

Dealing with Monetary Paralysis at the Zero Bound

Kenneth Rogoff

Despite an outward appearance of stability, the core of the global monetary system today is immersed in a level of intellectual turmoil not seen since the breakup of the Bretton Woods system in the early 1970s. Back then, it was the system of fixed exchange rates that constrained central banks (except for the United States at the center). More recently, the key constraint for central banks is the zero lower bound on nominal interest rates. The zero bound has its roots in a diverse range of frictions but is due above all to the fear of central banks that if they push the short-term policy interest rates, which they set, too deeply negative, there will be a massive flight into paper currency. Cash, of course, pays no interest, positive or negative.

This paper asks whether, in a world where paper currency is becoming increasingly vestigial outside small transactions (at least in the legal, tax-compliant economy), there might exist relatively simple ways to finesse the zero bound without affecting how most ordinary people live. Surprisingly, this topic has been relatively obscure during the past decade compared to the massive number of articles, well-represented in top journals, that take the zero bound as given and look for out-of-the-box solutions for dealing with it. In an inversion of the old joke, it is a bit as if the economics literature has insisted on positing “assume we *don’t* have a can opener,” without considering the possibility that we might be able to devise one.

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The path to effective negative interest rate policy is hardly something that can be implemented overnight. As I will argue, however, it makes sense not to wait until the next financial crisis to develop plans and, in any event, it is time for economists to stop pretending that implementing effective negative rates is as difficult today as it seemed in Keynes' time. The growth of electronic payment systems and the increasing marginalization of cash in legal transactions creates a much smoother path to negative rate policy today than even two decades ago. Fundamentally, there is no practical obstacle to paying negative (or positive) interest rates on electronic currency and, as we shall see, effective negative rate policy does not require eliminating paper currency.

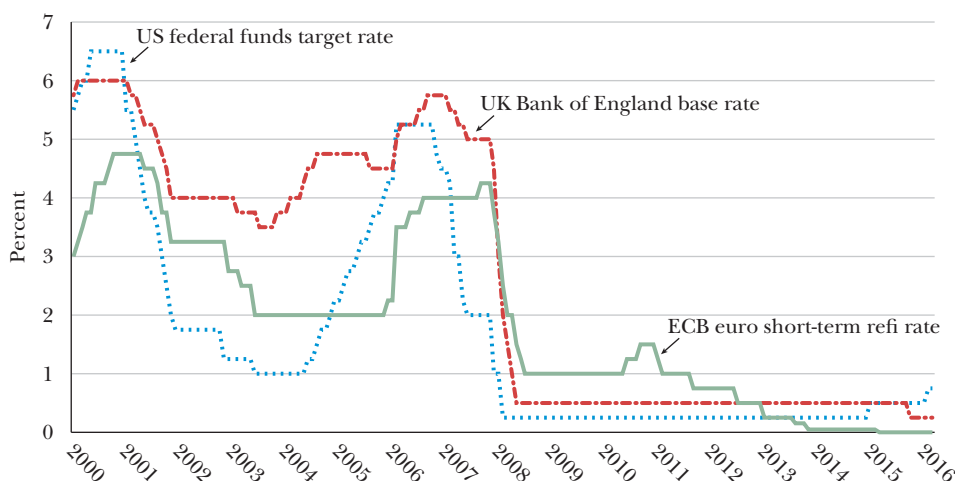
There are a variety of mechanisms to avoid a run into paper currency if the central bank needs to steer short-term policy interest rates deeply negative (say, to combat a major systemic financial crisis). One involves getting rid of large-denomination notes, which Henry (1976) and myself (Rogoff 1998, 2015, 2017) argue would be a good idea for fighting tax evasion and crime regardless. The other approach does not touch cash at all, but instead creates a crawling pegged exchange rate between paper currency and bank reserves. It might sound head-spinning for a single country to have two currencies, but as we shall see, it is not as complicated as it sounds.

Of course, part of economists' fascination with the zero lower bound is precisely that it forces a rethinking of conventional dogma. Just as the laws of physics imply strange and surprising consequences as an object approaches a black hole, the laws of economics can yield some strange and surprising results as an economy gets too near the zero lower bound on interest rates. Fiscally irresponsible budget policy can become responsible, and structural reforms to make economies more efficient can become counterproductive. The foundations of the international monetary system can be threatened by a shortage of safe assets, which economists once thought impossible under flexible exchange rates. To reduce the possibility that economies will get stuck on the zero bound in future crises, a significant number of leading macroeconomists have argued central bankers should abandon all pretense of long-term price stability and raise their inflation targets to 4 percent.

Although the modeling and empirical issues are indeed very interesting for researchers, this is hardly an idle academic discussion. With today's ultra-low policy interest rates— inching up in the United States and still slightly negative in the eurozone and Japan—it is sobering to ask what major central banks will do should another major prolonged global recession come anytime soon. During nine recessions since the mid-1950s, the US Federal Reserve has cut its policy interest rate by an average of 5.5 percentage points (Yellen 2016). There is hardly room for that now, or into the foreseeable future. Yes, during the financial crisis, central banks developed a number of unconventional monetary policy tools such as “quantitative easing,” but many economists are rightly concerned that unconventional monetary policy tools are poor substitutes for conventional interest rate policy and might well have more side-effects. Hence it becomes a research imperative to consider alternatives.

Figure 1

Policy Interest Rates for the Federal Reserve, European Central Bank, and the Bank of England



Source: Federal Reserve Board, European Central Bank, and Bank of England, February 2017.

The Sharp Fall in Nominal Central Bank Policy Interest Rates

The level of policy angst and research interest on how to navigate the zero bound reflects the very low interest rate environment in advanced countries that, outside of Japan, has not been seen since the Great Depression of the 1930s. It also reflects a view that even after post-financial crisis reflation, the general level of nominal interest rates is likely to remain suppressed for a long time to come. Intuitively, the lower the starting point for policy interest rates when a recession hits, the greater the odds of bumping into the zero lower bound.

Figure 1 plots policy interest rates for the United States, the European Central Bank, and the Bank of England since 2000. Notice that the Federal Reserve cut the federal funds interest rate target by roughly 5 percentage points after the bursting of the tech bubble in 2000, eventually falling to a level of 1 percent in 2003. The Fed subsequently tightened monetary policy, but then cut rates again by 5 percentage points to an official target range of 0 to 0.25 percent as the recession and global financial crisis unfolded in 2007–2008.

The European Central Bank does not have the Fed's long track record, having faced only two recessions since its founding in 1999. However, the ECB did cut its policy rate, the short-term euro refinancing rate, by 2.5 percentage points in the early 2000s recession and later by over 4 percentage points during the global financial crisis. As of March 2017, banks depositing funds at the ECB received -0.4 percent. The Bank of England base rate, also shown in Figure 1, follows a similar

pattern. Japan suffered its financial crisis starting in 1992 (Reinhart and Rogoff 2009), and the Bank of Japan's policy rate has been hovering around zero for roughly two decades and is now slightly negative.

The recent collapse in monetary policy interest rates to near zero is quite remarkable. When John Taylor (1993) first estimated his famous "Taylor rule" for monetary policy in 1993, he suggested that a normal central bank policy interest rate ought to be around 4 percent, which represented a combination of 2 percent target inflation rate and 2 percent "neutral" short-term real interest rate. For many years, major inflation-targeting floating-exchange-rate central banks used versions of the Taylor rule to benchmark their policies. But especially in the aftermath of the financial crisis, setting policy interest rates has not been nearly so straightforward.

Today's near-zero nominal short-term interest rates partly reflect the fact that central banks have been undershooting their inflation targets, thereby muting inflation expectations. But most of the action has come in the collapse of the equilibrium short-term real (inflation-adjusted) interest rate, which is now closer to -1 percent on average across the advanced countries than to Taylor's (1993) +2 percent (Holston, Laubach, and Williams 2016). For example, the interest rate on a 10-year inflation-indexed Treasury security fell from 2.7 percent before the financial crisis to almost -0.9 percent at the end of 2012; it rose subsequently, but by early March 2017 was still only 0.5 percent.

Several potential causes underlying this remarkable fall in real interest rates have been suggested, and there are a wide range of views on the quantitative significance of each. The variety of explanations include: increases in global savings due to the demographic cycle (Carvalho, Ferrero, and Nechio 2016); emerging-market demand for safe advanced-country assets (for example, Bernanke 2005); lower trend productivity growth (Gordon 2016); the falling cost of investment goods (Karabarbounis and Neiman 2014); and secular stagnation in world aggregate demand, perhaps exacerbated by rising inequality of incomes (Summers 2013).

There is also a strong case to be made that a good part of the recent drop in real interest rates is a legacy of the 2008 financial crisis, and of an ongoing debt super-cycle that was originally centered in the United States and then in the eurozone, and now perhaps has reached China (Rogoff 2016). On top of lingering debt overhang in some regions, the financial crisis has led investors to place a greater weight on tail risks, which can in turn lead to a sharp drop in safe real interest rates even with normal risk aversion parameters (for discussion, see Reinhart, Reinhart, and Rogoff 2015, who build on Barro 2006). Indeed, options prices reveal that even though market volatility has greatly abated since the peak of the crisis, concern over tail risk remains very high. Kozlowski, Veldkamp, and Venkateswaran (2017) argue that tail risk can explain a wide range of post-crisis phenomena, not least including low investment and a large (roughly 12 percent for the United States) drop in potential output.

Another factor is that heightened post-crisis financial regulation and weak bank balance sheets have made it more difficult for small and medium-size businesses to gain access to credit markets, even controlling for slower trend growth.

Reinhart and Sbrancia (2015) argue that post-crisis, rich-country regulatory policies, which emphasize liquidity and safety cushions, have tilted the playing field in favor of sovereign borrowers. One only need look at the eurozone, where national debts have been siloed into corresponding national banks, to see an example of their idea. Geanakoplos (2014) points out that even though posted interest rates for small and medium-size borrowers can appear to be quite low, there is considerable credit-rationing for this group. Although headwinds are fading, particularly in the US economy, many potential borrowers around the world face considerably stricter collateral constraints than they did before the crisis.¹

The implication of very low expected inflation and real interest rates is that “neutral” central bank policy interest rates are likely to remain low for many years to come. Laubach and Williams (2015) estimate a neutral nominal federal funds rate of 2 percent, well below Taylor’s (1993) estimate of 4 percent. Holston, Laubach, and Williams (2016) extend the approach to look at Canada, the eurozone, and the United Kingdom and find similar declines in the neutral policy rate. Even allowing for some reversion to the mean in global real interest rates, Federal Reserve chair Janet Yellen (2016) has suggested that a neutral Fed Funds rate (a rate consistent with full employment and the Fed’s 2 percent inflation target) will likely land around 3 percent.

Interest rates could surprise on the upside for any number of reasons, not least because of higher macroeconomic volatility due to a rise in populism. The central scenario, however, at least per current global bond markets, is that the general level of global interest rates is likely to remain low for some time to come, implying significant risk that central banks may have to wrestle again with a severe zero-bound episode sometime in the next couple decades, if not even the next few years.

Can Alternative Monetary Tools Obviate the Zero-Bound Constraint?

Central banks, naturally, want to reassure everyone that there is no reason to be overly concerned, and that they have already developed fully adequate alternatives to normal interest rate policy, should the need arise. These alternative tools include “forward guidance” over the path of future interest rates (with the idea of lowering today’s real interest rate by raising the expectation of future inflation) and “quantitative easing” policies involving large-scale purchases of public and private bonds. Drawing on results from simulations of the Fed’s empirical macroeconomic model, Yellen (2016) and Reifschneider (2016) argue that these alternative tools, already battle-tested during the financial crisis, can be fully as effective in stabilizing output and unemployment in a deep recession as being able to use the kind of unfettered negative interest rate policy discussed later in this paper. Wu and Xia (2016) take a

¹Gourinchas and Rey (2016) show that today’s low consumption/wealth ratio in the advanced world is likely a predictor of a sustained period of low global real interest rates, but not necessarily a predictor of lower trend growth.

very different path to the same conclusion, by constructing a “shadow interest rate” that attempts to take account of the overall effect of diverse Fed instruments on the economy.

Unfortunately, it is extremely difficult to produce convincing evidence, in part because experience with alternative monetary policy tools has been so limited, and results are very sensitive to modeling assumptions (Woodford 2012; Rogoff 2017). It is probably fair to say that the consensus among researchers is that the use of alternative policy instruments has probably been worth the risk but that their effectiveness has been limited. Nevertheless, before turning to an array of more radical proposals that economists have advanced, we discuss further the instruments that have already been used.

Quantitative Easing and Forward Guidance

Virtually every advanced-country central bank has engaged in some form of large-scale asset purchases, or quantitative easing, which involves issuing central bank reserves (essentially very short-term government debt) to purchase both public and private assets. The Federal Reserve engaged in quantitative easing to the tune of about 25 percent of GDP, but the Bank of Japan and the European Central Bank have done even more. The Bank of Japan’s program over the past four years has been particularly aggressive, with the Bank of Japan well on track to buying public debt equal to 100 percent of GDP. Despite all its efforts, the inflation rate in Japan remains well below the Bank of Japan’s 2 percent target, and long-term projections are that it may well fall even lower.

The limitations of alternative monetary instruments are underscored by the fact that the Bank of Japan has essentially tried even “helicopter money,” an approach suggested by Bernanke (2002) based on Milton Friedman’s famous thought experiment of having the central bank simply print money and hand it out. In fiscal year 2015, the Bank of Japan purchased far more government debt (80 trillion yen) than the government issued (30 trillion yen), and it did much the same in fiscal 2016 even after the Abe government’s July 2016 announcement of a massive (28 trillion yen) new debt-financed fiscal stimulus.² The effects were positive but not large.

The real problem is that central banks don’t have authority to make fiscal transfers (Cecchetti and Schoenholtz 2016), a nuance that seems to have largely escaped the global commentariat. Moreover, if central banks were ever to acquire the capacity to engage in helicopter money on their own, they would risk quickly losing any semblance of independence as politicians raced to use helicopter money to make opportunistic transfers.

²For details of the Japanese policy, see the Bank of Japan announcement of July 29, 2016, at http://www.boj.or.jp/en/announcements/release_2016/k160729a.pdf. See also the Japan Ministry of Finance plans for issuing debt at http://www.mof.go.jp/english/jgbs/debt_management/plan/e20151218issuanceplan.pdf and http://www.mof.go.jp/english/jgbs/debt_management/plan/e20160824issuanceplan.pdf.

The European Central Bank has walked a tightrope with its quantitative easing policies, because of course there is no government debt instrument for the eurozone as a whole, only national bonds. ECB quantitative easing therefore amounts to buying pro-rata shares of the debt of member states. Given that investors vastly prefer to hold German debt than, say, Portuguese or Italian debt, ECB quantitative easing policy involves actuarial transfers across governments, even if these transfers are not realized.

Another form of quantitative easing is the acquisition of private-sector stocks and bonds, which might be called “fiscal quantitative easing,” because it can be decomposed into normal quantitative easing (issuance of central bank reserves to buy longer-term government debt), combined with issuance of government debt to buy private debt assets (normally viewed as directed credit). In effect, fiscal quantitative easing uses taxpayer guarantees to subsidize private companies. In theory, this tool can be very effective at the zero bound, far more effective than central bank purchases of government debt. Caballero, Farhi, and Gourinchas (2016), for example, show how global central bank purchases of risky private debt can help boost growth and prices, whereas purchases of government debt would have little effect.

The downside to directed credit is that it exposes the central bank to political pressures—for example, to buy bonds of favored sectors, companies, or financial institutions. Such measures harken to the days before financial liberalization when many European central banks, for example in France and Italy, were *de facto* central planners. The fear is that in today’s much larger capital markets and advanced economies, fiscal quantitative easing could prove a slippery slope.³

Another idea is to drive down real interest rates (when nominal rates are stuck at zero) by talking up future inflation through “forward guidance.” One way to do this is for the central bank to commit not to raise interest rates too quickly, even after the economy returns to full employment.⁴ In principle, forward guidance to raise inflation expectations can be used to stimulate consumption and investment just as effectively as nominal interest rate cuts, since both work by lowering the real interest rate. Unfortunately, it is hard to make forward guidance credible, given

³Greenwood, Hanson, and Stein (2016) argue that even though the US Treasury effectively owns the Federal Reserve, the central bank can still play a helpful role in promoting financial stability by issuing very short-term bank reserves (or Federal Reserve debt) to buy up longer-term Treasury bills. They argue that the Treasury is not willing to issue at quite the same short horizons as the Fed, even though regulation gives many banks and financial market firms a strong appetite for super-short-maturity debt. However, shortening the maturity structure of debt exposes the taxpayers to greater risks to, say, a rapid and unexpected rise in global real interest rates, a risk that can hardly be ruled out given that so little is known with a high level of confidence about why interest rates fell so quickly.

⁴In Canzoneri, Henderson, and Rogoff (1983), we provide an early model of forward guidance, showing that if the central bank cannot respond by using the current interest rate (in our case due to implementation lags, rather than the zero-bound constraint), it is still possible for monetary policy to be just as effective by committing to manipulate future inflation in a way that gives the same real interest response as if the current nominal rate could be moved, as in Woodford (2012).

1) the turnover in central bank governing boards, and 2) the central bank has an incentive not to keep its promise if the economy does indeed recover.

Overall, alternative monetary policy instruments such as forward guidance and quantitative easing offer some theoretical promise for addressing the zero bound. But these policies have now been deployed for some years—in the case of Japan, for more than two decades—and at least so far, they have not convincingly shown an ability to decisively overcome the problems posed by the zero bound.

Higher Inflation Targets

A more radical idea is to raise central bank inflation targets from 2 percent to 4 percent. The idea is that if the inflation rate is, on average, 2 percent higher, the general level of nominal interest rates should be (on average) 2 percent higher as well; after all, theory teaches that monetary policy is neutral in the long run and cannot affect long-term equilibrium real interest rates. Thus, in principle, the central bank might be expected to have an extra 2 percent of nominal rate cuts to play with in a deep recession.

The pioneering papers on 4 percent inflation targets include the early quantitative analysis of Fuhrer and Madigan (1997) and the theoretical analysis of Krugman (1998). The idea really took off, though, with Blanchard, Dell’Ariccia, and Mauro (2010), written when Olivier Blanchard was Chief Economist at the International Monetary Fund. Blanchard and his co-authors argued that after the near brush with the zero bound at the beginning of the 2000s, followed by collapse to the zero bound in the global financial crisis, central banks needed to consider allowing higher trend inflation.

Raising the inflation target to 4 percent is a plausible approach, but it is not without drawbacks. First and foremost, central banks have invested over two decades in convincing the public that they are deeply committed to a 2 percent target, and that 2 percent inflation should be considered the moral equivalent of price stability. Any transition to a higher inflation target is likely to be quite disruptive, and it may never be possible to make the new higher target as credible as the old one. After all, if central banks changed their inflation target once, what is to stop them from changing their minds again?

A deeper problem, which is not simply transitional, is that there is arguably a fundamental difference between 2 percent and 4 percent inflation psychologically. At 2 percent inflation, most citizens feel little need to think much about inflation, especially as official indices likely overstate inflation due to the difficulty of incorporating new goods for which prices did not previously exist. Higher levels of inflation, if sustained for a long period, would likely lead to more indexing and more frequent price adjustment,⁵ which in turn would undermine the potency of monetary policy. Simply put, central banks might find themselves needing much of the interest room

⁵Nakamura, Steinsson, Sun, and Villar (2016) find that during the high-inflation 1970s, price-setting frequency was fairly stable; nevertheless, if the higher inflation is predictable and in place for a very long period, one would strongly expect an adjustment to more frequent price setting.

accorded by a higher inflation target simply to achieve the same degree of stabilization. This would be particularly problematic in a very deep recession such as in the aftermath of a financial crisis, where inflation might collapse for a sustained period requiring very deep interest rate cuts to bring it back, implying that the bite of the zero lower bound might still be quite severe.

To the extent that the frequency of wage and price adjustment did not change, even after a long adaptation period, then higher target inflation implies greater distortion across relative prices in a world where wage and price adjustment is staggered. This effect can be quite empirically significant, as Ascari and Sbordone (2014) document in a broad-ranging study. A very important detail is that the economy must bear the relative price distortions resulting from higher inflation all the time, not just during recessions.

All in all, despite its drawbacks, the idea of raising target inflation rates is an important one, and would be well worth considering if the significantly more elegant approach of (effective) negative nominal rate policy were not available (albeit after a longer preparation period). In the meantime, concerns that problems with the zero bound might make monetary policy relatively impotent in future deep recessions has set academic researchers looking at a wide range of backup tools. The ideas are all interesting, although each comes with its own set of problems.

Implications of the Zero Bound for Broader Macroeconomic Policy Debates

It has been known since Keynes that the zero bound can increase the case for fiscal stimulus beyond what would be warranted if monetary policy were not paralyzed. However, calibrating the intensity and duration of the “excess” stimulus is far from straightforward. In his early and prescient paper on the zero bound, Lebow (1993) makes the case for leaning more on fiscal stimulus than would otherwise be warranted. A temporary fiscal stimulus that is calibrated to come off when the economy lifts off the zero bound is significantly more effective than one that lasts indefinitely, because the drag from expected future taxes is less (Christiano, Eichenbaum, and Rebelo 2011). DeLong and Summers (2012; and also Eggertsson, Mehrotra, Singh, and Summers 2016) argue that fiscal deficits can lead to *lower* debt-to-GDP ratios in a depressed economy at the zero bound, because of their effect on nominal GDP growth.

Perhaps more surprising to many economists is that a number of policies normally thought of as structural can—in a situation with the zero bound—have profound aggregate demand effects through their impact on the real interest rate, at least in principle. In a very creative and influential series of papers with various co-authors, Gauti Eggertsson has argued that when monetary policy is temporarily paralyzed by the zero bound, one has to look carefully at the price effects of any structural adjustment or macroeconomic policy. Suppose, for example, a competitiveness-enhancing reform to goods or labor markets leads over time to lower

prices through increased efficiency. Normally, any deflationary impact on aggregate demand would be a second-order issue that the monetary authorities could easily counteract by lowering interest rates. But at the zero bound this is not possible and the adverse aggregate demand effects of higher real interest rates (because of lower inflation) can have a first-order impact (for example, see Eggertsson 2010; Eggertsson, Ferrero, and Raffo 2014; Eggertsson, Mehrotra, Singh, and Summers 2016). Similarly, increased price flexibility, normally thought to make an economy more efficient, can also be problematic at the zero bound (Werning 2011).

Some of these ideas, which have been quite influential in the policy debate, are reminiscent of policies adopted during the Great Depression to fight deflation. These included suspending antitrust policies in a way that increased monopoly concentration and raised prices in a movement (at least for a time) away from the zero bound, but also arguably had a major adverse impact on the long-term path of output (Ohanian 2001).

Not every structural reform is deflationary. Nevertheless, the new literature has produced important counterexamples to the conventional wisdom that countries should always take advantage of a financial crisis to engage in politically difficult structural reforms and that those who do will typically enjoy the strongest and most durable recoveries.

One can stretch this logic to suggest that almost anything that raises expected inflation is worth considering, thanks to the positive aggregate demand effects of a lower real interest rate. Eichengreen (1986, 2016), for example, argues that when an economy is at the zero bound, it is possible that trade protectionism might prove beneficial in the short run—though not if there is retaliation by a country's trading partners. Bodenstein, Guerrieri, and Gust (2013) show that in an economy stuck at the zero lower bound, oil price increases may be much less problematic than normally presumed for oil importers, once again because the price inflation effect helps reduce real interest rates.

The zero bound also can greatly complicate international transmission of monetary policy. When one country is mired in the zero bound, it can suck in other countries as well (Caballero, Farhi, and Gourinchas 2016; Eggertsson, Mehrotra, Singh, and Summers 2016). For example, the eurozone effectively transmits lower interest rates to the rest of the world through its large current account surpluses, which sap global demand in other areas, thereby tending to drive down rates. Similarly, Japan's chronic trade surpluses have put downward pressure on US and European interest rates.

Although negative transmission of demand shocks can take place in normal times, it becomes more severe if affected countries themselves hit the zero bound, thereby losing their own capacity for countercyclical monetary policy. Farhi and Maggiori (2016) argue that the problem of the zero bound has greatly compounded a modern-day parallel to the "Triffin dilemma" that plagued the postwar Bretton Woods fixed exchange rate system.

Robert Triffin was a Belgian-American economist who at various times worked at the Federal Reserve, the IMF, the OECD, and Yale University. Triffin pointed out

that a system in which the US dollar was pegged to gold, and other countries pegged to the dollar, contained a fundamental inconsistency. As countries in the rest of the world grew, they required an increasing supply of US dollars to maintain their exchange rate pegs and conduct transactions. This implied that the United States had to issue ever-growing debts (in Triffin's analysis, through currency account deficits). But with the rest of the world growing faster than the US economy and faster than its gold supply, eventually the dollar's gold backing would lose credibility. Eventually, of course, the fixed exchange rate system did collapse and the world transitioned to floating rates, which seemed to address the problem.

The modern parallel is that with emerging markets growing faster than advanced economies, there has been a strong and rising demand for "safe" advanced-economy debt. For much of the 2000s, market clearing for advanced-country bonds has required an ever-falling interest rate. Once the zero bound becomes binding, though, a lower interest rate can no longer clear the market. Advanced economies can still meet the demand by allowing their debts to outstrip their income growth, but then the "safe assets" they issue may eventually become risky. Regardless, the fact there is so little agreement about how major central banks should deal with the zero bound creates greater uncertainty about the future and creates volatility for emerging markets, as Rajan (2016) has emphasized.

The vigorous and stimulating debate over alternative mechanisms for dealing with the zero bound is certainly fascinating. However, so many of the policy proposals are clearly second- and third-best alternatives to normal monetary policy, which begs the question of whether the zero bound is really the barrier now that most economists and policymakers still believe it to be.

Paths to Effective Negative Interest Rate Policy

In recent years, a small but growing literature has started to argue that paper currency was never quite the obstacle to negative interest rates that it seemed. There are basically four approaches to implementing negative interest rates: 1) moving to a cashless society, since paying interest (positive or negative) on electronic bank reserves is no problem and already widespread practice; 2) finding a technological approach to paying interest (positive or negative) on paper currency, an idea that Keynes considered at length; 3) dispensing with the one-to-one exchange rate between electronic bank reserves and paper currency, which frees up the central bank to introduce approaches to discounting cash that mimic paying negative interest; and 4) taking steps to make large-scale hoarding of cash much more costly—for example, by phasing out large-denomination notes—without affecting normal retail cash transactions.

Curiously, to the limited extent the modern macroeconomics literature has discussed breaking the zero bound, options 1 and 2 have received virtually all the attention, even though neither is really viable. Eliminating cash would certainly obliterate the zero bound on interest rates because it is trivial to pay negative

interest on electronic money, unlike the situation with paper money. But for reasons of maintaining privacy, providing a safety valve to regulations, and offering a backup payment mechanism during internet/power outages, moving to a completely cashless society remains too high a price to pay simply to expand the central bank toolkit.

Directly paying negative interest rates on anonymous physical currency is also a nonstarter, though there have been some very creative suggestions for how it might be done. In *The General Theory*, Keynes (1936) has an extended discussion of the early writings of maverick economist Silvio Gesell (1916), who had proposed paying negative interest rates on paper currency by requiring that stamps be purchased and periodically affixed to the back of each note. Writing before the advent of electronic banking, Keynes ultimately rejected the idea because he believed that there was no simple and practical way to pay a negative interest rate on money without making it extremely illiquid. Goodfriend (2000) updates Gesell's idea by proposing that instead of requiring people to periodically get their currency stamped, the government can embed magnetic strips. It then records the time individual bills have been outside the banking system and charges a negative interest rate accordingly when the bills are re-deposited. Aside from the cost of the infrastructure required to implement this plan, it would be difficult for individuals and small proprietors to know how long any given bill has been outside the banking system (and therefore how much to discount it in retail transactions), again making currency relatively illiquid.

One wonders whether Keynes might have re-evaluated his position, and perhaps even restated his analysis of monetary and fiscal policy at the zero bound, had he been aware of the dual currency proposal of Robert Eisler (1932), which in recent times has been taken up by Buiter (2009) and by Agarwal and Kimball (2015).⁶ The idea of one country having two different currencies with an exchange rate between them may seem implausible, but the basics are not difficult to explain.

The first step in setting up a dual currency system would be for the government to declare that the "real" currency is electronic bank reserves and that all government contracts, taxes, and payments are to be denominated in electronic dollars. As we have already noted, paying negative interest on electronic money or bank reserves is a nonissue.

Say then that the government wants to set a policy interest rate of negative 3 percent to combat a financial crisis. To stop a run into paper currency, it would simultaneously announce that the exchange rate on paper currency in terms of electronic bank reserves would depreciate at 3 percent per year. For example, after a year, the central bank would give only .97 electronic dollars for one paper dollar; after two years, it would give back only .94. What is ingenious about this proposal (compared to Gessell's stamped-money) is that all currency notes sell at the same discount. No one needs to know how long an individual note has been outside the banking sector; all that matters is the current exchange rate of paper money for

⁶ In Rogoff (2017), I note that the 13th-century emperor Kublai Khan, grandson of Genghis Khan, also imposed an exchange rate between currency inside and outside the Mongol Treasury.

electronic money. Observe that it would have been perfectly possible to implement Eisler's (1932) approach in the 1930s when bank accounting was kept on paper books, albeit considerably more cumbersome in the absence of computers.

The dual currency system is elegant, but it does raise some issues of its own. One issue is that paper currency and electronic currency are not perfect substitutes (which is why the interest rate on bank money can deviate for long periods from cash), and so finding the correct path for the exchange rate is not quite as straightforward as the preceding example suggests. A further subtle but important point is that the Eisler (1932) approach only gets around the zero-bound constraint if the private sector follows the government's lead in converting all contracts to electronic currency. In most advanced countries, private agents are free to contract on whatever indexation scheme they prefer; this is not a condition that can be imposed by fiat. If the private sector does not convert to electronic currency, the zero bound would re-emerge since it still exists for paper currency. Finally, one must consider that after a period of negative interest rates, paper and electronic currency would no longer trade at par, which would be an inconvenience in normal times. Restoring par would require a period of paying positive interest rates on electronic reserves, which might potentially interfere with other monetary goals.

The fourth approach to implementing negative interest rates is perhaps the crudest, yet in some ways the simplest. This approach starts with the observation that the zero bound on interest rates is not literally zero, because it is costly to transport, store, and insure large quantities of cash. This is why several central banks (including Switzerland, Sweden, Denmark, Japan, and the Eurozone) have been able to set small negative rates (for example, -0.75 percent in Switzerland) without setting off a massive run into cash. No one quite knows the practical limits of just how low central banks can bring interest rates before creating a chaotic run. A plausible guess might be perhaps -1 or -2 percent; the exact number is sensitive to the length of time that negative interest rate policy is expected to persist, because hoarding imposes both fixed and variable costs. Banks can easily use their existing vaults to store some extra cash, but if they try to store billions extra, insurance companies will charge a nonlinear premium to compensate for the risk of very large losses. Banks would also have to pay the fixed shipping and insurance costs of transporting the cash, all the while not knowing how long the negative rate episode would last. Private hoarding companies would face the same problems, not to mention that new vaults take time to build.

There are several ways large-scale hoarding costs might be made even more prohibitive, short of the dual currency system, while still exempting small depositors. One place to start would be by phasing out large-denomination notes that hoarders would naturally use to economize on shipping and storage costs. In Rogoff (1998, 2017), I argue that independent of monetary policy considerations, there is a strong case for phasing out large-denomination paper currency notes, starting with large bills like the US\$100, the 500 euro note (about \$570 today) and the 1,000 Swiss franc note (worth about \$1,000). The argument is that even as paper currency

is becoming increasingly less important in medium- and large-scale legal transactions, it remains important in facilitating wholesale criminal activity and tax evasion. Large-denomination notes make up a huge fraction of the value of outstanding currency, even though relatively few people use them: for example, the US\$100 bill represents 81 percent of the US currency supply, while notes with denominations of \$10 and below account for only about 3 percent.

Getting rid of \$50s and \$100s would already multiply the bulk and weight of storage cash compared to \$10 bills by a factor of five or ten, and yet would have very little effect on ordinary retail transactions and the vast majority of people who do not rely on big notes for any of their cash activities. After all, \$100,000 in \$10 bills can still fit into an ordinary-size briefcase.

Restricting currency to small denominations should suffice to raise hoarding costs beyond any threshold where a wholesale run into cash by large-scale financial institutions like pension funds, insurance companies, and others is likely to be cost-effective in a plausible negative interest rate episode. This is particularly the case if regulators impose high standards of insurance on bulk cash hoarders, as well as on reinsurance companies that insure against theft and loss. It would be easy to take further steps, like charging a fee for redepositing large amounts of cash into the banking sector, in part to help defray the considerable handling costs that central banks otherwise provide for free.

The idea is to go to a less-cash society, not a cashless one. Although the poor do not rely much on large-denomination notes, any transition should nevertheless include provision for financial inclusion, such as free or highly subsidized checking accounts for low-income individuals, which could also be used to facilitate government transfer payments that are now made by check.

Among the largest economies, Japan is arguably the most natural candidate for an early transition to a less-cash economy, especially as it has floundered around the zero bound for so long. Also, after Switzerland, Japan has the highest per-capita cash issuance of any advanced economy, even though its physical currency is not held much outside of Japan. True, large notes are widely used by everyday people in Japan, but nevertheless a large share of the large-denomination notes appear to support various forms of tax evasion and criminal activity.

A far less obvious candidate is India, because like most emerging markets and developing economies, its financial infrastructure remains underdeveloped. Nevertheless, in November 2016, Indian Prime Minister Narendra Modi demonetized the country's two largest bills, the 500 and 1000 rupee notes (worth about \$7.50 and \$15 at the time), giving citizens only 50 days to make the exchange (as opposed to taking up to seven years as in Rogoff 2017). One problem the Indian government faced due to the rapidity of its move was that the central bank did not have on hand nearly a large enough supply of new notes to exchange for the old ones. While demonetization may still lead to long-run benefits in a country like India, where tax evasion is widespread (less than 2 percent of people pay taxes) and corruption is rife, the Indian experience reinforces the case for making any changes to the transaction system slowly over a period of years.

Paper currency is hardly the only constraint on negative interest rates (McAndrews 2015; Rogoff 2017). Another obvious constraint is that if central banks charge negative interest rates on bank reserves, it might be difficult for private banks to pass these costs on to depositors. In fact, early experience in Europe has shown that banks can quite easily pass on negative interest rates to wholesale customers, such as pension funds and insurance companies, but they are reluctant to do so for small depositors. This obstacle can be overcome by allowing an exclusion for small retail customers, where banks are compensated by the central bank (or treasury) so they do not lose anything, say for deposits up to \$1,000 per individual. The objective of negative interest rate policy is to achieve macroeconomic stabilization, not to raise revenues. Cynics might say the power of a central bank to employ negative interest rates, once granted, is likely to be abused, but central banks already have ample tools to abuse holders of cash and bank deposits through inflation and financial repression.

There are other obstacles. For example, with positive interest rates, lenders receive interest payments from borrowers; with negative interest rates, tax laws need to be adjusted so that lenders who are making interest payments get a deduction. As another example, consider those people who significantly overpay their estimated taxes and then claim a refund as an indirect way to make a loan to the government; with negative rates, it will be necessary for the government to charge individuals interest on such “loans.” None of these obstacles is particularly difficult to handle given sufficient time. Early experimenters with negative rates such as Switzerland, Sweden, and Denmark, have confronted such problems and generally found that they can be negotiated straightforwardly.

Of course, there are also psychological obstacles to nominal negative interest rates basically stemming from money illusion: people are already used to having inflation drive real interest rates (the nominal interest rate minus expected inflation) deeply negative. But having even slightly negative nominal interest rates is a relatively new phenomenon in the paper currency era. (Back in the days of coinage, sovereigns routinely called in coins in exchange for newer ones with lower silver content, which effectively gave a negative nominal interest rate on currency.) One presumes that if small deposits are excluded and the various frictions are dealt with, the psychological obstacles will disappear; after all, a large fraction of the world supply of government bonds is already paying negative interest rates today.

Once the zero bound is cleared away, would central bank policy moves into negative interest rate territory necessarily operate the same way as traditional monetary policy? In theory, yes—real interest rates are what matter and we have had deeply negative real interest rates in the past. Lower nominal rates would stimulate investment and consumption demand through the same channels as in standard new Keynesian models, which typically abstract from currency (except for incorporating the zero bound).⁷ In models with richer institutional settings that incorporate

⁷Cochrane (forthcoming) argues that for certain kinds of expectations mechanisms, it is possible to construct models where lowering the interest rate lowers inflation. Garcia-Schmidt and Woodford (2015) give a critique.

both bank reserves and currency, financial institutions have strong incentives to lend reserves into the financial system in some way rather than to hoard them.

Financial institutions have lobbied strongly against the early experiments with negative interest rates in Europe and Japan, complaining that they impinge on profitability, though in fact banks in Sweden and the Nordic countries have fared reasonably well over this period. Over the long run, though, with adjustments such as providing small savers with government-subsidized zero-interest accounts, financial institutions should be able to pass on the remaining costs. Many of the challenges that financial firms face today actually stem from a long period of negative real interest rates, and it is far from clear that allowing for negative nominal rates would worsen the problem, particularly of course if the negative nominal rates were used to combat another severe financial crisis or extremely deep recession.

Relatedly, some have objected to negative interest rate policy because it might exacerbate financial instability. But if central banks had access to open-ended negative rate policy, they might well be able to move the economy more quickly out of deep recession, particularly after a financial crisis, rather than be stuck in slow growth with zero interest rates for a decade. If negative interest rate policy works, it should promote financial stability.

There are, of course, a wide variety of potential objections, ranging from concerns about money illusion (people care more about nominal rates than real rates), distrust of monetary authorities (though an irresponsible central bank already can wreak havoc through inflation), to those who naively believe the world should try to restore the pre-war gold standard. It is beyond the scope of this paper to treat all of these; the reader is referred to Rogoff (2017) for a more detailed discussion. One objection that tends to be vastly overstated is that negative overnight interest rates constitute an unfair tax on savers and pension holders, but this is a very narrow perspective. First, the issue of the zero bound comes up in no small part because central banks have been so restrained with respect to inflation, unlike the high-inflation 1970s, a period that was really bad for savers. Second, in a deep recession, significant negative short-term rates will raise longer-term inflation expectations as well as accelerate growth in output and employment. Nominal interest rates on sufficiently long-term bonds should rise. Last but not least, low policy interest rates typically push up equity and housing prices. So the blanket statement that negative rates are unambiguously bad for savers and pension holders is naive.

In principle, restoring the effectiveness of interest rate policy by fully removing the zero bound will make it possible to have central banks return to being limited-purpose institutions whose objective is to stabilize inflation and output. It might reduce pressures on them to take on large balance sheets and engage in directed credit and even fiscal stimulus. Over the long run, limiting the scope of central banks should help them maintain their independence.

What about the international implications? By making monetary policy more coherent and predictable, negative interest rate policy should help provide a more stable global capital market environment for emerging economies, as well as

provide a better basis for communication and cooperation among advanced-country central banks. Greater instrument transparency should alleviate the concerns about competitive depreciations and currency wars. Of course, there is much research to be done in understanding the subtleties of negative interest rate policy, but the objections once raised by Keynes back in the 1930s should no longer be considered definitive today.

Again, it is important to re-emphasize that if the road can be paved for effective negative interest rate policy (in contrast to the early experiments in Europe and Japan where cash has not been dealt with and many other frictions remain), then episodes would presumably be much shorter-lived than today's zero-bound episode, since monetary policy would not be paralyzed in reflatting the economy. The main goal of enabling negative nominal interest rate policy is as a tool for dealing with very deep recessions, not as a routine policy. In normal times, central banks that want to debase currency already have ample tools by using inflation.

Conclusion

The international monetary system stands at a crossroads. Central banks, the linchpins of the global financial system, have come under enormous pressure in recent years as the zero bound on interest rates has forced them to employ alternative instruments. These alternative methods of conducting monetary policy expand the remit of central banks far beyond the limited-purpose institutions they had become in the era of financial market liberalization, and risk subjecting them to greater political interference and even loss of independence. In addition, there are significant theoretical and empirical questions about how well these alternative monetary instruments really work. The zero bound has confounded domestic macroeconomic policy and made international monetary policy extremely difficult, with countries accusing each other of trying to manipulate exchange rates in lieu of being able to affect interest rates. In the long run, undertaking institutional changes that clear the way for effective negative interest rate policy is likely to be the cleanest approach to restoring the efficacy of monetary policy at the zero bound. Creating the preconditions for effective negative interest rate policy will certainly require a number of tax, legal, and institutional changes in addition to dealing with cash, but the early experiences in Europe and Japan suggest these are manageable.

Eliminating the zero bound will not make an aging economy young, nor will it transform an economy with low productivity growth into a powerhouse of innovation. But effective negative interest rate policy can help monetary authorities in fighting deep recessions. In addition, it should end discussion of third-best alternatives to monetary policy facing a zero bound such as indefinitely postponing structural reform, reneging on trade agreements, and using fiscal policy to an extent beyond what normal cost-benefit analysis would suggest. Enabling effective negative rate policy is also much cleaner and more elegant than the second-best policy

of raising inflation targets. It thus could have many benefits in helping to foster a smoother and more natural functioning of the global financial system.

In an era where cash is becoming less important in the legal tax-compliant economy outside small-scale transactions, and where banking and retail transactions are increasingly electronic, it is perhaps time for macroeconomists to stop treating the zero bound as an immutable constant of nature. The zero lower bound was a major problem in the 1930s and again in the most recent global financial crisis. It does not need to be a major obstacle in the next one, and there are perfectly viable ideas for eventually solving it without going all the way to a cashless economy.

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