

INTERNATIONAL MONETARY FUND

# Putting Out the *NB*Fire:

## Lessons from the UK's Liability-Driven Investment (LDI) Crisis

Ruo Chen and Esti Kemp

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**Putting Out the *NB*Fire:  
Lessons from the UK’s Liability-Driven Investment (LDI) Crisis**  
Prepared by Ruo Chen and Esti Kemp\*

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**ABSTRACT:** Liability Driven Investment (LDI) funds were at the center of the severe stress that emerged in the UK gilt market in the aftermath of the September 2022 UK "mini-budget". The episode, which came on the heels of the "Dash for Cash" and "Archegos" stress episodes in the previous two years, highlights underlying vulnerabilities in the large and diverse non-bank financial institution (NBFI) sector. This paper seeks a deeper understanding of the factors that amplified the gilt market turmoil which ultimately led the Bank of England (BoE) to undertake temporary gilt purchases on financial stability grounds in late September/early October 2022 to restore orderly market conditions and enable LDI funds to build their capital positions. With the gilt market stress and the BoE’s purchases now fully unwound, this paper identifies the key reasons for the success of the BoE’s intervention. Then, drawing also on findings of the 2022 UK Financial Sector Assessment Program (FSAP), the paper discusses key gaps and policy issues related to the monitoring of financial stability risks in the broader NBFI sector for both individual jurisdictions and international standard-setting bodies.

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WORKING PAPERS

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## Glossary

AIFMD	Alternative Investment Fund Manager Directive
BCBS	Basel Committee on Banking Supervision
BoE	Bank of England
CCP	Central counterparties
CRE	Commercial real estate
DB	Defined benefits
DC	Defined contribution
ETF	Exchange-traded fund
ESRB	European Systemic Risk Board
FCA	Financial Conduct Authority
FSAP	Financial sector assessment program
FSB	Financial Stability Board
LDI	Liability driven investment
LME	London Metal Exchange
LMT	Liquidity management tool
MMF	Money market fund
MPC	Monetary policy committee
NBFI	Non-bank financial institution
OBR	Office for Budget Responsibility
OTC	Over the counter
PRA	Prudential Regulation Authority
SME	Small and medium-sized enterprise
SWES	system-wide exploratory scenario
TECRF	Temporary expanded collateral repo facility
TPR	The Pension Regulator

# 1. Introduction

**Market stress centered on Liability-Driven Investment (LDI) funds following the UK "mini-budget" announcement in September 2022 again cast a spotlight on vulnerabilities in the non-bank financial institution (NBFI) sector.** The sudden and sharp increase in gilt yields after the "mini-budget" forced defined benefit (DB) pension funds with leveraged LDI strategies to quickly raise a large amount of cash to meet margin and collateral calls, contributing to fire-sales of longer-dated gilts. The effect was compounded by rising long-term interest rates in the preceding 10 months, to which some pension schemes and LDI funds had failed to adjust their available liquidity resources. Imminent financial stability risks forced the Bank of England (BoE) to intervene in the gilt market in a temporary and targeted way to restore orderly market conditions while allowing the LDI funds time to recapitalize. At the core of the turmoil were the leverage, liquidity mismatches between assets and liabilities, and concentrated positions of the LDI strategies. Over the past several years there were several instances where similar risk factors triggered market stress to either originate in the NBFI sector or be amplified within the NBFI sector (see Box 1).

**The NBFI sector comprises a vast set of financial intermediaries that are not banks, central banks, or public financial institutions.** NBFIs are a heterogeneous group of institutions including insurers, pension funds, various types of investment funds, finance companies, broker-dealers, and central counterparties (CCPs) (see Table 1). While sometimes engaging in activities similar to banks, NBFIs are not deposit takers and are thus not subject to similar regulation or supervision as banks. Accordingly, NBFIs generally also do not have access to central bank backstops. Given the different business models of various NBFIs, they pose different kinds of systemic risk. The Financial Stability Board (FSB), for instance, identifies a subset of NBFIs (called the "narrow measure") that the authorities have assessed to be involved in credit intermediation activities – i.e., maturity/liquidity transformation, leverage or imperfect credit risk transfer, and/or regulatory arbitrage – and may pose bank-like financial stability risks.<sup>1</sup>

**In the UK, the relative weight of NBFIs in the financial system has risen, with an attendant increase in interconnectedness that could amplify and spread financial stress.** NBFI financial assets made up roughly half of total UK financial assets as of end-2021, up from roughly 45 percent a decade earlier. Moreover, NBFI lending has expanded domestically and across borders, especially in the commercial real estate (CRE) and small and medium-sized enterprise (SME) sectors (37 percent in total non-financial corporate lending) and in specific mortgage products (11 percent) and unsecured consumer credit (52 percent). The 2022 UK Financial Sector Assessment Program (FSAP) pointed out that some non-bank activities, such as buy-now-pay-later schemes and corporate loans, remain outside the regulatory perimeter and lack granular data for in-depth risk analysis, including interconnectedness to key market segments such as the gilt market. Furthermore, certain non-bank lenders rely heavily on bank funding and securitization, creating interlinkages with the rest of the financial system, including banks, that could amplify contagion. For instance, nearly half of the funding of UK finance companies comes from banks. Significant linkages exist among various NBFIs and between NBFIs and the banking system, and these links have become stronger over time. Such links are not limited to domestic entities, and balance sheet linkages exist with overseas banks and asset managers as well. The FSAP also

<sup>1</sup> Entities in the "narrow measure" are categorized by the economic functions they perform – including those that are susceptible to runs (Economic Function or EF1) for example MMFs and open-ended investment funds; those that lend and are dependent on short-term funding (EF2) for example finance companies; market intermediation dependent on short-term funding (EF3) for example broker-dealers; Facilitation of credit intermediation (EF4) for example credit insurance providers; and Securitization-based credit intermediation (EF5) for example securitization vehicles.

highlighted that liquidity mismatches in the internationally active NBFIs were the main source of risk in core sterling markets, namely equity, corporate bonds, commercial papers, and gilts.

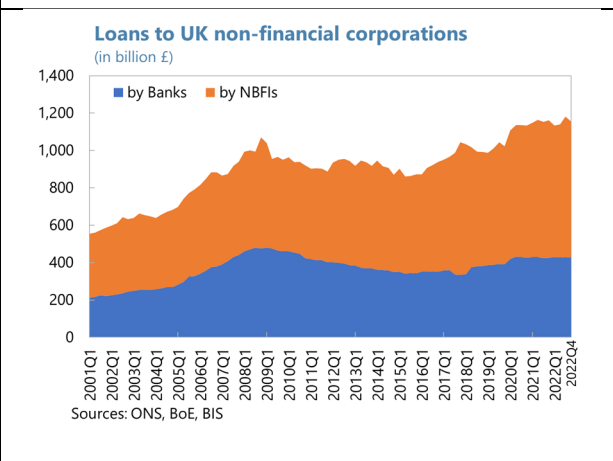
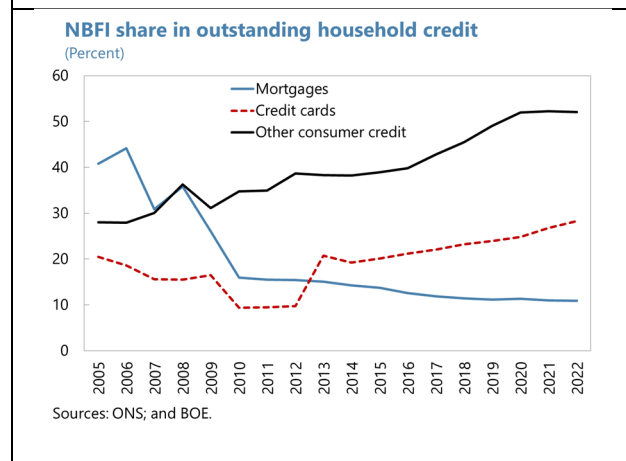
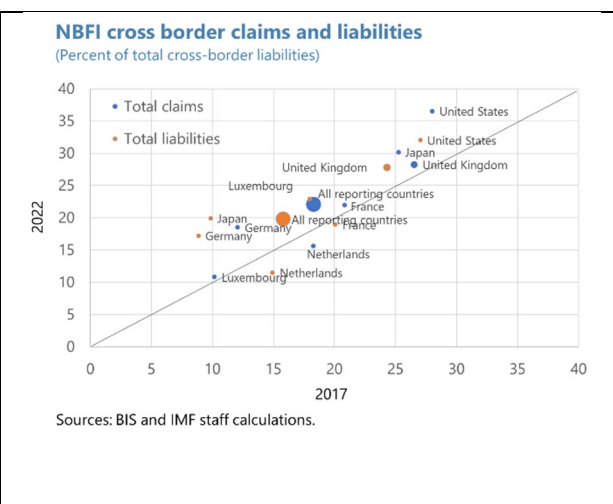
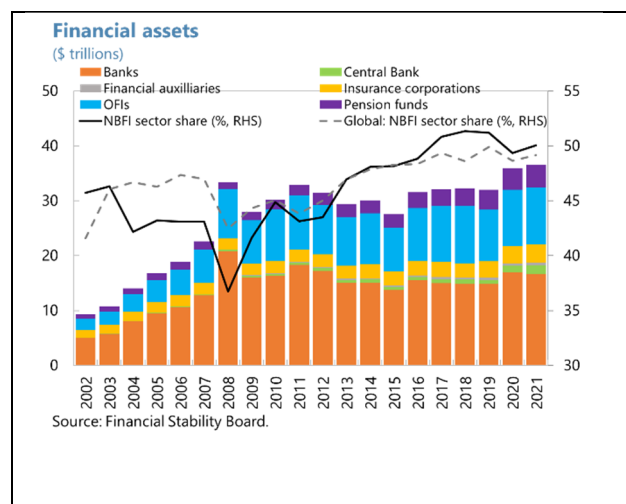
<b>Table 1. Major NBFIs Sub-Sectors in the United Kingdom</b>				
<b>Sub-sector</b>	<b>Est. AUM* (end-2021)</b>	<b>Main activities</b>	<b>Relevant regulator/supervisor (if domiciled in UK)</b>	<b>Potential source of financial stability risk (not exhaustive)</b>
Pension funds	\$4.1tn	Invest client contributions in public and private markets. Defined benefit pension funds often make use of leverage to match liabilities to assets	The Pension Regulator (TPR) (DB pensions); DC schemes jointly regulated with Financial Conduct Authority (FCA) <sup>2</sup>	Leverage in core markets
Insurance companies	\$3.2tn	Invest premia with aim of providing financial protection.	FCA & Prudential Regulatory Authority (PRA)	Links between banks and insurers
Hedge funds	\$10.4tn**	Invest client funds in a range of assets to maximize investor returns by making use of leverage.	Fund managers are authorized and regulated by the FCA <sup>3</sup>	Leverage
Exchange-traded funds (ETFs)		Typically, secondary-market trading of shares, redeemable in kind.	FCA	Liquidity mismatch in fixed-income ETFs.
Open-ended funds		Investor money pooled and invested into various assets (including more and less liquid). Redemption offered in short term (typically daily).	FCA	Liquidity mismatch; systemic risk – notably cross border linkages
Money market funds (MMFs)		Bring together demand and supply for short-term funding	FCA	Liquidity mismatch; Systemic stress in short-term funding markets
Real estate funds		Invest client contributions in illiquid real estate assets	FCA	Liquidity mismatch
Securitizations		Convert a vast range of illiquid assets into more tradable and accessible securities	PRA and FCA	Credit risk
Broker-dealers		Facilitate client trades e.g. derivatives, enable leverage.	FCA <sup>4</sup>	Market intermediation dependent on short-term funding
Center counter parties (CCPs)		Netting of risk by Act as the central counterparty to holders of financial contracts.	Bank of England	Liquidity stress amplification;
Commodity traders		Take positions to hedge activity in physical	Generally unregulated, given client-facing activities.	Liquidity risk, credit risk

<sup>2</sup> The FCA regulates the providers of contract-based DC contribution schemes (i.e. not the DC schemes themselves), while TPR regulates DC occupational schemes.

<sup>3</sup> Whether the FCA directly supervises would be dependent on the definition used for a “hedge fund” and also the type of fund structure.

<sup>4</sup> Broker dealers that enable leverage and are subsidiaries of banks would be regulated by the PRA as well as the FCA.

		Markets, could use derivatives to speculate on changes in commodity prices	
<p>* Assets under management values are based on the FSB Global Monitoring Report on Non-Bank Financial Intermediaries 2022                  ** Value denotes size of Other Financial Intermediaries (OFIs), i.e., assets of all financial institutions that are not central banks, insurers, pension funds, public financial institutions or financial auxiliaries.</p>			



**In this context, this paper aims to draw lessons from the LDI stress episode for mitigating and managing financial stability risks associated with the broader NBFI sector.** We seek a deeper understanding of what drove the market turmoil during the LDI stress episode and led to financial stability risks. We then document the BoE’s financial stability intervention and the factors – such as coordination, instrument choice, and communication – that led to its success. We also explore whether there are limits to the regulation and supervision of pension funds and LDI strategies. Drawing on the experience from this episode and the findings of the 2022 UK FSAP, the paper then proposes some takeaways for monitoring and mitigating financial stability risks associated with the NBFI sector. While the LDI episode has passed, a close analysis could help reduce the likelihood of similar events occurring in the future, even elsewhere in the NBFI sector, and enable authorities, including in other jurisdictions, to strengthen their crisis preparedness and response in case such events do occur.



**The remainder of this paper is organized as follows:** Section II provides the historical background for the popularity of LDI strategies among UK's defined benefits (DB) pension funds and its implications for the gilt market. Section III details our understanding of the unfolding of the LDI crisis and the BoE's financial stability interventions, based on discussions with market participants and the UK authorities. Section IV summarizes key takeaways. We stress that the underlying vulnerabilities revealed in the LDI crisis are not unique to UK pension funds and are shared by the wider NBF sector, including in other countries. Therefore, the lessons drawn should be beneficial to prudential regulators and supervisors worldwide.

### Box 1. Recent Financial Stress Episodes Involving NBFs

#### Dash for Cash (March 2020)

The “dash for cash” in March 2020 that followed pandemic-related restrictions saw major central banks turned to asset purchases to support market functioning as precautionary demand for liquidity surged. In the UK specifically, demand to transact in the gilt market increased for insurance companies, pension funds, LDI asset managers as well as other asset managers, hedge funds, and the foreign official sector. These transactions were intermediated by the banking system, but the capacity of dealers to intermediate was tested. NBFs' use of sterling repo markets also increased sharply over this period. In the case of NBFs, the liquidity demands were mainly driven by substantial margin calls on derivative exposures, large redemptions from open-ended and money market funds, and precautionary liquidity hoarding by some investors. These liquidity demands amplified the initial shock and had an adverse impact on other investor groups due to the structure and interconnectedness of the financial system (Kashyap (2020)). The BoE (together with peer central banks) quickly augmented its regular repo operations and front-loaded bond purchases to support market liquidity.

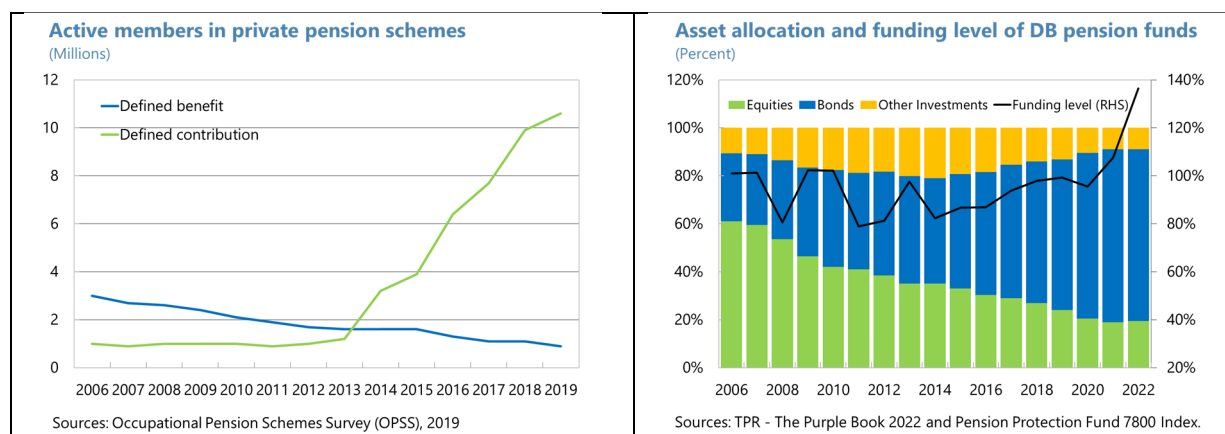
#### Archegos (March 2021)

In March 2021, a sharp drop in the value of large positions in equity derivatives built by a US family office, Archegos Capital Management, by borrowing from several global banks led to Archegos' failure to meet margin calls and to large losses by some creditor banks. In the wake of the failure, counterparties of Archegos sold off securities that they had used to hedge their derivative exposures, which in itself contributed to further margin calls and deleveraging. While the leverage of Archegos was not abnormally larger than typical of hedge funds with similar strategies, leverage was compounded by the high concentration and size of the family office's positions to a small group of equity issuers.<sup>5</sup> The failure of the family office incorporated in Delaware had a limited systemic impact but nevertheless resulted in over \$10 billion of reported losses across multiple firms. For example, Credit Suisse International and Credit Suisse Securities (Europe) Ltd, who provided prime brokerage services and entered into equity total return swaps with Archegos, booked around \$5.1 billion of losses when Archegos defaulted. Following this significant event, the Prudential Regulation Authority (PRA), Financial Conduct Authority (FCA), and other global regulators reviewed and assessed firms' equity finance businesses, including for those who were counterparties to Archegos, focusing in particular on counterparty risk management. The PRA and FCA identified weaknesses in the holistic management of risk across business units, narrow focus of onboarding arrangements and inadequate re-assessment of client relationships thereafter, inconsistent margining approaches and an absence of limit frameworks. Against this backdrop concerns were raised about banks' risk management, margin requirements for over-the-counter (OTC) derivatives, the opacity of family offices, and the ability of regulators to monitor system-wide risks. The PRA announced in July 2023 that it had imposed a fine of £87 million on Credit Suisse International and Credit Suisse Securities (Europe) Ltd for significant failures in risk management and governance related to the firms' exposures to Archegos Capital Management (BoE, 2023b).

<sup>5</sup> FSB, 2023. Enhancing the Resilience of Non-Bank Financial Intermediation: Progress report

## 2. The Lead-Up to the LDI Crisis

**Regulatory and demographic changes since the late 1990s have led many DB pension funds in the UK to close to new members and to shift their investments from equity to fixed income.** Changes to accounting standards since the late 1990s required corporates to recognize the full cost of their pension liabilities, discounted using market-based interest rates, on their balance sheets.<sup>6</sup> With increasing life expectancy, which means that pension schemes need to pay out retirement income for longer periods, most employers closed their DB schemes to new members and switched to defined contribution (DC) schemes. Active members of private pension funds decreased from 3 million in 2006 to 0.9 million in 2019 in DB schemes, while active members in DC schemes increased from 1 million to 10.6 million. Still, DB schemes held close to 90 percent of total private pension funds' assets as of mid-2022.<sup>7</sup> Without intergenerational saving channels, the DB pension funds have been managed only to serve the existing members with finite time horizons, like annuities. Accordingly, their risk appetite has decreased. The share of equity investment in DB fund assets declined from about 61 percent in 2006 to about 20 percent in 2022, while the share of fixed-income investments increased from 28 percent to 72 percent.



**To reduce DB pension fund deficits, which could pose risks to corporate balance sheets, DB pension plans have increasingly used LDI strategies since early 2000s to match the market exposure of their assets to the market exposure of their liabilities while freeing up funds to invest in growth assets.** DB pension funds guarantee future pension payments to members, with guarantees typically linked to inflation. The use of leverage under the LDI strategy, through repurchase agreements and derivatives such as interest rate swaps, allows the pension fund to obtain a higher exposure to long-term gilts and to hedge the interest rate and inflation risk in their liabilities, while also freeing up resources to invest in higher-yielding risk/growth assets.<sup>8</sup> The basic principle of these schemes was as follows: if interest rates fall, the LDI strategies return a profit, which helps to offset the rise in the present value of pension liabilities. If interest rates rise, the declining present value of pension liabilities bolsters solvency (by decreasing liabilities), but the LDI strategies themselves incur losses which need to be covered by pension funds through provision of collateral or cash margins. Persistently declining long-term interest rates over the past 15 years had led to the popularity of LDI

<sup>6</sup> In the late 1990s changes to the accounting standards FRS17 and IAS19 required corporates to include pension deficits on corporate balance sheets.

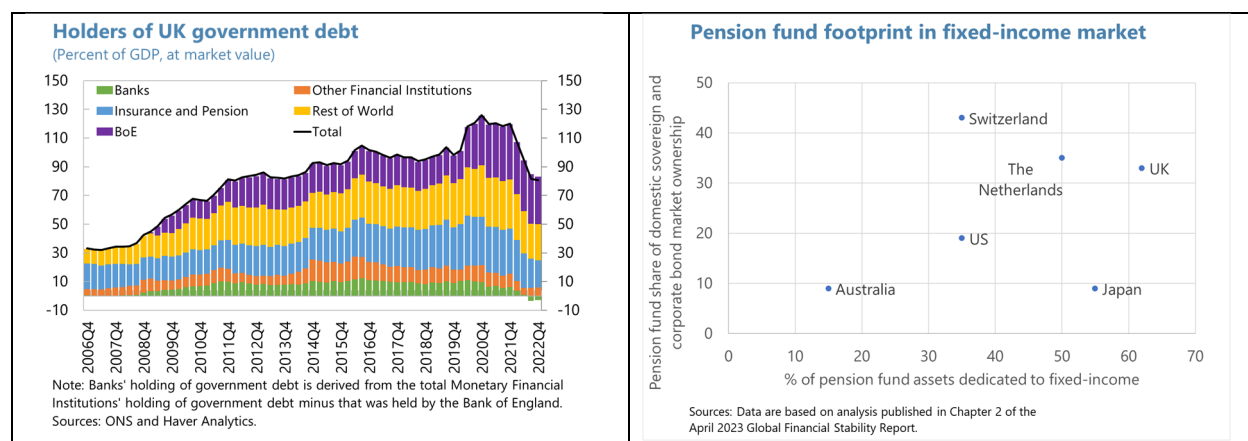
<sup>7</sup> See "[Funded occupational pension schemes in the UK](#)," published by the Office for National Statistics.

<sup>8</sup> Leverage requires collateral (generally a combination of cash and gilts) to be posted against repo or derivative contracts.

strategies. From 2011 to 2020, the amount of UK pension fund liabilities hedged through LDI strategies grew from £400 billion to a very sizable £1.5 trillion (about two-thirds of UK GDP), according to the Investment Association, with a large concentration in the gilt market.

**The structural changes in pension funds and the use of LDI strategies have led to funds having relatively sizeable gilt holdings compared to pension funds in other jurisdictions.** While LDI strategies are used in several jurisdictions, UK pension funds held a relatively large share of the outstanding gilt market, with DB funds investing a large part of their portfolio in gilts. LDI strategies have gained particular prominence in the United States, the United Kingdom, Canada, the Netherlands, and other European countries with well-developed private DB pension systems. In these countries, institutional investors have implemented LDI strategies to help match their assets more closely to their liabilities, typically by investing in fixed-income securities with maturities that align with their future payment obligations. In comparison to these jurisdictions, the UK DB pension plans have a larger share invested in fixed income, particularly in gilts. Among the top seven global pension fund jurisdictions, UK pension plans rank third in terms of the proportion of DB assets, surpassed only by Japan and the Netherlands.<sup>9</sup>

**LDI strategies in the UK are a highly concentrated market.** The top three LDI asset managers represent roughly 70 percent of the LDI market. During the early days, the LDI strategy was only available to large pension funds with their own accounts that were managed by designated asset managers, also called segregated accounts. The asset managers often also have access to other assets held by the relevant pension schemes, which can be used to meet margin calls. As the popularity of the LDI strategy rose, asset managers launched “pooled” LDI funds, which were open to small pension funds, with a more cost-effective hedging solution compared to the segregated accounts (see Northern Trust 2008). Such “pooled” LDI funds make up between 10-15% of the LDI market and are managed by a few asset managers, but often have very large numbers of pension fund investors.<sup>10</sup> In pooled funds, when existing liquidity buffers run out, asset managers send margin calls to pension funds’ trustees, who would need to raise cash by selling other assets (often requires approval from the board of governors and takes one to two weeks). Otherwise, their positions will be liquidated by LDI fund managers, which involves selling underlying gilts.



<sup>9</sup> See GFSR April 2023, Chapter 2.

<sup>10</sup> According to the Pension Regulator, there are about 175 pooled LDI funds with about 1800 pension schemes participating.

## 3. The LDI Crisis and Bank of England's Financial Stability Intervention

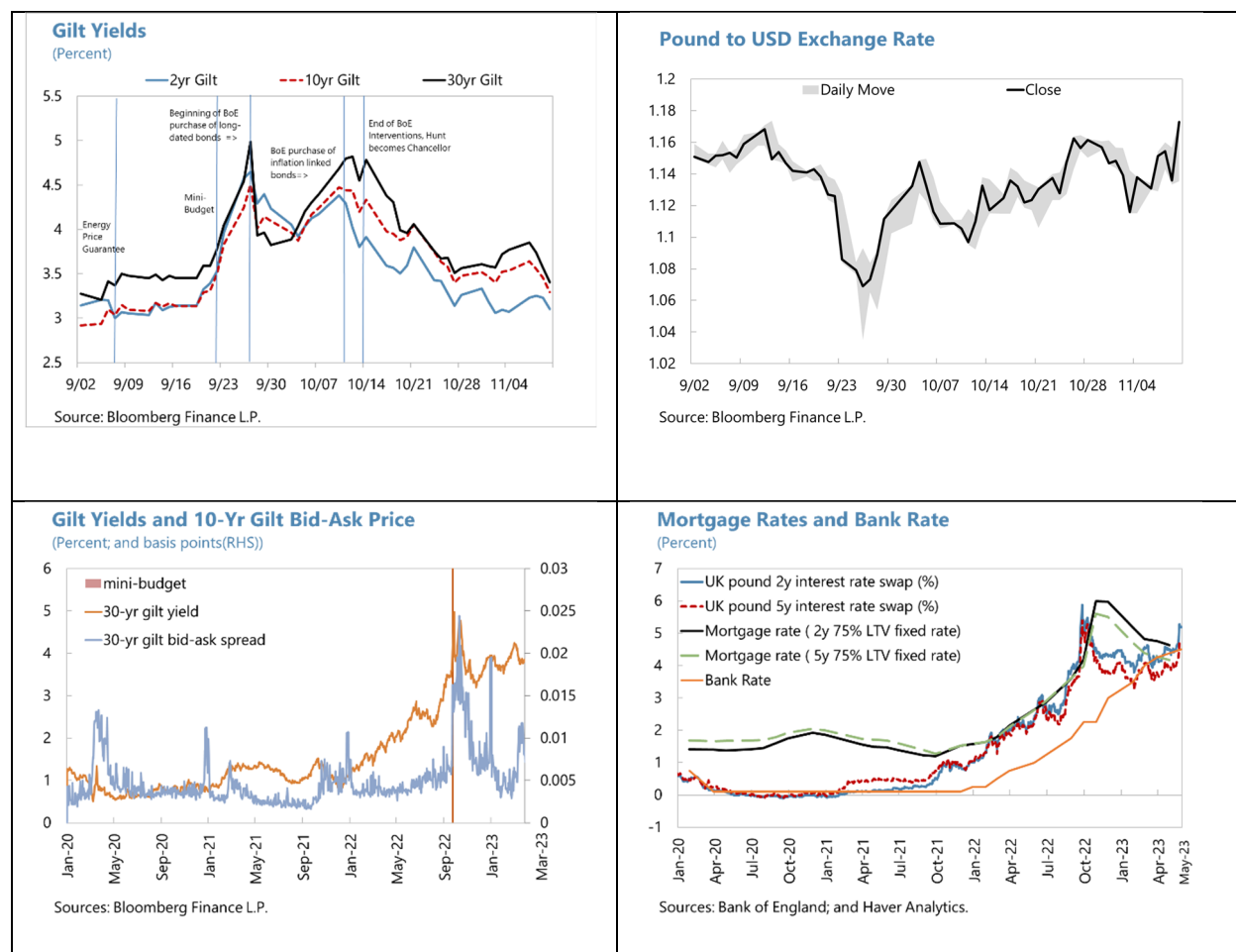
### 3.A The Unfolding of the LDI Crisis

**The September 23 "mini-budget" unnerved the UK's core financial markets.** While aimed at promoting growth, the £45 billion unfunded tax cuts were announced against the backdrop of historically high inflation and increasing yields. In addition, unlike most budgets, this "mini-budget" was not accompanied by an assessment by the Office for Budget Responsibility (OBR), the fiscal watchdog. The market's concerns about fiscal sustainability, skepticism around growth objectives/impact, and increased uncertainty around how inflation would be brought down, triggered a swift selloff in UK assets. By the following trading day, the pound fell to its lowest-ever level on record (1.03) against the dollar, while gilt prices collapsed. Most strikingly, the 30-year gilt yield jumped by an historic 140 basis points over three days, with moves intensified by the pension funds' forced sell-off of long-dated gilts (see below).

**The quick and sharp increase in gilt yields after the "mini-budget" saw the net asset value of LDI funds fall significantly and forced funds to raise cash quickly to post additional collateral on secured borrowing and to meet higher margin calls.** While higher yields improve pension funds' solvency ratios, they also meant losses for the LDI funds, who had to either rebalance their portfolios, for example by asking their pension fund investors for more capital, or had to deleverage. Pension funds generally have several days or weeks to raise cash to top-up their collateral in their LDI positions. However, the sudden and unprecedented move in gilt yields after the "mini-budget" required pension funds to raise a significant amount of cash before the opening of each business day. While segregated LDI account managers had ready access to additional assets and cash, pooled LDI funds with a large number of small DB pension fund investors faced operational challenges in mobilizing extra liquidity. Market liquidity – measured by bid-ask spreads – deteriorated rapidly, and without cash to meet the margin and collateral calls, pooled LDI funds attempted to sell gilts, to raise liquidity and deleverage, contributing to the fire-sale dynamics. LDI funds selling gilts into already thin markets pushed yields up higher.

**The concentrated nature of LDI strategies and large exposures in the gilt market meant that this forced selling behavior represented a sudden and profound shift in supply-demand dynamics in the gilt market.** Large quantities of gilt sales, particularly in long-dated and inflation-linked varieties, in an increasingly illiquid market pushed yields even higher, and further increased the required collateral payments. Other assets, including MMFs and investments in open-ended funds, were also liquidated. While MMFs were able to meet redemptions, some real estate funds had to suspend redemptions. Disorderly conditions became evident in the gilt markets, with an increasing risk of spreading to other market segments.

**The market turmoil also spilled over to the real economy, with swap rates spiking and several mortgage providers discontinuing mortgage offerings temporarily as it became difficult to price markets.** Amid higher gilt yields, interest rate swaps increased—the 2-yr interest rate swap typically used to price mortgage products reaching 6% in the aftermath of the mini-budget. While rates have stabilized since then, they remain at higher levels than prior to the crisis.



### 3.B The Bank of England's Financial Stability Intervention

**With imminent and growing financial stability risk, the BoE announced a temporary and targeted purchase of long-term gilts on September 28.** The Bank described that "multiple LDI funds were likely to fall into negative net asset value," which risked the fire-sale of a large amount of gilts, leading to "a self-reinforcing spiral and threatening severe disruption of core funding markets and consequent widespread financial instability." To restore orderly market conditions, the BoE announced that it would buy up to £5 billion daily in 20-year or longer-term gilts over 13 business days ending October 14 (implying a maximum of £65 billion in total). With the daily turnover in the long-term gilt market of around £12 billion, this appeared to provide a sufficient liquidity backstop. The market calmed immediately, with the 30-year gilt yield dropping more than 100 bps on the first day of the intervention (although yields rose again in the days that followed and did not durably come down until markets' concerns regarding fiscal policy had been addressed – see below).

**While the intervention constituted an emergency action of the BoE to stabilize markets, it was supported by close coordination among key stakeholders, including overseas regulators.** The Bank Executive (overseeing the delivery of BoE's mission and strategy), following the recommendation from Financial Policy Committee (FPC), decided to intervene in the market and designed the intervention approach. HM Treasury was in close communication ahead of the operation and provided full indemnification. The

Prudential Regulation Authority (PRA), the Pensions Regulator (TPR), and the Financial Conduct Authority (FCA)—regulating bank counterparties of LDI funds, pension funds, and delegated portfolio managers, respectively—together with the BoE, were closely monitoring the rebalancing progress of LDI funds. Regulators in Ireland and Luxembourg, where most LDI funds are domiciled, were also in close contact to ensure that the LDI funds used the opportunity of the intervention to build their resilience. At the same time, the Monetary Policy Committee (MPC) of the BoE was informed of the targeted and temporary nature of the operation, along with the assessment that it would not shift the underlying inflation dynamics or interfere with monetary policy operations.<sup>11</sup>

**Market intelligence provided vital information that informed the design and timing of the intervention.**

Once stress erupted, market intelligence confirmed that leverage was already high, that fund managers were struggling to sell assets into a thin market, and that a swift intervention from the BoE was needed. Neither the LDI funds nor pension funds have access to BoE’s liquidity facilities. BoE’s liquidity support is mainly through intermediaries (i.e., banks). Therefore, the transmission of BoE’s liquidity support relies on the banks’ willingness to access BoE’s liquidity facilities for their clients while taking over collateral risks to their books. Given the heightened uncertainty, this willingness would be significantly lower during stress episodes. More importantly, the LDI funds needed to deleverage, not re-leverage; thus, a repo facility with LDI funds was ruled out, and targeted gilt purchases were seen as the best option to provide orderly market conditions while allow the LDI funds to build resilience. Moreover, a repo facility would have only provided funding liquidity, not market stability, which was at the center of the stress at the time. The BoE also explained that a maximum daily limit (£5 billion) was aimed at providing more credibility to the backstop instead of a target purchase amount as in its quantitative easing (QE) operations. In particular, the operation was conducted using backstop pricing, focusing on removing the liquidity premium without distorting market prices.<sup>12</sup> However, markers were unfamiliar with backstop pricing and some participants interpreted as QE at the very beginning of the intervention (see WSJ, 2022). At the end of the first week of intervention, some market participants expected that the BoE would expand and extend the purchase facility (see New York Times 2022).

**Given the possibility of heightened gilt-selling pressure during the last week of its emergency operation, the BoE expanded its financial stability measures on October 10 and 11.** The Bank stated that “pooled LDI funds – which have a large number of smaller investors – are likely to take longer to raise capital” and greater clarity on the size of asset sales would only come in the week of October 10 “because of the underlying volatility of the market.” The Bank was informed that “the planned asset sales were large in aggregate and involved substantial quantities of index-linked gilts, a market which is smaller and less liquid than the conventional (nominal) gilt market.” Therefore, the BoE increased the daily maximum auction size to £10 billion on October 10 and later split equally for conventional long-term gilts and index-linked gilts when it widened the gilt purchases to include index-linked gilts on October 11.<sup>13</sup> In addition, the BoE announced a Temporary Expanded Collateral Repo Facility (TECRF) for banks through November 10 with expanded collateral, adding corporate bonds with credit quality of Baa3/BBB- or above, committed to maintaining liquidity support through its regular Repo operations.<sup>14</sup>

<sup>11</sup> The start of active gilt sales was postponed by one month.

<sup>12</sup> Backstop pricing, also called reserve pricing, refers to the price ceilings (in particular, relative to market mid-pricing) for asset purchases of central bank interventions to restore market functioning and act as backstops.

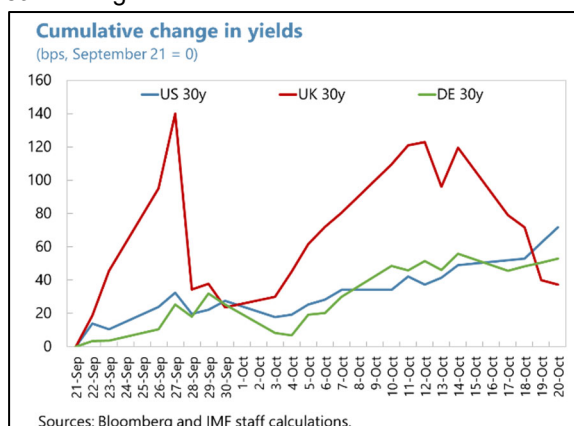
<sup>13</sup> Given the specific dynamics in the index-linked gilt market, the BoE set a minimum yield for its index-linked gilt purchases.

<sup>14</sup> This new repo facility was proven less attractive. As the BoE reported later, the total take-up of the TECRF was very small, at only £5.75 million.

**Approaching the end of the intervention period, markets became increasingly anxious about the October 14 expiration “cliff edge.”** Despite the increased daily limit of BoE’s gilt purchases at the beginning of the second week of intervention, some markets participants remained concerned about the realism of solving the LDI problem by the announced end-date of the intervention and worried about a major sell-off ahead of the expiration date (see the Guardian 2022). Governor Bailey communicated clearly that the intervention would end as planned and urged pension funds to rebalance their positions by expiration. While the BoE stated that the TECRF would remain operational till mid-November, this repo facility, similar to the regular repo operations, would need the participation of banks on behalf of their pension fund clients. Using the repo market would have raised banks’ capital requirements and increased their credit risk as they would have carried the loss if LDI funds defaulted and would also have added leverage where LDI funds were actively looking to deleverage. Moreover, unconditionally supporting the market could have led to moral hazard and reduced the incentives of the LDI funds and pension funds to accept the losses and rebalance their books. The BoE firmly insisted on the temporary nature of the intervention and worked with the LDI funds and relevant regulators during the period of the intervention to build resilience so that the operations could be ended as planned.

**The reversal of key “mini-budget” measures that was announced by the fiscal authorities during October 3-17 also proved beneficial to calm the market.** Although the start of the BoE intervention on

September 28 did calm down the market, with yields dropping sharply, gilt yields resumed an upward trend between September 30 and October 12. It was in this context that the then-PM Truss dropped her plan of removing the planned corporate tax rise and appointed Jeremy Hunt as the new chancellor (October 14). The following Monday (October 17), the new chancellor scrapped most of the remaining tax cuts in the “mini-budget,” and markets staged a major (and sustained) rally in response to what they perceived as a renewed commitment to fiscal discipline.



**In sum, the BoE’s financial stability intervention, together with the aforementioned fiscal policy reversals, successfully restored orderly market conditions in the aftermath of the “mini-budget” and enabled the LDI funds to build their resilience.** The intervention was indeed temporary and targeted. Its operation lasted for 13 days and bought a total of £19.3 billion in long-dated gilts (£12.1 billion in conventional and £7.2 billion of index-linked gilts). In total, DB pension schemes and LDI funds sold an estimated £37 billion in gilts over this period; this is smaller than the estimated total margin and collateral calls these entities faced over this period (roughly £70 billion), reflecting the fact that LDI funds and pension schemes were also able to sell assets other than gilts (such as equities or corporate bonds) and use existing cash buffers in order to meet these obligations as well. Market intelligence suggests LDI funds also raised tens of billion pounds in capital from end-investors, which also reduced their leverage.

**The BoE also successfully unwound all its financial stability gilt purchases by January 12, 2023, just three months after the end of its stability intervention.** By returning the gilts promptly to the market, the quick but orderly unwind of the portfolio delivered on the Bank’s commitment that the intervention would be temporary. The Bank commenced its QT in early November, only one month later than originally planned, and maintained its annual target of £80 billion reduction of its Asset Purchase Facility (APF) gilt holdings for

monetary policy purposes. While at the beginning of its QT operation, the Bank initially excluded long-dated gilts from its sales, before subsequently including them from January 2023.

<b>Table 2. LDI Crisis Timeline</b>		
<b>Date</b>	<b>Event</b>	<b>Market Reaction</b> <i>[Cumulative change in long-term gilts since September 21 shown in square brackets]</i>
September 22, 2022	The BoE hiked its policy rate by 50bps, as largely expected, but below market pricing. The BoE also voted unanimously to start selling its gilt holdings in early October.	Sterling depreciated (-0.5%) retracing opening gains and ending the day little changed at 1.125 against the dollar. <i>[Long-term gilt yields rose by 19 bps]</i>
September 23, 2022	The “mini-budget” was announced.	Sterling fell by around 4 percent against US dollar and around 2 percent against euro. <i>[+27 bps]</i>
September 26, 2022		Sterling plunged to 1.03 against the dollar, its weakest on record, early Monday when Asian market opened. Long-term gilt yields rose by 50 bps <i>[+95 bps]</i>
September 27, 2022		After a brief recovery in the morning, 30-year gilt yields reversed and increased by about 70 bps by the end of trading <i>[+140 bps]</i>
September 28, 2022	In line with its financial stability objective, BoE announced the gilt market operation at 10am. The BoE also announced that the beginning of QT operations that were due to start the following week would instead start on 31 October.	Gilt yields increase in opening trade but fall back dramatically following the announcement: 30-year gilt yields fall by more than 100 bps <i>[+34 bps]</i>
October 3, 2022	Then-Chancellor Kwarteng cancelled the planned abolition of top income tax rate.	<i>[+30 bps]</i>
October 10, 2022	BoE announces additional measures to support market functioning <ul style="list-style-type: none"> <li>• increased the size of its daily auctions</li> <li>• launched a Temporary Expanded Collateral Repo Facility (TECRF)</li> <li>• stood ready through its regular Indexed Long Term Repo operations.</li> </ul>	<i>[+110 bps]</i>
October 11, 2022	BoE widened gilt purchase operations to include index-linked gilts Governor Bailey said [pension funds] “got three days left.”	<i>[+121 bps]</i>
October 14, 2022	Then-PM Truss dismissed Kwasi Kwarteng and appointed Jeremy Hunt as the new chancellor. She also cancelled the planned corporate tax cut. Bank terminated gilt market operations and ceased all bond purchases.	<i>[+119 bps]</i>
October 17, 2022	Chancellor Hunt cancelled the basic income tax rate cut.	<i>[+79 bps]</i>
October 18, 2022	The BoE postpones the first gilt sales operation to November 1, in light of the Government’s fiscal announcements that were scheduled on 31 October – the same day that the first gilt sales were set to start.	<i>[+72 bps]</i>



October 20, 2022	BoE announces details on the changes to its planned gilt sales program. Then-PM Truss resigned.	[+37 bps]
October 24, 2022	Announcement that Rishi Sunak would be appointed as PM on October 25	[+17 bps]
October 26, 2022	PM Rishi Sunak postponed the fiscal event planed for October 31 to November 17.	[+9 bps]
November 1, 2022	Gilt sale operation starts in the short-maturity sector	[-10 bps]
November 10, 2022	BoE set out plans for a demand-led approach to unwind recent financial stability gilt purchases in a timely but orderly way.	[-18 bps]
January 12, 2023	BoE completed its sales of the £19.3 billion portfolio of temporary holdings of UK government bonds purchased in Autumn 2022 on financial stability grounds.	[-8 bps]

## 4. Key Takeaways

*Our takeaways focus on the key lessons from the LDI crisis for mitigating and managing NBFi vulnerabilities more broadly: (i) the need to address regulation and information gaps, (ii) enhancing NBFIs' liquidity management and oversight of leverage, (iii) when and how central banks should provide backstops to NBFIs, or act as the lender of last resort; and (iv) how to strengthen overall surveillance of the NBFi sector. There are also non-NBFi related lessons to be drawn from the LDI episode, such as the need for coherent policy packages to address macroeconomic imbalances, the heightened sensitivity of financial markets to policy missteps (including circumvention of important institutions and processes), and the perceived and actual interactions between monetary policy and financial stability. However, we abstract from these for this paper which is more narrowly focused on NBFIs.*

### 4.A Regulatory and information gaps

**Visibility of some parts of the NBFi sector has improved in recent years, but the LDI episode showed that UK regulators still have limited visibility and regulatory oversight of pooled and single client funds where leverage and liquidity data are not readily available.** Whilst the Prudential Regulation Authority (PRA) regulates bank counterparties of LDI funds, the BoE does not directly regulate pension funds, LDI managers, or LDI funds. Pension schemes and LDI managers are regulated by TPR and the Financial Conduct Authority (FCA) respectively. Moreover, while pension funds are typically based in the UK, the investment funds operating their LDI strategies are largely based in Ireland and Luxembourg and information is reported via UK AIFMD given the marketing to UK investors. However, data quality and availability are challenging, while reporting is done with a lag. Data gaps were also highlighted by the FCA, which noted that limited data were available on the use of LDI strategies, leverage, and collateral. As pointed out by the recently concluded UK FSAP, such data gaps limit the BoE's oversight of institutions' risk positions and visibility of some institutional behaviors in stress episodes. Also, because LDI funds are domiciled outside of the UK, the FSAP

was not able to evaluate their liquidity risks. More broadly, the BoE should consider how to collect information that fully matches its broader financial stability mandate.<sup>15</sup>

**Informational gaps around NBF activities and exposures, and lack of systemic oversight have been common threads in all recent crises involving NBFs.** For example, following the Archegos episode, concerns were raised about banks' risk management, margin requirements for over-the-counter (OTC) derivatives, the opacity of family offices, and the ability of regulators to monitor system-wide risks. Relatedly, the Basel Committee on Banking Supervision (BCBS) highlighted vulnerabilities and deficiencies in the risk management of banks related to NBFs, including insufficient information collection on clients' positions and exposures, together with limited efforts to understand and assess clients' investing strategies.

**Closing these data gaps would support a holistic overview of NBF vulnerabilities, but in itself would likely be insufficient to assess and respond to financial stability risks.** The FSAP recommended the authorities collect or systematize the collection and reporting of data for all Sterling holdings by all investors. Such data could help to enhance the analysis of the concentration of NBF investors in key sterling markets, including holders of various gilt maturities with similar business models and their behavior in stress together with resulting implications for liquidity in these markets. These data would also be critical for proper NBF supervision and designing appropriate backstop facilities. In addition to margin calls, for insurers - liquidity risks could stem from higher outflows as a result of policy surrenders (i.e., cancellation of policies) or catastrophe events, and also from lower premiums. To analyze combined liquidity drains, more granular data and a monitoring framework is needed. For a comprehensive analysis of liquidity risks, the PRA should enhance its supervisory reporting and monitor cash pooling arrangements within insurance groups. Moreover, intermediaries such as prime brokers should have access to data on a fund's overall leverage, not just the portion to which they have contributed.

**All data collection efforts need continued international coordination, but the authorities should continue to take the lead in this area.** The UK NBF sector is internationally connected thus information collection and supervision would require international cooperation. In this respect, the UK authorities should continue strengthening information sharing with relevant third-country authorities, including monitoring and supervising internationally active NBFs. For example, European Systemic Risk Board (ESRB) uses the Alternative Investment Fund Manager Directive (AIFMD) reporting to help analyze and monitor NBF risks. According to ESRB (2023), all the UK pooled LDI fund managers are domiciled in the EU, and their information can be accessed through the AIFMD data. The UK authorities should seek regular access to the AIFMD data through a bilateral agreement with the EU authorities and explore other sources for higher frequency data. In this regard it is worth noting that the FCA is reportedly receiving information from LDI managers on a more frequent basis now. In addition, consideration should also be given to limiting concentrated exposures and correlated behaviors that can strain market functioning and threaten financial stability through enhanced efforts to close information and data gaps.

#### ***4.B NBFs' liquidity management and oversight of leverage***

**Liquidity shortages, leveraged positions, and a high level of interconnectedness provide the vehicle through which financial stability vulnerabilities crystalize and risks are amplified.** The leveraged positions taken on by funds, liquidity shortages that they faced as a result of margin calls and the impact that

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<sup>15</sup> See IMF (2023b).

their selling of gilts had on the broader market demonstrated how quickly financial stress can amplify and spread. Against this backdrop the LDI stress event was not completely idiosyncratic: the Dash for Cash and Archegos stress events are also examples where leverage, a liquidity shortage and interconnectedness generated financial stability risks, particularly where markets were intermediated by dealers.

**LDI funds' risk management failed to withstand the gilt market turmoil in September 2022.** According to the 2019 The Pension Regulator (TPR) survey, not all pension schemes (only 55 percent) used interest rate shocks to estimate (and prepare for) potential collateral needs under market stress, where the average interest rate movement was 291 bps. While the magnitude of the interest rate movement is comparable with recent gilt yield moves, staff assumes that the duration of assumed market stress is likely to be over a longer period that would allow fund managers to collect margins, whereas large yield increases were realized very rapidly. Similarly, inflation shocks, used by 47 percent of schemes, were unlikely to mimic such rapid market movements. During extreme market movements, LDI managers, who had control of the collateral management (representing 59 percent of schemes), would still need to seek extra cash from pension sponsors or sell other pension assets, which could be operationally challenging.

**Strengthening NBFIs' liquidity management is key, as part of an effort to strengthen oversight of the NBFi sector.** This includes enhancing liquidity regulation of NBFIs holding leveraged exposures in core markets, in order to reduce risks of future disruption as well as the need for central bank backstops. Recent events demonstrated that stress tests were too mild and that mandated liquidity buffers for NBFIs should be reevaluated and strengthened if required. In terms of measures taken by LDI funds in the immediate aftermath of the crisis, funds have been strengthened considerably and secured an average yield buffer ("headroom") of around 300-400 bps. Moreover, ongoing work on liquidity mismatches in investment funds is important – with money market and open-ended fund regulation to be enhanced in line with recent FSB proposals. For MMFs, policy proposals include measures to reduce liquidity transformation (i.e., hold a higher share of liquid assets) or move the cost of redeeming to those investors that redeem (i.e., swing pricing for example). Moreover, there is a need to ensure that open-ended funds use adequate liquidity management tools. In line with global developments, UK authorities published a discussion paper in May 2022 with a number of potential policy options for MMFs, including a reduction in the liquidity transformation carried out by MMFs and the use of liquidity management tools (LMTs).

**Ex-ante liquidity facilities for NBFIs, such as contingent liquidity lines with banks, could be pre-negotiated.** The repo window that the BoE set up, which would have involved banks, did not work during stress episodes. This reveals that banks are unlikely to play the role of providing liquidity to NBFIs during a crisis, partly as a result of the more stringent regulations that they have been subject to since the GFC. In this case, ex-ante liquidity facilities for the NBFIs with banks could be negotiated, for example, contingency liquidity lines. There is precedent for this in Denmark.

**The UK authorities have recommended stronger safeguards and operational resilience to both pension funds and LDI managers.** Following the FPC recommendations and Bank of England staff proposals on indicative resilience standards (see BoE, 2023a), TPR set out a minimum liquidity requirement for pension funds investing in LDI strategies (as part of a steady-state level of resilience) to withstand a 250 bps move in long-dated gilt yields,<sup>16</sup> substantially higher than the 140 bps increase in long-term yields seen in a few days

<sup>16</sup>The TPR requires schemes to invest only in leveraged LDI arrangements where there is a buffer of 250 bps to withstand severed market stress together with an additional operational buffer.

during the LDI crisis. Overseas regulators of LDI funds denominated in pounds also engaged proactively with fund managers to improve the resilience of such funds across Europe (CBI, 2022). FCA and TPR also set out further guidance on enhancing resilience in LDI funds, including realistic contingency planning, applying appropriately designed stress tests, and ensuring clients can deliver collateral within five days.

#### **4.C Central bank liquidity backstops for systemic NBFIs**

**The design of BoE's financial stability intervention greatly benefited from timely information provided by market intelligence which helped to tailor the BoE's response to LDI stress.** For example, once stress emerged, market intelligence confirmed that leverage was already high and that a swift intervention from the BoE was needed, thus after consideration a repo facility for LDI funds was ruled out and targeted gilt purchases were seen as the best option.

**While the BoE's intervention also involved gilt purchases, the implementation was quite different during the dash for cash episode where monetary policy was expected to loosen.** Typically, central bank asset purchases contribute towards monetary easing, and accompanies situations where central banks are lowering interest rates. In the case of the LDI stress event, the BoE had already set out its plans for quantitative tightening – first by stopping reinvestments from March 2022 and then also announced plans for active gilt sales i.e., selling gilts, against a backdrop of interest rate hikes to tame inflation. When the BoE intervened, it paused the planned start of active gilt sales. Moreover, backstop pricing meant that, unlike in QE, the BoE did not set out to buy a given quantity of gilts in each auction. Rather, the Bank set a backstop price relative to the market for each gilt, above which it would not purchase. This ensured the intervention remained a backstop to market functioning, with the Bank purchasing only as much as required by the market to restore orderly functioning.

**Still, given the potential perceived tensions between price stability and financial stability, transparency and clear communication are critical for conducting effective market interventions during stress episodes.** Policies such as opening central bank liquidity support to NBFIs may make achieving price stability complicated if it involves asset purchases, while raising moral hazard concerns. For example, purchasing sovereign bonds to improve market functionality while raising policy rates and conducting quantitative tightening could create communication challenges. In such a scenario, clear communication by the central bank becomes even more important, especially if such measures are prolonged and untargeted (see GFSR April 2023). In this context, BoE's firm communication with markets on the temporary and targeted nature of the intervention and with pension funds on the need to recapitalize their funds swiftly was proven critical, despite some market participants initially perceiving tensions.

**At the same time, backstops for the functioning of core markets such as gilts should be strengthened, whilst minimizing moral hazard, as recommended by the FSAP.** For entities for which data are collected and analyzed, and which are subject to appropriate supervision and systemically interconnected, consideration could be given to grant access to a central bank liquidity backstop. In the context of the UK, the inclusion of certain NBFIs in the BoE's operational framework could improve the BoE's options in future stress situations – for example allowing appropriately regulated and systemically interconnected NBFIs possible access to some liquidity support from the BoE's facilities would widen the range of options available to counteract future market-wide stresses. The FSAP stressed that such support should be focused on maintaining the functioning of the core markets (such as gilts and gilt repos). Expanding the toolkit would be especially important as the BoE is currently in a monetary tightening phase. The design of facilities accessible to NBFIs should reflect their

diverse nature and safeguards would need to be in place with risk remaining in the marketplace to avoid moral hazard.<sup>17</sup>

#### **4.D Overall surveillance of the NBFi sector**

**The FPC’s stress analysis of the risks from leverage in the NBFIs was not as extreme as market stress experienced during the LDI crisis which exceeded previous historical moves.** An assessment conducted by the FPC in 2018 concluded that most non-banks (including pension funds) had sufficient liquid assets to meet margin calls under an interest rate shock as big as 100 bps; the report claimed that “a 100 bps increase over a single day, or a single week has never been experienced in 10-year sterling swap rates looking back to 1990.” But the actual move in late September was bigger, and liquidity shortfalls increased exponentially. The analysis saw a £1.4 billion shortfall with a 100 bps increase in interest rates faced by NBFIs with total assets around £1.8 trillion.<sup>18</sup> During the recent market turmoil, pension funds raised £40 billion in cash, whereas the total LDI investment was about £1.5 trillion. In addition, the FPC cautioned that pension funds did not pay sufficient attention to liquidity risks.

**In this context, the FPC’s plan to conduct a system-wide exploratory scenario (SWES) exercise focused on NBFi risks is a welcome step towards improving the understanding of NBFi-related vulnerabilities.**

The focus will be on both key entities (banks and NBFIs, including those domiciled abroad) and core markets. This exercise, which is voluntary, but intended to cover most systemic NBFIs and their links to banks, should help identify and possibly quantify the various risks, including hidden leverage, and channels of systemic risk propagation. The exercise should also help close some NBFi data gaps and is an important step toward stronger regulation and supervision of NBFIs and ultimately toward mitigating systemic financial stability risks.

**Nevertheless, continued horizon scanning is a prerequisite for identifying NBFi vulnerabilities and responding to stress in the NBFi sector.** The NBFi sector comprises a set of diverse institutions with different business plans and levels of risk taking. Moreover, the NBFi sector is continuously evolving and adapting. Hence, continued monitoring and improvement in assessments are required.

## 5. Concluding Points

**The LDI stress episode was not completely idiosyncratic, echoing NBFi vulnerabilities in past stress episodes—including liquidity stress, leverage, and interconnectedness.** While the BoE intervention on financial stability grounds successfully restored market functioning and provided LDI funds time to build more resilient positions, more can be learned through this experience.

**This episode was triggered by a fiscal event resulting in historical moves in gilt yields, exceeding any standard stress test parameters.** This illustrates the importance of macroeconomic policy coordination, but it also challenges the assurance from standard stress tests. In this context, reverse stress testing can be used as a complementary tool. The purpose of reverse stress testing is to identify extreme events or circumstances that

<sup>17</sup> See also IMF, 2023a for further guidelines for central bank intervention to provide liquidity.

<sup>18</sup> The NBFIs in the FPC’s analysis included the largest UK insurers, the biggest derivatives users among UK pension funds, UK investment funds, and hedge funds reporting to the FCA, amounting to over 100 institutions.

could potentially cause significant financial stability risks. By identifying these scenarios, the authorities and financial institutions can develop contingency plans and risk mitigation strategies to ensure resilience.

**Second, while the urgent need to close data and information gaps was demonstrated, the role of market intelligence was underscored even when data might be available but might not be timely or sufficient to inform policy responses.** While enhanced data availability helps identify potential vulnerabilities building, available data could be complemented by market intelligence, which could play a key role in the real-time decision-making process of authorities' crisis response. The ongoing SWES exercise could also contribute to this end, including identifying key market players and their behavior during stresses.

**Third, given the cross-border nature of NBFIs activities, international coordination to address NBFIs vulnerabilities is key.** NBFIs domiciled and possibly regulated in one jurisdiction are often marketed in other jurisdictions, creating cross-border links and the potential for stress spillovers. Moreover, an international response to regulatory changes is required to avoid the possibility of regulatory arbitrage.

**Finally, the episode demonstrated the importance of communication among regulators, but also to the public.** Given the various roles of the authorities in NBFIs regulation and oversight, clear and regular communication between regulators is key, not only in monitoring NBFIs vulnerabilities but also in times of stress. Moreover, given potential perceived tensions between monetary policy and financial stability, it is of utmost importance that the authorities communicate clearly and in a timely manner to the public, so that market participants understand the purpose of actions taken.

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