STRATEGIES *for* MONETARY POLICY

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CHAPTER TWO

The Case for Implementing Effective Negative Interest Rate Policy

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1. INTRODUCTION

This paper explores the case for gradually instituting the changes necessary to implement unconstrained negative interest rate policy as a long-term solution to the zero lower bound on interest rates (or more precisely the effective lower bound). To be clear, we distinguish between the very limited negative interest rate policy that has already been tried in Europe and Japan and the unconstrained negative interest rate policy we consider here. Effective unconstrained negative interest rate policy requires, at a minimum, that policy makers take administrative measures to forestall wholesale hoarding of physical currency by financial firms, insurance companies, and pension funds.[1] We shall argue that if unconstrained negative interest rate policy can be implemented, it would be by

1. A variety of approaches for implementing negative rates ranging from administrative measures to precluding large-scale hoarding to a dual electronic/physical currency system are discussed in Rogoff (2016, 2017). See Bordo and Levin (2019) for an approach that involves a combination of administrative measures and a digital retail currency. Agarwal and Kimball (2019) give a nuanced discussion of transition issues; see also Agarwal and Kimball (2015).

The authors are grateful to conference participants and especially Michael Bordo, Matthew Johnson, Andrew Levin, Edward Nelson, and John Taylor for helpful comments on an earlier draft for the May 2019 conference.

far the most elegant and stable long-term solution to the severe limits on monetary tools that have emerged since the financial crisis. Admittedly, the question of how to resuscitate monetary policy effectiveness is of more immediate relevance in Europe and Japan, where interest rates remain at the effective lower bound (in many cases mildly negative) more than a decade after the global financial crisis and more than two decades after Japan's financial crisis. But even the United States is likely to face severe constraints in the event of another financial crisis, possibly even in a deep recession.

No one should expect the United States to be an early adopter of unconstrained negative interest rate policy, especially given the central role of the dollar in the global financial system. But we would strongly disagree with those who say it is unthinkable and will lead to widespread market dysfunction. As of October 2019, over $15 trillion worth of bonds traded at negative interest rates internationally, without market breakdown. On top of that, over 1 trillion euros worth of bank deposits carried negative rates in the eurozone alone. There are ample historical precedents for cases where monetary policy innovation was resisted on the grounds that markets would collapse, including the move from fixed to floating exchange rates in the 1970s. Perhaps the closest analogy is during the 1951 episode when the Federal Reserve abandoned its bond price pegging program. As Milton Friedman commented:

> Before the Federal Reserve gave up the pegging of the bond price, we heard all over the lot that a free market in bonds was going to be chaotic, that the interest rate might go heaven-high or down, there might be capital losses, savings institutions might well be wiped out by their capital losses, and that we needed some basic peg price on which the market could form its anticipation. We abandoned the pegged price. None of these things happened. (Friedman and Roosa 1967, 173)

To be sure, implementing effective unconstrained negative interest rate policy will require a host of legal, regulatory, and tax

changes, and not all of these can be instituted by the central bank alone.[2] The obstacles in different countries will vary. It is notable, however, that in countries that have implemented mild negative rate policy, none has tackled the main challenge, which is how to prevent paper currency hoarding and, as a corollary, how to protect bank profitability if rates go deeply negative. Of course, if one believes that it is impossible to have negative deposit rates, then the capacity for instituting negative rate policy is very limited. But in our view, once wholesale hoarding is dealt with (the vast majority of retail depositors can straightforwardly be exempted from negative rates [Rogoff 2016, 2017]), then the pass-through of negative rates to wholesale bank customers should be straightforward, just as the pass-through of negative policy rates has been to mortgages and other wholesale private debt obligations in many countries in Europe. In general, all of the various approaches to instituting unconstrained negative rate policy should be increasingly easy to navigate as paper currency becomes further marginalized in legal, tax-compliant transactions (outside low-value transactions) and as countries deal with financial inclusion.

So how might the monetary authorities discourage wholesale hoarding of currency in the event of deeply negative interest rates? There are a broad number of approaches that do not require going cashless. These include raising the cost of hoarding by phasing out large-denomination notes,[3] imposing fees on wholesale redeposits of currency at the central bank, and instituting regulatory limitations on legal hoarding facilities (Rogoff 2016, 2017). Bordo and Levin (2019) offer a more fully articulated administrative approach involving instituting a retail central bank digital currency.

It should be noted that there is a way to eliminate the hoarding problem without any change to the issuance or regulation of paper

2. Rogoff (2016) discusses a number of the issues, and Agarwal and Kimball (2019) provide an extremely useful handbook on transitioning to unconstrained negative rate policy.

3. Rogoff (1998) argues that phasing out large-denomination notes would be helpful in combatting tax evasion and crime, even independent of interest rate–setting issues.

currency. It involves taking steps so that electronic currency (currently bank reserves at the central bank) becomes the unit of account, and creating a crawling peg between electronic currency and paper currency (analogous to the proposal of Eisler 1933). Admittedly, there are complications to the Eisler plan having to do with the fact that paper currency and electronic currency are not perfect substitutes.

Until now, central banks up against the effective zero lower bound have been relying mainly on various forms of quasi-fiscal policy, but the weight of evidence suggests these are far less effective than normal interest rate policy. Often lost in the popular discussion, or at best hidden behind dubious political economy arguments, is the fact that central banks are wholly owned subsidiaries of the central government. For example, when central banks purchase long-term government bonds by issuing bank reserves that match the short-term Treasury bill rate, this amounts to no more than shortening the maturity structure of the consolidated government balance sheet. Treasuries do this routinely and are perfectly capable of handling it on their own and on scale. In general, the fiscal authorities have ample tools to accomplish (or undo) any quasi-fiscal actions that central banks might take. They have access to greater resources and certainly have greater political legitimacy. The quasi-fiscal powers of the central bank are essential only in crises where the ability to move quickly trumps other considerations.

Aside from quasi-fiscal policies, alternatives such as forward guidance have proved to be of very limited effectiveness as well. The main problem is that zero bound episodes last for years if not decades, making the credibility and commitment problems to promising elevated future inflation (after escape from the zero bound) exceedingly challenging. Raising inflation targets is a serious alternative to negative rate policy, but it, too, comes with severe limitations. A modest rise in the inflation target (including proposals on keeping 2 percent while adopting an inflation-averaging target) would not create the kind of policy space needed for dealing with deep recessions, much less systemic financial crises. A more

significant rise in inflation targets, on top of greatly distorting relative prices even in normal times, would eventually lead to shorter nominal contract lengths and an increase in indexing. Both factors would limit the effectiveness of monetary policy, possibly even to the point of making an increase in the target inflation rate counterproductive. Another important drawback is that higher inflation targets would undermine central bank credibility after decades of committing to inflation targets of 2 percent or less. Last but by no means least, it is not clear how to make a higher target credible without having the tools (such as negative interest rate policy) to achieve it. The experience of Japan in raising its inflation target to 2 percent in 2013, accompanied by a large fiscal stimulus, and still failing to raise medium-term inflation expectations is emblematic.

In the first section of the paper, we discuss other options for dealing with monetary paralysis at the zero bound. The second part of the paper highlights the credibility struggles that major central banks have had in keeping inflation expectations at target over the medium term, arguably greatly exacerbated by investor skepticism that central banks have the tools to create inflation, even when the situation warrants it. This seems to be even more true today than during early rounds of quantitative easing when, as we show (following Lilley and Rogoff 2019), markets viewed there as being a small but measurable possibility that quantitative easing (QE) could lead to very high inflation for a decade. The third section of the paper discusses a range of issues related to implementing effective negative interest policy, including both economic and political economy problems. We conclude by arguing that the obstacles to unconstrained negative rate policy all seem fairly minor compared with some of the radical alternatives that have been proposed (e.g., the inherent difficulties implementing precisely calibrated, well-timed, and highly credible countercyclical fiscal policy on steroids). In a technical appendix, we show that even in the United States today, markets have at times attached a significant probability to having interest rates become at least mildly negative.

2. ALTERNATIVES TO NEGATIVE INTEREST RATE POLICY

One has to acknowledge that invoking significant negative nominal interest rates (say, at least −2 to −3 percent) in a deep recession or a financial crisis would be, at this stage, an experimental policy. Even after making any necessary legal, tax, and regulatory modifications—above all having a mechanism for discouraging wholesale cash hoarding by financial institutions, pension funds, and insurance companies—there is always a possibility of unintended consequences. To put this risk in perspective, we first discuss in this section alternatives that have been proposed. We divide these into four broad classes: (1) "pure quantitative easing" policies that (we argue) do little more than change the maturity structure of government debt in a way the Treasury can do at least as effectively, (2) "fiscal quantitative easing" policies where the central bank buys private assets; the same equivalent policy can be achieved by having the Treasury trade government debt for private debt at face value, then having the central bank buy up the government debt via quantitative easing, (3) having the central bank engage in pure fiscal policy via (market interest-bearing) helicopter money, and (4) policies that genuinely relate to monetary policy, including forward guidance and changing the inflation target.[4]

2.1. Pure Quantitative Easing and Maturity Management of the Consolidated Government Balance Sheet

We begin with pure quantitative easing (pure QE), where the central bank issues bank reserves to purchase medium- and long-term debt. The degree of confusion surrounding these pure QE poli-

4. The discussion here is necessarily brief; for a more thorough discussion, see Rogoff (2016). For excellent recent discussions of how alternative monetary instruments have worked to date, see Bordo and Levin (2019) or Eberly et al. (2019).

cies is remarkable, in part because many overlook the equivalence between money and debt at the zero bound, and even more so because central banks have not wanted to acknowledge the inadequacy of their instruments. Point number one is that central banks do not have their own independent balance sheet. Any profits or losses the central bank earns pass through directly to the central government. (There is an important nuance in the case of the European Central Bank's balance sheet that we shall come to shortly.)

True, one way a central bank's independence can be compromised is if the market value of its assets has a negative net value. As is well known, this is somewhat meaningless since the central bank's monopoly over currency creation means it can never go bankrupt if its liabilities are in its own currency. The central bank can be reprimanded. It can be absorbed back into the Treasury it grew out of. But it cannot be disowned.

We now turn to the question of whether quantitative easing involves creating a new class of government liabilities that might fundamentally alter debt management. The short answer is a resounding no, as established by Greenwood et al. (2015a, 2015b, 2015c). Consider first the current situation in the United States (as of May 2019), where both required and excess bank reserves have a virtually identical yield to the one-week Treasury bill rate. Consider a quantitative easing exercise where the Treasury issues $100 billion in thirty-year debt, which the Fed soaks up by issuing $100 billion in bank reserves to buy up the debt. The net effect is that privately held floating rate debt has risen by $100 billion and privately held long-term debt has fallen by the same amount. The same could be achieved by having the Treasury just issue 100-billion-dollar debt at a one-week maturity (instead of long-term) and having the Fed do nothing.

Nor does the Fed have greater capacity to perform this maturity transformation. In any given year, the US Treasury typically has to

roll over debt roughly equal to the Fed's $4 trillion postcrisis balance sheet, and should it desire to move faster, it buys up long-term debt before it matures, issuing very short-term debt to do so. The central bank is very much a junior partner when it comes to debt maturity management. Indeed, overreliance on quasi-fiscal policy deeply compromises central bank independence, since the fiscal authorities can undo all of the central bank's actions if they do not accord with the government's objectives. Whether inadvertently or not, the US Treasury's post-financial-crisis actions to extend the maturity structure of debt worked at cross-purposes with the central bank's quantitative easing policies to shorten maturity (Greenwood et al. 2015a).

Some may disagree and argue that changing the maturity structure of government debt on its own is enough, since the implementation of interest rate targeting has always involved the Fed purchasing securities, that is, merely changing the maturity structure of government debt. This critique overlooks the fundamental difference between reserves and government debt under conventional monetary policy. Away from the zero lower bound, swapping government securities for excess reserves (or the promise to) will serve to change the prevailing interest rate since banks would rather lend the excess reserves at a positive rate than hold them. It is only at the zero lower bound that swapping government debt for reserve balances is merely a maturity transformation.

A final question is whether maturity management is a substitute for monetary policy. Although early evidence suggested some effect from pure quantitative easing in the United States (again, this means central bank buying of government bonds), most recent academic authors have argued that the effects were extremely limited and in no way comparable to conventional interest rate policy (see Greenlaw et al. 2018; Chung et al. 2019). Eberly, Stock, and Wright (2019) are somewhat more positive and suggest that QE might have been more effective if the Fed had gone bigger and earlier. However,

we argue here that one must also take into account that the first time around, markets expected much more of a long-run inflation effect than actually transpired. Specifically, in the third section, we show that while inflation expectations remained robust during QE1 and QE2, this was mostly attributable to a belief that inflation may accelerate to be well above target in the coming decade—a belief that rapidly disappeared after the Fed exited the zero lower bound without seeing a boom in money demand. This expectation of high inflation, or perhaps the misunderstanding of whether it is caused by pure quantitative easing, is unlikely to be repeated in any future iterations.

It must be noted that the European Central Bank is something of an exception, as there is no fiscal counterpart to its actions. In essence, when the European Central Bank (ECB) engages in QE, it is effectively issuing a short-term synthetic Eurobond to buy up the national debts of individual countries. There is no central government yet willing and able to perform the same function, and ECB quantitative easing certainly appears to have been very effective as a crisis management tool. That said, the difficulties that Europe has had in reaching its inflation target underscores that even in Europe, QE is no substitute for normal interest rate policy.

2.2 Fiscal Quantitative Easing

We next turn to fiscal quantitative easing, in which the central bank purchases private sector assets. There is no real debate about the fact that fiscal QE played a critical role during the financial crisis in preventing markets from freezing up and collapsing with potentially dire consequences. Nor should there be any debate that emergency credit policy is a perfectly valid function of the central bank; in a crisis, swift, effective action can sharply reduce costs to the real economy and (likely) the government balance sheet. Although this may involve having the central bank absorb a lot of junk debt on

its balance sheet, in most countries the usual presumption is that within a relatively short period, the central government will create a special purpose vehicle to transfer the risk.

Outside of emergencies, fiscal QE can perfectly well be executed by the central government through a variety of mechanisms, most commonly by having the central government issue debt guarantees. Fiscal QE certainly has an effect, but outside of crises, it once again is much less powerful than normal interest rate policy, as the Bank of Japan's experience has clearly illustrated. On top of that, buying private debt in normal times involves picking winners and losers and is effectively a type of industrial or development policy. One can debate the extent to which the government should intervene directly into private credit markets. In principle, the real effects can be very large if the intervention is massive enough, but the distortions can be large too. In general, most advanced economies regard unelected central banker as ill suited to making these fundamentally political decisions. Regardless, the conclusion has to be that the fiscal QE is ill suited as a substitute for conventional monetary policy in normal times.

2.3. Helicopter Money, Debt Destruction, and Hyperactive Fiscal Policy

This takes us to helicopter money, where the central bank takes the lead in initiating fiscal transfers, which Buiter (2003), Turner (2015), and Bernanke (2016) have advocated, and which is enormously popular among the commentariat. In its crudest form, helicopter money involves having the central bank print money to issue pro-rata transfers to the public. This is, of course, equivalent to having the central government use debt finance to issue the same transfers to the public, then having the Federal Reserve engage in open market operations to buy up the debt. It is true that there is a strong theoretical presumption that temporary fiscal policy stimu-

lus is more effective at the zero bound (mainly because the fiscal multiplier is not muted by a rise in interest rates). If executed forcefully enough, fiscal policy can lift the economy out of the liquidity trap (provided its temporary nature is credible; otherwise it is much less effective, as, for example, Christiano, Eichenbaum, and Rebelo [2011] show).

The issue is not whether well-calibrated debt-financed transfer policies can be an effective means of stimulus; this is always true whether monetary policy is allowed to fully operate or not. We need not get into the details of just how large the multiplier is.[5] (A growing body of evidence suggests that fiscal multipliers are lower at high levels of debt, partly through a Ricardian channel, partly through an interest rate channel; for a recent discussion, see Huidrom et al. 2019). The important question is what, if any, should be the role of the central bank in fiscal transfers? In our view, the argument for any variant of helicopter money in which the central bank plays an active role is weak. The case for having an independent central bank stems first and foremost from the need to keep down long-term inflation expectations by delegating money creation to an independent authority with a clear but narrowly defined remit to stabilize output and inflation (Rogoff 1985).[6] However, no central bank has been given the power to decide on either the level or the allocation of politically contentious direct transfers to the general public.

Even Bernanke's suggestion that the central bank might take the lead in determining the aggregate size of a transfer by funding a dedicated account that could be used at the government's discretion,

5. In her thorough survey of the academic literature, Ramey (2019) gives a more guarded estimate of fiscal multipliers that some advocates of fiscal stimulus would suggest, even at the zero bound.

6. Rogoff (1985) introduced the idea of having an independent central bank with a high weight on inflation stabilization (including through inflation targeting) and showed how this institutional device can substantially resolve the credibility problems first modeled by Kydland and Prescott (1977).

would be far beyond anything that the "unelected power" of the Fed was ever intended to do (in Tucker's 2018 terminology). One might perhaps rely on Congress and the public being fooled by the claim that when the Federal Reserve takes the lead, then what Bernanke terms a "money financed fiscal program" is perhaps a free lunch, relying on the public's ignorance. At the zero bound, a "money financed fiscal program" is no better or worse than "very short-term Treasury debt financed fiscal policy." That is because, at the zero bound, the Treasury can issue zero interest debt on its own. And as Bernanke recognizes, if the central bank does not change its inflation target, the public will expect the "money" to be soaked up as soon as interest rates start rising.

Equivalently, the central bank will have to start paying interest on reserves (as it is now doing), which is in essence equivalent to the Treasury issuing floating rate debt. Of course, the Fed can instead promise this injection to be a permanent increase in the money supply and reduce its own equity in the process. But for all intents and purposes, the Federal Reserve is still owned by the government—either it reduces its remittances to the Treasury in the future, it eventually receives an equity injection, or it operates with perpetually reduced equity. Both of the former two options are still increases in taxes, making the operation merely an opaque form of debt. One can go in circles on this, but it is unlikely that money-financed deficits are the panacea many would wish them to be. It is possible that in some unique circumstances, the central bank might choose to mortgage its credibility and independence, but surely it cannot be considered the best long-run solution.

There is, of course, an important literature on having an independent fiscal authority (see, for example, Halac and Yared 2018). A number of countries including the United Kingdom and Sweden have instituted fiscal councils, albeit with a limited remit. Creating a way to have stronger and more powerful fiscal institutions remains an important policy topic, but for now this remains a distant vision.

Helicopter money is at best a distraction from finding a serious solution to the zero bound, at worst a fast track to ending central bank independence.

Of course, one can argue that there is no reason for the central bank to do anything at the zero bound since fiscal policy becomes more potent, in theory at least. One only has to observe that in the United States, and in many other countries, neither the right nor the left has clear long-term control of power, and the different parties almost invariably have extremely different interpretations what "active" fiscal policy implies. In the United States, the Democrats might view active fiscal policy as running bigger deficits by increasing government spending toward its larger optimal size. For Republicans, on the other hand, active fiscal policy might entail running deficits by cutting taxes and constraining the long-run footprint of government to be smaller. Such conflict is hardly a recipe for creating a credible long-term path for government taxes and expenditures, underscoring why even if fiscal policy is to be used more in recessions, it is important to restore the efficacy of monetary policy.

2.4. Forward Guidance and Raising Inflation Targets

So far, we have considered only quasi-fiscal policies where the central bank is very much the junior partner in its relationships with the Treasury, outside of crises where the ability to act expeditiously is everything. We now turn to more policies that might more genuinely be thought of as monetary policy. One such policy is "forward guidance," à la Eggertsson and Woodford (2003), where the central bank recognizes that it is unable to lower the current interest rate (below zero), but by promising that when interest rate policy is restored, it will allow inflation to overshoot in the future. As Eggertsson and Woodford show, it is possible to achieve an equivalent optimal path for real interest rates, and thus the same effects

on the real economy as if negative interest rate policy were possible. This is a completely reasonable idea from a theoretical perspective; Canzoneri et al. (1983) make a very closely related point, showing that if the central bank is unable to use the current interest rate to react, a lagged interest rate rule can have an exactly equivalent effect on the real interest rate through expected inflation.

However, in both cases, but particularly in the zero bound example, there is a severe credibility problem. The public needs to trust that the central bank will honor its promise to allow inflation to drift higher in the future. But the typical zero bound episode can last years (decades as in Japan and soon Europe), making it extremely difficult to trust commitments that are not time consistent, and will likely have to be honored by future policy makers backed by future politicians.[7] Forward guidance is an excellent idea but difficult to make credible, especially in deep recessions where the zero bound may be in place for a very long time, precisely the cases where having an effective monetary policy is most important.

This leaves only amending the path of the inflation target as a serious alternative. A number of alternative approaches have been proposed, from allowing a temporary overshoot after a period of low inflation (though this suffers some of the same credibility problems as forward guidance) to simply raising the inflation target, with the most common suggestion, originally analyzed by Fuhrer and Madigan (1997), being a rise in target inflation from 2 to 4 percent. Many others since, including Blanchard, have also suggested 4 percent. There are many possible objections, including (1) potential damage to the credibility of central banks that have long promised to target 2 percent, (2) the fact that higher inflation would lead to greater price dispersion in normal times if contracting frequency does not adjust, and (3) that if contracting frequency did eventually adjust (as theory would predict), monetary policy

7. Chung et al. (2019) emphasize this point; see also Rogoff (2016).

would be blunted (which could indeed imply that it would take larger policy rate changes to achieve the same stimulus, perhaps using up much of the extra 2 percent slack that higher inflation targets were supposed to buy); and (4) that absent a powerful instrument such a negative rate policy, markets might not take the new higher target as credible given the difficulties central banks have had with hitting a 2 percent target. One only has to look at the experience of the Bank of Japan, which set an inflation target of 2 percent in January 2013, constituting by any interpretation a hike in market perceptions of its inflation target, and yet long-term inflation expectation barely moved from its level of 0.5 percent.

Perhaps the biggest problem, though, is that even if raising the inflation target from 2 to 4 percent did help, it might not help nearly enough in the event of a sufficiently deep recession where the optimal interest rate change might still take interest rates well into negative territory if feasible.

Despite such reservations, Federal Reserve officials have still tried to reassure the public that the Fed's tools are sufficient (e.g., Yellen 2016). The fact that the top economics journals are replete with out-of-the-box alternatives to normal monetary policy at the zero bound is a testimony to general skepticism among economists. As we shall see in the next section, there is a serious skepticism in markets as well, with options pricing suggesting that markets seriously doubt the ability of even the US Fed to keep normal inflation rates at 2 percent. And of course, in the eurozone and Japan, there is really no one, even central bank officials, arguing that the existing tool kit is sufficient.

3. INFLATION EXPECTATIONS

The United States is not yet facing the paralysis of Japan, where the central bank has not been successful in pushing long-term inflation expectations up to 1 percent, much less 2 percent, or Europe,

where inflation expectations have anchored below 2 percent since 2013. Nevertheless, there appears to have been a steady decline in long-term inflation expectations (at least as measured by the Treasury Inflation Protected Securities [TIPS] market).[8] The ten-year breakeven inflation rate in the United States has declined from around 2.4 percent before the crisis to 1.8 percent today. This decline cannot be dismissed as merely a reflection of the current state of the economy—breakevens that begin in ten years' time, looking beyond the contemporaneous cycle, have declined by a larger amount. Indeed, even the thirty-year breakeven inflation rate from TIPS has fallen from over 2.5 percent in 2011 to under 2 percent as of April 2019.

3.1. Are Long-Term Inflation Expectations of under 2 Percent Evidence of Strong Credibility or Lack of Confidence in Alternative Monetary Instruments?

Inflation-targeting evangelists might herald this decline in medium-term inflation expectations as a triumph of central bank policy and communications that proves the markets have great confidence in existing "alternative monetary instruments." However, this interpretation seems overly sanguine. If a central bank's 2 percent inflation target is to be viewed as the target in normal times, with an escape clause for fiscal emergencies, then the breakeven between real and nominal bonds should be distinctly higher than 2 percent, as it was in the early 2000s.[9]

8. Throughout this section we will treat inflation-linked bonds as risk-neutrally priced, such that the breakeven is an unbiased measure of inflation expectations. If the price level were expected to jump in very low consumption states, as documented by Barro and Ursua (2008), then inflation breakevens would be an upwardly biased measure of inflation expectations. Kitsul and Wright (2013) estimate that investors have high marginal utilities for both deflationary and high inflationary outcomes by comparing inflation option prices with model forecasts of inflation.

9. A secondary issue is that breakevens measure market expectations on inflation as measured by the Consumer Price Index (CPI), which is not the Fed's price target. The Fed's

TABLE 2.1. Market-Derived Inflation Expectations

	Market Inflation Expectation (average 10 yr)		Market Inflation Expectation (average 10 year, *starting in 10 years*)	
Country	**2005–2007**	**2016–2019**	**2005–2007**	**2016–2019**
United States	2.51%	1.81%	2.87%	1.92%
Europe	2.35%	1.43%	2.51%	2.02%
Japan	0.54%	0.39%	0.58%	0.58%

Note: Inflation expectations are calculated using the difference in yields of real and nominal Treasury bonds for the United States, with adjustments to estimate their yields for a constant maturity and without coupons. For Europe and Japan, inflation expectations are derived from zero coupon inflation swaps, due the infrequent issuance of inflation-indexed bonds. Bond data are from Gürkaynak et al. (2007, 2010). Zero coupon swaps are from Bloomberg.

After all, on a time span of decades, the odds of a substantial fiscal shock at some point, sufficient to create strong pressures for inflation, are presumably nontrivial. Triggers could include an unprecedented catastrophic climate event, a cyberwar that spins out of control, a pandemic, a meltdown in the Chinese economy that leads to a deep global recession, or a new-age financial crisis, to name a few. These triggers are mainly abrupt events, but fiscal pressures to create higher inflation could also evolve very slowly over a long period of a decade or more. Although the United States may have ample fiscal space at present, excessive reliance on short-term debt to finance social programs, a greener society, or, for that matter, further tax cuts must ultimately have its limits. Another slow-moving fiscal shock would be a gradual reversal of the trend decline in global real interest rates that has allowed governments to manage high debt levels more easily than in the past. (Albeit it is still the case that countries with extremely high public debt levels such as Italy and Japan have also had very low growth.) While the risks may be small, it is naive to assert that no matter what the shock, the United

official target is the index of personal consumption expenditures, or PCE. The PCE includes a more comprehensive basket of goods and averages annual inflation, which is 30 basis points lower than the CPI (Bullard 2013).

States (or Europe or Japan) will simply be able to borrow as much as needed at ultra-low interest rates without a hiccup. Even if outright default (as with US abrogation of the gold clause in the 1930s) is unlikely, the duress could still be sufficient to create pressures for a sustained rise in inflation, say, to 4 percent or more for a decade.

Some have argued that even if fiscal pressures erupt, there will be no need for very high inflation because governments can simply resort to financial repression (as discussed in Reinhart and Rogoff 2009), using regulation and political pressure to force private agents to hold government debt at below-market interest rates. Financial repression can be useful in bringing down debt/GDP ratios gradually over time, but the process works much more quickly in an environment of moderate inflation. (Part of the reason Japan's debt/GDP ratio has continued to grow despite a moderate degree of financial repression is that inflation is so low, making it harder for growth in nominal GDP to outstrip the growth in debt.)

3.2. Measuring Inflation Expectations, Removing the Weight Coming from the Chance of Sustained High Inflation

It is possible that markets have bought into the view that advanced economies have such massive fiscal space going far into the future, that advanced country governments will be able to navigate any adverse scenario just by borrowing more without any consequence. To explore the tail risk of high sustained inflation in more detail, one can use a no-arbitrage argument to construct the price of a theoretical inflation-linked bond that features a cap, so that it provides insurance against moderate inflation but does not insure against a regime change that carries very high inflation.[10] Consider a ten-year real bond that would index to the Consumer Price Index (CPI) with a ceiling—if inflation averaged more than 3 percent for

10. Our analysis of tail inflation risks follows Lilley and Rogoff (2019).

ten years, it would only pay up to a ceiling of a cumulative 3 percent annual increase.[11] This bond would allow the Treasury to inflate debt away in an inflation-based default, but it would still provide for a complete inflation hedge if the government allowed the Fed to maintain its ordinary inflation-targeting mandate. In essence, part of the difference between a nominal bond and an inflation-linked bond is in default risk. A nominal bond has some default risk in real terms, while a real bond does not. By constructing this synthetic bond, we are making its inflation default risk equivalent to that of the nominal bond. (Note that if inflation temporarily strayed outside the band to a high level, say, 4 percent for a couple of years, it would not affect the cap—only a sustained deviation consistently over 3 percent would matter.) Such a bond would provide a better estimate of inflation expectations absent fiscal dominance.

If the Treasury were to offer such a bond, its payoff would be identical to an investor buying the ordinary inflation-linked bond but selling an inflation cap at a strike of 3 percent with the same principal as the inflation-linked bond. Under no-arbitrage, one can calculate the price paid for the theoretical bond in the time series by using the real bond price and the up-front payment received for selling this protection. We show the breakeven yield on this bond in figure 2.1. While the breakeven on the vanilla real bond has averaged 2.05 percent this decade, the breakeven on this synthetic bond has averaged only 1.81 percent. Notably, the difference between the ordinary and synthetic capped bond has shrunk in recent years, reflecting that markets appear to attach a much smaller probability to sustained inflation above 3 percent. In the first half of this decade, the breakeven inflation on this synthetic capped bond was 38 basis points (bps) lower than the actual TIPS breakeven inflation. Since the Fed's first hike in December 2015, the synthetic breakeven has averaged

11. It is worth noting that Treasury Indexed Bonds already include a floor of the opposite nature—if inflation is negative over the life of the bond, the principal indexation is capped at a cumulated 0 percent.

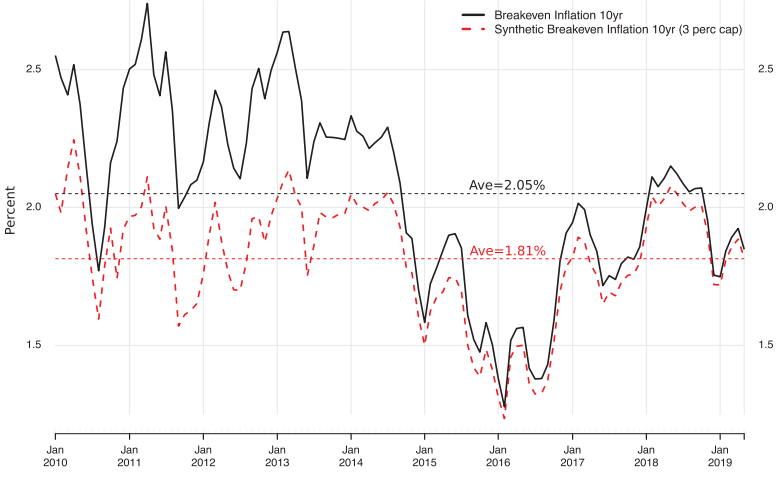

FIGURE 2.1. US CPI 10 Year Vanilla Breakeven and Synthetic 3% Cap Breakeven

Note: Breakeven Inflation 10 year is calculated using the difference in yields of real and nominal Treasury bonds for the United States, with adjustments to estimate their yields for a constant maturity and without coupons, using bond yield data from Gürkaynak et al. (2007, 2010). The synthetic ten-year breakeven is calculated with inflation option pricing from Bloomberg. To remove the impact of outliers, we use the median value within each month to construct each monthly observation. Further detail on the pricing of the synthetic inflation–linked bond is provided in the appendix.

only 7 bps lower than the actual. This vanishingly small premium must reflect evolving beliefs among market participants about the propensity for the Fed's enlarged balance sheet to create inflation.

3.3. Are Breakevens the Best Measure of Inflation Expectations?

A valid concern with measuring inflation expectations using breakevens is that the yield difference between nominal and real bonds may be changing due to other factors, which we would then comingle with changes in inflation expectations. Since we use the constructed yield curves of Gürkaynak et al. (2007, 2010), we do not need to be concerned with differences in coupons or maturities. The two most significant remaining factors are changes in inflation

risk premia and liquidity risk premia. In particular, if inflation-linked bonds are less liquid than nominal bonds, the breakeven will be compressed due to the market premium required to hold inflation-linked bonds. While our synthetic bond construction above mitigates the impact of inflation risk premia by capping inflation payoffs below 0 percent and above 3 percent—precisely in the regions where investors pay a premium for inflation protection (Kitsul and Wright 2013)—it does not correct for liquidity premia.

The liquidity difference in our measure is abated by the fact that the yields we use exclude both on-the-run and first off-the-run nominal Treasury securities (which command a liquidity premium relative to most other bonds) but include the on-the-run Treasury indexed bonds, which are the most liquid of the curve (Andreasen et al. 2018). Daily trading volumes in on-the-run TIPS now average ~2 billion per security, whereas off-the-run nominal Treasury bonds average <1 billion (Brain et al. 2018). As such, it is unlikely that our measure of current inflation expectations is materially underestimated by the illiquidity of TIPS. We note that we may be *under*estimating the decline in inflation expectations, given the increased liquidity of inflation-indexed bonds, relative to nominal bonds. D'Amico et al. (2018) estimate breakevens underestimated inflation expectations by up to 100 bps in the early 2000s due to liquidity differences, though this premium had disappeared by 2012.

Zero coupon CPI swaps for the United States highlight a similar decline in market prices, though with a higher level (from an average 2.8 percent in 2005–2007 to an average 2.1 percent in 2016–2019). Inflation swaps are a much smaller market than TIPS and are likely consistently upwardly biased due to the prevalence of agents who are natural buyers of inflation protection derivatives (pension funds) and due to a paucity of natural sellers.

Survey measures provide an alternative benchmark to market pricing. Broadly, survey measures all show a material decline in inflation expectations across both households and professional

TABLE 2.2. Survey-Based Inflation Expectations

	Surveys of Professional Forecasters (Average Long Term)		Household forecast (Average Long Term)	
Country	**2005–2007**	**2016–2019**	**2005–2007**	**2016–2019**
United States	2.46%	2.22%	3.0%	2.5%
Europe	1.91%	1.83%	NA	NA
Japan	NA	NA	2.9%	2.0%

Note: For the United States, the long-term inflation forecast comes from the Survey of Professional Forecasters (Philadelphia Federal Reserve, March 22, 2019) for which we report the ten-year inflation forecast; household data are from the Michigan Survey of Consumer Finances (University of Michigan, April 12, 2019), for which we report the average five-year inflation forecast. For Europe, we use the Survey of Professional Forecasters (European Central Bank, April 11, 2019), for which we report the longer-term (five-year) forecast. Japanese household data are from the 77th Opinion Survey on the General Public's Views and Behavior (Bank of Japan, April 5, 2019), available from 2006, for which we use the median household's five-year inflation expectation.

forecasters, though not necessarily to below-target levels (table 2.2). Notwithstanding this, these surveys are consistently positively biased in levels.[12]

4. UNCONSTRAINED NEGATIVE RATE POLICY

We have argued previously (Rogoff 2015, 2016, 2017) that the elegant and effective tool to restore monetary policy effectiveness at the zero bound would be unconstrained negative interest rate policy, assuming all necessary legal, institutional, and regulatory changes were first instituted. Above all, this requires taking steps to preclude wholesale arbitrage into paper currency by insurance companies, pension funds, and financial firms. Preventing such

12. For the United States, the long-term surveys of professional and household inflation expectations were on average 0.25 percent and 0.75 percent higher respectively than realized outcomes since 1997. For Europe, the five-year ahead survey of professional forecasters' inflation expectations was on average 0.125 percent higher than realized since the survey began in 1997. For Japan, the median survey of five-year inflation expectations from surveyed households was on average 2.5 percent higher than the realized level since the survey began in 2006. All forecast errors are rounded to the nearest eighth of a percentage point.

arbitrage by no means requires changing the currency system, as we shall see. However, the more paper currency becomes marginalized in tax-compliant legal transactions, the more straightforward things become both institutionally and politically. Importantly from a political and perhaps equity perspective, it would not be difficult to shield small retail bank depositors from negative policy rates.[13]

4.1. Early Experience with Mildly Negative Rate Policy in Europe and Japan

The early experiences with very mild negative policy rates in Europe and Japan have been very helpful in revealing issues that need to be navigated, and by and large, this has proved straightforward (Dell'Ariccia et al. 2017). It is important to stress, however, that no country yet has taken the steps necessary to have the kind of deeply negative rates we are discussing here (say, minus 2 percent or more).

Much of the pushback on mildly negative rates has arisen from the claim that they strain bank profit margins, due to depositor resistance to negative rates. This leads a number of authors, including Brunnermeier and Koby (2017), as well as Eggertsson et al. (2019), to argue that in theory, negative interest rates (at least past a certain point) will not be expansionary because as bank capital is depleted, banks will contract lending. In practice, bank performance does not seem to have suffered except at small banks (Lopez et al. 2018). Many large banks actually benefit because a significant share of their borrowing comes from wholesale markets where interest rates have followed government rates into negative territory. Large banks have also been better positioned to mark up other services and bundle these with deposits. Switzerland and Japan have moved to protect bank profits by "layering" reserves so that legacy levels are shielded

13. See Rogoff (2016, 2017) and Agarwal and Kimball (2019) for discussions of how small deposits can be handled under this framework.

from negative rates; the ECB has recently adopted this approach. A drawback, though, is that layering considerably weakens the transmission mechanism to the real economy and, as rates go deeply negative, does nothing to prevent a run out of negative-interest-bearing debt, including both public and private.

In any event, as Altavilla et al. (2019) find, banks in the eurozone have indeed been passing on negative rates to larger depositors (with over 100,000 euros in deposits), with over 1 trillion euros worth of deposits now carrying negative rates. Our conjecture is that if cash hoarding is taken off the table (via any of the mechanisms Rogoff [2016] discusses and as we suggest here) and assuming necessary tax, legal, and regulatory changes are put in place, there is no reason to believe that bank profits would suffer excessively.

4.2. Implementing Negative Rate Policy in the Cashless Limit

Moving to a completely cashless system is neither necessary nor desirable into the foreseeable future. However, in thinking about negative rates, it is helpful to start with this case, in order to separate out issues that have only to do with cash. If there were no way to arbitrage into paper currency, of course, there would be nothing to stop investors from pulling out their savings to buy stocks, real estate, art, and gold coins. This is hardly an objection; the incentives go in the same direction whenever the central bank lowers interest rates. Indeed, since the main driver of these investments is changes in real interest rates, as opposed to nominal interest rates, there are already many examples of central banks implementing deep negative real interest rates, with short-term policy rates well below inflation. And it must be noted that a negative rate of 3 percent when inflation is zero is no more a tax on deposits in real terms than when the deposit rate is zero and the inflation rate is 3 percent.

What about bank profits? It is very hard to see why in a cashless world, banks could not easily pass on negative reserve charges to wholesale depositors. There would be nowhere to hide. Of course, deposits would fall as money flows into other assets (and into consumption); large banks could easily substitute by borrowing more in wholesale markets. All banks would benefit to the extent the economy is stimulated, thanks to greater demand for loans and a lower default rate. Discouraging cash hoarding would help free banks from finding indirect ways to charge depositors negative rates (as they do now) and thereby reduce distortions.

If we assume cash is dealt with (or that we are living in a cashless world), what other obstacles might have to be cleared to make negative interest rate policy as effective as normal interest rate cuts? What steps can be taken to reduce attendant financial risks?[14]

Although much further study is warranted (perhaps by an independent commission), for the most part all of the issues seem to involve relatively straightforward plumbing fixes and nothing on the order of the much more radical interventions that have been widely analyzed in major economic journals, ranging from engaging in fiscal policy on steroids to avoiding policies that might increase economic efficiency (thereby lowering prices and exacerbating deflation; see Eggertsson et al. [2014] or Eichengreen [2016] on how increased protectionism can fight deflation).

All the countries that introduced negative rates of 0.75 percent or less have managed to deal with financial plumbing fixes and in a reasonably short time period. For example, the idea that millionaires can arbitrage the system by overpaying estimated taxes and then claiming large refunds (thereby lending money to the government at a zero rate) is easily dealt with by paying a negative

14. These issues are detailed in Rogoff (2016), and Agarwal and Kimball (2019) have recently produced an extensive handbook.

interest rate on large overpayments.[15] One important point that must be emphasized is that many of the necessary plumbing fixes, while relatively minor, require the cooperation of the government and cannot be instituted by the central bank alone.

Many of the objections to negative nominal rates are mainly political or philosophical and similar to objections presented against moderate inflation. For example, some might argue that negative interest rates are an unfair tax on savers in much the same way as inflation. Averaged over the cycle, however, an inflation-targeting central will not have a first-order effect on the average value of real interest rates. As long as central banks are using negative rate policy to hit their inflation targets or, more generally, to implement Taylor rule–type monetary policies, there will be no effect on the average real tax rate paid over the cycle (when most of the time nominal rates will be above zero anyway). It must also be kept in mind that long-term nominal rates would likely rise, not fall, if the zero bound were fully eliminated, as Yellen (2016) has argued.

Savers would also benefit to the extent that negative rate policy boosts the value of real assets such as housing and equity. To shield small savers, governments can allow every citizen to register one debit (or savings) account as eligible for zero interest rate protection, with banks being subsidized accordingly. In today's digital world, such a system would be straightforward and inexpensive to implement; let's remember that the government would earn large profits on its short-term debt in a negative interest rate world; some countries such as Germany already do so today.

Perhaps the most fundamental objection to deep negative interest rate policy is that it has not been tried before, and there would be risks. We absolutely acknowledge this; there were similar objec-

15. See Rogoff (2016) and Agarwal and Kimball (2019) for further discussion of issues that would need to be addressed.

tions to the transition to floating exchange rates in the 1970s, but it had, at least, been tried before by a few countries on a limited basis. To some extent, this is how mild negative interest rate policy has evolved until now. It is a reasonable forecast that there will be experiments with open-ended negative rate policy in smaller countries before it is tried in larger countries, although Japan is still a very strong candidate for early adoption.

In any event, deep recessions and financial crises already entail large risks and considerable unknowns, and all directions that policy might take entail risks. The early experimentation with negative rates suggests that these risks are manageable. The experience will likely evolve in coming years as more and more countries experiment with deeper and deeper interest rates.

4.3. Approaches to Dealing with Legacy Paper Currency

So far we have set aside the elephant in the room, which is paper currency. Ample experience has shown that paper currency does not get in the way of mildly negative interest rates. It is by no means easy to store whole quantities of cash (billions of dollars). Any registered institution (bank, pension fund, insurance company) would need insurance costing at least 0.5 percent of stored funds, if available. There are large fixed costs to building storage vaults, which must include humidity and temperature controls. Yet there are no guarantees of how long negative interest rate policy will last, and therefore over what period the fixed costs may be amortized. Even porting the money from the central bank to the storage site (and eventually back) would be an expensive operation. Although it will differ by country, existing obstacles to physical currency transportation and storage likely are sufficient to allow central banks to take rates to −2 percent without having the economy crippled by runs into cash; again, it is simplest to think of small retail depositors as being excluded. If large bills (say, equivalent to $50 and above) were

eliminated, the transportation and storage costs would be considerably amplified, most likely allowing negative policy rates of up to 2.5 to 3 percent without major cash runs. As Rogoff (1998) argues, getting rid of large-denomination notes likely makes sense anyway from a public finance perspective; it would take only a relatively small decrease in tax evasion and crime to more than pay back any lost seigniorage revenues. However, to allow the larger negative rates of 5 to 6 percent or more that might be needed in the event of a deep recession or a financial crisis, and to set aside bank concerns about pass-through of negative rates to large depositors, it is likely that administrative measures would also be needed, for example, taxing large redeposits of cash into the central bank and other regulatory impediments to cash hoarding (Rogoff 2016; see also Bordo and Levin 2019). Again, small depositors would be excluded, and the political economy of negative rates could be strengthened by providing universal basic debt accounts per Rogoff (2016), which might also in principle be at the central bank.

As noted in the introduction, there are approaches to placing a negative (or positive) interest rate on physical cash that are more nuanced. Setting aside impractical ideas such as a Gesselian stamp tax or Goodfriend's (2000) magnetic stripe in currencies, both of which are clever but flawed (mainly because cash becomes illiquid), by far the most important idea is the Eisler (1933) dual-currency system. Eisler's approach was first resuscitated in the modern context by Davies (2004, 2005) and Buiter (2005) and has been strongly advocated by economist Miles Kimball, including in Agarwal and Kimball (2019). Conceptually, the idea is to have a dual-currency system, where the central bank sets a moving exchange rate between paper and electronic currency. In the current regime, the exchange rate between electronic and paper currency is one. However, what the central bank can do when it wants to institute a negative rate on bank reserves is to announce that the exchange rate between paper currency and electronic currency will depreciate at the same negative

rate being applied to electronic deposits. Concretely, if the central bank maintains a negative interest rate of 4 percent, then anyone turning in paper currency after three months will receive 99 cents, after six months 98 cents, after nine months 97 cents, and so on. Assuming that prices are set in electronic currency, then the zero bound will be eliminated, but there will be no run into paper currency.[16]

Formally, if $S(t)$ is the rate at which the central bank trades one dollar in paper currency for electronic currency (in dollars), and $-i(t)$ is the negative nominal interest rate at time t, then the central bank needs to set the rate of depreciation of electronic currency as

$$dS/dt = i(t)$$

The central bank would enforce this exchange change rate by setting it as the rate at which it redeemed paper money for electronic currency at its cash window. Eisler's ingenious device solves the problem of charging a negative rate on paper currency without making users carefully look at each bill to determine its exact value, and without any extra input or devices.

Unfortunately, the Eisler approach is not quite as neat as its advocates sometimes portray it. One problem is that paper currency and electronic currency are not actually perfect substitutes, which is, of course, why some central banks have been able to charge negative rates without first dealing with cash. Setting the rate of depreciation at the same level as the negative interest rate (as in the above formula) could set off a runout of cash (as opposed to into cash). Accelerating the move toward a "lower cash" society is a worthwhile goal for public finance and safety reasons. However, too abrupt a move, without dealing with financial inclusion or

16. As Buiter (2005) notes, there would still be a problem if prices continued to be set in paper currency, in which case the zero bound problem would persist, but the government can probably ensure that electronic prices are the focal point by setting taxes and all government contracts in electronic currency.

legacy payment systems, would not be desirable. Another tricky issue is that when the period of negative rates ends, the exchange rate between electronic and paper currency will be stuck at a non-unitary value, which could be an inconvenience in normal times. It is feasible to restore it as the central bank begins to pay a positive rate of interest on reserves by having the exchange rate appreciate instead of depreciating, though there can be some tricky expectations issues to navigate (e.g., if the public expects that the central bank will immediately restore paper currency to par as soon as the negative rate episode ends, it will defeat the effort to prevent hoarding).[17]

Another (less compelling) concern sometimes expressed is that if investors had to worry about negative interest rates, there would be "no safe asset." But government short- to medium-term government debt already pays negative rates in countries such as Germany and Japan, and it has not seemed to make investors regard them as any less safe. As already noted in the introduction, Friedman (Friedman and Roosa 1967) argues that fears of monetary Armageddon in the event of monetary regime changes have often been overblown in the past.

Indeed, far from impeding market clearing, allowing for negative policy interest rates arguably can preclude much more dangerous dynamics when price (the interest rate) is stuck at the effective zero lower bound and cannot clear the market for safe assets. For example, Caballero and Farhi (2018) argue that excess demand for safe assets can potentially induce a fall in real output to bring demand into line with supply. Allowing for negative interest rate policy allows the price of the bonds to clear the market, thereby preventing the distortion of the zero bound from creating new sources of monetary non-neutrality.

17. Agarwal and Kimball (2015, 2019).

Are negative rates "unfair" not only to depositors but to holders of currency? No more so than inflation, which is already a tax on paper currency. Indeed, proposals to raise the inflation target to 4 percent would be a significant increase in the tax on cash. Compared to negative rate policy that is likely to be mainly invoked in deep recessions, the tax from a higher inflation target would be in place all the time, not just in exceptional circumstances.

One of the reasons why, among large countries, Japan is a more obvious candidate as an early adapter of negative interest rates is that unlike the dollar, only a very small share of yen paper currency appears to be held outside Japan. Indeed, the issue of foreign currency holdings makes the United States quite distinct from any other country, albeit the eurozone and Switzerland face some of the same issues. Exactly how much of US currency is held abroad is a matter of considerable debate, as is the question of whether foreign use is a positive or negative externality to the rest of the world on net.[18] Independent of whether the externality is positive or negative, foreign use of the dollar is a profit center for the United States, though the benefits must be weighed against the fact that paper currency significantly facilitates tax evasion and crime in the United States, not just abroad. Rogoff (1998, 2016) argues that even assuming only a very modest effect on tax evasion and crime, the gains from (gradually) withdrawing large-denomination notes from circulation likely outweigh the benefits.

Another distinction between the United States and other advanced countries is that demographics are not yet quite so grim in the United States as they are in the eurozone and Japan, and overall growth is more dynamic. Again, this makes the case for Europe and Japan to

18. Rogoff (2016) argues that the negative externalities for the rest of the world are significant.

consider preparing for unconstrained negative interest rate policy much stronger than for the United States, but it hardly eliminates it from the United States. Kiley and Roberts (2017) find that the zero bound could be a problem for the United States by as much as 30 to 40 percent of the time (albeit Chung et al. [2019] argue that these estimates are likely high-side).

4.4. Financial Stability Concerns

Last but not least is the question of financial stability concerns. Dell'Ariccia et al. (2017) find that negative rate policy to date has not raised particularly acute financial stability concerns, but this is always a question whenever real interest rates are low. Dealing with financial stability is always an important issue, and it is not obvious that negative nominal rate policy would introduce substantially new concerns from those studies in the long history of negative real rate policy; this is certainly an issue meriting further study.

The financial stability argument can be flipped on its head. If central banks had been able to invoke effective negative nominal rate policy after the financial crisis, it is possible that the recovery period would have been much faster, and the period of ultra-low interest rates much much shorter, thereby reducing financial risks rather than exacerbating them. Being able to create moderate inflation in the aftermath of a financial crisis might actually be extremely helpful, letting the steam out of private debt problems (and in Europe, periphery country debt problems). Whether or not central banks wanted to elevate inflation, quantitative easing proved relatively ineffective. Unconstrained negative interest rate policy would have provided the tool needed if it had been available.

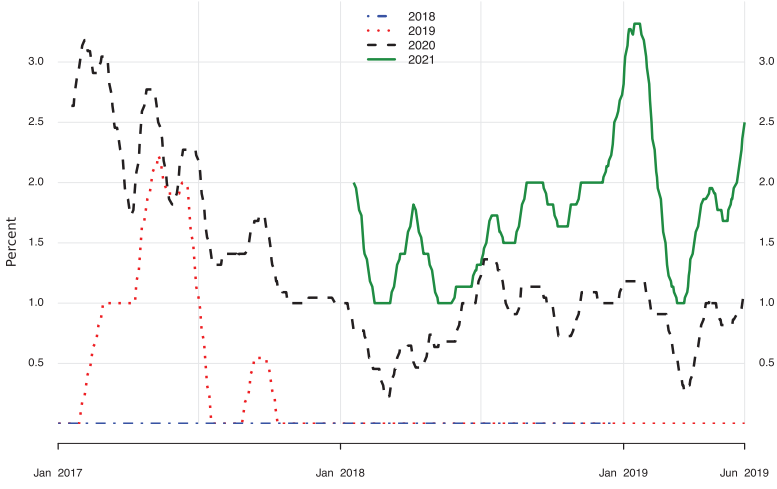

FIGURE 2.2. Market-Implied Probability of Negative Rates by End of Each Calendar Year

Note: Market-implied probabilities of three-month LIBOR (USD) rates setting below −0.25 percent at December 15 of 2018 through 2021. Market-implied probabilities are derived from options prices on the Eurodollar futures with strikes of 100.25 and 100.5, which correspond to LIBOR rates of −25 bps and −50 bps, respectively. Probabilities are lower bounds and are estimated assuming risk neutrality, averaged over the preceding month. Eurodollar option price data from Bloomberg. See appendix for details.

4.5. Expectations of Negative Rates Being Implemented in the Near Future

Though many may disagree with our prescriptions, it is worth noting that even in the United States, both market pricing and survey data attribute material probabilities to nominal interest rates moving into negative territory in the near future—and yet they hold these beliefs without an agreed framework for how they would be implemented.

First, we show that markets attribute a material probability to this event, using option prices. In figure 2.2, we show an estimate of the lower bound for the risk-neutral probability that markets ascribe to the short-term borrowing rates of high-credit banks (USD 3m LIBOR) being below −0.25 percent at the end of each

calendar year. Markets have consistently assigned a positive probability that these borrowing rates will be materially below zero within the next three years, at times as high as 3 percent, implying Federal reserve rates that are even lower.

Surveys of the relevant parties yield similar conclusions. In the New York Fed's most recent market surveys, participants were asked for the percent chance that they attached to the target federal funds rate being in certain ranges by year-end 2021, conditional on moving to the zero lower bound at some point before this date. Primary dealers and investment managers assigned average probabilities of 12 percent and 17 percent, respectively, of ending 2021 with a negative target federal funds rate.

5. CONCLUSIONS

The strong case for having a rule-based international monetary system (Taylor 2016), implemented by independent central banks (Rogoff 1985), is well established. The quasi-fiscal tools presently available to monetary authorities at the zero bound make it difficult to conform to rules in part because they are of such limited and unpredictable effectiveness, and in part because they can just as easily be implemented—indeed even reversed—by the fiscal authorities. Other ideas such as forward guidance on interest rates do fall within the realm of monetary policy but during long zero bound episodes are extremely difficult to make credible. Modifying inflation targets is a plausible option but comes with many problems of its own, one of which is that it is difficult to make a higher inflation target credible when markets doubt that the central bank has the instrument to achieve it; the case of Japan well illustrates this point.

Borrowing the phrase of former US Treasury secretary Hank Paulson, the central bank needs a "bazooka" at the zero bound that makes credible its commitment to achieving its policy rule. Negative

interest rate policy is precisely the requisite instrument and can be achieved by making the legal, tax, and regulatory changes needed to use unconstrained negative interest rate policy effectively in fighting a deep recession. Most of the necessary adaptations of the financial plumbing needed to make negative interest rate policy effective—potentially as effective as interest rate policy in positive territory—are straightforward. The most vexing issue is preventing large-scale cash hoarding by pension funds, insurance companies, and financial institutions (small depositors can easily be exempted). If hoarding is decisively dealt with (e.g., by allowing the trade-in value of paper currency at the central bank to depreciate over time during negative interest rate episodes à la Eisler [1933]), it should solve the problem of bank profitability (to the extent there is one) by making it straightforward to pass on negative interest rates on to large-scale depositors. This will ensure that the normal stimulus effects of lower interest rates on consumption and investment will transmit to the real economy. Of course, as is usually the case, lower interest rates will likely also push up the prices of housing, equities, and other assets, while at the same time pushing up nominal interest rates on longer-term bonds due to higher long-term expected inflation as well as stronger medium-term growth.

Monetary policy design should be forward looking and not backward looking. The increasing marginalization of cash (in legal, tax-compliant transactions) will make it ever easier to effectively implement negative interest rate policy in the coming years. The process could be constructively accelerated by phasing out large-denomination notes, which still play a significant role in tax evasion and crime but are largely vestigial in the legal economy. Indeed, thanks to the fact that hoarding cash is actually quite expensive for financial institutions, insurance companies, and pension funds, it is already possible to have mildly negative rates (perhaps as low as −2 percent) without any tax on cash, and eliminating large bills would likely increase the scope for negative rates somewhat further.

In any event, as cash steadily becomes marginalized in the legal economy, as countries take more steps to deal with financial inclusion, and assuming small depositors are excluded, political pushback on negative rate policy should evaporate, much as political pushback on flexible exchange rates evaporated over time.

The biggest drawback to unconstrained negative rate policy is that it has not really been tried anywhere, and unintended consequences are possible. But in a deep financial crisis, countries must often choose from a menu of difficult options, and a decade after the financial crisis, it is clear that none of the other options for restoring monetary policy effectiveness are particularly attractive or sustainable. As we have noted at the outset, the case for considering how to make unconstrained negative rate policy effective is stronger at present in Europe than in the United States, and stronger still in Japan. In our view, it is quite likely that in some advanced country central banks will experiment with unconstrained negative rate policy during a deep recession within the next decade. The United States is not the obvious first mover. However, given the steady downward drift in global real interest rates, the difficulties in raising expected inflation, the apparent ineffectiveness of quasi-fiscal instruments at the zero bound, and ultimately the importance to central bank independence of having an instrument that the Fed "owns," create a strong imperative for proactively preparing now for a negative interest rate world that is perhaps inevitable.

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APPENDIX: BOUNDING RISK-NEUTRAL PROBABILITIES FROM THE MARKET PRICES OF OPTIONS

We outline the process we use to infer risk-neutral probabilities from the market prices of various options. We first describe the process in general, since all probabilities in the paper are constructed in this manner. For parsimony, we assume a discount rate of zero in this explanation.

Consider the payoff of a call option over an asset with an underlying price of x, where the option has a strike of k. The payoff of the option at the exercise date has the following profile, where α is a general scaling parameter:

$$\Pi(x) = \alpha \cdot \begin{cases} x - k & \text{if } k < x \\ 0 & \text{if } x \leq k \end{cases}$$

We can then construct a synthetic option that combines buying a call with a strike of k_2 and selling a call with a strike of k_1 on the same underlying asset, where $k_1 > k_2$. The payoff function of such a synthetic option follows:

$$\Pi(x) = \alpha\left(k_1 - k_2\right) \cdot \begin{cases} 1 & \text{if } k_1 \leq x \\ \dfrac{x - k_2}{k_1 - k_2} & \text{if } k_2 < x < k_1 \\ 0 & \text{if } x \leq k_2 \end{cases}$$

The risk-neutral valuation (V) of this synthetic option is therefore given by $V = \int pdf(x)\Pi(x)dx$. We do not observe the value of this synthetic option directly since it is not traded, but we can infer it from the market price of the call option with strike k_2 minus the price of the call option with strike k_1. We then use this valuation to provide a lower bound on the probability that $x > k_2$ under the assumption of risk neutrality.

$$
\begin{aligned}
V &= \int pdf(x)\Pi(x)dx \\
&= \int_{k_2}^{\infty} pdf(x)\Pi(x)dx \\
&\leq \int_{k_2}^{\infty} pdf(x)\cdot\alpha\left(k_1 - k_2\right)dx \\
&\rightarrow \frac{V}{\alpha(k_1 - k_2)} \leq \underbrace{\int_{k_2}^{\infty} pdf(x)dx}_{Pr(x>k_2)}
\end{aligned}
$$

Therefore, we can use this general formula to provide a lower bound on the probability of interest rates being below −0.25%, so long as we can observe the market price of an option with a strike for the relevant event, and a second option that has a higher strike. The second option is necessary since there are an infinite number of combinations of outcomes and probabilities that would be consistent with one option price, but a second option price limits this space to at least a single lower bound.

Probability of negative rates: We provide a lower bound on the risk-neutral probability of three-month borrowing rates falling below −0.25% using Eurodollar call options. Eurodollar futures are cash-settled derivatives on the three-month LIBOR rate, the interest rate that a bank borrows at in US dollars for three months, subject to satisfying certain credit requirements. The price of these derivatives are quoted as 100 – *r* where *r* is in percentage points (e.g., for an interest rate of 0.5 percent the price of the derivative would settle at 99.50). A call option on Eurodollar futures with a strike of 100.25 entitles the buyer the right to enter into the long side of a Eurodollar future at the price of 100.25 with the option seller.

In this case, we construct the value of the synthetic option from the price of buying another Eurodollar call option with a strike

of $k_2 = 100.25$ ($P_t^{C,K=100.25}$) and selling another with a strike of $k_1 = 100.5$($P_t^{C,K=100.5}$), yielding a lower bound for the risk-neutral probability that rates are below −0.25%.

$$Pr_t(r < -0.25) \geq \frac{P_t^{C,k=100.25} - P_t^{C,k=100.5}}{100 \cdot (100.5 - 100.25)}$$

Estimating a Synthetic Breakeven with a CPI Indexation Cap

Consider a ten-year real bond that would index to CPI with a ceiling on the indexation as follows. If inflation averaged more than 3 percent for ten years, it would only pay up to a ceiling of a cumulative 3 percent annual increase. The payoff profile of this bond is identical to a compound payoff profile, one where the investor buys the ordinary inflation-linked bond, but selling an inflation cap at a strike of 3 percent with the same principal as the inflation-linked bond. Under no-arbitrage, we can calculate the price paid for theoretical bond in the time series by using the real bond price and the up-front payment received for selling this protection.

To convert this up-front payment into the equivalent yield on the inflation-linked bond, we must adjust the yield according to the modified duration of the inflation-linked bond. Since the bond we are pricing has no coupons, the Macaulay duration is the years to maturity, and since its compounding is continuous, the modified duration is exactly the Macaulay duration:

$$\mathrm{r}_t^{\text{synthetic}} = r_t - \frac{premium_t}{T}$$

The synthetic BEI is therefore the yield on the continuously compounding nominal bond minus the synthetic yield on the continuously compounding real bond.

DISCUSSANT REMARKS

Andrew Levin

This year's Monetary Policy Conference at the Hoover Institution was a particularly important occasion to reflect on monetary policy frameworks. May 2019 marked the tenth anniversary—within a month or so—of the date that the National Bureau of Economic Research (NBER) designated as the start of the recovery from the Great Recession. In retrospect, however, this recovery has clearly been the most protracted and painful since the Great Depression of the 1930s. Therefore, as policy makers proceed with their "Fed Listens" initiative, a key consideration should be that the current monetary policy framework has not provided satisfactory outcomes for ordinary American families. The ability of the Federal Open Market Committee (FOMC) to carry out its dual mandate has been substantially constrained by the effective lower bound (ELB) on nominal interest rates, and that constraint could become even more problematic in coming years. And in the context of a turbulent global economy, the challenge of strengthening the FOMC's policy toolbox has become increasingly urgent.

In light of these considerations, I am very glad to have this opportunity to discuss the work of Ken Rogoff and his colleague Andrew Lilley, who have presented a compelling case for expanding the Fed's capacity to push interest rates below zero in response to a severe adverse shock. I begin by highlighting some empirical findings from my forthcoming paper with Prakash Loungani, in which we document the limitations of quantitative easing (QE) as a tool for providing monetary stimulus.[19] And then I talk about how the introduction of digital cash can strengthen the Fed's ability to mitigate severe adverse shocks, drawing on my joint work with

19. See Levin and Loungani (2019).

Michael Bordo—including some highlights from the presentation that we gave at the Hoover conference two years ago as well as our recent Hoover working paper.[20] In particular, our analysis has demonstrated the merits of providing digital cash through a public-private partnership between the Federal Reserve and supervised financial institutions, and we've set forth design principles that would eliminate the effective lower bound while ensuring that ordinary households and small businesses are insulated from negative interest rates and are not burdened with any implicit taxes or fees.

ASSESSING THE ADEQUACY OF THE ECONOMIC RECOVERY

In assessing the efficacy of the Fed's current monetary toolbox, it seems sensible to start by reviewing the experience of the past decade. As shown in the upper panel of figure 2.3, the US unemployment rate peaked at nearly 10 percent in autumn 2009 and declined at an agonizingly slow pace over subsequent years; indeed, it did not return to its prerecession level until 2017. That outcome may partly owe to policy makers' pessimism about the sustainable level of unemployment (u^*); as of 2015, the median estimate of FOMC participants was about 5.5 percent, suggesting that the labor market was already on the verge of overheating, whereas their latest estimates (as of June 2019) had a range of 3.6 to 4.4 percent.

However, the unemployment rate is not a satisfactory measure of labor market slack, especially in the context of a severe downturn and sluggish recovery—a point that I emphasized in my 2014 Hoover conference paper.[21] For example, the US unemployment rate began moving downward during 2010 and 2011, but that decline did not reflect unemployed workers taking jobs; instead,

20. See Bordo and Levin (2017, 2019).
21. See Erceg and Levin (2014) and Levin (2014).

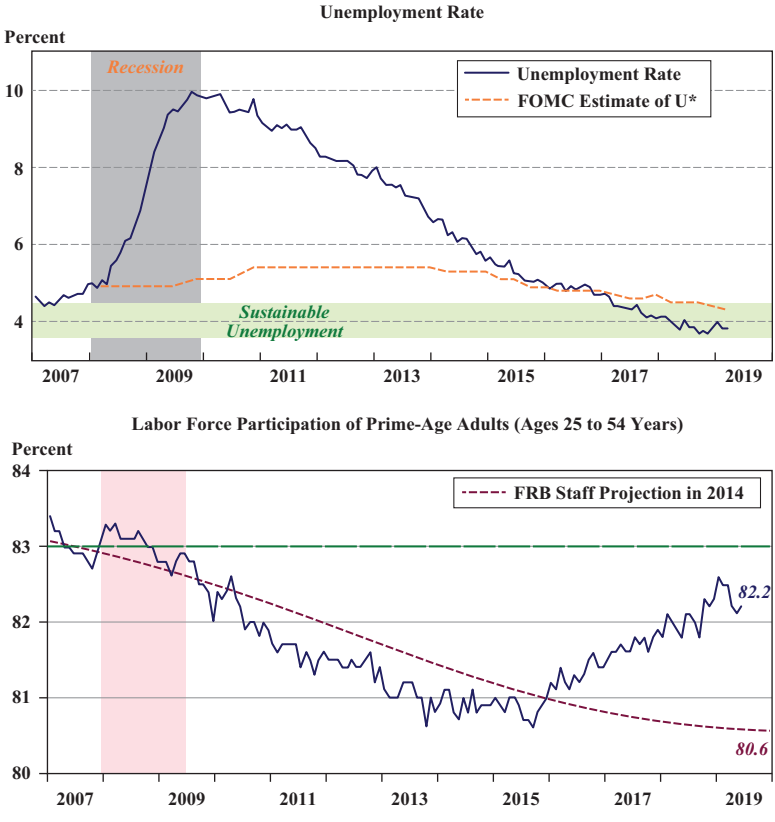

FIGURE 2.3. Characterizing the US Economic Recovery

Note: The unemployment rate and the prime-age labor force participation rate (LFPR) are published by the Bureau of Labor Statistics, and the recession dates are published by the National Bureau of Economic Research (NBER). The median projection by the Federal Open Market Committee (FOMC) of the longer-run normal unemployment rate (u^*) is published by the Federal Reserve Board. In the upper panel, the interval labeled "Sustainable Unemployment" denotes the range of FOMC participants' estimates of u^* as published in June 2019. In the lower panel, the short-dashed line denotes the projection of Aaronson et al. (2014), and the long-dashed line denotes the 2007 average.

discouraged individuals were simply giving up and exiting from the job market. As shown in the lower panel of figure 2.3, the labor force participation rate (LFPR) of prime-age adults declined markedly in the wake of the Great Recession. But the Federal Reserve Board's staff attributed that decline to structural factors as well as

"permanent damage" from the recession, projecting in 2014 that prime-age LFPR would continue heading downward through the end of the decade. In effect, that projection characterized millions of people in their prime working years as permanently unemployable. Fortunately, it proved to be utterly mistaken: since 2015, the prime-age LFPR has moved back upward to just a bit below its prerecession average, suggesting that the US labor market still may not have fully recovered even a decade after the start of the recovery.

One clear implication is that the FOMC should start quantifying its "maximum employment" objective in terms of measures of employment, not merely the unemployment rate. For example, the FRB/US model was formulated in the early 1990s and continues to serve as the Fed's benchmark for conducting macroeconomic analysis, but that model gauges labor market slack solely in terms of unemployment gaps. Going forward, the Fed's analytical tools should explicitly incorporate cyclical movements in labor force participation and should assess resource slack in terms of the shortfall of employment from its maximum sustainable level.

REASSESSING THE FED'S MONETARY TOOLBOX

The painfully slow and protracted economic recovery has also highlighted the intrinsic limitations of the Fed's monetary toolbox. In particular, the Fed's open-ended asset purchase program, commonly referred to as QE3, was launched in fall 2012 with the aim of boosting the pace of the recovery by exerting downward pressure on term premiums and longer-term bond yields. Subsequent Fed analysis has continued to maintain that assumption about the transmission mechanism of QE; for example, a recent paper by Fed Board staff states that "the balance sheet expansion lowers the path of the term premium on 10-year Treasury yields."[22]

22. Chung et al. (2019, 27–28).

The assumed efficacy of QE has mainly rested on event studies of the Fed's initial round of asset purchases (QE1), which was initiated in late 2008 and expanded in March 2009.[23] Nonetheless, at the Jackson Hole conference in August 2012, Michael Woodford noted that such balance sheet actions might be very effective in the midst of a financial crisis but relatively ineffectual (except as a signaling device) once those financial strains had subsided. Thus, it seems sensible to revisit the QE3 program and examine its impact on term premiums as well as broader macroeconomic indicators.

The New York Fed's survey of primary dealers is helpful in disentangling the transmission mechanism of QE3. In particular, these surveys regularly elicited dealers' expectations regarding the likely timing of liftoff, that is, the first hike to the target federal funds rate. As of early September 2012, just prior to the launch of QE3, the median projection of the primary dealers was that liftoff would occur in the third quarter of 2015. And that interest rate outlook remained stable over the subsequent two-year period until the end of QE3 in September 2014.[24] One key implication is that QE3 did not shift investors' perceptions regarding the likely path of the target federal funds rate, that is, the QE3 program was *not* associated with any substantial signaling effects about the Fed's conventional monetary policy tool.

The FOMC's decision to launch QE3 was informed by Fed staff assessments of its efficacy. Fortunately, since FOMC materials are routinely released to the public after a five-year interval, we can now take a look at the staff analysis that was sent to the FOMC just a few weeks beforehand. That analysis assumes a direct relationship between the anticipated size of the asset purchase program and

23. Chung et al. (2011) gauged QE1 as having reduced the term premium by about 50bp, whereas the effects of QE2 were gauged at around 15bp.

24. The median projection for liftoff was 2015:Q3 in almost all of the surveys conducted over that two-year period, except for the surveys conducted in late June 2013 (median = 2015:Q2) and in December 2014 and January 2015 (median = 2015:Q4).

TABLE 2.3. Key Federal Open Market Committee (FOMC) Communications about QE3

Event	Dates of FRBNY Primary Dealer Surveys	Change in Expected Size of QE3 Program
Sept. 2012 FOMC Meeting (9/13/2012)	9/4/2012 & 9/19/2012	+$500 billion
Sept. 2012 FOMC Minutes (10/4/2012)	9/19/2012 & 10/15/2012	+$300 billion
Dec. 2012 FOMC Meeting (12/12/2012)	12/10/2012 & 12/17/2012	+$90 billion
May 2013 JEC Testimony (5/22/2013)	4/22/2013 & 6/10/2013	+$60 billion
June 2013 FOMC Meeting (6/19/2013)	6/10/2013 & 6/24/2013	–$80 billion

Source: Federal Reserve Bank of New York (FRBNY). Calculations are the author's.

the projected decline in the term premium: "The staff's analysis . . . indicates that [asset purchases] affect term premiums and thus longer-term interest rates primarily via their effect on the private sector's expectations of the future path of the stock of longer-term securities that will be held by the Federal Reserve."[25] This link was assumed to be approximately linear, and its proportionality factor was determined from event studies of QE1, which totaled about $1.7 trillion in asset purchases and reduced the ten-year term premium by about 50 basis points. Thus, in analyzing the prospective impact of QE3, Fed staff projected that the announcement of a $1 trillion program would cause the term premium to "fall immediately by about 35 basis points."

Thus, in assessing the actual efficacy of QE3, one key ingredient is to gauge the evolution of investors' expectations about its overall size. For this purpose, we can draw on the New York Fed's survey of primary dealers, which regularly elicited dealers' projections of the size and composition of the securities held in the Fed's System Open Market Account (SOMA). As shown in table 2.3, the regular

25. Laforte et al. (2012, 1).

survey was conducted a few days before the September 2012 FOMC meeting, and a special follow-up survey was performed a few days afterward, indicating that the FOMC's initial announcement of QE3 caused primary dealers to ramp up their expectations of the Fed's total security holdings by about $500 billion. The release of the FOMC minutes three weeks later evidently led dealers to mark up their projections by an additional $300 billion, which remained stable for the next couple of months and then increased somewhat further in conjunction with the December 2012 FOMC meeting. By contrast, their projections about QE3 barely changed at all during the so-called taper tantrum episode of late spring 2013, which was triggered by the Fed chair's testimony to the Joint Economic Committee (JEC) in late May and further magnified by the June FOMC meeting a few weeks later.

It should be noted that the actual term premium cannot be directly observed but can be inferred from the term structure of Treasury securities and the forward contracts on those securities. Thus, we use two distinct measures that are maintained and posted by Federal Reserve staff, namely, the series published by the Federal Reserve Board, which uses the methodology developed by Kim and Wright (2005), and the series published by the New York Fed, which uses the methodology of Adrian, Crump, and Moench (2013).

In gauging the impact of QE3 announcements, we follow the approach of Krishnamurthy and Jorgensen (2011) in analyzing the two-day change in the term premium (i.e., the day after the event minus the day before the event). In particular, for each of the FOMC communications that shifted investors' expectations about the size of QE3, we can use the Fed staff's framework to obtain the predicted impact on the ten-year term premium, and then we can compare that prediction with the actual two-day change in the term premium. This approach enables us to disentangle the effects of QE3 from other economic and financial developments outside

each two-day window that may have influenced the overall level of the term premium.[26]

As shown in table 2.4, the Fed staff analysis implies that the initial announcement of QE3 in September 2012, which led investors to anticipate purchases of about $500 billion, should have reduced the term premium by about 17 basis points, whereas that announcement was actually associated with a substantial *increase* in the term premium. Similarly, the release of the September 2012 FOMC minutes should have reduced the term premium by an additional 11 basis points but instead generated a further *increase*. And the December 2012 FOMC meeting, which should have exerted downward pressure on the term premium, was also associated with an increase in the term premium. Evidently, the initial rollout of QE3 was not merely ineffectual but counterproductive, that is, each of these three FOMC announcements exerted upward pressure on the term premium.

Table 2.4 also documents the upward shifts in the term premium—totaling about 25 to 30 basis points—that were associated with the May 2013 JEC testimony and the June 2013 FOMC meeting. As noted above, investors' projections about the overall size of QE3 and the timing of liftoff hardly moved at all during this period. Rather, the surging term premium occurred in response to Fed communications about tapering the pace of asset purchases rather than simply ending the program. Such a taper was expected to have only minimal effects on the total amount of purchases, and hence the Fed staff's analytical framework indicated that it should not have substantial effects on the term premium. Thus, the Fed's leadership attributed the upward spike to transitory frictions and irrational market behavior, and hence this episode was labeled the "taper tantrum," analogous to the tantrum of an ill-tempered child.

26. Jim Hamilton's contribution to this volume also highlights the upward trajectory of the term premium following the launch of QE3.

TABLE 2.4. Was QE3 Helpful or Counterproductive?

	Term Premium on Ten-Year Treasury Security (basis points)		
		Actual Two-Day Change	
Event	Predicted Change	FRBOG Measure	FRBNY Measure
Sept. 2012 FOMC Meeting (9/13/2012)	−17	+6	+17
Sept. 2012 FOMC Minutes (10/4/2012)	−11	+8	+15
Dec. 2012 FOMC Meeting (12/12/2012)	−3	+7	+11
May 2013 JEC Testimony (5/22/2013)	−2	+8	+11
June 2013 FOMC Meeting (6/19/2013)	+3	+21	+14

Note: For each event, the second column indicates the predicted change in the term premium on a 10-year constant-maturity Treasury security, which is computed by applying the Federal Reserve Board staff's maintained assumption to the perceived shift in security holdings reported in table 2.3. The last two columns show the actual two-day change in the term premium for that event, as calculated by the Federal Reserve's Board of Governors (FRBOG) and by the Federal Reserve Bank of New York (FRBNY), respectively.

In retrospect, however, "taper tantrum" was an inapt characterization, because the upward shift in the term premium was not a transitory episode caused by market frictions but was in fact characteristic of the entire QE3 program. As shown in figure 2.4, the term premium started moving upward during the early stages of QE3, jumped 75 basis points in late spring 2013, and did not subside until QE3 ended in autumn 2014. Moreover, market participants specifically attributed these developments to the lack of clarity in FOMC communications. For example, the results of the New York Fed's June 2013 survey included the following summary: "Most primary dealers stated that a change in perception of or heightened uncertainty about the FOMC's view of appropriate monetary policy were key factors that generated the rise in the 10-Treasury yield."

FIGURE 2.4. QE3 and the Evolution of the Term Premium
Source: Federal Reserve Board.

Given that QE3 did not achieve its intended aim of reducing longer-term bond yields, it is not surprising that the program was ineffectual in spurring the US economic recovery. As shown in the upper panel of figure 2.5, QE3 had negligible effects on the growth of US real GDP, which fluctuated within a relatively narrow range in 2013 and 2014. Likewise, QE3 had no apparent impact on core PCE inflation (personal consumption expenditures, the Fed's preferred measure of underlying inflation), which averaged about 1.5 percent over this period, essentially the same as its average pace over preceding and subsequent years.[27]

The limited effectiveness of quantitative easing has also been underscored by the recent experiences of other major economies where conventional policy has been constrained by the ELB. For example, the Bank of Japan (BOJ) launched its quantitative

27. Levin and Loungani (2019) analyze a range of macroeconomic indicators and find no evidence of any statistically significant effects of QE3.

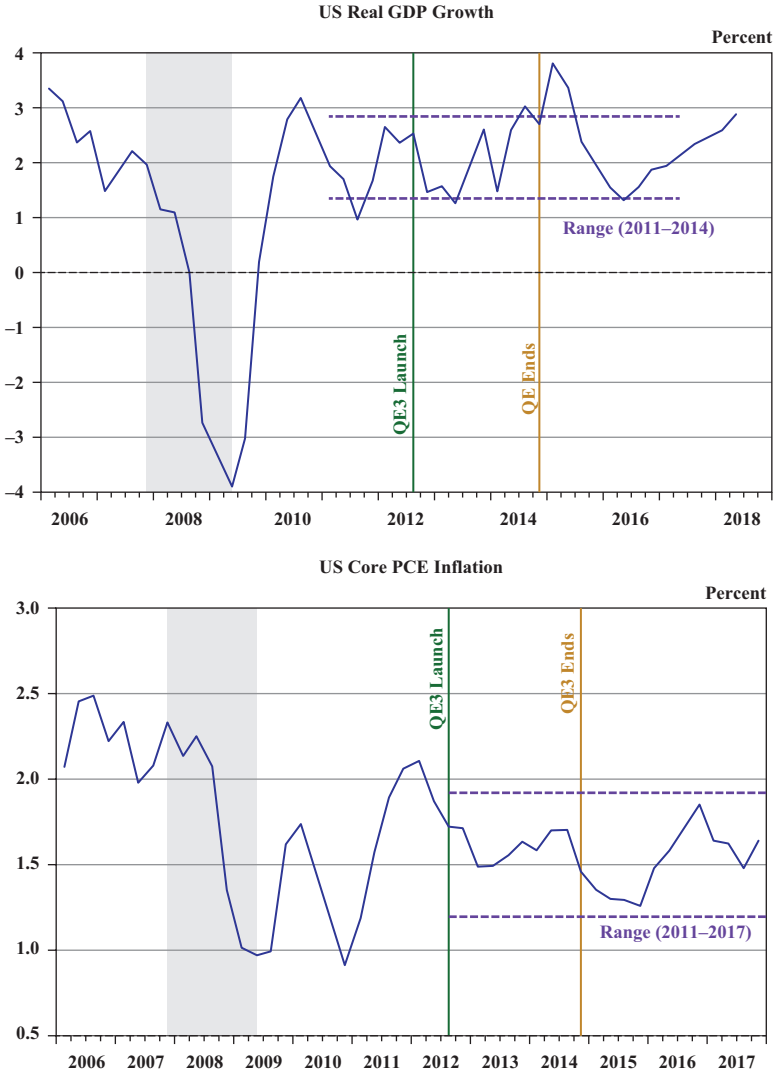

FIGURE 2.5. Did QE3 Affect the Economic Recovery?

Note: These two panels show the four-quarter average growth rates of real GDP and of the price index for personal consumption expenditures (PCE) excluding food and energy, as published by the Bureau of Economic Analysis, and the recession dates (shaded area) are determined by the National Bureau of Economic Research.

and qualitative easing program in April 2013 and initiated yield curve control in 2016, but Japanese core inflation (excluding food and energy prices) is still mired close to zero—far below the BOJ's 2 percent inflation target. Similarly, the European Central Bank (ECB) engaged in a large-scale asset purchase program from early 2015 through late 2018, but core consumer inflation (excluding food, energy, alcohol, and tobacco) edged upward only slightly and remains roughly a percentage point below the ECB's stated objective of keeping inflation "below but close to 2 percent over the medium run."

DESIGN PRINCIPLES FOR DIGITAL CASH

In my joint work with Michael Bordo, we have emphasized that digital cash can fulfill the three basic functions of money, serving as a practically costless medium of exchange, a secure store of value, and a stable unit of account.[28] While private forms of money can fulfill some aspects of these functions, there are intrinsic reasons why households and nonfinancial firms should also have access to a fiduciary form of money issued by the central bank. First, central bank money serves as a unit of measure—analogous to the inch or the meter—that facilitates the economic decisions and financial plans of ordinary consumers and small businesses. Second, in an efficient monetary system, the medium of exchange should also serve as a secure store of value that bears the same rate of return as other risk-free assets such as US Treasury bills; see Friedman (1960). By contrast, any purely private form of money (i.e., not backed by government authorities) is intrinsically subject to default risk and hence cannot serve as a reliable medium of exchange nor as a stable unit of account.

28. See Bordo and Levin (2017) for a comprehensive discussion of design principles for digital cash.

One conceivable approach to establishing digital cash might be for people to hold such accounts at the central bank itself. But it seems undesirable for the central bank to start competing directly with commercial banks in attracting deposits, especially in cases where the central bank also regulates and supervises those banks. Such an approach would also raise a host of concerns about privacy and bureaucratic inefficiencies and could pose risks to financial stability, for example, depositors shifting their funds from commercial banks to the central bank at the onset of a financial crisis.

Thus, our analysis indicates that digital cash should be provided through designated accounts held at supervised depository institutions, which would hold part or all of those funds in segregated reserve accounts at the central bank. This approach would foster competition among digital cash providers and protect the privacy of individual transactions while facilitating appropriate law enforcement. In effect, the provision of digital cash would be similar to that of many other public goods, such as water, electricity, and transportation.

Under this approach, payment transaction could be transmitted instantaneously and securely at practically zero cost, simply debiting the payer's digital cash account and crediting the payee's digital cash account. The scope and scale of fraudulent transactions could be mitigated by straightforward and convenient methods such as two-step identity verification.

Digital cash accounts could bear interest at essentially the same rate as Treasury bills, thereby serving as a secure store of value. This would tighten the link between the interest that banks earn on their reserves and the interest that they pay to ordinary depositors, thereby strengthening the monetary transmission mechanism. Moreover, such an arrangement would be a natural extension of the current monetary system, in which the Federal Reserve pays interest on the reserves of commercial banks, issues interest-bearing liabilities to a wider array of financial counterparties through its

reverse repo facility, and maintains segregated accounts on behalf of the customers of systemically important financial market utilities.[29]

The interest rate on digital cash would serve as the FOMC's key monetary policy tool. During normal times, this interest rate would be positive. But in the face of a severe adverse shock, the FOMC would be able to cut the digital cash interest rate below zero to foster economic recovery and preserve price stability. As discussed below, such a system would appropriately insulate ordinary households and small businesses from incurring negative rates on their digital cash accounts.

In effect, the Federal Reserve would be able to provide an appropriate degree of monetary stimulus without resorting to QE, and hence its balance sheet would become very transparent. In particular, the Fed could simply hold short-term Treasuries in the same quantity as its liabilities of digital cash. The Fed's operating procedures would be correspondingly transparent: it would engage in purchases and sales of Treasury securities to adjust the supply of digital cash in line with movements in demand for digital cash.

MITIGATING THE ELB

Ken Rogoff's book was titled *The Curse of Cash,* and that theme is underscored in his latest paper with Andrew Lilley. Nonetheless, it would be inappropriate to abolish paper currency; rather, individuals and businesses should remain free to continue using it for the foreseeable future. As digital cash becomes ubiquitous, however, demand for paper cash is likely to diminish rapidly. After all, paper currency is inefficient and costly: sorting and cleaning it at

29. For example, segregated reserve accounts at the Federal Reserve Bank of Chicago have been created to hold the funds of customers of the Chicago Mercantile Exchange (http://www.cmegroup.com/notices/clearing/2017/03/Chadv17-107.html) and the initial margin accounts of customers of ICE Clear Credit (https://www.theice.com/publicdocs/clear_credit/circulars/Circular_2017_015_FINAL.pdf).

the bank, supplying it to ATMs, maintaining cash registers and safes at retail stores, using armored cars for transport, and ensuring that no cash is lost or stolen at any point in this cycle. In contrast, digital cash can be used instantly at practically no cost at all. Thus, as digital cash comes into widespread use, it seems reasonable to expect that paper currency will rapidly become obsolescent, just like typewriters and audiotapes.

But if paper cash is not abolished, then how would the Federal Reserve eliminate the ELB? Some analysts have proposed a time-varying exchange rate between paper currency and digital cash.[30] But such an approach would impose a severe burden on ordinary households and small businesses and would be fundamentally inconsistent with the notion that the Fed should provide a stable unit of account.

Thus, a far superior approach would be to eliminate the ELB by curtailing incentives for financial arbitrage between paper cash and digital cash, in effect introducing "sand in the wheels." In particular, the Fed could establish a graduated system of fees for transfers between paper cash and digital cash. Small transfers—say, up to $100 per week for an individual or $10,000 for a small business—would be completely exempt from such fees. Moderately larger transfers would be subject to a nominal fee (e.g., 2–3 percent), roughly similar to the size of withdrawal fees at many ATMs and cash service fees incurred by many small businesses. And the largest transfers (say, over $5,000) would be subject to an even larger fee (e.g., 5–10 percent). These arrangements would effectively eliminate the ELB while ordinary consumers and small businesses would remain free to use paper cash if so desired.

Finally, the Fed could insulate ordinary households and small businesses from incurring negative rates on moderate levels of digital cash balances. For example, an individual might hold funds in a single

30. See Agarwal and Kimball (2015).

digital cash account, and moderate balances in that account (e.g., up to $5,000) could be exempt from negative rates, while balances exceeding that limit would be subject to the negative interest rate.[31] Of course, individuals and businesses would also be free to hold multiple digital cash accounts at various financial institution banks; in such instances, one of those accounts would need to be designated as the user's "primary" digital cash account, and the exemption would apply only to the funds held in that particular account.

With this design, the Federal Reserve would be able to effectively foster economic recovery and price stability without imposing implicit taxes or fees on the digital cash balances held by ordinary households and small businesses. After all, the crux of the rationale for cutting the digital cash interest rate below zero is to influence the incentives of wealthy investors and large financial firms—not to penalize moderate account balances that facilitate day-to-day payment transactions.

FINANCIAL STABILITY

During a financial crisis, the central bank can expand the stock of digital cash as needed to provide emergency liquidity to supervised financial institutions. Alternatively, the central bank could extend such emergency safeguards to another public agency such as a bank regulator or the deposit insurance fund. Appropriate legal safeguards will be necessary to ensure that the lender of last-resort actions does not undermine the central bank's ability to carry out its commitment to price stability.

In the event of a financial crisis, the central bank would be able to reduce the digital cash interest rate below zero, thereby preventing runs from other financial assets into digital cash. In effect,

31. In effect, the yield on digital cash accounts would be analogous to that of US Treasury Inflation-Protected Securities (TIPS), which provide compensation for positive inflation but never shrink in nominal value.

a widening of risk spreads would be reflected by a corresponding drop in the risk-free interest rate, rather than a surge in private lending rates (which would remain close to normal levels). Moreover, this policy strategy generates a steep yield curve that facilitates the expansion of bank credit and fosters prudent risk taking—precisely the opposite of QE and "lower for longer" forward guidance that encourage search-for-yield behavior. Thus, digital cash would foster more rapid *V*-shaped recoveries instead of the *U*-shaped recovery of the US economy over the past decade.

PRACTICAL STEPS

In light of these design principles, it's natural to ask whether digital cash is truly feasible in the United States and, if so, over what time frame? Rather than decades or centuries, our analysis indicates that the Federal Reserve could take the essential steps by 2020, although further refinements would surely take place in subsequent years. In particular, the Federal Reserve should: (1) establish a real-time clearing and settlement system that facilitates efficient payments for consumers and businesses, and (2) facilitate the establishment of safe and liquid bank accounts that accrue essentially the same rate of return as Treasury bills.

As noted above, a key feature of digital cash is to serve as an *efficient medium of exchange*. Thus, a real-time clearing and settlement system is crucial for facilitating secure payments and eliminating counterparty risks by finalizing such transactions within minutes rather than hours or days. The Federal Reserve should move forward expeditiously in establishing a secure and efficient real-time payment system.

Another key design principle is that digital cash should serve as a *secure store of value* that bears the same rate of return as other risk-free assets, thereby eliminating the opportunity cost of holding money. In effect, consumers and businesses should be able to

receive essentially the same interest on checkable deposits and other current accounts that commercial banks receive on reserves held at the Federal Reserve, that is, the interest rate on reserves (IOR) less a very small margin to cover operating costs.

In a competitive banking system, it would be reasonable to expect that the interest rate on liquid deposits would roughly match or exceed the IOR. After all, commercial banks are required to hold only a small fraction of their liquid deposits as reserves at the Federal Reserve (which accrue the IOR), and they can earn a higher return by lending out the rest of those funds or investing in Treasury securities and other safe assets. In fact, however, most checkable deposits earn little or no interest, and even short-term savings accounts accrue interest at a rate far below that of IOR. In effect, a substantial portion of banks' current profit margin is being earned by paying noncompetitive rates on those deposit accounts.

One simple way for the Federal Reserve to foster a more competitive banking system would be to encourage the establishment of narrow banks. The business model of a narrow bank is remarkably simple and transparent, because such a bank would hold 100 percent of its deposits as reserves at the Federal Reserve. Thus, such deposits would accrue interest at essentially the same rate as IOR (less a small margin to cover the bank's operating costs). Narrow banks could significantly enhance the competitiveness of the banking system without displacing most conventional banks. After all, huge banks obtain the bulk of their funding from wholesale markets and earn profits from managing complex portfolios, while community banks specialize in "relationship banking" with small businesses and local residents. Finally, narrow banks would operate under the same legal arrangements as other commercial banks, namely, a charter from a state banking agency or the Treasury Department. But a narrow bank would have no need for FDIC insurance or access to the Fed's discount window, since its deposits would be inherently safe and liquid.

CONCLUSION

Although memories of the financial crisis are gradually receding, the global economy remains turbulent and unpredictable. Moreover, the "new normal" for the target federal funds rate is now expected to be around 3 percent—markedly lower than its level preceding that crisis—and hence the ELB is very likely to reemerge as a binding constraint on conventional monetary policy in coming years. And a clear lesson from recent experience is that QE and other unconventional monetary policy tools are complex, opaque, and ineffectual.

Therefore, an urgent priority for the Federal Reserve is to move ahead with the provision of digital cash as a means of mitigating the ELB. Digital cash should be provided to the public through accounts at supervised financial institutions, which hold part or all of those funds in segregated reserve accounts at the central bank. In the near term, the Federal Reserve can take practical steps in this direction by implementing a real-time payment system and by encouraging the establishment of narrow banks.

This approach will ensure that monetary policy will be systematic, transparent, and effective during normal times and in responding to severe adverse shocks.

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GENERAL DISCUSSION

KENNETH ROGOFF: Well, thank you, Andrew, for those comments. I feel a little bit like we're in the fifties, and I have a design for an electric car and Andrew has a design for an electric car, but no one else wants to hear about electric cars. But I like their idea. I actually think it conforms very closely to my favorite idea in my book, which has the added element of encouraging the trend toward less use of cash. But my favored plan would have fees on large currency redeposits into the central bank under negative rates, would provide for financial inclusion, and would not necessarily require an explicit exchange rate between electronic and paper currency. Of course, before undertaking any approach, the first big step toward serious, negative, unconstrained monetary policy will be to put together a broad committee, one that has to have people from markets, etc., representation on the technical side and on the political side, etc. But I don't think the challenges are insurmountable. For most countries, when they went from a fixed exchange rate to a flexible exchange rate, critics made a very big deal about disastrous it would be. Yet after implementing negative rates, most of the countries found, "gosh, this works great." I, by the way, credit Marvin Goodfriend with emphasizing that point.

In practice, a lot of the pushback on negative rates has come from banks: "What about our profits?" This is particularly an issue at smaller banks. At many larger banks, which borrow extensively in wholesale markets at negative rates themselves, it has actually gone the other way. However, if you cushion small depositors, if you subsidize those accounts, then implementing effective negative rate policy will not be such a big deal for banks as they should be able to pass through negative rates to large depositors. Fundamentally, if you eliminate the cash arbitrage, the issue of bank profits should just go away.

PETER FISHER: I want to thank you both for a terrific summary of all the reasons why QE, forward guidance, and lower for longer didn't work very well, and certainly much less well than has been asserted. And I think that's something that both the fourth estate and the central bankers of the world might want to focus on.

But I'd love to ask each of you, Ken and Andy, to be a little more precise about the transmission mechanism you expect your version of negative rates to work. So if you're going to get negative rates, it's going to incent the pension funds and the insurance companies not to hoard cash, and they're going to do something else. Well, what is that something else? You've also said it will lead to faster rates of employment, and you've got a little more of a burden to explain how that's going to work.

And Andy and Mike, could you think about the shape of the yield curve, and it's not just bank profits you've got to worry about, you've also got to worry about whether the banking system's balance sheet on the liability side starts to contract too quickly. You may not get a lot of credit growth. I just want to press you each to think a little—explain a little more, the particular transmission mechanism you think your version of negative rates is going to work through.

ROGOFF: It works exactly as monetary policy works (when rates are positive). If you've taken care of the administrative, legal, and regulatory issues, it's exactly symmetric. So, no, there would be more consumption, more investment. The issues of credit expansion having to do with bank profitability should substantially go away if people can't arbitrage into cash.

ANDY LEVIN: Peter and I have talked about this quite a bit, and I've learned a lot from conversations with Peter Fisher. I think a big reason for moving in the reason that Ken's recommended and that Mike and I have been writing about is to get back to V-shaped recoveries, instead of the kind of "lower for longer." When we think about conventional monetary policy, like the

recovery in the early eighties, during '83 and '84, it was "happy days are here again." We had a V-shaped recovery. Well, that's because monetary policy had lots of room to cut as much as it needed low enough so you got a pretty fast recovery going, and then it pretty quickly normalized. And so, I think that if we can get into that world again, businesses, consumers, and families are all going to be very happy.

By the way, Ken is talking about this as decades away. I think this doesn't have to be decades away. It could be maybe a three- or four-year process to do this. But it doesn't have to be decades.

ROGOFF: I agree. The transition would be a three- or four-year process. But I think it's decades away, like my example of electric cars in the 1950s.

JOHN COCHRANE: I want to thank both of you. You gave a beautiful overview. The Treasury could issue overnight debt if it wanted to—fixed value, floating rate, electronically transferable, treasury debt, functionally the same as reserves. Why should the Treasury issue something else and then count on the Fed to transform it, in a form only accessible to banks? Let the Treasury issue it directly. It would solve most of the balance sheet problems.

I entirely agree with your main point: all the other proposals are ineffective or pie in the sky, exactly as you've said. I also agree: electronic interest–paying digital currency at low cost is a great thing. In fact, the Treasury could be doing that too. If attractive, it happens on its own, and it will happen on its own for other reasons, not to give us negative rates, and then by the way you get to have negative rates.

I want to express, though, a little skepticism that this will quickly produce V-shaped recoveries and it will be so powerful on its own. The premise is that the problem in a recession is a generic lack of 1930s Keynesian aggregate demand. It's a unidimensional view of our complex economy. Something goes wrong, and no matter what the source, the answer is more

stimulus. Where the stimulus comes from is as good as anywhere else. If the recession comes from somewhere outside the Fed, then the Fed's job is to heroically step in and provide this unidimensional aggregate demand.

In fact, lots of other views disagree with this simpleminded Keynesian premise. The credit-constraint types think the problem is there's a bottleneck in credit markets, and no matter how much aggregate demand, if the banks aren't open, you can't get the economy going. That was Ben Bernanke's famous view. The supply-side view that structural reform is the problem has the same flavor. You can add the aggregate demand you want, it's not going to help. Lots of countries have persistently high unemployment, terrible labor markets, and there's nothing their central banks can do about it. That may be the reason we had a slow recovery.

The other view of the Fed is, channeling Milton Friedman, that lots of recessions happened because the Fed screwed up, made matters worse, told the banks to hold back, and that the best thing for the Fed to do is simply not to screw up, as it did not in 2008. It should make sure that the banks are open and working, and don't pretend that it can solve the structural reform problem, especially in Europe and Japan.

ROGOFF: I certainly strongly agree with the point about Keynesianism becoming sort of a secular religion in a lot of circles, and it's missing a lot. And if one really looks across countries, there are structural issues, not just differences in aggregate demand. Someone asked me recently, why does Europe have worse performance than the United States? And I pointed them to Ed Prescott's work on tax differences. I had a slide that I skipped over emphasizing that monetary policy is not a panacea.

I did want to mention one interesting and important point about digital currency. And that is that this is a game that the Treasury can play. The United States actually has something

called TreasuryDirect. It takes about five minutes to set up. One can hold up to $20 million down to $100. You can make payments to other people on TreasuryDirect. In fact, a prototype digital savings account is already here. The Treasury doesn't advertise it much, perhaps because the banking system would go crazy if TreasuryDirect started accumulating too much money. By the way, TreasuryDirect charges no fees. So, that's proof of concept that this can be done and does not necessarily have to be done entirely by the Fed.

And one last point. There's a difference between the digital currency you want to use if you want to buy an apple, which is a high transaction cost, and a digital retail currency that can be used for larger payments. Cash is still very convenient for frequent small payments. But for large payments such as monthly rent, then the issues having to do with implementing a retail digital currency are very straightforward.

MICKEY LEVY: This is just a simple question following Peter's and John's point. If you hold retail accounts harmless, that is, keep the zero bound for consumers, then their incentive to save or invest is unchanged, and consumption will not be stimulated. That leaves the impact of expectations. Since consumption is 70 percent of GDP, how are you going to stimulate the economy if you don't impose negative rates on consumer accounts? Also, I worry about the transition from where we are to where you want to go, which may be tricky. The Fed now admits that its earlier assessments on the efficacy of QEII and QEIII overstated their stimulative impacts. How does the Fed transition to new regime and maintain credibility and build confidence in the business community?

LEVIN: So, Chris Erceg and I wrote a paper where we looked at disaggregated vector autoregressions to determine which components of consumption respond to a monetary policy shift. And what we found was the biggest shifts happen in consumer durables:

auto sales, refrigerators, and home construction. So, regarding Mickey's question about if it matters whether retail accounts have a zero or negative rate, I would say no, it doesn't matter. What matters to a household thinking about buying a car is: what's the car loan rate? When car loan rates were zero financing for five years, that made it much more appealing to buy a new car than when the rate was 2 or 3 percent or 4 percent. If the car loan rate went below zero, a family that's thinking about buying a new car would think, wow, that's really cool, they're going to pay us to take the new car. And so they might make the new purchase. The amount that they have on their thousand dollars in their checking account is not really material to those kinds of decisions.

ROGOFF: No, not at all. I agree with Andy that his major point is what are the interest rates that matter when a consumer is buying a car or consumer durable. Again, in my plan, small savers would be protected; they would be allowed an account of up to two or three thousand dollars where the interest rate would not go negative; the banks would be subsidized on those, when they're paying the negative interest rate on reserves. The Treasury and the Fed would be making a lot of money in negative interest rate environment, so providing such subsidies would not really be difficult to do.

You ask about the transition to negative rates, and of course that's a tricky question. I think the Fed is better positioned to carefully plan than is Europe or Japan, because they may need to make a transition more quickly. The Fed has a lot of time to sort of look at it in more of an abstract way, to have more distance. It's probably fair to say that almost everyone that thinks—I don't know if John does—that the Fed did a great job—I think you do say this—in 2008 and 2009. But after that, when the Fed was not in emergency mode anymore, it was trying hard to bolster public confidence by making big claims about the potency of its alternative monetary instruments. The Fed public relations

machine was whirring. In retrospect it probably would have been better for the Fed to say "there's just not much we can do at this point unless we can do something very different" (like effective negative interest rate policy). If Congress wants to do more fiscal policy stimulus, we think that would be great. That, of course, is a very difficult position for the Fed to find itself in. It understandably wanted to encourage markets to think it's had everything under control, and obviously you don't want to come out and give a speech and say, "We're helpless." But I do think that thrust of more recent academic work is guiding them in that direction, and it will get easier and easier to say over time.

GEORGE SELGIN: This is for Andy, and it's a question related to the question about the credit channel and all that. It concerns the risk of having the Fed's involvement in retail payments become something that's not just a cyclical development but a secular one. I wonder if you could comment on that. How do you keep the Fed from competing with the commercial banks permanently once it gets into this retail trade? And if you can't do that, isn't there a concern about the allocation of credit in the economy and the Fed becoming even more important than it is now as an intermediary of credit?

LEVIN: So, Mike and I have a new Hoover working paper that we issued in January (which is coming out soon in the *Cato Journal*) where we talk about some of these practical issues. And we emphasize that establishing a public-private partnership is crucial to the design of digital cash. And this is a conversation I've been having with people in Europe and Japan as well. The World Bank gives advice to governments all over the world about how to provide electricity and telecommunications and other types of infrastructure. It's well understood now that this shouldn't be done solely by the government. After all, the government can be very bureaucratic and very inefficient and not very innovative. Public-private partnerships, especially where there's a bunch

of private enterprises competing with each other, is the state-of-the-art approach for telecommunications and port facilities and so forth. And for the payment system, that's how it should be—there should be a partnership between the central bank and the supervised financial institutions that provides digital cash, ensuring that you have competition, that you can have privacy, that you can have innovation. If one bank comes up with a better smartphone app, and lots of digital cash holders start using that app, then other providers will have to improve their apps too. So, I don't see this as a static, stagnant initiative. It's going to be a dynamic process.

ROGOFF: I'd just say it's much more general than that, there are many ways to implement a digital government retail currency, and there are many ways the banking system can work together with it. We have very similar issues in the current system. Many countries have giant postal banks, gyro accounts, that soak up a lot of money that might go into the private sector banking system and that are incredibly inefficient. I've written about the analogies with the Chicago plan of the 1930s in my 2016 book. The problem is that digital currencies may be regarded by the public as a superior asset that will displace the banks. However, if one is looking over the next thirty or forty years, this may be coming regardless. If it isn't the government, it will be the tech industry. Banks are going to get disrupted one way or another, but the government doesn't have to be the one that supplants them.

UNKNOWN SPEAKER 1: Just a clarifying question. So, the point with introducing a negative interest rate policy is you want to prevent large players from storing large amounts of real value into hoarding cash. Is this correct?

ROGOFF: That's not the point of negative interest rates. What you have to stop is wholesale hoarding of paper currency.

UNKNOWN SPEAKER 2: Yeah, yeah. What you have to stop in order to implement this policy. So, what would prevent them from

hoarding real amounts of real value into gold or diamonds? This would still put a lower bound?

ROGOFF: No, no. It's exactly the same as monetary policy today, when they cut the interest rate from 3 percent to 2 percent; this of course encourages people to shift funds into risky real assets, and that is part of the transmission mechanism of normal monetary policy. Very low rates are a fair part of the reason stock prices have gone up over the last decade, as well as housing prices.

LEVIN: I think this is why in our first Hoover paper, which is the one that's in the Hoover volume, Mike and I emphasize these basic principles of the monetary system, the most important of which is stable unit of account. Consumers and businesses need a stable currency to serve as a unit of measure, just like a meter or a yard or a liter bottle. They need to have a unit of account that they can use when making transactions. So the problem with these other commodities and real assets is they have a floating exchange rate against the unit of account. So you can go ahead and buy a house if you think it's going to appreciate in value. Or you can hold Bitcoin if you think it's going to appreciate in value. But there's no guarantee that it's going to have a stable unit of account. And I think this comes back to Milton Friedman. Richard Clarida emphasized at the beginning of his speech, Ken emphasized it, Mike and I have emphasized it too. The central bank's most important responsibility is to preserve the stability of the unit of account. When Milton Friedman said inflation's everywhere and always a monetary phenomenon, my understanding is that's fundamentally what he meant, namely, that monetary policy has to be able to commit and ensure that the unit of account remains stable over time. And if we think that the Fed and other central banks are running short of ammunition, and that the next time could be worse, we could be ending up in a situation, like in the Great Depression, where the price

level dropped 30 percent, and it was catastrophic, because the Fed, constrained by the gold standard, was no longer able to carry out its commitment to maintain a stable price level. And so, there should be some sense of urgency here. We shouldn't just be thinking of ten- and twenty- and fifty-year horizons. We need to make sure that this problem gets solved soon enough so the Fed has the ammunition next time to carry out Milton Friedman's prescription.

ROGOFF: You stated that in a very precise way, and this conforms to the standard central bank answer for price stability, and it is a good one. But one has to remember that stuff happens. During World War I, central banks had little choice but to inflate; the seventies were a mistake. Right now, there are interesting ideas about making debt much, much, much larger and more short term, and having the Fed finance it. But of course there are risks. What if it turned out maybe not to work quite the way it was promised, and the federal government came under severe fiscal pressure from climate catastrophes, pandemics, cyberattacks, etc.? Do we really want to force the government to default rather than having the Fed inflate? And does the Fed have the tools to inflate at the moment. Another important issue is what to do if we have another financial crisis where the federal government still had good credit, but the private sector had huge debt problems, and you can't clean them up easily. Wouldn't it actually be good to have mild inflation to relieve private burdens? And how can this be done at present if interest rates are at the zero bound? I personally believe that having some inflation in the last crisis would have been great, perhaps 4 or 5 percent inflation for a few years, and I argued for that. Yes, that would be heterodox? But I'm not sure the Fed has the power to do that at the moment, anyway.

LEVIN: But this comes back again to ordinary consumers and small businesses. Because I think if you ask them. Ask them, not just

the economic theories, ask those small businesses and ordinary consumers in vulnerable communities, would they have liked to have had 5 or 6 percent inflation in order to promote a faster recovery? They'd say, "Boy, I'm not ready for that." That's why people hated the 1970s, because it's really tough, if you can't hire a financial planner or portfolio manager, to deal with that sort of situation.

ROGOFF: But they don't have any money. They're gaining from the jobs . . .

LEVIN: In principle, we're on the same page here, because what you want is a V-shaped recovery, using the nominal interest rate as the standard tool of monetary policy, so you don't have to resort to unconventional and unreliable policy tools.

CHARLIE CALOMIRIS: Thanks very much for a great panel. But as long as we're getting futuristic, I wanted to point out, it seems like one of the assumptions in this discussion is that central banks will maintain their monopoly over the unit of account and the payment system. I don't think that's obvious. I think you could imagine stable-value cryptocurrencies that wouldn't even be using the dollar and that wouldn't have to be part of this, let's say, three or four decades from now. And I think you could imagine that if there were a protracted period of negative interest on the Fed payment system, that would actually hasten that.

ROGOFF: Well, we can take that up at the Hoover conference next year, but the last part of my book is about this. As far as there being other units of account, if you look at the history of currency, and I know you've thought about it a lot and Mike has, but I fundamentally say, the private sector can innovate, the private sector can do things for a while. But the central bank makes the rules of the game. In the long run, the government always wins.

UNKNOWN SPEAKER 2: You seem to make it a very smooth transition from traditional monetary policy to negative rates, and I'd like to push back on two buckets. You mentioned criticisms but

then didn't dive into them. The one concern I have is on efficient capital allocation. I do have some questions on whether that is indeed happening and whether that happened after the financial crisis as well. You mentioned the survival of zombie companies or the creation of monopolies. But the question I'd like you to answer is the other bucket. You did mention fiscal policy would always be more efficient. Is there a point when monetary policy in your framework is really conducting fiscal policy, and if so, is there a limit as to how much monetary policy should be achieving? I guess it's more an ethical question than anything else, and a question also ultimately of independence. There are lots of arguments being raised. So in 2008 the government was ineffective; therefore, monetary policy had to step in. If that goes to an extreme with very negative rates, isn't there the theoretical solution of negative rates at risk because the government will intervene?

ROGOFF: You always want to use fiscal policy. The question is how nimble is fiscal policy. Did you watch the Kavanaugh hearings? Do you think this team is really going to be able to implement some highly refined technocratic policy to stimulate the economy and then turn off at exactly the right place? It's a joke. And I think you could say the same virtually about every country in the world. When it's a big crisis, fiscal policy acts, and it would be better if it acted more in some cases. It would be better if it acted more effectively. But I think to have monetary policy dead in the water, and Andrew and Mike said this very well in their paper also, is going to be a real problem when the next crisis happens. We'll get through it. We'll still be around. A lot of countries have not done as well as the United States, and they're still around. But it could be better.