the private would increase by about 36 percent. In 2002, debt issuance (to all including SOMA) increased 56 percent and another 30 percent in 2003. It also increased 113% in 2009.

[39] Tealbook assumes this fiscal expansion takes the form of a cut in personal income taxes in 2018:Q1.

scenario (including both SOMA redemptions and additional deficit financing) would total approximately $1.2 trillion annually in 2018 and 2019. Although these figures would roughly equal primary dealer estimates of coupon capacity, Treasury would likely raise additional financing through issuance of Treasury bills, at least on a transitory basis. This approach is relatively standard, and recent commentary suggests the market could accommodate up to an additional $100 billion each month in bills without significant distortions, providing a buffer even in the largest redemption scenario.

Figure 8 puts these new issuance numbers into a historical perspective, with the Treasury and Federal Reserve activity shown as red and blue bars, respectively, and the combined effect on changes in privately-held debt shown by the black line. In the early 2000s, Treasury's issuance to private investors grew by less than $500 billion per year and temporarily declined due to fiscal surpluses; the Federal Reserve purchased only a small amount of these securities (the blue bars lying below the x axis). From 2008 to 2012, issuance to private investors jumped by over $1 trillion per year, with the Treasury expanding coupon offerings by amount and frequency and reintroducing a 7-year original maturity point on the coupon curve. Over most of that time, the LSAP programs absorbed some of this issuance, but the amount of securities pushed out to private investors was still sizable.

Going forward, under the "immediate cessation" approach and current fiscal assumptions, issuance to private investors is projected to increase to levels similar to what was seen in the period following the financial crisis. Importantly, demand for Treasuries during the crisis period was very intense. It remains to be seen how the market would adjust to a rapid increase in Treasury issuance under more benign financial market conditions, without this boost in demand. Of course, the Treasury market is deep and liquid, and redemption approaches that dampen the run off of the SOMA's Treasury securities would require a smaller increase in private demand over the next few years and would help to insure against an outsized move in term premiums.

5.2 MBS CONSIDERATIONS

The SOMA's MBS paydowns (scheduled and unscheduled principal payments) are projected to be smaller than its Treasury maturities. Additionally, they are expected to decline over the projection period as rates are expected to rise, decreasing prepayments, and as the portfolio shrinks.[40] Nevertheless, a policy to redeem SOMA MBS holdings will lead to a roughly corresponding increase in the amount of securities that the market needs to absorb per month since paydowns are driven largely by prepayments. [41] These additional securities would add to any net increase in issuance of agency MBS expected over the same period.

[40] The mean/max/min monthly paydowns in 2016 were $31.6/42.6/19.3 billion, driven largely by prepayments. However, actual prepayments are dependent on the path of interest rates and can be volatile.

[41] The vast majority of SOMA agency MBS paydowns arise from loans that have refinanced into new loans. When this happens, refinanced loans are removed from their original mortgage pool and are resecuritized into a new mortgage pool and issued into the market. If interest rates increase, however, and refinancing activity slows, a greater share of SOMA paydowns will arise from principal amortization.

Table 3 notes the projected annual redemptions in each of the four scenarios in the next few years, with rows 1, 2 and 4 presenting the size of full redemptions.[42] Only the 2-year phase out provides an illustration where redemptions start small and then increase a bit. The FOMC has taken different approaches to ending agency MBS purchases in the past: it stopped purchases all at once in 2010 at the end of LSAP1 and phased purchases out in 2014 at the end of LSAP3.[43] In neither case did there appear to be any significant market functioning issues as the Fed exited the MBS market.

Table 3 – Annual SOMA MBS redeemed in each of the 4 scenarios ($, billions)

	2018	**2019**	**2020**
Immediate cessation	172	149	135
Capped Treasury Redemptions	173	149	135
2-yr phase out	57	128	152
MBS redemptions only	177	152	135

Looking ahead to the next three years, dealers expect the agency MBS universe to increase by about 5 percent per year, though these estimates are dependent on the evolution of mortgage rates, the demand for residential credit, and the rate of loan securitization. With respect to SOMA, under all but the "2-yr phase out" scenario, redemptions would add about an additional $160 billion in each of 2018, 2019 and 2020. Taken together, SOMA runoff and the organic growth of the agency MBS market will be sizable. Figure 9 illustrates the projected change in agency MBS outstanding that will need to be absorbed by the private sector, assuming an "immediate cessation" scenario, and compares it to historical levels. With the exception of just prior to the crisis, the projected change in private holdings (shown by the black dotted line) is much larger than what has occurred in the past. Indeed, there are a number of important differences in market structure that make the comparison more difficult, but one change in particular merits further discussion.

Prior to the financial crisis, the GSEs were active agency MBS buyers who absorbed a significant portion of issuance on a yearly basis. The GSEs stopped acquiring agency MBS after being put into conservatorship in 2008, and the Treasury and the Federal Reserve filled the void left behind.[44] Between the Federal Reserve, the GSEs, and the Treasury, official institutions have owned between 40 and 55 percent of total agency MBS outstanding since 2000. Once SOMA reinvestments end, there could be some adjustment to an environment without any official sector involvement. Upon cessation of SOMA reinvestments, private investors like commercial banks, money managers, foreign accounts and REITs will be relied upon to assume both the runoff from SOMA and new issuance. Predicting these entities'

[42] The values reported in Table 3 include expected redemptions as implied by SOMA holdings projected through 2020.

[43] For context, the Fed was purchasing roughly 50 percent of gross issuance towards the end of LSAP1, versus 40 percent as LSAP3 wound down compared to 30 percent today.

[44] Under the Senior Preferred Stock Purchase Agreement, the GSEs are mandated to reduce their retained portfolios to $250 billion by 2018. They have been reducing their holdings since 2009. This factor is not captured in the figure, which would shift the black line up a bit in those years.

purchasing activity can be challenging, and banks in particular are facing an evolving landscape of regulatory constraints that could influence their demand going forward.[45]

Most market participants expect some amount of spread widening given the significant amount of agency MBS the private sector will need to absorb when reinvestments end. On the other hand, the Federal Reserve has not increased its holdings of agency MBS since October of 2014, and MBS spreads to Treasuries have been stable despite nearly $433 billion of new net issuance over this period. In addition, a phase out policy could lessen the amount of MBS going back into private hands in the near term. And, the agency MBS market continues to be viewed as a deep and robust fixed income market and attracts a wide array of global investors because of its liquidity and principal guarantee.

6 Other Market Considerations

There are some other issues policymakers may want to consider in choosing how to modify their reinvestment strategy. Here we discuss a couple of operational matters and how the change in policy may affect large financial institutions' ability to meet their Leverage Coverage Ratios (LCRs).

Decisions regarding ending Treasury reinvestment will affect what securities are available in the securities lending program. Redemptions will result in SOMA owning effectively no on-the-run securities for a number of years. This matters because on-the-run securities are frequently in demand to facilitate interest rate hedging and market making and to cure settlement fails. Of course, with the Fed not reinvesting, this action would imply more on-the-run Treasury securities in the market's hands. However, the net supply of collateral available to securities borrowers absent SOMA ownership would depend on whether the new private holders participated as security lenders. In thinking about whether this policy change would induce market strains, it is important to remember that the Treasury market functioned well during 2013-2016 when the Maturity Extension Program resulted in a prolonged period where SOMA did not own benchmark Treasury securities. Therefore, this issue might not be a critical consideration and is even further dampened if policymakers consider a policy where some Treasury securities are reinvested.[46]

If policymakers turn off MBS reinvestments completely, there may be a question of how operationally ready markets perceive the Federal Reserve to be to restart purchases in the case of a bad economic

[45] Commercial banks, the second largest holder of agency MBS after the Federal Reserve, added virtually no agency MBS to their portfolios, on net, in 2012, 2013 and 2014 as they accumulated reserves and U.S. Treasuries as the Fed conducted LSAPs and to comply with Basel III implementation. In 2015 and 2016, by contrast, a few banks demonstrated strong demand for agency MBS, buying both GSE and Ginnie Mae securities, adding nearly $282 billion to their net holdings. It is uncertain how the end of reinvestments will affect banks desired holdings of MBS, in particular to help meet their Liquidity Coverage Ratios. Meanwhile, mortgage REITs have traded below book value since the taper tantrum meaning it will be difficult for them to raise accretive equity and add agency MBS. Foreign accounts, who mainly transact in Ginnie Maes, have also reduced their purchases of U.S. dollar fixed income assets as global yields have risen. Lastly, money manager demand for agency MBS will be influenced by fund flows, which have fluctuated widely amid a backdrop of rising interest rates.

[46] In the unlikely event that market function deteriorated because participants were unwilling to lend on-the-run securities in the market, the FOMC could direct the Desk to rebalance the portfolio by selling some securities and buying on-the-runs, which the Fed could then lend out.

shock. Due to the relative operational complexity of the asset class, they may find it desirable to have the Desk conduct purchase transactions that are larger or more frequent than the small-value exercise operations that are permitted under the Authorization for Domestic Open Market Operations and for which the Desk is doing for MBS sales and coupon swaps. For example, to maintain readiness, policymakers may want to consider reinvesting a small level of MBS each month, say $1 billion. Small-value sales, dollar rolls, and coupon swaps could periodically be used to maintain operational readiness in those types of MBS transactions as well.[47]

Another consideration is how a change in the reinvestment policy could affect the level of high-quality liquid assets available to large financial institutions that are subject to the LCR. Assuming no change in total securities outstanding, any SOMA redemptions will effectively push securities from the Fed's balance sheet to the books of private entities. There is great uncertainty about which entities will end up holding the additional securities; the associated flows will determine the effects on aggregate reserve balances and the stock of HQLA. For example, if the Treasury issued additional bills to cover SOMA Treasury securities redemptions and money funds purchased these bills in lieu of placing cash at the Fed's ON RRP facility, there would be no changes in the level of reserves in the economy or in the amount of HQLA available to large banking institutions. Another possibility is that nonfinancial corporate investors purchase the additional Treasury securities or MBS by drawing down their bank deposits (essentially, a reverse LSAP). In this case, both the numerator and denominator of the banks' LCRs are reduced, with little change in banks' ability to maintain their LCRs. A similar possibility is that banks purchase the additional securities; in this case, the additional securities would replace reserve balances and banks' ability to maintain their LCRs would essentially be unaffected. Of course in this case, banks' ability to maintain their LCRs could be affected to the extent that their MBS limit is binding, particularly if the Fed rolled off mainly MBS.[48] Finally, it could be the case that nonfinancial corporate investors purchase the additional securities without drawing down bank deposits but instead sell longer-term bank debt; here there would be a deterioration in banks' LCRs. Flow of Funds data suggest that during LSAPs households (which includes hedge funds) significantly reduced their holdings of Treasuries and MBS and replaced them with mostly corporate bonds and some bank deposits.[49] If hedge funds are again a major player in the redemption period, it could be that banks' deposits decline and other liabilities adjust as well.

7 Communication Issues

Finally, as the Committee continues its discussion about changing the reinvestment policy, it will need to determine what to communicate to the public. Having market expectations aligned with a future policy change ahead of implementation helps to minimize adverse responses in financial markets when the action is executed.

[47] If the Committee were concerned about the impact that regular purchases would have on the pace of reduction of the agency MBS portfolio, a matching amount of sales could be conducted rather than small-value sales.
[48] In meeting the LCR, MBS receive a 15 percent haircut and may comprise no more than 40 percent of total HQLA.
[49] See Carpenter et al. (2015) "Analyzing Federal Reserve Asset Purchases: From Whom Does the Fed Buy?"

Over the course of FOMC discussions, participants may want to convey information about several issues to the public.

- First, the Committee may want to qualitatively discuss how it sees the portfolio evolving over the medium and possibly longer term. The Committee would need to decide how to balance providing enough information to help markets understand its intentions without necessarily committing to a specific long-run monetary policy implementation framework, which does not need to be decided at this time.[50]

  One consideration is to reaffirm the applicable aspects of the PNP&P, such as wanting to reduce the size of the balance sheet gradually and predictably, and to hold primarily Treasury securities in the long run. The Committee may also want to provide guidance about the length of time the roll offs will continue. The guidance could note redemptions are expected to continue for some time or as long as short-term interest rates are close to the FOMC's targeted level for the federal funds rate. Or, if there is consensus and a desire to use a quantitative metric, the guidance could suggest redemptions would continue at least until the level of reserve balances drops below a stated amount.

- Second, policymakers will likely want to inform the public about their preferred approach for redemptions of Treasury securities and MBS. A complete cessation of reinvestment is most likely the easiest to communicate. Some form of a taper would require careful communication to explain the reasoning for this decision, the form of the taper, and the length of the taper. If the taper is over a lengthy period of time, the Committee may want to provide information about what would happen if there is an adverse economic shock. This is related to the third point of reversibility.

- Third, policymakers may want to signal if they see this change in policy as being reversible. That is, would policymakers want market participants to know that reinvestments could be restarted in the future, though still treating this policy lever as a secondary tool?

These details could be released in a redemption plan in the minutes leading up to the FOMC statement that initiates the change in the reinvestment policy.

8 CONCLUSION

This memo presented four illustrative scenarios to ceasing reinvestment. Broadly speaking, the options spanned a range of possible views about the appropriate speed of balance sheet normalization and the composition of the SOMA portfolio in the longer run. Within this context, the memo reviewed tradeoffs for the Federal Reserve's balance sheet and income over time, for term premiums, and for macroeconomic considerations.

[50] In the November 2016 minutes it is noted "policymakers agreed that decisions regarding the long-run implementation framework were not necessary at this time" and "Meeting participants commented on the advantages of using an approach to policy implementation in which active management of the supply of reserves would not be required."

9 Appendix - Some Approaches to Approximating the Smallest Level of Reserves Consistent with an Efficient and Effective Floor System and Implications for the Size of the Federal Reserve's Balance Sheet

In the discussion of long-run monetary policy frameworks at the November 2016 FOMC meeting, a number of participants noted that a floor-type system for implementing monetary policy could have a number of advantages. In this type of framework, policymakers would have some latitude in choosing the level of reserves while being able to keep the level of short-term rates at the desired level. In the spirit of the Policy Normalization Principles and Plans, we examine the quantity of reserves that might be necessary in a floor system to operate efficiently and effectively. In general, the appropriate quantity of reserves in such a system might be viewed as the sum of two components—the smallest level of reserves necessary to satisfy demand along the inelastic portion of the reserve demand curve and then an additional quantity of reserves that would serve as a buffer against shocks that could drain reserves below this quantity. The choice of the appropriate level of reserves would have implications for the time required to normalize the size of the balance sheet.

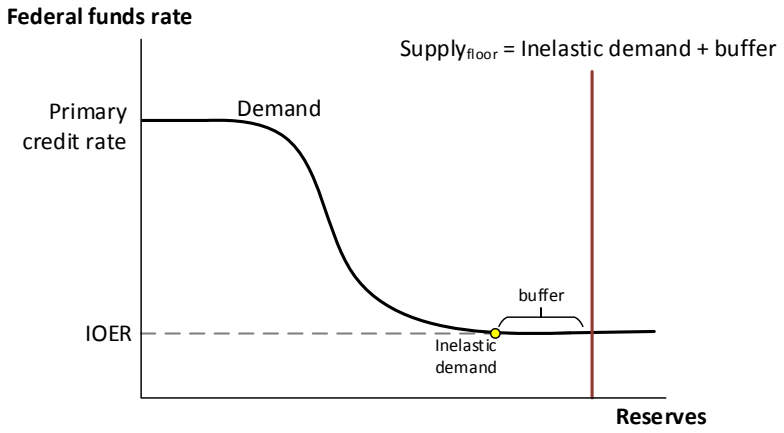
While reserves are currently the largest component of Federal Reserve liabilities, there are additional factors that will drive the overall size balance sheet. In the second part of the appendix, we discuss the potential levels of these other liabilities and then sum up with the implications for the size of the System Open Market Account (SOMA).

A. Some Approaches to Approximating the Smallest Level of Reserves Consistent with an Efficient and Effective Floor System

To estimate the smallest level of reserves necessary to comfortably operate in a floor system we first develop rough estimates of the smallest quantity of reserves necessary to satisfy demand along the interest-inelastic, or downward sloping, portion of the reserves demand curve, the yellow dot in figure A1 below. Second, we develop rough estimates of a range for the additional quantity of reserves that may be needed to serve as a cushion against unexpected drains of reserves, the quantity marked buffer. We derive the quantity of reserves consistent with a floor, $Supply_{floor}$, by adding these two estimates together.[51] As noted below, required reserve balances would also factor into the total level of reserves supplied; the rough estimate below are best viewed as estimates of the quantity of excess reserves in a floor system.

[1] This appendix builds on past work for the Long-Run Frameworks project. Please see the FOMC memo, "Considerations for the Design of Reserves Operating Regimes," distributed September 30, 2016.

Figure A1. Stylized Depiction of Federal Funds Market



I. Estimates of the quantity of reserves just past the interest-inelastic portion of the demand curve

a. Empirical Approaches

The empirical approaches to estimate the quantity of reserves just past the interest-inelastic portion of the demand curve outlined below draw on our long history of managing the federal funds rate. Prior to the crisis, we estimated a supply of reserves consistent with operating in a floor framework would be about $35 billion or higher. Changes in structural factors, notably including the advent of interest on reserves and changes in bank liquidity regulation, likely have affected the demand for reserves over time though it is difficult to disentangle these factors. Still, the estimates below, which are much greater than pre-crisis estimates, may provide some insight into the quantity of reserves necessary to reach the start of the inelastic portion of the demand curve (the yellow point in figure A1 above).[52]

i. **Pre-crisis perspective**. Prior to the crisis, staff provided the Committee with an estimate of supply of reserves consistent with operating in a floor framework around $35 billion or higher.[53] This estimate was broadly consistent with models of reserve

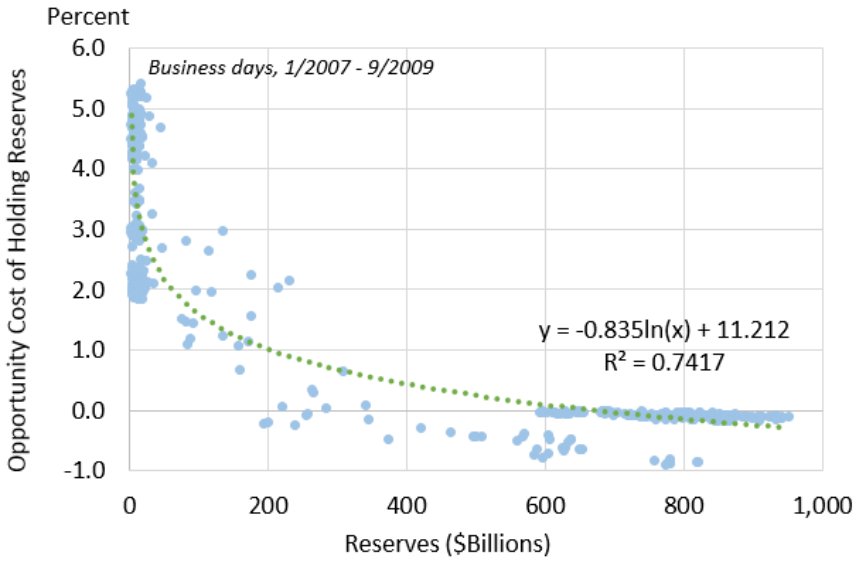
[52] Note the current level of required reserve balances is about $100 billion, while pre-crisis required balances were around $5 to 10 billion. We expect that the level of required reserve balances will be affected by a variety of factors as the Federal Reserve balance sheet shrinks including the net cost of funding bank balance sheets through transaction deposits, the net balance sheet costs of meeting reserve requirements, and the effects of regulatory treatment of these liabilities and assets. Policy makers may also decide that reserve requirements are no longer necessary for operating a floor framework.

[53] See FOMC memo, "Interest on Reserves: A Preliminary Analysis of Basic Options," April 2008, released to the public in May 2015. In the memo's discussion on operating a floor with high balances where the Federal Reserve would supply enough balances to keep banks in the perfectly elastic portion of their demand schedules every day, staff estimated the amount of reserve balances needed to be on the order of $35 billion and potentially higher on some days. It is important to note, however, that at the time of this analysis, staff envisioned a floor framework in which fed funds traded just above interest on reserves.

demand relationships in that environment. In particular, prior to the crisis, the level of "clearing demand" for reserves was thought to be on the order of $10 billion to $15 billion. The volatility of reserve factors, was also relatively modest so that a "buffer" of $20 billion to $25 billion was viewed as likely to be far enough out on the flat portion of the reserve demand curve to keep the federal funds rate close to the level of interest on reserves.[54]

ii. **Demand Curve over the Crisis Period.** Figure A2 below plots the relationship between the opportunity cost of holding reserves, defined as the effective federal funds rate less the interest rate on excess reserves, and holdings of reserves from 2007-2009—the period when the level of reserves moved well beyond historical levels.[55] Based on this simple picture, it appears that the reserve demand curve flattens out at levels of reserves around $600 billion. Of course, this time period encompassed the most acute period of the financial crisis—a time when precautionary demand for reserves may have been particularly high among a number of institutions. This caveat might suggest that in more normal times, the reserve demand curve could flatten out at considerably lower levels. On the other hand, as noted above, regulatory and other structural factors may now be contributing to higher levels of reserve demand even in more normal times.

Figure A2. Opportunity Cost of Holding Reserves versus Supply*



**Opportunity cost is calculated as the effective federal funds rate less the interest rate on excess reserve balances. In this calculation, the interest rate on excess reserve balances is set to zero for dates prior to October 9, 2008, the first day of the maintenance period for which the Federal Reserve paid interest on reserve balances.*

[54] In the pre-crisis period the Treasury General Account and the Foreign RP pool were subject to policies that significantly limited their volatility.

[55] For observations before the authority to pay interest on reserves, opportunity cost is equal to the fed funds rate.

iii. **Unexpected changes in supply**. Another approach to identifying the quantity of reserves just past the interest-inelastic portion of the demand curve is to estimate the slope of the reserve demand curve using the method of Hamilton (1997). This approach utilizes staff forecast errors for the balance in the U.S. Treasury General Account (TGA) as a measure of exogenous "reserve supply shocks".[56] We estimate rate sensitivity—the basis point response in the funds rate to a reserve shock of $1 billion—at reserve levels in $100 billion buckets. This approach is suggestive of interest rate sensitivity declining to zero as the level of reserve increases. However, the lack of statistical significance for the estimates in the reserve buckets greater than $100 billion makes it difficult to identify a specific level of reserves associated with interest rate insensitivity. With this caveat in mind, the results suggest this level may be around $600 to $800 billion.

Figure A3. Federal Funds Rate Sensitivity to Reserve Supply Surprises*
(Rate sensitivity = bps/billion)

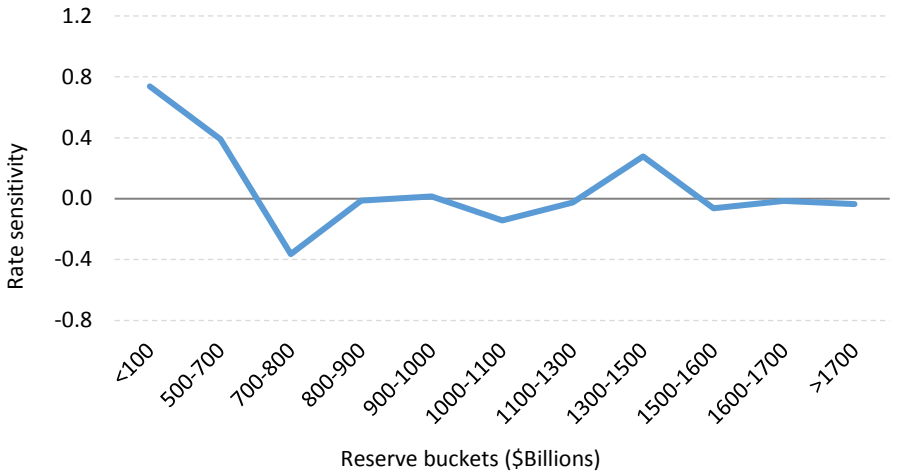


**Figure A3 plots the coefficient β from the regression: (FF Change) = α + β(TGA error) + γ(TGA forecast) + ε. The bucket "<100" corresponds to the pre-crisis period. For this bucket, the coefficient is statistically significant. We find no significance for the other buckets. The coefficient for the 100-500 bucket, which corresponds to fall 2008, is large, not significant and excluded from the plot.*

iv. **Bank Portfolio Preferences.** Prior to the crisis, domestic and foreign banks in aggregate held about 8 percent of their assets in short-term instruments, defined as reserves, federal funds sold, and reverse repurchase agreements. Using this percentage and an assumption about preferences for non-reserve short-term assets on the flat portion of the demand curve, we estimate that reserve supply of $800 billion would be sufficient to attain the interest-inelastic portion of the demand curve (Table A1).[57] This approach is scaled from the current size of banks' balance sheets.

[56] For details see Hamilton (1997) "Measuring the Liquidity Effect", American Economic Review, 87(1), March, 80-97, and Clouse and Elmendorf (1997) "Declining Required Reserves and the Volatility of the Federal Funds Rate".

[57] The $400 billion amount of non-reserve short-term assets is the current amount of such assets held by banks, an amount roughly unchanged since late 2009 (likely reflecting investments needed to maintain broader banking

The size of banks' balance sheets in the future will depend on a wide range of factors including their response to the Fed's balance sheet reduction, regulatory changes, and growth of the economy.

Table A1. Reserves Based on Short-Term Asset Preferences

1. Current Bank Assets	$14.4 trillion
2. Historical Short-Term Allocation	8%
3. Current "Desired" Short-Term Assets (=1*2)	$1.2 trillion
4. Non-Reserve Short-Term Assets	$400 billion
5. Current "Desired" Reserves (=3-4)	$800 billion

b. Anecdotal approach

The empirical approaches above may not adequately control for various factors that may have affected the nature of reserve demand over time. Evidence from bank consultations provides additional information on reserve demand in the current period. In 2016 Board and FRBNY staff asked nine large domestic and nine foreign banks for estimates of their long-run minimum demand for reserves.[58] In aggregate, the consulted domestic banks estimated levels that were roughly half of the balances they held around the time of the consultation, while foreign banks estimated minimum demand around 40 percent of their holdings.[59] A number of the domestic banks described their current metrics for estimating long-run minimum demand as based on models of liquidity risk.

A straightforward extrapolation of these responses to the universe of reserve holders implies the quantity of reserves just past the interest-inelastic portion of the demand curve is around $1 trillion. However, the banks in the consultation were among the largest reserve holders and likely have the highest levels of scrutiny over their liquidity risk management practices, driving them to estimate higher levels of reserve needs than might be desired by other banks. In particular, smaller banks may face less stringent liquidity needs. Accounting for this possibility, the estimate of reserve demand may be about $700 billion. Of course, a key caveat to this anecdotal approach is that banks' future affinity for reserve balances will be affected by the interest rate environment—that is, relative returns on other available liquid assets—a factor that is difficult to account for in the abstract.

relationship). These assets are likely to grow when the interest rates on such short-term non-reserve assets rise above IOER.

[58] Note the institutions were asked for their estimates of minimum demand for excess reserves regardless of opportunity costs, however, the concept of "minimum demand" in the survey is open to some interpretation. One plausible reading is that, given difficulty with abstracting from current conditions, banks provided estimates of the minimum level of reserves they would wish to hold with a structure of reserve remuneration and levels of short-term rates roughly consistent with the experience of recent years.

[59] The consultation included custodian global systemically important banks, non-custodian GSIBs, and non-GSIBs. Domestic banks' aggregate demand was about $400 billion, and the foreign banks' was about $175 billion.

c. Summary

The results of the four estimation methods described above are summarized in Table A2, and provide a range of estimates for the quantity of reserves just past the interest-inelastic portion of the demand curve.

Table A2. Summary of Estimation Results

Empirical Approaches	**Estimate ($, billions)**
1. Pre-Crisis Demand Curve	$10-$15
2. Demand Curve During Crisis Period	$600
3. Unexpected Changes in Supply	$600-800
4. Bank Portfolio Preferences	$800
Anecdotal Approach	**Estimate ($, billions)**
5. 2016 Bank Consultation	$700-1,000

II. Buffer Stock

The Committee may want to supply an additional buffer of reserves beyond the quantity of reserves just past the interest-inelastic portion of the demand curve to reduce the likelihood that unanticipated declines in reserves as a result of temporary shifts in other Federal Reserve liabilities push the fed funds rate out of the target range.[60] Reserve balances move inversely with changes in other liabilities such as the TGA, the foreign repo pool, and ON RRP usage.[61] As shown in Table A3, a conservative buffer to offset supply shocks due to typical autonomous factors as well as the ON RRP buffer could be as high as $300 billion.

Table A3. One Percent Tail of the Absolute Value of Selected Balance Sheet Changes

	TGA – all days	For. Repo Pool – all days	ON RRP – all days	ON RRP x qe	Reserves – all days
1-day	54	13	125	70	215
5-day	106	17	164	118	300

Data from 01/2016 to 02/2017, 99 percent of observations less than amounts shown, all numbers in $ billions. Note the 'ON RRP x qe' excludes quarter ends.

III. Total Level of Reserves

If the level corresponding to the "inelastic" portion of the demand curve is similar to the pre-crisis period ($10 to $15 billion), the total quantity of reserves necessary today to operate a floor system could be on the order of $300 billion depending on assumptions about the volatility of autonomous

[60] As per the November 2016 FOMC meeting minutes, "Meeting participants commented on the advantages of using an approach to policy implementation in which active management of the supply of reserves would not be required."

[61] The volatility of these liabilities has increased in recent years, as Federal Reserve policies that dampened their volatility were deemed unnecessary in the floor framework. In addition, new types of accounts have been offered or are being contemplated, which could create new sources of factor volatility. Policies could be re-imposed to dampen volatility of some liabilities, but returning to the level of pre-crisis factor volatility may not be practical.

factors. If the level of the inelastic portion of the demand curve is now more comparable to the other estimates shown, the quantity of reserves necessary to efficiently implement a floor system could be much higher. For example, using the average of the various estimates of the inelastic portion of reserve demand (roughly $700 billion) and a conservative buffer of $300 billion, the quantity of reserves associated with an efficient floor system could be on the order of $1 trillion. Bernanke (2017) also argues that reserve levels consistent with a floor system could be around this level.[62]

If the Committee, instead, wanted to maintain a somewhat smaller balance sheet and was comfortable with fine-tuning operations, a much smaller buffer to offset typical staff forecast misses would be sufficient to reduce the potential for shifts in autonomous factors to move the fed funds rate out of the target range. Indeed, most of the variation in the major components of non-reserve liabilities is predictable, and so offsetting open market operations could reduce reserve volatility to just forecast errors, which have averaged around $60 billion (Table A4).

Table A4. One Percent Tail of the Absolute Value of Forecast Errors

	TGA – all days	ON RRP – all days	ON RRP x qe
1-day	7	64	55

Data from 01/2016 to 02/2017, 99 percent of observations less than amounts shown, all numbers in $ billions. Note the 'ON RRP x qe' excludes quarter ends.

In addition, a smaller buffer would be necessary if policies were adjusted to limit the level and variability of non-reserve liabilities. For example, policies could be adjusted to reduce the size of the ON RRP facility, the TGA balance, and the foreign repo pool (discussed in Section B). That said, imposing such constraints may have other costs that would need to be weighed against the possible benefits of limiting the level and variability of autonomous factors.

As noted above, there is a very large degree of uncertainty in these estimates and particularly for the smallest level needed to operate on the inelastic portion of the reserve demand curve. If reserve demand was very elevated during the crisis, it is possible that the empirical estimates above considerably overstate the inelastic portion of the demand curve in more normal times. On the other hand, it is possible that new liquidity regulations and generally more cautious attitudes to liquidity risk management now could have boosted reserve demand to levels even higher than those prevailing during the crisis.

B. Implications for the Size of the Federal Reserve's Balance Sheet and the SOMA Portfolio

Section B integrates the discussion of reserves into the overall balance sheet and the size of SOMA. In addition to the reserves supply discussed in section A, the size of balance sheet would be driven by the stock of non-reserve liabilities.

I. **Other liabilities.** The key non-reserve liabilities driving the size of the balance sheet are currency in circulation (currently about $1.5 trillion), the Treasury General Account (for which the Treasury Department generally aims to hold about one week of net financing needs), the

[62] See Ben Bernanke, "Shrinking the Fed's balance sheet," January 26, 2017. (https://www.brookings.edu/blog/ben-bernanke/2017/01/26/shrinking-the-feds-balance-sheet/). Similar to some of the estimates above, the analysis in this note is based largely on evidence from the crisis period in late 2008.

foreign RP pool (currently about $250 billion), as well as the ON RRP. To illustrate how these other liabilities may look in the medium term, we provide the projections presented in the January 2017 Tealbook B (Table A5) based on a supply of reserves at $500 billion in which the balances sheet normalizes in 2021. For these projections, currency in circulation grows broadly in line historical trends, and TGA is set at the Treasury Department's stated minimum of $150 billion. Other significant liabilities include the foreign RP pool, which is set around the current value at $257. In accordance with the PNP&P, ON RRPs drop to zero by 2021.

II. **Implications for the size of SOMA**. Using these assumptions the size of the balance sheet is $2.8 trillion at normalization in 2021 and then grows to $3.6 trillion in 2030. Almost all assets are held in SOMA (non-SOMA assets include gold and discount window loans), and SOMA is much bigger than was the case pre-crisis. While reserves are currently the largest part of liabilities, projected reductions in securities holdings plus an assumption of continued currency growth lead to currency in circulation to be the largest liability by 2019, as was the case pre-crisis.

Under the Committee's existing policies, an assumption of a different level of reserves, such as alternative values discussed in Section A, would be associated with a different level of assets. For example, if policy makers determined that the amount of reserves consistent with efficiently operating a floor was around $1 trillion, the balance sheet could be considered normalized in 2019 in Table A5, and would grow from that point. In the long-run, SOMA's holdings of Treasury securities would be about $500 billion higher. Likewise, as discussed above, policy choices on other liabilities in a floor environment would also affect the necessary size of SOMA. For example, if TGA were higher than the stated minimum, it would also increase SOMA assets proportionally.

Table A5. Federal Reserve Balance Sheet: End-of-year projections with $500 billion in Reserves
($ billions)

	2007	2016	2017	2019	2021	2025	2030
TOTAL ASSETS	915	4,453	4,371	3,209	2,843	3,139	3,609
TREASURY SECURITIES	741	2,464	2,421	1,614	1,529	2,202	2,975
MBS	0	1,741	1,742	1,422	1,164	817	539
OTHER	175	248	208	173	150	120	95
TOTAL LIABILITIES	878	4,413	4,330	3,164	2,795	3,081	3,537
RESERVES	14	1,760	2,261	907	500	500	500
CURRENCY	792	1,463	1,551	1,748	1,878	2,164	2,620
REVERSE REPOS	44	725	357	349	257	257	257
TGA	16	399	150	150	150	150	150
OTHER	12	66	11	10	10	10	10

Source: January 2017 Tealbook. Note that the difference between total assets and total liabilities is total capital.

Figure 1 − Projected Receipts of Principal on SOMA Securities

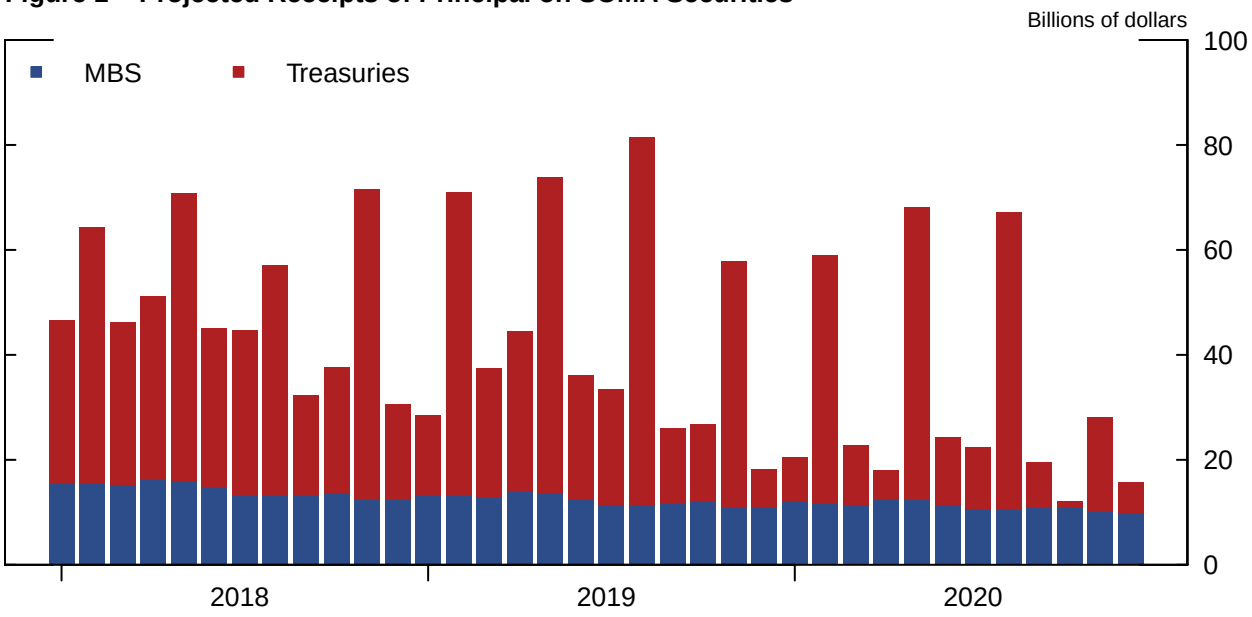


Figure 2.a − Immediate Cessation: Projected Receipts of Principal on SOMA Securities

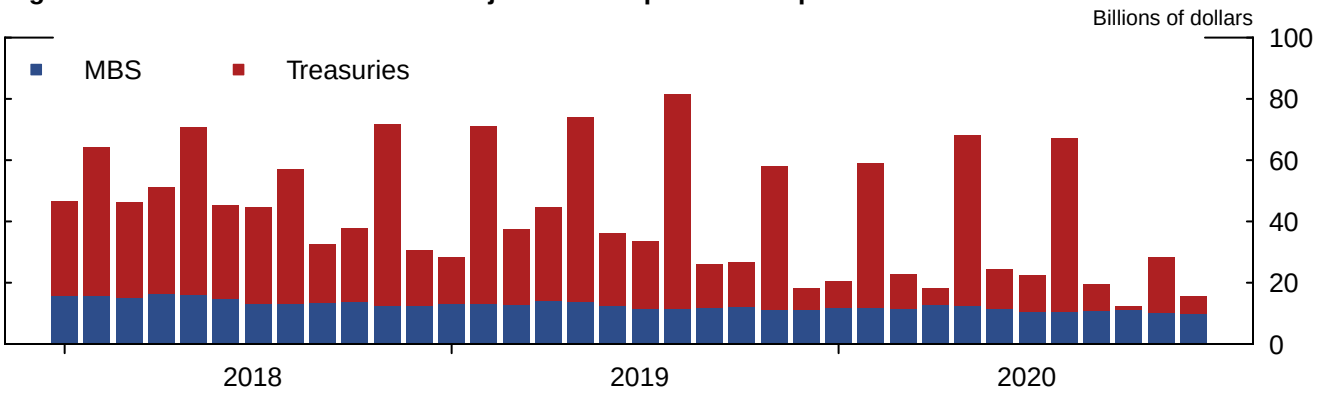


Figure 2.b − Capped Treasury: Projected Receipts of Principal on SOMA Securities

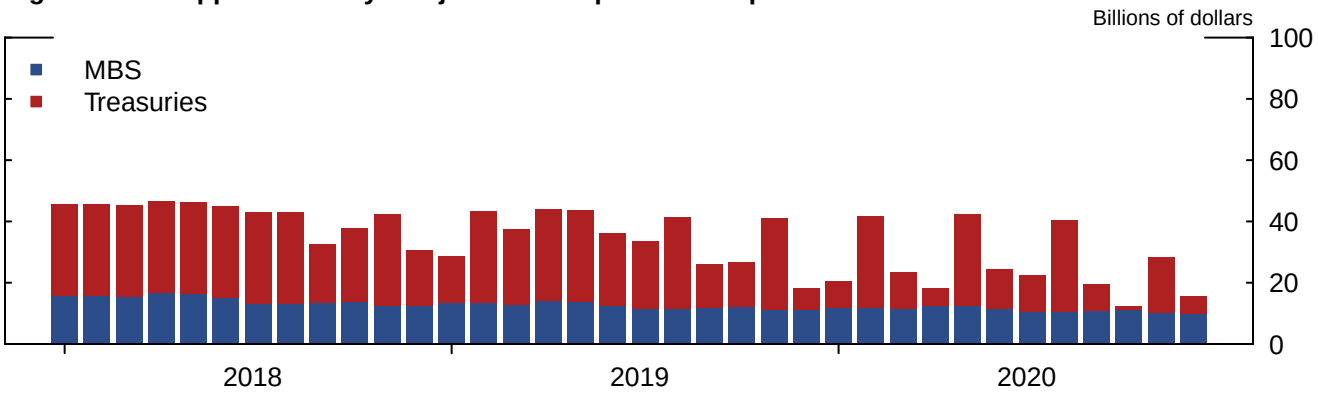


Figure 2.c − 2−Year Phase−Out: Projected Receipts of Principal on SOMA Securities

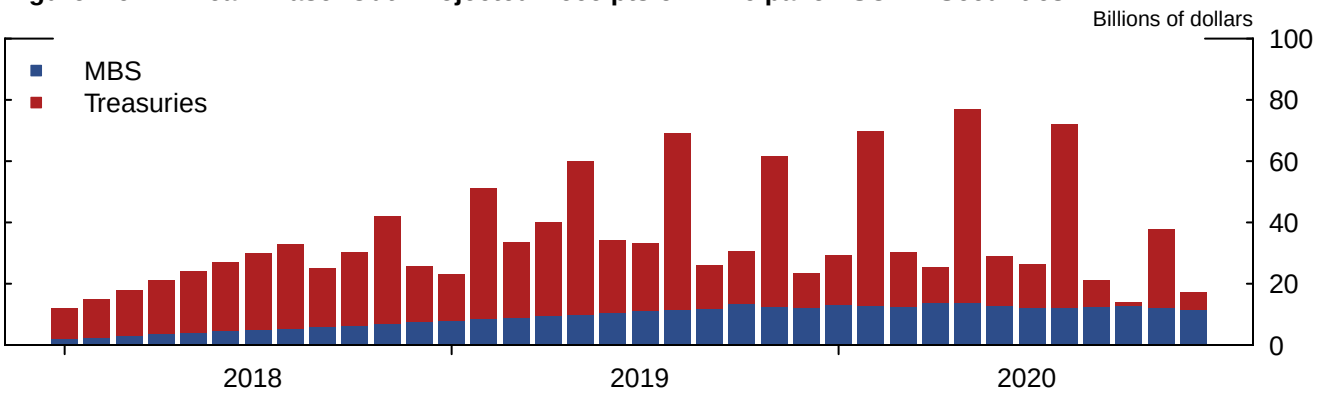


Figure 2.d − MBS Redemptions Only: Projected Receipts of Principal on SOMA Securities

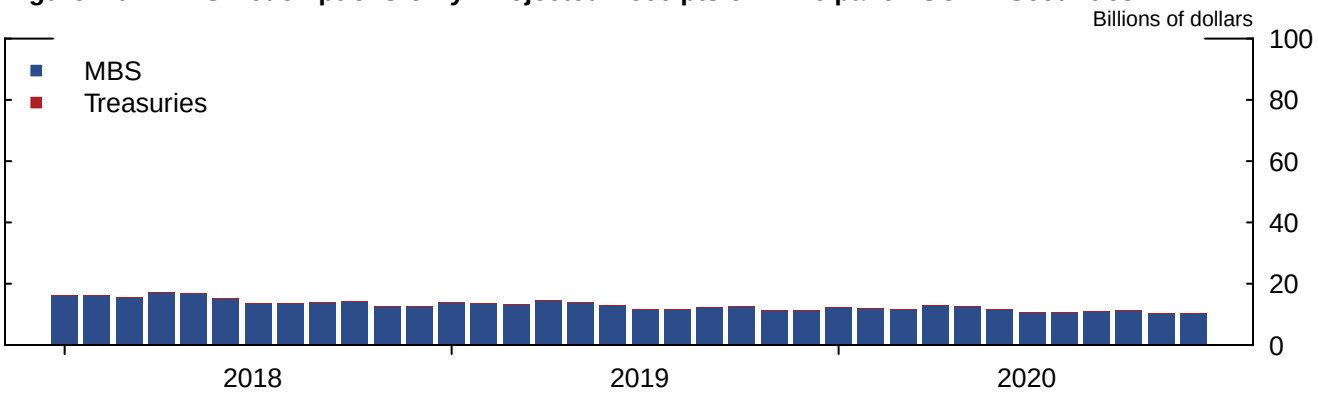


Figure 3: SOMA Holdings

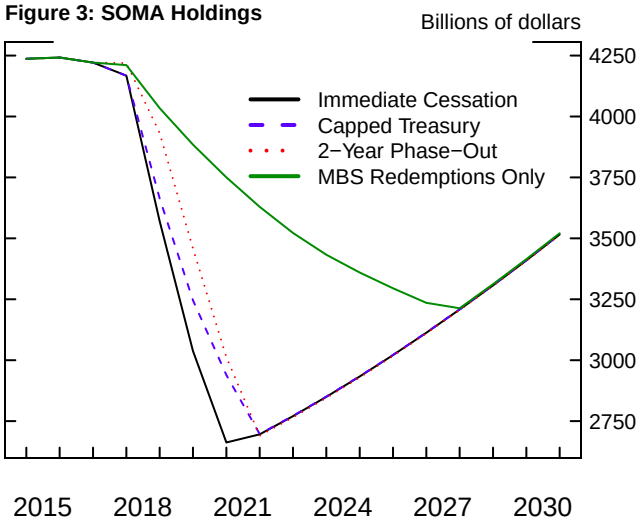


Figure 4: MBS Share of SOMA

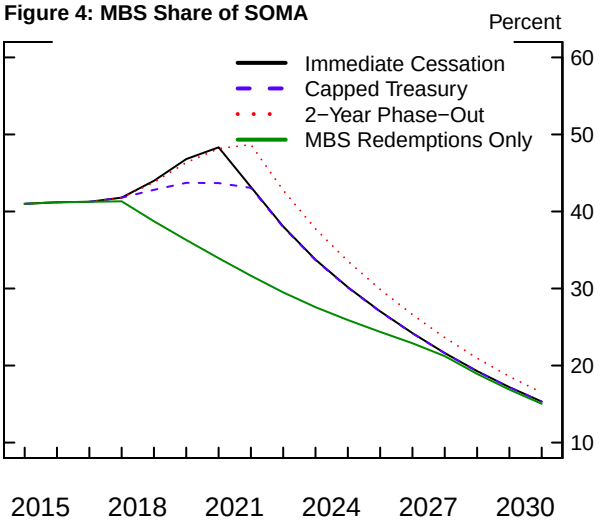


Figure 5: Treasury WAM

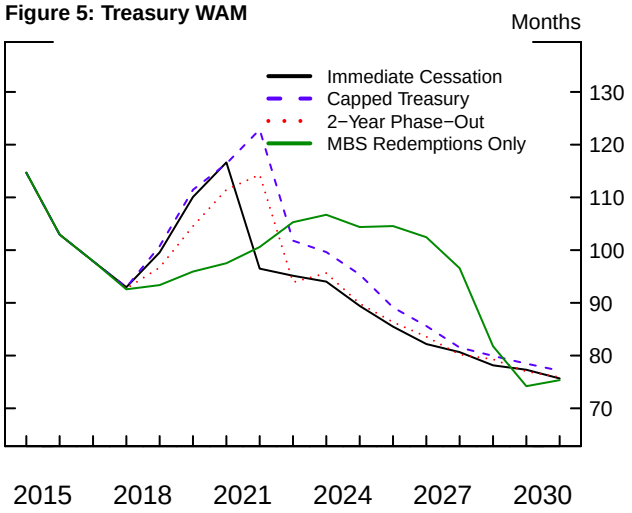


Figure 7: Remittances

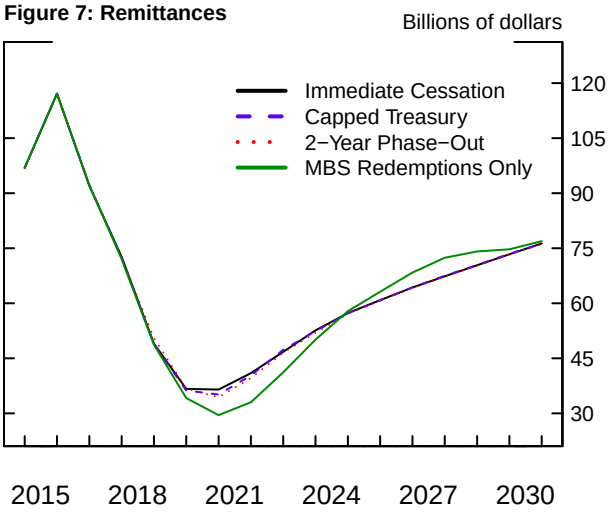


Figure 6: Size (Trillions) of SOMA Holdings at Zero Lower−Bound

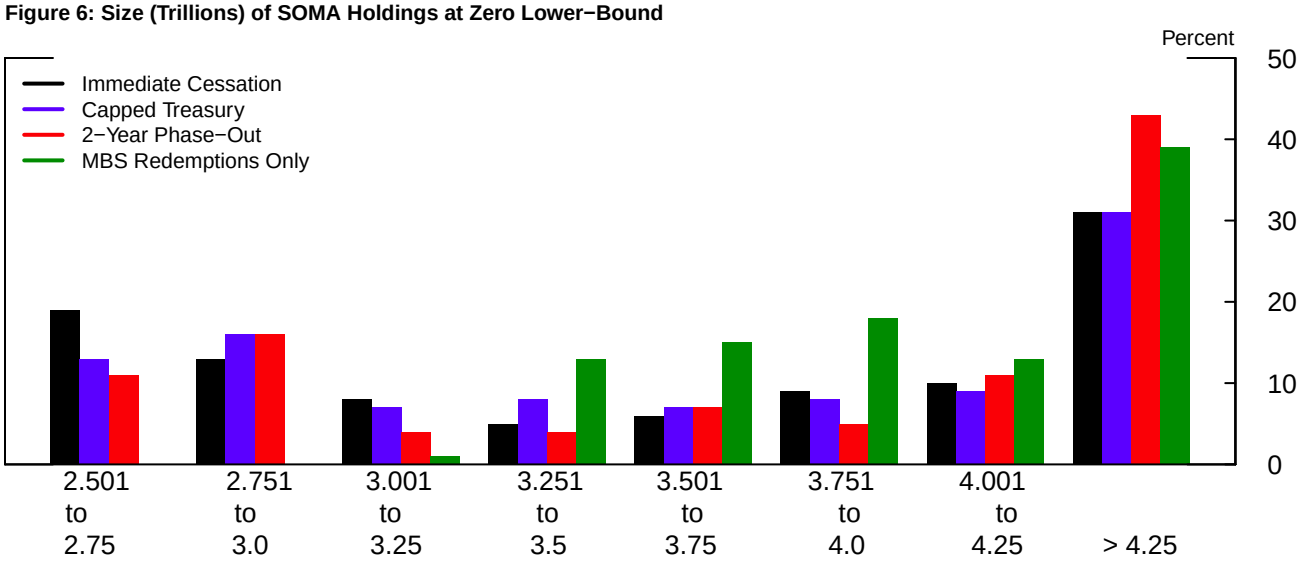
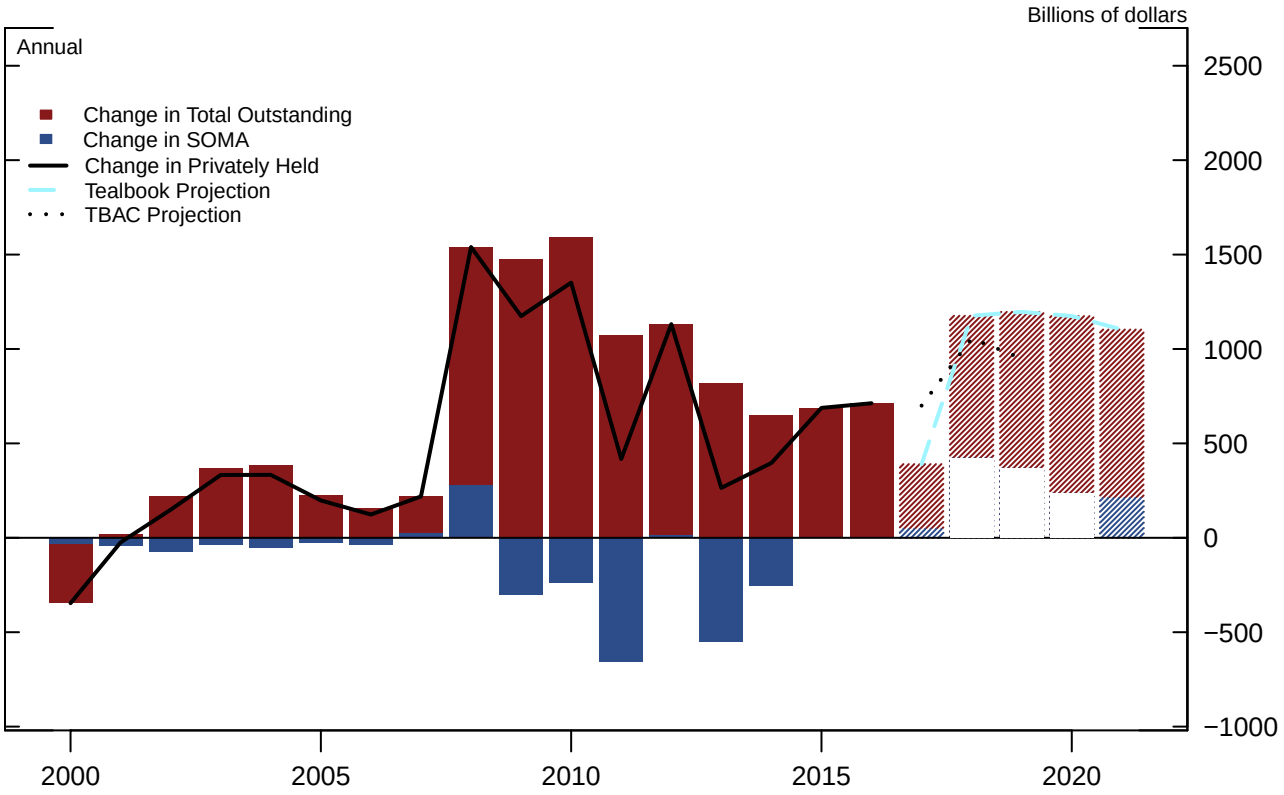
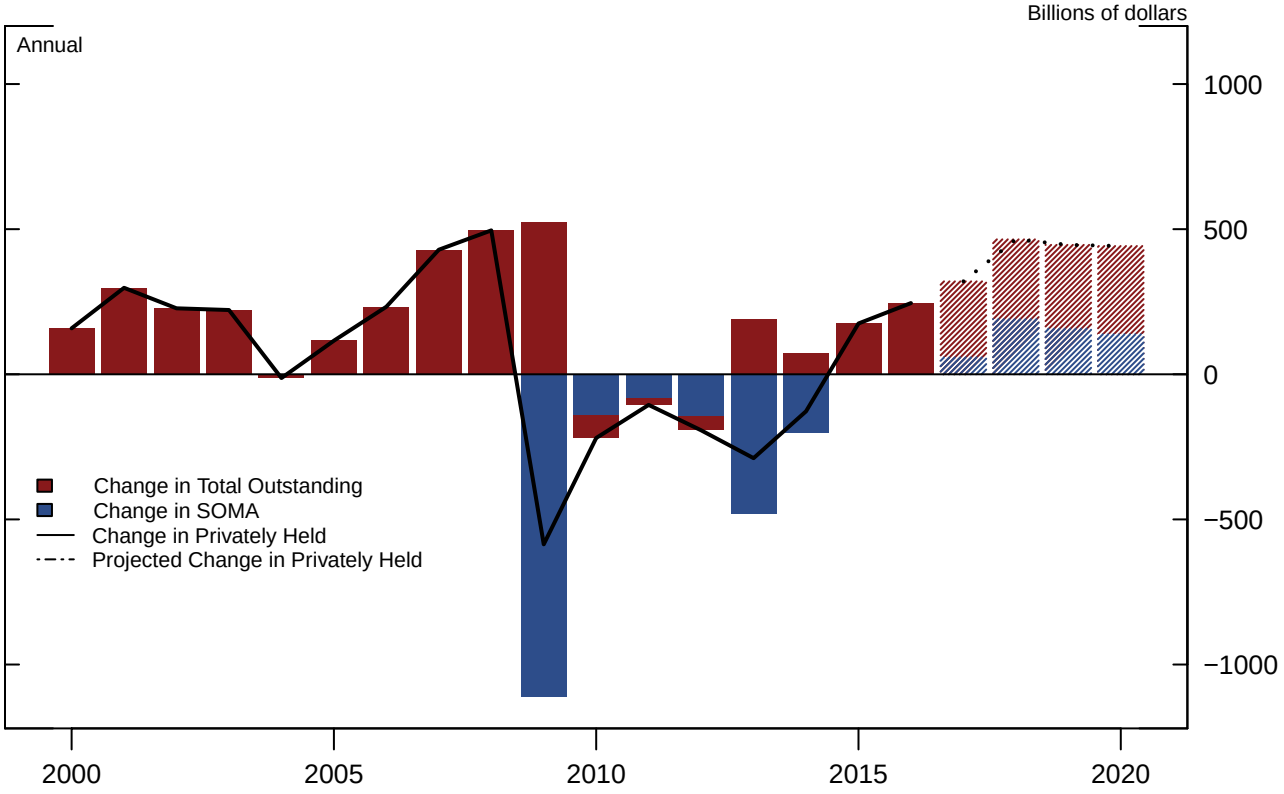


Figure 8: Change in Privately Held Treasury Debt: Historical and Projected



Note: SOMA Redemptions (purchases) are shown as positive (negative) changes. Projection is immediate cessation in late 2017.
Note: TBAC Projection adjusted for full redemption starting in 2017:Q4, consistent with the Tealbook.

Figure 9: Change in Privately Held Agency MBS: Historical and Projected



Source: FRBNY, eMBS, Staff Estimates.
Note: Projected total outstanding assumes that the fixed rate agency MBS universe grows by 5 percent per year. Redemptions (purchases) are shown as positive (negative) changes. Projection is immediate cessation in late 2017.