The Demand for Short-Term, Safe Assets and Financial Stability: Some Evidence and Implications for Central Bank Policies

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The Demand for Short-Term, Safe Assets and Financial Stability: Some Evidence and Implications for Central Bank Policies[1]

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Abstract

A number of researchers have recently argued that the growth of the shadow banking system in the years preceding the recent U.S. financial crisis was driven by rising demand for "money-like" claims—short-term, safe instruments (STSI)—from institutional investors and nonfinancial firms. These instruments carry a money premium that lowers their yields. While government securities are an important part of the supply of STSI, financial intermediaries also take advantage of this money premium when they issue certain types of low-risk, short-term debt, such as asset-backed commercial paper or repo. In this paper, we take the demand for STSI as given and consider the extent to which central banks can improve financial stability and manage maturity transformation by the private sector through their ability to affect the public supply of STSI. The first part of the paper provides new evidence that complements the existing literature on two key ingredients that are necessary for there to be a role for policy: the extent to which public short-term debt and private short-term debt might be substitutes, and the relationship between the money premium and the supply of STSI. The second part of the paper then builds on this evidence and discusses potential ways a central bank could use its balance sheet and monetary policy implementation framework to affect the quantity and mix of short-term liquid assets that will be available to financial market participants.

1. Introduction

Short-term, safe instruments (STSI) appear to carry a money premium that lowers their yields. This premium stems from their liquid, short-term, and "safe" nature—their money-like attributes. Greenwood, Hanson, and Stein (2014) present evidence that this money premium is especially large at the short end of the Treasury yield curve. They argue that this premium reflects the extra "moneyness" of short-term Treasury bills, above and beyond the well-established "convenience premium" that reflects the liquidity and safety attributes of both shorter-term and longer-term Treasury securities.[2] In particular, because Treasury bills provide a certain return within a short time frame, they are an attractive asset for money funds or corporate cash managers.

While public instruments—government debt securities and central bank liabilities—comprise an important part of the supply of STSI, short-term, high-quality privately issued securities also possess attributes of STSI, though perhaps to a somewhat lesser degree than public securities. As noted in Gorton and Metrick (2012), Gorton (2010), and Stein (2012), private financial intermediaries take advantage of this money premium when they issue certain types of collateralized short-term debt, such as asset-backed commercial paper (ABCP) or engage in repo transactions.[3] They argue that this "private money creation" was a big part of the growth in the shadow banking sector in the years preceding the financial crisis, where seemingly safe maturity and liquidity transformation led to the run-like behavior in financial markets observed during the crisis.[4]

In this paper, we take the demand for STSI as given and analyze the extent to which a central bank can improve financial stability through its ability to affect the public supply of STSI. For example, a central bank could use the size and composition of its balance sheet to affect the supply of STSI, thus potentially influencing the money premium and the incentives to create private STSI. Such an approach could be complementary to macroprudential policies targeted to

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[2] The money premium is different than a liquidity premium. For example, short-term Treasury bills are more liquid than Treasury notes and bonds with the same remaining maturities and consequently have lower yields (Amihud and Mendelson, 1991). However, both are similarly money-like at short-horizons: A money market fund can hold a three-month Treasury bill as well as a Treasury note with three months remaining maturity, even if the latter is much less liquid.

[3] Lucas (2013) argues that the interaction of Regulation Q and the U.S. inflation of the 1970s drove business deposits out of the regulated commercial banks and into the shadow banking sector.

[4] See a detailed discussion of the shadow banking system and financial stability in Tarullo (2012), available at http://www.federalreserve.gov/newsevents/speech/tarullo20120612a.htm.

limit the financial stability risks associated with the private issuance of STSI. It would also be similar to an approach where the Treasury could tilt its issuance more toward short maturities and supply more Treasury bills as discussed in Greenwood, Hanson, and Stein (2014).

The first part of the paper provides new evidence regarding the money-like attributes of STSI that complements the existing literature, focusing on two key ingredients that are necessary for there to be a potential role for policy: the extent to which public short-term debt and private short-term debt might be substitutes and the relationship between the supply of STSI and the money premium.[5] First, we extend the existing literature that analyzes the degree to which quantities of public and private STSI appear to substitute for one another by looking across a broader set of private STSI. We find that financial instruments issued by institutions with the most flexibility to adjust to changing money premiums, such as financial and nonfinancial commercial paper (CP), asset-backed CP, and time deposits, exhibit the strongest relationship to the amount of Treasury bills outstanding. Using vector autoregressions, we also show that private STSI tends to respond within two or three months to shocks to the amount of public STSI.

Second, we provide new evidence on the mechanism through which the supply of public STSI might crowd out short-term borrowing by the financial sector. Consistent with the hypothesis that this substitution is brought about by adjustments in the equilibrium price of safety, we find that an increase in the supply of Treasury bills leads to a decrease in the spread between the yields on private STSI and Treasury bills. We also present a new way to measure the money premium in terms of the realized one-month holding excess return to buying Treasury bills. Specifically, if the money premium results in very low yields at the front of the curve, then buying bills with longer maturities and holding them as they become more money-like should be profitable. Using CUSIP-level data for Treasury bills, we find that this holding return increases steeply at the very short end of the yield curve and diminishes as maturities grow and the securities become less money-like, consistent with the z-spread measured by Greenwood, Hanson, and Stein (2014). We then show that this positive excess return of longer-maturity bills

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[5] While we take the demand for STSI as given, it is important to note that this demand is likely to continue to be high and even grow, given upcoming regulatory changes such as DFA requirements that certain OTC derivatives are centrally cleared and the Basel III liquidity regulations. This increased demand will further add to the potential sources of pressures going forward.

is negatively related to the supply of Treasury bills. This effect is more pronounced at the short end of the yield curve, a result that is consistent with the view that shorter Treasury bills have the most money-like attributes. We also summarize discussions with several major issuers of, and investors in, very short-term financial instruments, who, for the most part, expressed some skepticism about the hypothesis that increasing the supply of Treasury bills results in a reduced supply of private money-like instruments.

Nevertheless, overall, the evidence appears to be broadly consistent with the substitution hypothesis, as well as with the results from the earlier literature that studies the relationship between the supply of government debt and interest rate spreads. Greenwood, Hanson, and Stein (2014) show that a 1 percentage point increase in the ratio of Treasury bills to GDP (roughly one-half of a standard deviation) leads to a 5.6 basis point narrowing in the two-week z-spread. They also find that the effect is strongest for very short-term Treasury bills, even after controlling for potential endogeneity between money demand and Treasury bill issuance. Gorton, Lewellen, and Metrick (2012) provide some rough evidence that government debt and bank debt may indeed be substitutes in meeting the demand for STSI. Krishnamurthy and Vissing-Jorgensen (2012) show that the spread between second-tier and first-tier CP falls when the supply of Treasury securities expands, which suggests that top-tier CP is indeed a potential substitute for Treasury securities. Sunderam (2014) analyzes the extent to which ABCP is money-like and shows that positive shocks to money demand increase the spread between ABCP and Treasury bill yields, and increases in Treasury bill supply decrease this spread. Moreover, he shows that the financial sector increases their issuance of ABCP in response to positive money demand shocks.

The second part of the paper then provides a discussion of policy options in light of these results. Our finding that there seems to be a relationship between public and private STSI has potential implications for monetary policy, suggesting that the monetary policy framework and implementation may influence the creation of private STSI for given demand. In particular, if the relationship between public and private short-term debt issuance is causal and robust, greater provision of public STSI by a central bank may result in smaller issuance of private STSI and lower levels of associated liquidity and maturity transformation, potentially improving financial stability. For example, a central bank could boost the supply of public STSI by keeping a

relatively large balance sheet and conducting its monetary policy using a floor system, where large holdings of longer-term assets financed by correspondingly large amounts of reserve balances that are, in turn, safe and liquid assets for financial institutions. Alternatively, a central bank could also boost the supply of STSI while still operating monetary policy using a corridor framework, rather than a floor framework, by, for example, financing its large asset holdings with a different composition of liabilities—a relatively small amount of bank reserve balances and a large volume of reverse repurchase agreements with nonbank counterparties. In this regard, we find that there is a strong negative correlation between the outstanding quantity of Treasury bills and the quantity of overnight reverse repos invested at the Federal Reserve in 2014, suggesting that reverse repo agreements with a central bank are very similar to Treasury bills as a form of public supply of STSI.

The remainder of the paper is organized as follows. Section 2 contains our empirical results. Section 3 provides some context for these findings based on discussions with market participants. Section 4 discusses policy options. The final section offers concluding remarks.

2. Empirical analysis

In this section, we provide new evidence that complements the existing literature on the three key ingredients that are necessary for there to be a role for policy in managing the implications of demand for STSI: the extent to which public short-term debt and private short-term debt might be substitutes, the dynamics of the money premium, and the relationship between the money premium and the supply of STSI.

In particular, a key argument in the literature is that public and private assets of this type are, to some degree, substitutes in meeting the demand for STSI, although for a number of reasons the public securities are preferable to private ones. As a result, the money premium on a particular set of safe and liquid instruments will, in turn, depend in part on the total supply of STSI, including the supply of public STSI. For instance, when there are more Treasury bills, the money premium is reduced for all private STSI as well as for Treasury bills (that is, yields are higher), because both public and private short-term debt instruments meet the demand for STSI. If, in addition, private issuance of short-term debt responds positively to this money premium,

then increases in the issuance of Treasury bills should also lead to a decline in private short-term debt issuance.

This reasoning suggests the following testable hypotheses about an exogenous shift in the supply of Treasury bills:

1. Increases in the supply of Treasury bills should lead to a reduction in the quantity of private STSI.
2. Increases in the supply of Treasury bills should lead to a decrease in the money premium on Treasury bills (higher yields).
3. Increases in the supply of Treasury bills should lead to a decrease in the money premium on private STSI (higher yields).
4. Increases in the supply of Treasury bills should lead to a decrease in the spread between the yields on private STSI and Treasury bills. (Yields on both Treasury bills and private STSI increase, but because of the greater moneyness of Treasury bills relative to private STSI, the money premium on Treasury bills is expected to react by more to changes in supply such that Treasury bill yields rise by more than those on private STSI, resulting in a narrower spread.)

The analysis below provides some support for these hypotheses.

2.1. The supply of Treasury bills and private short-term debt creation

Tables 1 and 2 report the results of regressions of the outstanding amounts of selected money market instruments (as a share of nominal GDP) on the outstanding amounts of current (table 1) or lagged (table 2) Treasury bills (divided by nominal GDP) using monthly data. The starting period of the analysis varies by instrument, but we end the sample period in 2007 so that our results capture the dynamics that prevailed before the crisis. We include month and year fixed effects to control for seasonal effects and time trends. The private money market instruments that we consider are: all financial CP, which includes both issuance by financial companies as well as asset-backed CP; all nonfinancial CP; total time deposits for banks and thrifts; financial CP alone; ABCP alone; and non-Treasury assets of prime money market funds.[6] In each case, an

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[6] All nonfinancial CP combines all the CP instruments, which allows us to construct a consistent time series dating back to late 1976.

increase in the amount of Treasury bills is associated with a material decline in the amount of the private money market instrument.[7] The effect is statistically significant for all instruments, with the exception of prime money market fund assets.

It is important to understand how the changes in private STSI in response to changes in Treasury bills are affecting private institutions. One possibility is that the money premium primarily affects the type or maturity structure of the liabilities that financial institutions issue, but that total liabilities are not greatly influenced. A second possibility is that financial institutions take advantage of lower financing costs afforded by a higher money premium to expand their liability base. We provide some evidence regarding this question by looking at large U.S. domestic banks. We first repeat the regressions in table 2 to verify that the large time deposits of these institutions respond similarly to total time deposits. We then test whether total liabilities of these institutions respond to changes in Treasury bills.

The results are shown in table 3. As shown in column (1), similar to total time deposits, we find that the large time deposits of large domestic banks decline relative to GDP when Treasury bills outstanding increase relative to GDP. However, as shown in column (2), we do not find that total liabilities change with Treasury bills outstanding. This result is robust to the inclusion of a variety of economic controls, such the unemployment rate, federal funds rate, and inflation rate. This finding suggests that the moneyness premium has stronger effects on the maturity structure or types of debt issued by financial institutions than on the amount of debt. It is also similar to the argument in Greenwood, Hanson, and Stein (2010) that corporate debt maturity responds to the maturity structure of outstanding government debt.

To improve our understanding of the dynamics of the relationship between outstanding amounts of Treasury bills and private safe and liquid assets, we estimated a series of vector autoregressions (VARs). These VARs allow us to investigate the timing of the responses of various money market instruments to changes in the outstanding amount of Treasury bills in a

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[7] We also looked at the effect of changes in the outstanding amounts of longer-term Treasury securities. In some cases, larger outstanding amounts of these securities were also associated with reductions in the outstanding amounts of private money market securities. However the effects were smaller than for Treasury bills and the effect was statistically significant for fewer types of private securities.

setting that also allows us to control for other factors, such as the state of the economy, which could also affect issuance of money market instruments and Treasury securities.

In all of our VAR specifications, the dependent variables are the growth of Treasury bills outstanding and the growth of a particular money market instrument. We order these variables so that the growth of Treasury bills can affect the growth of the money market instrument contemporaneously but not the other way around.[8] For most specifications, we use the same monthly data as in the univariate regressions (continuing to focus on the pre-2007 period). The different specifications include an increasing number of controls, starting with only lags of the dependent variables, then adding monthly dummies (to control for seasonal effects), and finally adding macroeconomic controls as exogenous factors in the VAR alongside the monthly dummies (unemployment, growth of industrial production, and PCE inflation).

Results for these three specifications using all financial CP are shown in figures 1 through 3. In general, as shown in the bottom-left panel of all of the figures, we find that an increase in the growth rates of Treasury bills tends to depress the growth rates of financial CP over the following two months. We find a similar response when using the growth of large time deposits (not shown). We do not find a significant response for the growth of nonfinancial CP or in the growth of money fund assets (excluding Treasury securities). The findings may owe to financial institutions, which tend to have some of the most flexibility in terms of managing their liabilities, having the strongest response to shifts in bill issuance.[9]

These results are broadly consistent with those from the levels regressions and with the hypothesis that increases in Treasury bills outstanding result in a reduction in the growth of other money market instruments.

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[8] In some cases, especially when the monthly dummies are not included, we find that a shock to financial CP affects the growth rate of Treasury bills. It is not clear how to interpret this finding. It is possible that there is some underlying factor affecting both series. Consistent with this notion, when monthly dummies and macroeconomic factors are included, this effect is notably diminished.

[9] These results are generally robust to using weekly data, although in the weekly VARs the peak response of private issuance to Treasury bill growth is typically estimated to be a few weeks out, rather than two or three months, as in the monthly VAR.

2.2. Supply of Treasury bills and the money premium

The evidence in the previous section suggests that Treasury bills and the private STSI are substitutes. One way that the supply of Treasury bills could crowd out private STSI is by affecting the equilibrium price of safety. To examine this hypothesis, we first estimate the effect of the growth rate of Treasury bills on money market rates and spreads. According to our hypothesis, greater availability of Treasury bills would result in a smaller money premium, thus narrowing the spread between yields on instruments such as financial CP and Treasury bills, as the latter provide more monetary services per dollar invested and thus have a higher and more sensitive money premium.

We estimate VARs involving rates and spreads using weekly data, as we expect prices to respond fairly quickly. We focus on the spread between rates on 30-day financial commercial paper and on the four-week Treasury bill, as the money premium in Treasury bills tends to be more pronounced for shorter maturities. Since four-week Treasury bills have not been issued for quite as long a time, we confine our sample period to October 2001 to June 2007.[10] Consistent with the STSI hypothesis, we find some evidence that increased Treasury bill issuance results in a narrowing of the spread between financial CP and Treasury bill rates (figure 4, bottom panel).[11]

Greenwood, Hanson, and Stein (2014) present evidence that Treasury bills carry a money premium that lowers their yields.[12] One way to think of this money premium is in terms of the realized one-month holding excess returns to buying Treasury bills. If the premium results in very low yields at the front of the curve, then buying bills with longer maturities and holding them as they become more money-like should be profitable. In particular, the one-month holding return should be high relative to the overnight rate and should increase sharply but at a

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[10] With the shorter sample period, we include monthly dummies in the VARs but do not include the macroeconomic variables.

[11] We also looked at the spread between rates on three-month commercial paper and Treasury bills, but did not find any robust relationship. With the three-month rates, we can use monthly data and extend the series back in time much further. In this case, the effect has a negative sign but is only statistically significant after four months, a much longer time lag than we would expect.

[12] Greenwood, Hanson, and Stein (2014) capture this money premium as the difference between actual short-term Treasury bill yields (with maturities from 1 to 26 weeks) and fitted yields, where the fitted yields are based on a flexible extrapolation of the Treasury yield curve from Gurkaynak, Sack, and Wright (2007), which is calibrated using only notes and bonds with remaining maturities greater than three months. They find that four-week bills have yields that are roughly 40 basis points below their fitted values; and for one-week bills, the spread is about 60 basis points.

decreasing rate as maturities grow and the securities become less money-like. Figure 5 illustrates this point. The figure presents the average realized one-month holding period return on a Treasury bill with n weeks to maturity in excess of the month-average one-week rate, calculated as follows:

$$xr_{t \to t+4}^{(n)} = \left(p_{t+4}^{(n-4)} - p_t^{(n)} \right) - r_{t-1 \to t+3}^{w}, \qquad (1)$$

where $p_t^{(n)}$ is the log price of a n-week Treasury bill, and $r_{t-1 \to t+3}^{w}$ is the average one-week bill rate over the month. The statistics are computed using weekly security-level data on Treasury prices from the FRBNY Price Quote System (PQS), and the holding period return is measured in annual percentage points. As would be implied by the money premium hypothesis, this holding return is indeed concave—increasing steeply at the very short end of the yield curve. To be clear on the interpretation of the figure, it implies that the ex post realized return to buying and holding a three-month bill for one month is 34 basis points greater than that on one-week bills; the corresponding differential for buying and holding six-month bills for one month is 54. Relative to the risks involved, these are extremely large return differentials, far too large to be accounted for by standard risk/return-based asset-pricing models.

To further explore if increases in the supply of Treasury bills lead to a decrease in the money premium of Treasury bills, we explore the relationship between the supply of Treasury bills and one-month holding excess returns at the front end of the yield curve. Specifically, we estimate the following regression:

$$xr_{t \to t+4}^{(n)} = \beta_0 + \beta_1 Bills/GDP_t + d_t + \varepsilon_{t \to t+4}, \qquad (2)$$

where $xr_{t \to t+4}^{(n)}$ is the one-month holding period excess return on a Treasury bill with n weeks to maturity as defined in equation (1) above, and d_t is a vector of monthly dummy variables. The results from these regressions are shown in table 3 and figure 6, and the uniformly negative coefficients on the bill-supply term suggest that an increase in Treasury bill issuance results in a decline in the money premium. Moreover, this effect is larger at the shorter horizons where the instrument is more money like. Both of these results are consistent with the money premium hypothesis.

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These results should also be interpreted with care, however, as there are a variety of caveats and confounding factors. An important confounding factor, for example, is that Treasury bill yields also reflect the variety of "special services" bills offer, which are importantly different from "money services." For example, a holder of a Treasury bill can use it as collateral in money market or clearing transactions. This "specialness" suggests that the Treasury bills and central bank liabilities or private STSI may be only imperfect, partial substitutes. Extrapolating from our empirical results based on the pre-crisis period is also complicated by ongoing changes in the regulatory and supervisory environment that will affect the demand and supply of STSI. For instance, the liquidity coverage ratio in Basel III bank regulatory rules may discourage the creation of private STSI by banks, the financial institutions found here to be the most responsive to changes in the supply of public STSI. Other regulatory changes, such as increased use of central clearing facilities and higher margin requirements for derivatives, will likely raise the demand for high-quality safe assets and may lead to an increase in private STSI (for example as part of collateral optimization and transformation services). Until the regulatory changes are fully implemented, attempts to quantify the effect of changes in public STSI on private STSI will be challenging, and gauging the effect of policy on the money premium will be accordingly uncertain.

3. Discussions with market participants

To help evaluate whether the empirical results reported above accurately reflect the current relationship between the supply of Treasury bills and demand for private substitutes, we talked to several major issuers of, and investors in, very short-term financial instruments. If issuers of private short-term debt are systematically able to raise funds more cheaply when the amount of Treasury bills outstanding is lower, it would seem likely that they would pay attention to the Treasury bill issuance calendar. Similarly, we were interested to see if investors in short-term debt reduce their demand for private debt in response to increased issuance of public debt.

Issuers

On the issuer side, we spoke with officials responsible for corporate funding at institutions that are major issuers of financial CP and certificates of deposit. Several of these issuers noted a change in liquidity risk management following the financial crisis that has resulted in a more

opportunistic approach to CP issuance. In particular, they had revised up sharply their assessment of the liquidity risks associated with CP, and regulatory changes have made CP less attractive. Consequently, they expected to use CP less as a consistent source of funding. They also suggested that empirical results based on pre-crisis correlations might no longer hold.

Overall, the officials unanimously indicated that they never consider the Treasury bill issuance calendar when deciding whether and when to issue CP and were generally skeptical of the hypothesis that greater Treasury bill issuance would lead to reduced issuance of private short-term debt. A number of them characterized their decision to issue as driven primarily by differentials between loan growth and deposit growth, although they also noted that opportunistic issuance can be rate-driven.

They did, however, point to some mechanisms through which Treasury bill supply could influence private CP issuance. In particular, these issuers indicated that they do react to investor interest, or lack thereof, in their paper. If investor demand were influenced by Treasury bill issuance, then CP issuance could be affected indirectly by Treasury bill supply. In addition, they noted that their issuance can be influenced by conditions in the repo market: If repo rates are high, CP issuance might be delayed because CP rates would also be high. Because heavy Treasury bill issuance, for example around the tax season, can drive up repo rates by increasing dealer inventory and thus financing needs, opportunistic CP issuance in such circumstances would result in a negative correlation between Treasury bills and financial CP. At a longer frequency, they noted that when the economy is growing briskly, financial CP picks up because loan growth outstrips deposit growth, while Treasury bill issuance may fall off because tax receipts go up and nondiscretionary expenditures fall.

Investors

On the investor side, we spoke to important players in money markets. They noted that the demand for Treasury securities and high-quality assets in general continued to be very strong, and that they expected such demand to persist and possibly even increase as a result of various ongoing regulatory changes (for example, money market fund reform, Basel III liquidity rules). They agreed that there was potentially some substitutability between public and private instruments. They added, however, that it might take an implausibly large change in yields to

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induce shifts in demand of economically meaningful magnitudes. For instance, in their view, an investor would always choose to invest in private STSI because it has a higher risk-adjusted yield, but an investor might also hold some Treasury bills to satisfy liquidity demands that cannot be met by private STSI. In that case, investors might increase or decrease the share of Treasury bills somewhat in response to relative yields but not by a large amount.

4. Policy options

To the extent that there is a durable tendency for the money premium on STSI to increase (and yields to decline) when the demand for STSI rises, a central bank might decide to intervene by increasing the supply of STSI (and thus affect the money premium indirectly) to reduce the incentive for the shadow banking system to create such instruments and thus improve financial stability. This consideration may be especially relevant as the demand for STSI is anticipated to increase in the future as a result of a number of regulatory changes as mentioned above.

Maintain a large balance sheet, with either a floor or a corridor system

One policy that a central bank could implement, and that would permanently boost the supply of public STSI, would be to maintain a large balance sheet financed with central bank liabilities that are, in turn, safe and liquid assets for financial institutions. To execute such a policy, the central bank could conduct its monetary policy using a floor system with large holdings of less-liquid or longer-term assets financed by correspondingly large amounts of reserve balances. While reserve balances can only be held by depository institutions, the reserve balances might, in principle, satiate the demand of depository institutions for liquid assets, who should, in turn, sell their other liquid assets, such as Treasury securities, to non-depository financial institutions.[13] Because the total supply of STSI would go up, the STSI premium should fall.[14]

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[13] A central bank could also facilitate the transfer of increased liquidity benefits of elevated reserve balances to the nonbank sector by creating segregated cash accounts as described in Kirk, McAndrews, Sastry, and Weed (2014). The accounts would enable banks to offer customers deposits that were completely collateralized by reserve balances and that are therefore completely safe. Such accounts would be a form of public STSI that could, in principle, displace private STSI.

[14] For example, the assets held by the Federal Reserve could simply be longer-term Treasury and agency securities. If the Federal Reserve further wished to maximize not only the public supply of safe short-term assets, but of safe assets more generally, it could hold as the primary asset on its balance sheet Term Auction Facility (TAF) loans rather than government securities. Banks would pledge illiquid assets to the discount window, so TAF lending would increase the availability of liquid assets for the financial system. However, this policy addresses a somewhat different set of issues—namely the total supply of available safe assets, rather than the supply of STSI specifically.

Alternatively, the central bank could boost the supply of STSI while still operating monetary policy using a corridor, rather than a floor, framework. For example, the central bank could finance its large asset holdings with the relatively small amount of reserve balances (consistent with maintaining its policy tool in the middle of the corridor) while at the same time engaging in large volumes of reverse repurchase agreements with nonbank counterparties. Reverse repurchase agreements with the central bank would be a very safe and attractive investment that could be held directly by cash managers and money market mutual funds, boosting the supply of STSI. This approach could also help if higher leverage ratio requirements lead dealer firms to engage in a smaller quantity of repo against Treasury securities, which would deprive money funds of a favored short-term investment. Reverse repurchase agreements with the central bank could essentially fill in this demand.

In this regard, the preliminary evidence from the ongoing testing of the Federal Reserve's overnight full allotment reverse repurchase agreement (ON RRP) facility is especially interesting. Figure 7 shows that there is a negative correlation between Treasury bill supply and the ON RRP take-up. For example, the figure shows that ON RRP take-up increased significantly around the April 15 tax date, when bill issuance, and hence bills outstanding, was down. This finding suggests that reverse repo agreements with a central bank are very similar to Treasury bills as a form of public supply of STSI and can help meet the demand for STSI and lower the incentives to issue private STSI. It is important to note, however, that increases in reverse repurchase agreements at the central bank reduce reserve balances by an equal amount when central bank assets are unchanged and so do not increase the total supply of STSI. However, the marginal effect of the increases in the reverse repurchase agreements may be higher because of their ability to reach nonbank counterparties who may be more responsive to changes in the money premium compared with banks whose demand for STSI may already be satiated. This is consistent with the evidence that reverse repurchase agreements conducted as part of the ongoing exercises by the Federal Reserve seem to have lessened the relationship between the supply of Treasury collateral and short-term rates.

Twist operations

Finally, a central bank could sell short-term Treasury securities and buy longer-term Treasury securities (a so-called twist operation), which would increase the public supply of short-term

Treasury securities, which are more STSI-like than long-term Treasury securities. Any such operation could only continue as long as the central bank had shorter-term securities to sell. Therefore, it could only respond to transitory increases in the money premium. The Federal Reserve's sales of shorter-term securities during the Maturity Extension Program (MEP) provide an example of this type of approach and one that contributed to noticeably higher repo rates. [15]

5. Conclusion

Our analysis provides some suggestive evidence in support of the hypothesis that increasing the supply of public STSI reduces the attractiveness of private STSI, and thus potentially helps improve the stability of the financial system. For example, the regression results support the notion that private and public STSI are substitutes, so that greater provision of STSI by a central bank, for example through reverse repurchase agreements, could meet the demand for STSI and help crowd out creation of private STSI. Nevertheless, as we note, the precise extent to which an increase in public STSI would crowd out private STSI remains uncertain. Given this uncertainty and the potential benefits of public money creation, additional research regarding the money premium, its dynamics and relationship with monetary policy, and the operations of the central bank is warranted.

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[15] It is unclear if the elevated repo rates were the direct result of increased supply of STSI or other factors. For example, market participants attributed the higher rates to the primary dealers' inventory of securities expanding to higher-than-desired levels as a result of the MEP. While dealers tended to buy the securities the Federal Reserve was selling and then later find a buyer, the dealers needed to finance the increased holdings of securities in funding markets.

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Table 1: Levels regression, monthly frequency: Private debt/GDP on Treasury bills/GDP

	(1) All financial CP	(2) All nonfinancial CP	(3) Total time deposits	(4) Financial CP	(5) ABCP	(6) MMF Assets – Treasury securities
Treasury bills/GDP	-0.306***	-0.127***	-0.465***	-0.371***	-0.196	-0.130
	(0.0434)	(0.0260)	(0.0526)	(0.0557)	(0.109)	(0.178)
Constant	44.40***	17.28***	102.0***	76.51***	76.50***	65.12***
	(3.576)	(2.226)	(5.257)	(4.437)	(9.107)	(17.64)
Observations	368	368	374	78	78	150
R^2	0.996	0.972	0.972	0.932	0.928	0.976

Table 2: Levels regression, monthly frequency: Private debt/GDP on *lagged* Treasury bills/GDP

	(1) All financial CP	(2) All nonfinancial CP	(3) Total time deposits	(4) Financial CP	(5) ABCP	(6) MMF Assets – Treasury securities
Treasury bill/GDP (lag)	0.239	-0.312***	-0.136***	-0.464***	-0.360***	-0.252* -
	(0.0432)	(0.0265)	(0.0501)	(0.0645)	(0.118)	(0.184)
Constant	45.34***	18.24***	102.2***	76.10***	81.31***	76.06***
	(3.661)	(2.287)	(5.044)	(5.248)	(9.925)	(18.40)
Observations	368	368	373	78	78	150
R^2	0.996	0.973	0.974	0.923	0.930	0.976

Note: Each column represents a different left-hand-side variable corresponding to a different definition of private debt. All financial CP is the sum of financial CP and ABCP. The sample period is 1976 to 2007 for columns 1 and 2, 1975 to 2006 for column 3, 2001 to 2007 for columns 4 and 5, and 1995 to 2007 for column 6. All of the regressions include month and year fixed effects. Standard errors are in parenthesis. * $p<0.05$,** $p<0.01$,*** $p<0.001$.

Table 3: Levels regression, monthly frequency: Liabilities of large domestic banks to GDP on *Lagged* Treasury bills/GDP

	(1) Large time deposits	(2) All liabilities
Treasury bills/GDP (lag)	-0.032* (0.014)	0.075 (0.069)
Constant	-18167 (13903)	-57270 (147085.2)
Observations	258	258
R^2	0.997	0.989

Note: The sample period is 1986 to 2007. All of the regressions include month and year fixed effects. Estimation also adjusts for first-order autocorrelation. Standard errors are in parenthesis. * $p<0.05$, ** $p<.01$.

Table 4: Supply of Treasury bills and the money premium

Panel A: Sample January 1988–September 2012

	4-week	5-week	6-week	10-week	13-week
β_1	-0.014	-0.023	-0.029	-0.035	-0.035
t-stat	-1.235	-1.720	-2.048	-2.027	-1.674
$H_0 : \beta_1 \geq 0$					
p-value	0.109	0.043	0.020	0.021	0.047

Panel B: Sample January 1988–December 2007

	4-week	5-week	6-week	10-week	13-week
β_1	-0.051	-0.046	-0.047	-0.038	-0.041
t-stat	-1.812	-1.485	-1.456	-0.959	-0.872
$H_0 : \beta_1 \geq 0$					
p-value	0.035	0.069	0.073	0.169	0.192

Note: This table presents the estimated coefficient on Treasury bills along its t-statistic obtained from a regression of the one-month holding period excess return on a Treasury bill with n weeks to maturity on the supply of Treasury bills as a share of GDP. The t-statistics are computed using Hodrick GMM correction for overlapping observations. The holding period return is measured in annual percentage points using weekly observations, and the Treasury bills-to-GDP is measured in percentage points. The holding period return is computed using security-level data on Treasury prices from the FRBNY Price Quote System (PQS).
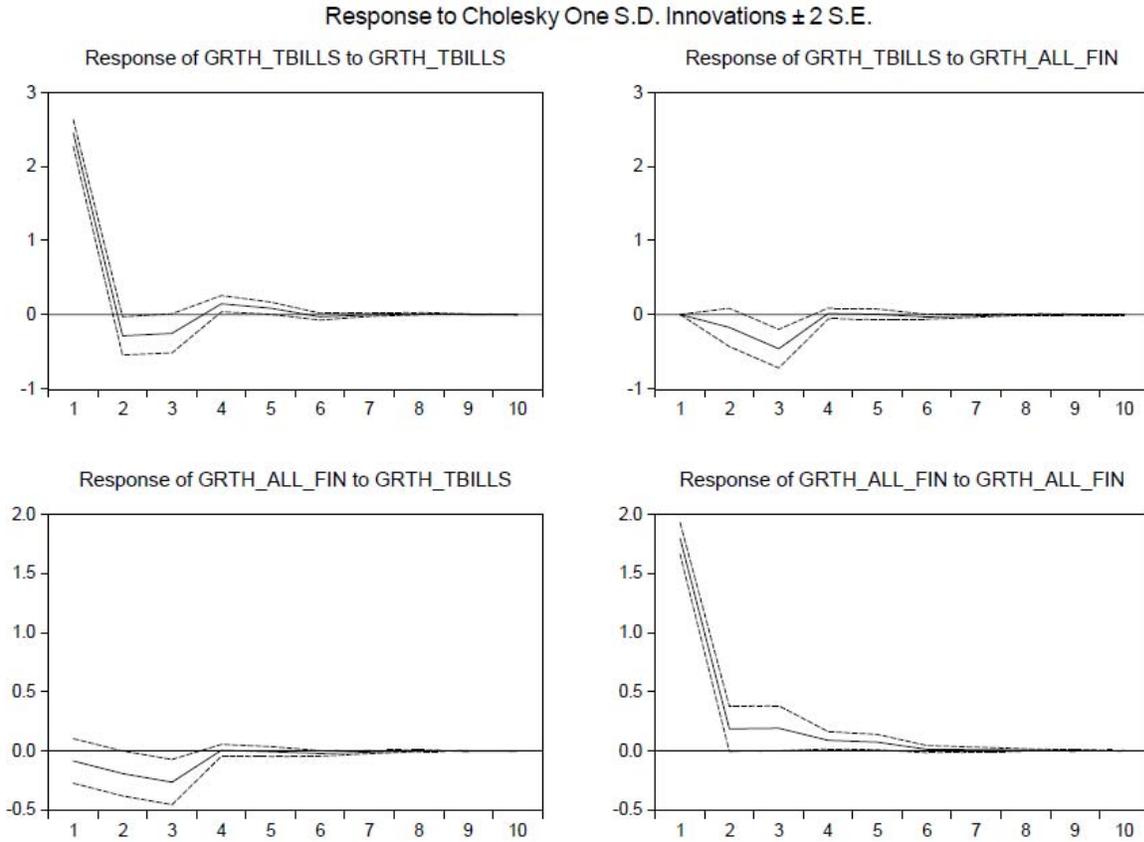
Figure 1: Growth of Treasury bills and of all financial CP
(No controls)
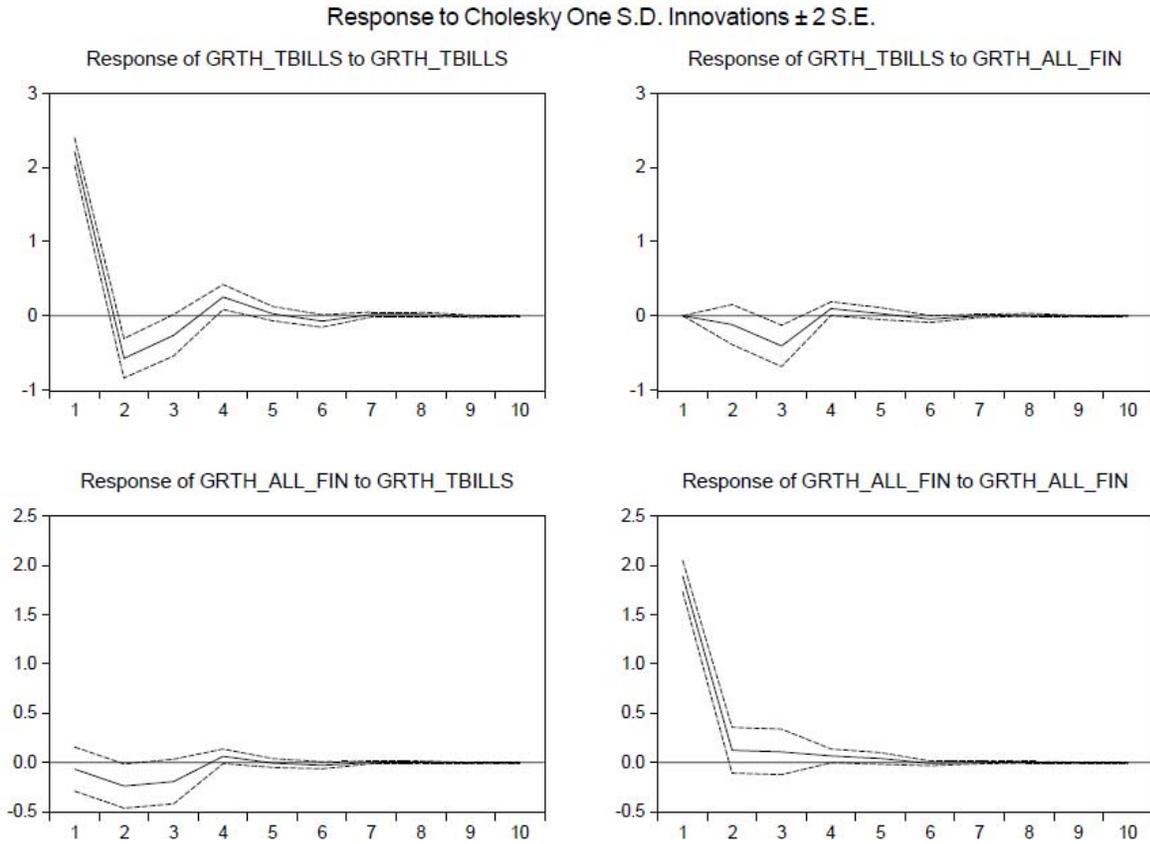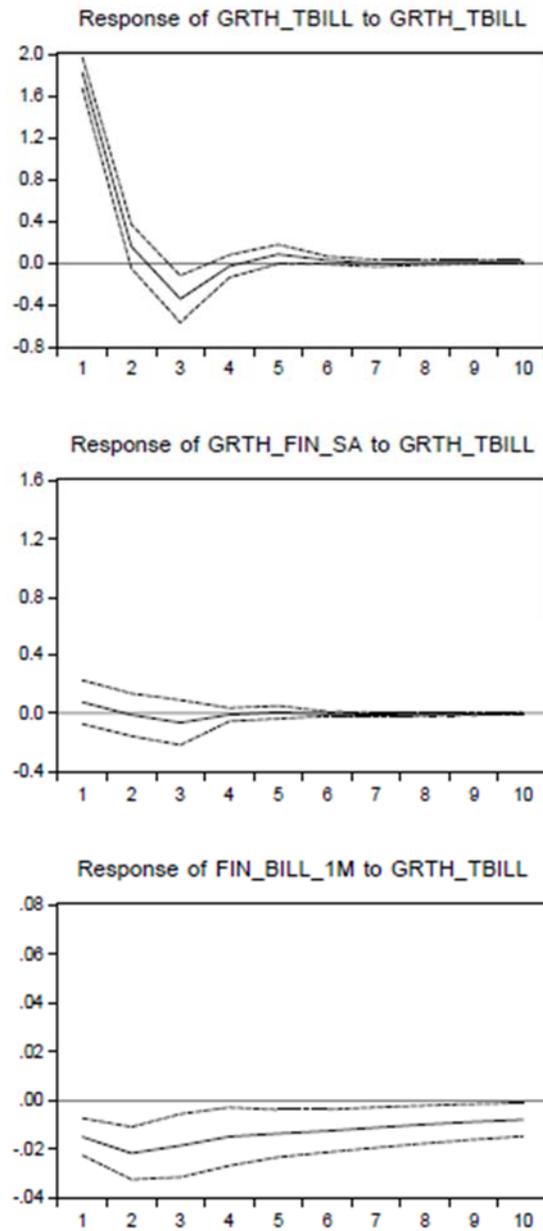
Response to Cholesky One S.D. Innovations ± 2 S.E.
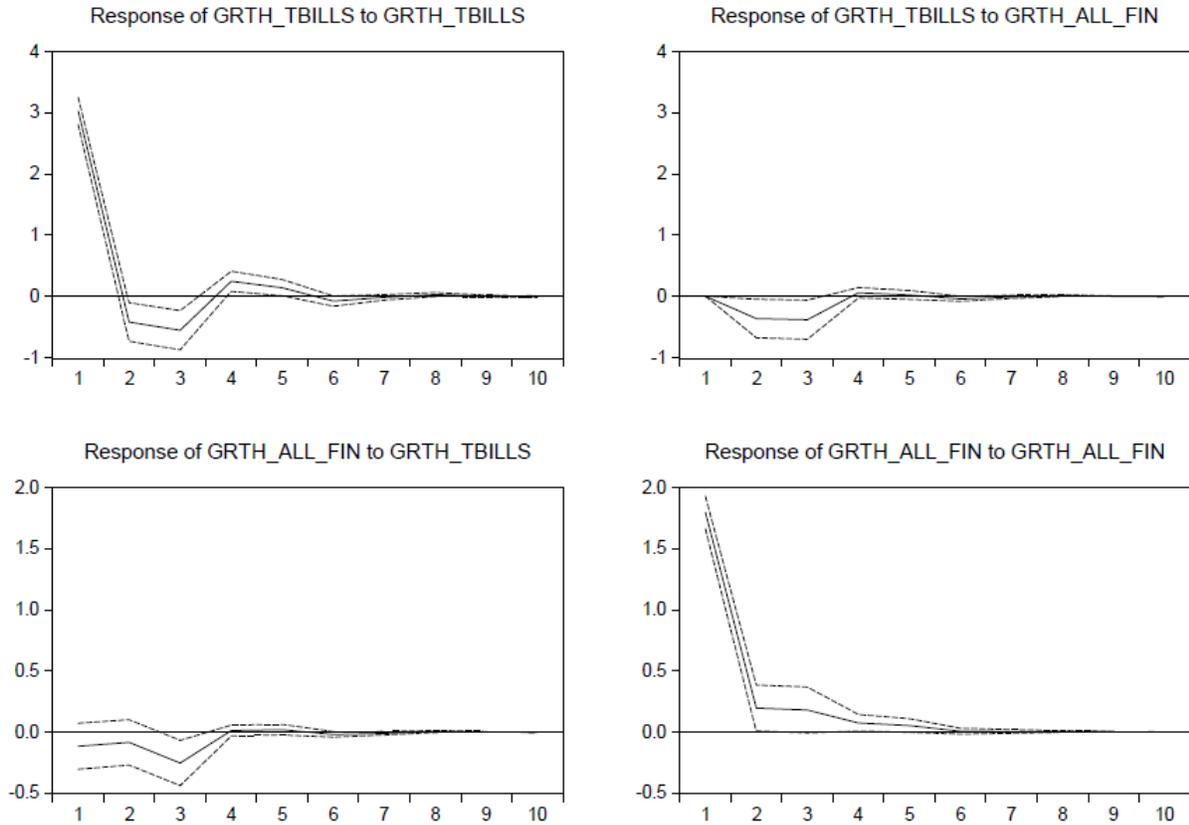
Note: This figure presents the impulse-response function obtainded from a VAR of the growth of Treasury bills and the growth of all financial commercial paper (CP). The top (bottom) panels display the response of the growth of Treasury bills outstanding (growth of all financial CP) to a one-standard-deviation shock to each of the VAR endogenous variables. The dotted lines are 95 percent confidence bands. The VAR is estimated using monthy data for the period of 1976 to 2007.

Figure 2: Growth of Treasury bills and all financial CP
(Includes only month dummies)

Response to Cholesky One S.D. Innovations ± 2 S.E.

Note: This figure presents the impulse-response function obtained from a VAR of the growth of Treasury bills and the growth of all financial commercial paper (CP). The VAR includes month dummies. The top (bottom) panels display the response of the growth of Treasury bills outstanding (growth of all financial CP) to a one-standard-deviation shock to each of the VAR endogenous variables. The dotted lines are 95 percent confidence bands. The VAR is estimated using monthy data for the period of 1976 to 2007.

Figure 3: Growth of Treasury bills and all financial CP
(Includes month dummies and macro factors—unemployment, IP growth, and inflation)

Response to Cholesky One S.D. Innovations ± 2 S.E.

Note: This figure presents the impulse-response function obtained from a VAR of the growth of Treasury bills and the growth of all financial commercial paper (CP). The VAR includes the unempleyment rate, the growth of industrial production, and personal consumption expenditures infaltion alongside month dummies as exogenous controls. The top (bottom) panels display the response of the growth of Treasury bills outstanding (growth of all financial CP) to a one-standard-deviation shock to each of the VAR endogenous variables. The dotted lines are 95 percent confidence bands. The VAR is estimated using monthy data for the period of 1976 to 2007.

**Figure 4: Growth of Treasury bills and interest rate spreads
(Includes month dummies)**

Response of GRTH_TBILL to GRTH_TBILL

Response of GRTH_FIN_SA to GRTH_TBILL

Response of FIN_BILL_1M to GRTH_TBILL

Note: This figure presents the impulse-response function obtained from a VAR of the growth of Treasury bills, the growth of all financial commercial paper (CP), and the spread between rates on 30-day financial commercial paper and on the 4-week Treasury bill. The VAR includes month dummies as exogenous controls. Each panel displays the response of each variable in the VAR to a one-standard-deviation shock to the growth of Treasury bills outstanding. The dotted lines are 95 percent confidence bands. The VAR is estimated using weekly data from October 2001 through June 2007.

Figure 5: Average excess one-month holding period return to buying Treasury bills
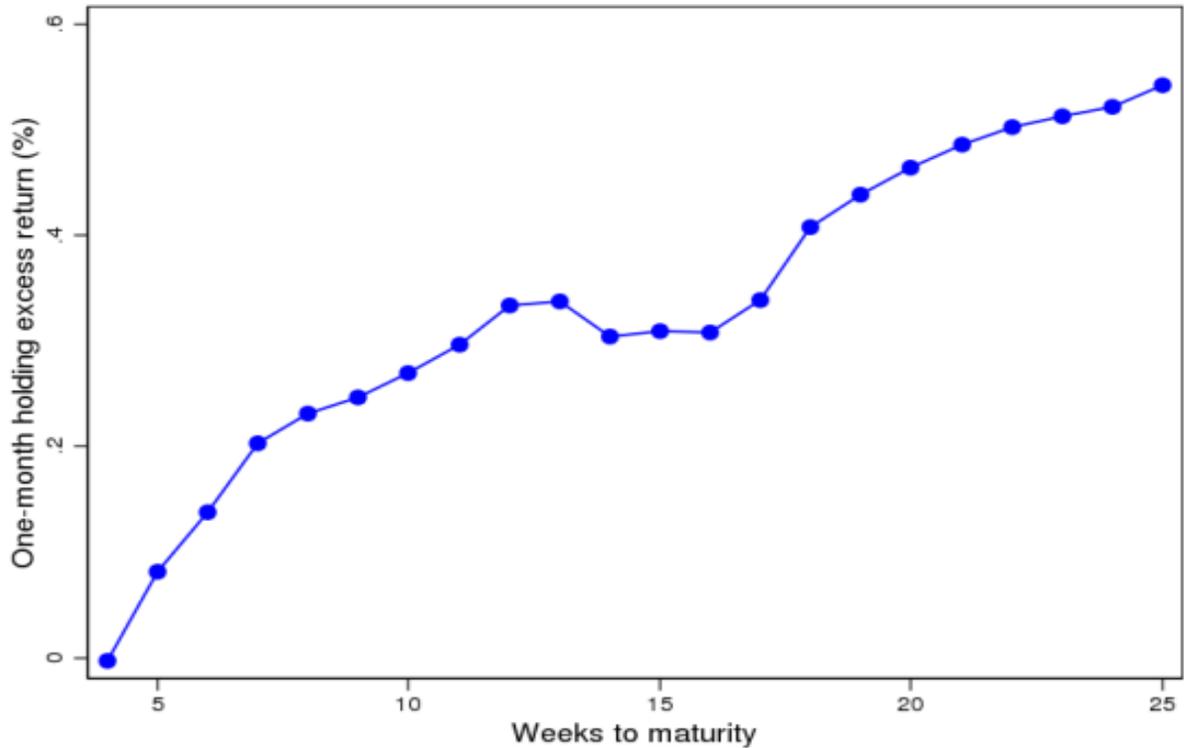

January 1988–December 2007

Note: This figure presents the average one-month holding period return on a Treasury bill with *n* weeks to maturity in excess of the one-week rate, as defined in equation (1). The statistics are computed using weekly observations. The holding period return is measured in annual percentage points, and it is computed using security-level data on Treasury prices from the FRBNY Price Quote System (PQS).

Figure 6: Supply of Treasury bills and the money premium
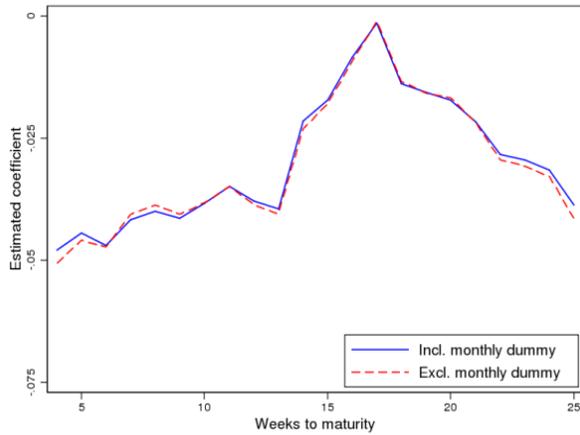
(a) Treasury bill supply coefficient

Jan 1998 – Dec 2007
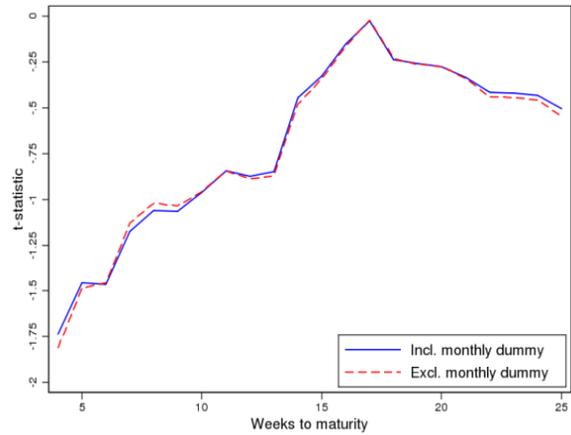
(b) *t*-statistic

Jan 1988 – Dec 2007

Note: The left column displays the estimated coefficient on Treasury bills as a share of GDP and the right column displays its *t*-statistic obtained from a regression of the one-month holding period excess return on a Treasury bill on the supply of Treasury bills as a share of GDP. The results are reported with and without monthly dummy variables as controls. The *t*-statistics are computed using Hodrick GMM correction for overlapping observations. The holding period return is measured in annual percentage points, and the Treasury bills-to-GDP is measured in percentage points. The coefficients are computed using weekly observations. The holding period return is computed using security-level data on Treasury prices from the FRBNY Price Quote System (PQS).

Figure 7: Change in the supply of Treasury bills and the ON RRP take-up
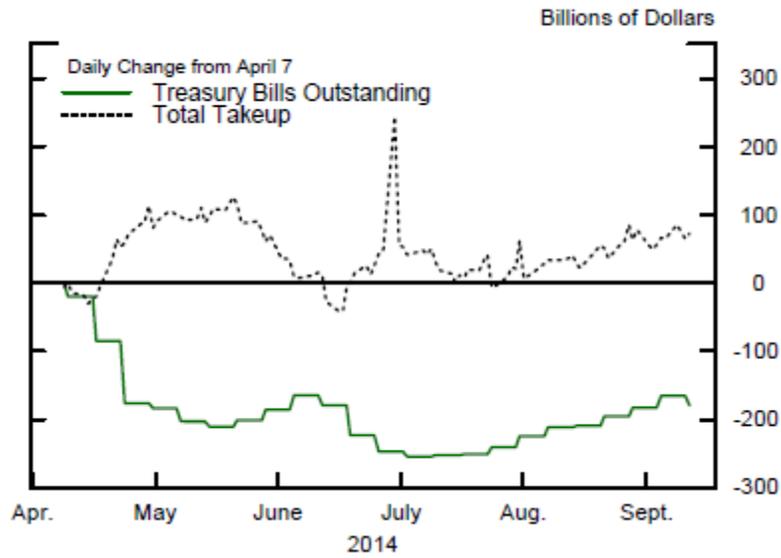
Note: This figure depicts the Treasury bills outstanding (solid line) and the Federal Reserve's overnight full allotment reverse repurchase agreement (ON RRP) take-up.