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Monetary Policy at the Effective Lower Bound: Less Potent? More International? More Sticky?

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During the 2008 crisis, many advanced economies lowered their policy interest rates to their effective lower bounds (ELBs). In some countries, interest rates are still there. Looking forward, there is a good chance that many central banks will operate at the ELB more often in the future, especially given the fall in the global neutral interest rate (r*) and the high probability that the next slowdown will hit before interest rates are raised to levels from which they could be lowered enough to provide substantial stimulus. Understanding how monetary policy at the ELB is different than "conventional" monetary policy is therefore critical for thinking about monetary policy in the future.

This paper explores three ways in which monetary policy at the effective lower bound may differ from more "conventional" monetary policy—defined as primarily consisting of changes in the central bank's main policy rate. First, it asks whether monetary policy at the ELB is less effective, making it difficult for the central back to meaningfully support the economy. Second, it asks if monetary policy at the ELB has larger international spillovers—through larger effects on the volume and volatility of capital flows or on exchange rates. Finally, it discusses whether the ELB is "sticky", in the sense that adjustments in monetary policy around the ELB generate disproportionate feedback effects that make it harder to tighten monetary policy.

Each of these questions addresses concerns that have been raised about monetary policy at the ELB—concerns which could provide reasons to adjust monetary frameworks in order to reduce the probability of reaching the ELB in the future. I will not venture into this broader debate, but simply focus on whether these arguments for concern about the ELB are valid. My attempts to answer these questions are far from definitive; if anything, the discussion suggests the need for more careful analysis of these important questions.

The preliminary evidence, however, suggests that these concerns about the ELB may be overstated. Monetary policy through "unconventional tools" can be effective at the ELB, assuming there are no political constraints to using these tools. There is also little convincing evidence to date that monetary policy at the ELB has greater international effects (than would occur through comparable adjustments in interest rates) on the volume or volatility of capital flows, or on exchange rates. Whether raising interest rates after being at the ELB is more challenging than raising interest rates from more normal levels is an open question—and one which has been even harder to answer given the small number of countries which have successfully exited the ELB to date. In fact, all of these questions are difficult to answer as any changes in the effectiveness and channels of monetary policy since the 2008 crisis could reflect

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changes related to operating at the ELB—or the many other structural changes in the global economy that have occurred over this period. On a more positive note, if the current improvement in global growth and inflation continues, there should be more examples of countries exiting the ELB and therefore more evidence to help answer these questions.

I. Less Potent?

One of the concerns most frequently cited about central banks operating at the ELB is that they will not have sufficient ammunition to provide stimulus in response to the next slowdown. In the decades before the 2008 crisis, adjustments to interest rates were the primary tool used by central banks to stimulate the economy. For example, in the UK, there were eight business cycle slowdowns from 1980 through 2010, during which the Bank of England reduced interest rates by an average of 3.75pp over each slowdown.[2] In the US, there were seven business cycle slowdowns over the same period, and the U.S. Federal Reserve reduced interest rates by an average of 4.59pp. If interest rates are at the ELB, then these types of reductions will not be possible. If central banks cannot provide stimulus through other mechanisms, and if fiscal policy is constrained due to high deficits or political constraints, countries could face periods of slower and more volatile growth. This is a key concern behind arguments to adjust inflation targets and reduce the probability of being at the ELB.

One challenge to this line of reasoning, however, is that reductions in interest rates are not the only channel by which central banks can provide stimulus. The global financial crisis of 2008 and prolonged recovery, combined with monetary policy at the ELB in many advanced economies, prodded many central banks to experiment with other forms of stimulus. Some were more potent than others, and the effectiveness of many is still widely debated.[3] Some policies which seemed to be effective at the time may have worked due to specific characteristics of the crisis period (such as poor market liquidity), so that they would be less effective at stimulating the economy during less stressed periods.

Nonetheless, my experience on the Monetary Policy Committee (MPC) at the Bank of England (BoE) convinced me that these unconventional tools can be effective, even outside of crisis periods. In fact, there are a number of ways in which central banks can stimulate the economy when at the ELB—even if most central bankers (myself included) would prefer to return to an era where adjustments in monetary policy were made primarily through adjustments in interest rates.

More specifically, before I joined the MPC in 2014, the BoE had embarked on several rounds of quantitative easing (from 2009 to 2012).[4] Most studies of this experience suggest that this provided meaningful stimulus to the UK economy. For example, Weale and Wieladek (2016) estimate that, on average over this period, asset purchases worth 1% of GDP boosted UK GDP by around 0.25%. This estimated impact of asset purchases worth 1% of GDP is roughly equivalent to the impact of a 25bp reduction in Bank Rate (the policy interest rate set by the BoE) on UK GDP—according to very rough rules-of-thumb. Total asset purchases as of 2012 were £375 billion, equivalent to about 20% of UK GDP at the time, which would imply a boost to GDP of about 5%—the equivalent of reducing Bank Rate by

[2] For details on these calculations, see Kristin Forbes (2015),"Low Interest Rates: King Midas' Golden Touch?" Speech available at: https://www.bankofengland.co.uk/speech/2015/low-interest-rates-king-midas-golden-touch

[3] See Greenlaw *et al. (2018)* for a summary of the evidence and more skeptical view of the effectiveness of asset purchases in the US.

[4] See Joyce, Tong and Woods (2011) and Haldane *et al.* (2016) for information on these programs and different estimates of their effects.

5.00%. Of course, these are only rough estimates and do not incorporate the many other factors that were effecting the economy at this time, but even if they are off by half, they still suggest that monetary policy at the ELB was able to provide meaningful stimulus.

I will admit, however, that I was always skeptical of these types of estimates, especially as some of the large estimated benefits from QE over this period likely arose from its ability to improve the liquidity and functioning of stressed financial markets. Would QE provide a similar stimulus when markets were functioning well? This was a critical question for the Monetary Policy Committee in 2016 after the UK voted to leave the European Union (the "Brexit" vote), and most surveys suggested economic growth would slow sharply. The policy interest rate was near what was then believed to be the ELB, and the majority of the Committee wanted to provide more support for the economy than could be achieved by lowering interest rates to the ELB. Were there other monetary policy tools that could provide meaningful stimulus at that time?

The majority of the Committee voted for a four-pronged easing program in August 2016: reduce Bank Rate by 25bps; purchase an additional £60 billion of government bonds; purchase £10 billion of corporate bonds; and start a "Term Funding Scheme" (TFS) that would provide contingent and targeted funding for banks to encourage them to pass on the reduction in Bank Rate to borrowing costs for businesses and households. BoE staff simulated the effects of this four-pronged package under model assumptions that the asset purchase programs would provide some stimulus, but less than the average effects from earlier rounds of QE. The reduction in Bank Rate was expected to account for less than one quarter of the total stimulus from the package—with most of the stimulus resulting from the additional purchases of government bonds. If interest rates were not at the ELB, the MPC would have had to lower Bank Rate by roughly 100bp to get the same estimated aggregate effect on GDP growth and inflation.

Although it is impossible to estimate the exact effects of this program, and especially the effects of the individual components of the program as their joint announcement may have amplified their impact, the evidence available suggests that the asset purchase programs and TFS provided a meaningful amount of stimulus to the economy. In fact, they appear to have provided an even larger boost than expected. For example, the BoE analyzed financial market data in the period after the package was announced and concluded that: "…if anything, the impact was slightly greater than had been anticipated."[5] Although the reduction in interest rates had largely been priced in prior to the announcement of the four-pronged package, Figure 1 shows that other market prices (which primarily reflect the impact of the "unconventional" components of the package) adjusted in ways that would support the economy. The sterling exchange rate index depreciated and the spread on 10-year gilt yields and various corporate bonds fell. The FTSE all-share index and equity prices for UK-focused companies increased. Funding costs of UK banks also decreased (likely supported by the TFS). All of these price adjustments are in the same direction that traditionally follows an unexpected easing in monetary policy, suggesting that the unexpected and unconventional components of the four-pronged package also acted to ease financial conditions.

[5] See Bank of England, *Inflation Report, November 2016, box on pgs. 2-3.*

Figure 1: UK Financial Market Indicators after the August 2016 Stimulus

	Cumulative change between Aug 3, 2016 and:	
	Aug 4, 2016	**Sept 30, 2016**
UK 10-Year gilt yield (%)	-17	-11
Sterling investment-grade corporate bond spreads (basis points)	-10	-17
Sterling high-yield corporate bond spreads (basis points)	-8	-20
FTSE All-Share (index)	1.5	4.2
UK-focused companies' equity prices (index: Aug 3 2016=100)	0.9	2.2
Sterling ERI (Jan 2005=100)	-1.3	-2.9

Source: Based on table in Bank of England, *Inflation Report,* November 2016, pgs. 2-3.

Although it is difficult to directly connect these developments to changes in the real economy, these movements in financial indicators are key channels by which monetary stimulus traditionally supports economic growth and inflation. Data over the subsequent year also suggest that the package supported the economy in ways that would normally occur from easing monetary policy when not constrained by the ELB. For example, retail interest rates for households and businesses fell.[6] Boneva, Roure and Morley (2018) estimates that the corporate bond purchase scheme reduced the spreads of eligible bonds by 13-14 basis points (compared to foreign bonds issued by the same set of firms), and boosted values for other UK assets that were not eligible for the purchase program.

All of these estimates are imprecise; it is impossible to know the counterfactual, and different monetary tools will undoubtedly have different effects in different economies (as well as different effects at different times in the same economy). Nonetheless, they suggest that central banks do have tools available to stimulate the economy other than lowering interest rates. As a result, central banks are not necessarily "out of ammunition" just because they are at their ELB. Of course, there are also constraints on these types of unconventional policies. For example, asset purchases will be limited by the size of the relevant asset market, and political constraints could limit the ability of some countries to use these types of unconventional tools (such as in the United States). Nonetheless, the fact these tools are available, and that they can be potent even when markets are functioning well, should alleviate some of the concerns around the potency of monetary policy at the ELB.

II. More International?

A second common concern around monetary policy at the ELB is that it works through different channels than traditional monetary policy. There are a range of ways this could occur. For example, if monetary policy is done more through forward guidance, then it could have larger effects on the longer end of the yield curve (relative to on short-term rates) than occurs with adjustments in policy rates. Or, if monetary policy is adjusted more through asset purchases, it could have greater effects on specific asset prices and therefore have different distributional implications. For my comments, however, I will

[6] See Bank of England, *Inflation Report, November 2016,* box on pgs. 2-3.

focus on two ways in which monetary policy at the ELB could have greater effects through international channels, and thereby generate larger global spillovers.[7] More specifically, do interest rates at the ELB in advanced economies stimulate excessive volumes or volatility in capital flows to other countries? And when countries are at the ELB, do adjustments in monetary policy have greater effects on the exchange rate?

A. Capital Flows around the ELB

Prominent policymakers in emerging markets have complained that quantitative easing and near-zero interest rates in major advanced economies stimulate excessive capital flows to emerging markets—described in colorful terms as "currency wars" by Guido Mantega (former Finance Minister of Brazil) and a "monetary tsunami" by Dilma Rousseff (former President of Brazil). They argue that these "surges" of capital flows can lead to challenges, such as elevated asset prices and currency appreciation, as well as increase vulnerabilities from the inevitable "sudden stop" when the abundant capital inflows reverse. There is no doubt that volatile capital flows create challenges for emerging markets—especially those with weaker institutions and financial systems. There is also evidence that monetary policy in advanced economies is an important driver of global capital flows, although most research suggests it is only one of a number of factors driving capital flow movements (with other variables, such as global risk, often more important).[8] The key questions, however, are if interest rates near the ELB in advanced economies tend to aggravate the surges of capital flows to emerging markets, and if they contribute to excess volatility in capital flow movements.

It is difficult to test these hypotheses formally, partly due to the limited episodes at which interest rates in major economies have been near the ELB, and partly because there is no clear benchmark for determining the optimal level of capital flow volumes or volatility. Nonetheless, as an informal test, it is useful to look at recent patterns in capital flows to assess if they appear to be elevated or more volatile during the last decade when interest rates in advanced economies were often at the ELB.

Figure 2 shows a first piece of evidence: gross global capital inflows to emerging markets as a % of emerging market GDP from 2000 through 2017.[9] The figure also shows (in red) the average interest rate set by four major central banks (the US Federal Reserve Board, European Central Bank, Bank of England, and Bank of Japan) over this period. Over the last decade, when interest rates have been around the ELB in these major economies, it is hard to make the argument that capital inflows to emerging markets have been "excessive"—at least compared to pre-crisis patterns. More specifically, gross capital inflows to emerging markets have averaged 4.0% of emerging market GDP from 2010 through 2017, below the five-year average before the crisis (of 5.2% from 2003-2007). Even in 2010 when capital flows to emerging markets rebounded as many experienced rapid recoveries, capital inflows never reached their peak of 2006. These patterns even continue to hold for the more volatile capital flows that are more

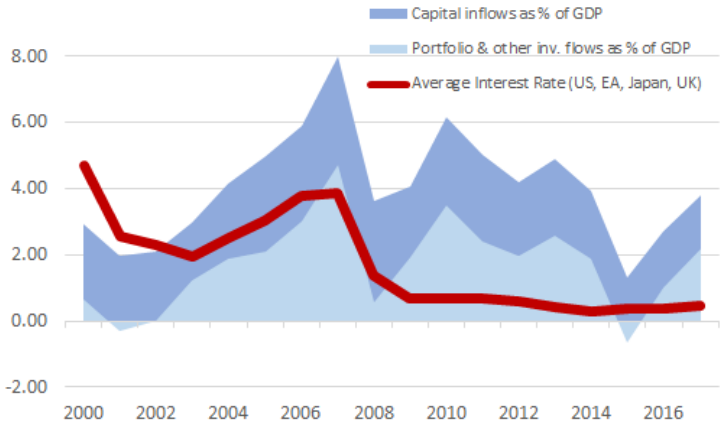
[7] Monetary policy at the ELB could also generate international spillovers by affecting foreign market prices. For analyses of whether these spillovers differ when monetary policy is conducted through quantitative easing or adjustments in interest rates, see Curcuru *et al.* (2018). Most research finds no consistent differences in the spillovers from conventional and unconventional monetary policy.

[8] See Forbes and Warnock (2012) and Rey (2013).

[9] Capital inflows are annual non-resident capital flows (changes in liabilities) to emerging markets, based on the Institute of International Finance, Emerging Market Capital Flows database, May 2018. GDP and interest rate data are from the IMF's World Economic Outlook database, April 2018. The interest rate is the annual average of the policy rate for the US and UK and discount rate for the Euro area and Japan.

tightly linked to monetary policy (shown in the lighter shading).[10] These more volatile capital flows have only averaged 1.9% of emerging market GDP from 2010-2017, as compared to 2.6% from 2003-2007. Granted, the volume of capital inflows to emerging markets may still be elevated relative to optimal levels, and large enough to create challenges for many countries, but the period of very low interest rates in major economies does not appear to have accelerated these flows relative to when interest rates were higher.

Figure 2: Capital Inflows to Emerging Markets (as % of emerging market GDP)



Notes: Capital inflows are non-resident capital flows (changes in liabilities) to emerging markets as a % of emerging market GDP. This includes foreign direct investment, portfolio investment and other investment. The lighter shaded area excludes foreign direct investment. The average interest rate is the average of the policy rate for the US and UK and discount rate for the Euro area and Japan in each year.

Sources: IIF Emerging Market Capital Flows database (May 2018) for capital flow data and IMF World Economic Outlook database (April 2018) for GDP and interest rate data

Many emerging markets, however, are more concerned about the volatility in capital inflows than the volumes, and especially the occurrence of "sudden stops" and "surges" of capital inflows. Therefore, to assess whether capital flows to emerging markets are more volatile around the period of interest rates at the ELB in advanced economies, I use the technique developed in Forbes and Warnock (2012) to calculate the occurrence of surges and sudden stops in capital flows from abroad, based on whether there are unusually large increases or decreases in foreign capital flows relative to historic country-specific trends. More specifically, this methodology uses gross quarterly capital inflow data and defines a "surge" as a period that includes an increase in year-over-year changes in four-quarter gross capital inflows that is more than two standard deviations above the historic average for at least one quarter. A "sudden stop" is defined symmetrical, requiring a decrease in gross capital inflows that is more than two standard deviations below the historic average.[11]

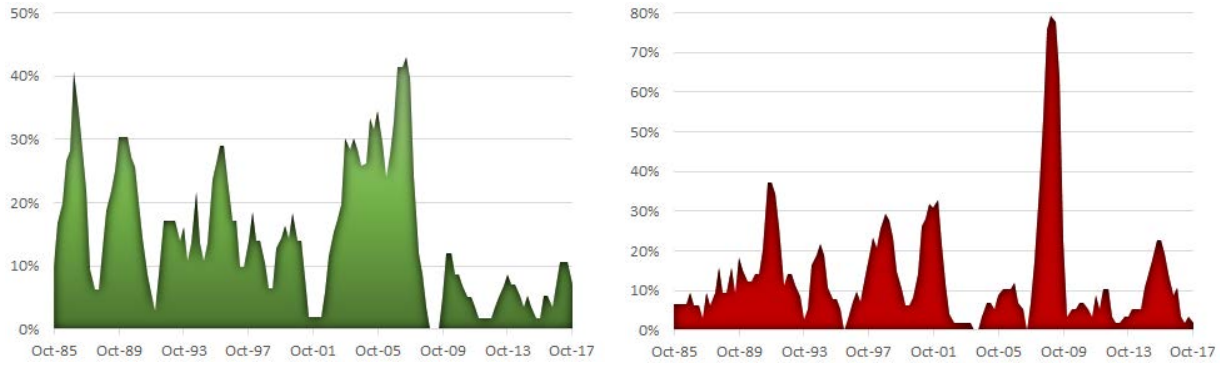
Figure 3 graphs the share of the sample that has experienced surges and stops from 1985 through 2017, using updated data and a slightly larger sample from when this methodology was introduced in Forbes and Warnock (2012). Panel A does not suggest any increase in the share of countries experiencing "surges" of capital inflows during the period of interest rates near the ELB in advanced economies. In

[10] More volatile capital flows are defined as portfolio flows and "other" investment flows, the later which is largely bank flows. This excludes foreign direct investment.

[11] Each surge and stop episode is defined as lasting for all consecutive quarters for which the year-over-year change in annual gross capital flows is more than one standard deviation above or below the historical average. The length of each episode is required to be greater than one quarter. Data is primarily from the IMF's International Financial Statistics, supplemented with country sources. See Forbes and Warnock (2012) for details.

fact, capital flow surges are even less frequent since 2009 than during the 1990s, and much less frequent than the period of relatively high interest rates preceding the 2008 crisis. Panel B also suggests that there has not been an unusual number of sudden stops. Although the incidence of sudden stops increased around the "taper tantrum" in 2013-4 (to peak at about 20% of the sample), this was not unusual when compared to the cycles experienced over the 20 years before the 2008 crisis—a period when interest rates in major economies were not near the ELB.

Figure 3: Incidence of Surges and Stops of Capital Flows From Abroad



Panel A: Surges **Panel B: Sudden Stops**

Notes: Graphs the % of countries in the sample experiencing a surge or sudden stop in capital inflows from abroad each quarter. Methodology discussed in text and described in more detail in Forbes and Warnock (2012). Underlying data is primarily quarterly capital flow data from the IMF's International Financial Statistics, supplemented with country sources.

B. Exchange Rate Sensitivity around the ELB

Even if interest rates around the ELB do not seem to have generated an unusually large volume or increase in the volatility of capital flows, adjustments in monetary policy around the ELB could still be generating unusual international spillovers through their effects on exchange rates. This is another angle of the concerns about "currency wars"; unconventional monetary policy could have greater effects on the exchange rate than a comparable stimulus provided through changes in policy interest rates. (In fact, a larger effect on the exchange rate could mute the subsequent adjustments in capital flows.) These concerns were serious enough that they were the topic of a G-7 meeting in 2013 and discussed in the resulting special G-7 statement establishing ground rules to address the potential effects on exchange rates of different monetary policy tools.[12] Neely (2015) is frequently cited as evidence supporting these concerns; it finds that Fed announcements of QE had larger effects on the dollar than non-QE announcements. This analysis, however, does not control for the fact that the average stimulus provided by the QE announcements was larger than for the non-QE announcements.

Nonetheless, there are reasons why unconventional monetary policy could have larger effects on exchange rates than comparable stimulus provided by adjusting interest rates. Unconventional monetary policy appears to work more through the term premium (and therefore long-term securities),

[12] See Group of Seven (2013), "Statement by G7 Finance Ministers and Central Bank Governors," February 12, available at: www.g8.utoronto.ca/finance/fm130212.htm

while conventional monetary policy works more through short-term rates (and therefore money market rates). Unconventional monetary policy may be interpreted as a longer term commitment to a path of monetary policy over a longer period, whether in the form of a commitment to asset purchases over an indefinite period or state-contingent forward guidance. Any of these channels could cause monetary stimulus at the ELB to have a larger effect on the exchange rate than more conventional changes in policy interest rates. This could, in turn, generate greater spillovers and challenges for any emerging markets that subsequently experienced sharp currency appreciations.[13]

Whether monetary policy at the ELB has a larger effect on exchange rates is an important question—but one which is extremely difficult to identify and test. Several papers (such as Glick and Leduc, 2015) have tried to assess one piece of the puzzle: if exchange rates respond differently to changes in short-term than long-term rates. These papers generally find no significant difference, although identification is a challenge given that movements in short-term rates tend to correspond to movements in long-term rates. Several studies (such as Glick and Leduc, 2015, Curcuru, 2017 and Ferrari *et al.*, 2017) have also found that that the responsiveness of the dollar to US monetary policy announcements or US monetary policy surprises rose after the 2008 crisis. This could result from structural changes not directly related to the form of monetary policy, however, which may have made the dollar more responsive to all forms of monetary policy over the last decade.

Curcuru *et al.* (2018) and Hatzius *et al.* (2017) take a different approach—and find somewhat different (albeit not contradictory) results. Curcuru *et al.* (2018) tackle the identification challenge by assuming that asset purchases affect the term premium (and therefore longer term bond rates), while conventional monetary policy only affects short-term rates. Based on this assumption, it finds that quantitative easing does not generate significantly larger spillovers (in terms of dollar movements, as well as other financial market measures) than conventional monetary policy. Instead, it finds evidence of the opposite: that a given increase in expected interest rates has more than double the effect on the dollar than the same increase in the term premium (which is assumed to be accomplished through asset purchases). Hatzius *et al.* (2017) reaches similar conclusions in an analysis which regresses exchange rates on components of the yield curve and also assumes a larger effect of asset purchases on the term premium. Two challenges to these studies, however, are the restrictiveness of the identification assumptions and the lack of broader understanding of what has been causing movements in the term premium over the last decade.

All in all, whether unconventional monetary policy used at the ELB has a larger effect on exchange rates than a comparable adjustment in monetary policy made through interest rates is still an open question—and a prime target for future research. Although there are valid arguments why monetary policy at the ELB could have larger international effects through exchange rates, as well as through the volume and volatility of capital flows, there is little convincing evidence to date that this has occurred.

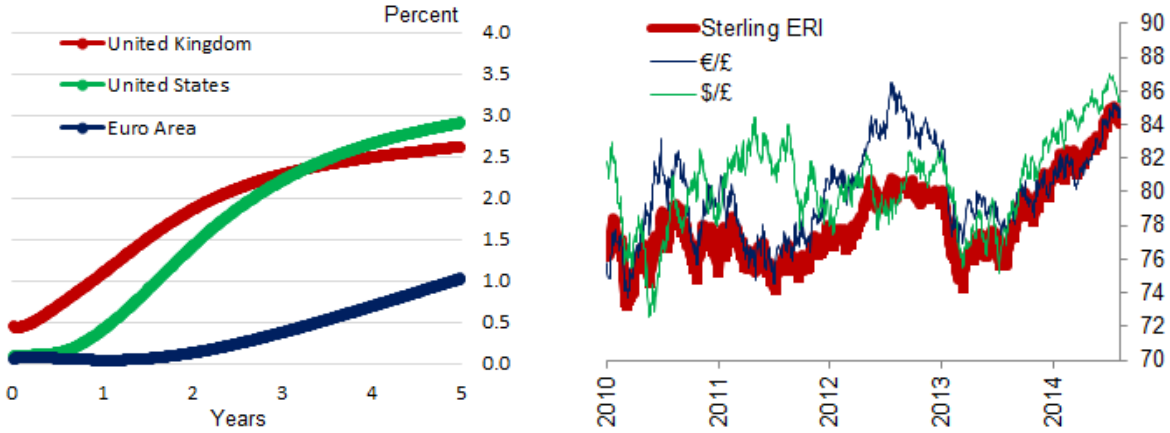
III. More Sticky?

A closely related issue is whether exchange rate adjustments at the ELB make it more difficult to raise interest rates and exit the ELB. More specifically, does the first increase in the policy interest rate from the ELB—or even providing guidance on the intent to do so—cause a larger exchange rate appreciation

[13] Brainard (2017) is an excellent discussion of these issues. It models the different spillovers from adjusting interest rates versus asset purchases, and shows how the spillovers will vary based on the country's exchange rate regime and output gap.

than would occur for a comparable increase in interest rates from a higher starting point? Since appreciations tend to reduce import price inflation and headline inflation (especially when the appreciation corresponds to a monetary policy shock, as shown in Forbes *et al.*, 2018), the subsequent drag on inflation could make it more difficult to justify an increase in interest rates. If the appreciation caused by forward guidance of a forthcoming exit from the ELB was large enough, it could even prevent the exit from the ELB occurring. Or, if a large appreciation was caused by the first increase in interest rates off the ELB, it could make it more difficult to raise interest rates again—leading to an unusually slow tightening cycle. In other words, does excessive exchange rate sensitivity around the ELB make interest rates more "sticky"?

Figure 4: Expected Interest Rates and the Sterling Exchange Rate in 2014



Panel A: Market Expectations for Interest Rates **Panel B: Sterling Exchange Rates**

Notes: Curves of market expectations for interest rates are estimated using instantaneous forward overnight index swap rates in the fifteen working days to August 6, 2014. Sterling exchange rate index is based on Jan 2, 2007=100
Source: Based on data from Bank of England, *Inflation Report,* August 2014.

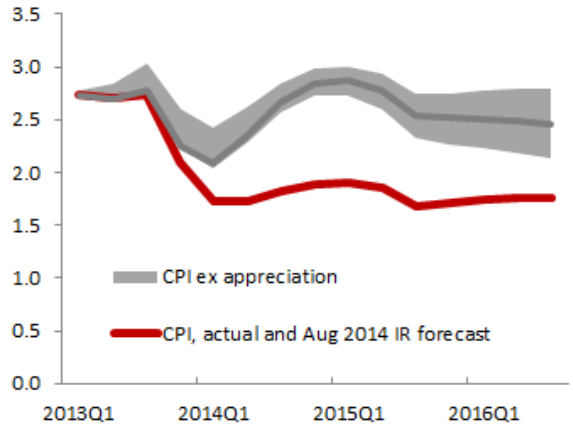
Although there has been no empirical work assessing these effects (to the best of my knowledge), my experience at the Bank of England suggests that the ELB may in fact be "sticky". More specifically, when I started on the MPC in July 2014, the MPC had recently provided guidance which raised expectations that Bank Rate would soon be increased—the first increase in the policy interest rate since 2009. Figure 4a shows market expectations for UK, US and Euro area interest rates around that time, indicating that investors expected this increase in UK rates to occur within the next 6 months.[14] Sterling had also been appreciating sharply (Figure 4b)—with the exchange rate index already up about 12% by October 2014 (from its recent low in March 2013). This appreciation would continue over the next few months (peaking at over 15%) and have a number of effects on the economy. For example, it contributed to tighter financial conditions and slower growth in net exports—both of which would drag on GDP growth and therefore inflation in the future. The currency appreciation was also expected to reduce import prices and CPI inflation. Using the BoE's rough rule-of-thumb at the time, a 12% appreciation would be

[14] Market expectations are measured by instantaneous forward overnight index swap rates from Haver and the BoE.

expected to reduce the level of import prices by about 11% and the CPI by over 3% over the next few years—very large effects.[15]

Moreover, these effects of sterling's appreciation on inflation were expected to have first-order importance for the appropriate path for monetary policy. Figure 5 shows the results of a simulation I did at that time (in Forbes, 2014) using the more complicated DSGE model used by the Bank of England to capture the full effects of the appreciation, combined with data on the economy that existed in October 2014.[16] The MPC inflation forecast (the red line) incorporated the effects of sterling's sharp appreciation to date. This forecast suggested that inflation would remain below the 2% inflation target over the next year, implying that interest rates would not need to be tightened as much or as quickly as suggested by the market curve. In contrast, the simulated path of inflation (in grey) assumes that sterling did not appreciate and instead remained at its 2013Q1 level. The simulation predicts that inflation would have been well over the 2% target over the next few years.

Figure 5: UK Inflation Forecast and Simulated Inflation Path Assuming no Sterling Appreciation



Notes: The gray swathe is COMPASS' predictions of CPI inflation if the exchange rate remained at its 2013Q1 level, under assumptions of different degrees of persistence of the appreciation. The appreciation is assumed to be exogenous, with no other changes in policy and no other shocks.
Source: Replicated from speech, "The Economic Impact of Sterling's Recent Moves: More than a Midsummer Night's Dream," by Kristin Forbes, 1 October 2014.

Although it is impossible to know what the MPC would have decided in this counterfactual situation, it is likely that interest rates would have been lifted off the ELB sooner if the exchange rate had not appreciated so sharply and substantially dampened the expected path of inflation. Instead, exit from the ELB was delayed for an extended period—and the next move in UK interest rates was actually down (after the Brexit vote) instead of up. UK interest rates were only lifted above 0.50% in August 2018—four years after this period of serious consideration of exiting from the ELB. Granted, much of this delay was due to other subsequent shocks (such as the sharp decline in commodity prices in 2015 and

[15] The rule-of-thumb at the time was that pass-through from movements in the sterling ERI was 90% to import prices and then 30% to headline CPI (so that a 10% depreciation corresponds to a 9% increase in the level of import prices and 3% increase in the level of the CPI). This rule-of-thumb was subsequently adjusted such that the pass-through to import prices was reduced to 60% (and no change in the second stage of pass-through).
[16] This simulation compares the path of CPI inflation predicted in the latest *Inflation Report* relative to if the exchange rate had remained at its 2013Q1 level and there had been no other shocks or changes in policy. The shift in the exchange rate is assumed to result from an exogenous exchange rate shock, and the bands around the grey line capture the range of outcomes based on different assumptions for the persistence of the appreciation.

uncertainty around the Brexit vote), but the initial move off the ELB would likely have occurred before these additional shocks if sterling had not appreciated so sharply when interest rates were at the ELB.

Of course, sterling would still have appreciated if the expected 2014 increase in interest rates occurred at a level of interest rates above the ELB. The key question is whether the appreciation during this episode was larger than it would have been if rates were not at the ELB. This is a more difficult question to answer, but a comparison with historic episodes suggests that sterling was more sensitive than would normally be expected. More specifically, a 25bp increase in interest rates is usually assumed to correspond to a sterling appreciation of about 0.25% to 1%.[17] This band reflects historic averages as well as model estimates, and suggests that the exchange rate movement in 2014 and early 2015 was meaningfully larger than would be expected based on expected changes in monetary policy.

There are several reasons why exchange rates could be more sensitive to changes in monetary policy as countries attempt to move away from the ELB. First, the initial movement away from the ELB is likely to occur through forward guidance about the near term, especially as central banks tend to be even more cautious than usual and not to want to create surprises when raising interest rates for the first time in an extended period. Forward guidance—especially if focused on imminent changes in policy—would likely have a large effect on short-term interest rates, which may be more closely linked to exchange rate movements. Second, raising interest rates off the ELB after an extended period of monetary stimulus may be seen as signaling a major shift in policy, a shift that affects not only short-term rates, but the whole market curve, and in a stronger way than normally occurs. Similarly, it could be interpreted as showing a shift in confidence about the economic outlook, similar to the "Delphic effect" in Nakamura and Steinsson (forthcoming). Finally, the relative size of the change in interest rates when starting at such a low level may matter; for example, raising interest rates by 25bp is a doubling of interest rates if moving from an ELB of 0.25%, but only about a 10% increase if moving from a level of 2.0%. The relative increase in carry costs or other prices related to the 25bp increase in interest rates could cause disproportionate effects on currency trading and other pricing.

If there is a "stickiness" to raising interest rates from the ELB, assessing the magnitude of this effect is challenging. Not only are there limited examples to assess, but any such effects will undoubtedly differ across countries and over time. Factors which would determine the magnitude of any such stickiness include: whether other countries are also tightening monetary policy at the same time, the sensitivity of the currency to interest rates, and the sensitivity of inflation, financial conditions and exports to exchange rate movements.

Given these challenges, it is not surprising there has not yet been a formal study of any of these channels which could make adjusting interest rates at the ELB "sticky". There are, however, numerous anecdotes from countries other than the UK which would support the hypothesis that it has been harder to exit from the ELB than expected. For example, as of June 2017, despite seven years of solid global economic growth above 3%, no advanced economy (other than Hong Kong and the United States) had been able to maintain an increase in interest rates since 2011. In fact, at that time, nine countries which had tried to "lift off" and raise interest rates since 2009 had then reversed the rate

[17] The lower estimate reflects the "rule-of-thumb" from the BoE's Compass model under a set of standard assumptions, described in Burgess *et al.* (2013). The higher number is estimated in Forbes *et al.* (2018).

increase.[18] Even the US, the advanced economy able to raise interest rates the most from its ELB, was only able to do so after a very slow start; it was a full year between when the US Federal Reserve first raised interest rates above the ELB and its next rate increase. Granted, the simultaneous challenges for so many countries in exiting the ELB may also reflect common global developments – such as a decline in the global equilibrium interest rate. Nonetheless, it also may reflect additional challenges and a "stickiness" in raising interest rates from the ELB.

IV. Conclusions

Research on monetary policy at the ELB is only in its infancy. Empirical analysis of whether monetary policy functions differently at the ELB is complicated by the fact that the last decade when many advanced economies were at the ELB coincided with many other structural economic changes—changes that would also affect the functioning of monetary policy. Nonetheless, my comments have drawn on what we know to date, including my experience setting monetary policy in the United Kingdom, to assess the validity of three different concerns about monetary policy at the ELB. Is monetary less potent at the ELB? Does it generate greater international spillovers (through capital flows and exchange rates)? And does the ELB make monetary policy "stickier" and harder to raise rates when appropriate? The last set of concerns is more speculative, but the first two have been raised as reasons to avoid the ELB when possible—potentially justifying changes to monetary policy frameworks.

The discussion in the paper, however, suggests that monetary policy at the ELB can still be potent, and does not necessarily generate any greater international spillovers through capital flows and exchange rates than comparable adjustments in interest rates. It may be more challenging to raise rates off the ELB than to raise rates from higher levels—possibly due to counterbalancing effects working through the exchange rate—although there are only anecdotes to support this "stickiness" rather than any formal empirical evidence. The debate on these issues will continue….albeit hopefully not as long as countries have been mired at the ELB.

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[18] See Kristin Forbes, "Failure to Lift", speech given at the London Business School on June 22, 2017 and available at: https://www.bankofengland.co.uk/speech/2017/failure-to-launch

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