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The Federal Reserve Is Not Very Constrained by the Lower Bound on Nominal Interest Rates

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1. Introduction

In December 2008, the Federal Reserve lowered the federal funds rate to essentially zero, where it remained until December 2015. Because U.S. currency carries an interest rate of zero, it's essentially impossible for the Fed to set the federal funds rate substantially below zero without triggering widespread conversion of deposits into currency. This constraint is commonly referred to as the "zero lower bound" (ZLB), or "effective lower bound" (ELB) to acknowledge that the bound may be somewhat negative rather than literally zero.

The existence of the Z/ELB has led many authors to conclude that it imposes a substantial constraint on the Fed's ability to conduct monetary policy in a low interest rate environment (e.g., Krugman, 1998; Williams, 2009; Kiley and Roberts, 2017). In this paper, I survey the recent literature to demonstrate exactly the opposite: that the Z/ELB has not been and is *not* a significant constraint on the Federal Reserve, either in the past or the future. This conclusion follows from three main observations: First, the Federal Reserve's forward guidance and large-scale asset purchases (LSAPs) are effective monetary policy tools at the Z/ELB, in fact, about as effective as the federal funds rate in normal times. Second, during the 2008–15 U.S. ZLB period, the Fed was not very constrained in its ability to affect medium- and longer-term interest rates and the economy. Third, the risks of the Fed being significantly constrained by the ELB in the future are typically greatly overstated.

2. The Fed Has Additional Monetary Policy Tools Available

The first main observation is that the Federal Reserve has other monetary policy tools available to it beyond just changes in the current federal funds rate. In particular, there is a large and growing literature on the effectiveness of forward guidance—communication by the Federal Reserve about the likely future path of the federal funds rate over the next several quarters—and large-scale asset purchases, or LSAPs—purchases by the Federal Reserve of hundreds of billions of dollars of longer-term U.S. Treasury bonds and mortgage-backed securities.

Theoretically, a standard New Keynesian IS curve

$$\hat{y}_t \;=\; E_t\hat{y}_{t+1} - \alpha\hat{r}_t + \varepsilon_t \tag{1}$$

can be solved forward, assuming $\lim_{j\to\infty} E_t\hat{y}_{t+j} = 0$, to get

$$\hat{y}_t \;=\; -\alpha E_t \sum_{j=0}^{\infty} \hat{r}_{t+j} + \varepsilon_t, \tag{2}$$

where t indexes periods, $\hat{y}_t$ is the output gap, $\hat{r}_t$ the deviation of the one-period real interest rate from steady state, E_t denotes the mathematical expectation conditional on information at time t, and ε_t is a mean-zero shock. The infinite sum in equation (2) illustrates how the Fed can affect the current output gap by changing people's expectations about the future path of $\hat{r}_{t+j}$ as well as the current value of $\hat{r}_t$ itself. Reifschneider and Williams (2000) and Eggertsson and Woodford (2003) use this fact to show that, even at the ZLB, the Fed can still stimulate the economy as long as it can credibly commit to a lower path of short-term interest rates in the future, when the ZLB is no longer binding.

Empirically, Gürkaynak, Sack, and Swanson (2005, henceforth GSS) showed that changes in the federal funds rate alone were not sufficient to explain financial market reactions to Federal Reserve Federal Open Market Committee (FOMC) announcements, and that there was a second dimension of monetary policy that was being missed. GSS developed a measure of forward guidance based on high-frequency changes in a range of federal funds futures contracts around FOMC announcements, orthogonalized to the change in the current federal funds rate. They showed that forward guidance had highly statistically significant effects on financial markets and dramatically increased the explanatory power of FOMC announcements for financial market responses. GSS also showed that large movements in their measure of forward guidance were associated with FOMC statements about the future path of the federal funds rate. Their results demonstrated that forward guidance is effective, and have since been updated and confirmed for the U.S. and other countries by Brand, Buncic, and Turunen (2010), D'Amico and Farka (2011), Campbell et al. (2012), Leombroni et al. (2017), Swanson (2018), and others.

An equally large and growing literature finds that the Fed's LSAPs had economically and statistically significant effects on longer-term bond yields. These analyses range from high-frequency event studies of the U.S. (e.g., Gagnon et al., 2011; Krishnamurthy and Vissing-Jorgensen, 2011) and U.K. (e.g., Joyce et al., 2011) to historical studies of "Operation Twist" in 1961 (Swanson, 2011), to lower-frequency analyses of U.S. Treasury yields and spreads vis-a-vis Treasury supply from 1919–2008 (Krishnamurthy and Vissing-Jorgensen, 2012), to a no-arbitrage affine term structure model with quantity effects estimated from 1990–2011 (Hamilton and Wu, 2012). Swanson (2011) and Williams (2013) survey these estimates, but a common benchmark is that $600 billion of LSAPs cause the 10-year Treasury yield to fall about 15 basis points (bp).

Swanson (2018) estimates the effects of both forward guidance and LSAP announcements on financial markets and finds that they are roughly as effective as changes in the federal funds

Table 1: Estimated Effects of Changes in the Federal Funds Rate, Forward Guidance, and LSAPs on Financial Markets, 1991–2015

	Treasury yields			Baa	S&P	
	2-year	5-year	10-year	yield	500	\$/yen
change in federal funds rate	3.68^{***}	2.04^{***}	0.95^{***}	0.56	-0.30^{***}	-0.13^{***}
[t-stat.]	[13.91]	[8.56]	[3.74]	[1.51]	[−6.98]	[−3.04]
change in forward guidance	4.85^{***}	5.09^{***}	3.92^{***}	1.99^{***}	-0.19^{***}	-0.18^{***}
[t-stat.]	[5.87]	[5.49]	[5.04]	[3.96]	[−3.92]	[−3.71]
change in LSAPs	−0.32	-3.71^{***}	-5.68^{***}	-4.22^{***}	0.04	0.25^{***}
[t-stat.]	[−1.01]	[−6.49]	[−7.17]	[−5.59]	[0.76]	[3.97]

Coefficients β from regressions $\Delta y_t = \alpha + \widetilde{F}_t\beta + \varepsilon_t$, where t indexes FOMC announcements, y denotes a given bond yield or log asset price, $\widetilde{F}$ the monetary policy factors estimated in Swanson (2018), and Δ the change in a 30-minute window bracketing each FOMC announcement (1-day window for Baa yield). Coefficients are in units of basis points (for bond yields) or percentage points (for stock prices and exchange rates) per standard deviation change in monetary policy instrument. Bootstrapped t-statistics in square brackets; *** denotes statistical significance at the 1% level. See text and Swanson (2018) for details.

rate in normal times. Table 1 summarizes the results.[1] The first four columns report the effects of changes in the federal funds rate, forward guidance, and LSAPs on 2-, 5-, and 10-year Treasury yields and Moody's index of Baa-rated corporate bond yields, in units of basis points per standard deviation change in the policy instrument.[2] Thus, the effect of a one-standard-deviation increase in the federal funds rate is about 3.7bp on the 2-year Treasury yield; for forward guidance, the effect on the 2-year yield is bigger, about 4.9bp per standard deviation change; and for LSAPs, the effect is smaller, about −0.3bp, and not statistically significant. LSAPs primarily affect longer maturities and the federal funds rate shorter maturities, but overall the three policies have effects on yields that are broadly comparable in magnitude. This is further supported by the last two columns of Table 1, which report the effects on the S&P 500 and the dollar/yen exchange rate, in units of percentage points per standard deviation change in each policy instrument. The effects of all three policies have the signs one would expect—higher interest rates imply lower stock prices and dollar appreciation—and are roughly comparable in magnitude. These results all suggest

[1] Some authors, such as Campbell et al. (2012), distinguish between two types of forward guidance announcements by the Fed—those that convey information about the economy vs. those that only convey information about monetary policy. Swanson (2018) does not try to separately identify these two types of forward guidance announcements, so the estimates in Table 1 represent an average forward guidance announcement effect.

[2] The standard deviation of surprise changes in the federal funds rate is 8.8bp, measured over the period from 1991–2008; the standard deviation of surprise changes in forward guidance is 6bp in the one-year-ahead expected federal funds rate, as measured by eurodollar futures from 1991–2015; and the standard deviation of a surprise LSAP announcement is about \$250 billion of long-term bond purchases, measured over the period from 2009–15. See Swanson (2018) for details.

that forward guidance and LSAPs are effective monetary policy tools; in fact, about as effective as changes in the federal funds rate in normal times.

Looking beyond high-frequency financial market responses, some authors have used detailed bank-level data to show that LSAPs have significant effects on bank lending. Rodnyansky and Darmouni (2017) show, via a differences-in-differences analysis of quarterly U.S. bank-level data, that banks that owned more LSAP-eligible mortgage-backed securities (MBS) increased business lending in response to the Fed's LSAPs. Di Maggio, Kermani, and Palmer (2016) apply a similar diff-in-diff analysis to monthly loan-level U.S. mortgage originations to show that conforming (eligible for purchase by Fannie Mae and Freddie Mac) mortgage originations increased in response to the Fed's LSAPs.[3] Koetter, Podlich, and Wedow (2017) analyze quarterly German bank-level, security-by-security data to show, via diff-in-diff, that German banks that held more eligible securities for the European Central Bank's Securities Markets Programme (SMP) increased lending in response to the program. Thus, the effects of LSAPs extend beyond just a high-frequency change in financial market prices.

Some authors have argued that, even though LSAPs had a significant effect on financial markets on impact, those effects tended to die out over time (e.g., Greenlaw et al., 2018). The monthly and quarterly bank-lending studies above provide evidence against this view—after all, if the financial market effects rapidly died out, why would banks increase their lending over subsequent months and quarters? Swanson (2018) also studies the persistence of financial market responses to LSAP announcements and finds that they were very persistent, with the exception of the very large and perhaps special "QE1" announcement on March 18, 2009. On that date, bond yields fell dramatically in response to the FOMC announcement, but then began to rise over subsequent weeks as the Dow gained over 1,000 points and the Fed's bank stress tests, released May 7, 2009, turned out better than markets expected; thus, the markets' behavior in those weeks may not be representative of the longer-run effects of LSAPs more generally. Figure 1 reproduces two charts from Swanson (2018) that show a tendency for the effects of LSAPs to die out when the March 18, 2009, observation is included (left-hand panel), but not when that one very influential announcement is excluded (right-hand panel).

To sum up thus far, there is a great deal of evidence that both forward guidance and LSAPs are effective monetary policy tools, in fact about as effective as changes in the federal funds rate

[3] To be precise, Rodyansky and Darmouni (2017) and Di Maggio et al. (2016) find that the Fed's LSAP purchases of MBS had a significant effect on bank lending; the Fed's purchases of long-term Treasury securities during the "QE2" program did not seem to have such an effect.

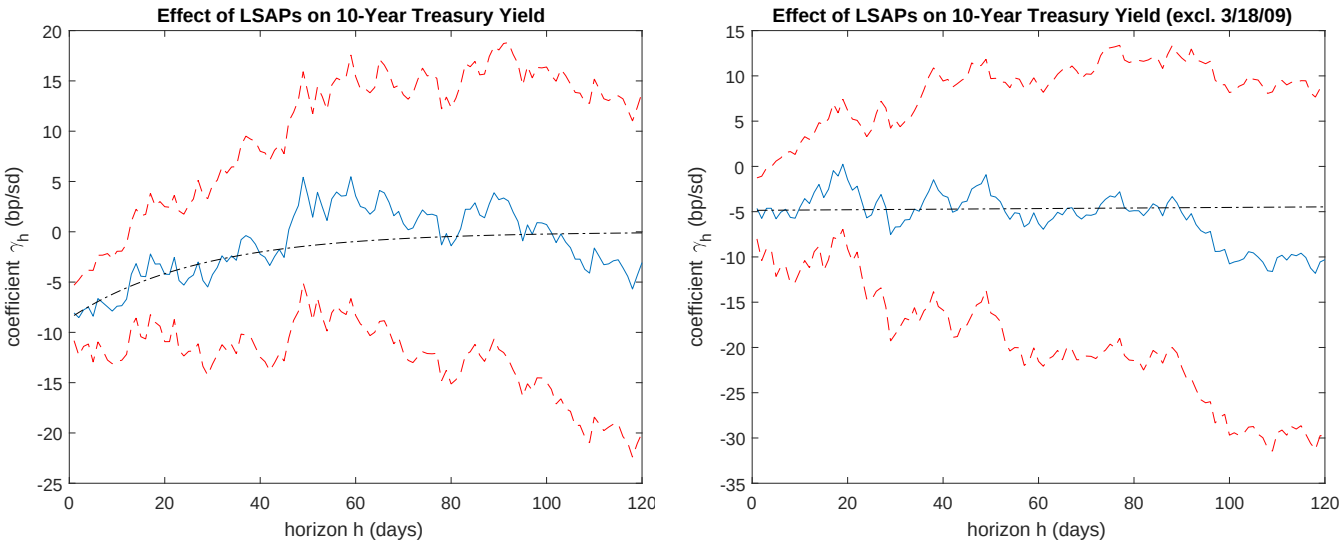

Figure 1. Estimated effects of LSAPs on 10-year zero-coupon Treasury yields, for different horizons h from 1 to 120 business days, including and excluding the influential March 18, 2009, "QE1" announcement. Estimated coefficients $\hat{\gamma}_h$ (solid blue line) and bootstrapped ± 1.96-standard-error bands (dashed red lines) are from regressions $y_{t-1+h} - y_{t-1} = \gamma_h \widetilde{F}_t + \varepsilon_t^{(h)}$. Restricted coefficient estimates $\gamma_h = ae^{-b(h-1)}$ (dash-dotted black lines) are from the same set of regressions estimated jointly via nonlinear least squares. See text and Swanson (2018) for details.

in normal times. There is also very strong evidence that LSAPs affected bank lending. Although some have argued that the effects of LSAPs are not persistent, that view seems to be driven by one very influential FOMC announcement on March 18, 2009, which may have been special for a number of reasons. Excluding that one announcement, the estimated effects of LSAPs on financial markets were essentially completely persistent.

3. The Fed Was Not Very Constrained by the ZLB in 2008–15

The second main observation is that, during the 2008–15 ZLB period, the Federal Reserve was not very constrained in its ability to affect medium- and longer-term interest rates and the economy. A quick way to see this is in Figure 2, which plots the federal funds rate and 1-, 2-, 5-, and 10-year zero-coupon Treasury yields from 2007–17.[4] Although the federal funds rate is virtually zero and never changes from December 2008 to November 2015, the 2-year Treasury yield—which is a better measure of the overall stance of monetary policy, as can be seen in equation (2)—averages about 55bp during this period and fluctuates substantially over time, ranging between 16bp and 140bp and moving up or down every day along with the economic outlook.

[4] Zero-coupon yields are from the Gürkaynak, Sack, and Wright (2007) dataset, available from the Federal Reserve Board's web site.

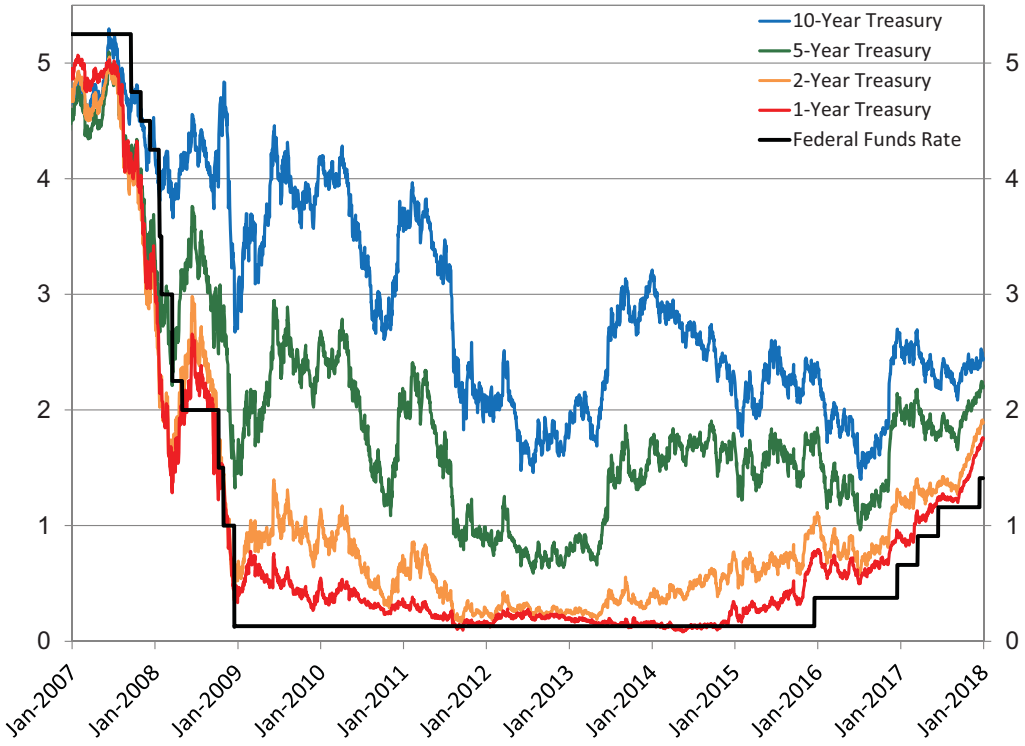

Figure 2. Federal funds rate and 1-, 2-, 5-, and 10-year zero-coupon Treasury yields from 2007 to 2018. See text for details.

Swanson and Williams (2014) extend this point by estimating how responsive the 2-year Treasury yield (and other yields) are to major macroeconomic announcements, relative to a benchmark sample from 1990–2000 when the ZLB was not a constraint. That is, they run daily-frequency regressions of the form

$$\Delta y_t = \gamma^\tau + \delta^\tau \beta X_t + \varepsilon_t, \tag{3}$$

where t indexes business days, Δy_t is the one-day change in the 2-year Treasury yield (or other yield), X_t is an n-dimensional vector of major macroeconomic data releases that day (such as nonfarm payrolls, CPI, GDP, etc.), β is an n-dimensional vector of parameters containing the normal responsiveness of the 2-year Treasury yield to each of those releases, and the parameters γ^τ and δ^τ are scalars that vary over time, with δ^τ normalized to unit mean over the baseline sample from 1990–2000.[5] Thus, the scalar δ^τ captures the overall sensitivity of the 2-year Treasury yield

[5] On most days, there is no news about a given macroeconomic statistic; thus, if the first column of X corresponds to nonfarm payrolls, then that column would be zero on every date t except once per month, when the nonfarm payrolls data is released. On each nonfarm payrolls announcement date, the first column of X_t contains the surprise component of the announcement—that is, the actual released value of nonfarm payrolls less the median market expectation from the day before. The scalar parameters γ^τ and δ^τ are estimated over rolling 250-business-day windows, while the vector β is fixed over the whole sample. See Swanson and Williams (2014) for details.

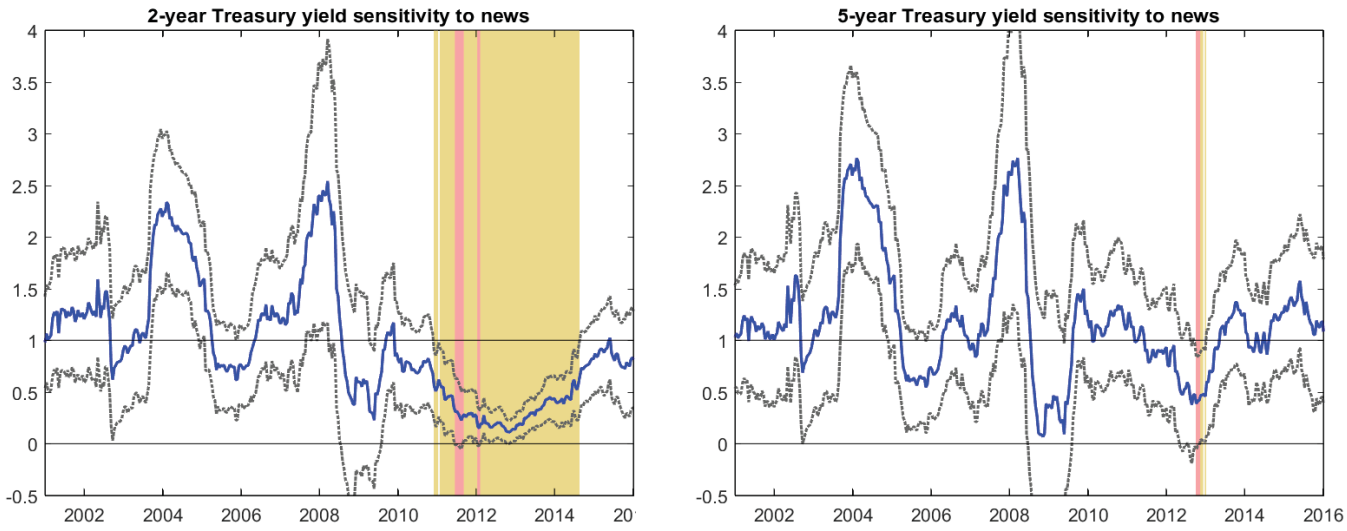

Figure 3. Time-varying sensitivity coefficients δ^τ from regression (3) applied to 2-year (left panel) and 5-year (right panel) Treasury yields. Dotted gray lines denote heteroskedasiticity-consistent ±2-standard-error bands , $\delta^\tau = 1$ corresponds to normal Treasury sensitivity to news, $\delta^\tau = 0$ to complete insensitivity. Light yellow shaded regions denote δ^τ significantly less than 1; darker red shaded regions denote δ^τ significantly less than 1 and not significantly different from 0. See text and Swanson and Williams (2014) for details.

to major macroeconomic announcements around a given date, with $\delta^\tau = 1$ corresponding to normal sensitivitiy to news and $\delta^\tau = 0$ to complete insensitivity to news.

Figure 3 plots the time-varying sensitivity coefficients δ^τ from regression (3) for the 2- and 5-year Treasury yields over the period 2001–15. The solid blue line in each panel plots the estimated value of δ^τ on each date τ, while the dotted gray lines depict heteroskedasticity-consistent ±2-standard-error bands. Horizontal black lines are drawn at 0 and 1 as benchmarks for comparison, corresponding to the cases of complete insensitivity to news and normal sensitivity, respectively. Light yellow shaded regions denote periods when the estimated value of δ^τ is significantly less than unity; in addition, if the hypothesis that $\delta^\tau = 0$ cannot be rejected, then the region is shaded darker red. Thus, red shaded regions correspond to periods in which the Treasury yield was essentially insensitive to news, while lighter yellow shaded regions correspond to periods when the yield was partially—but not completely—unresponsive to news.

The left-hand panel of Figure 3 shows that, from 2008–11, the 2-year Treasury yield's sensitivity to news was essentially never significantly less than normal. From 2011 to mid-2014, the 2-year yield's sensitivity did drop below normal, but was still greater than zero, except for two very brief periods around the end of 2011. Thus, despite the fact that the federal funds rate (and other short-term interest rates) were completely constrained by the ZLB throughout

2009–15, the 2-year Treasury yield continued to respond substantially to macroeconomic news. The 5-year Treasury yield, in the right-hand panel, was essentially never constrained by the ZLB during this period.

Carvalho, Hsu, and Nechio (2016) examine the effects of Federal Reserve communication on medium- and longer-term interest rates and come to the same conclusion. Those authors use textual analysis of newspaper articles in Factiva around each FOMC announcement to measure the perceived change in the Fed's "hawkishness" or "dovishness". They run regressions of medium- and longer-term Treasury yields on this measure of Fed communication, analogous to equation (3) above. Carvalho et al. (2016) show that their text-based measure of Fed communication had economically and statistically significant efffects on 2-, 5-, and 10-year Treasury yields throughout the 2008–15 ZLB period, with results that are generally very similar to Swanson and Williams (2014) and Figure 3, above. Their results provide direct evidence that the Fed was never very constrained in its ability to move medium- and longer-term interest rates throughout 2008–15.

Additional indirect evidence supporting this conclusion is provided by the macroeconomic VAR studies of Wu and Xia (2016) and Debortoli, Galí, and Gambetti (2018). Wu and Xia (2016) use an affine term structure model to estimate a "shadow federal funds rate" during the ZLB period—that is, a hypothetical negative federal funds rate that summarizes the effects of the Fed's unconventional monetary policies on the yield curve at each date. They estimate a VAR on output, inflation, and the shadow federal funds rate from 1960 to 2013, where the shadow federal funds rate is set equal to the federal funds rate in the pre-ZLB period, and find no evidence of a structural break in the VAR between the pre-ZLB and ZLB periods. They conclude that the Fed was able to affect the macroeconomy during the ZLB period in much the same way as it did before, albeit through unconventional rather than conventional monetary policy.

Debortoli et al. (2018) estimate VAR models with time-varying parameters and come to the same conclusion. They find no evidence of a change in the U.S. economy's responses to a technology shock or a demand shock in the pre-ZLB and ZLB periods. They also show that their methods would detect clear evidence of such a change if the economy followed a standard New Keynesian model and monetary policy was conducted by a Taylor-type interest rate rule that faced a ZLB constraint. They conclude that the Fed's unconventional monetary policies during the ZLB period were essentially a perfect substitute for changes in the federal funds rate.

Finally, Skaperdas (2017) performs a multi-sector analysis of the U.S. economy from 1970 or 1988 to 2012. He ranks sectors by their interest rate sensitivity in the pre-2008 period, with

sectors like construction, mining, and transportation being the most interest-sensitive and health care and services the least sensitive. If interest rates were kept artificially higher than normal by the ZLB in 2008–15, then interest-rate-sensitive sectors of the economy should have performed relatively worse than they did following the previous 1990–91 and 2001–03 recessions. Skaperdas (2017) shows that this was not the case: interest-rate-sensitive sectors performed about as well after 2007–09 as they did following previous recessions. Like Wu and Xia (2016) and Debortoli et al. (2018), he concludes that the Fed's forward guidance and LSAPs during the ZLB period were able to lower medium- and longer-term interest rates in much the same way as in previous recessions.

To sum up the results of this section, the Fed was not very constrained in its ability to affect medium- and longer-term interest rates throughout the ZLB period. Moreover, explicit tests for a structural break or change in macroeconomic behavior around 2009 fail to find any evidence that the economy behaved differently during the ZLB period than before, suggesting that the Fed's unconventional monetary policies during that period were a close substitute for changes in the federal funds rate.

4. Risks of Being Constrained by the ELB in the Future Are Overstated

Finally, the risks of the Fed being significantly constrained by the effective lower bound (ELB) in the future are typically greatly overstated. There are three main reasons for this overstatement: first, the federal funds rate must be constrained by the ELB for several quarters, rather than just one quarter, to have a noticeable effect on the economy; second, central banks in Europe have demonstrated that the ELB is substantially below zero, at least -0.75 percent and probably a bit below -1 percent; and third, even in those rare cases when the federal funds rate is at the ELB for several quarters, the Fed has alternative monetary policy tools available to it, as discussed above.

Christiano, Eichenbaum, and Rebelo (2011) study the effects of fiscal policy in a standard medium-scale New Keynesian model at the ZLB. They show that when the ZLB constrains the short-term interest rate for 8 or 12 quarters, the fiscal multiplier is substantially larger than normal because the standard monetary policy response to the fiscal shock is shut down. However, they also show that when the ZLB binds for only 4 quarters, then the fiscal multiplier is *not* any larger than normal (Christiano et al., 2011, footnote 11). The intuition for this result is

straightforward: according to equation (2), above, the output gap today is determined by the entire expected path of the federal funds rate, not just the federal funds rate today. If the federal funds rate is only constrained by the ZLB for a few periods, then the effect on the sum in (2) is relatively small, and the effect on the economy is correspondingly small. This helps to clarify that the ZLB is not a significant constraint on the economy unless it binds for several quarters (e.g., 8 or more).

Additionally, several central banks in Europe have shown that the ELB is substantially less then zero. In December 2014, the Swiss National Bank lowered the target for its short-term policy rate to -0.25 percent, followed by an additional cut to -0.75 percent in January 2015, where it has remained since. In Sweden, the Riksbank lowered its short-term policy rate to -0.1 percent in February 2015, followed by several additional rate cuts that brought it down to -0.5 percent in February 2016, where it has remained since. For the euro area, the European Central Bank reduced the lower end of its policy rate corridor, the deposit facility rate, to -0.1 percent in June 2014, followed by several additional cuts that lowered it to -0.4 percent in March 2016, where it has remained since; importantly, money market interest rates have traded near the lower end of the ECB's corridor throughout this period. In Denmark, the Nationalsbank lowered its deposit rate to -0.2 percent in July 2012 and eventually reduced it to -0.75 percent in February 2015, although they have since raised it to -0.65 percent. All of these central banks have maintained negative policy rates for several years with no widespread conversion of deposits into currency.[6] Evidently, the ELB in Europe is substantially below zero, at least -0.75 percent and probably a bit below -1 percent.

A concern that is sometimes raised regarding negative policy rates is that they might not pass through to other interest rates in the economy. For retail deposit rates, there is some evidence that this is the case (e.g., Eggertsson, Juelsrud, and Wold, 2017). However, De Rezende (2017) finds no difference in the pass-through from changes in the Swedish policy rate to Swedish government bond yields before and after the negative policy rate regime. Turk (2016) shows that policy rate cuts in Sweden and Denmark passed through to money market rates and bank loan interest rates in those countries to the same extent during the negative interest rate regime as before, and Turk (2016) and Gros et al. (2016) report that banks increased a variety of fees on retail customers as a substitute for charging those depositors an explicitly negative interest

[6] This is especially remarkable given that the ECB offers EUR500 denomination notes and the Swiss National Bank CHF1000 notes.

rate. Demiralp, Eisenschmidt, and Vlassopoulos (2017) analyze quarterly individual euro area bank balance sheet data and find that banks increased lending in response to policy rate cuts in the negative policy rate regime by at least as much as before.[7] Overall, the pass-through from negative monetary policy rates to other financial market rates does not seem to be inhibited by the policy rate being negative.[8]

Together, these two observations—that the ELB is significantly less than zero and must bind for 8 quarters or more to have noticeable effects on the economy—imply that previous estimates of the risks of the Fed facing a significant ELB constraint in the future are typically greatly overstated. For example, Kiley and Roberts (2017) define the ELB to be 0 percent—a ZLB—and then simulate a structural model to count the number of quarters in which the federal funds rate is less than or equal to zero, even if that episode lasts for just one quarter. Reifschneider and Williams (2000) and Williams (2009) perform calculations very similar to Kiley and Roberts (2017), albeit with a less pessimistic shock distribution.[9] Obviously, these calculations greatly overstate the number of times the short-term interest rate drops below a more realistic ELB of -0.75 percent for 8 quarters or more, which is the economically relevant question.

Even in those rare cases when the nominal interest rate does fall that far for that long, the simple calculations in Williams (2009) and Kiley and Roberts (2017) ignore the existence of unconventional monetary policies such as forward guidance and LSAPs. As shown in the previous two sections, there is extensive evidence that these policies are effective and provide a close substitute for changes in the federal funds rate.

5. Caveats

Although the observations above are supported by a wide variety of papers, data sets, and methods, there are still a few caveats to keep in mind.

[7] To be precise, Demiralp et al. (2017) compare more vs. less retail-deposit-funded banks. They show that more retail-deposit-funded banks, which are hit harder by negative policy rates, were relatively more likely to increase lending, reduce reserves, and increase government securities holdings in response to interest rate cuts in the negative policy rate regime than before.

[8] A second, related concern regarding negative policy rates is that they might depress bank profitability, which in turn might reduce bank lending or have other deleterious effects on the economy. However, because retail deposit rates are less than the policy rate, this argument applies to low *positive* interest rates just as much as it applies to negative rates; thus, if the Fed was willing to lower the federal funds rate from 0.75 percent to 0, it should be essentially just as willing to lower the funds rate into negative territory. In addition, Turk (2016) and Gros et al. (2016) found no decrease in the profitability of Danish and Swedish banks in the negative policy rate regime, perhaps because banks were able to increase fees to offset their retail deposit interest expenses.

[9] Kiley and Roberts (2017) draw shocks from the empirical distribution of shocks to the U.S. economy from 1970 to 2015, which implies that the U.S. will face another financial crisis and Great Recession every 40–45 years, on average.

First, in a very severe ELB scenario, in which the federal funds rate is expected to be at the lower bound for more than 8 quarters, the effectiveness of forward guidance could become much lower than in the past. This almost happened in 2012 (see Figure 3), when financial markets expected the ZLB to be a constraint for long enough that the 2-year Treasury yield's sensitivity to news fell substantially. In the end, the 2-year yield's sensitivity never fell to zero, but if such a severe ELB constraint arose in the future, the 2-year Treasury yield could cease to be a viable instrument of forward guidance. In principle, the Fed could work around this constraint by extending its forward guidance to even longer horizons, but in practice the Fed chair may have difficulty committing his or her successor to a given path for the federal funds rate. However, even in such a dire situation as this, the Fed still has the ability to conduct LSAPs and influence financial markets and the economy through that channel. As shown in Table 1, above, LSAPs have effects that are similar in magnitude to those of the federal funds rate and forward guidance, but operate substantially farther out along the yield curve.

Second, there may be political constraints that make it difficult for the Fed to use LSAPs and negative interest rates. During the 2008–15 U.S. ZLB period, LSAPs seemed to be poorly understood by the public and in many cases evoked strong negative reactions, such as being called "almost treasonous" by Texas Governor Rick Perry.[10] And even though the Fed never used negative interest rates in 2008–15, the idea evokes similarly vehement opposition from many commercial and investment bankers, presumably due to fears about bank profitability: for example, Deutsche Bank CEO John Cryan argued they have "fatal consequences," Allianz chief economic adviser Mohamed El-Erian called them an "insane experiment," Janus Capital financial manager Bill Gross said "Capitalism. . . cannot function" with them, Barclays CEO Jes Staley stated that "they are not helpful," and BlackRock CEO Larry Fink told shareholders they bring "potentially dangerous financial and economic consequences."[11] Given this opposition, it may be more difficult for the Fed to pursue these policies than the literature surveyed above would suggest.

[10] "Rick Perry: 'Quantitative Easing Akin to Treason,'" *The Guardian,* Aug. 11, 2016.

[11] "Deutsche CEO: Negative Rates Have 'Fatal Consequences'," *CNBC,* Aug. 25, 2016, Jeff Cox; "Negative Interest Rates Confront Growing Chorus of CEO Critics," *Bloomberg,* Apr. 27, 2016, Finbarr Flynn; "Bill Gross Steps Up Criticism of Fed, Central Banks for Zero Rates," *Reuters Business News,* Aug. 31, 2016, Jennifer Alban; "Barclays (BCS) CEO Staley: 'Negative Interest Rates Are Not Helpful'," *TheStreet.com,* Sep. 12, 2016, Ian Wenik.

6. Conclusions

The Federal Reserve has not been and is not significantly constrained by the lower bound on nominal interest rates, either in the past or the future. This conclusion is supported by three main observations: First, the Fed's forward guidance and LSAPs are effective monetary policy tools, about as effective as changes in the federal funds rate in normal times. Second, during 2008–15, the Fed was not very constrained in its ability to affect medium- and longer-term interest rates and the economy. And third, the risks of the Fed being constrained by the ELB in the future are typically greatly overstated. These observations are supported by dozens of papers analyzing a variety of countries and data sets and using a wide variety of methods, ranging from high-frequency financial market responses to affine term structure models to macroeconomic VARs to quarterly bank-level lending data. Although there are a few caveats to keep in mind, the overall conclusion is robust to these concerns.

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