

March 10, 2015

Recent Declines in Long-Term Interest Rates: Causes and Potential Policy Implications¹

1. Introduction

Longer-dated sovereign yields have declined substantially not only in the United States, but also in most of the advanced foreign economies (AFEs) since the beginning of 2014, despite a partial rebound since the beginning of February. Although domestic factors may explain some of the decline in U.S. long-term rates, it seems unlikely that developments in the United States can account for all of the movement, given the relatively good performance of the U.S. economy and expectations that the Federal Reserve will begin to normalize the stance of monetary policy this year. At the same time, in light of the relatively weak growth in economic activity outside the United States and continued foreign monetary policy easing, an appreciable amount of the fall in long-term Treasury yields may owe to spillovers from abroad.

In this memo, we explore the role of global factors behind the sharp decline in Treasury yields since the beginning of last year. Key findings are:

- The decline in global long-term bond yields owes largely to much lower distant-horizon forward rates, which in turn appears to reflect depressed term premiums, as opposed to lower anticipated short rates, particularly in the United States.
- We identify three possible channels through which global factors may have put downward pressure on U.S. yields:
 - Weakness in foreign growth and inflation may have caused investors to lower their expectations for U.S. growth or inflation, resulting in lower expected future short-term interest rates.

¹ David Bowman, Stefania D'Amico, Michiel DePooter, Paul Dozier, Benson Durham, James Egelhof, Don Kim, Tom King, Robert Martin, Michele Modugno, Fabio Natalucci, Marcelo Ochoa, Marius Rodriguez, Carlo Rosa, Min Wei. We thank Jim Clouse, Dan Covitz, Eric Engstrom, Chris Erceg, Steven Kamin, Thomas Laubach, Mike Leahy, Lorie Logan, David Lopez-Salido, Michael Palumbo, Simon Potter, Bethanne Wilson, and Jason Wu for their comments.

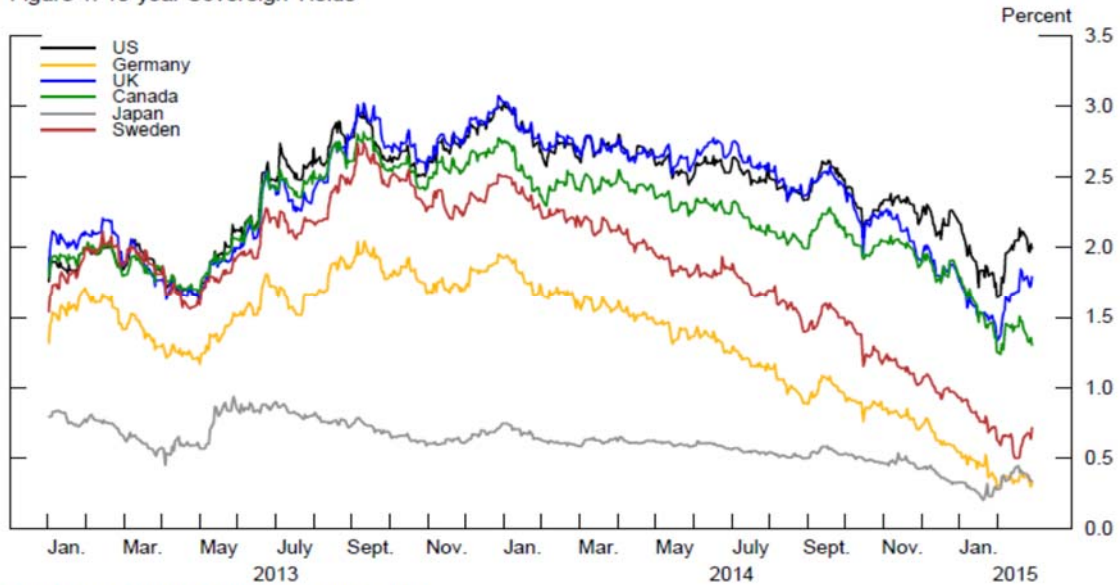
- Anxiety about the foreign economic outlook might have lowered the term premiums that investors require to hold longer-term Treasury securities.
- Monetary policy easing abroad may have had a direct impact on U.S. long-term yields and term premiums through a global portfolio balance channel.
- We find evidence suggesting that global factors did indeed compress term premiums and have been an important contributor to the decline in U.S. long-term rates mainly as a result of either concerns about the deteriorating global outlook or monetary policy easing abroad.
- Although we cannot entirely distinguish their relative importance, these channels have different implications for U.S. monetary policy.
 - If the drop in Treasury term premiums reflects mainly concerns about the global economic outlook and deflationary forces, and these concerns do materialize, then the FOMC may want to remove policy accommodation more gradually.
 - If instead the decline in term-premiums is mainly the result of additional policy accommodation abroad, then developments may call for future short-term rates to be higher, all else equal.

2. The Global Decline in Long-Term Rates

Most 10-year AFE sovereign yields have declined more than 100 basis points since the beginning of 2014, with German yields falling 160 basis points (Figure 1). As can be seen for a subset of countries in Table 1, long-term nominal yields, real yields, and inflation compensation have all fallen considerably. U.S. long-term nominal and real yields have decreased by less than AFE rates over the period and are currently higher than most foreign yields of comparable maturity. Nonetheless, the decline in U.S. long-term rates is still somewhat puzzling given the continued improvement in the U.S. economic outlook and the approaching commencement of the policy normalization process, which are both reflected in higher shorter-dated yields. Indeed, the movements in shorter-term yields seem somewhat easier to explain in light of the divergence in the

stance of monetary policy across countries. For example, 2-year rates rose in the United States while comparable maturity rates fell over the past year in the euro area and are now negative (Figure 2).

Figure 1: 10-year Sovereign Yields



Source: Bloomberg. Data through February 27, 2015.

Table 1. Domestic and Foreign Yields*

	Current Levels (Percent)			Change Since Jan 1, 2014 (Basis Points)		
	Germany	United Kingdom	United States	Germany	United Kingdom	United States
Nominal Yields						
2-Year	-0.23	0.59	0.66	-44	-13	27
5-Year	-0.09	1.28	1.54	-101	-71	-22
10-Year	0.33	1.86	2.10	-160	-130	-111
5-to-10 Year Forward	0.74	2.43	2.65	-219	-189	-201
Real Yields						
5-Year	-0.36	-0.93	-0.28	-20	-10	-7
10-Year	-0.88	-0.88	0.24	-125	-73	-64
5-to-10 Year Forward	-1.40	-0.83	0.77	-230	-137	-121
Inflation Compensation						
5-Year	0.27	2.22	1.83	-81	-61	-15
10-Year	1.21	2.74	1.86	-35	-57	-47
5-to-10 Year Forward	2.15	3.27	1.88	11	-52	-80

*U.S. and U.K. rates based on staff zero-coupon yield curves, German rates based on Bloomberg generic yields. Current levels and changes as of February 27, 2015.

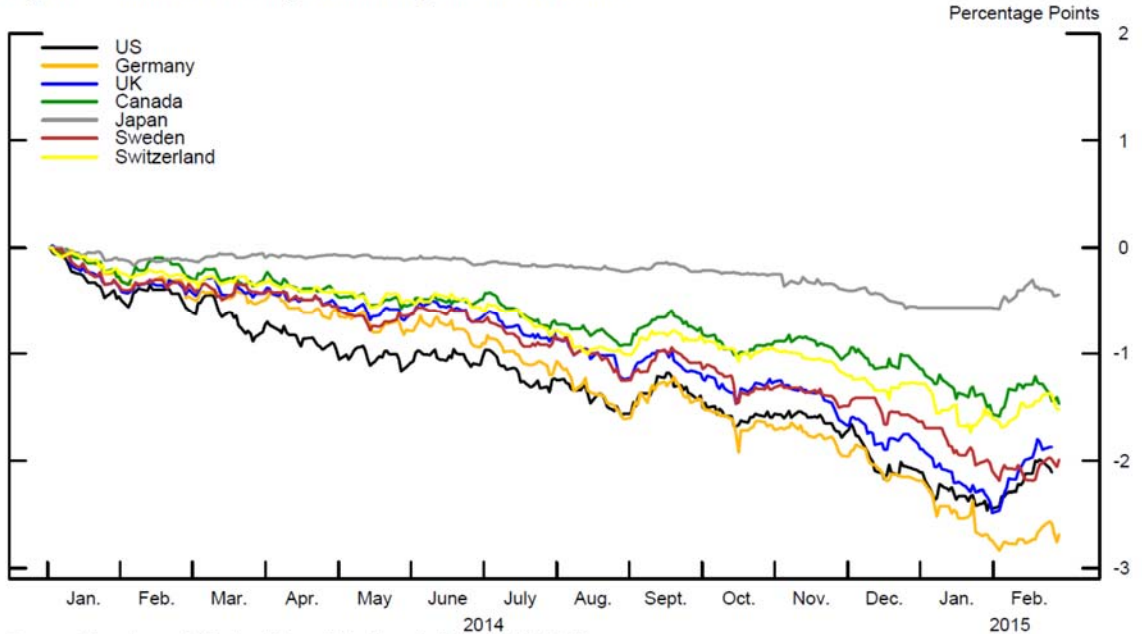
Figure 2: 2-year Sovereign Yields



Therefore, any puzzle regarding sovereign yields is related to the simultaneous global decline in longer-dated forward rates rather than to the behavior of near-term rates. As shown in Table 1, 5-to-10 year nominal forward rates have fallen around 200 basis points in the United States, United Kingdom, and Germany. In the United States, this drop has been associated with a notable decline in 5-to-10 year inflation compensation. As can be seen in in Figure 3, 9-to-10 year forward rates have decreased even more sharply in all AFEs, reaching their lowest levels in at least 30 years and outright record lows in the euro area and Japan. Similarly large declines have occurred for 5-to-10 year real forward rates. Long-term yields in the United States are typically highly correlated with U.K. and German yields (Figure 4a), but, interestingly, the correlation between far forward rates has risen since 2012, reaching the upper end of their historical range (Figure 4b).

The high correlation between U.S. and U.K. rates has continued even as those rates have moved back up over the intermeeting period. Both 10-year Treasury and Gilt yields have risen about 40 basis points in February, with most of the rise reflected in real far-forward rates. In contrast, German 10-year yields have remained essentially unchanged at very low levels.

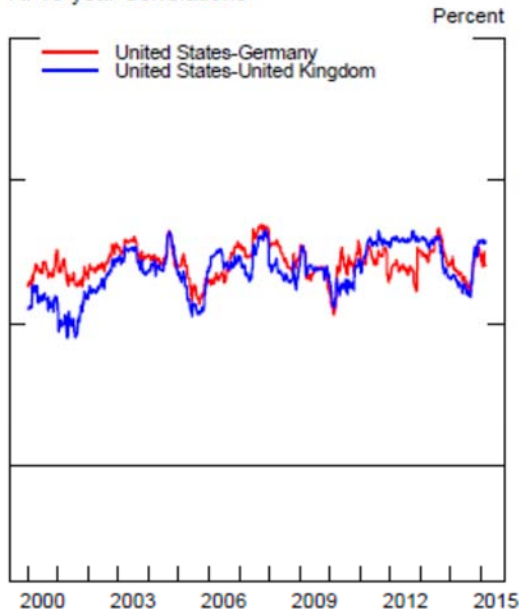
Figure 3: Cumulative Change in 9-to-10-year Forward Rates



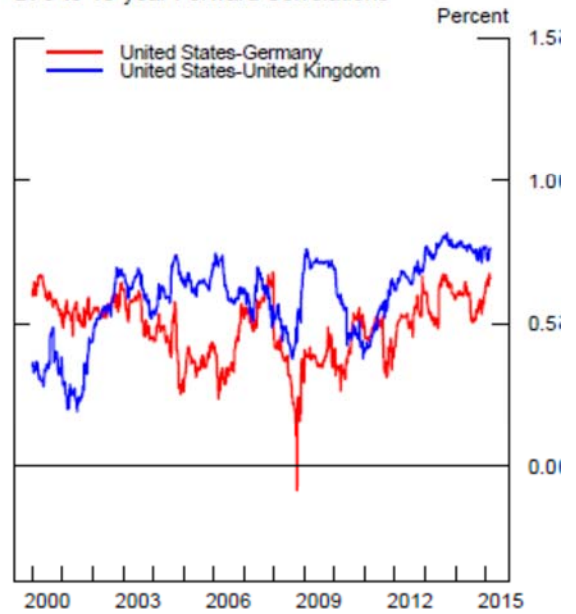
Source: Bloomberg, staff calculations. Data through February 27, 2015.

Figure 4: Yield Correlations*

A. 10-year Correlations



B. 9-to-10-year Forward Correlations



* 12-month moving average. Source: Bloomberg, staff calculations. Data through February 25, 2015.

Parsing Out the Decline in Long-Term Yields

Dynamic term structure models (DTSMs) can help shed some further light on the decline in long-term yields. Nominal DTSMs decompose nominal yields into average expected future short-term rates and term premiums, defined as the excess return investors require to hold long-term government bonds relative to rolling over a sequence of short-term bills.² Several DTSMs of U.S. nominal Treasury yields are estimated within the Federal Reserve System, and most (with the exception of the model maintained by the Chicago Fed) point to a decline in term premiums as the main driver of the sharp fall in 5-to-10 year nominal forward rates, with expected nominal short-term rates either declining by less or actually rising (Figure 5).³ Staff across the Federal Reserve System also maintain real DTSMs that further decompose changes in U.S. forward rates into average expected future real short-term rates, expected inflation, real term premiums, and inflation risk premiums.⁴ These decompositions are shown in Figure 6. Overall, these models point to reductions in both the real term premium and inflation risk premium, while the Board model and the Chicago Fed model also indicate modest declines in expected future real short rates and expected inflation.⁵

Board staff also maintain term structure models for a number of AFEs. Consistent with our findings for U.S. yields, these models imply that the majority of the declines in foreign far-forward rates can be attributed to falling term premiums (Figure

² DTSMs typically assume that movements in a few underlying factors span the variation in the yield curve and preclude arbitrage. The identification of various components (e.g., real rate expectations, inflation expectations, etc.) comes from the information contained in the historical time series patterns of nominal and TIPS yield curves, inflation, and possibly other relevant data, as well as the cross-section of yields at each point in time. The factors in DTSMs are typically assumed to be stationary. Therefore, especially given the short samples used to estimate key parameters, those models might have difficulty identifying permanent shifts in the equilibrium real rate in real time.

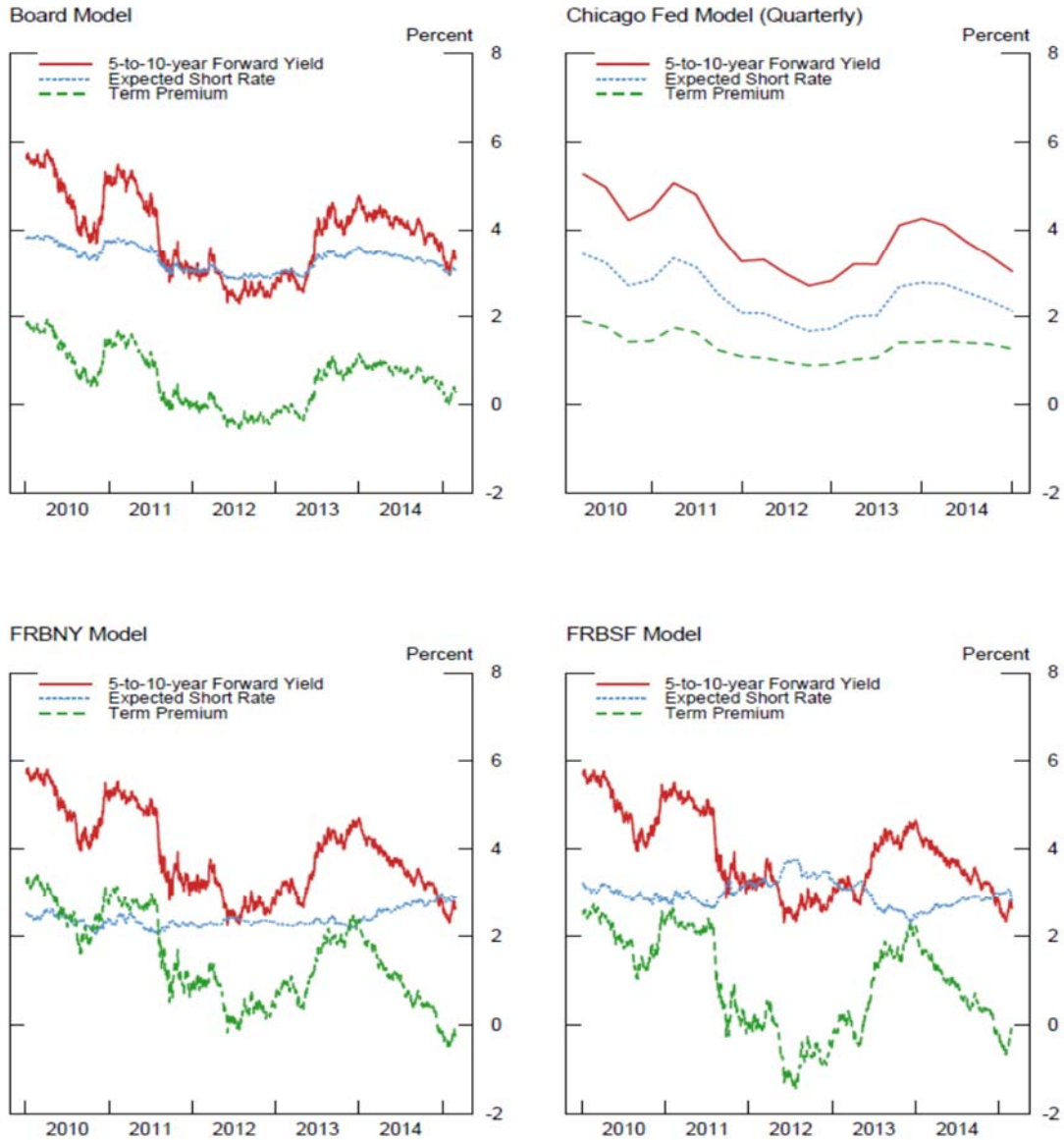
³ These models include the Board model based on Kim and Wright (2005), the New York Fed model based on Adrian, Crump, and Moench (2013), the San Francisco Fed model based on Christensen, Diebold, and Rudebusch (2012), and the Chicago Fed model based on Ajello, Benzoni, and Chyruk (2012). The models maintained in New York and San Francisco find that the decline in longer-term forward rates is more than accounted for by reductions in term premiums as the implied expected rates have actually risen.

⁴ These models include the Board model based on D'Amico, Kim, and Wei (2014), the Cleveland Fed model based on Haubrich, Pennacchi and Ritchken (2012), the Chicago Fed model based on Ajello, Benzoni and Chyruk (2012), and the New York Fed model based on Abrahams, Adrian, Crump, and Moench (2012).

⁵ In comparison, the average expected future real short-term rate from the Cleveland Fed model shows large swings prior to mid-2013 but is little changed, on net, since early 2014, while the New York Fed model indicates that the expected future real short-term rate has edged up over the past year.

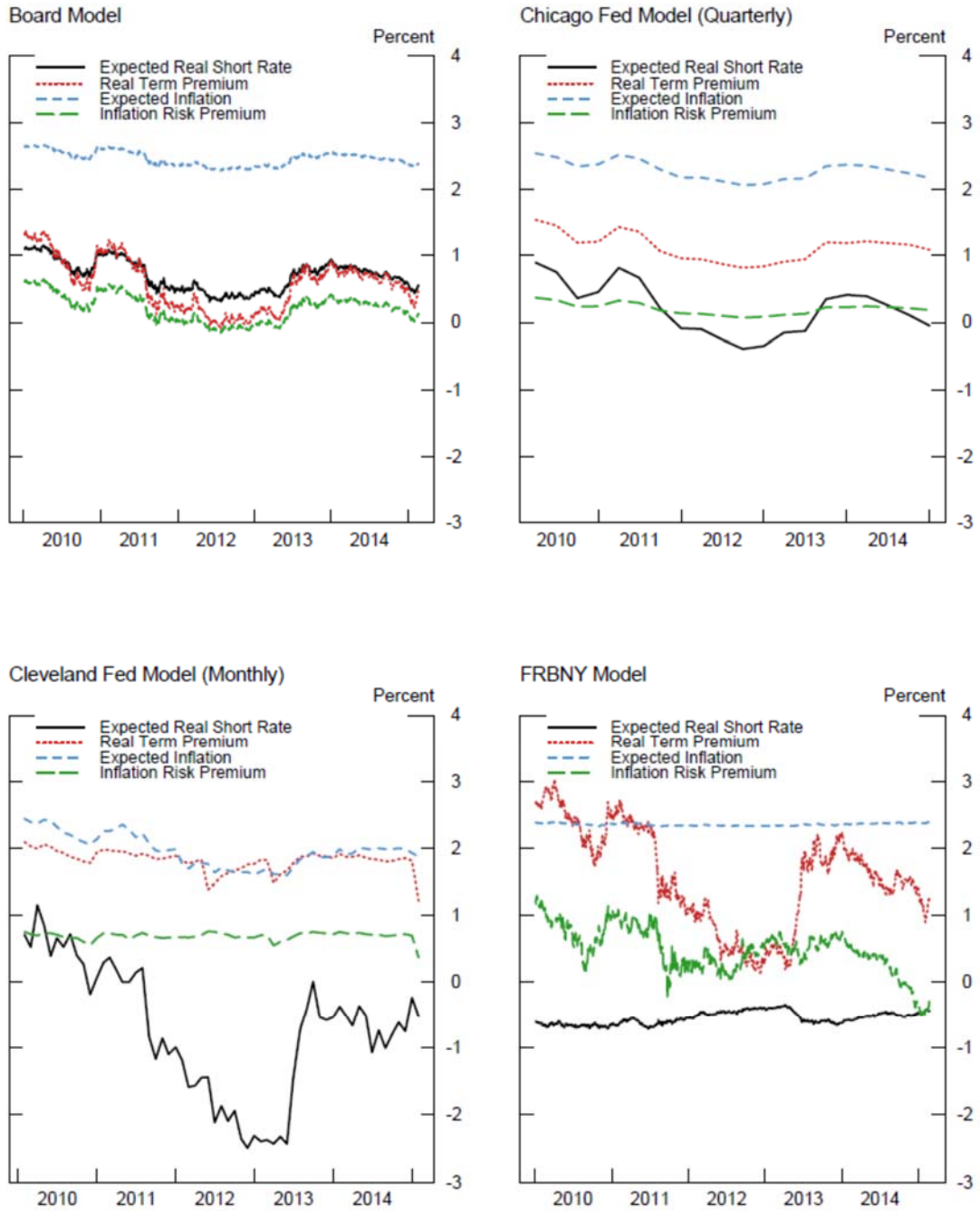
7). However, in accordance with generally weaker growth prospects abroad, we find that far-forward expected rates also declined, about 80 points in Germany (about a third of the overall decline), and somewhat less in the other countries.

Figure 5: Decomposition of 5-to-10-year Nominal Forward Rate based on Staff's Nominal Term Structure Models



Source: FRB Chicago, FRBNY, FRBSF, staff calculations. Daily data through February 27, 2015. Quarterly data through 2014 Q4.

Figure 6: Decomposition of 5-to-10-year Nominal Forward Rate based on Staff's Real Term Structure Models



Source: FRB Chicago, FRB Cleveland, FRBNY, staff calculations. Daily data through February 27, 2015. Monthly data through January 2015. Quarterly data through 2014 Q4.

Figure 7: Foreign 5-to-10-year Term Premiums

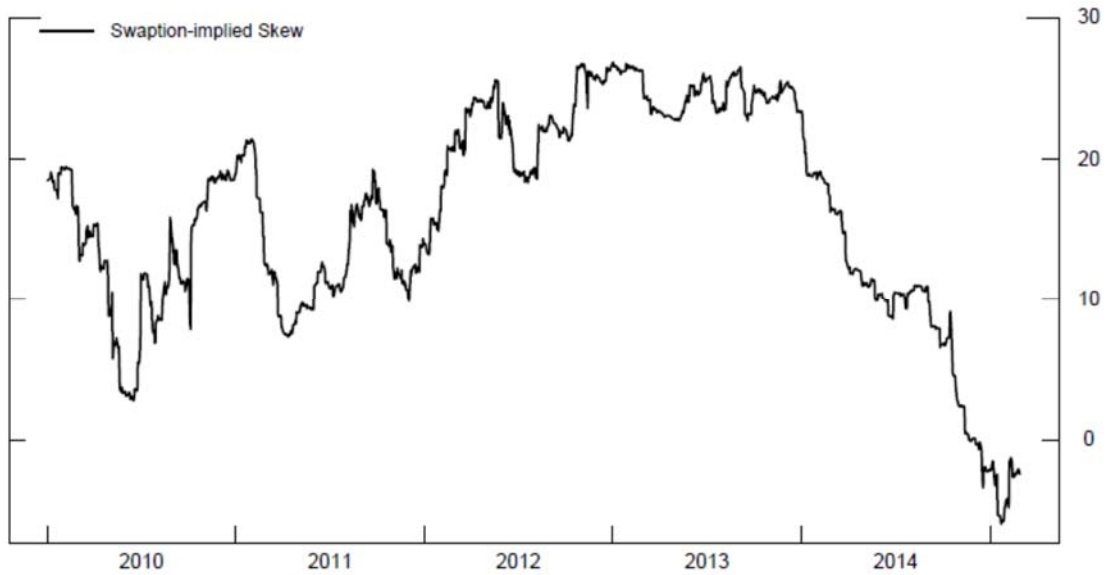


Source: Staff calculations. Data through February 2015.

In addition to the DTSM decompositions, there are other sources of indirect evidence pointing to a possible decline in term premiums and inflation risk premiums. For example, primary dealer surveys indicate that the median dealer revised down the expectations component (longer-run federal funds rate estimate) by 50 basis points over the past year, leaving about 150 basis points to be explained by lower term premiums. In addition, as shown in Figure 8, the swaption-implied skew of the 10-year swap rate declined notably over the past year and has turned negative. This drop may indicate that market participants are charging lower risk premiums to guard against higher yield outcomes. Similarly, the probability distribution for average headline CPI inflation over the next 10 years derived from inflation derivatives suggests that investors have become less concerned about relatively high inflation outcomes (Figure 9).⁶ Meanwhile, primary dealer surveys show that the probability distribution of inflation 5-to-10 years ahead has remained relatively stable (Figure 10). This suggests that at least a portion of the downward shift in the market-based probability distribution of future inflation may reflect decreased cost of insurance against high inflation outcomes.

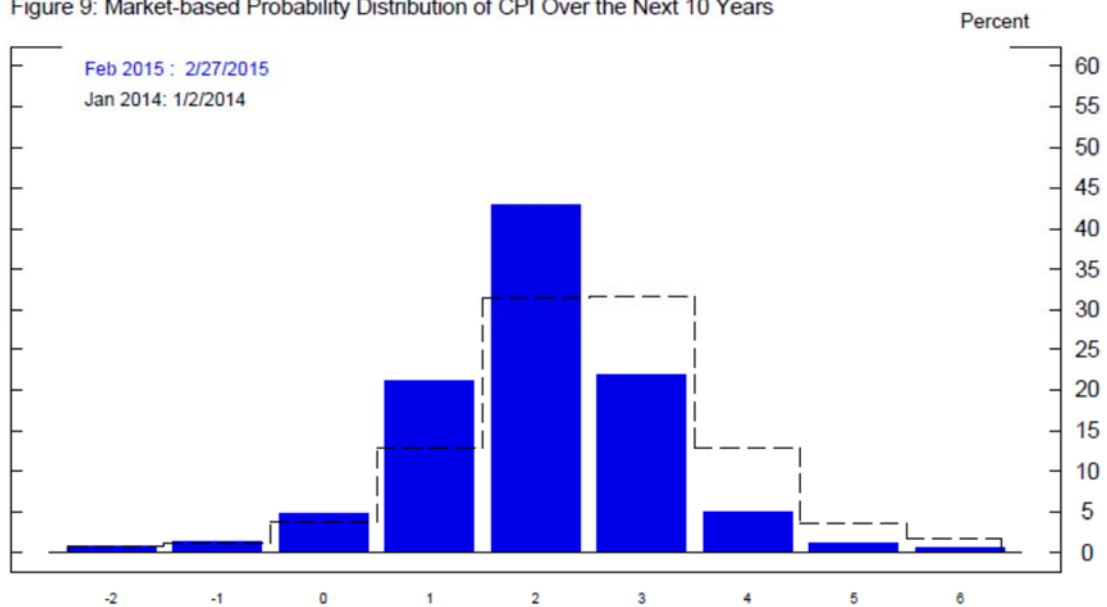
⁶ For a more detailed description of measures of inflation expectations see Kitsul (2014).

Figure 8: Swaption-implied Skew of the 10-year Swap Rate

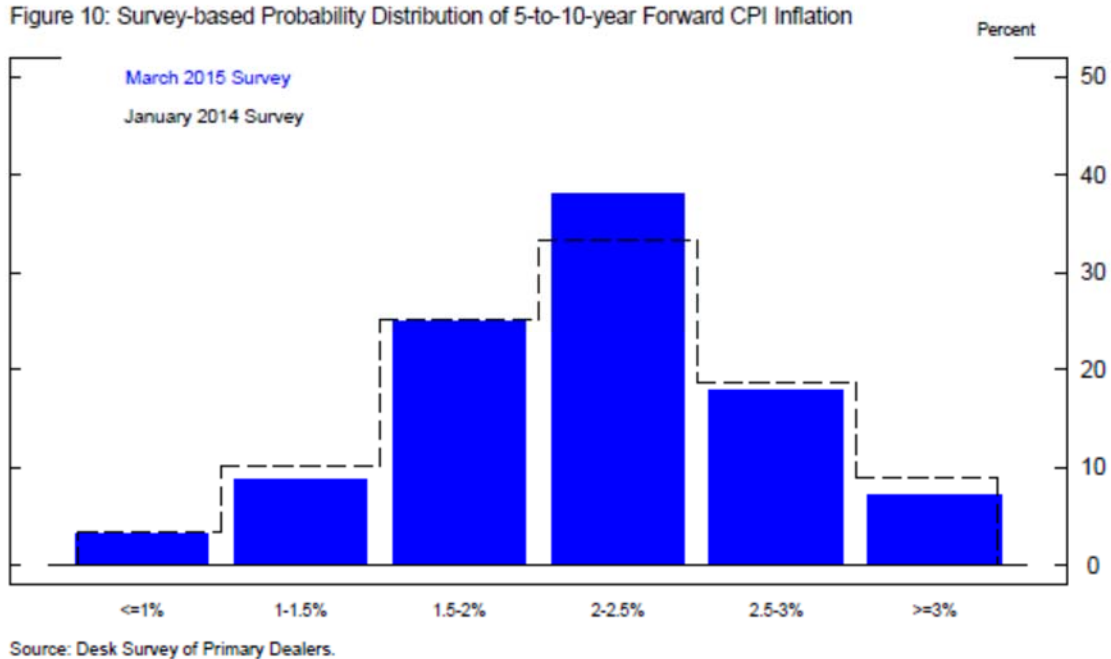


Source: Barclays, staff calculations. Data through February 27, 2015.

Figure 9: Market-based Probability Distribution of CPI Over the Next 10 Years



Note: Derived under the assumption that average inflation takes discrete values (e.g. the bar for 3 percent covers roughly the area between 2.5 and 3.5 percent). Source: Bloomberg, staff calculations.



3. Potential Factors Weighing on U.S. Long-Term Yields: Domestic and Global Factors

There are a number of possible economic factors that could have driven the decline in yields, some of which could be of primarily domestic origin while others might be linked to international developments. In this section, we briefly discuss some domestic factors that may have had an impact on U.S. long-term rates and then outline three main channels by which foreign factors may have helped to push them down.

Domestic Factors

A number of market participants last year linked the decline in real forward yields to a possible reduction in the expected equilibrium real interest rate, consistent with the so-called secular stagnation hypothesis. Although this might reflect broader global concerns, it may also in part owe to domestic factors such as an expectation of lower productivity growth following the recent financial crisis. Market participants have also cited several largely domestic technical factors that could be pushing down nominal term premiums, including heightened demand for high-quality liquid assets on the part of

domestic banks to satisfy Liquidity Coverage Ratios (LCRs) and lower expected net Treasury issuance amid the improved fiscal outlook.

Global Factors

While each of these domestic factors may have weighed on U.S. long-term rates to some extent, it seems quite likely that global factors have played a particularly important role in the sharp decline witnessed since the beginning of last year. There are a number of potential channels of transmission of such spillovers, which we group into three broad categories.

First, a reassessment of the global economic outlook for real activity, as well as increased worries about global deflationary pressures, may have caused investors to revise downward their long-run expectations for future real rates and inflation in the United States. A decline in expected U.S. growth and inflation could be driven by a perception that secular stagnation abroad would spill over into the United States via trade, a stronger dollar, or simply through the belief that if the foreign outlook was weak abroad then it could be weak here as well. However, survey evidence of long-term expected inflation in the United States has shown little decline, and although the dealer survey indicates a modest decrease in the expected policy rate, this would explain only a small portion of the overall drop in far forward rates. In addition, the DTSMs at the Board as well as those of the New York Fed and San Francisco Fed suggest that the decline in nominal yields owes primarily to term premiums, which points to a lesser role for long-run expectations for either growth or inflation.⁷

Second, beyond revisions in modal forecasts for either long-run growth or inflation, anxiety about the deteriorating foreign economic outlook might have lowered the term premiums that investors require to hold long-term Treasury securities. For example, U.S. inflation risk premiums may have declined as investors increasingly associate risk of continued foreign economic weakness with a risk of persistently low

⁷ Taken at face value, the fact that the New York Fed and San Francisco Fed models suggest that U.S. distant-horizon nominal expected short rates actually increased since the beginning of 2014 more directly contradicts the notion of increased investor perceptions of global stagnation or heightened disinflationary pressures. However, there is likely a very wide confidence band around these point estimates, given the ubiquitous difficulty of estimating real-world dynamics of yields precisely in short samples.

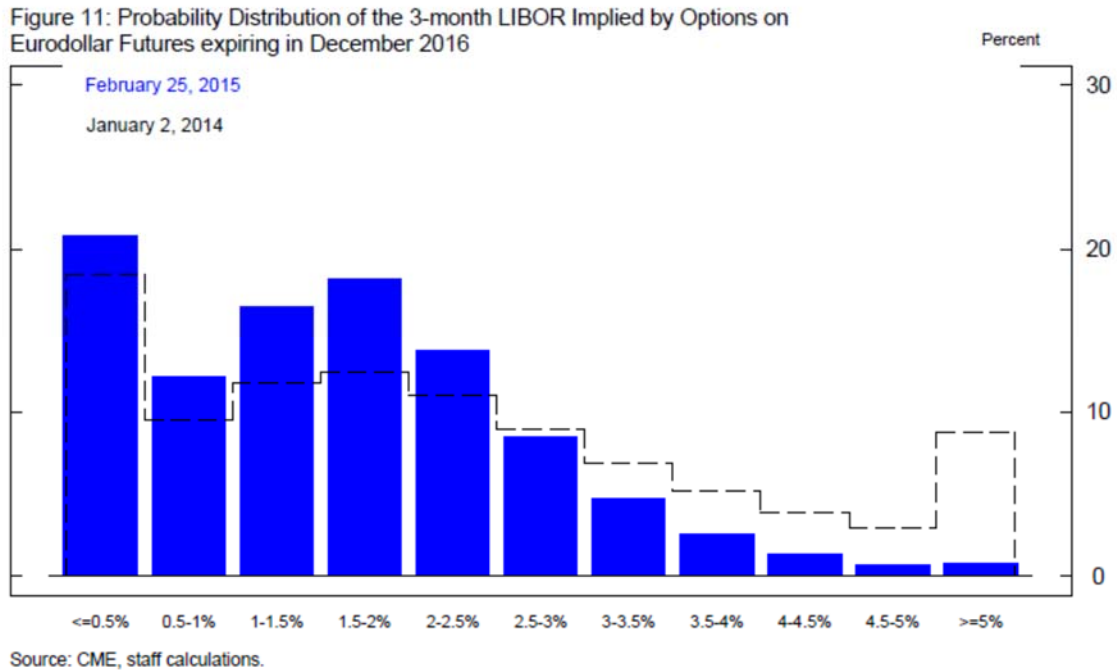
inflation or deflation at home. Investors may associate this with a risk of U.S. interest rates remaining at the effective lower bound for a long time. For example, pricing from the Eurodollar futures options market implies higher probabilities of very low 3-month LIBOR at the end of 2016 than a year ago (Figure 11).^{8,9} Some market participants have also noted the considerable reduction in perceived upside long-run inflation risk due to a few disinflationary forces that have been traditionally thought of as transitory in nature, including the appreciation of the U.S. dollar, the decline in energy prices, and low realized inflation.¹⁰ Finally, some market participants have also pointed to increased concerns about tail risks, stemming from various geopolitical concerns. Increased global anxiety or risk aversion may thus have increased demand for the liquidity and safety of Treasury securities. The decline in DTSM-based term premiums is generally consistent with this interpretation.¹¹

⁸ The distributions of the 3-month LIBOR are based on a lognormal mixture representation of the probability density function. For details, see Nozawa (2015).

⁹ According to the Desk's March 2015 surveys of primary dealers and buy-side firms, the median respondent assigns a 20 percent probability of a return to the zero lower bound sometime during the two years following liftoff. In response to a special question in the January 2015 surveys, respondents pointed to an adverse future shock to the U.S. economy as the most important factor motivating their probability estimates. Admittedly, these odds have changed little since the question was first introduced in September 2014.

¹⁰ Although such short-term disinflationary pressures should not, in principle, affect longer-dated forward breakevens, market participants cited a potential long-run shift in the pricing of oil as contributing to an apparent increase in pass-through effects.

¹¹ Admittedly, while periods of anxiety in financial markets have been evident since the beginning of last year, the appreciable increase in the price of risky assets over that period—equity and corporate bond prices, for example—seems to run counter to this interpretation.



A third possible explanation is that monetary easing abroad over the past year may have compressed term premiums on Treasury yields via a “global portfolio balance channel.” In line with this explanation, a number of market commentaries have focused on potential spillovers from increased monetary policy accommodation by the ECB and the Bank of Japan. The drop in term premiums is consistent with this view.¹²

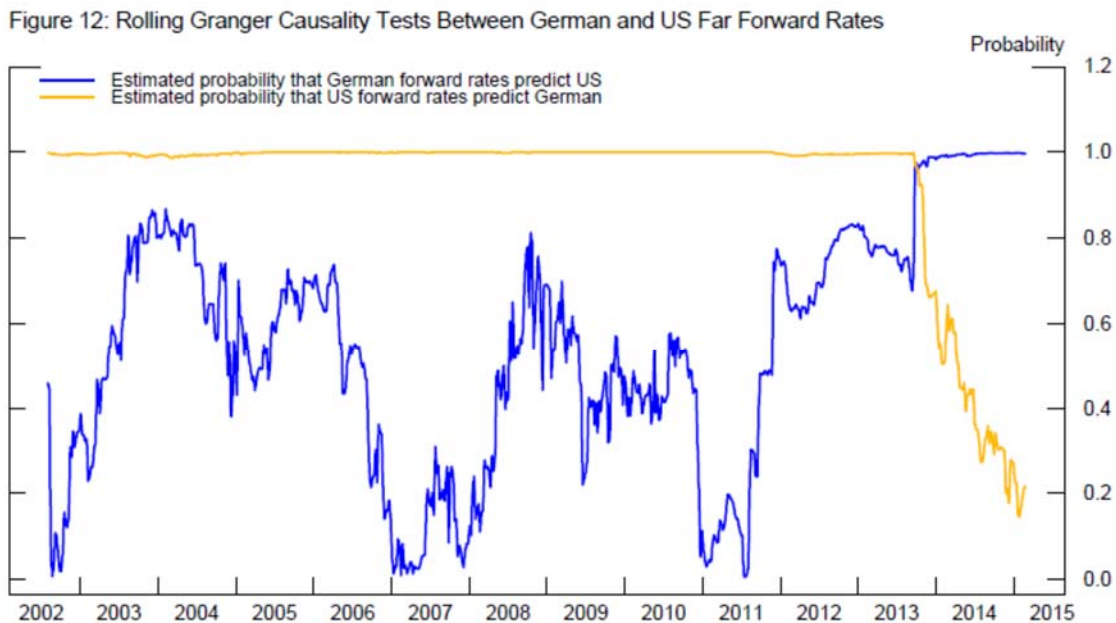
4. Evidence Supporting the Role of Global Factors

Having discussed three general channels of transmission, in this section we present several strands of evidence supporting the hypothesis that global factors played an important role in explaining the sharp decline in U.S. yields.

¹² The second and third channels are both consistent with the decline in term premiums. However, the second channel implies that term premiums are more pro-cyclical, namely lower as investors’ worries about the outlook increased during the period. The third channel largely reflects counter-cyclical term premiums, as decreased required returns on longer-dated bonds rate are the result of spillovers from foreign central bank policies, rather than deteriorating perceptions about the price and/or quantity of interest rate risk amid challenges from abroad.

Granger Causality Tests

Typically, movements in U.S. far-forward rates have tended to predict subsequent moves in foreign rates, but some evidence suggests that this pattern in Granger causality has reversed since the start of last year. Over this more recent period, foreign far forward rates seem to have predicted U.S. forward rates, supporting the hypothesis that foreign factors may have been a key driving force in the decline in global yields (Figure 12).



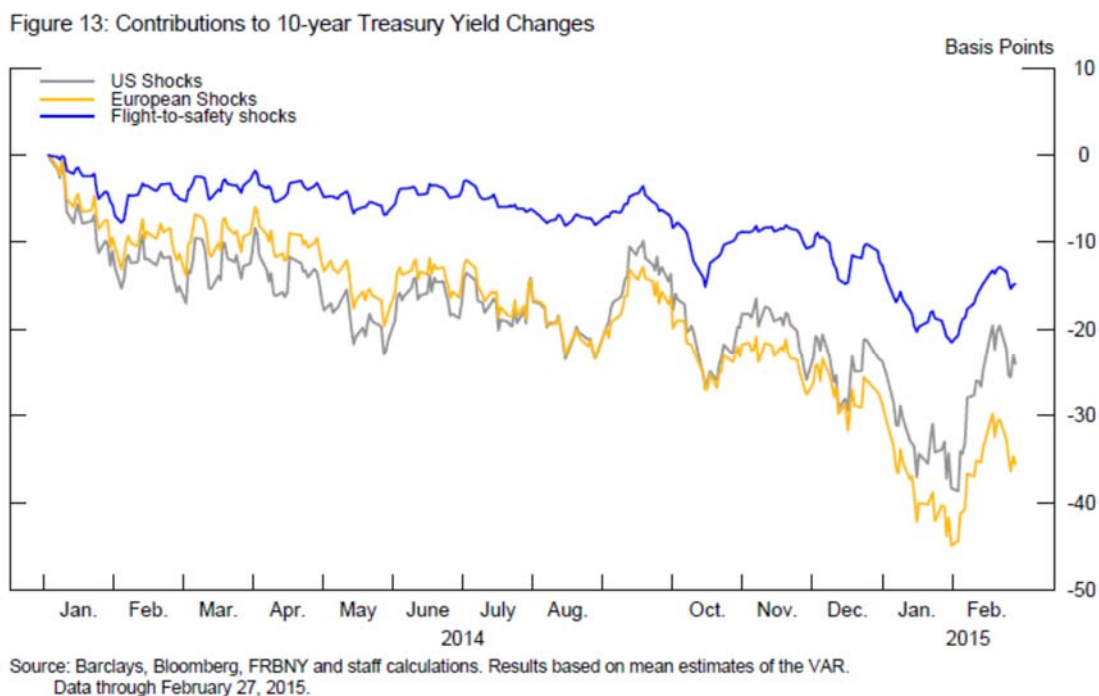
Source: Staff calculations based on rolling regressions using weekly data. Data through February 25, 2015.

Structural VAR Analysis

We estimated a daily Bayesian structural VAR on domestic and euro-area financial variables and examined the effects of various shocks on the 10-year nominal Treasury yield since the beginning of last year (see the appendix for more details). The shocks are identified by imposing sign restrictions on their immediate impact on the financial variables. In particular, we identify shocks to both foreign and domestic growth, inflation and monetary policy, as well as a flight-to-safety shock. For example, a positive shock to the U.S. economic growth outlook is assumed to push Treasury yields, U.S. equity prices, and the exchange value of the dollar higher. A shock to the euro-area growth outlook would have a similar impact on German yields, European equities, and the exchange value of the euro (with the U.S. dollar moving in the opposite direction). Because

monetary policy shocks are identified based on their impact on long-term yields (rather than shorter-term interest rates), equity prices, and the exchange rate, this methodology can capture effects of both conventional and unconventional monetary policies.

On average, the VAR estimates suggest that about one-third of the decline in 10-year Treasury yields since January 2014 is due to European shocks (the yellow line in Figure 13).¹³ In addition, flight-to-safety shocks (the blue line) are also estimated to have had a noticeable impact on U.S. long-term rates, and many of the concerns generating flight-to-safety flows were likely related to foreign events.



This analysis also allows us to examine the underlying sources of the European shock. Our *mean* estimates of the decomposition, which are subject to substantial uncertainty, indicate that a weaker-than-expected European growth outlook (the yellow line in Figure 14) and, to a lesser extent, deflationary shocks in the euro area and

¹³ U.S. inflation shocks can account for some of the decline in U.S. yields, but they are partially offset by the positive impact of shocks to U.S. growth on longer-term U.S. yields.

unanticipated ECB policy easing (the grey and blue lines, respectively) have been important drivers of the decline in U.S. rates over the past year.¹⁴

Figure 14: Contributions of European Shocks



Source: Barclays, Bloomberg, FRBNY and staff calculations. Results based on mean estimates of the VAR. Data through February 27, 2015.

Although the VAR approach has fairly minimal restrictions and uses a variety of asset prices, it does not directly incorporate any macroeconomic variables. To supplement this evidence, we also examine observable measures of macroeconomic news. As shown in Figure 15, an index of macroeconomic surprises in the euro area has generally been negative since the beginning of 2014, helping to reinforce the finding in the VAR that euro-area growth shocks may have weighed on U.S. yields.¹⁵

¹⁴ In comparison, the *median* estimates point to ECB policy shocks as having the largest contribution among all European shocks, while the impact of European growth shocks is smaller, albeit still significant.

¹⁵ We included these variables along with a number of other controls in a regression of daily changes in 10-year yields. We found that the effect of the news indexes were statistically significant, suggesting that concerns about euro-area growth surprises have indeed depressed U.S. yields, but the estimated impact on U.S. yields is fairly small (roughly 5 basis points in terms of far-forward rates) in that particular model. This may reflect the fact that the macroeconomic index only reflects the surprise on the day of each macro announcement rather than revisions to expectations prior to the announcement day. A broader index of AFE surprises also enters these regressions significantly, but likewise explains little of the decline in U.S. yields.

Figure 15: Euro-Area Macro Surprise Index



Source: Bloomberg, staff estimates. Data through February 10, 2015.

Event Studies: ECB Communications

To further gauge the impact foreign monetary policy decisions may have had on Treasury yields, we also conducted some event studies around key announcements. The similarity in the responses of U.S. yields and euro-area sovereign yields following the ECB's announcement of its expanded asset purchase program on January 22 provides some evidence about the effect of foreign monetary easing on U.S. interest rates. Table 2 shows results using a 2-day window of the impact of five ECB policy-oriented events on 10-year yields in the euro area, United States, and United Kingdom, the 3-year Eurodollar rate, and far forward rates. The events consist of ECB policy meetings and speeches by ECB officials between June 2014 and January 2015. The most recent date, January 22, is the latest ECB QE announcement.

Table 2: Event Study Around Recent ECB Policy Announcements and Speeches

	Two-Day Basis-Point Change*						
	10-Year German Yield	10-Year US Yield	10-Year UK Yield	3-Year Eurodollar Rate	Far- Forward Rate	US Far- Forward Rate	UK Far- Forward Rate
	June 5 2014	-7	0	-1	4	-6	-7
Aug 22 2014	-3	-2	0	3	1	9	1
Sep 4 2014	-3	4	0	-1	3	11	3
Dec 8 2014	-9	-12	-14	-9	-29	-16	-30
Jan 22 2015	-21	-13	-9	-6	-38	-24	-19

*Event window, beginning 5 minutes before event to end of the following day. Far-forward rates are 9-to-10 year. June 5, 2014: ECB lowers deposit rate by 10 basis points to -10bp. Aug 22, 2014: Jackson Hole speech by ECB President Draghi. Sept 4, 2014: ECB lowers deposit rate by 10 basis points to -20bp. Dec 8, 2014: ECB Governing Council Member Nowotny surprises markets by indicating support for Quantitative Easing. June 22, 2015: ECB announces QE program to purchase sovereign bonds.

ECB communications about monetary policy easing generally pushed both German and U.S. yields lower. On a cumulative basis, 10-year German yields fell 43 basis points during 2-day windows around selected ECB communication events. U.S. and U.K. 10-year yields declined by less, 23 and 25 basis points, respectively. These declines imply a pass-through multiplier from German yields to U.S. and U.K. yields of about half.

We find somewhat larger effects using shorter windows of an hour or less around key ECB events. We include the January 22 QE announcement, but also earlier ECB actions taken during the euro-area crisis following Rogers, Scotti, and Wright (2014). We regress changes in U.S. 10-year yields and Eurodollar future rates on changes in the 10-year German yields in the hour bracketing ECB announcements. Surprises in recent unconventional monetary policy announcements by the ECB have highly economically and statistically significant effects on U.S. interest rates (Table 3). For instance, a policy surprise that leads to a 100-basis-point decline in the 10-year Bund yield is associated with 81 and 88 basis point declines in 3-year-ahead Eurodollar rates implied by futures contracts and 10-year Treasury yields, respectively.¹⁶

¹⁶ We look at the implied Eurodollar rate 3-years-ahead to gauge the impact of ECB policy actions on U.S. short rates over the medium term. The pass-through effects of conventional ECB policy rate announcements (not included here) are smaller than those of unconventional policies, but still significant.

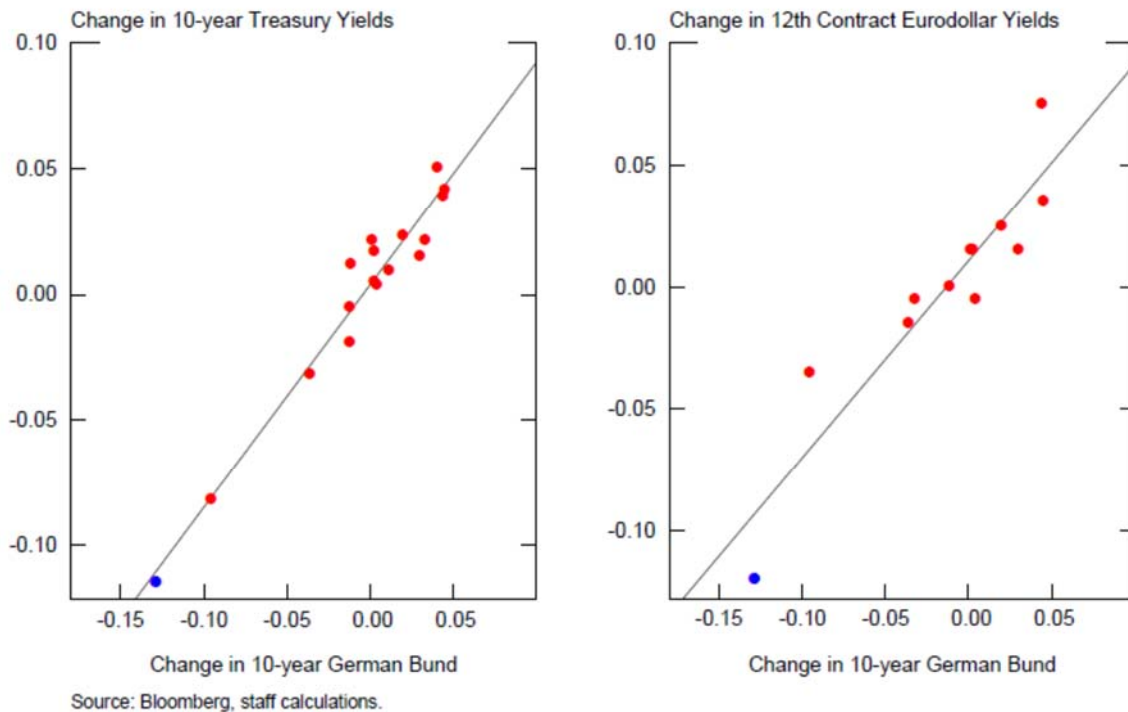
Table 3 – The Impact of ECB Unconventional Monetary Policy Announcements

	<i>Rate on Eurodollar Futures Contract 3-years- ahead</i>	<i>Rate on 10- year Treasury</i>
<i>Constant</i>	0.01*	0.00
<i>Δ 10-year Germany rate</i>	0.81***	0.88***
<i>R²</i>	0.85	0.95
<i>Observations</i>	12	17

NOTE: The table reports the results from regressions of intraday changes in U.S. yields on a constant, and ECB monetary policy surprises. The dependent variables are the intraday changes in the implied rates on Eurodollar futures contracts maturing in 3 years and the 10-year Treasury yield. Observations are on days of ECB unconventional monetary policy announcements from August 2007 to January 2015 (an updated version of the list provided in Table 3 by Rogers, Scotti, and Wright (2014)). As a robustness check, we also control for the surprise component of the U.S. jobless claims releases, which often coincide with ECB announcements, and for the intraday change in the 10-year Italian-German spread, and the estimation results do not change qualitatively. The superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively, and are based on Heteroskedasticity-Consistent standard errors.

As can be seen from Figure 16, which plots the responses of the 10-year Bund yield against those of the 10-year Treasury yield (left panel) and the Eurodollar futures rate 3-years-ahead (right panel) for various unconventional policy announcements, the effects of the announcement of the expanded asset purchase program by the ECB on January 22, 2015 (the blue dots) are about in line with the historical relationship. However, in contrast to the January 22 announcement, most of the earlier ECB actions actually raised German and U.S. rates, likely because they were often aimed at easing pressures related to the euro-area crisis and thus generated some reversal in flight-to-quality flows.

Figure 16: Changes in 10-year Bund yield vs. changes in US rates



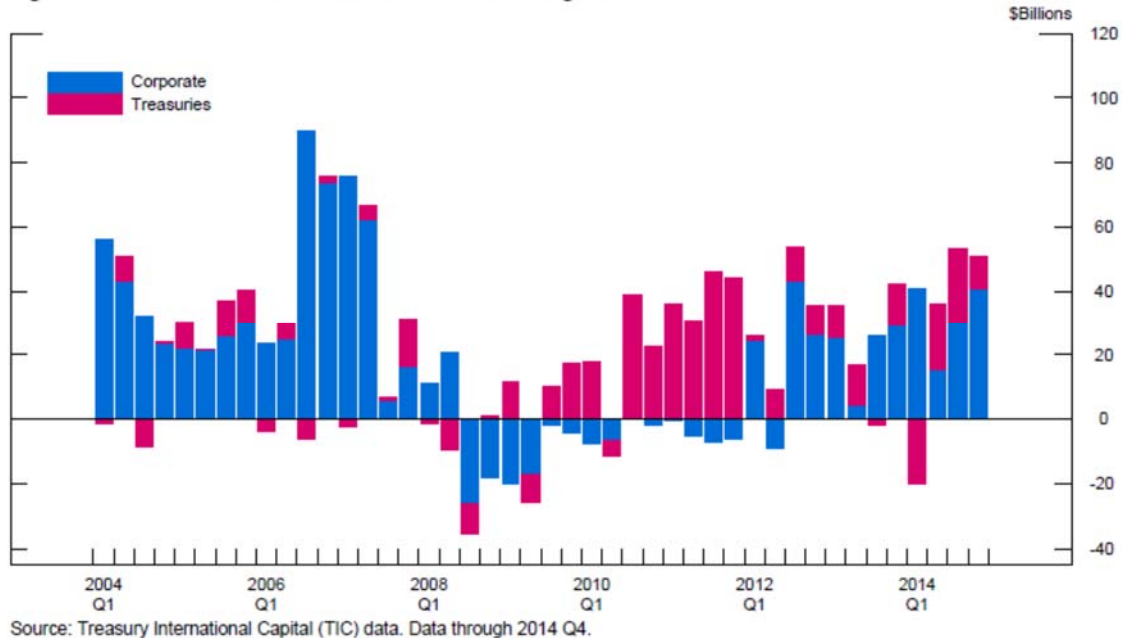
The Bank of Japan’s quantitative easing may also have weighed on Treasury yields over this period, but event studies suggest a smaller impact than for ECB policy actions. On the day of the April 4, 2013, QQE announcement, 10-year Japanese sovereign yields fell 12 basis points, but this drop reversed the next day, and Treasury yields fell only 5 basis points. The October 31, 2014, QQE2 announcements had no apparent impact on U.S. 10-year yields, likely because there was little impact on Japanese 10-year yields themselves on that day. The expected impact on yields from these announcements is ambiguous. QQE is explicitly aimed at raising inflation expectations, an outcome which the BoJ seems to have partially achieved. At the same time, they potentially lowered term premiums and offset the impact on yields.

Capital Flows

As previously noted, and as the evidence above suggests, foreign factors may hold down U.S. term premiums through a global portfolio balance effect, as lower foreign rates encourage investors to shift demand toward U.S. fixed-income instruments. However, it is unclear thus far from TIC flow data whether these considerations have led to an

increase in foreign purchases of U.S. debt. Purchases of U.S. long-term bonds by euro-area residents picked up over the course of last year (Figure 17). However, most of the increase was in corporate bonds rather than Treasuries. Of course, to the extent that corporate and government bonds are close substitutes, this increase in demand could have pushed Treasury yields lower.¹⁷

Figure 17: Euro-Area Residents' Purchases of U.S. Long-Term Bonds



Summarizing the Role of Global Factors

Taken as a whole, the evidence seems to indicate that global factors since the beginning of last year may have played a significant role in pushing down Treasury yields. These three channels of foreign spillovers are not mutually exclusive, and they may have all contributed to the sharp decline in U.S. long-term yields. In particular, our evidence seems to point primarily to a reduction in term premiums owing either to anxiety about the deteriorating global outlook or to monetary policy easing abroad. Nonetheless, we cannot rule out that there may have been also a modest decline in expectations for future short-term rates.

¹⁷ At least in principle, to the extent that investors can arbitrage across instruments (cash and derivatives, for example) and across markets, the lack of evidence of foreign inflows does not necessarily preclude the possibility that foreign demand for U.S. Treasuries has put downward pressure on U.S. long-term rates.

5. Potential policy implications

To the extent that global factors have played an important role in suppressing term premiums on U.S. long-term rates, a key policy question is what implications these explanations may have for the future path of monetary policy.

In particular, if the drop in long-term Treasury yields is mainly driven by a decline in term premiums reflecting concerns about the global economic outlook and deflationary forces, and these concerns actually materialize, the FOMC may want to remove policy accommodation more gradually than originally anticipated. Of course, in thinking about the implications for the stance of monetary policy, we need to take into account all influences, including the foreign exchange value of the U.S. dollar, which would likely increase in this scenario.

By contrast, if the decline in long-term Treasury yields mainly owed to reductions in term premiums associated with additional monetary policy accommodation abroad, and such reductions were being passed through to private yields in the United States, then there is a risk that U.S. long-term rates may stay lower than in our baseline forecast as foreign policy accommodation persists. Such developments may call for future short-term rates to be higher, all else equal, to bring financial conditions in line with the Committee's policy objectives.

References

Abrahams, Michael, Adrian Tobias, Crump Richard and Emanuel Moench, 2013, "Decomposing Real and Nominal Yield Curves," Federal Reserve Bank of New York Staff Report no. 570.

Adrian, Tobias, Crump, Richard and Emanuel Moench, 2013, "Pricing the term structure with linear regressions," *Journal of Financial Economics*, 110(1), 110-138.

Ajello, Andrea, Benzoni, Luca and Olena Chyruk, 2012, "Core and 'Crust': Consumer Prices and the Term Structure of Interest Rates," unpublished manuscript.

Christensen, Jens, Diebold, Francis and Glenn Rudebusch, 2011, "The Affine Arbitrage-Free Class of Nelson-Siegel Term Structure Models," *Journal of Econometrics*, 164(1), 4-20.

D'Amico, Stefania, Kim, Don and Min Wei, 2014, "Tips from TIPS: the informational content of Treasury Inflation-Protected Security prices", FEDS working paper 2014-24.

Enders, Zeno, Mueller, Gernot, and Almuth Scholl, 2011, "How do fiscal and technology shocks affect real exchange rates? New evidence for the United States," *Journal of International Economics*, 83(1), 53-69.

Haubrich, Joseph, Pennacchi, George and Peter Ritchken, 2012, "Inflation Expectations, Real Rates, and Risk Premia: Evidence from Inflation Swaps", *Review of Financial Studies*, 25(5), 1588-1629.

Kim, Don and Jonathan Wright, 2005, "An Arbitrage-Free Three-Factor Term Structure Model and the Recent Behavior of Long-Term Yields and Distant-Horizon Forward Rates", FEDS working paper 2005-33.

Kitsul, Yuriy, 2014, "A review of market- and survey-based measures of medium- and longer-term inflation expectations," Board memo.

Kitsul, Yuriy and Jonathan Wright, 2013, "The economics of options-implied inflation probability density functions", *Journal of Financial Economics*, 110, pp. 696-711.

Nozawa, Yoshio, 2015, "The probability density function of a short-term rate estimated from eurodollar futures options," Board memo.

Rogers, John H., Chiara Scotti, and Jonathan Wright, 2014, "Evaluating Asset-Market Effects of Unconventional Monetary Policy: A Multi-Country Review," *Economic Policy*, 29(80), 3-50.

Uhlig, Harald, 2005, "What are the effects of monetary policy on output? Results from an agnostic identification procedure," *Journal of Monetary Economics*, 52(2), 381-419.

Appendix –Structural VAR Analysis

The Bayesian structural VAR was estimated using daily changes in eight domestic and euro-area financial variables. As detailed in the table below, the shocks are identified by imposing sign restrictions on their immediate impact on the financial variables.¹⁸

Table: Sign Restriction*

	US growth shock	US monetary policy shock	US inflation shock	Flight-to-safety shock	Euro-area growth shock	Euro-area monetary policy shock	Euro-area inflation shock
US 10-year Treasury yield	+	+	+	-			
S&P 500	+	-		-			
US 10-year Breakeven			+				
VIX				+			
US dollar/Euro	+	+	-		-	-	+
German 10-year Bund yield					+	+	+
Euro Stock 600					+	-	
Euro 10-year inflation swap							+

* All signs are specified for positive shocks.

Once the sequence of shocks and their contemporaneous effects are estimated from the VAR, we compute the cumulative contribution of each shock to changes in the financial variables included in the analysis. Our methodology is similar to that of Uhlig (2005) and Enders, Mueller, and Scholl (2011). We estimate the model over the period January 3, 2005, to February 10, 2015, and report the *mean* estimates across 10,000 out of 15,000,000 random draws of the VAR with impact impulse responses that satisfy our sign restrictions.

¹⁸ In this framework, a shock is interpreted as a surprise to market participants. Thus, the absence of a policy shock does not mean that policy action did not have any impact, but rather that it evolved as market participants originally anticipated.