National Institute of Economic and Social Research

TREASURY SELECT COMMITTEE INQUIRY INTO THE EFFECTIVENESS AND IMPACT OF POST-2008 UK MONETARY POLICY

Dr Angus Armstrong, NIESR, and commissioned by the Association of British Insurers

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National Institute of Economic and Social Research
2 Dean Trench St
London SW1P 3HE
T: +44 (0)20 7222 7665
E: enquiries@niesr.ac.uk
niesr.ac.uk
Registered charity no. 306083

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Treasury Select Committee Inquiry Into The Effectiveness And Impact Of Post-2008 UK Monetary Policy

Dr Angus Armstrong

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Contact details

Dr Angus Armstrong (a.armstrong@niesr.ac.uk), National Institute of Economic and Social Research, 2 Dean Trench Street, London SW1P 3HE

Treasury Select Committee Inquiry Into The Effectiveness And Impact Of Post-2008 UK Monetary Policy

By Dr Angus Armstrong, NIESR,[1] and commissioned by the Association of British Insurers

March 2017

Executive Summary

- In January 2009, the Chancellor authorised the Bank of England to purchase financial assets, predominantly government bonds, financed by issuing central bank reserves. Since March 2009 the Bank's Monetary Policy Committee (MPC) has purchased £435bn of government bonds (equivalent to 23% of 2016 nominal GDP). In August 2016 the MPC also announced purchases of up to £10bn of corporate bonds.

- QE has reduced longer-term gilt yields and, in turn, has boosted demand on a range of longer-term assets, such as corporate bonds and equities, resulting in higher asset prices. These price changes have had a particular and pronounced effect on pension funds and insurance firms.

- QE has also had implications for the asset and liabilities on pension and insurance funds' balance sheets. By reducing longer-term interest rates and increasing equity prices, these policies have served to boost the value of assets held by insurers (particularly life insurance companies) and pension funds. However, because the longer-term interest rates used to discount future liabilities have decreased, the liabilities of insurers and pension funds have also increased.

- Although the net effect of QE on the balance sheets of pension funds and insurance companies is unclear *a priori*, scenario analyses indicate that two factors have *interacted* with the low interest rate environment and QE to generate adverse effects. A fund is more likely to face a funding deficit – where the present value of their future liabilities exceeds the market value of their assets – following low interest rate policy and QE if: (i) they held a mix of bonds and equities from 2007 onwards; and/or (ii) if they were in deficit at the onset of the 2007-2008 financial crisis. In particular, the larger the deficit of fund at the onset of the financial crisis, the larger the detrimental impact of QE.

- Many individuals have defined contribution pension schemes and, upon retirement, buy annuities with their pension wealth to provide an income stream during retirement. Low interest rates and QE have also had competing effects on annuity income for those retiring since 2007. By reducing longer-term interest rates, QE has placed downward pressure on annuity rates, reducing the flow of income pensioners can attain. However, falling yields and rising equity prices have increased the value of retirees' pension funds, countering the impact of the price of annuities, depending on asset mix.

[1] I wish to thank Simon Lloyd for invaluable input and assistance with this report. Any errors are mine alone.

- Scenario analyses show that the initial phase of QE – between March 2009 and February 2010 – did not reduce income flows from an individual's pension pot. In fact, it served to offset some of the losses arising from the depressed equity prices during the financial crisis. Subsequent expansions of QE have reduced annuity income, offsetting an increase in asset values by interacting with the mix of bonds and equities held prior to retirement. The August 2016 expansion of QE through the purchase of £60bn of gilts served to reduce annuity income and widen funding deficits that may existed.

- Although scenario analyses indicate that QE has had a negative impact on those taking new annuities, those protected by Guaranteed Annuity Rates (GAR) have benefited from lower interest rates and higher asset prices with the corresponding costs falling on insurers. This form of protection is now much less common for new buyers of annuities. The Pension Freedom reforms have led to a lower share of longer-term savers annuitizing their pensions.

- Looking ahead, the primary challenge for insurance companies, pension funds and the long-term savings market is the interaction of low interest rates and increased life expectancy. With an ageing population, low interest rates magnify the present value of funds' future liabilities, posing challenges for the sustainability of the long-term savings market.

- Increased longevity risk has additional implications for insurance companies. Low interest rates make the hedging of longevity risk costlier, while placing negative pressures on the solvency of funds under the Solvency II Directive. Insurers' investment strategies typically match the sensitivity of their assets to those of their liabilities, but, under Solvency II, reductions in longer-term interest rates have caused increases in capital requirements over and above increases in liabilities, creating a trade-off between the valuation of long-term savings funds and their solvency.

Introduction

1. In response to the Global Financial Crisis, HM Government and the Bank of England introduced several unconventional measures to support the financial system and economy.[2] The Government authorised the Bank to create the Asset Purchases Facility (APF), with capacity to purchase an array of assets including government bonds, loans and securitised assets. In the event, the Bank purchased mostly gilts from businesses like pension funds and insurance companies financed by the issuance of central bank reserves. The aim of QE is to support the economy while aiming for the 2% CPI inflation target.[3] This policy is not unique to the UK; similar policies were enacted by other major central banks around the world.[4]

2. The Treasury sets an upper limit on the value of assets to be bought under QE and provides an indemnity to the Bank for any losses. Since the creation of the APF, the Monetary Policy Committee (MPC) has authorised the purchase of £435bn of gilts and up to £10bn of UK corporate bonds in total. Between March 2009 and January 2010, the MPC authorised the purchase of £200bn of gilts. This was around 30% of outstanding gilts held by the private sector at the time, and equivalent to 14% of nominal GDP. Subsequently, the MPC has authorised five further tranches of purchases of: £75bn in October 2011; £50bn in February 2012; £50bn in July 2012; and £60bn in August 2016, and up to £10bn of UK corporate bonds.

3. The MPC also reduced Bank Rate sharply from 5.5% at the start of 2008 to 0.5% in March 2009. Although monetary policy was exceptionally accommodative by historic standards, the MPC judged that, without additional monetary support nominal spending may yet be too weak to achieve the 2% CPI inflation target in the medium term. The Bank Rate was further reduced by 25 basis points to 0.25% in August 2016.

4. A sustained low interest rate policy and unconventional monetary policies have influenced a range of interest rates and asset prices. Short-term interest rates, such as the Sterling Overnight Interbank Average (SONIA), have reached historic low levels, predominantly reflecting movements in Bank Rate. Similarly, QE has reduced longer-term interest rates and bid-up a range of asset prices. Because the portfolios held by insurers and pension funds are tightly linked to movements in longer-term interest rates, this policy mix has had a notable impact on these sectors.

5. This report examines the impact of QE and low interest rates on the pensions and long-term savings markets. The first section of the report discusses the impact of QE on financial markets, focusing on movements in interest rates on asset prices. The second section discusses the extent to which QE has influenced the banking sector and housing market. The third section documents how the effects of low interest rate policy and QE have passed-through to the long-term savings markets, with an emphasis on life insurance and defined benefit pensions, as well as defined contribution pension schemes and annuities.

[2] In particular, in January 2009 the Government announced the Asset Purchase Facility (discussed here) and the Asset Protection Scheme which offered insurance on £550bn of so-called toxic assets in the banking system.

[3] The initial aim of QE in the heat of the crisis was to support bank lending to the corporate sector. This evolved into providing broader support for spending.

[4] See, for example, Bhattarai and Neely (2016), and the references within, for a survey of the effects of unconventional monetary policies in the US.

6. Extensive research has been carried out into the potential channels through which QE can affect spending and inflation.[5] The primary channel through which QE can stimulate the economy is by reducing longer-term interest rates, the *interest rate channel*. This is especially useful when Bank Rate, which is closely linked to a range of short-term interest rates, is at its effective lower bound. By purchasing mainly gilts, QE has served to reduce longer-term gilt yields, with implications for the interest rates and prices of a range of other longer-term assets. To explain this causal argument, the interest rate channel can be decomposed into three sub-components.

7. The first is the *portfolio balance* sub-channel. When the Bank purchases gilts, it issues central bank reserves. Unless these reserves are regarded as a perfect substitute for the gilts, the sellers will seek to rebalance their portfolios by buying other assets. This, in turn, will bid up the prices of a range of assets and reduce associated interest rates. Lower interest rates and higher asset prices can, in turn, stimulate spending by, *inter alia*, increasing the net wealth of asset holders or lowering borrowing costs for companies and households. The APF, via the Bank effectively buys a high yielding assets by issuing overnight and low yielding bank reserves. While both assets have the same credit risk, they do not have the same price risk (due to duration).

8. The second sub-channel pertains to the *signalling effects* of QE. To the extent that QE provides information about the future path of monetary policy, the policy can have signalling effects. For example, QE may have led market participants to expect policy rates to remain low for longer than would otherwise have been the case.[6] By propagating through the signalling channel, QE will reduce longer-term interest rates on a range of assets.

9. QE can also have *liquidity effects* – the third sub-channel. This can be expected to have been most effective at the height of the financial crisis, when markets were lacking liquidity. By furnishing the sellers of assets with central bank reserves, financial market participants were directly provided highly liquid assets with which they were encouraged to trade on financial markets. To the extent that QE had liquidity effects, the policy can be expected to increase asset prices by reducing an illiquidity premia.

10. The impact of QE on financial markets has been widely studied. Most papers use an event study approach to isolate the impact of announcements about QE on financial market prices. This methodology is applicable to QE, because financial market prices are likely to change when expectations of purchases are formed rather than when purchases are made due to the forward looking nature of financial markets.

11. Joyce, Lasaosa, Stevens and Tong (2010) study the impact of the Bank of England's first set of asset purchases from March 2009 to January 2010, which involved the purchase of £200bn of 5 to 25-year maturity gilts. They estimate that QE announcements during this period led to a cumulative fall in longer-term gilt yields of around 100 basis points. A number

[5] See, for example, Benford, Berry, Nikolov and Young (2009) and Joyce, Tong and Woods (2011).
[6] See Bhattarai, Eggertsson and Gafarov (2015) for a theoretical underpinning for the signalling sub-channel, and Lloyd (2017) for an empirical discussion of the efficacy of the channel.

of other studies corroborate this finding. Breedon, Chadha and Waters (2012) find that, between 2009 and 2010, QE lowered gilt yields, with approximately 50 basis points of the reduction associated with the portfolio balance channel. Meaning and Warren (2015) extend the analysis to study the cumulative effect of the first £375bn of asset purchases between March 2009 and July 2012. They find that the policy significantly reduced gilt yields throughout this period.

12. Lloyd and Meaning (2016) study the most recent extension of QE in August 2016. They conclude that the August 2016 monetary policy announcement significantly reduced government bond yields – the 10-year gilt yield fell by 16 basis points on the day. Because the 25 basis point cut in Bank Rate on that date was anticipated, this movement in interest rates is likely to be more closely associated with the expansion of the UK's QE programme. Haldane, Roberts-Sklar, Wieladek and Young (2016) reach a similar conclusion.

13. To the extent that other assets – such as corporate bonds and equities – are viewed as closer substitutes for government bonds than central bank reserves, investors can be expected to rebalance their portfolios towards these assets following QE (Benford et al., 2009). The lower interest rates also imply a lower discount rate to apply to financial assets. This would be expected to place upward pressure on asset prices, downward pressure on other yields, and downward pressure on sterling.

14. Haldane et al. (2016) study the impact that QE had on a range of asset prices. They document that QE announcements, between March 2009 and August 2016, were associated with reductions in sterling investment-grade corporate bond yields that were comparable in magnitude to the reductions in gilt yields. However, there were larger reductions in sterling high-yield corporate bond yields – averaging about 150 basis points. Haldane et al. (2016) also conclude that, although the reaction of equity prices was not uniform across QE announcements, they do, in general, increase with QE interventions.

15. There is a wealth of evidence illustrating that US QE announcements led to a dollar depreciation versus a range of other currencies (Glick and Leduc, 2013; Rogers, Scotti and Wright, 2016). However, empirical evidence on the influence of UK QE on the sterling exchange rate is less clear cut because of the concurrent nature of QE in the US. Ashworth and Goodhart (2012) indicate that the sterling exchange rate might have been 5% higher if the Bank of England had not initiated the first round of QE between March 2009 and February 2010. However, because of simultaneous US QE, the actual sterling exchange rate changed very little over this period. Weale and Wieladek (2016) find that US QE led to a significant depreciation of the dollar real exchange rate, while UK QE had a statistically insignificant effect on the sterling real exchange rate.

16. On August 4, 2016, the MPC announced a corporate bond purchase scheme of up to £10bn of UK corporate bonds. This came as a surprise to many market participants. Haldane et al. (2016) find that, on the day of the announcement, sterling non-financial investment grade spreads fell by 10 basis points. There was also a reduction of bond spreads for financial firms, although this may have been influenced by the simultaneous announcement of the Term Funding Scheme. Haldane et al. (2016) suggest that the UK's corporate bond purchase

scheme may have had an influence on the issuance of corporate debt, which picked-up sharply following the announcement.

17. In sum, there is an array of evidence to indicate that UK QE reduced longer-term interest rates on gilts and corporate bonds, and increased equity prices. In turn, there is evidence to suggest that the policy supported aggregate economic activity. However, it ought to be noted that QE is intended to be a temporary measure and the Bank's balance sheet reduced when economic conditions allow. To that extent, the evidence thus far is of one leg of QE.

Whilst there have been attempts to measure the impact on the wider economy, it is difficult to isolate the changes in policy to changes in economic activity with precision as other major policies were occurring at the same time. For example, in 2009 the Government introduced the Asset Protection Scheme which offered insurance on over £500bn of toxic banking sector assets and a modest fiscal stimulus. Joyce et al. (2011) estimate that the initial £200bn of asset purchases may have raised the level of real GDP by 1.5-2% relative to what it might otherwise have been, and increased CPI inflation by 0.75-1.5 percentage points.

Section 2: QE, the Banking Sector and House Prices

18. There are many channels through which the lower yields induced by QE can influence the economy. QE may affect banks' portfolios and balance sheets and, in turn, stimulate the real economy through a *bank lending channel*. When assets are purchased from non-banks, the banking sector will gain new reserves and a corresponding increase in customer deposits. Higher levels of liquid assets on banks' balance sheets might have been expected to foster enhanced financial stability and even encourage the extension of more new loans than would otherwise have been done.

19. Butt, Churm, McMahon, Morotz and Schanz (2014) test whether QE provided a boost to bank lending in the UK, over and above its effect on asset prices. They find no evidence that QE boosted bank lending. Their empirical approach is able to control for concurrent changes in the banking sector, such as regulation. Instead, they conclude that their evidence is consistent with studies that suggest QE stimulated economic activity through a portfolio balance channel.

20. There is limited empirical evidence documenting the influence of QE on housing and real estate values. While lower interest rates imply a lower user cost of capital and higher property prices, the identification of house and real estate price effects is challenging because, unlike financial market prices which move within seconds of an announcement, property prices change slowly. Because of this, we discuss the efficacy of a number of channels through which QE might have been affected to influence property prices.

21. The first channel pertains to bank lending. If QE did stimulate increased bank lending, then one might expect QE to boost property prices, house prices especially, as long as lending was directed to mortgages and housing loans. However, because there is limited evidence on the transmission of QE through the bank lending channel, it is unlikely that QE had significant impact on house prices through this mechanism other than those areas where buyers may not require a mortgage or foreign buyers.

22. Notwithstanding this, there are other channels through which QE might be expected to influence housing values. For instance, QE might be expected to boost property prices through the portfolio balance channel, if real estate ownership is a component of investors' asset portfolios. M&G (2015) argue that QE has placed downward pressure on real estate yields, as investors have search for yield across various asset classes following QE. Standard and Poor's (2016) argue that QE has placed upward pressure on house prices, although they indicate that this has primarily been propagated through lower interest rates and mortgage lending – in direct contrast to the implication of the results in Butt et al. (2014).

23. In sum, the evidence of QE's effects on house and real estate prices is limited. Although one might expect QE to stimulate mortgage lending, there is limited evidence that this occurred in the UK. Nevertheless, to the extent that real estate forms part of an investor's diverse portfolio of assets, QE may still have boosted real estate values through a portfolio balance channel. We exclude the direct impact of QE on property prices because of the lack of clear evidence between QE announcements and property price changes. The extent to which there is a causal link would clearly have significant inter-generational and regional distributional consequences.

Section 3: The impact of QE on Insurance and Pension Funds

24. Low interest rate policy and QE can be expected to influence different types of savers in different ways. This report focuses on the implications of the policies for insurance companies (particularly life insurance companies) and pension providers. The majority of the analysis is on three sectors of the long-term savings and insurance market:

    i. defined benefit (DB) pension schemes, and associated pension funds, that pay out based on final or career-average salaries;

    ii. life insurance companies;

    iii. defined contribution (DC) pension schemes, where individuals and their employers pay fixed contributions per period and, upon retirement, typically purchase an insurance (or annuity) contract paying out a stream of payments for the remainder of their life.

25. The financial health of insurance companies and pension funds has important implications for a sizeable fraction of the population. In 2015, 26.9 million protection products – such as term life, whole of life, relevant life, income protection and critical illness insurance policies – were in force and 15.1 million employees were contributing to a pension (Association of British Insurers, 2016). Similarly, pensioners constitute a large share of the UK population. In mid-2010, around 17% of the population were 65 or over.[7] Towers Watson (2016) indicate that both DB and DC schemes are important aspects of the UK pension markets: 68% of UK pensions in DB schemes and 32% in DC schemes in 2015.

[7] Data Source: Office for National Statistics, www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2015.

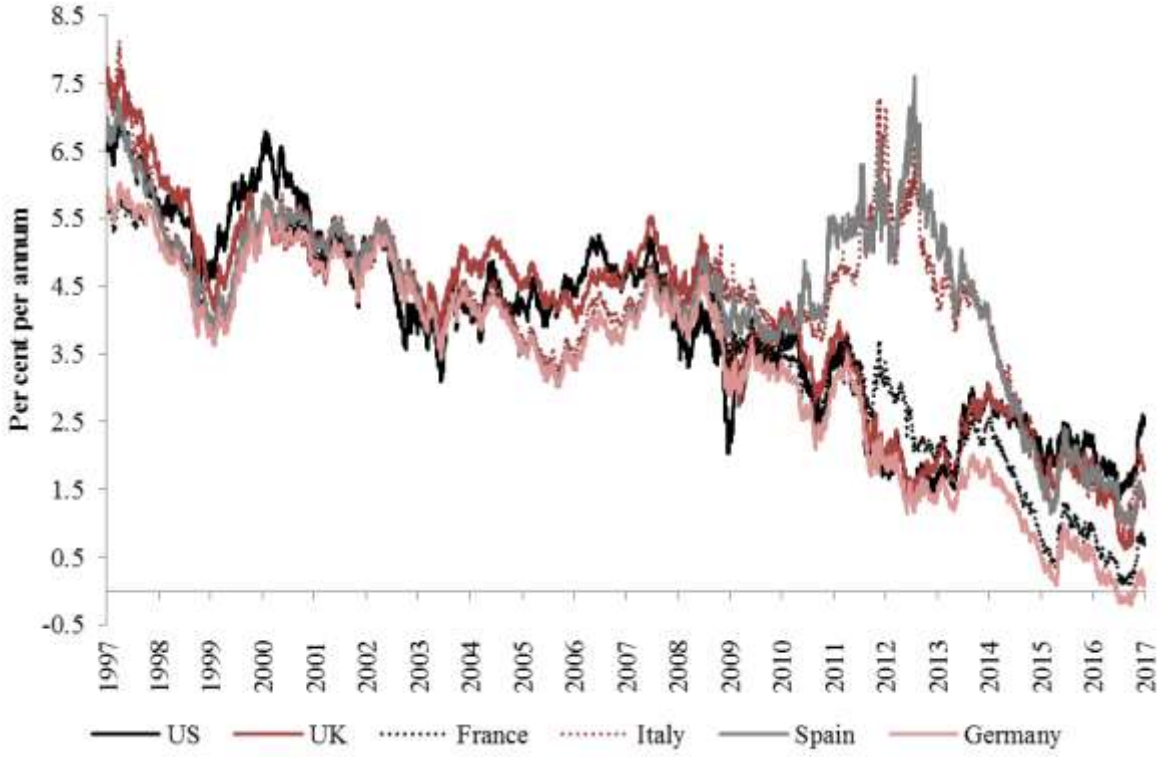
26. As the Bank of England (2012) point out, the pension incomes of people who had already retired prior to the start of the 2007-2008 global financial crisis will not have been adversely affected by QE. Some retired individuals may even have benefited from rising asset prices due to QE, if they were net holders of financial wealth. In particular, they may have benefitted from rising housing wealth mentioned above. However, Bank of England (2012) state that "[t]hose who have reached the State Pension age since mid-2008 will have potentially been more affected" (p.12).

27. It should be noted that QE has been one of many factors affecting insurers and pension funds. Although UK monetary policy has put downward pressure on gilt yields, it cannot explain all of the fall. In the past decade, there has been a similar fall in government bond yields internationally (see **figure 1**), which has been attributed to a range of factors, including a growth in the stock of savings from emerging market economies such as China.[8] Moreover, sustained growth in average life expectancy has raised the average costs faced by pension providers and increased the amount that people need to save for retirement, placing further downward pressure on longer-term interest rates (Gottfries and Teulings, 2015).

28. To illustrate the effects of low interest rate policy and QE on insurance companies and pension funds, we use scenario analysis. Before presenting the scenario analysis, we describe the features of DB pension funds and insurance companies, and discuss the channels through which low interest rate policy and QE could impact upon both the asset and liability-side of funds' balance sheets.

Figure 1 – Nominal yields on 10-year government bonds

[8] See Meaning and Piggott (2016), and the references within, for a discussion of these factors.



Source: Thomson Reuters Datastream

Defined Benefit Pension Funds

29. **Figure 2** presents a stylised balance sheet for a DB pension fund. DB funds hold a range of assets, predominantly government debt, corporate bonds and equity. The liabilities of a DB pension fund pertain to the expected future pension payments. Because these future payments are subject to uncertainty – most notably about the length of their payment ('longevity risk') – the employer bears the lion's share of risk under a DB scheme. Future liabilities are discounted using longer-term interest rates, and the discounted value of future cash flows will be increasing in the average life expectancy in the economy. Because DB pension funds discount future liabilities with longer-term interest rates, their balance sheet is exposed to movements in yields generated by QE.

Figure 2 – A Stylised Balance Sheet for Defined Benefit (DB) Pension Funds

Assets	**Liabilities**
Government Debt (B_G)	Discounted Future Pension Payments (L)
Corporate Bonds (B_C)	
Equity (E)	Deficit ($D=L-B_G-B_L-E$)

30. Lower interest rates and QE have competing effects on the balance sheets of DB pension funds. On the one hand, to the extent that QE lowers gilt yields and bids up equity prices,

the value of funds' assets can be expected to increase. However, simultaneously, diminished interest rates will increase the liability-side of funds' balance sheets, by lowering the rate at which future payments are discounted.

31. Antolin, Schich and Yermo (2011) note that the impact of low interest rates and QE on DB pension funds is largest when future payments are fixed. If a DB pension fund offers payments linked to salaries or inflation, the low interest rate environment combined with lower inflation will reduce the future benefits to be paid. Nevertheless, such funds will also face a reduction in their discount rate, meaning that, in practice, the influence of policy has been attenuated, rather than reversed in sign.

32. The present value of future liabilities is increasing in the average life expectancy of the population, because pension payments will persist for longer as people live to older ages. Because of this, rising life expectancies pose an important longer-term challenge for DB pension funds. Moreover, this challenge is magnified by the current low interest rate environment, as it reduces the rate at which future liabilities are discounted, and so increases the present value of current liabilities.

Life Insurance Companies

33. Like DB pension funds, life insurance companies hold a range of assets, including government debt, corporate bonds and equity, as the stylised balance sheet in **figure 3** indicates. Moreover, life insurance companies discount future cash flows, arising from insurance payments, using a discount rate linked to the long-term interest rate.

Figure 3 – A Stylised Balance Sheet for Life Insurance Companies

Assets	**Liabilities**
Government Debt (B_G)	Discounted Future Insurance Payments (L)
Corporate Bonds (B_C)	
Equity (E)	Capital ($K=L-B_G-B_L-E$)

34. The impact of low interest rates and QE on insurance companies is likely to be similar to their effects on DB pension funds. On the one hand, QE can boost the value of insurance companies' assets. However, depressed longer-term interest rates will simultaneously increase the value of their liabilities.

35. Joyce, Liu and Tonks (2014) study the response of insurance companies and pension funds' portfolios to QE in the UK. They use detailed micro-level data and find that, in response to QE, institutional investors rebalanced their portfolios, reducing their allocation to gilts and increasing their allocation to corporate bonds. These results are consistent with the hypothesis that QE resulted in some portfolio rebalancing. However, they note that portfolio rebalancing was limited to corporate bonds, with evidence that institutional investors moved out of equities during the period of QE purchases.

36. The impact of QE on life insurance funds is also likely to interact with increases in average life expectancy because, like DB pension funds, the liabilities of life insurance fund are subject to longevity risk. International Monetary Fund [IMF] (2016) state that "[the outlook for many insurance companies have continued to deteriorate in 2016 as expectations for an extended period of low interest rates have deepened" (p. 24), emphasising that UK insurers face increasing longevity risk related to increases in the life expectancy of policyholders.

37. The concurrence of low interest rates, QE and increases in average life expectancy have posed additional challenges for life insurance companies in light of Solvency II, an EU directive that codifies and harmonises insurance regulation which came into effect on January 1 2016. Solvency II is designed to reflect the new risk management practices of insurance companies in the design of capital requirements, and to reflect market consistent principles in the valuation of liabilities through the design of the Risk Margin. Under Solvency II, insurers need to hold enough capital to have 99.5% confidence they could cope with the worst expected losses over a year. As such, insurers must hold enough capital to cover both their market and non-market risks, amongst which longevity risk is one of the most pertinent for life insurers. Additionally, the introduction of the Risk Margin, intended to represent a transfer value in respect of non-market risks such as longevity risk, increases the value of liabilities. This further reduces the value of free assets.

38. When interest rates are lower, the cost of insuring longevity risk is higher because future liabilities are discounted at a lower interest rate. The capital requirement for longevity risk is therefore also higher and, further, there is a 'knock on' impact for the Risk Margin which is higher too. Therefore, under Solvency II, lower interest rates increase both the value of liabilities and the quantity of capital that insurers need to hold to insure their non-market risk, creating a trade-off between the fund's valuation and its solvency. The highly sensitive nature of these movements to interest rates can generate volatility, which is a challenge to manage, dis-incentivises the insuring of longevity risk, and acts pro-cyclically.

39. IMF (2016) state that, for UK insurers, "low rates are straining their ability to control longevity risk (resulting from increased life expectancy of policyholders) because of the higher cost of hedging" (p. 24). Although solvency concerns were raised in the 2014 stress tests of European Insurers (IMF, 2015), the current interest rate falls below the rate used for the adverse scenario used in those tests – namely the Quantitative Impact Studies (QIS) of the European Commission. Bank of England (2016a) estimate that a 50 basis point interest rate change will affect insurers' Risk Margin (part of the insurance liability) by 20%, generating excess volatility in solvency positions. The Bank has also noted that the Risk Margin's sensitivity to interest rates "could incentivise procyclical investment behaviour" (Bank of England, 2016b, p. 49).

Scenario Analysis for Defined Benefit Pension Funds and Life Insurance Companies

40. To study the longer-term impact of low interest rates and QE on DB pension funds and life insurance companies, we carry out scenario analyses, describing the evolution of a stylised balance sheet with respect to changes in longer-term interest rates since 2008. Our scenario

analysis builds on table 2 of Bank of England (2012). We extend their analysis to study the effects of recent monetary policy changes – most notably further QE and the lowering of Bank Rate in August 2016.

41. The illustrative scenarios in **table 1** predominantly pertain to DB pension funds, demonstrating how their deficits evolve over time, and measuring the extent to which these changes have been driven by QE *vis-à-vis* other factors. The table presents outcomes for three hypothetical funds. The first scheme ('scheme 1') portrays a balance sheet that was fully-funded in March 2007, holding £100 million in assets and liabilities. Moreover, the assets comprise only long-term bonds, such that the expected future cash flows from the assets match the expected liabilities. Because, under regulation, insurance funds must always be fully-funded, scheme 1 represents the illustrative scenario for insurance firms too. 'Scheme 2' differs by considering a fund that was fully-funded in March 2007 that holds a varied asset portfolio, investing 60% of it in equity and 40% in bonds. Finally, the fund in 'scheme 3' has the same asset breakdown as scheme 2, but enters March 2007 with a £30 million deficit – it was under-funded in March 2007.

42. We do not distinguish between government and corporate bonds in the analysis because evidence in Haldane et al. (2016) indicates that QE announcements were associated with reductions in sterling investment-grade corporate bond yields that were comparable in magnitude to the reductions in gilt yields. Bond values are assumed to move in line with 15-year nominal zero-coupon gilts, and this interest rate is also used to discount funds' future liabilities. Equity values are assumed to follow the FTSE All-Share index. As many companies in the FTSE have overseas affiliates, the movements in the index include any change in the currency on the valuation of overseas earnings. Therefore, the currency response on portfolios is at least partly included.

43. **Table 1** presents changes in the deficit of each illustrative fund from March 2007 to the following eight dates: February 2009, prior to the start of QE; February 2010, after the first £200bn of assets were purchased; September 2011, just before the first extension of the APF; May 2012, after the completion of a further £125bn of purchases; May 2016, prior to the UK referendum; June 2016, after the UK referendum and prior to further QE; August 2016, following the announced extension of QE by £60bn; and January 2017, following increases in longer-term interest rates during the latter half of 2016 (Piggott, 2017).[9]

44. In the bottom half of **table 1**, we trace out the specific impact of QE by calculating a counterfactual that makes the following assumptions. Between March 2009 and January 2010, we assume that the £200bn of QE reduced gilt yields by 100 basis points and increased equity prices by 20% (Joyce et al., 2011). We assume that the £175bn QE programme between October 2011 and May 2012 had the same proportionate impact, leading to a 87.5 basis point fall in gilt yields and a 17.5% rise in equity prices. We assume that the £60bn QE programme of August 2016 reduced gilt yields by 16 basis points (Lloyd and Meaning, 2016), but do not admit changes in equity prices due to their heightened volatility around the UK referendum. These counterfactuals illustrate that QE served to increase the value of funds'

[9] Importantly, the scenario analyses assume that there is no further accrual of new benefits/business written in this period. However, the cost of this has increased dramatically over the 2009-2016 period as interest rates have fallen.

assets by increasing the price of gilts and equities, but simultaneously increased the value of funds' liabilities by reducing the discount rate applied to *future* payments. The difference between the total impact and that due to QE can be interpreted as a residual, attributable to range of other factors including the low interest rate environment that has persisted in the UK since March 2009, as well as the sharp fall in equity prices during the 2007-2008 financial crisis and other global factors.

45. The results from scheme 1 show that if a pension fund was fully-funded prior to the 2007-2008 financial crisis, and held bonds with coupon payments that exactly matched the future flow of its liabilities, then changes in gilt yields due to QE had no net effect on the fund's deficit at any time.[10] The fund held £100 million of bonds and £100 of liabilities in March 2007, such that the expected future payments matched the expected future cash flows from its assets. Although QE served to increase the value of the fund's liabilities, it had an equal effect on the value of the fund's assets. Because the scheme is fully-funded, this reasoning holds for all changes in gilt yields, so the deficit of the fund is £0 at all dates.

46. However, even though the deficit of this fund remains at £0 at all dates, it does not mean that an insurance fund akin to the one in scheme 1 was entirely unaffected by low interest rates and QE. Under Solvency II, insurers most hold sufficient capital to cover both their market and non-market risks, including longevity risk. The cost of hedging this longevity risk is inversely related to the interest rate. When interest rates are lower, the capital requirement for longevity risk is higher and there is a further increase in the Risk Margin. Therefore, under Solvency II, lower interest rates increase both the value of liabilities and the quantity of capital that insurers need to hold to insure their non-market risk.

47. Schemes 2 and 3 demonstrate that the net impact of QE on pension funds' overall position reflects two factors that interact with QE's impact on the asset and liabilities-sides of funds' balance sheets.

48. First, scheme 2 illustrates that QE's net impact on funds' deficits depends upon the extent to which there is a mismatch between funds' assets and liabilities, even though this hypothetical scheme is fully-funded. Although the fund's assets match its liabilities in March 2007, a deficit immediately opens up over the financial crisis, reaching £26.4 million in February 2009. This predominantly reflects the large fall in equity prices during the 2007-2008. By February 2010, the deficit narrows to £9.6 million, with the decomposition indicating that the initial £200bn of QE served to improve the fund's net position, boosting asset values by more than it increased liabilities. By May 2012, the deficit of the fund in scheme 2 reaches £32.6 million (a cumulative loss of almost one third in value). Of this, £26.4 million is associated with factors other than QE. The £6.1 million associated with QE arises because, since the fund was in deficit by February 2009, QE acted to increase the absolute value of liabilities by more than it acted to increase the absolute value of assets.

[10] In reality, it is unlikely that a fund will create an asset strategy that exactly matches the future flow of liabilities, because there are many unknowns to consider – most pertinently, longevity risk – as well as the influence of changes in the regulatory environment (e.g. the pension freedom reforms, which changed the way customers want to access their pensions).

49. The second column of **table 1** indicates that the events of 2016 served to widen the funding deficit of the fund in scheme 2 further. In particular, the deficit reaches its peak in August 2016, at £34 million, following the most recent expansion of QE. The decomposition of this deficit indicates that the August 2016 QE programme widened the fund's deficit.

50. Second, scheme 3 demonstrates that, if a fund was in deficit at the onset of the 2007-2008 financial crisis, QE has played a role in widening that deficit. This has occurred because QE, although QE has proportional effects on assets and liabilities, the absolute effect on liabilities will dominant the absolute effect on assets. Thus, any detrimental impact of QE on funding positions can be expected to be increasing in the size of a fund's pre-existing deficit prior to the 2007-2008 financial crisis.

51. The third column of **table 1** shows that the results for scheme 3 are similar to the results for scheme 2. The fund is initially in a £30 million deficit in March 2007, which widens to £49.3 over the financial crisis. In February 2010, the deficit narrows to £36.6 million, although, unlike for scheme 2, QE does not serve to improve the fund's position. Of the £6.6 million growth in the fund's deficit between March 2007 and February 2010, £4.1 million is attributed to QE and £6.1 million due to other factors.

52. As for scheme 2, the deficit reaches a peak in August 2016 – of £74.5 million in this case. Of the £44.5 million increase in the fund's deficit between March 2007 and August 2016, £25.8 million is associated with QE – much greater than the fully funded case. However, the deficit fell to £57.3 million by the end of January 2017, closer to September 2011 levels, predominantly because of the recent pick-up in longer-term interest rates.

53. Faced with similar illustrative results for the 2007-2012 period, Bank of England (2012) highlight some implications of their results, which remain applicable here. First, they emphasise that these changes would have no implications for existing pensioners prior to the start of QE on a DB scheme. However, because employers bear increases in DB pension costs in the first instance, they might seek to counteract increases in costs by cutting other staffing costs, such as pay. For example, individuals on a final salary DB pension scheme might receive smaller pay rises than they had been expecting, or close the pension scheme, potentially reducing future retirement income.

54. Antolin et al. (2011) emphasise that low interest rates and QE may also have potential implications for financial stability. Because funds face widening deficits, as **table 1** depicts, they state that "the main concern is that insurers and pension funds affected by lower interest rates will seek higher yields via riskier investments" (p. 3) by, for example, rebalancing their portfolios into credit structures that are more complex.

Table 1 Scenarios for Insurance Companies and Defined Benefit Pension Schemes (£mn)

	Scheme 1 *Fully-funded Mar. 2007* *100% Bonds*			Scheme 2 *Fully-funded Mar. 2007* *40% Bonds, 60% Equity*			Scheme 3 *30% Deficit Mar. 2007* *40% Bonds, 60% Equity*		
	Assets	Liab.	Deficit	Assets	Liab.	Deficit	Assets	Liab.	Deficit
Mar. 2007	100	100	0.0	100	100	0.0	70.0	100	-30.0
Feb. 2009	102.8	102.8	0.0	76.4	102.7	-26.4	53.5	102.8	-49.3
Feb. 2010	99.4	99.4	0.0	89.8	99.4	-9.6	62.9	99.4	-36.6
Sep. 2011	124.0	124.0	0.0	98.1	124.0	-25.9	68.7	124.0	-55.3
May 2012	138.5	138.5	0.0	106.0	138.5	-32.6	74.2	138.5	-64.4
May 2016	146.8	146.8	0.0	121.4	146.8	-25.4	85.0	146.9	-61.9
Jun. 2016	158.0	158.0	0.0	127.5	158.0	-30.6	89.2	158.0	-68.8
Aug. 2016	169.2	169.2	0.0	135.2	169.2	-34.0	94.7	169.2	-74.5
Jan. 2017	148.8	148.8	0.0	130.7	148.8	-18.1	91.5	148.8	-57.3
Change Mar. 2007 to Feb. 2009									
Total	2.8	2.8	0.0	-23.6	2.8	-26.4	-16.5	2.8	-19.3
Due to QE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	2.8	2.8	0.0	-23.6	2.8	-26.4	-16.5	2.8	-19.3
Change Mar. 2007 to Feb. 2010									
Total	-0.6	-0.6	0.0	-10.2	-0.6	-9.6	-7.1	-0.6	-6.6
Due to QE	15.4	15.4	0.0	16.2	15.4	0.8	11.3	15.4	-4.1

Other	-16.0	-16.0	0.0	-26.4	-16.0	-10.4	-18.4	-16.0	-1.6
Change Mar. 2007 to Sep. 2011									
Total	24.0	24.0	0.0	-1.9	24.0	-25.9	-1.3	24.0	-25.3
Due to QE	19.5	19.5	0.0	17.5	19.5	-2.0	12.3	19.5	-7.2
Other	4.5	4.5	0.0	-19.4	4.5	-23.9	-13.6	4.5	-18.1
Change Mar. 2007 to May 2012									
Total	38.5	38.5	0.0	6.0	38.5	-32.6	4.2	38.5	-34.4
Due to QE	44.3	44.3	0.0	35.7	41.8	-6.1	25.7	44.3	-18.6
Other	-5.8	-5.8	0.0	-29.7	-3.3	-26.4	-21.5	-5.8	-15.7
Change Mar. 2007 to May 2016									
Total	46.8	46.8	0.0	21.4	46.8	-25.4	15.0	46.8	-31.9
Due to QE	47.1	47.1	0.0	41.3	44.5	-3.2	29.6	47.1	-17.5
Other	-0.3	-0.3	0.0	-19.9	2.3	-22.2	-14.6	-0.3	-14.3
Change Mar. 2007 to Jun. 2016									
Total	58.0	58.0	0.0	27.5	58.0	-30.6	19.2	58.0	-38.8
Due to QE	51.0	51.0	0.0	43.4	48.2	-4.8	31.1	51.0	-19.9
Other	7.0	7.0	0.0	-15.9	9.8	-25.7	-11.9	7.0	-18.9
Change Mar. 2007 to Aug. 2016									
Total	69.2	69.2	0.0	35.2	69.2	-34.0	24.7	69.2	-44.5
Due to QE	60.4	60.4	0.0	49.5	60.4	-10.9	34.6	60.4	-25.8
Other	8.8	8.8	0.0	-14.3	8.8	-23.1	-9.9	8.8	-18.7
Change Mar. 2007 to Jan. 2017									
Total	48.8	48.8	0.0	30.7	48.8	-18.1	21.5	48.8	-27.3
Due to	52.6	52.6	0.0	47.7	52.6	-4.9	33.4	52.6	-19.2

QE									
Other	-3.8	-3.8	0.0	-17.0	-3.8	-13.2	-11.9	-3.8	-8.1

Notes: These figures depict illustrative scenarios for the evolution of insurance/DB pension funds' balance sheet between 2007 and 2016. In all schemes, liabilities are discounted with the 15-year zero-coupon gilt (spot) yield. The value of bonds held as assets is assumed to move in line with the same 15-year zero-coupon gilt (spot) yield. Equity values move in line with the FTSE All-Share Index. In scheme 1, the fund is assumed to be fully-funded in 2007 – i.e. hold assets and liabilities of equal size – and hold all its assets in bonds. In scheme 2, the fund is fully-funded, but holds 40% of its assets in bonds and 60% in equity. In scheme 3, the fund has a deficit equal to 30% of its liabilities (Purple Book, 2012) and holds 40% of its assets in bonds and 60% in equity.

To gauge the impact of QE on balance sheets, we use the following ready reckoners. Between March 2009 and January 2010, we assume that the £200bn of QE reduced gilt yields by 100 basis points and increased equity prices by 20% (Joyce et al., 2011). We assume that the £175bn QE programme between October 2011 and May 2012 had the same proportionate impact, leading to a 87.5 basis point fall in gilt yields and a 17.5% rise in equity prices. We assume that the £60bn QE programme of August 2016 reduced gilt yields by 16 basis points (Lloyd and Meaning, 2016), but do not admit changes in equity prices due to their volatility around the UK referendum.

All figures are reported to the nearest £0.1 million, explaining why some impacts do not add up.

Data Sources: Bank of England, Thomson Reuters Datastream and NIESR calculations.

55. Bank of England (2017) study the macroeconomic risks of DB pension schemes. As schemes 2 and 3 indicate, low interest rates and QE have interacted with the asset composition and deficits of DB pension schemes. To the extent that funds held a mixture of assets and/or had pre-existing deficits prior to 2007-2008, low interest rates and QE have served to widen DB pension scheme deficits in recent years. Importantly, employers are exposed to the majority of risk emanating from DB pension schemes. Bank of England (2017) study the extent to which "changes in DB pension fund deficits could potentially have an impact on companies' spending decisions or solvency, which could in principle influence aggregate business spending and the stability of credit conditions" (p. 14). They conclude that "[there is evidence to suggest that changes in contributions to DB pension funds can affect the spending decisions of those companies affected" (p. 14). However, "given the small proportion of firms with DB pension funds, the effect on aggregate investment growth is estimated to be very small" (p.14).[11]

56. In sum, low interest rates and QE have competing effects on the balance sheets of DB pension schemes and life insurance funds. Early stages of QE were beneficial for insurance and pension funds, serving to offset some of their losses during the 2007-2008 financial crisis. Subsequently, low interest rates and QE have combined with other factors to have adverse effects on these funds. For a DB pension, the primary factors that have interacted with QE have been: the mix of bonds and equities; the deficit of the scheme prior to 2007-2008; and increasing life expectancy. For a life insurance firm, the interaction factors

[11] Bank of England (2017) state that around 8% of private sector employees are currently members of active DB pension schemes, and many of those schemes are in relatively larger firms.

include: the mix of bonds and equities; the mix of business type (the proportion of business with guarantees, and the level of those guarantees), increasing life expectancy; and the Solvency II directive.

Defined Contribution Pension Schemes and Annuities

57. Under a DC scheme, employees and/or their employers pay in a fixed contribution per period, with no pre-defined income in retirement. Upon retirement, individuals typically use the assets accumulated in the scheme to purchase an annuity contract that pays out a stream of payments for the remainder of their life.

58. Individuals can also save for their retirement using assets they accumulated over their life-time independently of a pension scheme. However, if an individual chooses to purchase an annuity upon retirement, the influence of QE and low interest rate policy are likely to be similar to those for DC schemes.[62] The process of saving in a DC pension scheme and taking out an annuity can be split into two stages. In the first stage, individuals accumulate assets to fund their retirement. In the second stage, individuals retire, purchase an annuity, and draw down from their stock of assets. However, the Pension Freedoms reforms appear to have reduced the popularity of annuitizing pension savings.

59. During the first stage, when individuals accumulate wealth, QE will affect the value of asset portfolios. Bank of England (2012) note that the net impact of QE will therefore depend on the composition and type of assets held by individuals with DC pension schemes.

60. During the second stage, individuals normally exchange their pension for a life annuity. Bank of England (2012) emphasise that there may be some flexibility in the exact timing of when the annuity is taken out – e.g. some individuals may delay purchasing the annuity. Upon purchasing the annuity, the annuity rate offered will depend on the size of the individual's pension wealth and the market-wide annuity rate, which will, in turn, depend on the discount rate that the supplier of the annuity places on its future liabilities. Thus, the net impact of QE on annuity income will depend on two competing factors. On the one hand, by increasing the value of asset holdings QE will boost future annuity income in stage 1. On the other hand, QE will bid down the annuity rates offered to retirees in stage 2.

61. Some retirees with guaranteed annuity rates (GAR) will unambiguously benefit from QE's asset price effects, as their annuity rate will not be affected by QE or other factors. Savers are insured against changes in interest rates that they are usually unable to hedge. However, GARs create challenges for annuity providers who have to honour the guarantee by holding a suitable asset portfolio and/or altering the pricing structure of their non-guaranteed annuities.[12] Consequently, this form of protection is now much less common for new buyers of annuities.

62. **Table 2** presents illustrative scenario analysis for the annual annuity income available to a 65-year old male with a lump sum of £100,000 saved in a DC scheme by March 2007. Like

[12] GARs are a feature of DC pensions, normally associated with old-style Retirement Annuity plans. They were withdrawn from the market on June 30, 1988. Despite their existence, some people have failed to take advantage of their GAR, not realising they were entitled to it (see, for example, www.telegraph.co.uk/finance/personalfinance/pensions/9937300/The-annuities-that-can-double-your-money.html).

table 1, this scenario analysis builds on the illustrative scenario analysis in table 3 of Bank of England (2012). Again, we extend the analysis to investigate the effects of the 2016 expansion in asset purchases.

63. The upper half of the table shows the annual annuity income that this individual would have received had they purchased an annuity on the same eight dates considered in **table 1**, while the value of their pension wealth is in brackets. For instance, the individual holdings £100,000 in accumulated wealth in March 2007 would attain an annual annuity income of £7,140 were he to purchase the annuity then. Because we track both the value of the pension pot at each date, as well as the annuity income attainable, this scenario analysis accounts for the two competing influences that QE has on DC pension schemes.

64. The three central columns of **table 2** depict three alternative scenarios. In the first column, the pension portfolio ('portfolio 1') is formed solely of bonds. In 'portfolio 2', 50% of the pension pot is saved in bonds, while 50% is saved in equity. 100% of the pension pot in 'portfolio 3' is saved in equity. The fourth column of **table 2** documents the standard annuity rate offered to a 65-year old male at each of the nine dates.

65. As in **table 1**, the bottom half of **table 2** decomposes changes in annuity income into changes associated with QE, and changes associated with other factors. To attain these figures, we make the same assumptions as we do in **table 1**. In addition, we assume that estimated reduction in long-term gilt yields due to QE is fully passed-through to annuity rates. As Bank of England (2012) note, this may over-state the negative impact of QE via lower annuity rates, as empirical evidence suggests that the pass-through of longer-term gilt yields to annuity rates is less than 100%.

66. The first column of **table 2** illustrates that in portfolio 1 – where all the pension wealth is saved in bonds – the early phases of QE had a negligible effect on annuity income. If, in March 2007, the individual had used his £100,000 of bond-wealth to purchase an annuity, he would have received £7,140 in annual annuity income. Although the annuity value fell to £6,721 in February 2010, the decomposition indicates that QE had a broadly neutral impact on this. If anything, QE served to increase the annual annuity income by £47. By May 2012, the annual annuity income attainable had increased by £965 to £8,105. The decomposition in the lower half of **table 2** indicates that QE had a negligible effect on this income, reducing annual annuity income by only £9 between March 2007 and May 2012.

67. Between June 2016 and August 2016, the annual annuity income from portfolio 1 fell from £8075 to £7682. This fall is predominantly associated with the August 2016 expansion of QE, but the recent pick-up in longer-term bond yields have served to attenuate some of the negative effects of recent QE.

68. At every point in time after March 2007, the performance of portfolios 2 and 3 are inferior to portfolio 1. Between March 2007 and May 2012, annuity income from the portfolios 2 and 3 fell by £622 (£7,140 less £6,518) and £2,210 (£7,140 less £4,930), respectively. However, in both cases, QE served to increase annuity income from the two portfolios by £130 and £269, respectively. Therefore, the reduction in annuity income from these two portfolios to May 2012 reflects other factors, including the large fall in equity prices during the 2007-2008 financial crisis.

69. Since May 2012, annuity incomes from portfolios 2 and 3 have increased to £6,862 and £6,090, respectively, although these figures lie below their starting value in March 2007. As for portfolio 1, columns 2 and 3 of **table 2** indicate that the August 2016 expansion of QE served to reduce annuity income from these portfolios. However, the recent pick-up in longer-term interest rates has more than reversed this – annual annuity income from portfolios 2 and 3 in January 2017 exceed the June 2016 level.

Table 2 – Scenarios for Annuities and Defined Contribution Schemes

Annuity Purchase Date	Portfolio 1 *100% Bonds*	Portfolio 2 *50% Bonds & Equity*	Portfolio 3 *100% Equity*	Annuity Rate
Mar. 2007	7,140 (100,000)	7,140 (100,000)	7,140 (100,000)	7.14%
Feb. 2009	7,152 (102,763)	5,621 (80,770)	4,090 (58,776)	6.96%
Feb. 2010	6,721 (99,428)	6,179 (91,393)	5,635 (83,357)	6.76%
Sep. 2011	7,638 (123,999)	6,309 (102,423)	4,980 (80,847)	6.16%
May 2012	8,105 (138,545)	6,518 (111,412)	4,930 (84,280)	5.85%
May 2016	7,416 (146,846)	6,346 (125,655)	5,276 (104,463)	5.05%
Jun. 2016	8,075 (158,016)	6,773 (132,545)	5,471 (107,074)	5.11%
Aug. 2016	7,682 (169,207)	6,397 (140,908)	5,113 (112,609)	4.54%
Jan. 2017	7,633 (148,801)	6,862 (133,755)	6,090 (118,710)	5.13%
Change Mar. 2007 to Feb. 2009				
Total	12	-1519	-3050	-0.18 pp
Due to QE	0	0	0	0.00 pp
Other	12	-1519	-3050	-0.18 pp
Change Mar. 2007 to Feb. 2010				
Total	-419	-961	-1,505	-0.38 pp
Due to QE	47	170	293	-1.00 pp
o/w higher asset val.	1,041	1,084	1,127	
o/w lower ann. rate	-994	-914	-834	
Other	466	1,131	-1,798	0.62 pp
Change Mar. 2007 to Sep. 2011				

Total	498	-831	-2160	-0.98 pp
Due to QE	-38	75	188	-1.00 pp
o/w higher asset val.	1,202	1,099	996	
o/w lower ann. rate	-1,240	-1,024	-808	
Other	536	906	-2,348	0.02 pp
Change Mar. 2007 to May 2012				
Total	965	-622	-2,210	-1.29 pp
Due to QE	-9	130	269	-1.88 pp
o/w higher asset val.	2,589	2,219	1,849	
o/w lower ann. rate	-2,598	-2,089	-1,580	
Other	974	-752	-2,478	0.59 pp
Change Mar. 2007 to May 2016				
Total	276	-794	-1,864	-2.09 pp
Due to QE	-374	-177	20	-1.88 pp
o/w higher asset val.	2,379	2,179	1,978	
o/w lower ann. rate	-2,753	-2,356	-1,959	
Other	650	-617	-1,884	-0.21 pp
Change Mar. 2007 to Jun. 2016				
Total	935	-367	-1,669	-2.03 pp
Due to QE	-357	-157	44	-1.88 pp
o/w higher asset val.	2,606	2,329	2,052	

o/w lower ann. rate	-2,963	-2,485	-2,008	
Other	1,292	-210	-1,713	-0.15 pp
Change Mar. 2007 to Aug. 2016				
Total	542	-743	-2,027	-2.60 pp
Due to QE	-7.2	-538	-374	-2.04 pp
o/w higher asset val.	2,741	2,329	1,917	
o/w lower ann. rate	-3,443	-2,867	-2,292	
Other	1,244	-205	-1,653	-0.56 pp
Change Mar. 2007 to Jan. 2017				
Total	493	-278	-1,050	-2.01 pp
Due to QE	-331	-232	-132	-2.04 pp
o/w higher asset val.	2,697	2,490	2,284	
o/w lower ann. rate	-3,028	-2,722	-2,416	
Other	825	-47	-918	0.03 pp

Notes: Illustrative scenarios for annual annuity income for male aged 65 with £100,000 of pension wealth in March 2007. Numbers in brackets are the values of pension wealth at each point in time. Annuity rates are on a guaranteed five-year and level payment basis. In all portfolios, liabilities are discounted with the 15-year zero-coupon gilt (spot) yield. Bond values assumed to move with the same yield, and equity values move in line with the FTSE All-Share Index. The impacts of QE are based on the same assumptions as those underlying table 1. In addition, we assume that QE had the same impact on annuity rates as on gilt yields. Estimates are rounded to the nearest £1. *Data Sources*: Bank of England, Thomson Reuters Datastream, William Burrows Annuities and NIESR calculations.

Non-Life Insurance Funds

70. The low interest rate environment may also have implications for non-life insurance firms as a result of its impact on the compensation individuals and/or families receive following catastrophic injury. Rather than pay compensation in a single lump-sum award, Period Payment Orders (PPOs) – where compensation is paid to claimants at regular intervals – are increasingly being used. This transfers longevity risk from the claimant to insurers (Institute and Faculty of Actuaries, 2011).

71. When non-life insurance firms settle personal injury claims with a lump-sum payment, instead of a PPO, this lump sum is calculated using a specific discount rate, labelled the 'Ogden rate'. The Ogden rate was set at 2.5% in 2001 by the then Lord Chancellor. On 27 February 2017, the Lord Chancellor announced this rate will be reduced to minus 0.75% based on 3-year average yields of index-linked gilts. The ABI has described this as being based on a "broken formula".[13] The current low yields on index-linked gilts, and the consequential change in the Ogden rate is a direct consequence of the low interest rate environment. This reduction in the Ogden rate is likely to have adverse effects on non-life insurers. Direct Line has estimated the decrease in the Ogden rate will reduce its profits by between £215 million and £230 million;[14] Admiral has estimated it will reduce its profits by £70 million to £100 million;[15] and Aviva as estimated it will reduce its profits by approximately £385 million.[16]

Conclusion

72. Following the 2007-2008 financial crisis, the UK's conventional monetary policy instrument, Bank Rate, was sharply reduced, reaching 0.5% in March 2009, where it remained until August 2016 when it was reduced by a further 25 basis points. With the short-term interest rate near its effective lower bound, monetary policymakers sought to provide further stimulus to the economy with 'unconventional monetary policies'. In the UK, the MPC created the APF, which authorised the purchase of financial assets from non-banks as part of the QE programme. Because QE has directly impacted on longer-term interest rates, it has had important implications for insurers, pension funds and the long-term savings market.

73. In this document, we show that initial rounds of QE were beneficial for insurers and pension funds, serving to reverse losses during the financial crisis. However, more recently, although QE has not had a detrimental impact on insurers and pension funds on its own, it has interacted with a number of factors to adversely affect the long-term savings industry. Important determinants of QE's impact on DB pension schemes have been: their mix of bonds and equities; their initial deficit prior to 2007-2008; and increases in average life expectancy. The impact of QE on life insurance firms has depended on: their mix of bonds

[13] https://www.abi.org.uk/News/News-releases/2017/02/BI-RESPONDS-TO-CHANGES-IN-PERSONAL-INJURY-DISCOUNT-RATE
[14] See RNS announcement 9010X, February 27, 2017.
[15] See Nasdaq GlobalNewswire Statement, February 27, 2017.
[16] See RNS announcement 0914Y, February 28, 2017.

and equities; increases in average life expectancy; their mix of business (in particular the proportion of business with guarantees, and the level of those guarantees); and the introduction of Solvency II capital requirements. Similarly, the effects of QE on DC pension schemes have interacted with the mix of bonds and equities held.

74. QE has been one of many factors that have served to reduce longer-term interest rates in the last decade. Looking ahead, the primary challenge for insurance companies, pension funds and the long-term savings market pertains to the interaction of low interest rates and increased life expectancy. With an ageing population, low interest rates magnify the present value of funds' future liabilities, posing challenges for the sustainability of the long-term savings market.

75. Increased longevity risk has additional implications for insurance companies. Low interest rates make the hedging of longevity risk more costly, while placing negative pressures on the solvency of funds under the Solvency II Directive. Insurers' investment strategies typically match the sensitivity of their assets to those of their liabilities, but, under Solvency II, reductions in longer-term interest rates have caused increases in capital requirements over and above increases in liabilities, creating a trade-off between the valuation of long-term savings funds and their solvency.

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