GOVERNMENT DEBT MANAGEMENT AT THE ZERO LOWER BOUND

Robin Greenwood, George Gund Professor of Finance and Banking, Harvard Business School
Samuel G. Hanson, Assistant Professor, Finance Unit, Harvard Business School
Joshua S. Rudolph, Master in Public Policy, Harvard Kennedy School of Government
Lawrence H. Summers, Charles W. Eliot University Professor, Harvard University

ABSTRACT

This paper re-examines government debt management policy in light of the U.S. experience with extraordinary fiscal and monetary policies since 2008. We first document that the Treasury's decision to lengthen the average maturity of the debt has partially offset the Federal Reserve's attempts to reduce the supply of long-term bonds held by private investors through its policy of quantitative easing. We then examine the appropriate debt management policy for the consolidated government. We argue that traditional considerations favoring longer-term debt may be overstated, and suggest that there are several advantages to issuing greater quantities of short-term debt. Under current institutional arrangements, neither the Federal Reserve nor the Treasury is caused to view debt management policy on the basis of the overall national interest. We suggest revised institutional arrangements to promote greater cooperation between the Treasury and the Federal Reserve in setting debt management policy. This is particularly important when conventional monetary policy becomes constrained by the zero lower bound, leaving debt management as one of the few policy levers to support aggregate demand.

INTRODUCTION

At least since the 1980s, the domains of U.S. monetary policy, fiscal and debt management policy, and the prudential regulation of financial intermediaries have been separate and distinct. Fiscal authorities chose the level of the budget deficit and decided in what maturity and form federal debt would be issued. Monetary authorities determined the level of short-term interest rates with a view toward economic stabilization. And supervisory authorities regulated the capital and liquidity of banks and other financial intermediaries.

With the onset of the financial crisis in 2007 and 2008 and the subsequent easing of monetary policy, the clean lines between these domains have blurred. With short-term interest rates at the zero lower bound, conventional monetary policies have lost their impact. As a result, the Federal Reserve has resorted to quantitative easing (QE) policies to support aggregate demand. Because QE works by shortening the maturity structure of debt instruments that private investors have to hold, the Fed has effectively entered the domain of debt management policy.[1] And with the decision to pay interest on central bank reserves, the nearly $3 trillion of reserves on bank balance sheets have become the functional equivalent of Treasury bills not reflected in Treasury debt statistics. At the same time, the Treasury has been extending the average maturity of the debt to mitigate fiscal risks associated with the government's growing debt burden. The Treasury's actions have operated as a kind of reverse quantitative easing, replacing money-like short-term debt with longer-term debt.

This blurring of functions—and the observation that Federal Reserve and Treasury policies with regard to U.S. government debt have been pushing in opposite directions—suggests the need to reconsider the principles underlying government debt management policy. Building on recent work by Greenwood, Hanson, and Stein (2014), hereafter referred to as GHS, Rudolph (2014), and Summers's efforts as a policymaker, this paper undertakes such a reconsideration. We address desirable policy on a consolidated government basis as well as the appropriate institutional arrangements needed to support it. We conclude that substantial changes in current practice are appropriate. We present our argument in 5 sections.

Section I documents the extent to which monetary and fiscal policies have been pushing in opposite directions in recent years. We show that, despite successive rounds of QE, the stock of government debt with a maturity over 5 years that is held by the public (excluding the Fed's holdings) has risen from 8 percent of GDP at the end of 2007 to 15 percent at the middle of 2014. Said differently, the volume of 10-year duration equivalent debt has *doubled* from 13

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[1] Discussing the Fed's large-scale asset purchases, Yellen (2011) states that, "central bank purchases of longer-term securities work through a portfolio balance channel to depress term premiums and longer-term interest rates.". Similarly, Bernanke (2012) has argued that "changes in the supplies of various assets available to private investors may affect the prices and yields of those assets. … Declining yields and rising asset prices ease overall financial conditions and stimulate economic activity."

percent of GDP to 26 percent of GDP over the same interval. Pressure to absorb long-term government debt has actually increased rather than decreased over the last six years!

We find that between two-thirds and three-quarters of the increased supply of longer-term Treasuries is explained by the dramatic growth in outstanding debt due to the large deficits associated with the Great Recession. The remaining one-quarter to one-third is due to the Treasury's active policy of extending the average maturity of the debt.

In discussions of its QE policies, the Federal Reserve has focused purely on the effects that its bond purchases were expected to have on long-term interest rates and, by extension, the economy more broadly. However, in doing so, it completely ignored any possible impact on government fiscal risk, even though the Federal Reserve's profits and losses are remitted to the Treasury. Conversely, Treasury's debt management announcements and the advice of the Treasury Borrowing Advisory Committee (TBAC) have focused on the assumed benefits of extending the average debt maturity from a fiscal risk perspective, and largely ignored the impact of policy changes on long-term yields. To the extent that the Federal Reserve and Treasury ever publicly mention the other institution's mandate, it is usually in the context of avoiding the perception that one institution might be helping the other achieve an objective. Specifically, the Fed does not want to be seen as monetizing deficits, while the Treasury has been reluctant to acknowledge the Fed as anything more than a large investor.

Section II places the current tension between Federal Reserve-led debt management and Treasury-led debt management in historical perspective. Before 2008, changes in Federal Reserve holdings of long-term bonds had only a tiny impact on the amount of long-term Treasury debt held by the public (i.e., Fed policy had little direct impact on the consolidated debt management strategy of the U.S. government). However, we describe a few historical examples in which the Federal Reserve and the Treasury agreed to coordinate policy for the purpose of achieving a common set of objectives with regard to debt management. Thus, history suggests that greater cooperation on debt management is certainly possible.

Section III considers the appropriate debt management policy on a consolidated government basis. Drawing on the work of GHS, we argue that optimal debt management policy balances a number of considerations. First, debt managers attempt to achieve a low cost of financing for taxpayers over time. For instance, the public benefits when debt is issued in forms that investors are eager to hold and, therefore, carries a lower equilibrium yield. As a number of authors have suggested, short-term Treasury bills have many of the same valuable properties as traditional money and therefore command a liquidity premium. As a result, short-term debt may be a 'cheaper' form of financing than long-term debt. Second, it is desirable for the government to reduce the risks associated with government financing. Issuing longer-term debt may help insulate future taxes and spending from fluctuations in interest rates, while also guarding against the possibility, albeit remote, of a self-fulfilling debt rollover crisis. Third, to the extent that changes in the maturity structure of the debt influence long-term interest rates and other asset

prices, reductions in the average debt maturity are likely to have an expansionary impact on the economy—a consideration that looms large when monetary policy becomes constrained by the zero lower bound. Fourth, changes in the supply of short-term, money-like government debt may impact the amount of "liquidity transformation" pursued by private financial firms which, in turn, has potential ramifications for financial stability.

Our evaluation of these issues suggests that, on average, the case for shorter-term debt is stronger and the case for maturity extension is weaker than generally supposed. We develop arguments that: (1) issuing more shorter-term debt the government can generate substantial savings over time; (2) shortening the average maturity would only modestly increase fluctuations in the fiscal deficit and the gains from reducing the volatility of these fluctuations are arguably small; (3) at the zero lower bound, any reduction in term premia due to a shorter average debt maturity may have an important stimulative impact on aggregate demand; and (4) an increased supply of short-term government debt is likely to enhance financial stability by counteracting the financial system's tendency toward excessive liquidity transformation. To illustrate point (2), we perform a counterfactual exercise in which we compute the path of the debt and deficits since 1952 had the Treasury financed its spending entirely using 3-month T-bills.

We further show how the forces listed above vary over time. This implies that the optimal maturity structure of the debt is not constant. For instance, we note that many of the forces that typically favor a shorter term maturity structure are currently weak.

Section IV briefly applies the framework to issues in debt management policy beyond maturity structure, including the appropriate mix between inflation-indexed and nominal debt.

Section V proposes an alternative institutional framework which we believe should promote greater cooperation between the Treasury and the Federal Reserve in setting debt management policy. Adopting our tradeoff perspective, we describe the settings in which, under current institutional arrangements, the Treasury may come into conflict with the Federal Reserve. While the potential for conflict is greatest when interest rates are at the zero lower bound, we suggest that a lack of coordination leads to suboptimal policy during ordinary times as well, although the costs are not as great because the Fed can offset debt management decisions using the short-term interest rate. During normal times, conflict can arise because there are only two policy instruments—the short rate and debt management—with at least four policy objectives. These conflicts are exacerbated when interest rates become constrained by the zero lower bound. We suggest how improved policy coordination could reduce these conflicts. At the zero lower bound, a fully coordinated policy—such as the Treasury and the Fed already pursue with respect to currency intervention—should be the norm.

I. FED VERSUS TREASURY: 2008–2014

Starting in 2008, U.S. monetary policy and debt management dramatically changed course in response to the unfolding financial and economic crisis, pulling the government balance sheet in opposite directions.

Table 1 shows a stylized depiction of the major financial assets and liabilities of the U.S. government in December 2007 and July 2014. The size of the Federal Reserve's balance sheet has grown fivefold over this period due to its purchases of $1.8 trillion of long-term Treasuries and $1.8 trillion of mortgage-backed securities (MBS) and Agency securities, financed by an increase in interest-bearing reserves.[2,3] The duration of the Federal Reserve's portfolio of Treasury securities increased from 3.3 years to 7.8 years.[4] At the same time, Treasury debt outstanding rose from 31 percent of GDP in 2007 to 70 percent of GDP in 2014. The duration of the outstanding Treasury debt increased from 3.9 years to 4.6 years. On a consolidated basis, however, the duration of the U.S. government's liabilities has moved very little, from 4.0 years to 2.9 years, as Table 1 shows.

This section isolates the policy-driven component of these changes, and assesses the net impact of these policies by converting them into common and economically meaningful units of interest rate risk. We start with the Federal Reserve's balance sheet, summarized in Panel A of Table 2 at year-end dates beginning in December 2007. The vast majority of the securities held by the Federal Reserve System are held in the System Open Market Account (SOMA). In December 2007, securities held in the SOMA had a face value of $750 billion. These securities were comprised of mostly Treasury bills, notes and bonds, with an average duration of 3.3 years, similar to the duration of outstanding Treasury debt. After falling in 2008, by December 2009 the face value of all securities in the SOMA had reached $1,839 billion, including $771 billion of Treasury securities, $160 billion of debt issued by Fannie Mae and Freddie Mac (the GSEs), and $908 billion of MBS guaranteed by the GSEs and Government National Mortgage Association (GNMA). By July 2014, the securities held by the SOMA had doubled again, reaching $4,121 billion (58 percent in U.S. Treasuries, 41 percent in MBS, 1 percent GSE debt). Thus, the total increase from 2007 was $3,371 billion, or 19.4 percent of 2014 GDP.

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[2] The initial surge in the Fed's balance sheet occurred after Lehman Brothers' failure in September 2008 and was due to lending to private intermediaries and firms under various liquidity facilities. Since early 2009, Fed balance sheet growth has been due to large-scale asset purchases (LSAPs), often referred to as quantitative easing (QE).

[3] Historically, the Fed did not pay interest on reserves, and instead controlled short-term nominal interest rates by varying the supply of reserves to target a desired level for the rate on overnight loans between banks (the Federal funds rate). However, central banks in many other countries control short-term rates by paying interest on reserves. The Fed obtained the authority to pay interest on reserves under the Emergency Economic Stabilization Act of 2008.

[4] Duration is the weighted average time to receipt of the cash flows on a bond. Duration captures the sensitivity of a bond's price to its yield and is an indicator of how much interest rate risk is being borne by a bondholder.

Table 1
Consolidated U.S. Government Balance Sheet: 2007 versus 2014

Table 1 shows a stylized depiction of the major financial assets and liabilities of the U.S. Treasury and Federal Reserve in December 2007 and September 2014. *FV* denotes face value of the claim in trillions of U.S. dollars, and *Dur* denotes the Macaulay duration in years, as estimated by the authors based on the July 2014 yield curve. Consolidation nets out the Treasury debt that is held by the Federal Reserve. The table is based on the authors' calculations using data from the Treasury's Monthly Statement of the Public Debt, the Federal Reserve System's H.4.1 Release (Factors Affecting Reserve Balances), and the Federal Reserve Bank of New York's System Open Market Account Holdings release.

	Assets					Liabilities			
	December 2007		July 2014			December 2007		July 2014	
	FV ($tr)	*Dur* (yrs)	*FV* ($tr)	*Dur* (yrs)		*FV* ($tr)	*Dur* (yrs)	*FV* ($tr)	*Dur* (yrs)
Federal Reserve									
Treasury Debt	$0.7	*3.3*	$2.5	*7.8*	Currency	$0.8	*N/A*	$1.2	*N/A*
MBS + Agency Debt	$0.0	*N/A*	$1.8	*5.6*	Reserves	$0.01	*0.0*	$2.7	*0.0*
Other	$0.1	*N/A*	$0.1	*N/A*	Other	$0.1	*0.0*	$0.4	*0.0*
Treasury									
Taxing Power	N/A	*N/A*	N/A	*N/A*	Treasury Debt	$4.5	*3.9*	$12.2	*4.6*
Consolidated Balance Sheet									
					Treasury Debt	$3.8	*4.1*	$9.6	*3.8*
Taxing Power	N/A	*N/A*	N/A	*N/A*	Currency	$0.8	*N/A*	$1.2	*N/A*
MBS + Agency Debt	$0.0	*N/A*	$1.8	*5.6*	Reserves	$0.01	*0.0*	$2.7	*0.0*
Other	$0.1	*N/A*	$0.1	*N/A*	Other	$0.1	*0.0*	$0.4	*0.0*
Total	**$0.1**	***N/A***	**$1.9**	***N/A***	**Total**	**$4.6**	***4.0***	**$14.0**	***2.9***

Table 2

Quantitative Easing and Treasury Maturity Extension: 10-Year Duration Equivalents

Panel A describes the impact of QE programs on the Federal Reserve balance sheet, at year-end dates beginning in December 2007. SOMA refers to the System Open Market Account. Between 2003 and 2007, the SOMA was an average of 95% of currency in circulation. We define QE Impact to be SOMA minus 0.95×currency in circulation. To convert into 10-year duration equivalents, we multiply face values by the ratio of portfolio duration (denoted by *Dur*) to the duration of a 10-year bond (8.9 years). Duration is computed based on the July 2014 yield curve. Panel B describes the impact of U.S. Treasury's expansion and maturity extension of the public debt. We convert Treasuries outstanding into 10-year equivalents. We further break down the cumulative change in 10-year duration equivalents between December 2007 and July 2014 (estimated) into two components: the expansion of the debt and the maturity extension according to:

$$\Delta\left(\frac{Debt_t \cdot Dur_t}{Dur_t^{10-yr}}\right) = \left(\frac{1}{Dur_t^{10-yr}}\right) \cdot \left(\underbrace{\Delta Debt_t Dur_{t-1}}_{\text{Debt Expansion}} + \underbrace{\Delta Dur_t Debt_t}_{\text{Maturity Extension}}\right)$$

Duration of Federal Reserve Holdings and outstanding Treasury debt are computed by the authors as described in the text. The table is based on the authors' calculations using data from the Federal Reserve System's H.4.1 release (Factors Affecting Reserve Balances) and the Treasury's Monthly Statement of Public Debt. GDP is from the Bureau of Economic Analysis.

	Panel A: Impact of Quantitative Easing							Panel B: Impact of Expansion of Debt and Treasury Maturity Extension					
	Fed Holdings				10-Year Equivalents			Debt Outstanding		10-Year Equivalents			
	SOMA ($bn)	Currency x 0.95	QE ($bn)	*Dur* (yrs)	SOMA ($bn)	QE ($bn)	**QE % GDP**	Debt ($bn)	*Dur* (yrs)	Total ($bn)	**Cum Δ %GDP**	**Debt expand % GDP**	**Mat Extend % GDP**
12/2007	750	784	0	3.3	279	0	**0.0%**	4,537	3.9	2,005	**0.0%**	**0.0%**	**0.0%**
12/2008	490	844	0	5.4	299	0	**0.0%**	5,798	3.5	2,287	**1.9%**	**3.8%**	**-1.9%**
12/2009	1,839	883	956	5.4	1,119	744	**5.4%**	7,272	3.9	3,189	**8.1%**	**8.3%**	**-0.2%**
12/2010	2,150	934	1,215	5.3	1,288	941	**6.2%**	8,863	4.1	4,101	**13.8%**	**12.6%**	**1.2%**
12/2011	2,604	1,020	1,584	5.6	1,655	1,276	**8.1%**	9,937	4.3	4,817	**17.7%**	**15.1%**	**2.7%**
12/2012	2,649	1,105	1,544	7.2	2,144	1,733	**10.6%**	11,053	4.5	5,535	**21.5%**	**17.6%**	**4.0%**
12/2013	3,743	1,178	2,564	7.0	2,938	2,500	**14.6%**	11,869	4.5	6,066	**23.8%**	**19.0%**	**4.8%**
7/2014	4,121	1,220	2,901	6.8	3,172	2,718	**15.6%**	12,163	4.6	6,339	**24.9%**	**19.4%**	**5.5%**

To estimate the impact of QE—as opposed to the normal growth in the size of the Fed's balance sheet due to the growth in the demand for currency in circulation—we adjust the growth in the SOMA for growth during ordinary times. A simple way to do this is based on the observation that from 2003 to 2007 the SOMA averaged 95 percent of currency in circulation. Thus, we estimate the abnormal growth in the Fed's balance sheet due to QE by subtracting 0.95 times currency in circulation. Column (3) shows that this adjustment implies a cumulative *abnormal* growth in the Fed's balance sheet of $2.9 trillion between December 2007 and July 2014.

If one's objective is simply to assess the scale of the Federal Reserve's balance sheet, one could simply track the *face value* of its security holdings, as we have just done. However, the goal of QE was to reduce the amount of interest rate risk borne by private investors, thereby lowering long-term interest rates through a portfolio balance channel. Thus, the analysis is more informative if holdings are converted into common units. We do so by adjusting Federal Reserve holdings by their Macaulay duration, which captures the weighted average maturity of the debt.[5]

Specifically, we convert the Federal Reserve holdings into "10-year duration equivalents" by multiplying the face value of the portfolio by its weighted average duration, and dividing the result by the duration of a 10-year Treasury note.

$$Debt_t^{10-yrEquivalent} = \frac{Debt_t \cdot Dur_t}{Dur_t^{10-yr}}. \tag{1}$$

This calculation recognizes that, from the perspective of private investors, the amount of interest rate risk they are asked to bear would be the same if there were $1 trillion 20-year zero-coupon bonds as if there were $2 trillion 10-year zero-coupon bonds.[6] Likewise, this calculation treats the purchase of $1 billion 10-year zero-coupon Treasury bonds as equivalent to $1 billion MBS with a duration of 10 years. Put differently, this calculation implicitly assumes that the relevant policy instrument in the case of QE is the total amount of duration removed from the bond market.[7] Our conclusions here are not sensitive to methodology; we obtain similar results if we instead convert SOMA holdings and Treasury issuance into common units by simply rescaling by maturity.

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[5] Vayanos and Vila (2009) and Greenwood and Vayanos (2014) show that bond supply shocks may impact term premia if they change the amount of interest rate risk that must be borne by fixed income investors.

[6] This is only strictly true if the yield curve shifts in a parallel fashion.

[7] This is a clear simplification because it implies that it does not matter in which market the duration is purchased. In perfectly integrated fixed-income markets a $1 purchase of 5-year duration MBS has the same policy impact as a $1 purchase of 5-year duration Treasuries. Krishnamurthy and Vissing-Jorgensen (2011, 2012) find strong evidence that the market for Treasury securities is partially segmented from agencies and MBS. At the same time, Hanson (2014) finds evidence that duration supply shocks in the MBS market are transmitted nearly one-for-one to the broader fixed income market. Greenwood, Hanson, and Liao (2014) formally explore bond pricing dynamics in a setting in which a pair of markets is partially segmented in the short run, but is more integrated in the long run.

To compute the duration of all securities in the SOMA, we combine our estimate of the average duration of the Fed's Treasury holdings with an estimate of the duration of its MBS and agency holdings. To isolate changes in duration due to changes in the Fed's holdings—as opposed to changes in the term structure of interest rates—we compute duration based on a constant yield curve on July 31, 2014. Table 2 shows that the combined duration impact of the Fed's QE policies, which is $2,901 billion in face value terms, was $2,718 billion in 10-year equivalents, or 15.6 percent of GDP through July 2014.

In Panel B of Table 2, we describe the growth in outstanding Treasury debt since 2007 and the Treasury's decision to extend the maturity of the debt. We focus on marketable Treasury securities held by the public and the Federal Reserve. Data were obtained from the Monthly Statement of the Public Debt. As shown in the table, the weighted average duration of outstanding Treasury debt first fell from 3.9 years in December 2007 to 3.5 years in December 2008, after which it rose to 4.6 years in July 2014. This rise in maturity occurred alongside a dramatic increase in outstanding Treasury debt, which grew from $4.5 trillion in December 2007 to $12.2 trillion by July 2014.

To compare the increase in Treasury supply with the growth of the Federal Reserve's balance sheet, we again convert these quantities into 10-year duration equivalents. The adjustment has a large impact because the average duration of outstanding Treasuries is considerably shorter than the duration of the Federal Reserve portfolio, which disproportionately contains long-term bonds as a result of QE. Expressed in 10-year duration equivalents, the debt grew from $2 trillion in December 2007 to $6.3 trillion in July 2014. Thus, the total increase from 2007 was $4,334 billion in 10-year equivalents, or 25 percent of GDP.

The growth in the quantity of 10-year duration equivalents issued by the Treasury reflects two forces: the expansion of the debt and maturity extension. More formally, we can decompose the change in 10-year duration equivalents into two terms:

$$\Delta\left(\frac{Debt_t \cdot Dur_t}{Dur_t^{10-yr}}\right) = \left(\frac{1}{Dur_t^{10-yr}}\right) \cdot \left(\underbrace{\Delta Debt_t Dur_{t-1}}_{\text{Debt Expansion}} + \underbrace{\Delta Dur_t Debt_t}_{\text{Maturity Extension}}\right) \qquad (2)$$

The first term reflects the growth of the debt, holding constant the duration of the debt at its initial value. The second term captures the effects of the rise in the average duration. Since debt management policy plays almost no role in driving the short-term growth of the debt stock (which is driven by fiscal policies outside the control of debt managers), the second term captures the impact of active debt management policies.

This decomposition is shown in the last two columns of Table 2. Roughly a quarter of the increase in 10-year equivalents was driven by the extension of maturity, with the remaining three quarters driven by the expansion of the debt. Comparing Panel A and Panel B of Table 2, we see that the Treasury's active maturity extension program offset 35 percent of the duration supply

impact of QE, insofar as the proximate goal of QE was to reduce the amount of interest rate risk in private hands. More specifically, QE reduced the supply of 10-year duration equivalents by 15.6 percentage points of GDP, but the maturity extension increased the net supply of 10-year equivalents by 5.5 percentage points of GDP. Because of our choice of a 2007 baseline, these numbers are a conservative estimate of how much the Treasury's maturity extension offset QE; if we use December 2008 instead, 63 percent of QE was "canceled" by the Treasury's maturity extension. Irrespective of which baseline we use, when measured in 10-year equivalents, the *combined* effect of maturity extension and the increased debt stock far outpace QE.

The calculations we have just described are shown graphically in Figure 1. Panel A shows the cumulative duration supply impact of the rising debt stock and the Treasury's maturity extension. Below the *x*-axis, we show the offsetting duration supply impact of QE, which the figure further breaks into Treasuries, Agencies, and MBS. Units are in 10-year duration equivalents, scaled by GDP. Panel B shows the weighted average duration of Treasury debt, both taking account of and ignoring consolidation of the Federal Reserve and Treasury balance sheets.

Figure 2 provides a back-of-the-envelope estimate of the net impact on long-term yields by combining our duration supply estimates from Table 2 and Figure 1 with consensus estimates of the price impact of Fed asset purchases. Specifically, based on the meta-analysis in Williams (2014), we assume that a $600 billion large-scale asset purchase (corresponding to $397 billion 10-year duration equivalents) lowers the 10-year term premium by 20 basis points (bps). This suggests that the cumulative impact of QE has lowered the term premium by 137 bps [=20 × (2,718 ÷ 397)]. At the same time, Treasury's active maturity extension has raised the term premium by 48 bps [=20 × (962 ÷ 397)], for a net reduction of 88 bps. While these calculations are crude, they capture the stark difference between Fed and Treasury debt management policy.[8]

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[8] Specifically, Figure 2 assumes that the entire impact of LSAPs works through reductions in term premia, which is a simplification (see below). Furthermore, it applies a constant price impact to these supply shocks. In practice, there are good reasons to think that the price impact of supply shifts may be diminishing and that there be diminishing stimulative benefits to reducing term premia, Stein (2012b). However, there is little evidence on these scores.

Figure 1
Comparing Quantitative Easing and Treasury Maturity Extension, 2007–2014

Panel A presents the cumulative change in 10-year equivalents (scaled as a percentage of GDP) associated with the respective balance sheet policies undertaken by the Federal Reserve and the Treasury. Positive values increase the interest rate risk placed in public hands (Treasury policies), while negative values decrease it (typically Fed QE, but also Treasury maturity shortening in 2008–2009). Panel B presents the weighted average duration (WAD) of Treasury debt, as well as the WAD of the consolidated government debt position. The difference between the two lines is that Treasuries held by the Fed are excluded from the consolidated duration, and short-term interest-bearing Fed liabilities (excess reserves and reverse repos) are added.

Panel A. 10-year Equivalents, QE vs. Treasury Maturity Extension
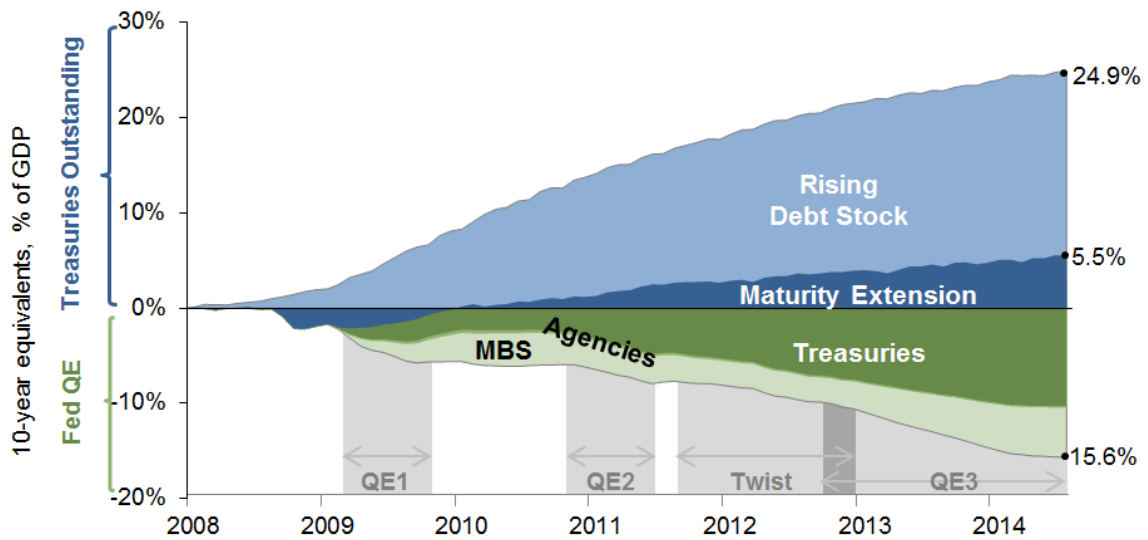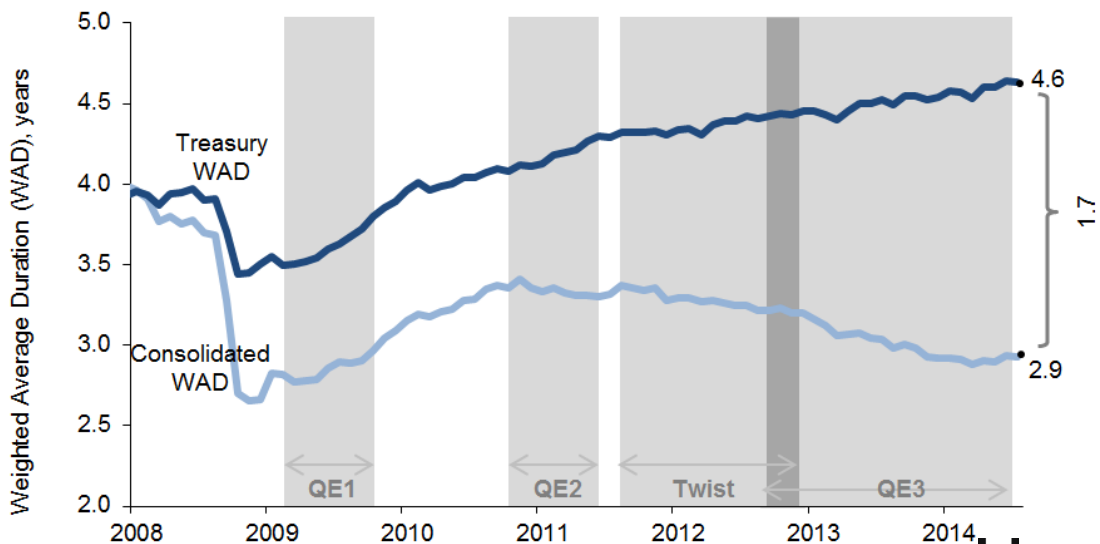
Panel B. Weighted Average Duration

Figure 2
Estimating the Market Impact of QE and Treasury Extension

The figure estimates the impact QE and Treasury maturity extension had on the 10-year Treasury term premium. The calculations are based on our 10-year duration equivalents in Table 2, as well as the price-impact estimates in Williams (2014). Williams summarizes results from a large number of research papers that differ in methodology and data, finding a central tendency that a $600 billion Fed LSAP lowers the 10-year yield by 15 to 25 basis points. In order to convert this $600 billion face value into 10-year equivalents, we assume a LSAP purchases with a duration of 5.86 years and a 10-year bond duration of 8.84 years. These numbers come from the announcement of QE2, which is the purchase program that established the tradition of scaling QE studies to an amount of $600 billion. The result is that $600 billion equates to $397 billion of 10-year equivalents. Using the midpoint of the Williams central tendency, we assume that $397 billion of 10-year equivalents impacts the term premium by 20 basis points.
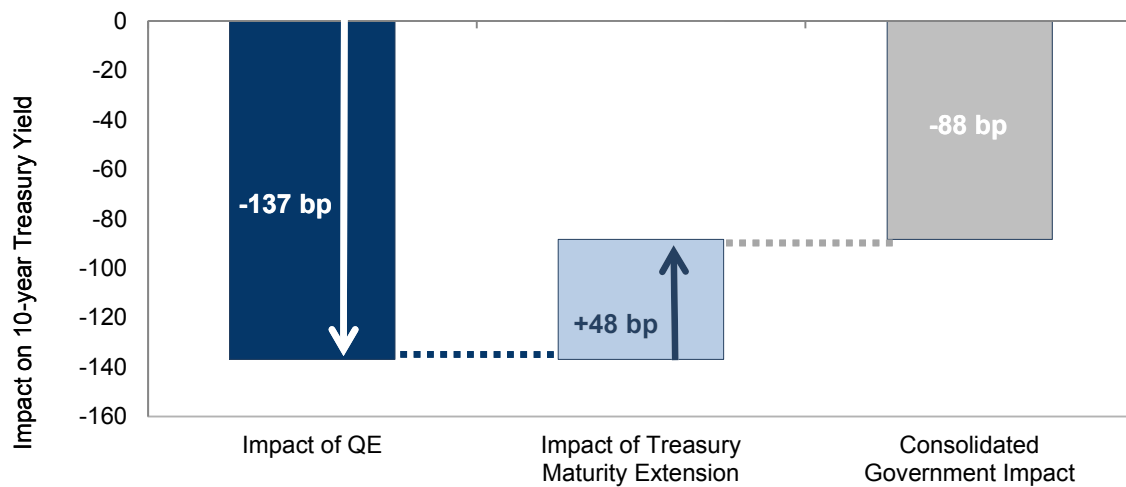
This finding has both positive and normative implications. From a positive perspective, much has been made in recent years of the impact of QE not just on long-term yields (Gagnon, Raskin, Remach, and Sack 2011), but also on stock prices, exchange rates, and foreign asset prices.[9] A common view is that Fed asset purchases have a *mechanical* downward effect on long-term interest rates through the so-called portfolio balance channel. To the extent that QE is thought to operate through such a direct channel, the argument has to confront the reality that the totality of policy has *raised* rather than reduced the quantity of long-term government debt held by private investors. It is not consistent to believe—as some seem to—that QE primarily works through a direct price pressure effect that reduces yields, but that the crowding out effects of large prospective deficits can be largely neglected.

But if the direct supply effects of QE have been offset by the massive expansion in outstanding government debt and the Treasury's decision to extend the debt maturity, then what explains the

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[9] See, for instance, Neely (2012), Bauer and Neely (2014), Hooper, Slok, and Luzzetti (2013), Glick and Leduc (2013), Mamaysky (2014).

large market impact of QE announcements documented in so many studies, as well as the fact that estimates of term premia on long-term bonds have been steadily driven into negative territory and remain miniscule today, as shown in Figure 3? The most natural explanation is that the Fed's announcements about its intended asset purchases also conveyed information about its future policies, including both the likely path of future short-term rates and the Fed's willingness to undertake further asset purchases in response to evolving economic conditions.[10] Furthermore, as Stein (2013a) argues, there are good reasons to think that the Fed's announcements and its accommodative policies may have lowered the term premium on long-term bonds through a number of more indirect channels.[11]

Carrying this logic further, there are reasons to think that announcements of Fed asset purchases may have a greater impact on term premia than comparably sized Treasury supply announcements. Consistent with this, Rudolph (2014) provides event-study evidence suggesting that Fed announcements have about twice the impact as Treasury announcements of a similar size. Rudolph's analysis is reproduced in Figure 4. Specifically, the figure shows the daily change in the estimated 10-year term premium based on the Kim and Wright (2005) model in response to Treasury's quarterly refunding announcement. The estimated term premium rose by 25 bps cumulatively over the five quarterly refunding dates when the Treasury clarified it intention to extend the average maturity of the debt. As noted above, this is only half of the price impact (+48 bps) that one would have anticipated based on an extrapolation of LSAP price impacts.[12]

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[10] There is strong evidence that the Fed's LSAP announcements moved the expectations component of long-term interest rates by essentially serving as an implicit form of forward guidance about the path of future short-term interest rates. See, e.g., Krishnamurthy and Vissing-Jorgenson (2011, 2013) and Bauer and Rudebusch (2014). However, we are skeptical of the view that Fed has used LSAPs in an attempt to *credibly commit* to keeping short rates lower for longer than it otherwise might because, say, the Fed is concerned with maintaining a certain level of remittances to Treasury. Indeed, the Fed has repeatedly emphasized that the future evolution of short-term rates will not be limited by the elevated size of its balance sheet and its large holdings of long-term bonds. Nonetheless, Gagnon, Raskin, Remache, Sack (2011) have used model-based estimates to argue that movements in term premia explain the vast majority of the announcement effect on 10-year yields. However, Bauer and Rudebusch (2014) are skeptical about the ability of such models to accurately disentangle term premia from expected short rates.

[11] In particular, the Fed's policies may have boosted investor demand for long-term bonds *holding fixed* the expected path of short-term rates. First, the expectation that the Fed would "do whatever it takes" using both conventional and unconventional measures may have lowered the perceived risk of investing in long-term bonds going forward. Second, a decline in interest rates may boost the demand for long-term bonds from investors who want to maintain the current yield on their portfolios (Hanson and Stein 2014). If such a demand "recruitment channel" is operative, it means that the Fed's total impact on long-term yields may exceed the effect of any forward guidance on the expectations component and the direct effect of asset purchases on term premia (Stein 2013a).

[12] An alternative interpretation is that Fed asset purchases and Treasury supply changes have the same price impact, but that it is easier for investors to predict the evolution of Treasury supply than Fed purchases. As a result, much of the supply "news" released on quarterly refundings may already be reflected in term premia. In contrast, investors may have been more surprised by the Fed's LSAP announcements, leading to larger announcement effects.

Figure 3
Estimated Term Premia on Long-Term Bonds

This figure shows estimates of the term premium on 10-year zero-coupon Treasuries based on the Kim and Wright model (Kim and Wright 2005). This model decomposed long-term yields into an "expectations component" that reflects the expected short-term interest rate over time plus a "term premium" that investors require for bearing the interest rate risk associated with long-term bonds. Major QE announcements are marked by lines in Panel B.

Panel A: Term Premium on 10-Year Zero-Coupon Treasuries (1990 to 2014)
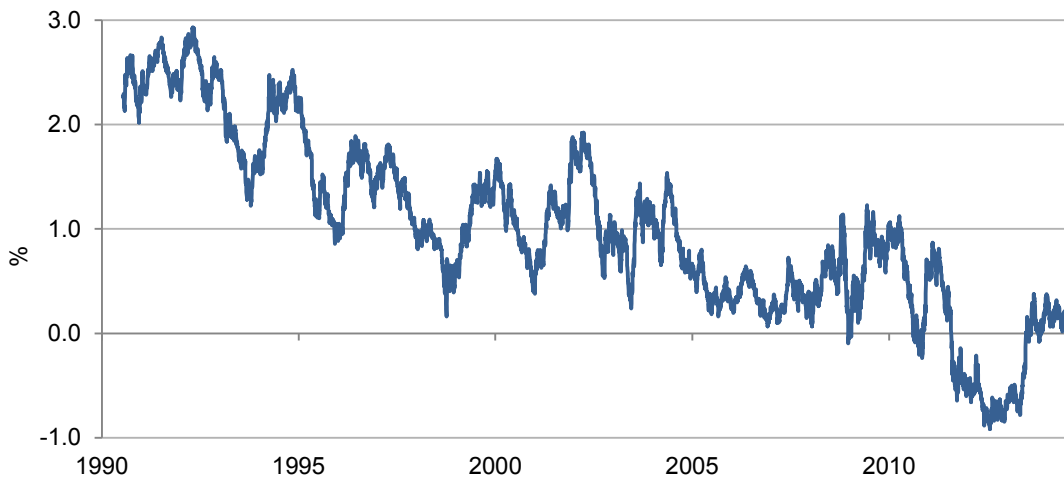
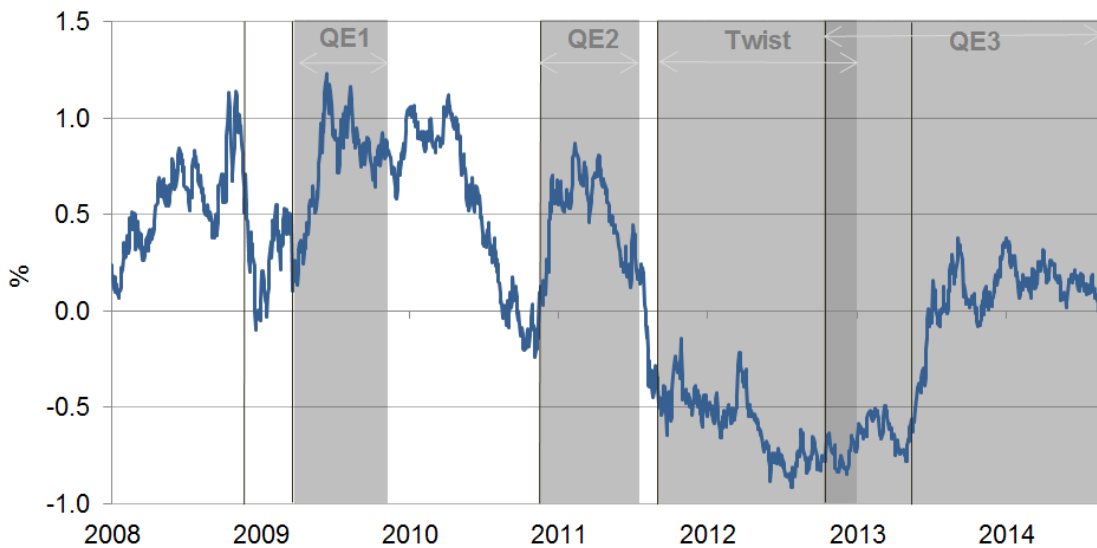Panel B: Term Premium on 10-Year Zero-Coupon Treasuries (2008 to 2014)

Figure 4

Event Study: Impact of Treasury Refunding Announcements on Term Premia

Panel A shows the weighted average maturity (WAM) of marketable Treasury debt over the past decade. Panel B adds up the daily and cumulative changes in the 10-year term premium on days when the Treasury's quarterly refunding announcements were released. These documents are released at 8:30 a.m. on a Wednesday once every three months, which is how Treasury debt management policies are publicly announced. This approach of adding up daily changes in the term premium on announcement dates follows the methodology of QE event studies such as Gagnon, Raskin, Remache, and Sack (2011). The WAM data and refunding dates are sourced from the Treasury. The term premium data is from Kim and Wright (2005). Shaded in both panels are the five quarters when the Treasury was telegraphing its intent to extend the average maturity of the debt in its refunding announcements.

Panel A: Weighted Average Maturity of Marketable Treasury Securities
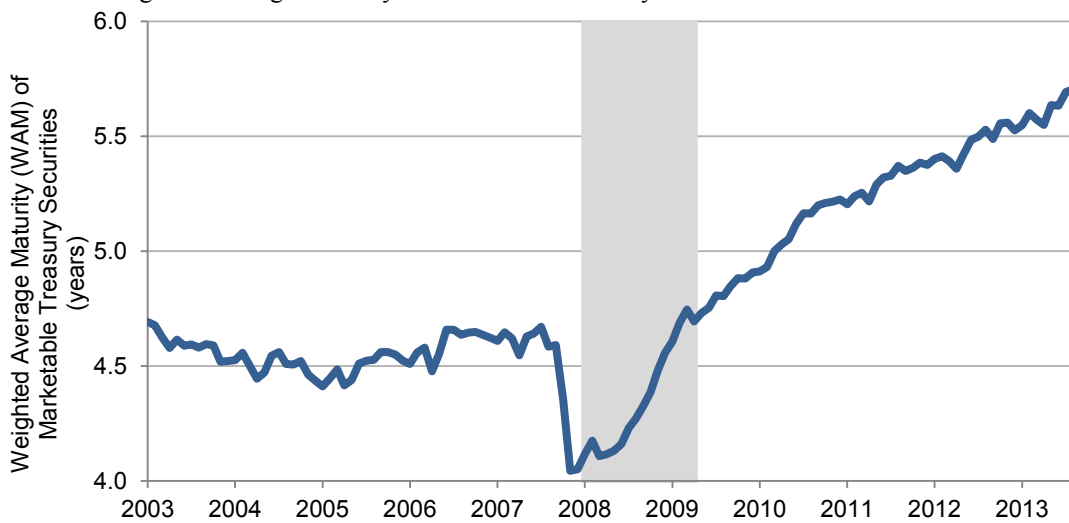
Panel B: Impact of Treasury Refunding Announcements on Term Premia
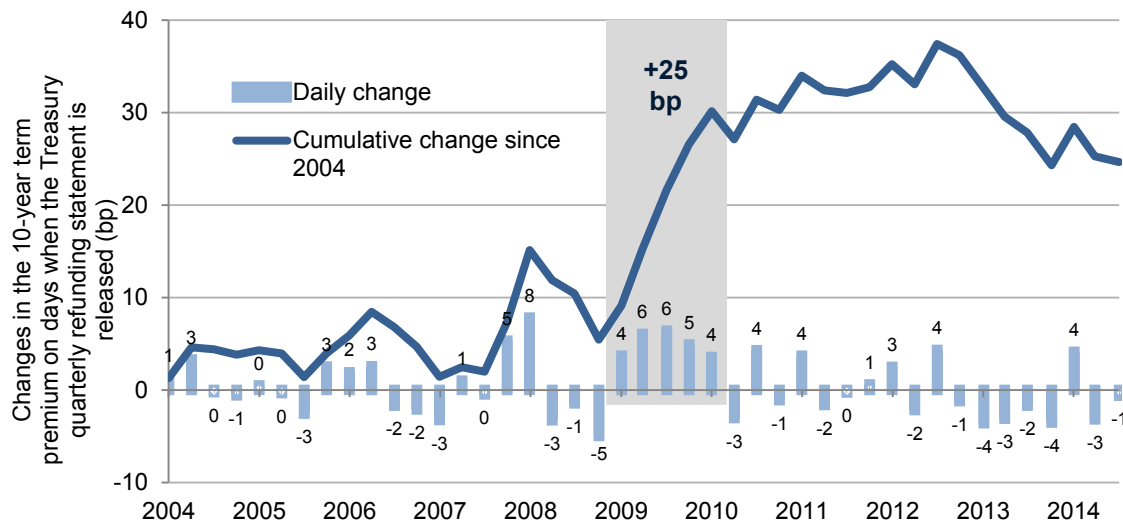
Nonetheless, from a normative perspective it seems very odd that the Federal Reserve is taking actions that have the effect of substantially reducing the duration of the debt held by the public at a time when the Treasury is arguing that it is in taxpayers' interest to extend the duration of the debt at a rapid pace. Moreover, the Federal Reserve has done so without formally acknowledging any of the considerations invoked by the Treasury. Similarly, the Treasury is taking steps that in the judgment of the Fed are contractionary, while committing itself in general to expansion of demand as a principal policy without ever addressing the concern about contractionary policy. Below we consider the merits of lengthening versus shortening the maturity of the public debt and address the question of the process by which a government committed to both democratic control over economic policy and an independent central bank should address this issue.

II.   PRECEDENTS FOR FED–TREASURY COOPERATION

Before the 2008–2009 financial crisis, it was thought by academics and policymakers that the Federal Reserve's dual objectives of low inflation and full employment were not in conflict with those of debt managers at the U.S. Treasury, who sought to minimize the cost of managing the federal debt while limiting fiscal risk. This understanding reflected the reality that the Treasury and the Federal Reserve each could independently pursue their respective policy objectives without much formal coordination.

This has not always been the case. Prior to the late 1970s, coordination between the Treasury and the Federal Reserve was commonplace, and can be seen in both official communications and the correlation between the balance sheet positions of the two agencies.

A.   Historical precedents

Figure 5 provides an historical perspective on the link between the Federal Reserve holdings of Treasury securities, expressed as a percentage of GDP, and the size of the overall public debt. Over our 1936–2013 sample[13], the correlation between these two series is 66 percent, which mostly reflects central bank balance sheet growth during World War II and the Great Recession. Outside of these two large events, in the 1952–2007 period, the correlation between the size of the Fed's balance sheet and the ratio of debt-to-GDP is near zero.
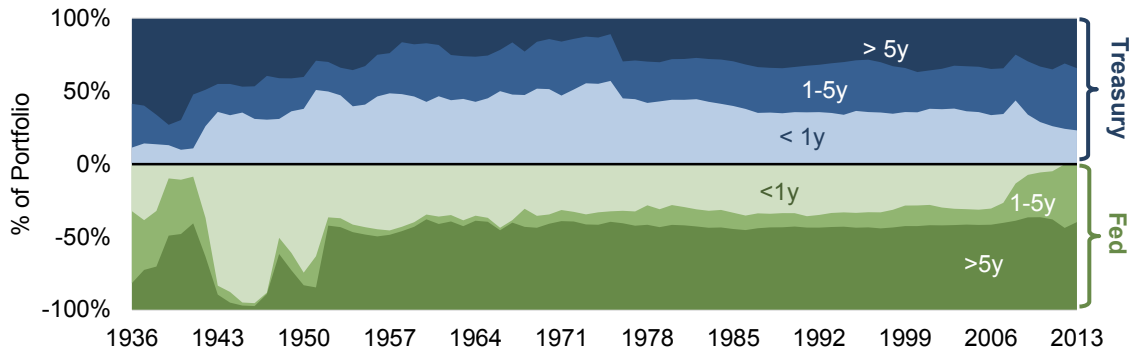
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[13] There is limited data on the maturity structure of Federal Reserve securities holdings prior to 1936.
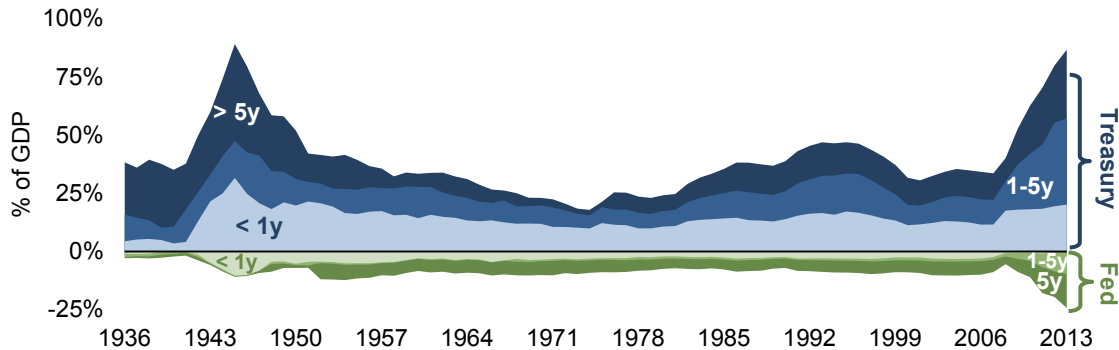
Figure 5
Fed and Treasury Balance Sheets, 1936-2013

Outstanding balances of Federal Reserve (asset) and Treasury (liability) balance sheets are broken down into three buckets of remaining maturity: less than 1 year, 1–5 years, and greater than 5 years. Panel A shows this data expressed as a percentage of total Treasury assets (Fed) or Treasury liabilities (Treasury). In Panel B, outstanding amounts are shown as percentage of GDP. In Panel C, we show the long-term debt share, computed as the fraction of debt that is of 5-year maturity or greater. The Consolidated time-series nets out Federal Reserve holdings from Treasury liabilities. Data were compiled from various issues of the Monthly Statement of the Public Debt, Treasury Bulletin, Banking and Monetary Statistics, and Federal Reserve Bulletin.
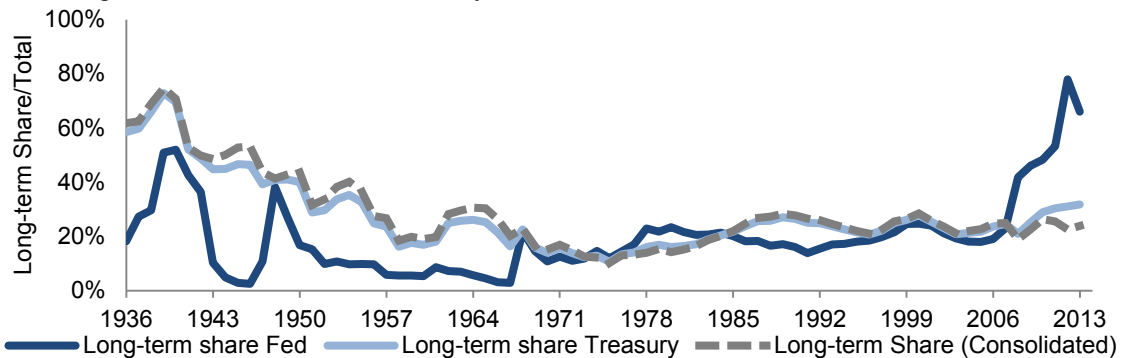
Panel A. Breakdown by Maturity

Panel B. Notional Values, as a % of GDP

Panel C. Long-term Debt Share, Fed vs. Treasury

Long-term share Fed   Long-term share Treasury   Long-term Share (Consolidated)

BROOKINGS

Panels B and C show that there is little correlation between the maturity structure of federal debt and the maturity structure of Treasury holdings on the Fed's balance sheet. Although the figure shows periods when a lengthening maturity of outstanding Treasury debt was also associated with a maturity extension within the Fed's portfolio (e.g., 1995–2007), the overall correlation is zero. The most discernible variation in the time-series, apart from the post-crisis era (i.e. 2008–2013), is the 1940–1950 sub-period, when the Fed played an important role in facilitating the rapid growth in national borrowing during World War II.

From the long history of debt management, there are a few interesting episodes that suggest debt management can be better coordinated when the circumstances warrant. Consider first the cooperation between the Fed and Treasury on debt management during World War II. A few months after the U.S. entered World War II, and in the midst of a rapid increase in government spending, the Fed and the Treasury agreed to fix the entire yield curve of Treasury securities. Three-month bill yields were limited to 0.375% and bond yields were held at 2.5%. The Fed stood ready to buy or sell any amount of treasury securities necessary to maintain this positively-sloped yield curve.

Because long-term rates were fixed, bonds experienced almost no price volatility in the secondary market, a condition that made them more attractive to investors. But while such an increase in the appeal of long bonds might otherwise flatten the yield curve, the Fed had committed itself to enforce a positive slope. The result was that during World War II, private investors bought almost all of the notes and bonds issued by the Treasury, which left the Fed to buy almost all of the bills. This can be seen in Figure 5, where the share of long-term Treasury securities on the Fed's balance sheet plummets. In short, the Federal Reserve and Treasury effectively agreed during World War II that financing the war was the main objective of debt management policy, and they coordinated with each other to reach this outcome. While the nature of the cooperation (the Federal Reserve was acting to support fiscal expansion) does not carry over to the current debate, the fact that they *could* cooperate closely on debt management does have implications for current policy.

Following the end of World War II, the Federal Reserve sought to assert independence by pushing for greater fluctuations in short-term interest rates. However, as the Treasury faced a large and growing debt burden, it maintained its pressure on the Fed until 1947 (Chandler 1966, Humpage 2014). In this way, monetary policy objectives were secondary to those of debt management. In 1947, the Treasury and Fed jointly agreed to a series of increases in the interest rate on short-term bills, which reached 1 percent in early 1948. This led some individuals and banks to sell their holdings of longer maturity bonds. In response, the Fed began purchasing these longer-term securities while simultaneously selling an approximately equal value of short-term Treasury bills (Humpage 2014).

Tension between the Treasury and Fed reached a boiling point in January 1951, when the Treasury Secretary publicly announced that maintaining a 2.5 percent yield on Treasury bonds

was an "integral part of the financial structure of the country." The Federal Reserve, in a memo to President Truuman, stated that it did not agree with the directive. Following intervention by the President, the Secretary of the Treasury and the Chairman of the Federal Reserve released a joint statement in March 1951 that declared "The Treasury and the Federal Reserve System have reached full accord with respect to debt-management and monetary policies to be pursued in furthering their common purpose to assure the successful financing of the Government's requirements and, at the same time, to minimize monetization of the public debt" (Hetzel and Leach 2001). This agreement restored greater independence to the Fed and became known as the 1951 Treasury-Federal Reserve Accord.

A second instance of cooperation—in fact a series of repeated instances—occurred through the "even keeling" policy the Fed abided by in the years after the 1951 Accord. The Fed agreed to not alter monetary policy during the 3-week periods when the Treasury was building up an order book for new debt issues in the primary market. Under the even keeling policy, the Fed would hold rates steady during Treasury offerings, thus avoiding disruptive changes that might endanger the success of the offering process. Wanting to limit the amount of time when monetary policy was unable to change, the Treasury began concentrating its issuance into four annual mid-quarter refundings (Garbade 2007). But overall, the even keeling process was meant to ensure that central bank objectives did not interfere with debt management.

The third and most prominent example of Fed and Treasury cooperation in the domain of debt management comes from the Operation Twist program of 1961. At the time, the Fed wanted to adopt a more accommodative policy but was reluctant to further reduce short-term interest rates because of concerns that this would impair the nation's balance of payments and result in gold outflows under the Bretton Woods system. In response, the Fed and Treasury tried to lower long-term interest rates by reducing the term premium on long-term bonds while holding short-term interest rates constant. Specifically, the Fed agreed to buy longer-term securities while the Treasury would sell predominantly short-term securities. Studies conducted shortly thereafter used quarterly interest rate data and found no meaningful impact of the 1961 program (Modigliani and Sutch 1966). However, more recent studies that make use of a modern event study methodology have found a significant impact (Swanson 2011).[14]

Operation Twist is perhaps the best example of the potential for Fed and Treasury cooperation, because the circumstance was, much like the zero lower bound today, that the Fed was constrained in its use of the short rate as a policy instrument. However, unlike in the more recent period, during Operation Twist the Fed was able to complement its own actions with the secured cooperation of the Treasury to alter the maturity structure of new debt issuance.

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[14] Long-term interest rates fell on most dates in early 1961 when the initial information about Treasury and Fed policies was released. The only exception was when the Treasury surprised both the White House and the Fed by issuing longer-term bonds on March 15, 1961. This made James Tobin (then a member of Kennedy's CEA) "furious." Treasury continued to extend its maturity thereafter and within a year the average maturity had increased by 3.5 months. Thus, Treasury began working at cross-purposes with the Fed, just in as the current episode.

B.   Internationalprecedents

Beyond the historical evidence of cooperation in the United States, another relevant benchmark is practice across the major economies.

Table 3 compares debt management practices across G-7 countries. The table highlights the wide variety of institutional arrangements adopted to coordinate debt management with monetary policy. In all countries in the G-7, debt management resides in the Treasury or a debt management office (DMO) controlled by the Treasury. While the comparison to Germany, France, and Italy is muddled by the fact that those countries do not have central banks that determine monetary policy, the experience of the other large countries is illustrative.

Upon hitting the zero lower bound and venturing into QE, two different paths emerge for policy coordination. One alternative is shown by Japan and the U.S., where debt managers extended maturity more aggressively than in any other G-7 country. Both countries lack any formal avenues for policy coordination between debt managers and central bankers. The other alternative is exemplified by the UK, where policymakers have a clearer record of coordinating debt management and monetary policy, perhaps because of the historical roles the Bank of England has played in both policy areas. The UK DMO is mandated to "ensure that debt management is consistent with the aims of monetary policy." As the Bank of England was getting ready to begin QE in early 2009, its governor sent a public letter to the Chancellor of the Exchequer. The Bank of England claimed that in order to ensure consistency between debt management and monetary policy, the government should not alter its issuance strategy as a result of QE. The government confirmed that it would not alter its debt issuance strategy based on the Bank of England's asset purchases. Indeed, the DMO shortened the average maturity by 1 year between March 2009 and March 2010.

Table 3

Debt Management in the G7: Coordination between the Central Bank and Treasury

The table describes, in brief, the pre-2008 arrangement, if any, for coordinating debt management between the central bank and Treasury. The "QE Era" columns describes how debt management has evolved in the years since the financial crisis. The rightmost column lists the average debt maturity in 2014. Data compiled by authors from various sources, including the OECD, the IMF Fiscal Monitor, Sundararajan, Dattels, and Blommestein (1997), and national finance ministry websites.

Country	Pre-2008 Debt Management Arrangement	QE Era	Average Maturity in 2014
United States	There are no formal institutional arrangements to coordinate with monetary policy. Treasury has full authority over U.S. debt management. The Fed tends to mimic Treasury issuance patterns and only target short rates (with some exceptions, such as WWII and 1961 Operation Twist).	Treasury extended its debt maturity to reduce rollover risk and catch up with other countries. The side effect was to counteract a portion of Fed's QE effects. It is not clear which agency controls the U.S. government maturity policy.	5.7 years
Canada	Debt management resides in the Ministry of Finance. The Canadian Finance Department formally consults with the Bank of Canada on debt management decisions and issuance schedules are announced on the Bank of Canada's website. In policy reports, there is discussion of the shared responsibilities and joint efforts of the Ministry and the Bank.	In the decade before the crisis, Canada's average maturity moved very slowly within a range of 6.0 years to 7.0 years. During the crisis, however, average maturity fell from 7.0 years in 2007 to 6.0 years in 2009, as bills were used to fund both fiscal deficits and the government's MBS purchase program. In 2012 the government announced that it would reallocate issuance towards long-term bonds to reduce refinancing risk.	6.0 years
France	There are no institutional arrangements to coordinate with monetary policy. In 2000, the Agence France Trésor was created within the Finance Ministry to manage the debt. The idea of an independent office was rejected on the grounds of democratic accountability and linkages to fiscal policy.	Maturity of French debt is currently at approximately the same level as it was in 2006 and 2007.	7.0 years
Germany	There are no institutional arrangements to coordinate with monetary policy. From 1997 to 2011, Germany's debt managers held the government's average maturity near 6.0 years. In 2001, debt management was taken out of the Finance Ministry and given to a private company to be wholly owned by the Finance Ministry.	In 2012, Germany's debt managers joined the international trend towards lengthening, increasing the average government debt maturity by nearly one full year since then (from 5.6 years in 2011 to 6.5 years in 2014). This has been the largest 3-year shift in Germany's average maturity seen in the past 15 years.	6.5 years

Table 3 (continued)

Debt Management in the G7: Coordination between the Central Bank and Treasury

Country	Pre-2008 Debt Management Arrangement	QE Era	Average Maturity in 2014
Italy	The Italian Treasury has the authority over debt management. However, the Bank of Italy advises the Treasury on debt management. In its advisory capacity, the Bank of Italy takes into account monetary conditions.	The average maturity of Italian government bonds has decreased by nearly 1 year since 2009. However, this may be more due to sovereign credit pressures than an attempt to ease monetary conditions. In 2014, the Italian Treasury has been trying to issue longer-term.	6.3 years
United Kingdom	In 1997, when the government gave the Bank of England independent control over interest rates, debt management policy was also taken out of the Bank of England to avoid any perceived conflicts with monetary policy. Debt management was assigned to the newly established Debt Management Office (DMO), an executive agency of Treasury. However, the DMO must "ensure that debt management is consistent with the aims of monetary policy."	As the Bank of England began its quantitative easing program in early 2009, the Governor of the Bank of England sent a public letter to the Chancellor of the Exchequer that in order to ensure consistency between debt management and monetary policy the government should not alter its issuance strategy in response to QE. The directive was accepted by the Chancellor.	14.9 years
Japan	An office within the Ministry of Finance determines which maturities to issue, with a goal of ensuring smooth and cost-effective issuance. The central bank acts as fiscal agent but the Ministry announces all issuance plans and auction results. There is no special committee or working group to ensure coordination between debt management and monetary policy, despite both being actively involved in bond markets.	Bank of Japan has been engaged in a large quantitative easing program since 2010. Debt management since 2009 has been aggressively extending maturity to reduce rollover risk associated with large debt levels. The conflicting tactics of monetary policy and debt management are similar to the U.S., except that in Japan, rollover risk may loom larger than refinancing risk.	7.7 years

III.   THE OPTIMAL MATURITY STRUCTURE OF THE NET CONSOLIDATED GOVERNMENT DEBT

In this section we argue that modern debt management has four competing policy objectives: (1) financing the government at the lowest cost, (2) minimizing fiscal risk, (3) managing aggregate demand, and (4) promoting financial stability. For each of these objectives, it is the composition of the government's *net* consolidated debt (publicly held Treasury debt *plus* interest-bearing Federal Reserve liabilities *minus* Fed holdings of Treasury debt) that matters. The composition of the net consolidated debt is the key instrument of debt management policy because it summarizes the set of government liabilities held by the private sector and accounts for the fact that the Federal Reserve remits its profits to the Treasury.[15]

We first use this framework to address the central decision of debt management policy—namely the optimal maturity structure of the debt. In Section IV, we then turn to other aspects of debt management policy, including the optimal mix between nominal and inflation-linked debt and how to capture the "on-the-run" liquidity premium. Finally, in Section V we discuss the optimal implementation of this strategy and the question of the appropriate division of labor between the Treasury and the Federal Reserve.

A.   The Ricardian equivalence benchmark

Theories of optimal government debt management hinge on failures of "Ricardian equivalence." Ricardian equivalence is the public finance analog of the Modigliani-Miller (1958) irrelevance theorem, which states that—under certain strict conditions—the way that a corporation finances itself has no effect on the firm's total value. Analogously, Ricardian equivalence says that the manner in which the government finances its expenditures using taxes and various types of debt has no effect on household consumption and well-being if: (1) taxation creates no deadweight losses, (2) government debt is valued solely for its cash flows in different states of the world (i.e., private agents do not derive liquidity services from holding government debt in the same way that they derive services from holding base money), and (3) capital markets are frictionless (Barro 1974).[16] If Ricardian equivalence holds, then not only is debt management (i.e., the maturity structure of the debt) irrelevant, but deficit spending is also irrelevant.

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[15] In other words, in a regime with interest on reserves, T-bills and reserves are very close substitutes. This is a simplification because, unlike T-bills, reserves are base currency and thus may have additional transactional value. However, these distinctions are trivial in the QE era, because the demand for reserves is satiated.

[16] More formally, the assumption that capital markets are frictionless means that any agent's marginal utility of income (stochastic discount factor) must price all financial assets in the same way. However, markets need not be complete so there need not be a unique stochastic discount factor and risk-sharing across agents need not be perfect. However, there cannot be important constraints to participating in financial markets, borrowing constraints, short-selling constraints, agency frictions, or other forms of market segmentation which lead agents to assign different

A simple example illustrates the power of the Ricardian benchmark for debt management. Consider a government with an initial accumulated deficit and no future expenditures that must decide whether to finance the deficit by issuing short- or long-term bonds. If the government finances itself solely through the issuance of short-term debt, then the government will have to raise taxes if short-term interest rates rise. However, the rise in interest rates will leave a household that is lending short-term to the government with a bit more in its bank account. Since the government's sources of funds (taxes and proceeds from issuing new debt) must equal its uses of funds (paying off maturing debt), the gain in the household's bank accounts must *precisely* offset the increase in taxes. As a result, issuing more short-term government debt increases the interest rate exposure of households' future tax liabilities, but has a perfectly offsetting effect on the value of its portfolio of bond holdings. It follows that the government should be completely indifferent between issuing short- or long-term debt. This reflects the deeper point that, in a Ricardian world, government debts are not a form of "net wealth" for private actors; they simply reflect the present value of future tax liabilities.

To reach these striking conclusions, the Ricardian benchmark relies on a number of strong assumptions. Modern debt management policy hinges on four important real-world deviations from these assumptions. First, certain types of government debt are "net wealth" in the sense that they offer investors a valuable set of liquidity services above and beyond their financial cash flows in different states of the world. By liquidity services we mean providing *transactional* services or relaxing constraints that would otherwise restrict investors. Krishnamurthy and Vissing-Jorgensen (2012) find strong evidence that Treasury securities offer valuable liquidity services and, thus, embed a significant "liquidity premium." For example, Treasury bills appear to provide investors with many of the same liquidity and storage services as base money. As a result, the yields on T-bills appear to be lower than they would be in the absence of these valuable monetary services (GHS). Recognizing these benefits, the government can improve welfare by issuing debt securities that offer investors these special liquidity services.

Second, debt management may play an important role in managing fiscal risk. A standard rationale for fiscal risk management stems from the insight that government taxation distorts private incentives, creating *deadweight costs*. It is natural to think that the deadweight cost of taxation is a convex function of the level of taxes. This implies that, all else being equal, society is best off when taxes are low and smooth over time (Barro 1979; Stokey and Lucas 1983). By insulating the budget from the refinancing risk associated with a very short-term maturity structure, prudent debt management may play a valuable role in smoothing taxes. Going further, rolling over too much short-term debt might even make the government vulnerable to bank-run problems, whereby a growing fear about the government's ability to service its debts leads to a sharp rise in interest costs and makes the fear self-fulfilling (Bohn 2011). However, a variety of

values to the same asset. Proofs of Ricardian equivalence also assume that agents have infinite horizons and this is often cited as a reason why Ricardian equivalence may fail. However, lifetimes are long enough that finite lifetimes cannot account for meaningful failures of Ricardian equivalence (Poterba and Summers 1987).

political economy factors suggest that managing the debt to limit the volatility of the government's interest bill may be desirable for reasons beyond tax smoothing and avoiding run-like spirals. For instance, a natural aversion to deficit financing, even if short-lived, means that temporary fiscal shocks may lead to large cuts in valuable government programs.[17]

Third, real-world capital markets operate with a variety of frictions not envisioned in the Ricardian benchmark. The most important friction from the perspective of debt management is the segmentation of capital markets, which suggests that the marginal holder of a given financial asset is a typically specialized investor who is more exposed to that asset's idiosyncratic risks than the average taxpayer. This segmentation explains why policies such as quantitative easing can influence the prices of financial assets and can therefore function as a tool for managing aggregate demand. Specifically, shortening the maturity of the net government debt causes specialized fixed-income investors to bear less interest rate risk, and may therefore lower the long-term interest rates relative to short-term rates. Quantitative easing is done in the belief that such interest rate changes are passed through to private borrowers, helping to stimulate long-term corporate investment, residential construction, and spending on consumer durable goods.

Fourth, because private financial intermediaries can also create money-like short-term debt, debt management policy may be able to alter the behavior of intermediaries so as to promote financial stability (GHS; Krishnamurthy and Vissing-Jorgensen 2013; Pozsar 2011, 2012). Specifically, by issuing more short-term debt, the government can reduce the attraction of short-term debt for financial intermediaries. In this way, the government may be able to reduce the amount of liquidity transformation in the financial system, thereby limiting the likelihood and severity of future financial crises.

Below we develop a framework for government debt management that emphasizes the four real-world frictions outlined above. We start with the first two frictions and describe the model developed by GHS in which the government pursues a tradeoff between its desire to issue "cheap" securities that provide liquidity services and its desire to manage fiscal risk. This simple tradeoff model captures the essence of the traditional debt management problem, as framed by Treasury officials: how to finance the public debt at the lowest cost while being prudent from the perspective of fiscal risk.

We then extend the model to consider the two non-traditional goals of debt management suggested above: promoting financial stability and managing aggregate demand. Although these two policy goals are hardly new, the idea of using debt management policies to pursue them has only emerged in recent years. Because our model already considers a tradeoff between competing government objectives, it is well-suited for analyzing these nontraditional objectives of debt management.

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[17] For instance, Auerbach and Gale (2009) find that, controlling for the difference between actual and potential GDP, roughly one-quarter of the annual change in the Federal deficit from 1984 to 2009 was offset by policy, with changes in outlays accounting for slightly more of the response than changes in revenues.

Our framework suggests that optimal debt management hinges on a set of potentially quantifiable forces. Although a rigorous analysis of this sort is beyond the scope of the current paper, we provide some educated guesses regarding the likely magnitude of the relevant forces, as well as describing how these forces may vary over time. Taken together, we argue that over the long-run, the optimal maturity structure of government debt may be shorter than the government has entertained historically. We explore this idea by describing a counterfactual financing history of the federal government in which the government relies on a much shorter-term funding mix in the post-war era. We also argue that the optimal maturity structure of debt may vary over time, in a direction that is correlated with the path of monetary policy. In the last section of the paper, we turn to what this means for coordination between the Fed and Treasury.

B.   A trade-off model of government debt maturity

GHS consider a government that trades off a desire to issue "cheap" securities versus a desire to manage fiscal risk. For the time being, we focus on the optimal maturity structure of the debt and postpone other facets of debt management to Section V.

This trade-off framework captures the essence of the debt management problem as described by Treasury officials. For instance, in 1998 Assistant Secretary Gary Gensler emphasized the importance of "achieving the lowest cost financing for taxpayers." At the same time, he noted that, "Treasury finances across the yield curve" because "a balanced maturity structure mitigates refunding risks." Ten years later, in 2008, Director of the Office of Debt Management Karthik Ramanathan echoed that sentiment, stating that the primary objective of debt management was to achieve the "lowest cost of financing over time," while emphasizing that it is crucial to "spread debt across maturities to reduce risk."

What does it mean to issue "cheap," or to achieve "the lowest cost financing over time"? It cannot simply mean issuing securities with a low current yield-to-maturity. A clear reason why is the expectations hypothesis of interest rates: short-term rates may be low compared to long-term rates because short-term rates are expected to rise in the future. In this case, issuing short term rates, while resulting in low current interest payments, is likely to lead to higher interest payments in the future, implying that the government should be indifferent between rolling over short-term debt and issuing long-term debt.

However, the nature of what ought to count as "low cost" goes beyond simply adjusting for the expected path of future short-term interest rates. For instance, if long-term bonds offer a higher expected return than short-term bonds simply because longer-term bonds are riskier in the frictionless asset-pricing sense—i.e., if the returns on long-term bonds tend to underperform those on short-term bills in bad economic times when the typical household's marginal utility of income is high, then this is not a coherent policy rationale for issuing short. In this case, we are back to the standard Ricardian result, where the government cannot make households better off by changing around its maturity mix. This is because in a Ricardian world such a debt

management strategy shifts risk between households' government bond portfolios and their tax liabilities, but leaves households bearing the same total amount of interest rate risk.

A role for debt management arises if there is a special, non-risk-based demand for particular types of government securities—i.e., if different securities provide different amounts of liquidity services, leading their yields to embed differential liquidity premia.[18] GHS argue that short-term Treasury bills typically embed a larger liquidity premium than long-term Treasuries because bills provide more of the valuable services offered by traditional money (e.g., tremendous liquidity and absolute safety as a near-term store of value).[19]

However, when debt managers say they are trying to achieve the lowest cost financing for taxpayers, we sense that they have more in mind than capturing differential liquidity premia. Specifically, it seems that—all else being equal—debt managers might prefer a shorter average maturity for the debt in order to conserve on the "term premium" that compensates long-term bond investors for bearing interest rate risk.

Is economizing on the term premium a coherent rationale for shortening the average maturity of the debt? If markets are frictionless, and all households assign the same value to long-term bonds, then the answer is a clear "no," as explained above. However, if markets are segmented, meaning long-term bonds are priced by specialized bond investors who are more worried about interest rate risk than the typical taxpayer, then the government can make the typical taxpayer better off by borrowing short.[20] Since this same segmented market logic underlies the portfolio balance channel of QE, conserving on the term premium may be a defensible rationale for lowering the average maturity of the debt.[21]

Turning to the other side of the tradeoff, the government also seeks to minimize fiscal risk, meaning that the cost of servicing the debt should not be too volatile. Issuing too much short-term debt exposes the government to the possibility that interest rates may rise. The formal justification for fiscal risk management in GHS is that government should try to avoid budget

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[18] If all forms of government debt provide the same amount of liquidity services, then Ricardian equivalence fails, and the overall quantity of government debt will matter; however, the composition of the debt—i.e., debt management policy—would be irrelevant.

[19] As we discuss in Section V, there are also circumstances in which certain long-term securities embed a differential liquidity premium. Most famously, "on-the-run" notes and bonds often trade at lower yields than off-the-run notes and bonds with nearly identical cash flows (Warga 1992; Fleming 2000; Krishnamurthy 2002). More recently, several studies have found that nominal government debt typically embeds a significant liquidity premium relative to inflation-indexed debt (Campbell, Shiller, and Viceira 2009; Fleckenstein, Longstaff, and Lustig 2013; and Pflueger and Viceira 2013). Finally, Greenwood and Vayanos (2010) find that long-dated UK government bonds trade at a special premium due to hedging demand by British pensions.

[20] If markets are segmented, the expected tax savings from conserving on the term premium demanded by specialized bond investors can more than compensate the typical taxpayer for the additional tax volatility.

[21] For instance, in 1993 some of President Clinton's economic advisers argued that it would be desirable to shorten the average maturity of the government debt (Wessel 1993). First, they argued that this would reduce the government's interest bill over time by conserving on term premia. Second, they argued that the reduction in supply would lower term premia via a portfolio balance channel, thereby depressing long-term private borrowing rates.

risk because this directly leads to volatility in tax rates. And, because the marginal deadweight costs of taxation are increasing in the level of taxes—i.e., the costs are *convex*—this generates a desire to smooth taxes over time.

The reasons to minimize fiscal risk likely go well beyond any deadweight costs associated with volatile taxes. For example, a very short-term maturity structure might make the government vulnerable to bank-run problems. Furthermore, one may want to limit budget volatility to avoid cutting valuable government programs in the face of temporary negative shocks. [22]

For the sake of concreteness, we introduce a simplified version of the model in GHS. Consider a government with an initial accumulated debt (D)*,* and no future expenditures, that must finance itself through a combination of short-term bonds, long-term bonds, and taxes. Let S denote the fraction of the debt that is short-term and $1-S$ the fraction that is long-term.

Suppose there is a special demand that makes it cheap to issue short-term debt because short-term debt offers more the same services as base money: tremendous liquidity and absolute safety as a store of value. It is natural to assume that the demand for these monetary services is downward sloping, so the money-like premium on short-term debt is decreasing in the total amount of short-term debt (SD). We assume that debt managers take the path of short-term interest rates (i.e., conventional monetary policy) as given, but recognize that their issuance decisions may impact the liquidity premium on short-term debt.

On the one hand, this liquidity premium makes the government want to issue more short-term debt. On the other hand, because the government must refinance this short-term debt at an uncertain future interest rate, issuing more short-term debt exposes taxpayers to refinancing risk and makes future taxes more volatile, which is costly. Specifically, a spike in interest rate would lead tax rates to jump. However, in a more general sense, such a shock to the budget might lead to a combination of tax increases and spending cuts, both of which would be painful.

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[22] An aversion to deficit financing, even if temporary, may be a natural response to agency or informational problems between taxpayers and their elected representatives. In the US, such an aversion to deficit financing has been formalized through the use of pay-as-you-go budgeting rules, which mandate that statutory spending or tax changes cannot add to the deficit. While formal PAYGO rules only apply prospectively to new spending authorization or changes in tax policy, it seems plausible to think that using deficit financing to optimally smooth large temporary shocks to the interest bill over time may also be politically infeasible.

Formally, assume that the liquidity premium on short term debt is γ, that the deadweight costs of taxation are $(\lambda/2)\tau^2$, and that the variance of short-term interest rates is V_r. If the government finances itself by issuing fraction S of short-term debt and $(1-S)$ of long-term debt, it captures a total money premium benefit of γSD. At the same time, this raises the volatility of taxes, which have costs $(\lambda/2)Var[\tau] = (\lambda/2)D^2 V_r (S - S_0)^2$ where S_0 is a small number that reflects the maturity structure that minimizes fiscal risk in isolation. Thus, the optimal fraction of short-term government debt is

$$S^* = S_0 + \frac{1}{\lambda D}\frac{\gamma}{V_r}. \tag{3}$$

Absent a liquidity premium on short-term debt ($\gamma = 0$), the government immunizes itself against refinancing risk by opting for a long-term maturity structure, setting $S = S_0$.[23] In contrast, if short-term securities trade at a special premium ($\gamma > 0$), so the government issues more short-term debt, exposing taxpayers to greater refinancing risk in order to capture more of the liquidity premium. The larger the premium, the more aggressively the government relies on short-term debt. More generally, one could associate γ in equation (3) with other policy-relevant savings from issuing short term (e.g., with the component of the term premium that compensates specialized bond investors for bearing greater interest rate risk).

Similarly, when short-term interest rates are less volatile (V_r is low), or when budget volatility is less costly (λ is low), the more aggressively the government seeks to capture the liquidity premium on short-term debt.[24] In the limit, if there were no cost associated with budgetary volatility, then the government should continue to shorten the maturity of the debt until the special demand for short-term debt is satiated. In this limiting case, optimal debt management is generalization of the Friedman (1960) rule of monetary policy which says that, absent any costs, the Federal Reserve should expand the monetary base until the demand for money is satiated.

Equation (3) suggests that for larger values of accumulated debt, the government should issue longer term, with both sides of the key trade-off pointing in the same direction. First, as the overall debt burden grows, the fiscal costs associated with refinancing risk or the possibility of a

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[23] There is a close analogy between equation (3) and the classic formula from the theory of portfolio choice. For an investor with a risk aversion of a, the optimal share in a risky asset whose excess returns have mean $E[rx]$ and variance is $w = E[rx]/(aV[rx])$. Thus, the money premium (γ) in equation (3) corresponds to the expected excess return ($E[rx]$), the cost of tax volatility times the level of debt-to-GDP (λD) corresponds to the degree of risk aversion (a), and the variance of short-rate shocks (V_r) corresponds to the variance of excess returns ($V[rx]$).

[24] In GHS, shortening the maturity structure has three logically distinct effects on household well-being. First, this directly raises household well-being because household derive liquidity services from holding money-like T-bills. Second, this raises the volatility of future taxes, which reduces well-being. Third, this lowers taxes today because selling T-bills that embed a liquidity premium provides the government a form of seignorage revenue. If raising tax revenue is distortionary, but raising seignorage revenue is not, this adds another force to those summarized in equation (3). However, if raising all forms of government revenue—whether through taxes or seignorage—is distortionary, this tax-lowering consideration disappears.

debt rollover crisis loom larger. Second, because the demand for liquidity services is downward sloping, the liquidity premium on short-term debt falls as *D* rises, further reducing the incentive to tilt towards short-term debt.

Consistent with this trade-off view, the U.S. has had a strong tendency in the post-Accord era to extend the maturity of the public debt as the overall debt burden grows. Figure 6 plots the fraction of outstanding debt that is long term (defined as maturing in more than 5 years) against the debt-to-GDP ratio from 1952 to 2013. The two series are strongly positively correlated (correlation coefficient of 0.71). This relationship between debt maturity and debt-to-GDP is one of the most direct implications of the trade-off model.[25] It is precisely this view that explains why the Treasury lengthened the maturity of its debt beginning in 2009. The Treasury Borrowing Advisory Committee suggested in November 2009 that "the potential for inflation, higher interest rates, and roll over risk should be of material concern.… lengthening the average maturity of debt from 53 months to 74–90 months was recommended."

How large is the special liquidity premium embedded in short-term T-bills? And why might T-bills provide greater liquidity services that longer-term notes and bond? Krishnamurthy and Vissing-Jorgensen (2012) argue that all Treasuries have some of the same features as traditional money, namely liquidity and absolute safety. They find that the liquidity services associated with these special attributes lead Treasuries to have significantly lower yields than they otherwise would. Their estimate of the liquidity premium on Treasuries from 1926 to 2008 is 73 basis points.[26] However, Krishnamurthy and Vissing-Jorgensen suggest that short- and long-term Treasuries offer very different types of safety, and so are unlikely to be perfect substitutes. T-bills provide short-term safety: the absolute stability of near-term market value. While long-term Treasuries offer long-term safety in the sense of absolute certainty of repayment, they are nevertheless subject to interim market risk. Consistent with the existence of a special demand for short-term safety, the yields on short-term T-bills are often quite low relative to those on longer-term notes and bonds (Amihud and Mendelson 1991, and Duffee 1996). GHS confirm this by comparing actual T-bills yields with "fitted yields" based on a flexible model of the Treasury yield curve. Their analysis suggests that on average, from 1983 to 2009 4-week bills had yields that were roughly 40 basis points *below* their fitted values based on longer-term Treasuries.
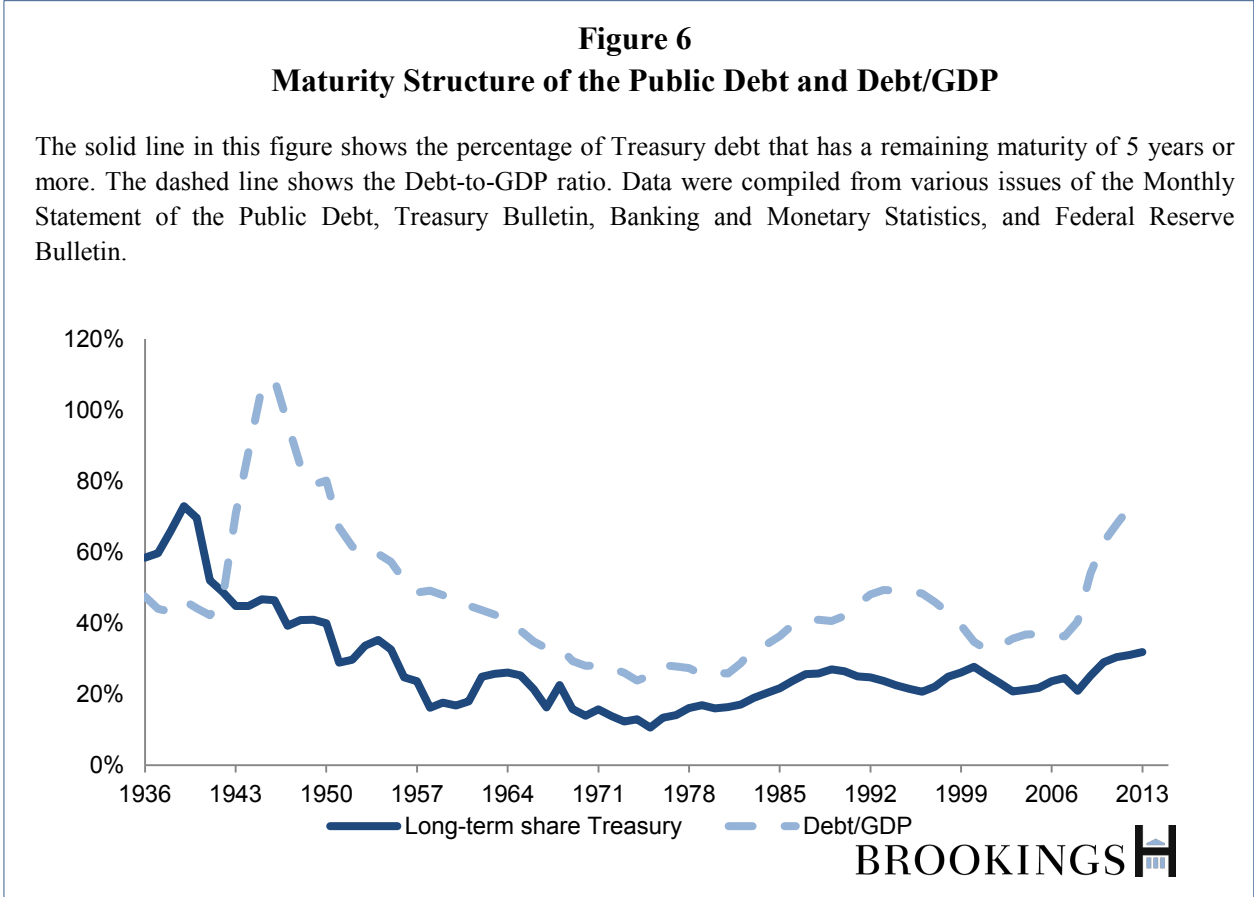
Figure 7 illustrates the special money-like premium on very short-term Treasury bills. Panel A plots the yield on 1-month T-bills versus the 1-month overnight index swap (OIS) rate, which is a good proxy for the default-free short-term rate that does not benefit from these special liquidity

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[25] The strong relationship between government debt maturity and debt-to-GDP is also noted by Greenwood and Vayanos (2014); Greenwood, Hanson, and Stein (2010); and Krishnamurthy and Vissing-Jorgensen (2012).

[26] Krishnamurthy and Vissing-Jorgensen's estimate is based on measuring the impact of changes in Treasury supply on a variety of yield spreads. For example, they show that an increase in Treasury supply reduces the spread between long-term Treasuries and AAA-rated corporate bonds and the spread between short-term Treasury bills and highly-rated commercial paper.

premia.[27] Panel B plots the spread between the 1-month OIS rate and the 1-month T-bill rate. This spread reflects the special money-like liquidity premium on T-bills. GHS show that these convenience premia are particularly pronounced for very short-term bills such as those maturing in less than a quarter or a month.
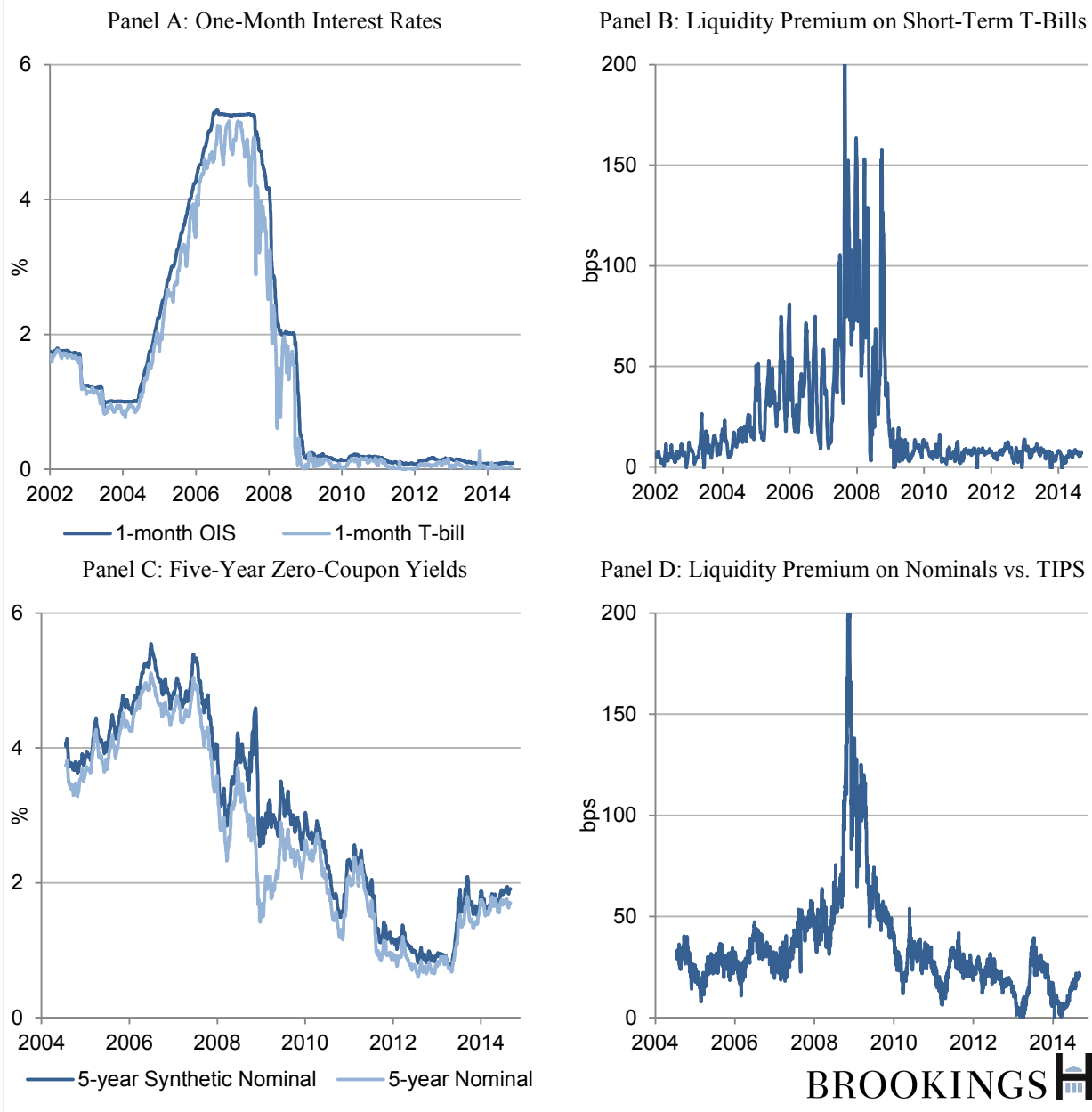
Figure 6
Maturity Structure of the Public Debt and Debt/GDP

The solid line in this figure shows the percentage of Treasury debt that has a remaining maturity of 5 years or more. The dashed line shows the Debt-to-GDP ratio. Data were compiled from various issues of the Monthly Statement of the Public Debt, Treasury Bulletin, Banking and Monetary Statistics, and Federal Reserve Bulletin.

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[27] The OIS rate is unlikely to be affected by default risk since it is based on the expected overnight Federal funds rate. And it is largely free of any convenience premium since it is not a rate at which a money market investor can invest principal (i.e., a swap is not a stable-value store of value in the same way as a T-bill or financial CP).

Figure 7
Estimates of Liquidity Premia on Treasuries

This figure shows estimates of the liquidity premia on short-term Treasury bills and nominal Treasuries. Panel A plots the yield on 1-month Treasury bills from the FRED database and the 1-month overnight index swap (OIS) rate from Bloomberg. Panel B plots the difference between the 1-month OIS rate and the 1-month T-bill rate which is a measure of the liquidity premium on Treasury bills. Panel C plots the yield on a *synthetic* 5-year zero coupon nominal Treasury—computed as the sum of the 5-year TIPS yield at the 5-year inflation swap yield—versus the actual 5-year zero coupon yield for nominal Treasuries. Panel D plots the difference between the synthetic nominal yield and the actual nominal yield which is an estimate on the liquidity premium on nominal debt. Zero-coupon nominal Treasury and TIPS yields are from Gürkaynak, Sack, and Wright (2007, 2010), and 10-year zero-coupon inflation swap yields from Bloomberg. In all four panels, we show the weekly moving averages of daily data.

Panel A: One-Month Interest Rates

Panel B: Liquidity Premium on Short-Term T-Bills

Panel C: Five-Year Zero-Coupon Yields

Panel D: Liquidity Premium on Nominals vs. TIPS

There is strong evidence that shifts in these liquidity premia are driven by shifts in the demand and supply of money-like assets. Specifically, Krishnamurthy and Vissing-Jorgensen (2012) and GHS (2014) find that shifts in T-bill supply due to movements in the debt-to-GDP ratio can explain much of the low-frequency variation in the liquidity premia on T-bills. Nagel (2014) argues that shifts in the demand for money-like debt associated with changes in the level of short-term nominal interest rates explains much of the business-cycle frequency variation in these premia. Specifically, demand for money-like debt and hence liquidity premia are high when short-term interest rates are high. This pattern is clearly evident even in the short time-series below.[28] At higher frequencies, the variation in these spreads is explained to seasonal fluctuations in T-bill supply (GHS) and week-to-week shifts in the institutional demand for money-market investments, as well as flight-to-quality episodes (Sunderam 2014).

How large are the fiscal risk costs associated with issuing more short-term debt? In the GHS model, fiscal costs coming from the deadweight costs of taxation are $(\lambda/2)\tau^2$, so the marginal deadweight cost is $\lambda\tau$. A conservative upper bound on the marginal deadweight cost is 0.5 (Chetty 2012). Assuming a tax-rate of roughly 25 percent, this implies an upper bound of $\lambda = 2$. Thus, the costs of distortionary taxation are no greater than $E[\tau^2] = (E[\tau])^2 + Var[\tau]$. Assuming $E[\tau] = 25$ percent, this implies that $(E[\tau])^2 = 6.25$ percent. However, the component of $Var[\tau]$ driven by fluctuations in interest rates is likely an order of magnitude smaller. In other words, plausible estimates of the welfare costs from the failure to smooth taxes over time are tiny.

Although emphasized by GHS in their formal model, thinking of fiscal risk as solely the distortionary costs of taxation is probably too limited. Consider the following back-of-the-envelope calculation. Suppose all the debt is short term and is refinanced once each year. Then, at the current debt-to-GDP ratio of 70 percent, a 1 percentage point increase in short-term real interest rates raises the ratio of interest expense to GDP by 0.70 percent, or $120 billion based on 2014Q2 GDP of $17.3 trillion. This is not a trivial shock to the Federal budget, exceeding the projected 2014 outlays of the Departments of Homeland Security ($50 billion), Education ($65 billion), Labor ($75 billion), and Transportation ($80 billion). An unlikely 5 percentage point increase in short-term real rates would raise interest costs by 3.5 percent of GDP, or by $600 billion, exceeding the projected 2014 outlays for the Department of Defense ($595 billion). Calculations of this sort have often been used to motivate a strategy of extending the maturity of the debt (Cochrane 2012).

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[28] Nagel's (2014) argument is that short-term debt is a partial substitute for traditional forms of money such as currency and checking deposits. Since traditional money pays little or no interest, the nominal interest rate is the opportunity cost of holding money. Similarly, the liquidity premium—e.g., the difference between the yield on an illiquid short-term deposit and the yield on liquid short-term debt—is the opportunity cost of holding money-like short-term debt. All else equal, this suggests that savers will want to hold less traditional money and more money-like short-term debt when short-term interest rates rise. Consistent with this view, savings tend to flow out of non-interest-bearing checking accounts and into money market funds when short-term interest rates are high.

Common sense suggests that the government might be willing to pay some insurance premium to avoid such scenarios. For instance, suppose we pay an additional 0.20 percent in interest on the debt to keep the interest expense smooth. In dollar terms, an annual premium of $25 billion [= $17.3 trillion × 70% × 0.20%] could insure against potential budgetary shocks of the magnitude described above.

However, even if the government is willing to pay *some* insurance premium to reduce fiscal risk, there are two important reasons to think that the government may be able to take advantage of the large liquidity premium on short-term bills without incurring much additional risk. First, substituting 6-month T-bills, for which liquidity premia may be quite modest, with 1-month bills, for which liquidity premia are higher, may allow the government to capture the liquidity premium without significantly increasing overall budget volatility (assuming this would not make the government more vulnerable to debt rollover crisis).

Second, issuing short-term debt may be a natural hedge for fiscal shocks to the primary budget deficit. Specifically, the only source of fiscal risk in the baseline GHS model is due to uncertainty about the path of future short-term interest rates. However, debt managers also deal with volatility from the budgeting process that increases the overall debt burden. Consider the case where government debt managers are uncertain about both the path of future short-term interest rates as well as future primary fiscal deficits. In this regard, the existence of automatic stabilizers—the fact that government tax proceeds tend to fall and transfer payments tend to rise in recessions—suggests that that primary fiscal deficits will tend to be high recessions when short-term interest rates are low. This adds an additional fiscal hedging motive for issuing short-term debt. The idea is that the cost of refinancing short-term debt tends to be low in states when primary deficits are high. Specifically, adapting the baseline GHS model, it is straightforward to show that the optimal fraction of short-term government debt is

$$ S^* = S_0 + \frac{1}{\lambda D} \frac{\gamma}{V_r} - \frac{\beta_{G_1,r}}{D}, \tag{4} $$

where $\beta_{G,r}$ is the coefficient from a regression of unexpected future government deficits (G) on short-term real rates (r).[29] Since we expect $\beta_{G,r} < 0$, this fiscal hedging motive should push the government to adopt even short-term debt maturity structure.

C.   Debt management and aggregate demand

Policymakers have tended to see monetary policy as separate and distinct from debt management. However, the clean lines of demarcation between these branches of policy have been blurred since 2008. The Fed's quantitative easing policies, which have swapped long-term Treasuries for short-term interest-bearing reserves, have shortened the maturity of the net

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[29] Equation (4) follows from the observation that with, an unknown future deficit of G, we have $(\lambda/2)Var[\tau] = (\lambda/2)[V_r D^2(S - S_0)^2 + V_G + 2D(S - S_0)C_{G,r}]$ where $V_G = Var[G]$ and $C_{G,r} = Cov[G,r]$.

consolidated debt held by the public.[30] Fed officials have argued that shortening the maturity of the consolidated public debt should lower the general level of long-term interest rate relative to short-term rates, thus stimulating long-term investment and consumption. In other words, the maturity structure of the public debt may be a tool of aggregate demand management. Furthermore, this may be one of the only available tools for combatting high unemployment and the threat of price deflation once nominal interest rates reach the zero lower bound.

Holding fixed the path of short-term interest rates and the total size of the debt, how can the average maturity of government debt affect long-term interest rates? The idea is that a reduction in government debt maturity lowers the amount of interest rate risk that fixed income investors have to bear, leading to a decline in the term premium—i.e., the difference in expected returns between long- and short-term bonds—due to a Tobin-style portfolio balance effect (Tobin 1958). Thus, the relevant summary statistic for such portfolio-balance policies would be the weighted average (or total dollar) duration held by private, fixed-income investors.[31]

Of course, in a frictionless Ricardian world, debt maturity would have no impact on term premia or on aggregate demand. This is because a market operation (whether conducted by the Treasury or the Fed) that, say, purchased long-term bonds and sold short-term bonds would not change the total amount of interest rate risk born by households: it would simply shift risk from households' asset holdings to their tax liabilities (Wallace 1981, Eggertsson and Woodford 2003).

The strong evidence that debt management policies do impact term premia suggests that interest rate risk that is borne by investors directly through bond markets looms larger than interest rate risk that is borne indirectly by taxpayers.[32] As noted above, the most natural explanation for this non-Ricardian result is that the marginal investor in bonds is a specialized, fixed-income investor who is far more heavily exposed to interest rate risk than the typical taxpayer. Thus, a reduction in the duration of government debt only succeeds in lowering term premia because it asks the typical taxpayer to bear a tiny bit more interest rate risk, so that the marginal bond investor can bear much less risk (Woodford 2012; Greenwood and Vayanos 2014; and Hanson 2014).

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[30] Technically, QE can be thought of as combination of a "conventional monetary easing" in which the Fed expands the supply of bank reserves by purchasing T-bills and an Operation Twist in which the Fed sells T-bills and buys long-term Treasuries. The conventional easing component has no effect at the zero lower bound, so the entire effect must come from the Operation Twist component (Woodford 2012).

[31] In the formulation of this idea by Vayanos and Vila and Greenwood and Vayanos, term premia are proportional to the product of interest rate risk and dollar duration, scaled by the risk tolerance of bond investors (Vayanos and Vila 2009; Greenwood and Vayanos 2014).

[32] See Greenwood and Vayanos (2014) for comprehensive evidence from the post-war era. See also Gagnon, Raskin, Remache, Sack (2010); Krishnamurthy and Vissing-Jorgensen (2011); Jarrow and Li (2012); and Li and Wei (2013) for appraisals of the Fed's recent LSAP programs. See Bernanke, Reinhart, and Sack (2004); Greenwood and Vayanos (2010); and Swanson (2011) for event study evidence pre-dating the LSAPS. Relatedly, Hanson (2014) and Malkhozov, Mueller, Vedolin, and Venter (2014) provide strong evidence that shifts in the duration of US mortgage backed securities move bond term premia, even though they would have no effect if markets were frictionless.

D.   <u>Debt management as a financial regulatory tool</u>

Financial regulation and debt management have historically been seen as separate spheres of policy. However, GHS argue that the desire to promote a stable financial system should push the government further toward a shorter-term maturity structure.

To understand the argument, note that the government is not the only entity that can create riskless money-like short-term debt. Specifically, Gorton (2010), Gorton and Metrick (2012), Stein (2012a), Krishnamurthy and Vissing-Jorgensen (2013), and Pozsar (2011, 2012) argue that when financial intermediaries issue money-like short-term debt that is collateralized by long-term risky assets, they are engaged in liquidity creation. In this way, they capture some of the same liquidity premium as the Treasury does when it issues T-bills. While some amount of private liquidity transformation is desirable, the incentives for private liquidity creation are likely excessive because individual intermediaries do not take into account the full financial stability costs that are generated by their use of short-term funding. Put differently, liquidity transformation generates negative externalities, so government policies that work to reduce intermediaries' over-reliance on short-term funding may be desirable. And, private liquidity transformation may be hard to regulate, particularly if it is done by the shadow banking sector.

What role can the government play through debt management? The government may "crowd-out" some private sector short-term issuance by shortening its own maturity structure. The idea is that an expansion in T-bill supply would lower the premium on short-term money-like debt and reduce the temptation for private intermediaries to issue short. Of course, this policy response is not without cost since it generates additional fiscal risk. Thus, it is not optimal for the government to issue so much short-term debt as to completely counteract intermediaries' tendency to over-rely on short-term funding. Said differently, the government should keep shortening its maturity as long as it has a comparative advantage over the private sector in the production of money-like short-term debt.

This line of thinking adds a regulatory dimension to debt management. Of course, another way to address the financial stability externalities associated with private liquidity transformation would be to regulate short-term private liabilities (Cochrane 2014; Ricks 2013). Private liquidity transformation could be directly controlled using a regulatory cap as under the Basel III bank liquidity regulations, or using a Pigouvian tax, as suggested by Stein (2012a) and Kashyap and Stein (2012). However, to the extent that direct regulation simply pushes liquidity transformation into the unregulated shadows, there will be a complementary role for a debt management policy. Specifically, by impacting the liquidity premium on short-term debt, debt management can influence private sector incentives to engage in liquidity transformation, reaching into corners of the financial markets that lie beyond the grasp of regulators. In other words, the advantage of debt management over direct regulation is that it "gets in all the cracks" (Stein 2013b).

GHS argue that this crowding-out motive for issuing short-term T-bills may be of the same order of magnitude as the direct motive for producing debt with the liquidity services highlighted above. Thus, when weighed against the fiscal risk costs of issuing additional short-term debt, this financial stability benefit may be sufficient to meaningfully shorten the optimal maturity structure of the government debt.

E.   Quantitative assessment and debt counterfactuals

Taken together, the analysis suggests that the forces in favor of short-term debt appear to be larger than conventionally thought. Similarly, the arguments in favor of long-term debt appear to be weaker than often thought. Still, this does not provide much quantitative guidance as to whether the weighted average maturity of the debt should be 12 months, 60 months, or 120 months. In this section, we take a simple approach to this question by describing the results of a counterfactual exercise in which we suppose that the government had relied much more heavily on short-term debt following the 1951 Accord.

We focus on the extreme case in which the government had financed the debt using 3-month T-bills, meaning that the entire outstanding debt would be refinanced four times per year. We start by noting that the change in the debt equals the primary deficit (outlays and net transfer payments minus total tax revenue) plus interest paid:

$$Debt_t = Debt_{t-1} + PrimDef_t + Interest_t, \tag{5}$$

where $Debt_t$ refers to the public debt held at the end of the fiscal year t (including debt held by the Federal Reserve), $PrimDef_t$ refers to the primary deficit, and $Interest_t$ refers to interest paid, including coupons on notes and bonds and imputed interest on Treasury bills that do not pay a coupon. We obtain $Debt_t$, and $Interest_t$ from the Office and Management and Budget, and use this to back out the primary deficit according to equation (5). Our data start in June 30, 1951 (start of the 1952 fiscal year), to capture the start of the post-Accord period. All calculations for this section are provided in an online appendix.

Figure 8 shows the time-series of average interest payments, expressed as a percentage of GDP. Interest payments average 1.8 percent of GDP per year, reflecting an average effective nominal interest rate paid of 4.97 percent. *Interest/GDP* is quite smooth over time, with a standard deviation of only 0.72 percent. In part, this reflects the average long-term nature of the debt and the fact that debt-to-GDP has been moderate over much of this 1952–2013 sample.

Figure 8
Debt and Deficits under Counterfactual Debt Management Plans

The counterfactual exercise measures the path of deficits and debt supposing that the U.S. Treasury had financed itself using rolling 3-month Treasury bills starting in 1952. We use the identity:

$$Debt_t = Debt_{t-1} + PrimDef_t + Interest_t,$$

and data on debt and net interest payments to back out primary deficits. Debt held by the public is from the Office of Management and Budget, Net Interest Expense is also from the Office of Management and Budget. In the counterfactual case, starting in September 1952, we compute Net Interest as the compounded interest from rolling over 3-month Treasury bills over the government fiscal year. Interest rates are from the Federal Reserve of St. Louis. Panel A shows actual and counterfactual interest payments, scaled by GDP. For purposes of comparison, it also shows the path of primary surpluses and deficits (surpluses carry a positive sign). In Panel B, we combined interest payments and the primary balance to show the combined total surplus, in both the actual data and the counterfactual. In Panel C we show the debt burden, as a percentage of GDP, in the realized and counterfactual cases.
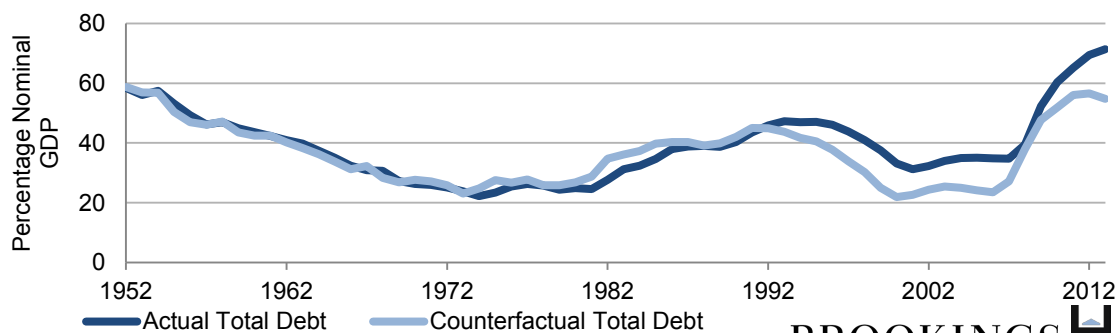
Panel A: Actual and Counterfactual Interest Payments, and Primary Balance (% of GDP)
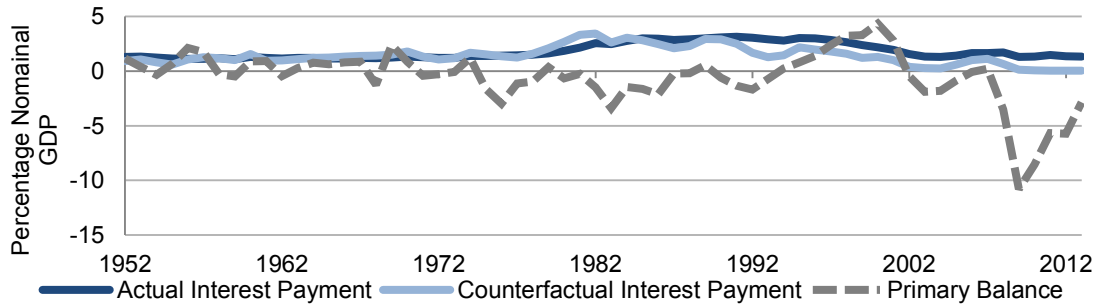
Panel B: Total Surplus in Actual Data and Counterfactual (% of GDP)
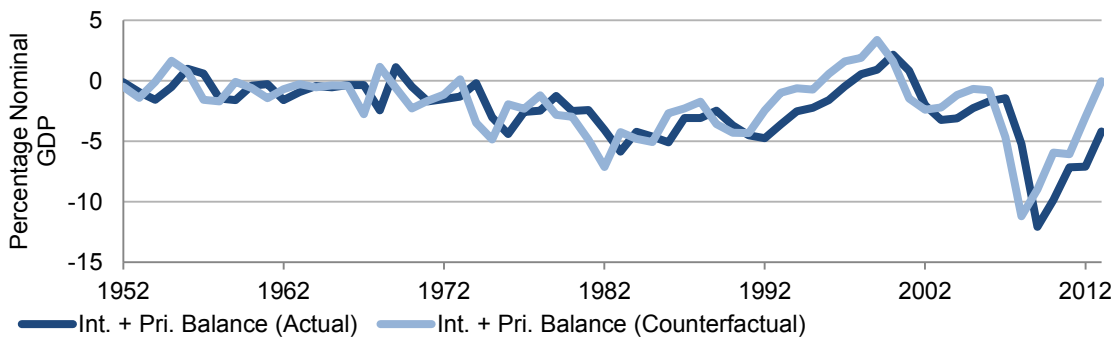
Panel C. Debt and Counterfactual Debt Burden (% of GDP)

Our counterfactual exercise assumes a debt management strategy of continuously rolling over 3-month Treasury bills. We assume that the actual short-term interest rates that have prevailed since 1952 would have also prevailed under this counterfactual strategy. In doing so, we ignore the fact that the path of short-term interest rates would likely have been slightly different due to the deviations from Ricardian equivalence discussed above. For instance, in the extreme, financing the government entirely with short-term bills might make the government susceptible to bank-run-like outcomes which could have a significant impact on interest rates.

We compute the effective annual interest rate under this counterfactual debt management policy, $R^{Counterfactual}$, by compounding 3-month Treasury bill rates.[33] We then compute counterfactual interest payments according to

$$Interest_t^{Counterfactual} = Debt_{t-1}^{Counterfactual} \times R_t^{Counterfactual}. \tag{6}$$

Modifying equation (5), this allows us to compute a counterfactual evolution of the debt stock

$$Debt_t^{Counterfactual} = Debt_{t-1}^{Counterfactual} + PrimDef_t + Interest_t^{Counterfactual}. \tag{7}$$

Thus, starting with the actual debt outstanding at the end of 1951, we can construct a counterfactual path for *Interest/GDP* and *Debt/GDP*, taking as given the government's realized primary deficits.

Figure 8 shows that issuing short-term debt results in higher volatility of interest payments. The volatility of *Interest/GDP* is 0.84 percent under the counterfactual strategy, compared to 0.72 percent under the actual strategy. How should we evaluate these numbers? Panel A shows that the volatility of *Interest/GDP*—whether in the actual or counterfactual case—is quite small compared to the volatility in *PrimDef/GDP*, which has an annual time-series volatility of 2.54 percent. But a simple comparison of the time-series volatilities under different financing regimes does not suffice, because the net increase in the debt stock is the *sum* of interest payments and the primary deficit, meaning that a short-term financing policy can serve as a hedge against primary deficits. This is for the simple reason that the primary deficit tends to be larger when the economy is performing poorly, and is associated with low or declining short-term interest rates. The correlation between the 1-year interest rate and the primary deficit is -0.26. The correlation between the interest rate on 10-year bonds and the primary deficit is, on the other hand, not essentially zero.

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[33] We obtain month-end data on 3-month T-bill rates from the Federal Reserve Bank of St. Louis's FRED database. To compute the interest paid on a fiscal year basis (the Federal government's fiscal year runs from October 1 to September 30), we compute the effective annual rate as

$$R^{Counterfactual} = [(1+r_{(Sept.)})(1+r_{(Dec..)})(1+r_{(March)})(1+r_{(June)})]^{1/4} - 1,$$

where the subscripts on the 3-month T-Bill rate indicate the relevant month-end.

How much did the government save in this counterfactual financing strategy? Our calculations suggest the government would have saved 0.38 percentage points of GDP per year. Panel B shows that the cumulative interest savings would have meaningfully lowered the debt stock over time. By the end of the sample, the public debt was 71.3 percent of GDP, whereas in the counterfactual case, it was only 54.8 percent.

What this makes clear is that *ex post*, the government would have been better off financing its debt over the short term. But, to be clear, we are not suggesting that we should use this exercise as an estimate of the interest cost savings that would be obtained by shortening the maturity of the debt going forward. For one, in the 1980s, the U.S. experienced a decline in inflation that was unexpected by market participants, a situation unlikely to be repeated. Notwithstanding, Figure 3 shows estimated *ex ante* term premia as estimated by Kim and Wright (2005), which averaged 45 basis points per annum on 5-year zero-coupon debt from 1989 to 2013. Second, the logic of our model suggests that the average savings we computed overstates that welfare benefits from adopting a shorter debt maturity profile. The reason is that some of the term premium on long-term bond is surely compensation for risk in the traditional frictionless, asset-pricing sense. However, the government is not making households any better off by issuing short-term to "economize" on this risk premium since this necessarily increases the interest rate exposure of household's tax liabilities. Only the component of the term premium that is due to the fact that T-bills provide higher liquidity convenience services or stemming from segmented bond markets should count from a welfare perspective.[34]

In summary, the main messages we take from these counterfactual exercises are (1) that the additional budgetary volatility incurred by shifting the government debt into short-term securities is less than is commonly supposed, and (2) that doing this would have allowed the government to capture liquidity premia on an ongoing basis.

IV.   DEBT MANAGEMENT BEYOND MATURITY STRUCTURE

This framework for debt management can be extended to accommodate a host of issues beyond the question of the optimal maturity structure. We briefly discuss these extensions here.

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[34] We have repeated this counterfactual exercise in real terms, meaning that we compute the real value of the debt and the real interest (both as it happened and in the counterfactual case in which the government rolled over short-term debt). Expressed in real terms, the "interest burden" of the debt reflects a combination of shocks to real interest rates and inflation. Real interest payments are more volatile than nominal interest payments. The standard deviation in the counterfactual case is 1.97 percent, more than twice the standard deviation of actual interest paid (0.81 percent). Both series are still less volatile than real primary deficits, which have a standard deviation of 2.52 percent. The correlation between the real actual interest payment and the real primary deficit is not significantly different from zero. In the counterfactual case, however, the correlation between effective real interest payments and the primary deficit is -0.39. This can be compared to the -0.26 (above) correlation in nominal terms.

A.   The choice of nominal versus inflation-indexed debt

Consider first the choice between long-term nominal and inflation-indexed debt. To do so, we need to distinguish between shocks to real interest rates and the rate of inflation. The government can now issue short-term bonds (automatically inflation-indexed since we assume that uncertainty about inflation is minimal at short horizons), long-term nominal bonds, and long-term inflation-indexed bonds.

Suppose that government debt managers take path of inflation and short-term real rates as given. If short-term real interest rates tend to be high when inflation is high—as one would expect if the Federal Reserve follows a standard Taylor rule—then short-term debt and long-term nominal debt will be complementary from a fiscal risk perspective. Suppose for example that inflation is low, so that the real tax burden needed to service long-term nominal debt is high. Since short-term real rates are likely to be low in such a state, this makes short-term debt a good hedge for long-term nominal debt.

Beyond these risk management considerations, there is strong evidence that long-term nominal Treasuries embed a significant liquidity premium relative to long-term Treasury Inflation-Protected Securities (TIPS), (Campbell, Shiller, Viceira 2009); Fleckenstein, Longstaff, and Lustig 2013; Pflueger and Viceira 2013).

How large is the premium on nominal versus inflation-indexed debt? Fleckenstein, Longstaff, and Lustig (2013) estimate an average liquidity premium of roughly 55 bps on nominal Treasuries compared to TIPS from 2004 to 2009.[35] Pflueger and Viceira (2013) find similar magnitudes for the U.S., as well as from inflation-indexed debt in the UK. Both papers argue that this is not simply the capitalized value of future bid-ask spreads or other transaction costs. Instead, it appears to reflect a special liquidity premium.

In Figure 7, we show an estimate of the liquidity premium on nominal bonds from 2004 to 2014. Specifically, following these authors, our estimate of the nominal liquidity premium is the yield on 5-year TIPS, plus the yield on a 5-year inflation swap, minus the yield on a 5-year nominal Treasury note. Since an investor can generate the exact same financial cash flows by buying a 5-year nominal Treasury or by buying a 5-year TIPS note and entering into an inflation swap (receiving the swap yield and paying realized inflation), this spread should be zero if investors derived the same liquidity services from holding nominal and inflation-indexed debt. By contrast, this spread will be positive if investors derive greater liquidity services from holding nominal debt. As shown in Figure 7, the liquidity premium on nominal Treasuries versus TIPS spiked during the financial crisis and has average roughly 35 bps from 2004 to 2014.

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[35] Specifically, Fleckenstein, Longstaff, and Lustif (2013) show that the price of nominal Treasury bonds exceeds the price of a portfolio consisting of a maturity-matched TIPS and an inflation swap that replicates the cash flows on the nominal Treasury. This implies that the yields on nominal Treasuries are lower because of a liquidity premium.

Formally, let S be the fraction of debt that is short term and N be the fraction of debt that is long term and nominal. The remaining $1-S-N$ of the debt will be long term and inflation-indexed. Let $\theta \geq 0$ be the liquidity premium on long-term nominal debt and $\gamma \geq 0$ be the premium on short-term debt, both measure relative to long-term TIPS. Extending the logic in GHS, the optimal debt portfolio is given by

$$S = \frac{1}{2} + \frac{1}{\lambda D}\frac{\gamma}{V_r}\frac{1}{1-R_{r,\pi}^2} + \frac{1}{\lambda D}\frac{\theta}{V_r}\frac{\beta_{r,\pi}}{1-R_{r,\pi}^2} \qquad\qquad (10a)$$

$$N = \frac{1}{\lambda D}\frac{\theta}{V_\pi}\frac{1}{1-R_{r,\pi}^2} + \frac{1}{\lambda D}\frac{\gamma}{V_\pi}\frac{\beta_{\pi,r}}{1-R_{r,\pi}^2}, \qquad\qquad (10b)$$

where V_π is the variance of inflation, $\beta_{r,\pi}$ is the coefficient from a regression of short-term real rates on inflation, $\beta_{\pi,r}$ is the coefficient from the reverse regression of inflation on real rates, and $R_{r,\pi}^2$ is the goodness of fit from these regressions.[36]

To interpret equations (10a) and (10b), note that if $\gamma = \theta = 0$, the government should not issue long-term nominal debt since doing so only raises the variability of the tax burden in real terms. This is consistent with Summers (1997), who summarized the rationale for introducing TIPS in 1997 as: "We were attracted to them by their ability to stabilize debt payments by the government."

Next, if shocks to short-term real rates and inflation are uncorrelated (so $\beta_{r,\pi} = \beta_{\pi,r} = R_{r,\pi}^2 = 0$), the optimal short-term share S depends on the premium on short-term debt (γ) and is limited by the volatility of short-term real rates (V_r), and the optimal share of long-term nominal debt depends on the premium on nominal debt (θ) and is limited by the volatility of inflation (V_π). Finally, in the plausible case where inflation and real rates are positively correlated, equations (10a) and (10b) capture the complementarity of short and nominal debt from a fiscal risk perspective. For instance, the tendency to issue short and nominal debt is largest when the R^2 from a regression of real rates on inflation is high. In this case, short-term debt is a good hedge for nominal debt and vice versa, so the government can be quite aggressive in catering to the special liquidity demands for short-term debt and long-term nominal debt without incurring significant tax-smoothing costs.

We have assumed that government debt managers take the inflation process as given. While this strikes us as an accurate description of the situation today and in most of the post-war era, this may not be true in situations where the debt burden becomes extreme. By relying on nominal debt, governments may be able to implement *ex post* state-contingency by engineering a large inflation following the accumulation of significant fiscal deficits, and the government may be able to smooth the real tax burden over time (Stokey and Lucas 1983). Of course, this form of *ex post* state-contingency comes at a significant cost: economists typically think that a large,

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[36] Equations (10a) and (10b) follow from the observation that with, an unknown future inflation of π, we have $(\lambda/2)Var[\tau] = (\lambda/2)D^2[V_r(S-S_0)^2 + V_\pi N^2 - 2(S-S_0)NC_{\pi,r}]$ where $V_\pi = Var[\pi]$ and $C_{\pi,r} = Cov[\pi,r]$.

unexpected surge in inflation is costly. Nonetheless, this important safety valve may make it desirable to rely on long-term nominal debt as opposed to inflation-indexed debt. Looking across history, Reinhart and Sbrancia (2011) and Piketty (2013) describe how the accumulation of massive government deficits during major wars has often been followed by inflationary episodes that have significantly reduced the debt burden in real terms.[37] Relatedly, Ferguson, Schaab, and Schularick (2014) suggest that periods of central bank balance sheet growth have been undone mostly via inflation rather than nominal declines.

B.   Catering to other liquidity premia

B.1   On-the-run Treasuries

"On-the-run" Treasuries typically embed a liquidity premium relatively to "off-the-run" issues with nearly identical cash flows (Warga 1992; Krishnamurthy 2002). As explained in Vayanos and Weill (2008), such a liquidity premium arises due to thick-market externalities that make on-the-run securities especially useful from a risk-management and hedging perspective. Debt-buyback operations, such as those undertaken from 2000 to 2001, can be understood as a case where issuing securities with a greater liquidity premium imposes little if any additional fiscal risk for the government. Specifically, if there is a special liquidity premium on "on-the-run" Treasury securities (e.g., the on-the-run 30-year bond), then the government can engage in a form of liquidity creation that entails little, if any, fiscal risk by issuing 30-year bonds that command a large convenience premium and repurchasing these bonds when they become 29-year bonds with a much smaller convenience premium (Garbade and Rutherford 2007).

B.2   Market infrastructure

Our trade-off framework is also useful for thinking about an often-mentioned objective of Treasury debt management: promoting the infrastructure and broader efficiency of U.S. capital markets. In particular, it may be useful to investors in other fixed-income assets—including corporate bonds, municipal bonds, mortgage-backed securities, and asset-backed securities—to have liquid benchmark Treasury securities with maturities of 2, 5, 10, and 30 years. Such transparent benchmarks for the risk-free rate may facilitate new issue pricing in these other markets and may also be useful for hedging (Fleming 2000). The desire to maintain liquid benchmark Treasury issues became an increasing concern in the late 1990s when the government ran a series of large fiscal surpluses and was expected to significantly pay down the debt over the time. Indeed, one of the major rationales for the Treasury's 2000–2001 buyback operations was to maintain large 5, 10, and 30-year on-the-run benchmark issues in an era of declining overall

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[37] This regularity is linked to the fiscal theory of the price level (Leeper 1991; Sims 1994; Woodford 1995; Cochrane 2001). This theory says that if a government has an unsustainable fiscal policy, such that it will not be able to repay its debts out of future primary surpluses, then it will choose to inflate away the debt. Thus, the current nominal price level is pinned down by the current level of nominal government debt and the expected value of future real primary surpluses. In this way, fiscal discipline is a critical necessary condition for price stability.

debt supply (Sachs 1999, Fleming 2000). Indeed, several sovereigns, including Chile, have opted to maintain a liquid benchmark yield curve even when total debt was near zero.[38]

Promoting financial market infrastructure by issuing liquid benchmark securities can be viewed as a kind of nonpecuniary service generated by government debt. However, some of the "benchmark" value of Treasuries has a public good character, since it is nonrivalrous and nonexcludable, and unlike the case of other liquidity services—which are rivalrous and excludable—this value is unlike to be fully captured in the market price.

V.   THE OPTIMAL DIVISION OF LABOR BETWEEN TREASURY AND FED

Given the target structure for the consolidated government debt, how should this be operationalized by the Fed and Treasury? And how should decision-making authority shift—if at all—between the Treasury and the Fed as economic conditions change?

A.   Optimal debt maturity and the monetary policy cycle

In Sections III and IV we described a series of tradeoffs that the consolidated government must make to determine the maturity structure of the debt. For simplicity, our discussion treated these tradeoffs as static in nature. However, if the tradeoffs shift over time—leading to a time-varying optimal debt structure—who should be in charge? For instance, how should the government respond if heightened concerns about fiscal risk suggest a longer average maturity at the same time that a desire to bolster aggregate demand suggests a shorter average maturity? The consolidated debt maturity generated by independent Treasury and Fed action may differ substantially from the maturity structure that would result from a coordinated policy. Under the current arrangement, neither the Federal Reserve nor the Treasury is caused to view debt management on the basis of the overall national interest.

Table 4 describes the current division of labor between the Treasury and the Fed. Over the past 30 years, the two traditional objectives of debt management—achieving low-cost financing and minimizing fiscal risk—have been handled by Treasury. The two nontraditional objectives of modern debt management include managing aggregate demand and promoting financial stability. The former has been the exclusive domain of the Fed, while the latter has involved cooperation between Fed and Treasury, with the Fed taking a lead in bank regulation.[39]

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[38] Since 2003, the Chilean government has regularly issued domestic bonds despite being in a net creditor position. The stated aim of these issuances is to enhance bond market liquidity in Chile.

[39] For example, see the joint statement by the Federal Reserve and Treasury, "The Role of the Federal Reserve in Preserving Financial and Monetary Stability: Joint Statement by the Department of the Treasury and the Federal Reserve," March 2009.

Table 4
Debt Management over the Monetary Policy Cycle

The four columns of the table list the four objectives of debt management: Achieve the lost cost financing, managing fiscal risk, managing aggregate demand, and promoting financial stability. For each objective, the table describes which agency is historically charged with the objective, the main policy instrument used to manage the objective, and the normal implication for debt maturity. The bottom rows consider two scenarios, one expansionary, and one contractionary, and the implications for debt management.

	Traditional Policy Objectives			Nontraditional Policy Objectives	
	Achieve Lowest Cost Financing		Managing Fiscal Risk	Managing Aggregate Demand	Promoting Financial Stability
Weight on Objective	??		??	??	??
Agency Historically Charged with Objective	Treasury Department		Treasury Department	Federal Reserve	Federal Reserve
Key Market Friction(s)	Investors derive money-like services from holding short-term debt	Long-term bond market partially segmented from other markets	Convex costs of taxation, budget volatility costs, run-like problems	Long-term bond market partially segmented from other markets	Excessive maturity transformation by private intermediaries
Main Policy Instrument	Fraction of debt that is very short term	Weighted average duration of debt	Weighted average duration of debt	Weighted average duration of debt	Fraction of debt that is very short term
Normal Implication for Debt Maturity	Issue more debt that is very short term	Target a shorter average duration of debt	Target a longer average duration of debt	Target a shorter average duration of debt	Issue more debt that is very short term
Implications of Contractionary Monetary Policy that Raises Short-Term Nominal Rates	→ Rise in premium on money-like assets → Increase amount of very short-term debt		→ None, assuming government holds average duration constant	→ None, assuming government holds average duration constant	→ Rise in premium on money-like assets → Increase amount of very short-term debt
Implications of Recession Where Deficits Rise and ZLB is Reached	~	~	→ Extend average duration since fiscal risk looms large	→ Shorten average duration to bolster aggregate demand	~

Left margin labels: Objectives and Tactics; Conflicts Driven by Monetary Policy

To tackle the question of who should be assigned responsibility over debt management (and whether this assignment should change with economic circumstances), we start by describing more precisely the circumstances in which debt management objectives, as they are currently interpreted by the Treasury, conflict with the traditional output-inflation tradeoff objectives of the central bank, and how easily this conflict can be overcome.

A.1 Conflict between the Fed and Treasury due to variation in liquidity premia

Consider the stylized description of the monetary policy objectives as given by the Taylor rule (Taylor 1993), in which the central bank raises interest rates when inflation is above target, and lowers interest rates when output is below potential. Further, suppose that the central bank uses the short-term interest rate as its only policy instrument. How might the optimal maturity structure of the consolidated debt be expected to vary over the monetary policy cycle, and how might this interact with the central bank's traditional objectives of promoting both full employment and stable prices?

Consider the case in which the central bank raises interest rates to reign-in aggregate demand to head off an incipient rise in inflation. With higher short-term rates, the opportunity cost of holding paper money and non-interest-bearing deposits increases, and this increases demand for money-like short-term debt such as Treasury bills (Nagel 2014). If the Treasury places weight on issuing "cheap" money-like securities to minimize the cost of the debt, the government should partially accommodate this greater demand by issuing more short-term T-bills. This motive may be further enhanced if the Treasury seeks to lean against the possibility that elevated demand for money-like debt may lead to excessive private liquidity transformation—i.e., to avoid a surge in short-term debt issuance by financial intermediaries seeking to capture the heightened liquidity premium.

In this case, the conflict between the Fed and the Treasury arises because the Treasury's effort to shorten its debt results in unintended consequences from aggregate demand. As argued earlier, shortening the debt might reduce the duration-weighted supply of debt held by the public, and thereby depresses the term premium component at long-term rates at precisely the same moment when the central bank is trying to tighten monetary policy.[40]

Is there a way out in which both Treasury and central bank objectives could be accomplished without explicit coordination on debt management? In the case described above, this could be accomplished by the central bank raising the short rate by more than it might otherwise have

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[40] This assumes that expanding the supply of very short-term bills forces the Treasury to lower the average duration of the debt. However, at noted by GHS, one may be able expand the supply of short-term bills while holding average duration or roughly constant. For instance, to respond to the heightened demand for very short-term debt, the Treasury might increase its issuance of 1- and 3-month bills and reduce its issuance of 6-month and 1-year bills. At the same time, the Treasury could expand its issuance of 2-year notes in order to hold the average duration constant. In this way, the government might be able to respond to the heightened demand for short-term money-like debt without depressing the term-premium component of long-term yields.

done, absent the Treasury's debt management response. Through this form of "sterilization"—although a strict second-best to joint decision on debt management—the central bank can undo aggregate demand consequences of debt management.

The opposite case—in which the central bank lowers rates while the Treasury lengthens debt maturity—poses more difficulty. If nominal interest rates are positive, then the central bank can sterilize a rise in the average maturity by lowering rates. However, if interest rates are at or near the zero lower bound, debt management limits the central bank's ability to pursue its traditional dual mandate.

A.2 Fed and Treasury conflict due to changes in outstanding government debt

A second reason why optimal debt maturity may vary over the monetary policy cycle has to do with fiscal risk. When the debt rises as a percentage of GDP, the Treasury will prudently want to extend the average maturity of the debt to reduce refinancing risk. In ordinary circumstances, the debt-to-GDP ratio evolves slowly, reflecting the gradual accumulation of deficits or surpluses over time. And thus, during ordinary circumstances, we wouldn't expect debt-to-GDP ratio—and thus the optimal maturity structure of the debt—to be tightly linked with monetary policy objectives, which vary at a business cycle frequency. However, things are different when the economy enters a severe downturn, such as what the U.S. experienced in 2009. In this case, increased fiscal expenditures result in a rapidly growing debt stock, leading the Treasury to reevaluate the optimal maturity structure of its debt. At the same time, the central bank would like to aggressively use its conventional policy instrument to stimulate aggregate demand.

As long- as short-term interest rates are above zero, the central bank can in principle offset the impact of rising Treasury debt maturity through further reductions in the short-term rate. But sterilization of this sort is impossible once interest rates reach the zero lower bound. At this point, unless there is coordination between the Treasury and the Fed, it is as if the Fed has partially ceded stabilization policy to the Treasury.

A counterargument to this is that the Fed can always use its own balance sheet policies—effectively debt management—to undo whatever actions Treasury takes. For instance, if the Fed wants to reduce the supply of 10-year equivalents by $3 trillion to depress long-term rates and the Treasury's precautionary maturity extension raises the supply by $1 trillion, the Fed can simply perform an additional $1 trillion of QE to undo the Treasury's maturity extension. In other words, if the Fed is always the last mover, and the Fed has access to the same set of policy tools as the Treasury, it can always undo whatever the Treasury does.

Clearly, such a "solution" is problematic on many fronts. First, it puts all of the weight on the Fed's objective function, and thus ignores the Treasury's fiscal motivation for increasing maturity in the first place. Second, it is a roundabout way of achieving the central bank's objective. If the central bank is free to choose the government's consolidated debt structure, then the Treasury should simply hand over the keys. Third, the Fed may already be constrained in its

QE operations by public perceptions about the size of its balance sheet, and in this case it makes no sense to further constrain the policy by forcing it to additionally undo Treasury action.[41]

B.   The optimal division of labor

To sum up, debt management may conflict with monetary policy objectives for at least two reasons. First, when the government alters the share of its debt that is short term to react to shifts in money demand, this may have implications for aggregate demand that differ from the Fed's objectives under its traditional dual mandate. Second, the set of circumstances in which fiscal risk looms large—leading the Treasury to lengthen the average maturity of the debt—are also circumstances in which the central bank may be up against the zero lower bound on conventional monetary policy.

Where does that leave us? In the case of positive short-term interest rates, we favor an arrangement under which the central bank can manage the inflation output tradeoff as it sees fit, and can sterilize the aggregate demand impact of any policies that change the maturity composition of the debt using the short-term interest rate. Debt policy can be made by the Treasury on grounds of optimal public finance broadly understood to include financing the government at least cost over time, managing fiscal risk, and promoting financial stability. But, because of the importance of debt management for the functioning of financial markets and because of its relation to financial stability, the Federal Reserve should have a more significant advisory role than it does currently.

If the central bank is able to sterilize the effects of debt management on aggregate demand using the short-term interest rate, then is there any reason for the Fed and Treasury to cooperate? Suppose that, following Treasury's decision on the maturity structure of the debt, the Fed can precisely fine tune the short-term interest rate to achieve a desired level of aggregate demand. Absent cooperation on debt management, policy outcomes will be at second best, because they necessarily reflect the central bank's weights on the output-inflation tradeoff over Treasury debt management objectives. More broadly, using two instruments sequentially to achieve four policy goals is inferior to choosing the two instruments simultaneously. This conclusion is further reinforced when we recognize that policy instruments map to policy outcomes with long and variable lags and with considerable uncertainty.

How do we see cooperation between the Fed and the Treasury occurring in practice? A natural solution would be for the Fed and the Treasury to annually release a joint statement on the strategy for managing the U.S. government's consolidated debt. This would establish a plan for the maturity structure and composition of debt issued by the Treasury, and supported by the Federal Reserve. The Fed would be given the flexibility to make interim adjustments to debt

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[41] Rudebusch (2009) suggests that the $2 trillion Fed balance sheet in 2009 "only partially offset the funds rate shortfall." Relatedly, Rudolph (2014) argues that the Fed asset purchases would need to reduce long-term rates by 200 basis points to offset the shortfall implied by a standard Taylor rule.

management policy to engage in large-scale outright purchases or sales in response to economic or financial developments if such policies were needed to pursue its dual stabilization mandate. At the same time, annual coordination of this sort would make it unlikely that the Fed and the Treasury would be working at cross purposes for long periods of time.

At the zero lower bound, this arrangement would cause the Treasury to internalize the Federal Reserve's desire shorten maturity in order to stimulate aggregate demand. Similarly, the Federal Reserve would have to recognize the Treasury's precautionary fiscal motive for lengthening the maturity. In such situations a fully coordinated policy that the Treasury and Fed pursue with respect to currency intervention should be the norm.

There is also the question about which agency should accommodate shifts in the demand for money-like short-term debt that may arise over the business cycle as well as higher-frequency demand shifts due to "flight to quality" events. For instance, consider the large increase in demand for liquid short-term debt during the 2008–2009 global financial crisis or during the fall 1998 crisis. Should such a demand shock be accommodated by the Treasury quickly issuing a large amount of bills? Or should it be accommodated by the Fed purchasing longer-term Treasuries financed either through an increase in interest-bearing reserves or reverse repurchase agreements (i.e., via Fed balance sheet expansion) or by selling Treasury-bills (i.e., via an Operation Twist)?

Because Treasury bills, reverse repurchase (RRP) agreements with the Fed, and interest-bearing reserves are all very close substitutes, in principle either the Fed or the Treasury could take the lead in accommodating shifts in the demand for money-like short-term government debt. And regardless of whether the Treasury or Fed played the lead role, greater coordination is called for on this front since the Treasury and the Fed share responsibilities for promoting the stability of the financial system.

On balance, it seems most natural to delegate this role to the Fed due to its operational expertise in open market operations and its expertise in communicating with participants in funding markets.[42] In a sense, responding to shifts in the demand for money-like short-term debt is central banking in the classic sense of elastically supplying a special asset that supplies liquidity services and impacts financial stability. For instance, by using its RRP capability, the Fed could expand and contract the size of SOMA's holdings of long-term Treasuries backed by reverse repo funding in order to target a constant convenience premium on short-term money-like debt, which would be accomplished through standard open market operations. Of course, if this

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[42] Such high-frequency accommodation would likely pose significant operational challenges for the Treasury. For instance, it would be difficult to quickly contract the supply of bills in response to a change in market conditions (i.e., it would need to issue long-term notes or bonds to repurchase bills). In contrast, the Fed would simply contract the size of the SOMA by open-market sales of long-term Treasuries, unwinding the associated RRP funding. It can also be argued that the Fed has a comparative advantage at managing any "rollover" risk associated with short-term debt: there cannot be a destabilizing "run" on the monetary base, but there could be a run on the T-bill market.

liquidity provision and financial stability role were delegated to the Federal Reserve it would likely need to maintain a balance sheet that was larger than its pre-crisis balance sheet.[43]

VI. CONCLUSION

Motivated by the blurring of functions between the Federal Reserve and Treasury following the financial crisis, this paper reconsiders the problem of the optimal management of the public debt. Our primary contributions are to quantify the extent to which the Fed and Treasury have been working at cross purposes and to present a framework in which traditional debt management objectives—financing the government at the lowest cost over time and insulating the budget from refinancing risk—can be considered in conjunction with the nontraditional objectives of the QE era: managing aggregate demand and promoting financial stability.

We emphasize three findings. First, we suggest that the case for shorter-term debt is stronger and the case for maturity extension is weaker than is generally thought. Specifically, the additional budget volatility caused by shifting more debt to short-term is modest, particularly when compared with the volatility of primary deficits. Second, a primary motive for issuing more short-term debt—capturing the extra liquidity premium on short-term bills—varies substantially over time. At the time of writing, for example, the liquidity premium on short-term bills stands at all-time lows, reducing the incentive to go short-term right now. This also means that, even absent aggregate demand implications, debt management cannot be static. Third, because debt management is time-varying and has implications for aggregate demand, it puts the Treasury into conflict with the Federal Reserve, even if the Federal Reserve is not explicitly using debt management as a policy tool. However, we suggest how improved policy coordination could substantially reduce this conflict.

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[43] Gagnon and Sack (2014) and Cochrane (2014) also argue in favor of maintaining a permanently larger Fed balance sheet in the new era with interest-bearing Fed liabilities.

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