

September 30, 2016

THE FEDERAL RESERVE'S BALANCE SHEET AND FINANCIAL STABILITY¹

Executive Summary

In this memo, we consider possible interactions between the Federal Reserve's balance sheet, financial stability, and the functioning of financial markets.

Section 1 considers the potential to use the balance sheet and, in particular, long-term asset purchases to promote liquidity and functioning in markets during stress periods. The experience of the financial crisis, during which policymakers deployed the balance sheet to support market functioning, provided strong evidence that such actions are effective. As a result, operational capacity to support liquidity and market functioning when needed may be desirable. Such capacity would not necessarily require the Federal Reserve to maintain large holdings in normal times. However, a framework in which market participants expected such support in stressful periods would raise concerns regarding moral hazard.

Section 2 considers the role of Federal Reserve liabilities as a means to mitigate risks associated with private money creation and maturity transformation. Greater provision of reserves or reverse repurchase agreements (RRP) by the Federal Reserve could satisfy a larger proportion of investors' demand for money-like assets, potentially displacing some unstable privately-created "money," reducing maturity transformation, and thereby fostering a more stable financial system. The available empirical evidence is limited and does not suggest these effects would be large. Moreover, the literature does not provide much guidance on the optimal degree of maturity transformation by the private sector or the quantitative effect of any shift in private-sector maturity transformation on the stability of the financial system.

Section 3 discusses the interaction of safe-asset demand and the Federal Reserve's balance sheet along another dimension. If the Federal Reserve were to provide more safe, short-term liabilities to the private sector by holding a balance sheet composed of long-term Treasury securities, the amount of longer-term Treasury securities available to the public would be reduced. Long-term Treasury securities allow investors to hedge against certain macroeconomic risks, as the value of these assets rises during economic downturns, and some research suggests investors have strong demand for such safe assets. A reduction in the ability of the private sector to hedge macroeconomic risk via Treasury holdings may lessen risk-bearing capacity, although the related literature provides limited quantitative evidence on the importance of this channel.

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The issues discussed in both sections 2 and 3 involve balance-sheet practices that change the consolidated liability structure of the Federal Reserve and Treasury. Prior to the crisis, the Federal Open Market Committee preferred a balance sheet structure that was relatively small and broadly reflective of the liability structure chosen by the Treasury Department. Alternative balance sheet practices in the future may require coordination with the Treasury and the broader public.

Section 4 reviews the possibility that changes in Federal Reserve asset holdings could affect maturity transformation by changing the slope of the yield curve. A flatter yield curve, all else equal, lowers the incentive to borrow short to invest in long-term assets. Experience with large-scale asset purchases and the Maturity Extension Program (MEP) illustrates the ability of changes in Federal Reserve assets to alter the slope of the yield curve, even without changes in the size of the balance sheet (absent substantial shifts in the volume or composition of Treasury issuance). The magnitude of these effects may not be sufficiently large to substantially affect maturity transformation unless the Committee were willing to entertain larger adjustments in the balance sheet's size or composition than in operations such as the MEP, although the evidence is also very limited in this area.

Section 5 reviews issues that would be associated with adjustments in the size or composition of the balance sheet to affect mortgage and housing market conditions, which may have implications for financial stability given the role of real estate in past banking and economic crises around the world. In principle, the Federal Reserve could try to enhance financial stability by "leaning against the wind" by selling MBS during periods of exuberant mortgage or housing market activity, thereby putting upward pressure on mortgage rates. This may require holding a large stock of MBS, on average, and such holdings may depress mortgage rates and overstimulate housing finance and real activity. The Federal Reserve's experience in the MBS market outside of crisis periods is limited; in particular, it is difficult to assess the degree to which the stock of asset holdings or the flow of purchases/sales affect mortgage spreads when investor demand for MBS is strong. Moreover, large-scale sales or purchases of MBS could affect financial conditions more broadly, potentially working at cross-purposes to policymakers' macroeconomic objectives.

Several key questions for policymakers lie beyond our discussion: Do financial stability considerations fall within the FOMC's statutory mandate? To the degree they do, should related actions taken by the FOMC be coordinated with other regulatory agencies and the Treasury? And, finally, what risks to monetary policy independence may accompany such an expansion in the FOMC's objectives?

1. Asset Purchases during Periods of Stress

Background

Experience during the financial crisis demonstrated that Federal Reserve balance sheet operations have the potential to enhance the liquidity and functioning of targeted markets in times of stress. For example, pronounced effects were observed in the agency MBS market where, during the first half of LSAP1, the Federal Reserve's purchases were an important component in the restoration of market functioning.

Quantitative Assessment

As Figure 1 illustrates, key measures of liquidity in the Treasury market suggest that liquidity improved between the first and second halves of the first LSAP program. Average trading volumes increased by 20 percent, the yield premium paid for on-the-run 10-year notes relative to off-the-run securities with comparable remaining maturities fell by a quarter, and failures to deliver securities into repurchase agreements on Treasuries dropped 80 percent. The average yield curve fitting errors declined by about half between the two sub-periods, suggesting improved arbitrage activity. It is worth bearing in mind that these results occurred with a relatively small intervention in the market—the first LSAP program purchased only \$300 billion of longer-term Treasuries, although Treasury market liquidity may have benefitted from “spillovers” associated with the Federal Reserve's substantial purchases of agency MBS.

Hancock and Passmore (2011) estimate that the MBS purchase program reduced “abnormal pricing” (the component of the spread by which they measure market dysfunction) by about 70 basis points over its first six months. Other measures of market functioning also improved notably. For example, the spread on one-month MBS repo over Treasury repo declined by about 60 basis points (to near zero) after the program was announced, and implied financing rates from dollar roll transactions narrowed by about 300 basis points over the course of the program.

Policy Implications

The apparent and persistent efficacy of the first LSAP program compared with the evident effects from subsequent programs suggests that an important element of LSAPs operates through limits to arbitrage that can become pronounced during stressed market conditions. Consequently, it is reasonable to consider the value of expanding the balance sheet in future periods of stress to enhance liquidity at such times. Toward this end, it may be important to maintain some operational capacity to conduct sizable purchases in agency MBS and Treasury markets. Such flexibility would not necessarily require large Federal Reserve holdings in normal times.

Any program that sets out to purchase a sizable fraction of the market in a particular type of security runs the risk of creating moral hazard or going too far and creating distortions and dysfunction in that market. However, to the extent that interventions of the sort contemplated

here would be relatively rare, “emergency” measures—only to be enacted when markets are suffering from insufficient participation and conceivably unwound relatively quickly—this sort of concern may be mitigated.

2. Federal Reserve Liabilities and the Supply of Money-like Assets

Background

Short-term liquid and “safe” assets, either publicly or privately created, have money-like properties because they are nearly immune to information asymmetries, making them particularly useful to investors as a store of value, to facilitate trade as a ready means of payment, or as collateral to obtain low-cost funding. Consistent with these observations, there is substantial empirical evidence that the prices of money-like assets incorporate a significant liquidity premium (or “convenience yield”). That is, investors are willing to accept lower yields on these money-like assets to receive a nonpecuniary return associated with these other benefits. Very short-term Treasury bills are a classic example of such assets, and both central bank reserves and overnight reverse repos from the Federal Reserve may serve similar functions for eligible institutions or investors.²

The liquidity premium can be seen in Figure 2, which presents an estimate of the excess return required by investors on Treasury bills with remaining maturities of more than one week. Researchers have interpreted this premium as signaling that the public sector has not fully met the demand for money-like assets and thereby left room for the provision of such assets in the form of private money-like liabilities by financial institutions. Such private money typically holds the characteristics of public money during normal times—when investors perceive it as seemingly liquid and safe. The ability to issue such private money at a yield incorporating a relatively high safety premium and invest the proceeds in higher-yielding, longer duration assets has provided a strong incentive for the creation of private money and maturity transformation.

Figure 3, which is taken from Greenwood, Hanson, and Stein (2016), provides some evidence on the rising demand for money-like assets among domestic investors in recent decades. That is, since the late 1970s, the total amount of money-like assets—including Treasury bills, money market fund shares, checkable deposits and currency, and other uninsured short-term assets—held by nonfinancial businesses and households has risen from 28 percent of GDP to 42 percent. Moreover, a considerable shift in the composition of these holdings of businesses and households (the shaded areas in the figure) show that *privately-produced* money-like assets accounted for a disproportionate share of the growth—until the financial crisis, that is. Between the late 1970s and the mid-2000s, the share of Treasury bills and checking deposits in businesses’ and

² See, for example, Greenwood, Hanson, and Stein (2015).

households' holdings of money-like assets dropped, while money market shares and uninsured deposits became dominant.

Going forward, a variety of institutional and regulatory factors may change the supply of and demand for these assets over time. For example, the liquidity-coverage ratio better aligns the liquidity risks associated with short-term bank liabilities, shifting incentives of large bank-holding companies (BHCs) away from less stable short-term liabilities and tilting demand toward asset holdings of specified liquid assets; the supplementary leverage ratio, by not differentiating by risk, may shift the demand of large BHCs away from low-return liquid assets; money market fund reform—including floating net asset values—appears to be reducing the attractiveness of investment in prime funds to some extent, increasing investor demand for government-only money funds and shifting exposures away from riskier short-term funding instruments.³ The supply and demand for money-like assets may also shift in response to changes in issuers' and investors' perceptions of, and tolerance for, liquidity risk, particularly given the experience of the financial crisis.

In quiescent market conditions, privately produced money-like assets can meet investor demand for liquid assets and provide important liquidity services to private agents. For example, a traditional role of financial firms in the economy has been the issuance of short-term debt (e.g. deposits), providing valuable payments services to businesses and consumers and funding productive investment. Similarly, the commercial paper market provides a source of funding for nonfinancial firms, and the repo market facilitates a variety of transactions and positions within the financial system. Nonetheless, seemingly liquid, privately produced money-like assets do not have the safety of claims against the U.S. government and can become illiquid if investors suddenly become dubious about the liquidity or safety of such instruments. Such shifts in investor perceptions were powerful catalysts for instability during the financial crisis, when investors came to question the worthiness of credit ratings and quickly ran from the short-term liabilities of institutions perceived to be under strain and soon thereafter ran from private money-like instruments more generally, leading to government support for money markets along many dimensions.⁴

As suggested by Stein (2012), Krishnamurthy and Vissing-Jorgenson (2014), and others, government liabilities may be able to crowd out excessive private money. An increased supply of very short-term liabilities by the government would satisfy a larger share of the demand for safe short-term assets and decrease the liquidity premium, making creation of private money less attractive to the private sector. For example, Greenwood, Hanson, and Stein (2015) estimate that a given increase in short-term Treasury bills tends to crowd out about half as much privately

³ For a more comprehensive discussion, see Committee on the Global Financial System Markets Committee (2015) and the Federal Reserve System staff memo on “Money Market Regulations” by Li, et al (2016).

⁴ For example, see Brunnermeier (2009), McCabe (2010), Gorton and Metrick (2012), and Covitz, Liang, and Suarez (2013).

produced safe assets, and Carlson, et al. (2016), show that the supply of private money-like assets responds in just a matter of weeks following unanticipated changes in government-provided securities. This evidence focuses on changes in volume of short-term wholesale funding of financial institutions, particularly commercial paper. More broadly, large changes in the supply of short-term government liabilities in a manner designed to substantially alter the volume of public and private money-like assets from the trends observed over decades would represent a policy effort well outside the historical experience embedded in the empirical analysis of previous authors, and the effects on the supply of alternative money-like assets is difficult to assess.

While the empirical evidence has primarily examined the role of short-term Treasury securities, Federal Reserve liabilities such as reserve balances and ON RRP could also satisfy investor demand for such assets. Figure 4 shows the take-up of ON RRP over time. At least two features of this graph are consistent with ON RRP playing a role as a money-like asset. First, ON RRP balances spike on every quarter end, a time when the desire of foreign banks (largely) to deleverage temporarily at financial disclosure dates (so-called “window dressing” activities) decreases their demand for short-term funding and, thus, lowers the supply of money-like assets available to U.S. money market funds. In response, it appears that money funds have shifted their demand to the ON RRP facility around these dates. Second, take-up increased significantly, hovering near \$200 billion, around the tax date of April 15, 2014. During this period, Treasury bill issuance had declined due to the Treasury's reduced borrowing needs (as often occurs during tax season), and investors apparently substituted their demand for Treasury bills with demand for Fed ON RRP.

Quantitative Assessment

The potential for publicly-produced money to substitute for privately produced money is an ongoing area of research, and the literature has not settled on the strength of these linkages. Furthermore, whether Federal Reserve liabilities, rather than Treasury bills, can effectively crowd out excessive private money is an even more-open question. Reserves can only be held by the banking sector, and the degree to which their liquidity is transmitted to the rest of the economy depends on their intermediation, suggesting that they may not be as effective as Treasury bills in crowding out private short-term debt. Indeed, Figure 3 evinces only a little net decline in private money since 2007, a period during which reserves increased by over \$3 trillion, and some of the decline that did occur was likely due to regulatory reform and other factors. Nagel (2016) studies the introduction of interest on reserves (IOR) in the United Kingdom and Canada and does not find evidence that its implementation changed the liquidity/safety premium, casting further doubt on this channel.⁵

⁵ Bowman, Gagnon, and Leahy (2010) study the implementation of IOR by foreign central banks and find that although in some cases policy tightening was accompanied by declines in balances, these declines seem small

On the other hand, the ON RRP program is open to a larger set of counterparties than the reserves market and so may be able to provide money-like assets that could circulate beyond the commercial banking sector.⁶ Infante (2016) provides evidence that Term and ON RRP take up increases with the level of the safety premium, whereas private tri-party repo decreases with the level of the safety premium. This evidence suggests that the ON RRP may be more effective than reserves at crowding out excessive private money. Greenwood, Hanson, and Stein (2016) also emphasize the potentially broader reach of ON RRP.

Policy Implications

In terms of providing liquidity services, the Federal Reserve's liabilities may play a similar role to that of Treasury bills, since both reserves and RRP balances provide a safe store of value.⁷ In addition, reserves may also have a convenience yield since they can be used as a means of transaction. Any Federal Reserve policy or operating regime that maintained a large balance sheet might therefore produce some of the "crowding out" effect discussed above, and such a reduction in private-money creation could be beneficial for financial stability. Greenwood, Hanson, and Stein (2016) emphasize these effects as a motivation for a larger steady-state balance sheet, a point also emphasized in Cochrane (2014). Other researchers—including Kashyap and Stein (2011), Stein (2012), Greenwood, Hanson, and Stein (2016), and Woodford (2016)—have gone further and suggested, on theoretical grounds, the Committee might consider actively using changes in the size or composition of the Federal Reserve's liabilities to target the level of private-money creation as perceptions of fragility change over time. That said, researchers have not pin-pointed the *amount* (or range) of private money-like assets that might be consistent with a stable financial system or whether the Federal Reserve (or the Treasury) should aim to displace essentially all of that private activity. The latter approach, of course, could require a very large Federal Reserve balance sheet.

Nevertheless, even if the stock of private money was seen as too larger, it is not clear the Federal Reserve needs to take responsibility for displacing private money-like assets. In principle, Treasury could probably entirely satiate investor demand for safe short-term assets by issuing a mix of bills and floating-rate notes. Moreover, the fact that bills, unlike reserves and RRP, can circulate freely suggests that the Treasury may have an advantage in doing so. However, Greenwood, Hanson, and Stein (2016) argue that, unlike the Federal Reserve, the Treasury faces the risk that its auctions of bills could fail, and that, therefore, it may be more advantageous for the Federal Reserve to supply money-like assets. These authors also note that the money premium accrues largely to assets of very short duration, and the Federal Reserve could increase

relative to the increase in rates induced by the IOR. This suggests that the IOR controls rates through prices and not quantities.

⁶ Although it does not emphasize financial stability considerations, the recent paper by Duffie and Krishnamurthy (2016) does underscore market segmentation and the ability of the ON RRP to improve the pass-through of monetary policy rates to wholesale money market rates.

⁷ See Carlson et al. (2016), which analyzes the possible monetary policy option of providing short-term safe assets.

the supply of such assets while also reducing the amount of current duration (and therefore fiscal) risk in its asset holdings by concentrating asset holdings in securities with duration between 2 and 6 years.

To the extent that the Federal Reserve does supply such assets in the form of ON RRP, it may wish to do so in a way that is less than perfectly elastic. While the complete displacement of runnable private money would eliminate run risk, incomplete displacement and the availability of an elastic supply of safe assets from the Federal Reserve could exacerbate run risk on the remaining private money. If ON RRP supply were elastic, the program would provide cash investors with an investment opportunity (a truly safe asset) which could quickly replace previously-held liabilities of the private sector. Consequently, the perception among investors of a highly elastic (and unconditional) supply of Federal Reserve-backed assets could be a source of destabilizing run-risk in private wholesale markets.

Frost et al. (2015) discuss some design considerations for the RRP program that could mitigate run risks. In particular, predetermined “dynamic” caps on the aggregate amount of RRP balances could substantially limit cash investors’ ability to rapidly shift a large portion of their portfolio to the facility. Such caps, in conjunction with an auction mechanism to allocate take-up, would limit rapid changes in volumes and take advantage of the price-sensitivity of cash investors’ decisions, thereby providing some discipline particularly at times of stress. That said, Frost et al. (2015) caution that a tendency for investors to become rate-insensitive during episodes of financial panic may limit the ability of a well-designed auction mechanism for RRP to effectively mitigate run risk once panic begins to take hold.

Substantial provision of Federal Reserve liabilities to crowd out excessive private money may require very large holdings of Treasury securities (or MBS). Such large holdings could have implications for the functioning and liquidity of the Treasury (or MBS) market. For example, the reduction in the amount of Treasury securities in private hands, in the face of strong post-crisis demand for such assets owing to risk management and regulatory changes, could reduce trading activity and lead to increases in liquidity premiums or other changes in market structure. That said, the supply of Treasury securities has expanded substantially since 2008. Overall, it is not clear that a potential shortage of supply poses a material risk to market functioning.

A large balance sheet could also have adverse financial stability implications if it causes the interbank market to atrophy. All else equal, an active interbank market provides a means of flexibility, funding diversification, and information generation that could deteriorate in a world in which most banks always held significant excess reserve positions (see Bindseil, 2016). On the other hand, ongoing RRP broaden the set of Federal Reserve counterparties—and, perhaps, ultimate investors with nearly direct access to Federal Reserve liabilities—which could entail certain benefits for financial stability. For example, ongoing interactions with a broader set of counterparties may provide valuable information on market conditions. Such benefits might be analogous to the considerable information about Treasury and tri-party repo pricing and market

functioning that the Federal Reserve has traditionally accessed as a consequence of its ongoing operations.

3. Federal Reserve Holdings of Long-Duration Assets and Private Sector Risk-Bearing Capacity

Background

While the previous section and Greenwood, Hanson, and Stein (2016) touch on one strand of the safe-asset literature—the provision of safe money-like liabilities by the Federal Reserve to reduce maturity transformation—an alternative strand emphasizes a broader notion of safe assets, and this literature may also have implications for the interaction of balance sheet policies and financial stability. Research suggests that long-maturity Treasury securities, though not money-like, also earn a convenience yield.⁸ Moreover, Gorton, Lewellen, and Metrick (2012) and Krishnamurthy and Vissing-Jorgensen (2012) have emphasized the notion of investor demand for safe assets defined broadly to include long-duration assets such as Treasury bonds. Under this view, the Federal Reserve would have very limited ability to affect the net supply of safe assets by changing the size of its balance sheet because, for example, increased issuance of reserves or ON RRP would also require an increase in holdings of Treasury securities (and a corresponding decrease in safe Treasury securities available in the market).

One reason for this may be that long-maturity Treasury securities provide a unique benefit: They have a “negative beta” and thus provide investors a valuable hedge against a range of macroeconomic risk factors. Caballero and Farhi (2016) suggest that this negative-beta characteristic allows private-sector participants to hedge some macroeconomic risk. If this is the case, diminished availability of longer-term Treasury securities brought about by an expansion of the Federal Reserve’s balance sheet (all else equal) could be expected to decrease the ability of the private sector to hedge macro risks.⁹

The Federal Reserve’s holdings of long-term Treasury securities could also have consequences for financial institutions’ management of liquidity risks as well as certain aspects of the reformed regulatory regime. For example, under the Basel III rules, both Treasury securities and reserves (as level-1 assets) count equally as high-quality-liquid assets (HQLA) under the liquidity coverage ratio (LCR). As a result, larger balance sheet holdings of Treasuries to back reserves would have essentially no effect on the net supply of HQLA. In contrast, MBS are level-2 assets, which face haircuts and quantitative limits. Thus, the Federal Reserve could adjust the volume of HQLA available to satisfy the LCR by, for example, taking MBS onto its balance

⁸ See Krishnamurthy and Vissing-Jorgensen (2012).

⁹ See Greenwood and Vayanos (2014).

sheet and issuing reserves. While this possibility exists, current estimates suggest that HQLA are available in more-than-sufficient supply.

Policy Implications

The idea that longer-term Treasury securities provide a useful risk-hedging device for the private sector implies that the Federal Reserve could enhance financial stability by ensuring that the private sector had access to as many of these securities as possible. In other words, one cost of a large balance sheet—or, at least, a balance sheet more tilted toward longer-duration safe assets—would be that it increases the costs of macroeconomic hedging and therefore increases the private sector equilibrium exposure to aggregate risk. Similarly, if a shortage of HQLA were to arise, the liquidity considerations just mentioned suggest that, all else equal, the Federal Reserve may want to tilt its asset portfolio toward less-liquid assets (e.g., MBS), leaving as great a supply of liquidity as possible to satisfy regulatory requirements and investor demand stemming from other sources.

4. Federal Reserve Assets and the Incentives for Maturity Transformation

Background

Excessive private maturity transformation contributed significantly to the financial crisis. By financing longer-term assets with short-term debt, financial intermediaries subject themselves to significant interest-rate risk, as well as to risks stemming from the typical liquidity differentials between long- and short-term contracts. The incentive to take these risks, of course, is that longer-duration assets typically compensate investors more, through term and liquidity premiums. The size of term premiums—which, in principle, can be influenced by the configuration of the consolidated government balance sheet—thus helps to determine the extent of maturity transformation in the economy and thus its sensitivity to fluctuations in interest rates.

By purchasing longer-term securities, the Federal Reserve affects the slope of the yield curve and thus can potentially reduce the amount of maturity transformation taking place in the private sector. Moreover, the slope of the yield curve can be affected by balance sheet actions that alter the composition, but not the size, of the balance sheet: For example, Operation Twist in 1961 and the Maturity Extension Program (MEP) initiated in 2011 altered the slope of the yield curve without changing the total supply of Treasury securities held by the public; both programs involved sizable increases in Federal Reserve holdings of longer-term Treasury securities accompanied by an increased supply of shorter-term Treasury securities to the private sector. (In Operation Twist, the Treasury Department increased the supply of shorter-term Treasury securities as the Federal Reserve purchased long-term securities; during the MEP, the Federal Reserve sold shorter-term securities as it purchased longer-term securities.) Actions that flatten

the yield curve may reduce maturity transformation, as a flatter yield curve implies less incentive to borrow via short-term debt to invest in long-term assets.

Quantitative Assessment

There is limited direct evidence on the degree to which the Federal Reserve's balance sheet has actually affected private sector maturity transformation. The literature has focused more directly on the effects of balance sheet actions on the yield curve, with much less focus on any accompanying shifts in behavior by investors or financial institutions. Theoretical models that have been calibrated to match the observed behavior of the yield curve have trouble generating large duration effects (King, 2016), and the cleanest empirical estimates suggest that duration effects are likely to be relatively modest in size.¹⁰ Li and Wei (2013) estimate that actions on the scale of the Federal Reserve's asset purchase programs through 2012 (equivalent to about \$1 trillion in ten-year equivalent Treasuries in addition to \$1.25 trillion of MBS) lower the ten-year nominal yield by about 100 basis points on average. The estimates of Greenwood and Vayanos (2014) are of similar magnitudes.¹¹

Operation Twist and the MEP attempted to alter the slope of the yield curve by changing the duration of Treasury securities held by the public rather than the overall quantity of such private-sector holdings. Swanson (2011) estimates that Operation Twist, which involved approximately 5 percent of outstanding Treasury debt at the time, reduced the slope of the yield curve by approximately 25 basis points (with roughly equal declines in long-term yields and increases in short-term rates). The MEP (which on announcement equaled a bit less than 5 percent of outstanding Treasuries at the time, totaling \$400 billion) had a similar or somewhat smaller effect (Ehlers, 2012, and Cahill et al., 2015).¹² As can be seen in Figure 5, yields on Treasury securities with duration up to 3 to 4 years increased by up to 5 basis points, while yields at the 10- or 15-year horizon declined by 10 or more basis points.

It is not clear that changes of this magnitude would have a significant effect on the amount of maturity transformation taking place in the financial sector. Adrian and Shin (2010) note that broker-dealers' use of repo, for example, is an increasing function of the slope of the yield curve; while this reduced-form result loosely suggests some reduction in maturity transformation could accompany a flatter yield curve, a fair number of other financial factors, which may also change

¹⁰ Empirical studies that have found sizeable effects of asset purchases have frequently interpreted their results as supporting the importance of the duration channel (e.g., Gagnon et al., 2012), but it is not always clear that this is the only possible interpretation since it can be difficult to disentangle the duration channel from other channels discussed below. D'Amico et al. (2012) and Cahill et al. (2015) attempt this sort of decomposition and conclude that the scarcity channel, for instance, is of comparable importance to duration.

¹¹ As a caveat to these estimates, asset purchases may operate through both stock effects and flow effects, these effects may be different for asset purchases and asset sales, and their potency is likely to vary depending on market conditions and other circumstances, such as whether short-term interest rates are constrained by the effective lower bound.

¹² While the MEP was initially announced to be \$400 billion in size, the amount was later increased to \$627 billion.

should policy actions attempt to manipulate the yield curve, are also included. Foley-Fisher, Ramcharan, and Yu (2016) find some increase in the issuance of long-term debt and in investment in productive capacity by nonfinancial corporations following the MEP, consistent with a reduction in the maturity mismatch between their borrowing and investments. But they also find some increase in reach-for-yield behavior by institutional investors that increased their exposure to risky corporate debt, and weighing the financial stability implications of these countervailing forces is difficult. That said, the effects in either direction seem likely to have been modest.

Policy Implications

A reasonable conjecture is that an investor facing both higher costs of short-term borrowing and lower yields on longer-duration assets would be less likely to engage in maturity transformation. Thus, to the extent that an elevated spread of long rates over short rates encourages maturity transformation, MEP-type operations could affect the volume or profitability of maturity and liquidity transformation activity. One could envision a situation in which the FOMC might wish to cut short-term rates to provide stimulus to the economy but simultaneously be worried that doing so would steepen the yield curve and give rise to an undue amount of maturity mismatch on investors' books. Accompanying the rate cut with a bond-buying program has the potential to engineer more of a parallel shift in the term structure of Treasury yields. This sort of mechanism has been suggested, for example, by Stein (2013).

A shift of the Federal Reserve's balance sheet toward longer maturities entails certain risks. Interest-rate risk taken out of the market by the central bank does not disappear; it is transferred to the central bank's balance sheet and is ultimately borne by taxpayers. Moreover, if the Fed removes interest-rate risk from the market, yield-oriented investors could end up taking on risk in other ways, for example, by increasing their own financial leverage or their exposures to credit risk. Such concerns are palpable in current discussions of the potential effects of low long-term interest rates on the profitability—and risk-taking behavior—of banks, insurers, and pensions funds around the world. These concerns are reminiscent of the “reach for yield” incentives sometimes pointed to as a potential cost of maintaining a low policy rate. Such incentives could offset the benefits of any reduction in maturity transformation, leaving the ultimate impact on the stability of the financial system unclear. An important difficulty is that we do not currently have a robust framework for gauging how much maturity transformation is appropriate for a well-functioning financial system.

5. MBS Holdings and the Housing Market

Background

The experience of the first LSAP program, announced in late 2008, showed that the Federal Reserve could drive down spreads in the MBS market by purchasing agency mortgage-backed securities in strained market conditions. Subsequent research, such as Hancock and Passmore (2011), showed that this narrowing of spreads passed through significantly to primary mortgage rates, thereby materially lowering the costs of home-buying and encouraging borrowers to refinance their loans on more attractive terms. While the literature has not produced conclusive results on the degree to which the MBS LSAP program boosted the market for residential real estate, circumstantial evidence suggests that at a minimum it helped to stem its rapid deterioration; indeed, house prices leveled off in early 2009, shortly after the program became operational. So one could ask whether the Federal Reserve, by significantly adding to or reducing its MBS holdings, could materially affect the housing market even in normal times.

Quantitative Assessment

Hancock and Passmore (2011) argue that the Federal Reserve's 2009 purchases of \$1.25 trillion of agency MBS reduced mortgage rates by 100 to 150 basis points. The extent to which this experience can be extrapolated to non-crisis periods is far from clear, however. The effects of MBS purchases on mortgage rates depend upon (among other factors) the liquidity of the MBS market and the willingness of banks to undertake new lending. Furthermore, the pass-through of lower mortgage rates to increased prices of residential real estate—which is difficult to evaluate even during the LSAP period—depends on (among other factors) the creditworthiness of potential borrowers and the elasticity of housing supply. There is no particular reason to expect these factors to be symmetric for MBS purchases versus MBS sales or to be similar in crisis versus non-crisis periods.¹³ For example, an important part of the sizable effect of purchases in the stressed period of 2009 likely reflected highly impaired liquidity and market functioning. Consequently, it is difficult to say to what extent the Federal Reserve would put upward pressure on housing markets by maintaining a sizeable stock of MBS on its balance sheet. Likewise, the degree to which targeted sales of MBS securities could put downward pressure on the residential real estate market is highly uncertain.

Policy Implications

Some commentators have suggested that adjustments in the Federal Reserve's holdings of MBS may be a useful tool in mitigating boom/bust cycles in the housing market; given the role of

¹³ While there is no comprehensive research examining possible asymmetries between the effects of asset purchases and asset sales, flow-effect regressions based on the MEP program suggest that such asymmetries were small in the cash market. However, sales appear to have had smaller effects on the repo market than purchases did. (See D'Amico et al., 2015.)

housing in banking and financial crises, such mitigation may promote financial stability. For example, the FOMC could sell MBS during a period of rapid growth in mortgage debt and home prices, thereby tightening conditions in mortgage markets and leaning against the increase in risks associated with an exuberant housing market (Friedman, 2014). Inverting this idea, if, for whatever reason, the Federal Reserve were to maintain a portfolio of MBS as a permanent component of its balance sheet, it would most likely put continual downward pressure on mortgage rates and upward pressure on house prices. In the extreme, therefore, such a policy could run the risk of over-stimulating housing market activity and amplifying a debt-fueled cycle.

At this stage, it is difficult to assess the possible efficacy of these channels in affecting mortgage-market conditions. Most research has emphasized stock effects in gauging the impact of Fed MBS holdings on mortgage market conditions, but it is hard to disentangle the effects of the flow of purchases. Moreover, sales of MBS may have different effects than purchases.

Further, attempts to cool the housing market by selling MBS would generally require the FOMC to maintain a large position in MBS. If the sale of MBS tightened mortgage market conditions to the same extent that the first LSAP program eased mortgage market conditions, the balance sheet adjustment required to raise mortgage rates by 100 basis points would be on the order of \$1 trillion dollars. Since MBS tend to prepay relatively quickly, the Federal Reserve would likely have to maintain a more or less continual presence in the market to sustain such a reserve. It would be worth monitoring the extent to which that purchase activity was putting downward pressure on mortgage rates and leading to some overheating in the housing market.

In addition to the effects on housing markets, a balance sheet policy that involved the Federal Reserve routinely in the MBS market could also have implications for the functioning and liquidity of that market. Kandrak (2016), for example, finds that the Fed's MBS purchases after 2011 led to a deterioration in measures of liquidity and market functioning, particularly at the beginning of new purchase programs (although these effects appeared to have been fairly short-lived).

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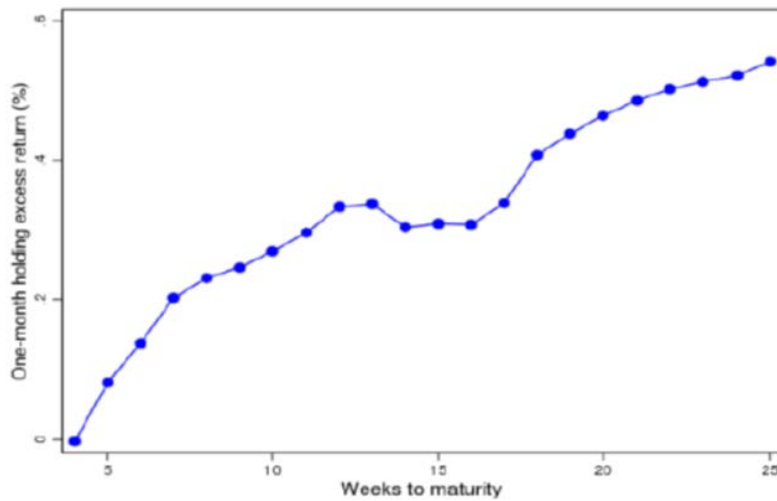
Figure 1. Measures of Treasury Market Liquidity around the First LSAP Program

Date	Daily volume	10Y on-the-run prem	Fails to deliver	Ave. abs. fitting error*
3/17/09	\$83 bil	54 bp	\$109 bil	10.6 bp
3/25 – 7/6/09	\$100 bil	39 bp	\$73 bil	6.4 bp
7/6 – 10/29/09	\$120 bil	29 bp	\$15 bil	3.3 bp

*Based on the Svensson (1994) model.

Source: D'Amico and King (2013).

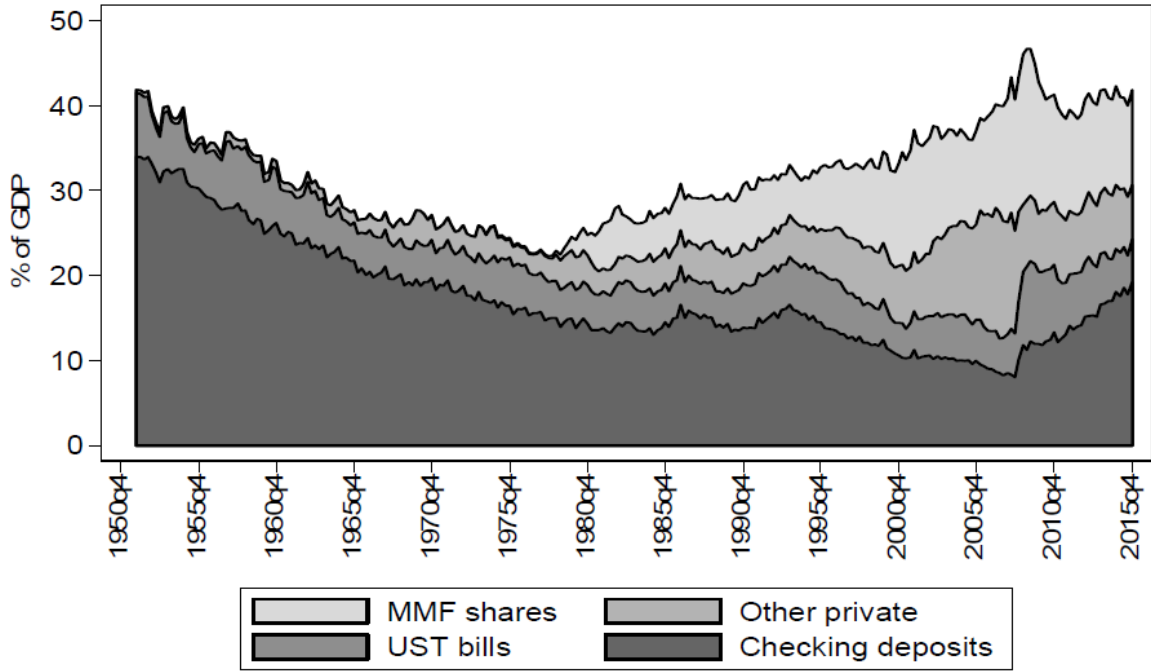
Figure 2. Excess Returns on Treasury Bills, Relative to One-Week Rate



January 1988–December 2007

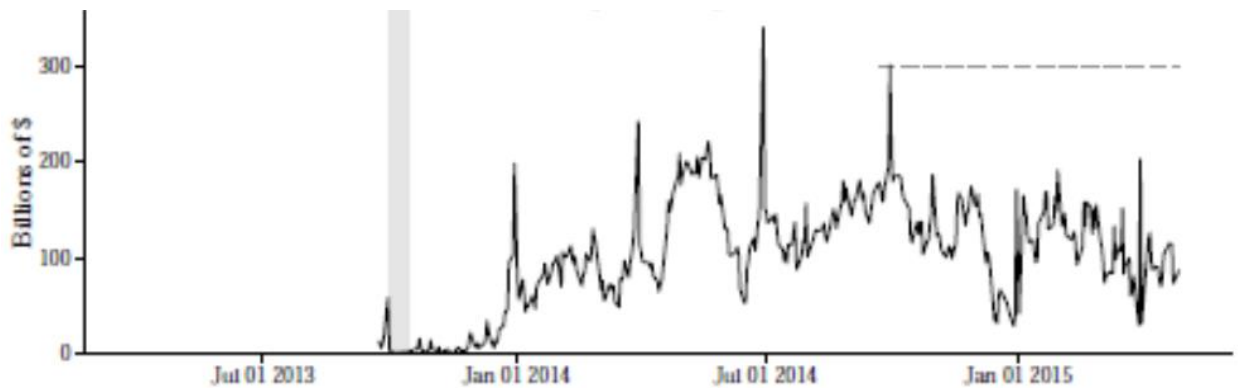
Source: Carlson et al. (2016)

Figure 3. Short-Term Safe Assets Held by the US Nonfinancial Sector



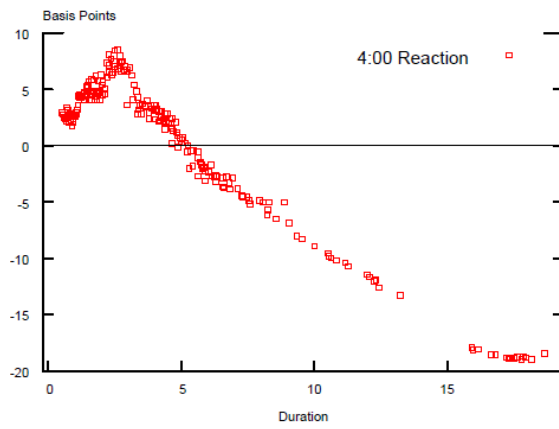
Source: Financial Accounts of the United States via Greenwood, Hanson, and Stein (2016).

Figure 4. Total Volume of the Reverse Repo Facility



Horizontal line represents \$300 billion aggregate cap on the facility that was in place from September 22, 2014, through December 16, 2015.

Figure 5. Event Study around the announcement of the Maturity Extension Program



Source: Cahill et al. (2015)