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Did central banks cause the last financial crisis? Will they cause the next?

By

Philip Turner

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DID CENTRAL BANKS CAUSE THE LAST FINANCIAL CRISIS? WILL THEY CAUSE THE NEXT?

Philip Turner*

Abstract

Recent history suggests that raising interest rates higher than warranted by macroeconomic prospects would not be the right policy for financial stability. The significant tightening of monetary policies in the advanced economies from mid-2004 to mid-2006 failed to stop increased risk-taking in the financial system. The pre-GFC policy failure was not lax monetary policy but the failure of regulators to address (and markets to sanction) new risks created by innovation in international banks. Post-crisis monetary expansion, inadequate at first but ultimately taking many radical forms, ended a severe global recession. It did so without increasing aggregate debt/income ratios of the non-financial private sector in the advanced economies. But it has increased the interest rate sensitivity of the balanced sheets of financial intermediaries, an effect magnified by new regulations. Accounting rules and prudential regulations, which do not treat interest rate risk well, need to be re-examined. Current macroprudential policies largely fail to address the increased exposures to interest rate and liquidity risks faced by financial firms. The problem for monetary policy is that, given the scale of interest rate risk on the balance sheets of financial intermediaries, the macroeconomic effects of interest rate increases have become larger and much more uncertain.

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Keywords: Term premia, central banks, unconventional monetary policies, interest rate policy, Taylor rule, macroprudential policy

*Visitor at the NIESR and Visiting Lecturer at the University of Basel. Former Deputy Head of the Monetary and Economic Department and member of the Senior Management of the BIS. Email: turnerphilip27@gmail.com. This paper benefited from seminar comments at Sciences Po, the Banque de France, the Financial Markets Group at LSE and the National Institute. I am indebted to very helpful suggestions from Bill Allen, Jagjit Chadha, Tim Congdon, Joe Gagnon, Morris Goldstein, Charles Goodhart, Graham Hacche, Steve Grenville, Jean-Pierre Landau, Brian Madigan, Philipp Mekler, Paul Mizen, Chander Ramaswamy, Y V Reddy, Sweta Saxena, Lars Svensson, Anthony Turner and Graeme Wheeler

"Monetary policies in the G7 countries resemble the actions of the sorcerer's apprentices who are no longer able to control the powers of the nether world…called up by their spells … (with) a systematic easing bias, G7 central banks perpetuate extreme monetary stimulus delaying the normalisation of monetary policy … sowing the seeds of the next systemic crisis…The 2008 crisis may only have been a dress rehearsal for a worse crisis which lies ahead."

Hannoun and Dittus (2017)

INTRODUCTION

Central banks are under attack. The recent policy manifesto of Hervé Hannoun and Peter Dittus makes a comprehensive case that lax and reckless monetary policies in the G7 countries are leading straight into a systemic crisis. It is tightly reasoned, supported by hard-to-come-by but telling statistics and blunt in its policy message. Their policy prescription to forestall this "ticking time bomb" is that the Fed funds rate, which they believe has been kept far below the range of Taylor-rule implied rates for much too long, should by early 2017 have been well over 3%[1]. The ECB's policy rate should be 2.5%. Exit from QE must be postponed no longer if central banks are to avoid the "slippery slope leading to government debt monetisation". And Parliaments should legislate to prevent central banks from setting negative deposit rates.

Some would agree with their indictment of G7 central banks. Others worry that such complaints about the successful actions taken by central banks could encourage ill-informed and politically motivated efforts to limit the independence of central banks (Wolf (2017)). Many would switch between these two perspectives according to their

[1] See pp 98-101 of Hannoun and Dittus (2017). Denouncing the G7 central banks for a "misguided crusade against too low inflation", they suggest consideration of a rules-based monetary policy framework. Their Taylor-rule calculation is based on an update of Hofmann and Bogdanova (2012). The estimated Taylor rules are discussed in section 2 below. Section 6 below echoes some of their criticisms of major failures in recent regulation of the financial industry (see their section on regulatory capture and failure, pp 38-48).

judgement about how depressed the economy is, supporting exceptional monetary expansion only when unemployment is high. But there is much wider agreement about the uncertainty created by the very long period of low interest rates and massive central bank balance sheets. There are legitimate worries about what this might imply for financial stability and for the efficacy of monetary policy in the future. This paper addresses these worries.

The radical expansionary monetary policies pursued since 2009 could, through the effects on the financial system, create difficulties or constraints for future monetary policy. Even in the absence of a financial crisis, any significant increase in the risk aversion of financial intermediaries (banks, pension funds or insurance companies) once extraordinary monetary accommodation is removed could have major macroeconomic consequences. No one should dismiss this worry lightly: the last two global recessions (the 2000s tech bubble and the Global Financial Crisis (GFC)) were both caused by asset price declines, rather than inflation. Nor should one panic: asset price declines, even sharp, are inevitable and do not always produce financial crises.

Do the financial risks from low interest rates mean that central banks in the advanced economies should tighten monetary policy before (or more than) warranted by macroeconomic conditions such as unemployment and inflation? There are broadly two opposed perspectives on this question. Those who answer "yes" are confident that they can measure aggregate financial risk in an economy. Their reading of history is that lax monetary policy has been the key common factor behind earlier financial crises, and that higher interest rates must play a part in curbing excessive financial risk-taking. Those who answer "no" are usually not confident about even the meaning of aggregate financial risk, and would say that such risks tend to sector-specific. While lower interest rates make it easier to borrow (so that monetary policy is important), many other influences are more important in determining how risk exposures change over time. Their conclusion from history is that the financial system is constantly

changing: policy-makers need to be forward-looking and watch for new future risks – including those created by expansionary monetary policies.

The first view is that the extremely low interest rate policies of central banks in the advanced economies since 2009 have gone too far because central banks neglected the financial stability risks they were creating. The catch-phrase for an alternative policy prescription is that central banks should "lean against the (financial) wind", or L.A.W. for short. The proposal is that, when the favoured empirical relationship indicates a financial boom, the policy interest rate should be set above that justified by purely macroeconomic considerations (that is, "interest rate leaning" to use Brunnermeier and Schnabel's more precise terminology). Higher interest rates are seen as the surest way of countering financial stability threats such as asset-price booms, over-indebtedness, bubbly financial markets, excessive credit growth and so on.

Some empirical credit or financial aggregate (usually constructed from past data on credit expansion, indebtedness, asset prices, market risk-taking or similar variables) is typically used to calibrate how much higher interest rates should have been. The BIS has since 2015 made much of its definition of a financial cycle, and has proposed a new rule to guide setting the policy rate: a financial cycle-augmented Taylor rule (BIS (2016)).[2]

Using some rule based on aggregate credit or financial ratios that had led to crises in the past has two obvious drawbacks. The first is that it is backward-looking. A second drawback of using an aggregate financial ratio is that it ignores the *causes* of credit cycles. In an ideal world, efficient credit *should* respond to productivity and demand shocks. Such credit cycles are benign. But credit cycles induced by inefficient

[2] Their proposal is relevant for current monetary policy choices. in June 2017, the BIS said that central banks should "tolerate longer periods of inflation below target, and tighten monetary policy if demand is strong, even if inflation is weak, so as not to fall behind the curve with respect to the financial cycle" (Financial Times (2017a)). By September 2017, however, the worry was that higher interest rates might disrupt financial markets and could derail the global recovery (Financial Times (2017b).

credit (e.g. created by microeconomic distortions) are malign and policy might wish to counter them[3]. Hence any policy recommendation based on such cycles must take account the nature of the shock driving credit. What works best at one time (or for one country) will not necessarily work at another time or for another country. In developing countries, where the structure of the financial system is being transformed as financial deepening drives growth, financial cycles are especially hard to identify (Reddy (2010)).

The second and opposing view is forward-looking. The financial system is always innovating and new risk exposures emerge whatever monetary policy does. Dealing with such risks – whether from innovation or from monetary policy – requires a regulatory approach. Risk-taking is often concentrated in a few sectors, arguing for a sector-specific policy. The challenge is to correctly identify such risks and design effective regulatory responses. Whether monetary policy should be expansionary or not depends on macroeconomic conditions. There is nothing necessarily inconsistent with a policy mix of tightening financial regulations and easing monetary policy.

This view does not of course mean that monetary policy, which gets transmitted through the financial system, can ignore the financial risks it creates. The point is rather that policies to address financial risks need to be especially alert to new or unfamiliar risks. The financial system is constantly changing under the pressure of advances in technology, of globalisation and of shifts in the propensity to save or invest. The recent review by Claessens (2016) shows how regulatory policies often fail to take sufficient account of such changes. The financial system also changes under the influence of monetary policy (especially when maintained for an extended period).

Crises so often arise not because banks or regulators make the same mistakes they had made in the previous crisis, but rather because they fail to fully appreciate

[3] A fascinating paper by Gourio et al (2017) develop a DSGE model which distinguishes between "efficient" and "inefficient" credit in order to examine the conditions under which a L.A.W. policy might be warranted. In their model, when credit swings are driven by productivity and demand shocks, the Bernanke and Gertler (1999) conclusion that stabilising inflation is sufficient applies: the central bank which controls aggregate demand also controls credit and limits the risk of a financial crisis.

the new risk exposures (and the reaction functions of financial firms) which arise as a result of changes in the financial system. Thus, as Claessens puts it, "systemic risk … cannot be fully captured by metrics that are static or backward-looking". Likewise, past correlations between the movement in financial variables and the probability of a financial crisis are not generally strong or stable enough to override the usual macroeconomic guideposts for monetary policy.

This means that central banks have to analyse how monetary policy today is shaping future financial exposures, and may even change the financial system. As the nature or size of financial exposures changes or as different forms of intermediation emerge, the macroeconomic consequences of future monetary policy action are likely to be different than in the past. These mutual interactions between monetary policy and the financial system are likely to be large after a very long period of monetary ease. Hence to assess the *macroeconomic* consequences (that is, even leaving aside financial stability issues) of any monetary policy action, central banks have to take account of its financial consequences.

Summary

The point of view of this paper can be briefly summarised. Financial stability is not best furthered by keeping the policy rate higher than warranted on macroeconomic grounds (Section 1). Section 2 shows that the substantial increase in the Federal funds rate from mid-2004, reinforced by higher policy rates elsewhere, did not prevent further increases in risk-taking in the financial markets during this period. One international comparison is particularly telling about the ineffectiveness of monetary policy as a financial stability tool. The Bank of England's tight monetary policy from late-2001 until mid-2005 did not prevent financial excesses from building up in the United Kingdom. The Bank of Canada, in contrast, reduced its policy rate in line with Fed policy; Canada avoided the crisis because of the tighter regulation of banks and fatter profit margins from a less contestable domestic banking market. The prime culprit for the GFC was the failure (of both regulators and markets) to recognise the new dangers created by financial innovation (Section 3). Section 4 considers how

financial variables contain valuable information that is not fully taken into account in the macroeconomic models used by central banks. The added value that financial variables bring to macroeconomic forecasts is much greater in busts than in booms. This is because down movements are sharper than up movements and because liquidity constraints can suddenly tighten in busts. Central banks did not appreciate quickly enough from July 2007 the strong deflationary threat from severely impaired banks and a strong and persistent flight to safe and liquid assets. The Fed (and other central banks) erred during the pre-Lehman stage of the crisis in failing to cut rates more radically. And earlier action to reduce term premia in bond markets would have eased the market stresses on those institutions holding leveraged bond portfolios. Section 5 argues that the eventual adoption of very expansionary monetary policies (with central banks operating at different dates) succeeded in ending a deep recession, doing so in the face of strong fiscal contraction. Such policies have inevitably created some new financial risks. But is has **not** led to increased leverage in the private non-financial sector in the advanced economies over the past decade. What it has done is to increase interest rate exposures in banks and other financial intermediaries – exposures which remain rather hidden. Section 6 argues that accounting rules and new regulations have encouraged or acquiesced in greater interest rate risk exposures. Banks and institutional investors have been induced to lengthen the maturity of their bond holdings, and their behaviour may have even become pro-cyclical as they increase their duration as bond yields decline. As long-term yields are forced still lower, there are further feedback effects on duration. Term premia in benchmark government bonds were driven negative. This means that regulatory policy today needs to take interest rate risk and possible pro-cyclical dynamics more systematically into account than is the case at present. Section 7 considers what role macroprudential policies could play to counter these risks. Three dangerous shortcomings in the current mechanisms of prudential oversight are identified: the rigidity of bank liquidity rules; the virtual absence of macroprudential tools directed at non-banks; and complacency about liquidity illusion in bond markets. Section 8 examines how the exposures of

financial firms will have altered the transmission channels of monetary policy. Because the macroeconomic effects of interest rate increases will be larger and much more uncertain, caution will be needed when increasing interest rates.

1. L.A.W. AND ECONOMIC THEORY

The L.A.W. question was extensively debated by economists long before this catch-phrase became popular. The common-sense answer to the question whether the central bank should raise interest rates when there is no inflation threat but there are signs of a financial boom is, "No, central banks should be guided by their macroeconomic mandate in setting the policy rate". This is because interest rates high enough to curb an asset price boom in one sector would cripple the rest of the economy (Persaud (2010)). Consider the example of housing markets. If households expect property prices to rise by 10% over the next 6 months, adding even 200 basis points to the policy rate will not be much of a deterrent to taking a mortgage. But such a rise in rates would have strong macroeconomic effects. The studies reviewed by Smets (2014) conclude that the macroeconomic costs of raising interest rates to counter a property price boom would be too high. The foreign exchange market provides another example. The history of central banks raising rates by very large amounts to counter strong market expectations of currency depreciation is littered with failures.

There is, however, one important qualification to the argument that the policy rate is a poor tool to address financial stability objectives. On those occasions when market expectations are very uncertain, determined official action – involving a package of both government policies and monetary measures – can have a big impact. The government will sometimes want the central bank to enact at least a symbolic increase in interest rates to reinforce the signal sent by other (more relevant) policies.[4]

[4] See pp 258-61 of Reddy (2017) for a fascinating account of government pressure on the central bank to raise interest rates outside the calendar of monetary policy statements.

A common theme at a 1997 BIS meeting of central bank economists was that the policy rate was quite ill-suited as an instrument to avert financial instability. Addressing more recent worries, Simon (2015) shows that the historical evidence is that low interest rate environments are not inherently unstable – either in creating macroeconomic instability or in destabilizing the financial system (Simon 2015)). As Bordo and Jeanne (2003) put it, many financial crises had arisen from tail-probability events (or combination of events), in which non-linearities had been important. Agénor and Pereira da Silva (2013) show that financial imbalances often have a sectoral dimension and general rise in interest rates would also hold back those sectors where there is no overheating. Brunnermeier and Oehmke's (2012) wide historical review of booming asset prices puts emphasis on fundamental or financial innovation as a trigger and on the complexity of amplification mechanisms related to how risk perceptions are formed. Addressing more recent arguments, Simon (2015) shows that the historical evidence is that low interest rate environments are not inherently unstable – either in creating macroeconomic instability or in destabilizing the financial system.

In any event, neither expectations which determine asset prices nor changing propagation mechanisms are likely to be a stable function of macroeconomic or policy variables (BIS (1998)). Expectations can change in unpredictable ways (as the taper tantrum showed?). Any systematic short-run response of the policy rate to an asset price could actually make that price more volatile. Furthermore, if a central bank were to use the single instrument of the policy rate to achieve two objectives (for example, inflation and asset prices), it would have to make a discretionary trade-off between these two objectives (Goodhart (2010)).

In his influential book on the causes of the financial crisis, Pringle (2014) rightly argues that it is "politically naïve" to suppose that politicians would give central banks carte blanche to play safe and stop an economic upswing in its tracks whenever there was a faint whiff of a financial boom. He warns that tampering with the inflation-

targeting regime in such a way would undermine the only "putative monetary standard" that is currently available. For all these reasons, most practitioners in central banks would not support having asset prices as an objective of monetary policy (Icard (2007)). Few (if any) central banks have sustained an avowed leaning-against-the-wind policy for very long.

Empirical studies have generally supported this practical conclusion. The comprehensive analysis of Lars Svensson (2016) provides the most general treatment of the costs and benefits of including a financial variable in monetary policy objectives. Because leaning against the wind increases both the non-crisis and the crisis unemployment gap, he shows that the marginal cost of a L.A.W. policy would exceed the marginal benefit (mainly the lower probability of a crisis). His findings seem robust to recent challenges, and is consistent with most empirical research on this question (Svensson (2017)).

Finally, most examinations of the specific case of the GFC do not assign a major role to unwarranted ease in US monetary policy. A careful review by José de Gregorio (2014) of the literature after the recent financial crisis concludes that it was rather the toxic combination of leverage and financial contagion, not earlier monetary policy ease, that made the recent crisis so lethal.[5]

Although this conclusion is shared by most economists, some still believe that a L.A.W. policy can make the financial system safer. There is a small but vocal current of opinion which puts much of the blame for the GFC on Federal Reserve monetary policy that was, before the crisis, blind to the build-up of financial system risks. Those who hold this view agree with Hannoun and Dittus that the Fed's monetary policy response to the crisis from 2008 has only made another crisis more likely.

[5] De Gregorio (2014), pp 72–76. He notes that the bursting of the dot–com bubble (financed by low-leverage investment funds) had fewer macroeconomic effects than the bursting of the housing bubble in 2007 (which was associated with much greater leverage). Bean et al (2010) make a similar argument that raising interest rates to counter the housing boom in the United Kingdom would have been too costly in terms of the macroeconomic goals of monetary policy.

According to this view, very expansionary monetary policies of the Federal Reserve from late-2001 to mid-2004, when the Federal funds rate was reduced to a low point of 1%, fuelled an extraordinary appetite for risk in global financial markets. Such low rates eventually led to the marked compression of market volatility, lower risk premia and asset price inflation, sowing the seeds of the 2008/09 financial crisis. After acquiescing in quite extreme asset price booms (the argument runs), the Federal Reserve reacted to the GFC by cutting rates too far in order to put a floor under asset prices. The subsequent maintenance of low rates for so long, despite multiplying signs of "froth" in financial markets, is blamed for increased leverage, making future financial busts more likely. (This is the asymmetric reaction criticism of the Fed, considered in Section 4)

An FT comment in October 2016 by an authoritative commentator (Sebastian Mallaby, author of a recent biography of Alan Greenspan) provides a convenient statement of this connection. He drew parallels between the current situation and that in the first half of the 2000s:

> "The cause of this [recent] alarming froth is extraordinarily loose monetary policy. The financial historian…has seen a version of this movie before. It did not end happily. A dozen years ago, Greenspan had cut the short-term borrowing rate to 1% and…[had] pushed down on long-term interest rates by guiding investors to expect a "considerable period" of low short-term rates…Faced with [a] 2016 mix of frothy markets [and] low inflation, the Greenspan Fed chose not to act. We now know this was a mistake: by 2005–06, "untoward" risks were accumulating…central banks [today] face an excruciating dilemma. Low growth and low inflation call for stimulus; markets untethered from fundamental value make stimulus seem dangerous".[6]

[6] Mallaby (2016). But note that even Mallaby recommends a leaning-against-the-wind orientation to interest rate policy only when the economy is at full employment (interview with Stephen Grenville at the Lowy Institute (2017)).

The view that financial stability worries should keep interest rates higher than justified on macroeconomic concerns is hardly new. Dennis Robertson (1928/1966), in a famous 1928 lecture at the LSE, took the (young) Federal Reserve to task for having its interest rate policy guided by what he called its Principle of Productive Credit. He quoted the FRB's 1923 Report: "The Federal Reserve system is a system of productive credit. It is not a system for either investment or speculative purposes." Discouraging speculative lending of commercial banks was the key aim of the Fed's interest rate policy. Robertson showed the fallacy of this argument, noted the danger at that time of an undesirable fall in the general price level, and proposed instead the Principle of Price Stabilisation, "the stabilisation of the price level as the sole and sufficient objective of (central) banking policy".

The Federal Reserve in 1928, however, remained true to its Principle of Productive Credit and raised interest rates to deflate a bubble on Wall Street. Keynes argued strongly against such a misguided policy. He did not believe that a stock market boom should be halted by higher rates: "a rate of interest high enough to overcome the speculative excitement," he wrote in the *General Theory, "*would have checked every kind of reasonable new investment."

No one now disputes the fact that monetary contraction deepened the Great Depression of the 1930s. Yet the predilection for higher interest rates in some central bank circles has proved to be enduring. James Meade, then Director of the Economic Section of the Cabinet Office, recounted the Bank of England's argument in May 1945 that the UK government's proposed low interest rate policy to follow the end of the Second World War would lead to excessive liquidity in financial markets. It is interesting that Meade dismissed this argument on reasoning very similar to that of Svensson. His diary record of the conversation has a very modern ring to it:

> "…I tried hard to persuade Lucius Thomson-McCausland of the Bank of England that the correct criterion for an expansionist or restrictionist monetary policy was whether the total national expenditure was showing signs of declining or rising

too rapidly. Beneath a general stability of the total national expenditure one could let private enterprise go ahead on its own…even though particular firms…would from time to time burn their fingers. But Lucius persists in thinking in terms of pools of what he calls 'flabby' money which rushes from commodity to commodity causing speculative booms and slumps, undermining confidence and thus leading to a general slump. He wishes to drain away such stagnant pools, keeping money what he calls 'taut'. But the danger is, of course, that the general process of keeping money 'taut' will maintain the rate of interest at an unduly high level so that there is a more or less permanent deficiency of total national expenditure."[7]

2. THE LAST CRISIS: PRE-2007

This section argues that the consequences of monetary policies pursued up to 2007 reinforce the argument against the leaning-against-the-wind thesis[8].

There are three reasons why higher policy rates would not have prevented the GFC:

The first is that the 425 basis point rise in the Federal funds rate from mid-2004 to mid-2006, reinforced by similar rises in other advanced economies, **did not curb risk-seeking** behaviour in global financial markets. Central banks hoped higher short-term rates would deflate financial market exuberance but they did not.

The second is that the **long-term interest rate is not determined by the policy rate**. Changes in the policy rate and expected future rates influence the long-term rate in any currency. But the pass-through to the long-term interest rate has often been incomplete. Any "story" about the policy rate and financial risk-taking cannot ignore

[7] Meade (1990), p 74.

[8] The argument that monetary-led unsustainable booms lead to permanent output losses is not examined in this paper. A recent insightful paper by Cerra and Saxena (2017) examines why post-GFC growth has been so low. Using historical data from 160 countries, they found no evidence that GDP tends to be abnormally high just before recessions. In general terms, this refutes the thesis that "unsustainable booms" tend to precede crises. In the specific 2007 case, it is hard to believe that the advanced economies as a whole had got into an unsustainable boom that central banks failed to halt in time.

questions about the weak and unstable link between the policy rate (set by the central bank) and the long-term rate. Longer-term rates in all countries with open capital markets are endogenous to *global* economic and financial developments – and not just *domestic* developments. Shifts in risk sentiment/liquidity preferences in international financial markets will often be decisive.

The third concerns the impact of higher interest rates on **the exchange rate**. Advanced economy countries that had kept interest rates well above US levels in the early 2000s – notably the United Kingdom – did not escape the financial crisis. But they ran the risk of over-appreciating their currencies. Recent work by the BIS has shown how prolonged periods of overvalued exchange rates, often suddenly reversed, create their own financial stability risks. Higher interest rates can thus destabilise the financial system.

i) A simple benchmark for the policy rate

There was no evidence in the recent cycle of any simple link between the policy rate and the usual measures of volatility or risk appetite in financial markets.[9] Graph 1 (which is an update of a similar graph in Turner (2009)) shows a simple standardised average of those financial market variables most often cited in discussions about risk appetite in markets: credit spreads (US corporate high-yield bonds and emerging market global bonds) and the volatility of core financial markets (US equities, US Treasuries and exchange rates). Virtually all measures show that risk premia and volatility continued to fall after the Federal Reserve had concluded its tightening phase in June 2006, with the Federal funds rate at 5¼%. Graph 1 shows that the simple aggregate measure of market volatility and risk spreads (red line) bears no relationship with the US policy rate (shaded histogram). Since the five components of this financial

[9] Risk appetite is not of course directly measurable. Changes in price spreads in a specific market can equally well reflect changes in the underlying risk of the specific asset. A similar qualification applies to measures based on volatility. But an aggregate measure of risk premia/volatility in many different markets provides a reasonable proxy for present purposes. In any case, the individual components used in Graph 1 moved in a broadly parallel way: see Graph A1 in Turner (2009).

market risk variable move broadly together, an alternative weighting of them would not reverse this conclusion.

The pricing of risk in the specific case of US sub-prime securitisations tells a similar story. By mid-2006 not only was the Fed funds rate at 5¼%, but an increasing share of mortgages was adjustable rate. These changes made it harder for borrowers to service their mortgages as interest rates rose and delinquencies on subprime loans began to increase. By early 2007, banks were beginning to report losses on their sub-prime loans. Yet markets were very slow to re-price these risks. Between July 2006 and May 2007 there was no deterioration in market sentiment for AAA, AA or A-rated tranches of securitisations backed by US subprime loans issued in the first half of 2006 (Ramaswamy (2017)).

The 2004–06 tightening phase was global (as expectations of the world policy rate, shown in Graph 7 and discussed in section 5 below, rose) and expected to be sustained. The long-run expectation of the world short-term rate rose by between 100 and 150 basis points. But this utterly failed to curb financial market risk-taking. This is consistent with Posen (2010): his statistical examination of a large number of earlier cases found no evidence that monetary ease was a pre-condition for asset price booms.

Nevertheless, this lack of financial market reaction came as a surprise to many. Summarising the perceptions of many central bankers, Don Kohn in 2006 coined the phrase "irrational calm" of financial markets, inverting Greenspan's famous remark. In December 2006, Larry Summers (2006) wrote a note in the FT entitled, "A lack of fear is a cause of concern", drawing attention to market complacency in the face of dramatic increases in speculative capital and in the use of credit derivatives. Eventually, it was the macroeconomic slowdown (as the US housing market turned) that preceded financial disruptions that began from mid-2007.

What can be said about the time path of the 2004–06 policy tightening? A plausible argument could be made that it was the too-smooth and too-well-announced nature

of the path of policy rate increases (i.e. the famous "measured pace" from 2004) that caused the problem. Being too predictable in increasing rates allowed banks and others to leverage positions more safely than if sharper movements in rates – more closely corresponding to the irregular movements in macroeconomic prospects? – had caught market participants by surprise. If a central bank in effect announces a future path of interest rates, it cannot complain if investors design their trading strategies accordingly. There is then reason to think that it was the too-clear intimation by the Federal Reserve of the future path of policy interest rates that encouraged excessive leverage in interest rate and other risk exposures.

The logic of this argument is plausible. Assessments of near-term economic prospects do not change smoothly enough to justify a sequence of 17 one-quarter point increases over two years. Surely new macroeconomic information would have justified a 50 basis point rise at one FOMC meeting? The reason for such timidity was that the FOMC did not want to repeat the 1994 bond market crisis, which was provoked in large part by excessive and too-sudden increases in short-term rates by an FOMC that had become obsessed with being "ahead of the curve" in fighting inflation. This plausible logic, however, faces a problem of magnitudes. If a 425-basis point rise in the Federal funds rate failed to reverse financial exuberance, is it likely that a somewhat earlier start to tightening (or more irregular movement thereafter) would have made a fundamental difference?

A simple Taylor rule versus a financial cycle-augmented Taylor rule.

One problem with the assertions that the Federal Reserve should have leaned against the build-up of financial risks before the crisis is the lack of a proposed alternative time path for the policy rate. The BIS, however, in its June 2016 *Annual Report* suggested such an alternative path guided by a Taylor rule augmented by a financial cycle proxy. The simulated effects of such an alternative path are reported in some detail (BIS (2016), Juselius et al (2016)).

To examine the plausibility of this financial cycle rule, it is illuminating to compare it with a very simple Taylor rule. With hindsight, it seems clear that the FOMC should have begun to raise interest rates well before June 2004. Many economists have come to this conclusion on straightforward macroeconomic grounds – including John Taylor himself (Taylor (2007)). One reason the FOMC did not raise rates earlier is that they waited until the macroeconomic case for raising rates had become irrefutable – and they would not have known in the second half of 2003 whether the nascent upturn would be sustained. Another reason is that Fed governors were worried that financial markets would over-react to the first rise in rates for some years, and thus risk aborting the recovery. The Federal Reserve has pointed out that such risks justify a more gradual path of rate increases than any Taylor rule would prescribe[10]. As Mallaby usefully documents, FOMC members in January 2004 were extremely worried about an out-sized reaction of markets once they would begin to raise rates.[11] But the FOMC then relaxed once markets had digested the first increase with little disturbance, and proceeded with a major but gradual tightening in monetary policy.

The macroeconomic assessments entering policy rate decisions are of course complex affairs depending on (imperfect) measurements of macroeconomic variables. Nevertheless, consideration of a very simple Taylor-type macroeconomic benchmark rule shows that some criticisms of the Federal Reserve seem unfounded. For instance, monetary policy did not "over-react" to the financial crisis: on the contrary, a quicker and greater easing would have been justified from mid-2007 on purely macroeconomic grounds. But the main purpose for using an extremely simple

[10] See the informative 4-page box "Monetary policy rules and their role in the Federal Reserve's policy process" in Federal Reserve (2017).

[11] Mallaby (2016) notes, "At their interest-rate meeting in January 2004, Timothy Geithner, then president of the New York Fed, warned of future "distortions in financial markets that can only be unwound with some drama". Mr Greenspan sounded even more worried. "When we get down to the rate levels at which everybody is reaching for yield, at some point the process stops and untoward things happen," he said grimly." The minutes also show, however, that by September 2004 (i.e. a few months after the first increase in the Fed Funds rate) the FOMC had become more relaxed. The beginning of their tightening cycle did not spook financial markets as they had feared, and the Fed continued to tighten.

benchmark (based on macroeconomic variables as we now know them) is to compare it with a rule incorporating a financial cycle variable.

To do this, this paper considers the period 2002 to 2016 as a whole – because this is when the policy of extremely low rates took root. The idea is to look for some simple statistical relationship linking the Federal funds rate to two standard macroeconomic variables over this period. This would be a way of measuring the Federal Reserve's *average* reaction over this period to the macroeconomic variables used. It cannot of course say whether the policy was correct or not: it just provides a purely macroeconomic benchmark.

The Federal funds rate during much of the post-2008 period, stuck at the Zero Lower Bound (ZLB), is not an adequate measure of monetary policy. Each of the four versions of the Taylor rule outlined in Federal Reserve (2017) would have called for a negative Fed funds rate from early 2009. The transcripts of the 17–18 March 2009 meeting of the FOMC (page 209) reveal that Janet Yellen argued that, given the "very severe recession, the optimal policy simulations would take the Fed funds rate to *minus* 6% if it could, and because it can't, I think we have to do everything we possibly can to use our other tools to compensate." At the ZLB, monetary policy stimulus did indeed take the form of asset purchases. To allow for this, Lombardi and Zhu (2013) have estimated the policy rate equivalent of these purchases – the so-called shadow policy rate. This is shown in panel C of Graph 2. In what follows, this shadow rate is used for the period November 2008 to August 2015.

The standard macroeconomic drivers of the policy rate are the degree of slack in the economy (usually measured by the ratio of real GDP (Y) to potential GDP ($\bar{Y}$) and inflation (%CP) (usually measured by the year-on-year core inflation rate). Panels A and B in Graph 2 chart the values of ($Y/\bar{Y}$) and (%CP) for the period 2002 to 2016. These are the values known now – estimates available at the time to policy-makers (especially that of $\bar{Y}$, potential output) would have been somewhat different.

The policy rate should be set according to the central bank's assessment of the **underlying** values of these 2 key macroeconomic variables. Those setting policy will not of course know at the time what is transient and what is underlying in macroeconomic data becoming available. So the central bank does not change the policy rate solely on the basis of the value of these variables in the current quarter. For the sake of simplicity, a simple average of measures for the current quarter, and the two preceding quarters is taken as a proxy for the underlying movements in these variables.[12] The idea is to compute what only these 2 macroeconomic variables would imply for the Federal funds rate in the simplest possible way. Three quarters of data should be enough for the central bank to work out what the macroeconomy is doing. This is, of course, backward-looking: had the Federal Reserve known in the first half of 2008 how sharply output would decline in 2009, bringing core inflation to around 1%, it would have cut rates more drastically.

Note that no central bank preference for interest rate smoothing is imposed (that is, no lagged dependent variable). Interest rate smoothing for its own sake (e.g. no more than a ¼ percentage point change at any meeting) – rather than as a practical response to uncertainty about the true underlying values of the macroeconomic variables it is targeting – opens the central bank to the criticism of "being behind the curve". Note further that at the intercept term does not change over time. It would fall if the natural rate were declining over time so that the Fed would have to raise interest rates by less. Graph 4 below shows estimates by Fed economists showing that the natural rate has declined.

The equation for the nominal Federal funds rate using the Lombardi-Zhu shadow rate for the QE period (FFLZ for short) estimated over the period 2002 Q2 to 2016 Q2 is equation (1) in Table 1. Equation (2) is identical except for the addition of a variable for risk. This is the risk aversion/volatility variable shown in Graph 1. It is significant at

[12] The coefficients in the estimated equation reported in Table 1 are not sensitive to small variations in this lag.

the 10% level, but it does not much affect the coefficients on the macroeconomic variables. Once allowance is made for macroeconomic determinants, therefore, there is no evidence that the Federal funds rate changed in response to what were very sharp changes in financial market risk appetite. But it may suggest that the Fed's macroeconomic assessment took account of financial variables in addition to the output gap and core inflation.

Regressions of the Federal funds rate Table 1

	Constant	Ln(Y/Ȳ)	%CP	RISK	R^2	Period of observation
(1)	–0.22	0.76	1.81		0.74	2002Q3–2016Q2
	(1.57)	(0.15)	(0.76)			
(2)	–0.81	0.89	1.65	0.335	0.75	2002Q3–2016Q2
	(1.60)	(0.16)	(0.80)	(0.174)		
(3)	–0.63	0.86	3.16		0.39	1995Q1–2004Q2
	(1.67)	(0.12)	(1.0)			

Note: Figures in parentheses are Newey-West standard errors.

Both independent variables in equation (1) are significant. A decrease in economic slack by 1% of potential GDP leads to an increase in the policy rate of 0.76 points. And a rise in core inflation of 1 percentage point adds 1.81 points to the policy rate. This suggests a reaction similar to Taylor's original rule (1.5 for 1) and shows that the Fed took its low inflation mandate seriously.

The dotted line in panel C shows the predicted value of FFLZ. The first remark is that this predicted value of the Federal funds rate peaks at 4% in the first half of 2006, when the Y/ Ȳ variable reached its highest value of the decade and core inflation was above 2%. The actual peak of the Federal funds rate is higher – 5¼% – and came later. The narrowing in economic slack began in mid-2003, followed by a sharp rise in core inflation from early 2004: these macroeconomic developments suggest that, with the advantage of hindsight, the first increase in the Federal funds rate (from an exceptional level of 1%) should have come earlier.

The fact that the 5¼% is above the fitted line (which suggests about 4%) does not necessarily have much economic significance. The nature of statistical regressions is that extreme values usually lie outside the regression line. Nevertheless, some market commentary at the time did suggest that that Fed had gone too far in its tightening. Sundaresan (2016) using a term structure model shows that the market has been expecting a rate cut from early 2006. This may well suggest a pattern of "too much, too late", which has often characterised monetary tightening phases in the past.

The second observation concerns the sharp decline in output from the second half of 2008 to late-2009 and the steep drop in core inflation. The fitted value of the Fed Funds rate falls by about 600 basis points, but the actual cut was "only" 400 basis points (using the Lombardi-Zhu shadow rate). Recall Graph 1 above: the period when financial markets were most disturbed was from late-2008 to around mid-2009. So it does not appear to be true that, over this period, extreme financial market conditions led the Federal Reserve to inject more monetary stimulus than macroeconomic conditions warranted. On the contrary, hindsight would suggest that greater stimulus applied earlier would have been justified on macroeconomic grounds.

To examine the sensitivity of the estimated coefficients to periods of estimation that exclude the pre-crisis tightening phase, equation (1) is re-estimated over the 1995–2004 period (i.e. before the peak), and is equation (3) in Table 1. Using the coefficients from this period gives a higher predicted Federal funds rate throughout the whole period. But the shape of it is very similar to the first fitted line because the same independent variables are statistically significant (Graph 3). The earlier conclusion that macroeconomic variables suggest earlier tightening (starting in mid-2003 rather than mid-2004) and much bigger cuts earlier from late-2008 stands.

The predicted value of the Federal funds rate estimated over the 1995–2004 period is, by mid–2016, about 200 basis points higher than the predicted value estimated using the 2004–16 estimation period. One interpretation of this is that the Federal Reserve has become more lax. A rejoinder to this interpretation is that the real natural

interest rate in the United States has fallen by 200–250 basis points over the past decade (Graph 4) – so that it is changed economic conditions that justify the lower rate. And subsequent low rates of inflation hardly suggest prolonged monetary laxity.

The third observation is that, from early 2011 to mid-2012, macroeconomic indicators suggested a need to scale back exceptional monetary expansion: the worst of the recession passed and core inflation rose. The Lombardi-Zhu measure of the Federal funds rate did indeed rise although, once again, later than the fitted equation would have suggested. The reinforcement of QE in late-2011 (reflected in a decline of the Lombardi-Zhu Federal funds rate to –4%) was due to the sharp deterioration in global growth prospects as the euro area's existential crisis deepened. With the end of QE (in the sense of halting further increases in the Federal Reserve's stock of bonds) in October 2014, the shadow Federal funds rate rose broadly in line with the fitted equation. Thus monetary stimulus was gradually reduced as macroeconomic conditions improved.

Graph 5 shows the hypothetical Federal funds rate put forward by the BIS as following a financial cycle-augmented Taylor rule. The financial cycle proxy is the deviation of the debt service burden from its long-run equilibrium (BIS, 2016). The main characteristics of this financial cycle-driven hypothetical rate can be briefly summarised. The hypothetical rate rises earlier than the actual rate so that, by the second quarter of 2004, is 2.89% (compared with the actual 1.1%). And the peak of this hypothetical Federal funds rate (only 3.5% in mid-2005) is well below the actual peak of 5¼%, which was reached in 2006. Finally, the simulation makes the (strong) assumption that the financial crisis would have been avoided if the Federal Reserve had lent against the financial cycle in the way suggested. This would have resulted in a gain of about 1% a year in US GDP over a decade or so, or 12% cumulatively.

Three observations about this calculation. A first observation is that the movement over time – that is, the cyclical response – is remarkably similar to the profile suggested by the very simple Taylor rule. This can be seen from the Graph, and is confirmed by

the high R^2 of a simple regression of one fitted rate on the other[13]. This suggests that the financial cycle proxy does not explain much of the time profile of their hypothetical interest rate.

The second observation is that the hypothetical rate derived from a financial cycle-augmented Taylor rule does not vary much over time. It is much less responsive to the macroeconomic variables than the simple Taylor rule. For a Taylor-rule implied rise of 100 basis points, the hypothetical rate would rise by only 68 basis points.

The third observation is that the hypothetical rate takes no account of the policy stimulus from QE during the period when the Federal funds rate was close to zero. The simple Taylor-rule type estimates reported above makes use of calculations which translate Fed balance sheet expansions, at the ZLB, into an equivalent negative "shadow" policy rate. The average of the adjusted Fed funds rate over the observation period is therefore lower than the average of the actual rate, constrained by a zero lower bound. This difference raises the hypothetical rate during the ZLB period by an average of about 1.5 percentage points above the shadow policy rate used in this paper. The evidence in the previous section was that the large pre-crisis increase in the Fed funds rate failed to constrain financial risk-taking. It is therefore doubtful that the small difference between the hypothetical Fed funds interest rate path and the actual one from mid-2003 to mid-2005 would have been large enough to have prevented the financial crisis.

(ii) The long-term interest rate

The second objection to the L.A.W. thesis is that it ignores the fact that key market rates – particularly the long-term interest rate – are endogenous. They are not (normally) set by the central bank by administrative fiat. The substantial increases in

[13] An OLS regression of the hypothetical interest rate on the fitted value (FITTED) of equation (1) in Table 1 and (standard errors are shown in parentheses) is:
0.65FITTED (0.02) + 1.56D (0.32) + 0.95. R^2 = 0.68
where D is a dummy variable equal to 1 from November 2008 to August 2015 (when the shadow rate was negative) and zero otherwise.

the Federal funds rate from mid-2004 to mid-2006 left the US long-term interest rate unchanged – Greenspan's famous conundrum – as global forces (global savings glut, global banking glut, the preference for "safe" asset such as US Treasuries etc) drove down the term premium (Graph 7, panel A). (There is, however, one QE-related monetary policy dimension that seems to have played a role in the early 2000s: the shortening in the maturity of US Treasury issuance, discussed briefly below).

Panel B of this graph shows a recent estimate of the "world" long-term interest rate prepared from macro-financial models using data from the euro area (using French data) and the United Kingdom as well as that of the United States. Policy rates in most advanced economies rose broadly in parallel with US policy tightening. The long-run expectation of the world policy rate (that is, expected on average over the subsequent decade) rose from 3.3% at the start of 2004 – when strengthening US growth led to market expectations that Federal Reserve rate increases were imminent – to a peak of 4.5% by mid-2007 (see Graph 7, panel B and, for the monthly data, Annex 3 of Hördahl et al). Thus the Federal Reserve's tightening of monetary policy was expected to be sustained for years and was shared by all advanced economies. Markets revised up their long-run expectations of nominal short-term interest rates by almost 150 basis points. Yet this failed to stop the build-up of financial risk-taking charted in Graph 1. In a sense, this period can be thought of as an experiment in an internationally co-ordinated L.A.W. since all were worried about financial excesses but none faced large inflation threats.

But it did not work. Instead, what financial markets delivered was a decline in the term premium – which can be thought of as a risk premium for holding long-term bonds rather than a series of short-term bills – to around zero by mid-2005. As discussed below in Section 5, it was the decline in the term premium that seems to have been behind the global decline in real long-term interest rates since early 2010. In addition, the term premium was key for the international transmission of interest rate shocks (Hördahl et al (2016)).

Finally, note one important, if overlooked, monetary policy influence on the long-term rate that explains part of Greenspan's conundrum: the shortening of maturity of government debt sold to the market. As fiscal deficits grew at that time, US Treasury policy was to concentrate new issuance at the shorter end. Any policy that lowers the average maturity of government bonds held outside the central bank (whether done by central bank purchases of bonds as recently or by changes in Treasury issuance as in the early 2000s) tends to reduce the long-term interest rate. The average maturity of US Treasuries fell from 70 months in late-2001 to a low point of 56 months in March 2005, just after Greenspan made his remarks. According to Chadha et al (2013), this reduced 10-year yields by between 150 and 170 basis points. Hence part of the explanation of Greenspan's conundrum is US Treasury-implemented QE! This came on top of the expansionary impetus from sizable increases in the Federal budget deficit (tax cuts from 2001 and the second Gulf war from 2003).

(iii) The exchange rate

The third objection to raising interest rates to curb domestic financial excesses is that it could lead to an unwarranted appreciation of the currency. The comparison between Bank of England policy (which was to keep the UK policy rate well about the Fed funds rate) and Bank of Canada policy (which was to follow US rates) is particularly instructive.

During the time the Federal Reserve held the Funds rate at 1%, the Bank of England kept Bank rate in the range 3½% to 4½%. They did this even though core inflation remained below 2%, and lower than the United States. The macroeconomic consequences of a very powerful property boom fuelled by debt seems to have made the Bank of England reluctant to lower rates. (See the Section 4 below on how developments in property and financial asset prices can affect the central bank macroeconomic assessments by providing information that is often absent in the standard macroeconomic models used by central banks).

The UK began the 2000s decade with sterling overvalued (suggesting a need to cut rates) and house price inflation very strong. The Bank of England's Monetary Policy

Committee in February 2000 agreed that, "it would be preferable to have a lower exchange rate and higher interest rates from the point of view of economic conditions and balance more generally." It raised Bank rate by 25 basis points and considered, but rejected, forex intervention. With mounting losses and closures in the tradable sector (especially manufacturing), the central bank came under strong pressure from businesses and unions to cut interest rates and lower the exchange rate (Brittan (2000)).

Given strong domestic demand, continued rises in house prices and a rise in core inflation from zero to 2%, however, the Bank of England did not follow the sharp cuts in the Federal funds rate during 2001. By mid-2001, the UK had the highest real short-term interest rate in the G7. Although core inflation declined, the Bank of England kept Bank rate at 4% for all 2002. The MPC minutes of October 2002 said that one reason for not cutting rates, with the economy growing close to potential, was that cutting interest rates would mainly have the effect of further boosting house prices and household borrowing which were already increasing strongly. The macroeconomic rationale put forward in the minutes was that the sudden unwinding of an unsustainable increase in debt would "increase the risk of undershooting the inflation target in the medium term."[14] Stephen Nickell dissented from this reasoning centred on house prices and voted for a rate cut at this meeting: without an interest rate cut, he argued, inflation was likely to undershoot target throughout 2004 (Nickell (2005))[15]. From late-2003 (after Bank rate had been cut to 3½% earlier that year), there was a renewed tightening with rates reaching 4¾% (by mid-2004: see Graph 6, Panel A).

[14] Note the phrase "medium-term". One Bank of England official explained to the BBC's economics correspondent in 2003 that the Bank was keeping "interest rates a bit tighter because we are worried about … financial imbalances creating problems beyond the two-year horizon of our inflation target" (see pp 192-93 Peston (2012)). Nickell rejected this argument because he did not believe the assertion of the putative effect on inflation over the period beyond the two-year horizon, and said that no evidence had been provided to support this assertion.

[15] Nickell also reports a simulation suggesting that eliminating the surge in house price inflation in 2003-04 would have required a 300 basis points rise sustained for 13 quarters.

This sustained a substantial appreciation of sterling against the dollar (see Graph 6, Panel B).[16] The real effective exchange rate remained well above historical levels. What prevented the Bank of England from following US rates down was not the risk of failing to meet their inflation target: core inflation remained well below 2%[17]. It was worries about the apparently inexorable rise in house prices – and the rising household indebtedness associated with it – that kept Bank rate up. This was not because of any explicit L.A.W. policy – indeed MPC members disavowed any such policy orientation, stressing their inflation-targeting framework – but because of the macroeconomic implications of a debt-financed house price boom (as noted in Section 4 below, this also appears to have been the reasoning of the Reserve Bank of Australia: see Macfarlane (2002)).

Focussing on the prices of property or domestic financial assets has the added drawback of ignoring the macroeconomic and financial stability risks of excessive currency appreciation. Currency appreciation can reduce fixed investment in the tradable sectors, and limit future capacity. Currency appreciation also tends to stimulate private consumption, and may even persuade households that their permanent income has risen. They feel they can borrow more. And the banks think that local borrowers have become better risks. Borrowers with foreign currency debts (e.g. in an emerging market) see their balance sheets strengthen when the currency appreciates, and banks are willing to lend them more. Historically credit expansions and currency appreciation have indeed gone together, suggesting that they actually reinforce each other (Gourinchas and Obstfeld (2012)). The model developed by Bruno and Shin (2014) has currency appreciation making the balance sheets of local borrowers appear even stronger, encouraging banks to lend them even more. When

[16] Once Federal Reserve tightening had reduced the gap between US and UK policy rates, sterling fell against the dollar.

[17] This describes the ex post developments. Monetary policy settings are determined by forecasts of inflation, and such forecasts are not reviewed here.

this risk-taking channel of currency appreciation is strong, lowering the policy rate can actually make the financial system safer (Hofmann at al (2015)).

In any event, there can be no doubt about the rigour of UK monetary policy in the years before the GFC. The UK kept short-term rates above US rates until 2006 – but this did not protect them from the GFC. Some UK banks were reckless, especially in their investments in US assets notwithstanding their higher (local) interest rate environment. The Bank of Canada's interest rate policy was the opposite to that followed by the Bank of England. By mid-2003, they also had policy rates well above US levels. But thereafter, facing an inflation outlook very similar to the UK, they cut rates aggressively, and kept them low until late-2005. (An additional factor was that the rise in oil prices was already pushing up the Canadian dollar). Low interest rates, however, did not induce their banks to become overextended. This was because of much stricter regulation pre-crisis (notably the existence of a leverage ratio and limits on banks' off-balance sheet exposures to securitised products) and because a less contestable domestic banking market allowed fatter margins. Canadian banks weathered the crisis much better than UK banks despite Canada's closer financial and economic links to the United States, which was at the centre of the GFC. Following US monetary policy did not create a crisis for the Canadian banking system.

One final observation is that this international dimension qualifies Stein's famous remark on monetary policy "gets in all the cracks" which regulation can miss. It does not apply in an open economy where monetary conditions depend not only on the local policy rate but also on the world long-term rate and on the exchange rate. Because easy global financial conditions can push the long-term interest rate below, and the exchange rate above, its long run equilibrium level, "domestic monetary policy does *not* penetrate all risk-taking channels and institutions" as Tucker (2014) memorably put it. Supporting this view, Landau (2013) analyses the many ways that global liquidity, the quantity dual of low real interest rates, can affect domestic financial conditions irrespective of the exchange rate regime in place.

3. REGULATORY AND MARKET FAILURES

The conclusion is that US monetary policy – in the sense of the setting of the Federal funds rate – was not a major factor behind the GFC. Hence the idea that the monetary policies pursued by the largest economies since 2010 are just "repeating their mistakes before the GFC" is not convincing. There is no reason for supposing that a plausible alternative path for the Fed funds rate from 2003 would have prevented that crisis. Nor is it clear how a different path for the overnight rate would have affected the long-term rate (which is endogenous to financial and macroeconomic developments). As for other central banks, the Bank of England's policy of keeping Bank rate much higher than US rates did not spare their banks from the crisis. It is difficult to quarrel with the conclusion of Yellen (2014) that "there is no simple rule that can prescribe, even in a general sense, how monetary policy should adjust to shifts in the outlook for financial stability". In any event, as de Gregorio noted, soaring asset prices do not necessarily end up in a crisis.

We now know that the GFC reflected primarily microeconomic and regulatory failures: Bayoumi (2017), Shafer (2013), Stgilitz (2010) and Wolf (2014) provide lucid expositions of this history. Central bank governors had understood by early 2006 that substantial rises in their policy rates were failing to curb financial excesses. Trichet (2008) reminded *Financial Times* readers that he, in his press conferences as Chairman of the global economy meetings of central bank governors at the BIS, had repeatedly during 2006 and early 2007 relayed to market participants the consensus of central banks that financial markets had become over-extended. He urged them to prepare for a significant correction. Central banks had prepared the ground by raising interest rates substantially as economies neared full employment but markets remained complacent.

The problem was that official bodies with operational responsibility for banking supervision (not always central banks) were too laissez-faire in their attitude to

financial innovation. And several aspects of regulation actually encouraged a demand by financial firms for AAA-rated bonds on a scale that surpassed the supply of government or corporate bonds by AAA-rated entities. Bank regulators acquiesced as banks manufactured AAA-rated securities on the back of risky credits[18]. The credit-rating agencies, enjoying the increased fee income that ratings for new debt structures earnt them, were also lax. The financial stability risks were clear and indeed the subject of several detailed BIS reports from 2003. But there was no agreement among central banks about what to do[19]. Faced with the difficulty of understanding the full long-term consequences of innovation, regulators in most advanced economies too readily gave the benefit of the doubt to the banks and the markets. Regulators in the developing world were tougher: the former Governor of the Reserve Bank of India (RBI) points that, if the RBI found the benefits of an innovation were not convincing enough, it would be banned or subject to restrictions (Reddy (2013))[20].

The Basel Committee fell into this laissez-faire trap. In putting far too much trust in risk weights based on banks' own internal models and in stress test results provided by the industry, it made two major mistakes in Basel 2. It allowed very light capital requirements both for securitised products held on bank balance sheets and for credit

[18] In particular, accounting rules and regulations for pension funds increased the demand for highly-rated fixed-income securities. The zero or very low risk-weights for AAA-rated asset-backed securities (ABS) under Basel 2 encouraged banks and others to manufacture new AAA-rated ABS on the back of risky credits. The share of ABS in total bond issuance rose dramatically from 2001, peaking only in 2006. The share of floating-rate bonds in ABS issuance was much higher than for other bond categories: yet the substantial rise in short-term rates from mid-2004 did not stop this boom. For a statistical summary of the elastic supply of AAA-rated paper, see pp 29-33 of Turner (2014).

[19] The first such report of a working group of G10 central banks was on credit risk transfer, published in January 2003 (BIS, 2003). The consensus of that report was that CRT could create new risks, notably in concentrating risks in a non-transparent way. One central bank, however, decided to add a note of dissent that such worries were unfounded: "One view was that the experience of financial institutions in recent years illustrated that CRT mechanisms had worked successfully to disperse credit risk more widely".

[20] See also the Per Jacobsson lecture of Reddy (2012) for a powerful statement of the importance of central banks avoiding capture by the private sector. The relaxation of regulations on banks under strong pressures from the industry can create large risk exposures and, especially in developing countries where the real economy is often over-regulated, may lead to a misallocation of resources.

commitments given to off-balance sheet vehicles holding such products (Ramaswamy (2017)). It was the sizable investments of European banks in US mortgage-backed securities and other securitised products that helped to drive down the spread between the yield on such risky products and that on US Treasuries (Bertaut et al (2011)). Smaller US banks, which never adopted Basel 2, were not affected by this regulatory change. The Basel Committee was well aware of these shortcomings before the crisis broke, and discussions about how to fix them were already underway. "If only they could have waited a bit before starting the crisis" was the ironic comment in September 2007 of one member of the Basel Committee.

Banks made the securitisation of debts ever more complex so that their very opacity would induce buyers to overpay for the resultant products. This proved for a time very profitable. In other words, they deliberately exploited the *information asymmetries* that lie at the heart of the banking business. There was also a *classic agency* problem: traders took risky positions which earnt them handsome bonuses but left banks holding large losses. Finally, there was *moral hazard* because banks were too big to fail. Stiglitz (2010), who did so much to make economists aware of these market failures, underlined that at the centre of the GFC was the failure to understand the economics of securitisation and the nature of systemic risk.

"The culprit," de Gregorio concludes, "was unrestrained financial innovation that generated deep distortions that neither markets nor regulators were able to predict." Market failures mean that normal competitive forces cannot be counted on to produce a level system-wide leverage consistent with stability. The policy response to this is more effective regulatory oversight, and this indeed shaped the post-crisis policy agenda.

To limit the post-crisis decline in aggregate demand, the burden fell on more and more expansionary monetary policy. After expansionary measures in 2009, fiscal policy became restrictive in most advanced economies. This macroeconomic policy choice meant seeking to curb the rise in government debt while favouring higher private

sector indebtedness. Shirakawa (2015) is worried about the longer-term damage higher private indebtedness could do, either through future financial stresses or through the lower propensity to spend of very indebted households. He does not believe that raising the policy rate by x% to reduce financial imbalances would be the correct way of formulating the links between monetary policy and financial stability. He is rather concerned that markets could come to believe that the policy regime has become a "put-option type of monetary policy" if central banks react too readily to declines in asset prices.

The Japanese predicament, not considered in this paper, where very high government debt is combined with a massive scale of QE (much greater as a proportion of GDP than in the United States) is special. But the view that US monetary policy has amounted to a put option supporting equity and other asset prices is not longer tenable (if it ever were). In the 30 years since the 1987 stock market collapse, the Federal Reserve held interest rates up on several occasions after sharp declines in equity prices (e.g. after October 2008). And it is very difficult to believe that the strong rise in equity prices this year (2017) reflects a market belief that "the Fed would step in to support prices" because most market commentary now focuses on how little room the Fed has to cut rates. If anything, US monetary policy has in recent years operated like a short-seller's stop-loss order, with tightening on the agenda whenever inflation threatens to exceed 2% (Garcia (2017)).

An alternative to the too-lax-US-monetary-policy thesis as the fundamental driver of higher debt/income ratios is that the main driver is the rise in the desired financial asset/income ratios as the population ages. If desired wealth exceeds the debt that the productive sector needs to issue to finance fixed capital formation given a decline the marginal product of capital (e.g., due to slower trend growth and the limited scope for further capital deepening), the natural interest rate could be negative (von Weizsäcker (2013)). The decline in the real long-term rate of interest over many years suggests

that ex ante demand has tended to rise more strongly than ex ante supply, which is consistent with von Weizsäcker's thesis.

In such circumstances, expansionary fiscal policy might be the right policy choice. In any event, higher government debt is a safer choice than the increased private debt engendered by very expansionary monetary policy (Poloz (2016)). Although the government debt/GDP ratio did tend to rise in the advanced economies, much of this reflected a recession-induced loss of tax revenue. Once account is taken of such cyclical effects, fiscal policy was actually very restrictive from 2011 to 2015.[21] As discussed further in section 6 below, regulation has probably added to the downward pressures on the long-term interest rate by encouraging institutional investors to move out of equities into debt securities (Claessens (2016)).

Two observations follow from considering the asset side of the balance sheet as well as their liabilities. The first is that any interest rate change is likely to affect both the asset and the liability side of the balance sheet. In a closed economy, households hold as assets much of the debt of other households (including indirectly through financial intermediaries). Because the government is a net debtor, private sector liabilities will be smaller than their assets. The second consideration is that, if the financial asset/GDP ratio continues to rise, and if one is worried about the risks of borrowers becoming more highly leveraged, then one policy challenge is to get investors to hold a higher proportion of their assets in equity claims.

4. FINANCIAL MARKETS, ASSET PRICES AND MACROECONOMIC FORECASTS

[21] Over the 5-year period from 2011 to 2015, fiscal policy was strongly contractionary. The IMF estimated that the cyclically adjusted budget deficit of the advanced economies as a group was reduced by a cumulative 4% of GDP, with the reduction in the United States amounting to 6% of GDP. See Skidelsky (2017). Akyuz (2017) notes that governments did not even spend the fiscal dividend from QE: by the end of 2012, reduced debt service costs and increased profits remitted by central banks amounted to a total of $1.6 trillion for the United States, the United Kingdom and the euro area.

Monetary policy is guided by forecasts or expectations of an uncertain macroeconomic future. Asset market variables (including house prices) and indicators of financial market conditions contain information about expectations of that future. The problem is that such variables are not usually incorporated in the macroeconomic models used by central banks in setting monetary policy. This may mean that macroeconomic forecasts may have a downward bias during financial booms and an upward bias during financial slumps.

Because of this bias, inflation-targeting central banks will take account of asset market developments. One illustration of this is the Reserve Bank of Australia's response to the very strong Australian real estate boom in the early 2000s – which often incorrectly hailed as an example of "leaning against the wind". Financial deregulation and innovation (including the securitization of mortgages) had made it much easier and cheaper to get a mortgage. A reduction of the tax on capital gains from property further supported the boom. Over a period of five years, house prices doubled and debt-to-income ratios followed a similar trend. From mid-2002, the Reserve Bank of Australia began to increase its policy rate. How did the Governor, who was worried about this debt-financed property price boom, justify the decision to raise rates? His statement read, "To persist with a strongly expansionary policy setting would risk amplifying inflation pressures and, over time, could fuel other imbalances such as the current overheating in the housing market, potentially jeopardizing the economy's continued expansion" (Macfarlane (2002))[22]. He did not say that rates were going up to preserve financial stability. He did say rates were low for an economy growing very strongly. Although the inflation forecast was not calling for an immediate rate rise, he did not want macroeconomic stability in the future to be undermined by keeping the policy rate below normal for too long. The economy continued to expand.

The challenge in less extreme circumstances is to translate generalisations about the macroeconomic consequences of financial booms into specific policy

[22] Ellis and Littrell (2017) give a full account of specific actions taken by the bank regulator (APRA) which ensured that Australian banks entered the GFC with a "sounder and better capitalised home loan portfolio". The steady interest rate increases of the RBA were "justified by generally strong economic conditions".

recommendations. To do this, much more needs to be known about how the link between financial market variables (for example, equity prices, bond spreads (Stein (2014)), financial sector leverage (Woodford (2012)) and so on) and growth prospects. Financial variables therefore help central banks make their judgement calls on macroeconomic forecasts: as noted above, this may explain the (weak) significance of the RISK variable in Table 1.

One prominent variant of the L.A.W. thesis is the "asymmetric reaction" argument. This is that the Federal Reserve willingly countenanced quite extreme asset price booms (e.g. in the late 1990s) but then cut rates whenever prices fell sharply. Such asymmetric policy reactions, some believe, have been responsible for a sequence of financial crises. Hannoun and Dittus (2017) document the BIS's repeated criticism of the "fundamental asymmetry in the conduct of monetary policy which induces a downward bias in interest rates and an upward bias in debt."

According to this line of argument, the central bank should have paid more attention to asset price increases. It is true that changes in asset prices (and other financial information) contain information that can correct shortcomings in conventional macroeconomic models. Yet this is much more likely to be the case during sharp downturns than during upturns. A generalised fall in asset prices (or widening in credit spreads) is almost always sharper than the preceding rises. Graph 1 above shows that developments in the years before the GFC followed this general pattern. The financial upswing phase (credit spreads narrowing and volatility declining) was gradual but the reversal from April 2007 was sharper. A financial downswing tightens budget constraints for a large number of debtors simultaneously. This *forces* spending cuts and leads banks to tighten credit supply quite quickly and in unison. By contrast, rising asset prices only allow (not force) increased spending. And because the price volatility of financial assets usually rises in a falling market, market positions tend to be adjusted more abruptly than in a rising market. Behavioural economics might illuminate this, especially the idea of loss aversion from psychology -- people seek to

avoid losses more keenly than achieve gains (Kahneman (2012)). In any event, there are reasons why declines in asset prices will have a stronger effect on the economy than do increases in asset prices. If so, an asymmetric policy reaction can be optimal and not, as advocates of L.A.W. often contend, a symptom of policy laxity.

This issue was much debated from the late 1980s. It was explored twenty years ago, by my late BIS colleague Palle Andersen. He showed in a careful econometric analysis that financial variables can indeed account for errors in forecasts produced by standard macroeconomic variables in "bad" times (ie asset prices falling). This suggests it is wise to adjust macroeconomic forecasts downward in the wake of a sharp fall in asset prices (and to change monetary policy accordingly). But Andersen also found that financial variables did not account for forecast errors during "good" times suggesting no need to adjust forecasts or monetary policy (Andersen (1997)). The GFC showed that a sudden rise in credit spreads and the increased risk aversion of banks depressed GDP much more than standard macroeconomic models had predicted. Hall (2011) showed how a sharp rise in financial frictions (creating a wedge between what savers receive and borrowers pay) has a very sizable macroeconomic effect. A recent comprehensive study by the IMF found that their Financial Conditions Indices contain powerful signals about downside tail risk to the global economy but are less informative about the baseline growth forecast and about booms (IMF, 2017). Farmer (2013a) shows how important the stock market crash was in causing the recession after the GFC.

How far any extreme disruption in financial markets should over-ride macroeconomic forecasts was a deeply controversial question in the summer of 2007. Risk aversion in global financial markets had risen sharply (cf Graph 1). Major banks were finding it difficult to fund themselves in wholesale markets, and worries that this could worsen forced even apparently strong banks to cut exposures. There were fears that some large banks might fail. Overnight LIBOR had risen from 5.3% in May to 6% by August, and this was but the tip of the iceberg. Many at that time, especially those

with close knowledge of how crippled the banks really were, judged the 50 basis point cut in the Fed funds rate on 18 September as insufficient.

Martin Feldstein (2007), in a prescient final summary of the annual Jackson Hole conference at the beginning of September, argued for a more aggressive cut (of up to 100 basis points). He gave two reasons for his recommendation. The first echoed Andersen: financial forces such as the disruption in credit and banking markets were "inadequately captured by the formal macroeconomic models used by the Federal Reserve and other macro forecasters." In particular, model-based projections inevitably underestimated the serious risk of a big decline in GDP. The second reason was that making a mistake on inflation at that juncture would be the "lesser of two evils": the Fed should persuade markets that such a risk-based approach in cutting rates with current inflation still high was not an abandonment of "its fundamental pursuit of price stability".

Some in the markets at that time expressed nostalgia for the Greenspan reign. In a September 2007 interview with the *Financial Times,* however, Greenspan took pains to stress that, given what he saw as significant inflation risks, he would not have cut interest rates more aggressively than the Bernanke Fed (Greenspan (2007)). On 31 October, the FOMC cut by only 25 basis points. The mistake the Fed made was failing to cut rates more quickly in the early months of the crisis – quite contrary to the assertion that the Fed is always too eager to cut when financial markets weaken. Equity markets were also slow to recognise the macroeconomic fallout of the unfolding banking crisis: US equity prices continued to rise until early October.

A second mistake of central banks was the failure to recognise the severity and the persistence of the global scramble for liquidity set off by the GFC[23]. Governments in the advanced economies, aware of the political unpopularity of banks, failed to make

[23] Sinclair and Allen (2017) argue that this was aggravated by new financial regulations that impaired banks' capacity as market-makers and by national policies that impeded international banking flows. This intensified demand for safe and liquid assets (including the reserves accumulation of EMEs) must have weakened global growth in the post-crisis period.

clear immediately that they stood "100% behind their banking systems" (Pringle (2014))[24]. How well central banks exercised their lender-of-last-resort responsibilities in the early stages of the crisis will be an important question for economic historians. In a hard-hitting review of the UK's fumbling over the failure of Northern Rock in September 2007 (a highly leveraged mortgage bank that was too dependent on wholesale funding), Hanke (2017) blames the refusal of the governor of the Bank of England to provide a large standby loan to support a takeover by a stronger bank[25]. But King had legitimate reasons: the solvency of Northern Rock was far from assured and the government itself had delayed offering a State guarantee for Northern Rock's deposits until forced to act by chaotic scenes of panic. In his analysis of the lessons from the crisis once he had left office, King (2016) put particular emphasis on the need to modernise Bagehot's concept of the lender-of-last-resort function of central banks. Ways have to be found to get banks take more responsibility for managing the liquidity of their own balance sheet before a crisis. He proposed the central bank be a "pawnbroker for all seasons", lending at pre-determined haircuts on a wide range of assets held offered as collateral. The commercial bank would have to decide which assets it would pre-position with the central bank as collateral in order to borrow at a moment's notice. This policy proposal is considered further in Section 7.

Liquidity strains on banks increased from mid-2007. Worries about a supply-determined credit crunch only increased as global financial stress spread. The composite measure of risk aversion shown in Graph 1 remained elevated. Banks knew they could not borrow easily in money markets: they had to reduce their credit-risk exposures and to make their balance sheets more liquid. The forces emphasised by

[24] Pringle correctly points out that, while stronger liquidity support would have reduced the costs of the crisis, banks still needed more capital.

[25] Once a run on that bank did develop later that month, the Bank of England did lend heavily See pp 170-74 of Hanke (2017). He says that all the FSA's senior staff and Paul Tucker of the Bank of England were in favour of such a facility before a run developed. But at a meeting on 7 September, Governor King was adamant that it was not the job of the central bank to support commercial take-overs.

Feldstein in September 2007 only grew in strength. But this strong deflationary prospect did not lead to an immediate fall in inflation, and oil prices in particular rose. In July 2008, the ECB committed an error (which it was to repeat in 2011) of raising interest rates "despite mounting political opposition and increasing signs of a contracting European economy"[26]. There was a similar debate inflation versus negative demand shock in the United Kingdom, where the Bank of England had been raising rates steadily up to July 2007 (5.75%). Subsequently, there were public calls for sharper cuts[27]. By the time of Lehman's failure, however, Bank rate was still at 5%.

The balance sheet policies of central banks from August 2007 until 2009 or so – which at the time shocked everybody by their sheer size – actually took rather traditional forms. They mainly involved lender-of-last-resort lending to banks and action to keep some key short-term markets liquid. With hindsight we know that such policies, less radical than what eventually followed, were not ambitious given the magnitude of the financial shocks. The Lombardi-Zhu estimation shows that the Fed's balance sheet policies reduced the shadow Fed funds rate in a large and durable way only from the second half of 2010[28]. The term premium in 10-year US Treasuries actually rose (by about 100 basis points) from the onset of the crisis until early 2010: the purchase of long-dated assets on a big scale could have reduced this premium.

Looking at the GFC through the lens of the Freidman-Schwartz monetary contraction thesis for the Great Depression, Congdon (2017) notes the sharp decline in the growth of broad money in the euro area, the United Kingdom and the United States. Challenging the official narrative, he asks whether it was this "crash in money growth" that explains the long global slump. But distilling the fundamental monetary

[26] The quotation is from "ECB raises interest rates to 4.25%" in *The Guardian* of 3 July 2008. The article said that France, Italy and Spain already faced a downturn and that euro area exporters feared this move could drive the euro above $1.60.

[27] Cable (2010), who understood the dilemma the Bank of England faced given continued high inflation, called for a cut of 200 basis points.

[28] In 2008 and 2009, fiscal policy of the advanced economies was expansionary but was contractionary from 2011 to 2015.

policy dimension of sharp changes in money growth is difficult at times when the regulation of, or the appetite of banks for, lending is changing. Banks that had become over-extended before 2007 had to make their balance sheets safer by reducing loans relative to deposits and by issuing more equity and long-term debt: such measures reduce broad money. Bank of England economists show that the positive impact of QE on money growth was therefore much smaller than the value of Bank of England asset purchases (Thomas (2017)).

In any event, it is now clear (and some did warn about this at the time) that the major central banks failed to recognise the full effects of the crisis engulfing financial markets and major banks on macroeconomic developments. Future economic historians will doubtless debate the consequences of central banks being too slow to cut interest rates during the first year of the crisis and whether the radical balance sheet policies they did eventually devise should have come earlier.

5. INTEREST RATE EXPECTATIONS

What does all this mean for the future? Central banks were right during the years after the crisis to keep their eye on macroeconomic developments as they used many new tools to keep monetary policy expansionary. They showed great imagination in avoiding the blunders of the 1930s, recognizing that, to use Hawtrey's famous phrase, central banking is an art. As Panetta (2016) put it, "monetary policy is not a mechanical exercise carried out by wooden technocrats." Growth recovered albeit modestly and the serious threat of deflation was averted (e.g. Farmer (2013a), Casiraghi et al (2016) and Gagnon (2016)). Even if a sustained period of price declines was never the central scenario in the advanced economies, bond investors were encouraged to accept negative term premia to buy insurance against the tail risk of deflation. The priority given regulatory reform (rather than trying to keep the policy interest rate artificially high in the face of depressed aggregate demand) was the right choice.

Obviously rejecting the simple L.A.W. does not mean that central banks – even those focused only on macroeconomic stability – can ignore the financial consequences of their monetary policy. In particular, the conclusion that the low Federal funds rate from early 2002 to late-2004 did not "sow the seeds" of the 2008/09 financial crisis does not imply there will be no adverse macroeconomic consequences from exceptionally prolonged monetary ease since 2008.

We have yet to find out the full longer-term financial and macroeconomic consequences of the radical monetary policy measures taken in recent years (that is, of negative deposit rates and of the large-scale purchase of long-term assets, driving down long-term rates and expanding bank reserves). An objective assessment of the relative effectiveness of the many instruments used will be possible only much later. These matters deserve priority in the research agenda on monetary policy.

But we do know that a decade of easy monetary policy has *not* induced the **private non-financial sector** in the advanced economies to become more indebted than it was at the onset of the crisis – contrary to what is so often asserted. The debt of this sector was about 160% of GDP at end-2016, a little less than it had been at end-2007. In addition, debt-service ratios in most advanced economies have declined sharply. The US ratio fell from 18.2% at end-2007 to 14.6% at end-2016[29]. Hence blanket assertions about a "debt-driven growth model" in the advanced economies are mistaken.

The more relevant, and much more difficult, question concerns exposures in the **financial sector.** It is financial intermediaries which have had to cope with the interest rate earthquake and its possible aftermath.

Expectations about future interest rates have changed radically since the crisis, even if the relative importance of different candidate causes (monetary, regulatory or secular) is not known. This has called into question earlier conventional wisdom about

[29] Data from BIS *Statistical Bulletin*. General government debt rose from about 70% of GDP at end-2007 to 115% of GDP at end-2016.

the "normal" shape of the yield curve and about longer-term equilibria for interest rates. The experience of so many years of very low interest rates along the whole yield curve is unique. And past experience based on large cyclical movements in interest rates, when markets expected low policy rates to revert rather quickly to some historical norm, may not be a good guide to the future. In addition, volatility in bond markets has probably been suppressed by central bank purchases. As El-Erian (2016) memorably put it, because central banks have a "highly elastic balance sheet with few constraints, they can stick with a losing trade much longer than most hedge funds can bet against it."

Such developments will influence the future environment for monetary policy. The implications of the recent period of monetary policy ease for the balance sheets of financial institutions – notably on interest rate risk – will be greater than in earlier periods because of the length of the low/near-zero interest rate period. Near-zero or negative interest rates on shorter maturities have induced banks and other investors to lengthen the maturity of the bonds they hold as assets. Interest rate carry-trades, which can be implicit as well as explicit, have been profitable in recent years. The aggregate result of much of the financial industry simultaneously lengthening the maturity of their bond investments is to drive the long-term rate even lower. Thus the initial effects of central bank bond purchases driving the long rate down have been magnified.

A parallel development reducing the long-term rate of interest is that new banking and other regulations have encouraged banks and other financial firms to increase interest rate risk exposures by buying more longer-dated bonds (and sometimes lower credit risk exposures). The transitional effects of such regulations – as firms adjust to the new rules – will be larger than the permanent effects.

Regulations have therefore reinforced the impetus coming from monetary policy in generating a sizable build-up of interest rate risk in the wake of the GFC. This was quite different from the pre-GFC case: monetary policy at that time was actually

tightened but this did not prevent a big increase in opaque credit risk exposures through securitised debt. So the exoneration of monetary policy for the last crisis may not necessarily apply to the next crisis.

In order to analyse the impact on the Treasury yield curve of the evolution in central bank policies in the face of persistently weak demand and some threat of deflation, Graph 7 summarises a simple device which used by Hördahl et al (2016). A constructed "world" 10-year yield (based on US Treasuries, gilts and the French bond as a proxy for the euro area[30]) is decomposed into an expected future path for the short-term rate and a term premium. Monetary stimulus during the first two years or so of the post-crisis period (that is, 2009 to early 2011) took the form of lower policy rates that markets apparently expected to be sustained for years. The long-run expectation of the world nominal short-term rate fell from around its pre-crisis level 4 to 4½% to around 2 to 2½% in mid-2011. This was a radical drop but represented a familiar form of monetary easing (albeit long-lasting) concentrated on the price of short-term debts.

Thereafter, however, monetary expansion took the new direction of large-scale central bank purchases of long-term assets. This mainly took the form of buying credit risk free government bonds, which is the main focus of this paper. Central banks also bought assets with credit or equity risk such as mortgage-back securities, corporate bonds and exchange-traded funds (ETFs). Some policy implications of such purchases are outlined at the end of this section. Had central banks bought fewer government bonds but more credit or equity risk assets, the impact on long-term yields would have been smaller.

As it was, purchases of government bonds helped to depress the nominal long-term rate of interest to below 2%, an historical low. The term premium component fell

[30] Note that the yield on JGBs was not included in our calculation because of the scale of BoJ purchases and the near-captive demand of Japanese regional banks and other domestic institutions. At present, the yield on the 10-year JGB, kept close to zero as a matter of policy, is not a market rate.

from a positive 1% to a negative 1%. If this calculation is correct, and it is a model-based estimate about an uncertain future path of the economy, bond investors will get lower returns over the next 10 years than if they had invested in short-term paper.

This has provided substantial macroeconomic stimulus as many writers have demonstrated (Casiraghi et al (2016), Gagnon (2016), Iwata and Samikawa (2013)). Near-zero or negative interest rates on shorter maturities have also induced banks and other investors to lengthen the maturity of the bonds they hold as assets. And banks holding large stocks of government bonds have reaped large windfall capital gains.

This effect was especially marked in the euro area periphery countries. A large proportion of the ECB's offering of 36-month financing for banks under the LTRO from November 2011 was taken up by Italian and Spanish banks. In what became known as the "Sarko trade", this policy meant that euro area periphery countries could rely on their own banks to buy more of their bonds[31]. Acharya et al (2015) have shown how the ECB's Outright Monetary Transactions policy, which was decided in August 2012, subsequently narrowed the spreads between the yield on Italian and Spanish bonds and that on bunds, giving Italian and Spanish banks capital gains. Particularly aggressive QE by the ECB from January 2015 drove the term premium in euro bonds to around minus 1½%, well below that in US Treasuries (Graph 4 in Hördahl et al (2016)).

The analysis of the "world" 10-year yield can be extended by decomposing the term premium into an inflation-risk premium and a real interest rate risk premium. Since 2013, the inflation risk premium has remained constant. The lower term premium therefore reflects a fall in the real interest rate risk premium. This suggests that the consensus view in markets at present that real long-term rates will remain low for years is quite strongly held.

[31] Named after the French President at the time who explained to the world's press this logic of the LTROs, rather undermining ECB protestations that its policies were not meant to finance governments.

This is in line with recent research which suggests that a significant part of the post-GFC decline in interest rates will persist (Laubach and Williams (2015) who look at short rates; Rachel and Smith (2015) who look at long rates). The structural factors thought to be behind the apparent decline in the marginal product of capital in the global economy (lower productivity growth, higher saving propensities, reduced demand for housing as population growth slows, technical progress that does not demand investment in long-lived assets etc) are indeed expected to persist in the medium term. But we cannot exclude a reversal: as King (2016) underlines, economists from Keynes on have stressed the fundamental or radical uncertainty of long-term rates. We cannot be confident that structural factors will keep real long-term rates low. Alternative scenarios are quite plausible. Goodhart and Pradhan (2017), for instance, build a persuasive case that real interest rates will rise as the ageing of the population reduces the global saving rate more than the investment rate. This analysis challenges the now-orthodox view that a lower potential growth rate as the working age population shrinks will keep the world real long-term interest rate very low.

It is possible that market participants, confronted with the fundamental uncertainty about equilibrium real long-term rates, have allowed the high-profile of central bank policies to loom too large as they form their expectations. The rise of bond funds may have created an illusion of liquidity. If so, there would be a risk of an outsized market reaction if expectations of central bank policies were to change abruptly. In addition, market stresses might at some point lead to a sharp rise in market rates that hits borrowers hard and lands bond investors with heavy losses. No one can know or when how such worries might materialize.

Finally, a postscript on the purchases of credit or equity risk assets. Such purchases were very effective when normal market functioning was interrupted, notably for mortgage-backed securities. The Bank of Japan recently bought ETFs on Japanese shares, in a step designed to avoid an exclusive emphasis on government bonds. The microeconomic case for acting on several markets is that it reduces the risk of

dislocation or illiquidity that would arise from concentrating all firepower on one market. Although such purchases take central banks away from their conventional habitat of government paper, a new chapter in macroeconomic/macroprudential policy may have been opened. New thinking on monetary policy frameworks has begun in earnest: Farmer (2017) provides a lucid and readable account of how monetary theory needs to catch up with recent monetary practice. Following the question that Keynes famously addressed, he shows how a sudden pessimistic turn in expectations for the future can generate self-fulfilling feedback effects between declining wealth and lower aggregate demand can generate higher unemployment for long periods of time. He argues that the Treasury (or central bank) could buy or sell shares in ETFs in the stock market in order to stabilize the unemployment rate[32]. His proposal might also mitigate the creation of interest rate risk in the financial system that this paper addresses.

6. REGULATORY POLICY AND INTEREST RATE RISK

The challenge for the immediate future is how to address interest rate risk which QE has created. Even in normal circumstances, the regulatory system does not handle interest rate risk well. Part of the reason is that capital market regulation is driven by legal considerations related to the protection of investors, rather than economic considerations of how to efficiently intermediate risk. Part is also political: the benchmark long-term asset is the government bond, and governments like to keep their own financing costs low. The big rise in government debt in the advanced economies during the crisis has made cheap finance all the more attractive. In any event, governments through regulation have in effect acquiesced in increased duration risk coming from the holding of long-term government bonds by banks and other

[32] Because it is instability in financial markets which causes high unemployment, he argues, "the remedy is to design an institution, modelled on the modern central bank, with both the authority and the tools to stabilise aggregate fluctuations in the stock market." (Farmer (2013b)).

regulated financial intermediaries (financial repression?) and discouraged the increased credit risk coming from lending to the private sector (see BIS (2011), Hannoun (2012) and Turner (2013)). The private sector now holds a larger stock of longer-dated government debt than before the crisis[33], and does so at very low yields.

There are many estimates of aggregate interest rate exposures outside the official sector. Government debt issuance data show, for many advanced economies, both an increase in outstanding Treasury debt and a rise in its average maturity. This has made bond portfolios more sensitive to changes in the benchmark long-term rate. Hannoun and Dittus (2017) cite, for example, a Goldman Sachs estimate that a 100 basis point rise in the 10-year yields on US Treasuries would cause investors in US bonds a loss of $2.4 trillion.

Which financial intermediaries bear this interest rate risk is not known. This section summarizes in general terms how accounting practices (notably mark-to-market rules and the use of a bond yield to discount future pension obligations) and major international regulations (notably the Basel rules for banks and Solvency II) treat interest rate risk.

The Basel Committee has striven to make banks more resilient to macroeconomic shocks, often in the face of strong opposition from governments wishing to obscure the weaknesses of their own banks[34]. In particular, banks are now less vulnerable to sudden increases in short-term rates (or liquidity shocks) thanks to the Liquidity Coverage Ratio and the Net Stable Funding Ratio. Nevertheless, two regulatory shortcomings mean that banks in several jurisdictions face increased interest rate risk.

[33] However, official holdings of government debt have also risen: according to Hannoun and Dittus (2017), 43% of the government debt of major reserve currency countries is now held by other official institutions. The private sector's direct interest rate risk is thus smaller.

[34] Hannoun and Dittus (2017) put the point with their hallmark bluntness (page 40): "in the course of 2016, the European Authorities, under the influence of the large European banks, have intensified their pressure against any effort from the Basel Committee to strengthen the capital buffers that are needed to improve the resilience of the banking system against the high risk of a new financial crisis."

The first shortcoming relates to interest rate risk on bonds held in the banking book. The Basel Committee has struggled with this since the 1990s. Each time it has failed to reach agreement on a global Pillar 1 capital charge (Goodhart (2011)). Yet, as the key Basel 2 document put it in 2001, "the Committee remains convinced that interest rate risk in the banking book is a potentially significant risk, and one that merits capital" (BIS (2001)). Recall that government bonds in the local currency effectively have a zero risk weight in the risk-weighted assets calculation of required capital. Given the extremely low long-term interest rates since the crisis and much-increased holdings by banks in Europe and Japan of long-term government bonds, the case for a capital charge has become much stronger. After much debate, however, Basel 3 failed to include a capital charge on interest rate risk in the banking book.

It is true that some national supervisory authorities have in place various mechanisms to ensure banks manage interest rate risk from large holdings of government bonds. The US stress tests, for instance, have involved a 300 basis point shift/steepening in the yield curve. Using forward-looking scenarios in the design of stress tests for banks is especially useful when new risks (or old risks on a much-magnified scale) arise. The published stress tests of many supervisors, however, do not inspire confidence. Goldstein (2017), for instance, demonstrated the shortcomings of the euro area stress tests. The EU's sovereign debt stress test in July 2010 simply ignored sovereign debt exposures held in the banking book. ECB policies from 2011 have made banks in the weaker euro area countries more dependent on the bonds of their own state.

Governments can be expected to resist any supervisory action that would induce banks to reduce their holdings of long-term government bonds – especially when bond prices are falling. The absence of a simple capital charge leaves supervisors more open to pressures to relax their discretionary efforts to limit interest rate risk in their banking systems.

A second feature of Basel 3 reinforcing interest rate risk exposures is the allowance of long-term government bonds as a liquid asset to meet the Liquidity Coverage Ratio. In the past when central banks relied heavily on liquid asset ratios to keep banks safe, liquid assets had to be short-dated paper in order to avoid the interest rate risk from holding bonds[35]. When the Bank of England used a liquid asset ratio as a key variable for both monetary and prudential control before 1981, for instance, it did not allow banks to count government securities with a residual maturity of more than 6 months as a liquid asset. (In addition, a cyclical element needs to be built into the liquidity ratios, as discussed in Section 7 on macro-prudential policy).

More damaging than bank rules have been new regulations and accounting rules governing non-banks[36]. These regulations have had a pro-cyclical effect in encouraging increased holdings of long-term bonds as they offered lower and lower yields. The spread of fair value accounting principles requiring firms to revalue assets and liabilities as market interest rates change has encouraged "liability-driven" strategies. One example of this is IAS 9 which requires that defined-benefit pension liabilities be discounted by a bond yield. A fall in the bond yield, increasing the present value of liabilities, can lead to accounting losses and firms may even face the prospect of a negative net asset position. To protect themselves, firms can sell equities and buy more very long-term paper. Such purchases by many funds responding to the same shock drive market yields even lower, magnifying the initial interest rate shock with the feedback effect of further increasing the present value of liabilities (Claessens (2016)).

[35] Historically, high-quality private sector short-term paper satisfied liquidity rules, a feature that Moessner and Allen (2015) would like to see in the modern rules.

[36] The most lucid exposition of how the use of International Financial Reporting Standards made the GFC crisis worse and would aggravate herding and so severely strain market liquidity in a crisis is chapter 8 "How accounting, credit, and risk standards create risk" pp 137-150 Persaud (2015) updating an article that first appeared in the Banque de France *Financial Stability Review* October 2008.

The comparison with sovereign wealth funds (which take seriously their role as a long-term investor and do not face sudden demands to liquefy their assets) is illuminating (Turner (2017)). Norway's government pension fund has progressively cut the share of bonds in its portfolio, a policy recently reinforced by depressed bond yields. But private sector pension funds in many countries have moved in the opposite direction. There is, however, no easy or widely acceptable way of adapting mark-to-market rules to the investment needs of long-term investors. Persaud (2015) suggests a mark-to-funding rule but this has not been accepted (difficulty of knowing future cash flows and of valuations in the event of bankruptcy). Nor is it clear how to adapt mark-to-market rules when the benchmark bond yield has been temporarily depressed as a matter of official policy. Such rules, designed to protect investors and pensioners' entitlements, have clear justifications at the level of the individual fund. If accounting rules lead private pension funds to invest less in equity risk than judged *socially* optimal, however, the government could issue more long-term bonds and invest the proceeds in equity assets. Thus the scope of sovereign wealth funds would be widened, and such finds could be operated o help stabilise the domestic economy (Farmer (2017)).

Another example of regulations creating procyclicality in bond purchases is the European Solvency II directive. In an effort to reduce credit risks, this directive pushes European insurers to hold fewer equities or corporate bonds and more government bonds. To try to maintain returns on their assets as they reduce credit-risk exposures, firms tend to increase the duration of their government bond portfolios. Such substitution of interest rate risk for credit risk on their financial assets can lead to destabilising market dynamics. A number of studies have shown that some institutional investors increase in a pro-cyclical way the duration of their assets as long-term rates fall. As noted above, the more fundamental problem is that mark-to-market rules

induce long-term investors into too-liquid and inferior investment choices (Persaud (2015)).[37]

Finally, new bond market infrastructures may have created some liquidity illusion in bond markets that could magnify any shock to long-term interest rates in a crisis. A major new development is that institutional and retail investments in bonds are increasingly held through bond funds which attract investors by their apparent liquidity. There has been a huge expansion in open-ended bond funds and in ETFs which promise daily liquidity even if the underlying securities are illiquid. The deleveraging of global banks and insurers after the GFC means that investment funds have become the main buyers of new debt issues. The asset management industry has become more concentrated with the top 10 asset managers accounting for around 30% of the sector's total assets under management (Haldane (2014)). The concentration of assets managed in the hands of a few "star" managers means that strong redemptions in one of an asset manager's funds could spread quickly to the other funds of that asset manager (IMF (2014)). Less liquid bond funds tend to hoard more cash when faced with a wave of redemptions: by adding extra discretionary sales during turbulent markets, such funds accentuate market declines. Morris et al (2017) provide evidence that cash hoarding by bond funds could amplify fire sales when end-investors decide to sell.

The huge growth in such funds has made less transparent how the capital losses of institutional bond investors would materialise once long-term interest rates rise. Such funds may well affect market dynamics in a bond market downturn. Many firms, aware of how interest rate exposures everywhere have risen, may act quickly to get out of bonds once interest rate sentiment changes. In addition, some leveraged investors could be forced to sell into a falling market. None of this necessarily represents a systemic financial risk if institutional investors losing money do not infect

[37] See Turner (2014) pp35-37 for a fuller argument and see BIS (2011) for a critical analysis of Solvency II.

banks (Ramaswamy (2017)) and markets continue to function. But it could lead to disruptive market movements and to some bond segments becoming illiquid. Any prolonged liquidity strain in bond markets could have such large macroeconomic effects that it becomes systemic.

7. MACROPRUDENTIAL POLICY

The GFC demonstrated that the policy rate was too blunt an instrument to be used to counter financial booms. And a decade of low interest rates has **not** increased aggregate leverage in the non-financial private sector in advanced economies – contrary to what is often claimed. Of course, excess leverage in some sectors and countries could increase financial and macroeconomic risks. But such sector-specific risks would not be best addressed by a monetary policy tightening affecting everybody.

Fortunately, major post-crisis reforms have given most central banks new macroprudential policy tools to deal with specific risk exposures. Although the term is new, the policy focus is not. central banks have always played close attention to the macroeconomic and systemic effects of too rapid or too imprudent credit growth. Traditionally, central bank policies have almost always incorporated a close focus on the nature and the growth of credit (Allen (2015), Kenç (2016), Rotemberg (2014) and Tucker (2014)). The modern Federal Reserve is no exception. The Humphrey-Hawkins Act of 1978 required it to set twice a year quantitative ranges for money and debt growth. Accordingly, the FOMC regularly voted on a benchmark range for the year-on-year growth in total domestic nonfinancial debt as well as for M2 and M3. But after this reporting requirement had lapsed (in May 2000), the FOMC stopped setting such ranges, noting that "these ranges for many years have not provide useful benchmarks for the conduct of monetary policy".[38] Nevertheless, the FOMC continued, "the

[38] See Federal Reserve (2000).

bahavior of money and credit will continue to have value in gauging economic and financial conditions."

It would be very satisfying to fall back on the two objectives, two instruments of Tinbergen: the policy rate determines macroeconomic outcomes and macroprudential policies to moderate credit expansions and preserve financial stability.

Alas, real life is more complex. The imposition of *any* binding regulatory constraint will not only limit credit but will have macroeconomic consequences. With monetary policy unchanged, restricting credit will also reduce spending and raise saving with consequences for GDP, market interest rates and the exchange rate. Exactly this point was the nub of the seminal Bernanke-Blinder closed economy model of the bank-lending channel: it was the greater willingness of banks to lend – not monetary policy – that cause financial booms and drive up the long-term interest rate (Turner (2016)). Tighter banking regulation is just the opposite of this, constraining the willingness of banks to lend.

Macroprudential-type regulatory measures have even deeper macroeconomic links than standard regulatory ratios because their settings are designed to vary with macroeconomic or financial market conditions. For example, a debt-financed property price boom can lead the central bank to lower loan-to-value (LTV) ratios applying to mortgages. Such a step could have large macroeconomic effects. For instance, the Reserve Bank of New Zealand estimates that their LTV restrictions reduced consumer price inflation by an amount similar to a 25-50 basis point increase in the policy rate.

The inescapable conclusion is that macroeconomic and financial considerations will weigh heavily in any decision to impose macroprudential constraints. Hence the dilemmas and uncertainties that led some to advocate L.A.W. monetary policy are not automatically solved by the introduction of new non-interest rate policy instruments. But the assertion that tightening non-interest rate policy instruments must be

supported by higher interest rates has no logical foundation[39]. The Tinbergen principle works because different instruments affects different parts of the economy differently. As the Governor of the Reserve Bank of New Zealand noted, the introduction of macroprudential speed limits on high loan-to-value lending for mortgages "moderated excesses in the housing market, thereby enabling the Bank to delay the tightening of interest rates, and reducing the incentive for further capital inflows into the New Zealand dollar" (Wheeler (2014)). Sinclair and Allen (2017) put the point well: when monetary and macroprudential policies need to pull in opposite directions, "the best answer may be to increase the dosage of both – and not to do nothing".

After a long period of unusually low long-term interest rates, those holding portfolios of bonds surely face increased risks of large capital losses. The increase in global bond issuance by non-core and higher credit risk borrowers has probably increased liquidity risks in bond markets. How well can new macroprudential policies deal with all these new risks?

The short answer is, "well for bank credits, work-in-progress for bank liquidity and for poorly for capital market-related intermediation". Consider four examples: mortgage lending; maturity transformation within banks; exposures in non-banks; and bond market functioning.

First, rules for mortgage lending. Households should not incur long-term mortgage debt just because they can afford to meet interest servicing costs when rates are exceptionally low. In such circumstances, debt-to-income (DTI) ratios may help limit the rise in household indebtedness and keep borrowers solvent (helping financial

[39] This point deserves emphasis as some have claimed that macroprudential policy restrictions work only when used as a complement with higher interest rates. Hannoun and Dittus (2017), for instance, repeat the BIS view that, "it is better to think of monetary policy and macroprudential policy as complements, not substitutes." There is no logical basis for this, and this is not altered by empirical findings of some researchers that certain macroprudential policy instruments have been more effective in affecting some variables when combined with higher interest rates. Faced with some shocks (e.g., a positive productivity shock), monetary policy will need to ease while macroprudential policy should tighten.

stability). DTIs can also help macroeconomic stability by ensuring that those with mortgages are less disposable income-constrained when interest rates rise. Studies suggest that using DTI limits can increase the lifetime income of borrowers (Ingves (2017)).

Second, maturity transformation within banks. Macroprudential policies on liquidity in banks could be very effective in dealing with excess domestic money creation, especially when global liquidity seems to be growing too fast. And banks are now – for the first time – subject to quite demanding liquidity ratios agreed at international level under Basel 3. But the problem is that these rules do not change over the economic cycle – quite unlike capital rules (which incorporate a countercyclical buffer). This is a mistake: as Landau (2016) argues, the macroprudential toolkit should include the cyclical regulation of liquidity creation and maturity transformation within banks. Goodhart (2017) echoes this criticism of the new liquidity rules which require banks to wastefully maintain "a hugely inflated amount of high-quality liquid assets (HQLA)". Supporting King's pawnbroker proposal mentioned in Section 4 above, Goodhart argues for a contingent, pre-positioning scheme to allow banks to swap their illiquid assets into HQLA during a crisis. In addition, the central bank can expand or contract the maturity transformation undertaken through its own balance sheet.

Third, macroprudential policies with respect to non-banks. As discussed in the previous section, the main focus of the accounting rules and regulation affecting pensions and insurance companies is to ensure that such firms do not cheat those on whose behalf they invest. Economists have often analysed how the current practices of such firms can entail pro-cyclical and destabilising reactions to changes in market interest rates. The economic logic has been questioned often (why invest more in long-term bonds when the term premium falls?). Some firms report the sensitivity of their portfolios to interest rate changes, but most do not. It is not possible to know the exact location in the financial system of much-increased interest rate risk exposures.

Macroprudential policies towards capital markets are not comparable to what has been put in place for banks. The proposal of Farmer (2017) for the Treasury to trade actively in ETFs on the country's equity market to counter the macroeconomic effects of mood swings in the stock market might also help fill a macroprudential gap.

Fourth, market functioning. Much has been written about the risks created by bond funds which offer daily liquidity even when the markets for the bonds are illiquid. The number and diversity of bond funds has increased greatly over the past decade. Questions remain about how resilient the new clearing houses for derivatives will be if faced with a large market shock.

Despite all these shortcomings, however, the widening in policy instruments available to central banks is still one of the most promising reforms since the crisis. How to co-ordinate monetary policy and macroprudential policies, and calibrate the settings of each, is a further challenge. There will have to be a lot of learning by doing. The central bank must have the tools to be able to forestall the build-up of excessive leverage in the financial system – if only because over-indebtedness can create medium-term macroeconomic risks. As Ingves (2017) argues forcefully, "dispersing responsibility for macroprudential policies across several different authorities is not a good solution."

8. FUTURE MONETARY POLICY

Future monetary policy will depend on (unknown) future shocks. It will also be shaped by the durable implications of such a long period of very low interest rates. Lower interest rates have reduced debt-service burdens of debtors. Lower rates have also increased asset prices, raising the value of collateral held by firms and households, making them seem better credit risks in the eyes of lenders. These effects could be benign. A durable rise in debt/income ratios and in asset prices could be expected if the natural rate of interest is now lower than in the past (as discussed in section 5 above). If the decline in interest rates does indeed persist (the "new normal"?), higher

debt and higher asset prices can be regarded as natural equilibrating mechanisms in a move to a low interest rate environment.

The worries begin if the long-run equilibrium or natural rate of interest is actually much higher than most assume at present. Consider first an external interest rate shock. Suppose that the world long-term real interest rate rises more than the market currently expects without any improvement in domestic growth prospects. This would mean that longer-term interest rates in the domestic economy would rise even if the local policy rate is held constant, and financing would become more expensive. In addition, the non-government sector (including banks, pension funds and insurance companies) would suffer capital losses on their holdings of government bonds. Capital losses would be much higher than they would have been before the crisis because interest rate exposures are now greater. Financial firms with large interest rate risk on their balance sheets can react in ways that lower aggregate spending. Banks may tighten their lending conditions. Some pension funds and insurance companies could alter the terms of their products. Where the depressive effect on domestic demand is large, the central bank should lower domestic interest rates.

This conclusion might seem a counterintuitive when international interest rates are rising. It arises because the period of very low interest rates has itself changed balance sheets in such a way that higher long-term rates depress domestic demand much more than would have been the case when interest rate risk exposures were smaller.

Consider next a domestic interest rate shock. Suppose domestic inflation pressures rise, requiring a higher policy rate. How far the policy rate needs to rise to bring about a reduction in aggregate demand will depend on, among other things, debt/income ratios and on the reactions of investors who had built up interest rate carry-trade exposures (borrowing short to invest long). The policy rate will need to rise by less when debt is higher. The policy rate would also need to rise less if any rise leads to a sudden reversal of carry trades, implying a jump in longer-term rates (increasing the term premium).

Brunnermeier and Schnable (2016) concluded their historical review of central banks and asset prices with the Swedish Riksbank's decision to raise interest rates in 2010 to counter rapid increases in property prices (associated with increased borrowing). This tightening in monetary policy hit indebted households who then cut back spending, and the economy was pushed back into recession. Their conclusion was that raising interest rates to lean against the wind when banks are vulnerable and leverage in the economy high might be a bad option.

The general point that a monetary policy stance maintained for a long time (in this case, very low rates) will alter balance sheets in the financial system in ways that would justify smaller increases in rates to meet inflation targets in the future than when debt/income ratios were lower and interest rate exposures less marked.

The problem of course is that we know very little about such exposures and how firms would react to an unexpected change in the interest rate environment. There are no commonly agreed measures of the true interest rate exposures on their balance sheets (including derivatives overlays) of banks, pension funds or insurance companies. We know that some new regulations have induced them to increase the proportion of their assets in long-term bonds but we do not know by how much. Nor do we know what might happen in the steady state once they have adjusted to the new rules.

The policy choices of central banks are further complicated by the fact that they now have two policy tools: the size or nature of their balance sheets as well as the familiar policy rate. Central banks having contributed to driving the term premium into negative territory hesitate about now selling these assets. The FOMC's June 2011 principles envisaged beginning the sale of agency (i.e. mortgage-related) securities only after the Fed funds rate had been raised. But Bernanke said at the June 2013 press conference that a "strong majority" of the FOMC did not expect to sell assets during the normalisation process. Dudley (2013) stressed caution about any such sales "because of uncertainty about how (this) would work and (risks to) future financial stability". In September 2017, the FOMC clarified its plan to shrink the Fed's balance

sheet very slowly over many years in order to minimise any disruption to the bond market.

An alternative view is that some asset sales at an early stage of normalisation would permit a slower rise in the Fed funds rate. The combination of asset sales and a lower policy rate for longer might help to lift the term premium gradually and so reduce the risk of a sudden snap-back in the long-term interest rate. But if the aim during the exit phase is just to avoid disrupting government bond markets, and not intended to serve any monetary policy objective, the process might be managed by the Treasury rather than by the central bank[40]. In an overnight off-market transaction, the Treasury could exchange the long-term government bonds held by the central bank for Treasury bills. Interest rate risk on the central bank's balance sheet would be removed, and market prices would be unaffected because the portfolio of government securities held by investors in the market would not be affected. Macroeconomic conditions and prospects, which would be improved if banks become less risk averse and lend more, would determine increases in the policy rate. Anxieties about disturbing the government bond market would no longer constrain central bank policy in the tightening phase. One reason for a faster exit from QE than at present envisaged by central banks is to prepare their balance sheets for the next global recession. Such a recession (as the previous two) may come from a decline in asset prices (eg, a drop in bond prices) and not inflation. If policy rates are still not far from zero at the onset of the next recession, QE may again be needed.

None of these matters is easy to judge. At the moment inflation risks are dormant, and few expect any inflation flare-up in the years immediately ahead. But if inflation risks were to rise more quickly than now seems likely, central banks could face some awkward choices between remaining true to their inflation mandates and supporting banks or other financial firms that could be hit hard by any rapid rise in interest rates. Because the macroeconomic effects of allowing a bank to fail are so uncertain, and

[40] Much depends on the institutional arrangements governing QE: see Goodhart (2017).

could be very large, the central bank in a crisis might shrink from a tightening justified on macroeconomic grounds. This was the point of Hannoun's (2014) worries about the risk of financial repression from pushing too far for too long beyond the conventional limits of monetary policy.

CONCLUSION

Is the monetary policy framework of the Federal Reserve (and indeed that of all central banks of advanced economies) fundamentally flawed because it fails to take account of financial stability risks of low interest rates? Should a central bank raise interest rates above the level justified by macroeconomic considerations when some credit or financial ratio exceeds a certain threshold? This hardy perennial of a question was given new life by the GFC. According to some, a major cause of that crisis was that the Fed pushed the policy rate too low from 2001 and was too-timid in raising the policy rate thereafter. And they believe that the Fed has, since 2009, compounded this error by keeping interest rates too low for too long even in the face of large increases in asset prices – the "2016 mix of frothy markets and low inflation" in the words of Greenspan's biographer.

This paper rejects this interpretation. There are three reasons why higher policy rates would not have prevented the GFC. The first is that a large increase in the Fed funds rate from mid-2004 to mid-2006 (associated with higher rates in other advanced economies) did not curb financial risk-taking on almost any dimension that can be measured. The second is that market interest rates along the yield curve are endogenous. It was a narrowing in the term premium in holding 10-year US Treasuries that kept the benchmark long-term rate down while the policy rate rose in the years before the crisis. The third reason is related to the exchange rate, and is illustrated by the difference between the tight monetary policy stance of the Bank of England and the more relaxed stance of the Bank of Canada before the GFC. Greater monetary

rigour over the pre-GFC years did not spare the United Kingdom the financial crisis while tighter financial regulation protected Canada.

Any analysis of the links between monetary policy and financial stability should be forward-looking. It should recognise that expansionary monetary policies have *both* reduced near-term financial risks *and* increased some future financial risks. Growth would have been lower with less expansionary monetary policy. As it was, years of sub-par growth in many countries brought some companies close to bankruptcy and lowered the quality of loans on banks' balance sheets. With inflation very low, central banks cannot extricate themselves from the undoubted risks of low rates by raising their policy interest rates because weaker aggregate demand itself creates financial risks – especially when there is a risk of deflation. Recall that deflationary policies in the Great Depression did not succeed in reducing debt. Indeed, the contrary: total US debt (public and private) rose from 185% of GDP in 1929 to almost 300% of GDP by 1932, creating massive losses for the banks.

Nevertheless, no one can be complacent about the threats to financial stability that current exceptional monetary policies have created. It would be very surprising if such a long period of extremely low interest rates has not led households, companies and financial institutions to take some risks that could turn ugly when interest rates rise.

The nature of monetary stimulus in recent years is crucial for assessing future risks. Monetary stimulus during the first three years or so of the post-crisis period (that is, until early 2011) took the traditional form of central banks cutting policy rates and encouraging markets to think that policy rates would be kept low for an extended period. The long-run expectation of the world nominal short-term rate fell from around its pre-crisis level of 4 to 4½% to around 2 to 2½% in mid-2011. A radical drop certainly but still exemplifying a familiar form of monetary easing (albeit long-lasting) concentrated on the price of short-term debts.

Thereafter, however, monetary expansion took the form of aggressive central bank purchases of long-term assets. This helped to drive the world term premium from a positive 1% to a negative 1%. The decline in the term premium over the past four years has not reflected a lower inflation risk premium. It has instead reflected a lower real interest rate risk premium. Markets are apparently confident that the current low level of real long-term rates will last – whether this will be justified remains to be seen. In any event, current expectations are that bond investors will get lower returns over the next 10 years than if they had invested in short-term paper. At the same time, very low or even negative short-term rates induced some investors to lengthen the maturity of their fixed-income assets – the so-called "search for duration".

This lengthening in the maturity of bonds held on the balance sheets of financial firms has been encouraged by regulation. Accounting regulations, rules for defined-benefit pension funds and Solvency 2 for European insurance companies have pushed financial firms to hold more bonds (and fewer equities), and especially government bonds. In addition, Basel 3 has allowed banks to increase the duration of their bond portfolios. The financial industry has therefore become much more exposed to interest rate shocks than it was before the crisis. Which investors bear the main exposures is unclear, but there is a large aggregate exposure of the non-government sector, whose holdings of government bonds has risen and the average duration of their bond portfolios is much longer than before the GFC. Higher interest rates would cause capital losses. Financial firms with large interest rate risk on their balance sheets can react to expectations of higher rates in ways that would lower aggregate demand. But very little is known about the magnitude of these exposures, about how they will affect the response of individual firms to higher interest rates or about risks from contagion from sectors where the materialisation of interest rate risk is concentrated.

In principle, macroprudential policies should address such risks. In practice, current macroprudential policies are too narrowly focused on bank lending. Attention is also required for the maturity transformation within banks, the behaviour of non-banks and

the risks of destabilisation from market structures. A recent speech by the Vice-President of the ECB rightly concluded with a warning that unless macroprudential policy is taken more seriously – with an expanded toolkit to cover maturity mismatches and leverage in non-bank financial institutions – there will be other financial crises that monetary policy cannot prevent (Constâncio (2017)).

The implication is that the combination of QE contributing to negative term premia since 2011 and financial regulations favouring the holding of government bonds has made the economy much more sensitive to interest rate changes than it was before 2007. Future monetary policy choices and trade-offs may therefore be quite different in this new world of negative or zero term premia and large interest rate exposures. The long-term rate could rise sharply if a market re-assessment of its future equilibrium level coincides with decisions to tighten global monetary policy. In addition, a central bank tightening monetary policy for domestic macroeconomic reasons would have to be aware of the possibility that a given interest rate change has become more potent, with effects probably more difficult to predict than before the crisis. Hence central banks may need to raise the policy rate less than in the past to bring about a given slowing in aggregate demand. A central bank in an economy facing an externally-driven rise in the world interest rate might paradoxically have to reduce its policy rate (or seek other forms of monetary expansion).

The case for only moderate and cautious increases in the policy rate would be reinforced if inflation now rises less in response to temporary periods of excess demand than in the past. Such a development could be driven by increased competition – whether domestic (Amazon, Uber, Airbnb and other internet-based consumption) or international (tourism, education, construction contracts etc). The greater elasticity of oil supply from new technologies could work in the same direction. These developments may raise potential output more than is incorporated in current estimates.

There is another development which may moderate future interest-rate cycles -- rise of macroprudential policies on bank lending. Having policy instruments which can vary in line with the business cycles should limit financial risks, and may reduce the amplitude of the business cycle (Chadha (2016)). If so, policy rates could move less in future cycles. Working out how the interactions between the new tools of macroprudential policy and monetary policy change according to circumstances is a challenge for central banks.

There is little in past history for judging the size or the timing of these interest rate-dampening effects. The forward-looking question is: how will monetary policy in the future be influenced by changes in the financial system wrought by the radical monetary policies in recent years? This will depend in part on reforming those regulations which actually encourage investment by financial intermediaries in longer-maturity bonds irrespective of yield. Much also depends on how effectively the authorities (governments and central banks) devise new macroprudential instruments to address the new risks (many outside the banking system) from abundant global liquidity and extremely low interest rates.

The great success of central banks in the advanced economies in using radical monetary measures to counter financial market collapse and end the worst recession since the second world war deserves recognition. Lasting public confidence will depend on how they reduce monetary stimulus as their economies return to full employment. It will also depend on how they manage the financial risks these policies have inevitably created. Future effectiveness will depend on the willingness to think hard and without prejudice about new central bank (or Treasury) instruments as circumstances develop. Macroeconomic theory needs to develop so we analyse better the old question of Keynes: how too-pessimistic animal spirits in financial markets can sustain high-unemployment equilibria for too long (Farmer (2013b)). The much-needed analysis of the effectiveness of the monetary policy tools central banks have

used in this crisis should not be cut short by imposing artificial constraints based on what central banks have traditionally done.

References

Acharya, V, T Eisert, C Enfinger, and C Hersch (2015): "Whatever it takes: the real effects of unconventional monetary policy."

Agénor, P-R and L Pereira da Silva (2013): "Inflation targeting and financial stability: a perspective from the developing world" Inter-American Development Bank and CEMLA

Akyüz, Y (2017) *Playing with fire* Oxford University Press

Allen, W A (2015): "Asset choice in British central banking history, the myth of the safe asset, and bank regulation", *Journal of Banking and Financial Economics*, June, vol 2 no 4, pp 18–31.

Andersen, P (1997): "Forecast errors and financial developments", *BIS Working Papers,* no 61, November.

Bank for International Settlements (1998): "The role of asset prices in the formulation of monetary policy" *BIS Conference Papers,* vol 5, March

--------- (2001a): "Overview of the new Basel Capital Accord." Basel Committee on Banking Supervision. January.

--------- (2003): "Credit risk transfer." A report of a working group of the CGFS. January

--------- (2011): "Fixed-income strategies of insurance companies and pension funds", *CGFS Papers,* no 44, July.

--------- (2016): "The financial cycle, the natural rate of interest and monetary policy" pp 78-79, *86th Annual Report*, June.

Bayoumi, T (2017): *Unfinished business* Yale University Press

Bean, C, M Paustian, A Penalver and T Taylor (2010): "Monetary policy after the Fall", Federal Reserve Bank of Kansas City, Jackson Hole, 26–28 August.

Bernanke, B S and M Gertler (1999): "Monetary policy and asset price volatility" *Economic Review* vol Q IV

Bertaut, C, L Pounder DeMarco, S Kamin and R Tryon (2011) "ABS inflows to the United States and the Global Financial Crisis" Federal Reserve Board, International Finance Discussion Papers, no 1028. August

Bordo, M D and O Jeanne (2002) "Monetary policy and asset prices: does "benign neglect" make sense?" *IMF Working Papers,* WP/02/225

Bruno, V and H S Shin (2012): "Capital flows and the risk-taking channel of monetary policy", *BIS Working Papers*, no 400, December.

Brunnermeier M K and O Oehmke (2012) "Bubbles, financial crises and systemic risk" *NBER Working Paper* no 18398. September

Brunnermeier M K and I Schnabel (2016): "Bubbles and central banks: historical perspectives" in *Central banks at a crossroads; what can we learn from history?* Cambridge University Press

Cable, V (2010) *The storm: the world economic crisis and what it means*. Atlantic Books. London

Casiraghi, M, E Gaiotti, L Rodano and A Secchi (2016): "The impact of unconventional monetary policy on the Italian economy during the sovereign debt crisis" *International Journal of Central Banking*

Cerra, A and S C Saxena (2017): "Booms, crises and recoveries: a new paradigm of the business cycle and its policy recommendations." Mimeo

Chadha, J S, P Turner and F Zampolli (2013): "The interest rate effects of government debt maturity" *BIS Working Papers* no 415, June

Chadha, J S (2016): "The new art of central banking" *NIESR Discussion Paper* no 472, October

Claessens, S (2016): "Regulation and structural change in financial systems" *ECB Forum on Central Banking,* June

Congdon, T (2017): "The quantity theory of money – why another restatement is needed, and why it matters to debates on the Great Recession" in *Money in the Great Recession*. Editor: T Congdon. Edward Elgar

Constâncio, V (2017)): "The evolving risk landscape in the euro area" Speech at Banco do Portugal conference on Financial Stability, 17 October

De Gregorio, J (2014): *How Latin America weathered the global financial crisis*. Peterson Institute for International Economics. Washington, DC.

Dudley, W (2013): "Why financial stability is a necessary prerequisite for an effective monetary policy" Remarks at the Andrew Crockett Memorial Lecture at the BIS, June

El-Erian, M A (2016) *The only game in town* Random House, New York

Ellis, L and C Littrell (2017): "Financial stability in a low interest rate environment: an Australian case study" RBA conference 2017

Farmer, R A E (2013a): "The stock market crash really did cause the Great Recession" *NBER Working Paper,* no 19391

---------- (2013b): "Qualitative easing: a new tool for the stabilisation of financial markets" *Bank of England Quarterly Bulletin* Q4 pp 405-413

---------- (2017): *Prosperity for all*. Oxford University Press

Federal Reserve (2017): *Monetary policy report*. 7 July

Financial Times (2017a): "Central banks warned on inflation risk: BIS annual report focuses on the danger of interest rates staying too low for too long" 26 June

Financial Times (2017b): "Rate rise threatens global growth, warns BIS" 19 September

Federal Reserve (2000): *Monetary policy report to the Congress*. 20 July

---------- (2017): *Monetary policy report to the Congress*. 7 July

Feldstein, M (2007): "Housing, housing finance and monetary policy" Final summary at the Jackson Hole conference of the Federal Reserve Bank of Kansas City. 1 September

Gagnon, J E (2016): "Quantitative easing: an under-appreciated success" Peterson Institute for International Economics . Policy Brief PB16-4

Garcia, C (2017): "Chief unlikely to stop bank prioritising low inflation over growth" *Financial* Times 4 November

Goldstein, M (2017): *Banking's final exam* Peterson Institute for International Economics, Washington

Goodhart C A E (2010): "Procyclicality of financial regulation" Bank of Spain

--------- (2011): *The Basel Committee on Banking Supervision: a history of the early years 1974–1997. Cambridge University Press.*

--------- (2017): "A central bank's optimal balance sheet size?" Financial Markets Group . London School of Economics

Goodhart C A E and M Pradhan (2017): "Demographics will reverse three multi-decade global trends", *BIS Working Papers,* no 656, August

Gourinchas, P-O and M Obstfeld (2012): "Stories of the Twentieth Century for the Twenty-first", *American Economic Journal: Macroeconomics*, 4(1), pp 226–265.

Gourio, F, A. K. Kashyap and J Sim (2017): "The trade-offs in leaning against the wind" NBER Working Paper no 23658. August

Greenspan, A (2007): "A global outlook: Alan Greenspan sees inflation pressures building" An interview with Krishna Guha, *Financial Times*. 17 September

Griffith-Jones, S, J A Ocampo and J E Stiglitz (2010): *Time for a visible hand*. Oxford University Press

Haldane, A (2014): "The age of asset management?" Speech at the London Business School, 4 April

Hall, R E (2011): "The high sensitivity of economic activity to financial frictions" *Economic Journal,* 121, May, pp 357-378

Hanke, S (2017): "The Basel rules and the banking system" in *Money in the Great Recession*. Editor: T Congdon. Edward Elgar

Hannoun, H (2012): "Monetary policy in the crisis: testing the limits of monetary policy" Speech at the 47th SEACEN Governors' Conference, 13-14 February

Hannoun, H and P Dittus (2017): *Revolution required: the ticking time bombs of the G7 model*. ebook, available on Amazon

Hofmann, B and B Bogdanova (2012): "Taylor rules and monetary policy: a global Great Deviation?" *BIS Quarterly Review* September 2012, pp 37-49

Hofmann, B, I Shim and H S Shin (2016): "Sovereign yields and the risk-taking channel of currency appreciation", *BIS Working Papers,* no 538, January.

Hördahl, P, J Sobrun and P Turner (2016): "Low long-term interest rates as a global phenomenon", *BIS Working Papers*, no 574, August.

Icard. A (2007): *Stabilité financière et banques centrales* Economica Paris

IMF (2014): *Global financial stability report,* October

----- (2017): "Financial conditions and growth at risk" *Global financial stability report* October 2017, pp 91-118

Ingves, S (2017): "Monetary policy challenges – weighing today against tomorrow" Speech at the Swedish Economics Association. 16 May.

Iwata, K and I Fueda-Samikawa (2013): "Quantitative and qualitative monetary easing effects and associated risks". Japan Center for Economic Research, Tokyo

Juselius, M, C. Borio, P Disyatat and M Drehmann (2016) "Monetary policy, the financial cycle and ultra-low interest rates." *BIS Working Papers,* no 569. July

Kahneman, D (2014): *Thinking, fast and slow* Penguin books

Kenç, T (2016): "Macroprudential regulation: history, theory and policy", in *BIS Papers, no 86*, September, pp 1–15.

King, M (2016): *The end of alchemy* Little, Brown

King M and D Low (2014): "Measuring the "world" real interest rate" NBER Working Paper, 19887, February

Landau, J-P (2013): "Global liquidity: private and public" Federal Reserve Bank of Kansas City

------ (2016): "A liquidity-based approach to macroprudential policy", in *BIS Papers,* no 86, September

Laubach, T and J C Williams (2015): "Measuring the natural rate of interest redux", Hutchins Center of Fiscal and Monetary Policy at Brookings. Working Paper, no 15.

Lombardi, M and F Zhu (2014): "A shadow policy rate to calibrate US monetary policy at the zero lower bound", *BIS Working Papers,* no 452, June.

Lowy Institute (2017): Stephen Grenville's interview with Sebastien Mallaby. (https://www.lowyinstitute.org/the-interpreter/quick-comment-sebastian-mallaby-trump-fed-and-global-economy)

Macfarlane, I (2002): "Statement by the Governor: Monetary Policy" Reserve Bank of Australia, 8 May

Mallaby, S (2016): "Bubbly finance and low inflation cause alarm", *Financial Times*, 8 October.

Meade, J (1990): *The collected papers of James Meade, Volume IV: The cabinet office diary 1944–46*. Edited by Susan Howson and Donald Moggridge, University of Toronto, Unwin Hymin.

Moessner, R and W A Allen (2015) "International liquidity management since the crisis" *World Economics* vol 16 no 4, October-December

Morris, S. I Shim and H S Shin (2017): "Redemption risk and cash hoarding by asset managers" *BIS Working Paper* no 608. January

Nickell, S (2005): "Practical issues in UK monetary policy" Keynes Lecture at the British Academy. 20 September

Panetta, F (2016): "Central banking in the XXI century" SUERF/BAFFI/CAREFIN Center Conference "Central banking and monetary policy: which will be the new normal?", Milan, April

Persaud, A D (2010): "The role of policy and banking supervision in the light of the credit crisis" in Griffith-Jones et al (2010)

------- (2015): *Reinventing financial regulation*. Springer, Apress

Peston, R (with L Knight) (2012): *How do we fix this mess?* Hodder and Stoughton, London

Poloz, S S (2016): "Monetary/fiscal policy mix and financial stability" Doug Purvis Memorial Lecture, Bank of Canada Staff Discussion Paper 2016-13, June

Posen, A (2010): "Do we know what we need to know in order to lean against the wind?" Cato Institute 28th Annual Conference, November

Rachel, L and T D Smith (2015)): "Secular drivers of the global real interest rate" *Bank of England Staff Working Paper* no 571. December

Ramaswamy, S (2017): *Financial crisis and regulatory reforms*. IngramSpark, Basel

Reddy, Y V (2010): "Regulation of the financial sector in developing countries: lessons from the 2008 financial crisis" in Griffith-Jones et al (2010)

------ (2012): "Society, economic policies and the financial sector" Per Jacobsson Lecture. Bank for International Settlements. June.

------ (2013): "Financial intermediation: asking new questions" in Y V Reddy *Economic policies and India's reform agenda* Orient Blackswan Private Limited, Hyderabad

------ (2017): *Advice and dissent* HarperCollins

Robertson, D H (1928/1966): "Theories of banking policy" Lecture at the LSE, 13 February 1928, reprinted in *Essays in money and interest* (1966) Collins, Fontana Library

Rotemberg, J (2014): "The Federal Reserve's abandonment of its 1923 principles", *NBER Working Paper*, 20507, September.

Shafer, J R (2013): "Five years later: lessons from the financial crisis" McGraw Hill Financial Global Institute

Shirakawa, M (2015): "Excessive debt and the monetary policy regime" *BIS Papers* no 80 January

Simon, J (2015): "Low interest rate environments and risk" Paul Woolley Centre for the Study of Capital Market Dysfunctionality Conference. Sydney. 8 October

Sinclair, P and W A Allen (2017): "Monetary policy normal, future and past" *National Institute Economic Review*. No 241, August

Skidelsky, R (2017) "How would Keynes have analysed the Great Recession of 2008 and 2009?" in *Money in the Great Recession*. Editor: T Congdon. Edward Elgar

Smets, F (2014): "Financial stability and monetary policy: how closely interlinked?" *International Journal of Central Banking*. 10(2)

Stiglitz, J E (2010): "The financial crisis of 2007-8 and its macroeconomic consequences" in Griffith-Jones et al (2010)

Summers, L (2006): "A lack of fear is a cause for concern" *Financial Times,* 27 December

Sundaresan, S, Z Wang and W Yang (2016): "Dynamics of the expectation and risk premium in the OIS term structure" March.

Svensson, L E O (2016): "Cost-benefit analysis of leaning against the wind: are costs larger and also with less effective macroprudential policy?" *IMF Working Paper*, WP/16/13, January.

--------- (2017): "Re-evaluating the result that the costs of "leaning against the wind" exceed the benefits" VOX 24 January

Taylor, J (2007): "Housing and monetary policy" Federal Reserve Bank of Kansas City. Jackson Hole Conference.

Thomas, R (2017): "UK broad money growth and nominal spending during the Great Recession: an analysis of the money creation process and the role of money demand" in *Money in the Great Recession*. Editor: T Congdon. Edward Elgar

Trichet, J-C (2008): "Macroeconomic policy is essential to stability" *Financial Times,* 13 November

Tucker, P (2014): "A new constitution for money (and credit policy)", Myron Scholes Lecture, Chicago School of Business, 22 May.

Turner, P (2010): "Central banks and the financial crisis", *BIS Papers,* no 51, March.

--------- (2013): "The benign neglect of the long-term interest rate", *BIS Working Papers,* no 403, February.

--------- (2014): "Is the long-term rate a policy victim, a policy variable or a policy lodestar?" in *Developments in macro-finance yield curve modelling*. Editors Chadha, J S, A C J Durré, M A S Joyce and L Sanio. Cambridge University Press.

--------- (2016): "Macroprudential policies, the long-term interest rate and the exchange rate" *BIS Working Paper* no 588. October.

--------- (2017): "Sovereign funds' message for regulators" *The Bulletin* October OMFIF

Von Weizsäcker, C C (2013): "Public debt and price stability" *German Economic Review* 15(1) pp 42-61

Wheeler, G (2014): "Reflections on 25 years of inflation targeting." Speech to a RBNZ and International Journal of Central Banking conference in Wellington. 1 December

Wolf, M (2014): *The shifts and the shocks* Penguin Press

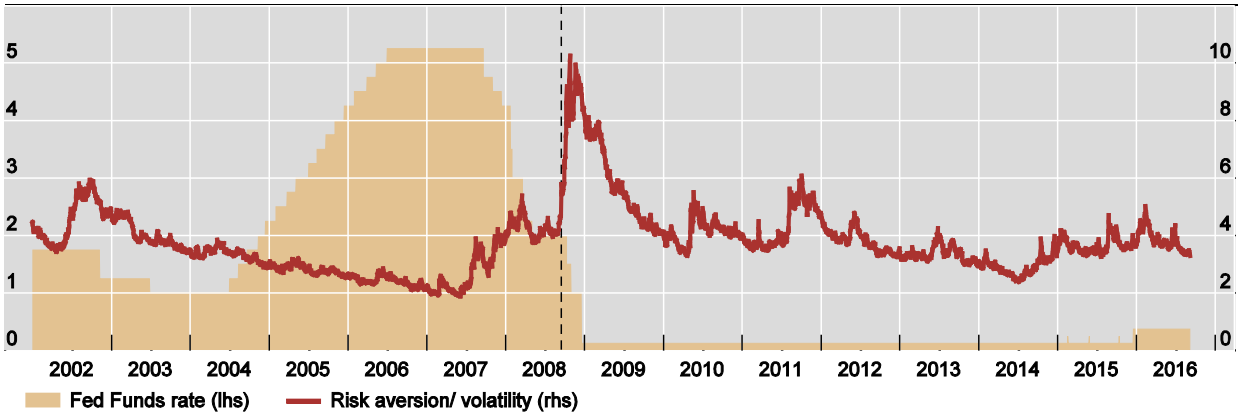
-------- (2017): "Unusual times call for unusual strategies from central banks" *Financial Times* 13 November

Yellen, J (2014): "Monetary policy and financial stability", 2014 Michel Camdessus Central Banking Lecture, IMF, Washington, DC, 2 July.

Annex

Risk-taking increases despite higher policy rates

Composite indicator of risk aversion/volatility renormalised as a credit spread[1] Graph 1



The shaded area represents the target federal funds rate. The vertical dotted line marks 15 September 2008 (the Lehman Brothers bankruptcy).

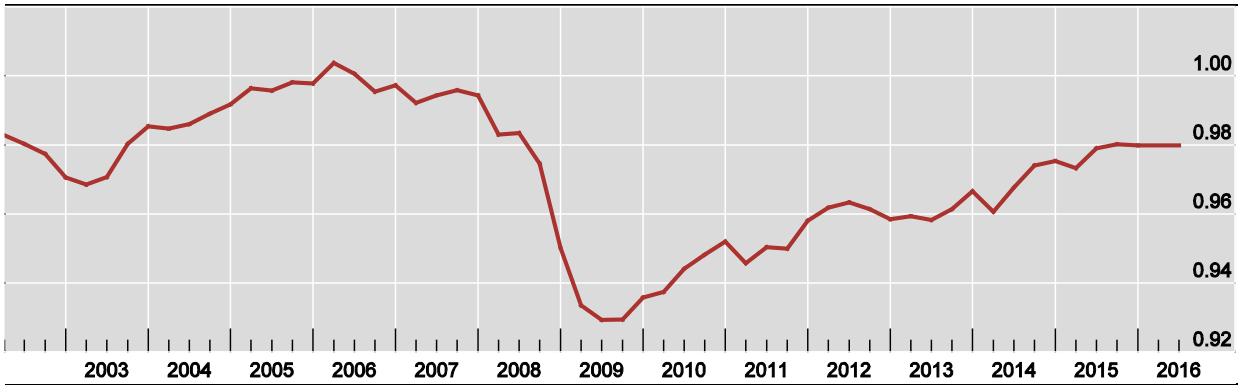
[1] Simple average of standardized scores of EMBI Global spread, US corporate high-yield spread, implied volatility of US equities (VIX index), implied volatility of US Treasury bonds (MOVE index), implied volatility of G10 exchange rates (JPMorgan GVXF7 index). Calculations cover the period 1 January 2002–31 August 2016.

Sources: Bank of America Merrill Lynch; JPMorgan; national data.

Macroeconomic determinants of the Federal funds rate

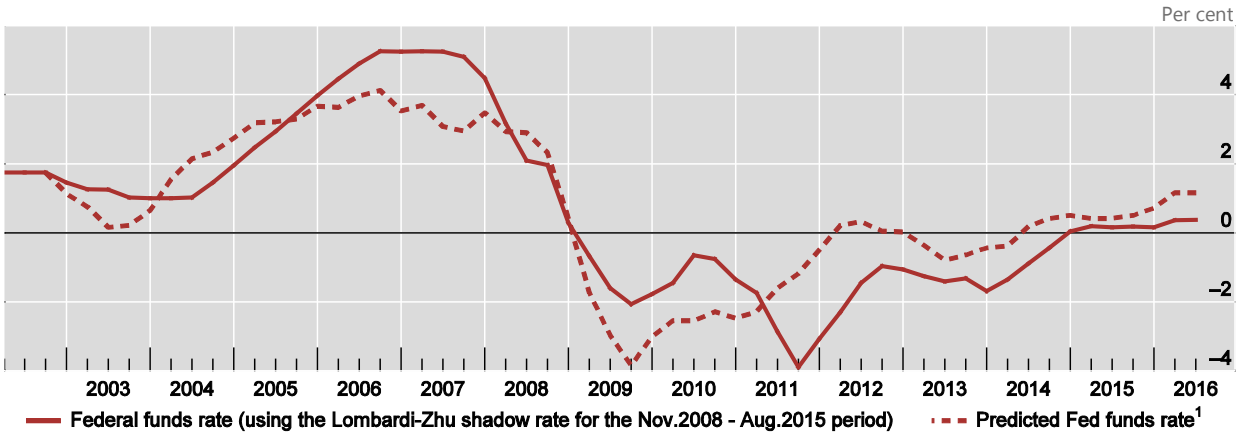
Graph 2

A. Real GDP/potential GDP



B. Core inflation, year-on-year growth

C. Federal funds rate: actual and predicted

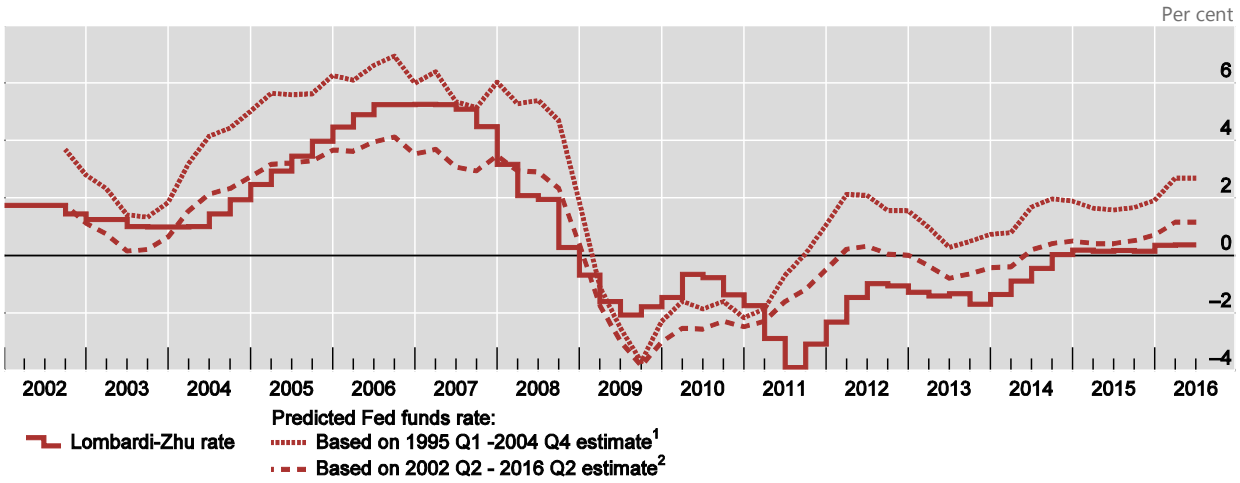


[1] Estimated equation: 0.755 log (Real GDP/potential GDP) + 1.815 (Core Inflation) -0.222.

Sources: Lombardi and Zhu (2014); national data

Federal funds rate: predictions from different estimation periods

Graph 3

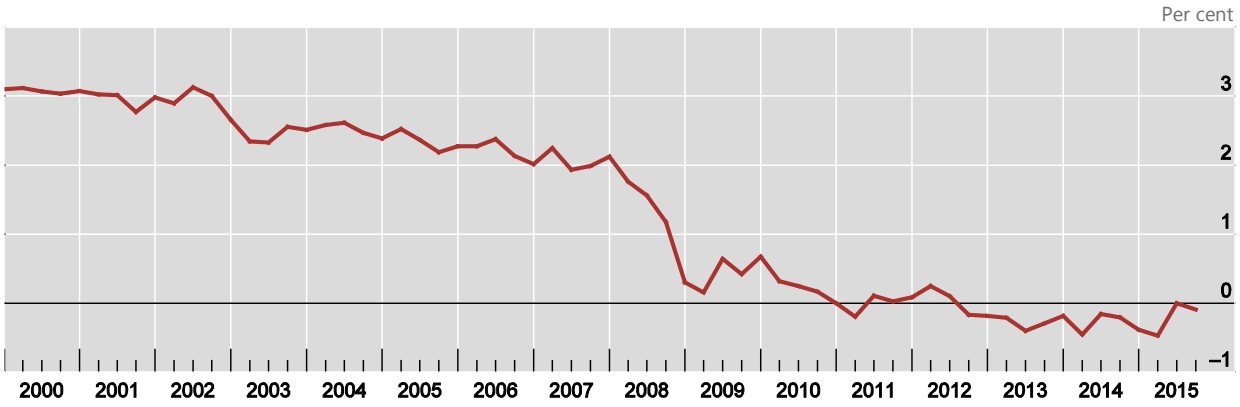


[1] Estimated equation: 0.863 log (Real GDP/potential GDP) + 3.155 (Core Inflation) -0.627. [2] Estimated equation: 0.755 log (Real GDP/potential GDP) + 1.815 (Core Inflation) –0.222.

Sources: Lombardi and Zhu (2014); national data

The real natural rate of interest in the United States

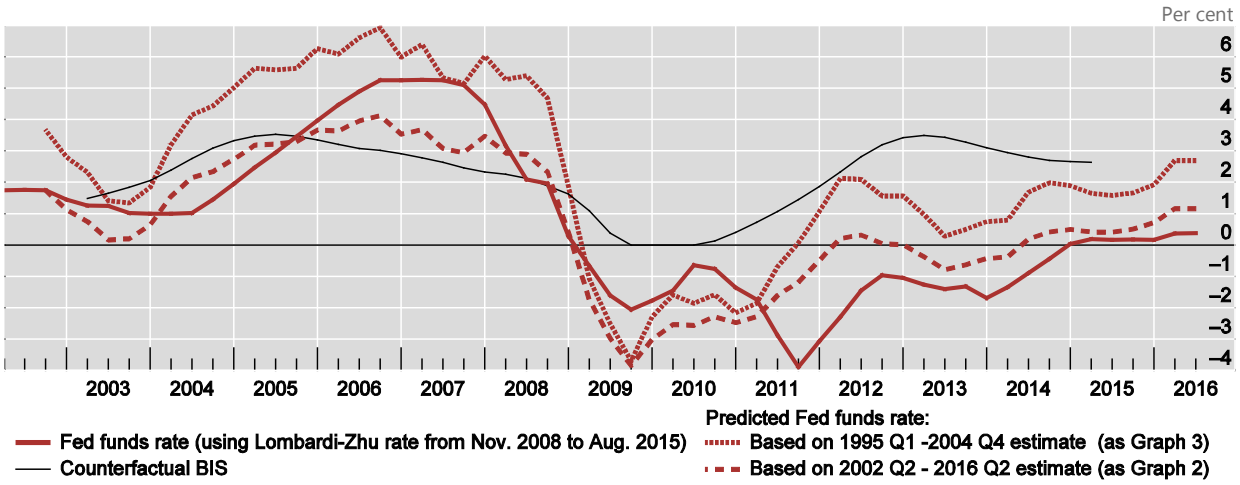
Graph 4



Source: Laubach and Williams (2015).

Federal funds rate: adding the financial cycle

Graph 5



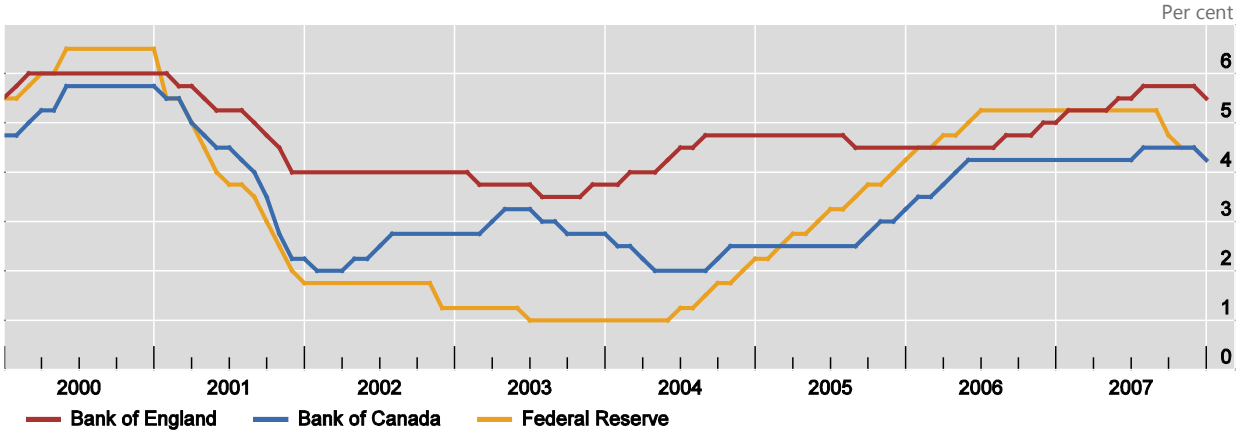
Predicted rate equations: as shown in graph 2 and 3.

Source: Author's calculation.

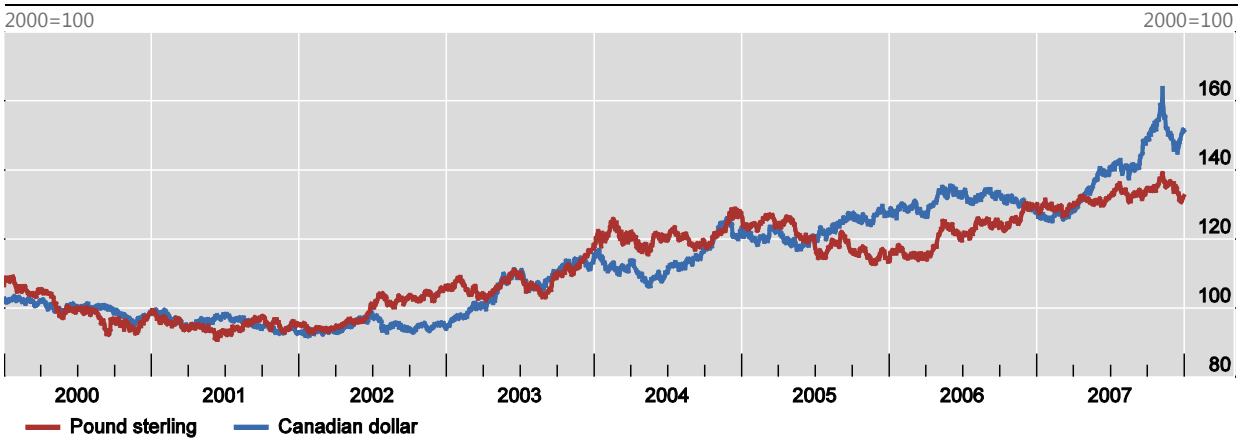
A comparison: Bank of England, Bank of Canada and the Federal Reserve

Graph 6

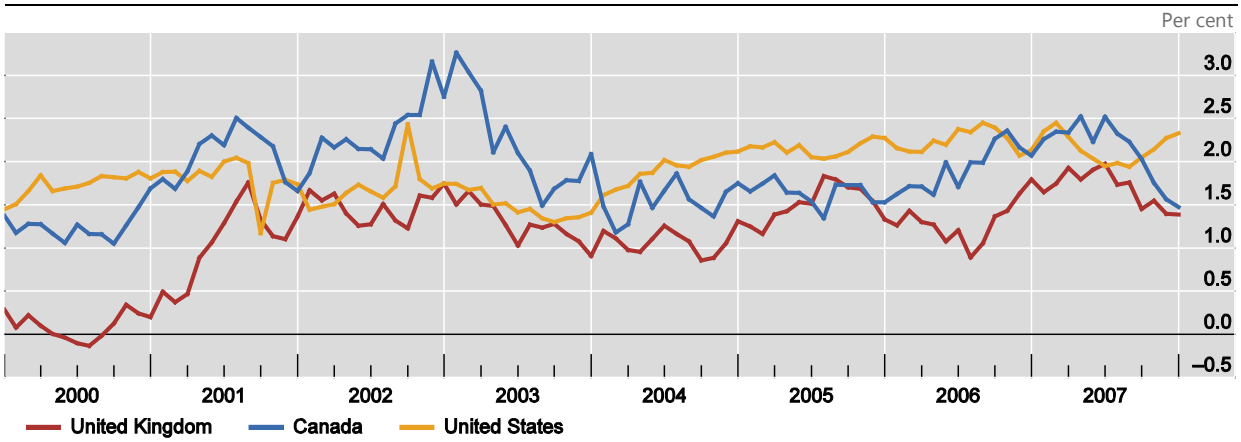
A. Policy rates



B. Exchange rate against the US dollar[1]



C. Core inflation, year-on-year change

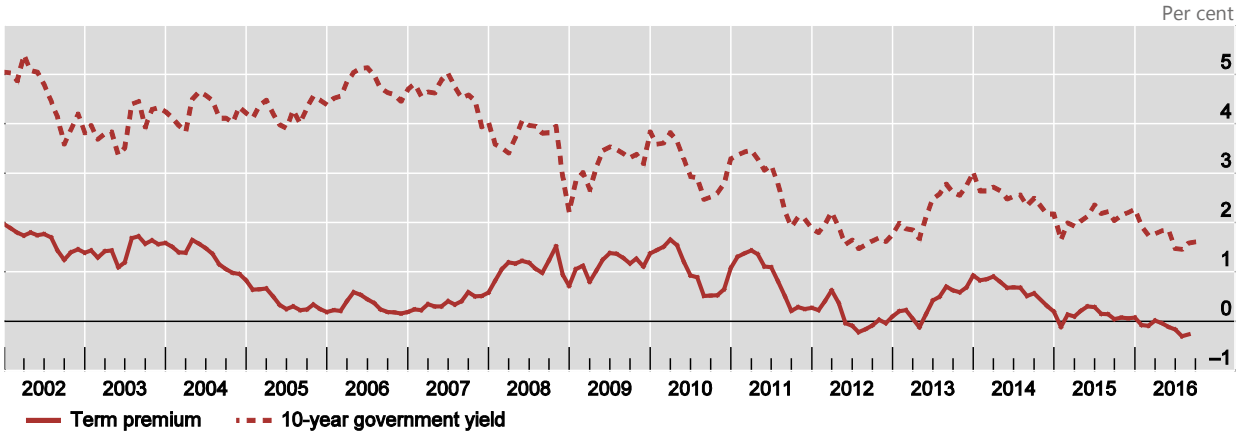


[1] An increase indicates an appreciation of the Pound Sterling and the Canadian dollar.

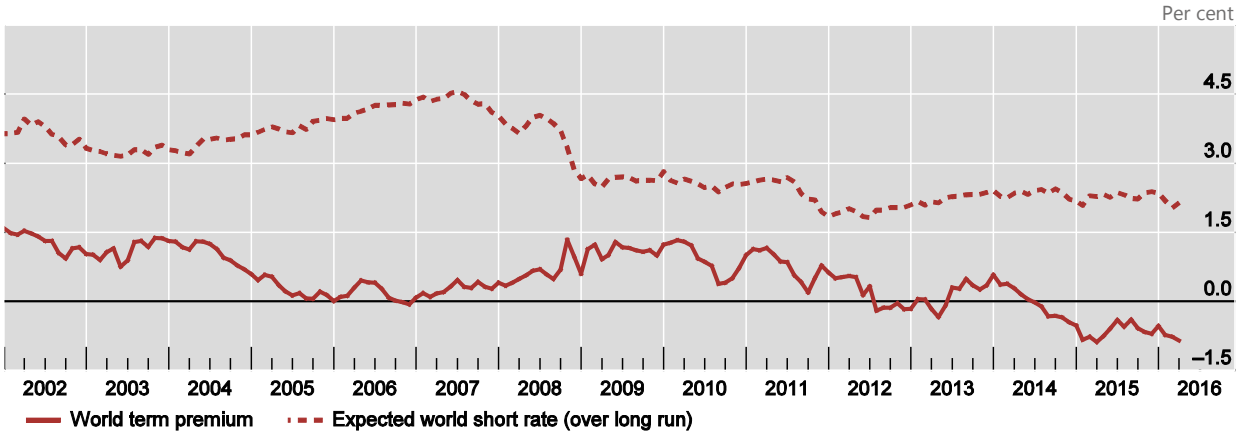
Sources: National data

United States 10-year government bond yield and term premium

Graph 7



Decomposition of 10-year world yield



The monthly estimates of the world long-term nominal term premium and the world nominal short rate over the long run are given in the annex of Hördahl et al (2016).

Source: Hördahl et al (2016).