FSB FINANCIAL STABILITY BOARD

The Financial Stability Implications of Leverage in Non-Bank Financial Intermediation

6 September 2023

The Financial Stability Board (FSB) coordinates at the international level the work of national financial authorities and international standard-setting bodies in order to develop and promote the implementation of effective regulatory, supervisory and other financial sector policies. Its mandate is set out in the FSB Charter, which governs the policymaking and related activities of the FSB. These activities, including any decisions reached in their context, shall not be binding or give rise to any legal rights or obligations.

Contact the Financial Stability Board

Sign up for e-mail alerts: www.fsb.org/emailalert
Follow the FSB on Twitter: @FinStbBoard
E-mail the FSB at: fsb@fsb.org

Copyright © 2023 Financial Stability Board. Please refer to the terms and conditions

Table of Contents

Executive summary

Leverage is a financial technique used to increase exposure, boost returns or take positions that can offset potential losses from other exposures (hedging). If not properly managed, the build-up of leverage creates a vulnerability that, when acted upon by a shock, can propagate strains through the financial system, amplify stress and lead to systemic disruption. This has been demonstrated by a series of recent financial incidents. It can do so via two propagation mechanisms: the position liquidation channel and the counterparty channel. Any disruption could be further amplified by factors such as the amount and concentration of leverage as well as its opaqueness, volatile asset valuations, market participants' inadequate risk management, and liquidity imbalances in leveraged non-bank investors and in the markets they operate in.

Leverage can take the form of financial leverage (borrowing through loans, bonds, repurchase agreement (repo) and other securities financing transactions (SFTs)) or synthetic leverage (using derivatives that create exposures whose value depends on the value of an underlying asset). Leverage can be taken on-balance sheet through, for example, loan or bond issuance; or off-balance sheet – for example, by holding shares of investment vehicles that use leverage techniques. Leverage that is difficult to identify or measure by market participants or public authorities is referred to as 'hidden leverage'. In some cases, leverage is hidden because no data are available to assess its presence or magnitude. In other cases, leverage can be hidden because available data are not sufficient or adequately used to assess vulnerabilities.

Several recent market events, such as the March 2020 turmoil as well as the failure of Archegos Capital Management and strains in commodities and bond markets, underscore the need to strengthen the resilience of non-bank financial intermediation (NBFI). Building on the lessons from the March 2020 market turmoil, the FSB developed a comprehensive work programme to examine and address vulnerabilities, including those associated with NBFI leverage, that contribute to systemic risk. This report forms part of that work.

The level of debt issued by the NBFI sector in FSB member jurisdictions is significant and similar in scale to household debt. However, this is unevenly distributed within the sector. While insurance companies, pension funds and investment funds represent two-thirds of NBFI assets, more than 90% of on balance sheet financial leverage is in so-called other financial intermediaries (OFIs), such as broker-dealers, hedge funds, finance companies, holding companies and securitisation vehicles. While aggregate data points to a decline in OFI leverage in the period since the 2008 global financial crisis, this has largely been due to a change in the composition of the NBFI sector rather than widespread deleveraging by non-bank entities.

Non-bank entities have been taking on additional leverage through off-balance sheet exposures, including foreign exchange swaps and forwards. These positions have grown significantly over the past decade. While it is difficult to assess NBFI synthetic leverage from publicly available information, aggregate proxies suggest that this may be higher than its historical average.

Amongst non-bank investors, hedge funds display high synthetic leverage in aggregate, obtained through derivative positions. Within the hedge fund sector, there is a group of funds, typically pursuing macro and relative value strategies, with very high levels of synthetic leverage. In addition, large hedge funds usually spread their borrowing across several prime brokers, which helps diversify their funding sources but can also create hidden leverage in the financial

system. Furthermore, a few prime brokers dominate the provision of lending to hedge funds, and this concentration could amplify shocks and propagate them through the financial system.

Although long-term investors take financial leverage on their balance sheet, this does not appear to be significant in aggregate. Insurance companies sometimes have a significant notional amount of derivatives (implying synthetic leverage) on their balance sheet for hedging purposes. In some jurisdictions, defined benefit pension funds take off-balance sheet leverage through liability-driven investment (LDI) vehicles that borrow in repo markets and also take-on synthetic leverage. These types of leveraged strategies could impact financial stability through the liquidation of positions (asset fire sales) during times of highly volatile price movements, when leverage leads to unexpectedly large margin and collateral calls, and be amplified through concentrated positions by a small number of investors and within particular market segments.

The report identifies a number of data gaps which have made it difficult to fully assess the vulnerabilities associated with NBFI leverage. Family offices, for example, may be taking on leverage, but little public and regulatory data are available to measure the nature, size and concentration of those positions. Similarly, pension funds' leverage is difficult to assess without more information on their investments. The limited availability of data, problems in aggregating existing data, and difficulties in estimating meaningful measures of leverage may lead to a misestimation of overall leverage in the NBFI sector and, in particular, the inability to identify large and concentrated positions. In addition to hampering vulnerabilities assessments, this impedes mitigating measures from being put in place by market participants and regulators.

Actions that could be considered to address the most salient identified data gaps include: (1) making more intensive use of existing data, such as those available in trade repositories; (2) further implementing the November 2015 FSB standards for collecting and aggregating global data on SFTs; (3) enhancing reporting requirements for non-bank investors, especially those (in particular OFIs) that have high leverage levels; (4) changing existing frameworks for assessing leverage to include new and consistent metrics; (5) sharing more information between authorities and across jurisdictions; (6) expanding disclosure requirements for firms to shed light on concentrated positions; and (7) collecting and publishing more information on NBFI leverage and balance sheets, for example in national statistics and flow of funds accounts. Measures to address data gaps should take into account the costs of such measures to market participants and authorities, as well as potential financial stability risks.

Authorities might also want to examine whether any policy responses are needed to address vulnerabilities and amplification factors from NBFI leverage. Examples include: implementing the agreed FSB minimum standards and haircut floors on non-centrally cleared securities financing transactions; developing additional rules on haircuts and margins; or assessing whether rules on leverage could be extended to financial institutions not subject to such requirements, taking account of differences in risk profiles. In addition, measures could be considered to mitigate the financial stability consequences of high NBFI leverage, for example by enhancing prime broker risk management, improving the liquidity preparedness of market participants, augmenting the resilience of liquidity provision in core funding markets during times of stress, or enhancing the stress tests used by non-bank investors and authorities.

The FSB, in cooperation with standard-setting bodies (SSBs), is already working on some of these issues as part of its NBFI work programme. The FSB and SSBs will undertake further policy work to enhance authorities' and market participants' ability to identify, monitor and contain systemic risk associated with leverage in NBFI, drawing on the findings of this report.

1. Introduction

Many incidents have demonstrated that leverage can create and amplify vulnerabilities in the global financial system, including the 1998 collapse of Long-Term Capital Management, the 2008 global financial crisis, the March 2020 market turmoil, the 2021 Archegos failure, and the September 2022 dislocation in the UK gilt market.

The March 2020 turmoil underscored the need to strengthen the resilience of NBFI.[1] Building on the lessons from the turmoil, the FSB developed a comprehensive work programme to examine and address vulnerabilities, including those associated with NBFI leverage that contribute to systemic risk.[2] This report forms part of that work by providing an overview of aggregate NBFI leverage trends across FSB jurisdictions and the vulnerabilities associated with that leverage.

The report also focuses on leverage in some types of non-bank investors: (1) hedge funds and their links with prime brokers; and (2) long-term investors (i.e. insurance companies and pension funds). These non-bank investors were chosen, as illustrative examples, because they use leverage and because some of them were at the heart of market events over the past few years.[3] As noted in the report, leverage is also present in a number of other NBFI market segments.

The report is structured as follows: Section 2 discusses the vulnerabilities associated with NBFI leverage, including propagation and amplification mechanisms; Section 3 looks at aggregate trends in NBFI leverage through a set of metrics; Section 4 discusses hedge fund leverage and the links with prime brokers; Section 5 covers leverage, LDI strategies, and long-term investors; Section 6 describes the data gaps that lead to hidden leverage; and Section 7 concludes.

2. Vulnerabilities associated with NBFI leverage

Leverage is a financial technique used to increase exposure, boost returns or take positions that can offset potential losses from other exposures (hedging). Leverage can take different forms (Figure 1). It can be financial – through borrowing via loans, bonds, repo and other securities financing transactions – or synthetic using derivatives that create exposures whose value depends on the value of an underlying asset. Leverage can either be on the balance sheet of investors (e.g. loans or bonds) or off-balance sheet (e.g. by holding shares in investment vehicles that use leverage techniques or in special purpose vehicles created to finance the origination of risky assets).

---

1 See FSB (2020), *Holistic Review of the March Market Turmoil*, November.

2 See FSB (2023), Enhancing the Resilience of Non-Bank Financial Intermediation: Progress Report, September.

3 Hedge funds were involved in the March 2020 market turmoil through the unwinding of basis trades in US government bonds, prime brokers faced losses as a result of the Archegos failure, euro area pension funds faced significant margin calls in March 2020, and certain UK pension funds were at the centre of the UK gilt market episode in 2022.

Illustration of different forms of leverage **Figure 1**

	Financial leverage	Synthetic leverage
On-balance sheet	Investor borrowing (e.g. via bonds, loans, and repos or other SFTs)	Investor derivative positions
Off-balance sheet (e.g. taken by investing in a collective investment vehicle or CIV)	e.g. CIV repo borrowing, mortgage-backed securities	e.g. CIV derivative positions

Source: FSB.

Leverage that is difficult to identify or measure by market participants or public authorities is referred to as 'hidden leverage'. In some cases, leverage is hidden because no data are available to assess its presence or magnitude. In other cases, leverage can be hidden because available data are not sufficient or adequately used to assess vulnerabilities (see section 6). This opaqueness inhibits the extent to which market participants and authorities are able to monitor associated vulnerabilities and can therefore help amplify the propagation of shocks.

If not properly managed, the build-up of leverage creates a vulnerability that, when acted upon by a shock, can propagate strains through the financial system, amplify stress, and lead to systemic disruption. It can do so via two main propagation mechanisms: the position liquidation channel and the counterparty channel. Any disruption could be further amplified by a combination of several related factors, including the amount and concentration of leverage (and its opaqueness), asset valuations, market participants' inadequate risk management, and liquidity imbalances in leveraged non-bank investors and in the markets they operate in. These propagation and amplification channels are discussed below.

2.1. Propagation mechanisms

As leverage can be used to increase exposure and boost returns, it also has the potential to amplify losses through the combination of position liquidations or counterparty defaults.

Position liquidation channel

Leverage can lead to large or unexpected liquidity demands from collateral or margin calls. The liquidity demands might lead leveraged non-bank entities to sell assets to raise funds. These asset sales, if they take place when a market is already under stress, could add to market volatility and result in an adverse feedback loop. The unwinding of positions can further depress prices in the affected markets, generating additional liquidity demands on the investor, as well as on other market participants with exposure to the same markets and instruments.

Even in cases where an investor has sufficient liquid assets, the liquidation of these assets could transmit stress from the leveraged investor to other markets. For example, leveraged investors

confronted with large margin calls could redeem their money market fund (MMF) shares to raise cash. This can create severe liquidity pressure and outflows from MMFs that would in turn need to liquidate their positions (e.g. in commercial paper, certificates of deposit or government bonds), transmitting stress to these markets.

Leverage can also propagate shocks if the investor aims to maintain a target level of leverage on their balance sheet or seeks to have a stable value-at-risk in their portfolio. Adverse price movements lead to mark-to-market losses, eroding capital, increasing balance sheet leverage and, through higher asset price volatility, increasing value-at-risk. Investors may then aim to restore target levels of leverage and value-at-risk by sales of assets.[4]

Finally, non-bank investors may liquidate their positions as a result of their so-called "leverage-like behaviour",[5] even in the absence of actual leverage. Long-term investors typically look to match the duration of their assets and liabilities to minimise the impact of interest rate movements on their equity but, in doing so, this can create convexity mismatches. This arises because the duration of the liabilities of pension funds and life insurance companies is typically more sensitive to changes in market yields than the duration of their assets. As a consequence, when yields snap back and long-term rates spike higher, the duration of their liabilities falls much faster than the duration of their assets. In order to match the duration of both sides of their balance sheet, long-term investors look to reduce the duration of their assets by selling long-term bonds.[6] This convexity mismatch can generate perverse demand responses, as long-term investors sell bonds as their prices fall (or yields rise). This behaviour means that long-term investors may not step-in to buy bonds and stabilise the market as prices fall.

Counterparty channel

Leverage – be it through cash lending, securities financing or derivatives transactions – often entails a counterparty exposure. If a leveraged entity's asset sales are insufficient to meet its counterparties' collateral or margin calls, or if mark-to-market losses eradicate the leveraged entity's capital, then it will default. In this case, the original shock can be propagated to the entity's counterparties. If these lenders are not sufficiently resilient to absorb losses due to the default, the counterparties may experience financial distress, and the shock could potentially propagate even more broadly.

Shocks might also propagate without a default. When the perceived risk of counterparty credit losses increases, the counterparty's own lenders may decide to reprice or withdraw their financing, which could create funding stress for the non-bank entity's counterparty, especially if the leveraged position has a short-term maturity and needs to be constantly rolled-over.

Furthermore, regardless of the resilience of the counterparties, a non-bank investor's failure may lead to the liquidation of any collateral posted or assets funded, as well as the termination and replacement of any remaining derivatives contracts. These liquidations and unwinds can then

---

4 Fire sales of assets may be magnified by the existence of automatic or binding mechanisms for investors. For a discussion of the shock propagation, see Adrian and Shin (2010), Liquidity and leverage, Journal of Financial Intermediation, July.

5 For example, see Shin (2014), *Financial stability risks: old and new*, December; and Caruana (2016), *Financial regulation: cementing the gains of post-crisis reforms*, May.

6 See Domanski et al (2015), The hunt for duration: not waving but drowning?, *BIS Working Papers*, No 519, October.

instigate a new cycle of the shocks through an indirect position liquidation channel and can further propagate the shock to other counterparties. The extent to which a position is collateralised and the quality of the collateral play a role in the transmission of the shock.

2.2. Amplification factors

Other factors may amplify the vulnerabilities related to NBFI leverage, accelerating and magnifying the disruptions that leverage can generate within the financial system.

Interconnectedness

The degree to which a leveraged entity is interconnected, both in terms of the number of its counterparties and the scale of its exposures, determines the likelihood and magnitude of losses that could propagate through the financial system.

Non-bank investors can be interconnected through both direct and indirect exposures. Direct exposures correspond to the network of financial relationships. Indirect exposures arise when non-bank entities that do not have a direct financial relationship have similar portfolios or investment strategies, exposing them to the impact of each other's asset sales and making them more likely to react in a correlated manner during stress. Indirect exposures are typically more difficult to identify and quantify.

Concentration

Concentration of leverage can manifest in a variety of ways. First, leverage can be concentrated in a particular security or sector, or in both. As illustrated by the Archegos episode, an investor could accumulate a significant position in total return swaps referencing a narrow set of technology sector firms that would be difficult to unwind without impacting the market price of both the underlying securities and the derivatives based on those securities.

Second, concentration can also arise from a popular leveraged strategy, where several entities have indirect interconnections through similar exposures, even where no single entity's exposure is large. In these circumstances, an initial shock to the common risk exposure can propagate stress across the larger set of entities.

Third, concentration can often build up if leverage is hidden. For example, a non-bank investor could borrow from several prime brokers to obtain more leverage that an individual prime broker would provide. However, no single prime broker would know the full extent of the concentrated position that has been built-up by the leveraged entity. The prime brokers would then not be able to take measures to mitigate the potential impact of unwinding the concentrated position.

Liquidity imbalances

Both internal and external liquidity imbalances can act as amplification mechanisms. External liquidity imbalances develop when the providers of liquidity are unable to absorb increases in the demand for liquidity. Banks, broker-dealers and other intermediaries might be unable or unwilling to intermediate in markets during periods of stress, which can accelerate the

propagation of shocks through the position liquidation channel.[7] Thin liquidity conditions can amplify asset price movements, which in turn can amplify the need for leveraged entities to raise liquidity by selling assets. In extreme stress conditions, this adverse feedback loop can result in fire sale dynamics.

Internal liquidity imbalances correspond to liquidity and maturity mismatches within leveraged entities. This is often the case with non-bank investors that finance leveraged positions with shorter-term sources, such as short-term repo funding, margin loans, commercial paper and other money market instruments. The resulting maturity mismatches can create internal liquidity imbalances in periods of stress if the funding cannot be rolled-over at short notice. Another type of liquidity imbalance can arise from the use of derivatives (i.e. synthetic leverage) that require daily mark-to-market margining. Significant adverse price movements can generate large and unexpected liquidity demands relative to the NBFI's liquid assets or its ability to raise liquidity through asset sales and unwinds.

3. Aggregate trends in leverage

This section looks at aggregate NBFI leverage using data that are readily available across FSB member jurisdictions.[8] The aim is to assess broad trends that can help in assessing vulnerabilities at a system-wide level. Such an aggregate picture, however, is not intended to draw conclusions about leverage across the wide range of individual types of non-bank investors that have various business models and financial risk profiles. Furthermore, there are other types of leverage that emanate from, or are available to, non-bank entities that may not be captured by aggregate measures of leverage.[9] Nevertheless, this work identifies several interesting findings on the scale, location and trends in NBFI leverage.

3.1. Financial leverage

Scale of NBFI leverage

The level of debt issued by the NBFI sector is significant in scale. Looking at the G5 economies, where flow of funds data provide information on NBFI balance sheets, the total amount of debt stands at $34 trillion, almost 75% of GDP, similar to household debt (Graph 1, panel 1).[10] Data from the FSB's Global Monitoring Report on Non-Bank Financial Intermediation (GMR) suggest that these economies represent around 70% of global NBFI assets.[11]

---

7 Potential reasons might be the size of banks' balance-sheets compared to size of debt markets, market developments and risk-adjusted return of intermediation, post-crisis regulatory reforms, and changes in business models. See FSB (2021), *Enhancing the Resilience of Non-Bank Financial Intermediation: Progress Report*, November.

8 In this section, the definition of NBFI excludes public financial institutions – in line with the definition used in other FSB analysis.

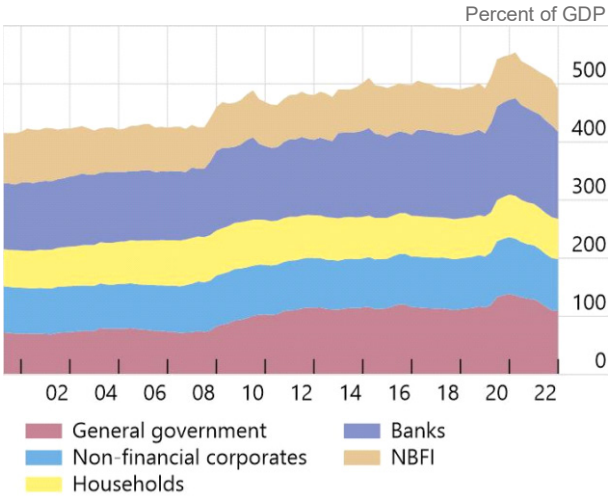
9 For instance, the tranching of bonds issued from a securitisation vehicle creates different levels of exposure to the underlying assets, which essentially provides different levels of leverage to the performance of the assets (embedded leverage).

10 In this report, the G5 data are for the total euro area (instead of just France and Germany) as well as Japan, United Kingdom and United States.

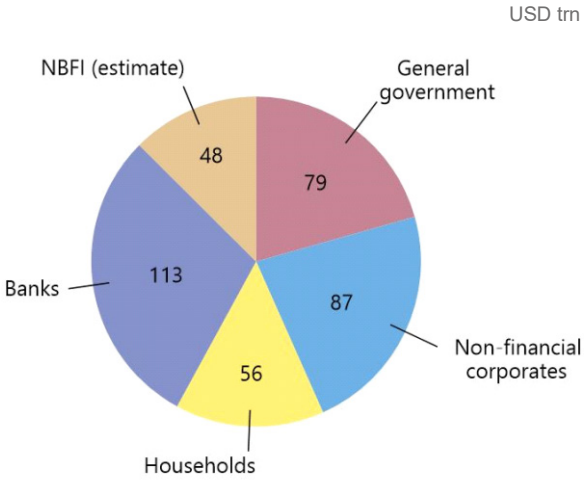
11 See FSB (2022), *Global Monitoring Report on Non-Bank Financial Intermediation*, December.

NBFI debt[1] **Graph 1**

1. G5 economy debt[2]



2. Global debt levels: Q4:2022



[1] NBFI excludes public financial institutions, including government-sponsored enterprises (GSEs). The data for the United States include all hedge funds that report to the SEC, even if they are not domiciled in the United States. Bank debt includes interbank liabilities, debt issued, and borrowing via loans and repo. [2] For the purposes of this graph, the G5 economies are the euro area, Japan, the United Kingdom and the United States.

Sources: BIS; national flow of fund accounts; FSB calculations.

It is difficult to obtain a number for the global amount of NBFI debt, and this highlights the significant data gaps that exist. Information collected for the GMR, however, can be used to form an estimate. This dataset includes partial information on NBFI balance sheets for all of the FSB jurisdictions and a few other economies. Using these data implies that global NBFI debt stands at around $48 trillion or about 50% of global GDP (Graph 1, panel 2). This would again be broadly similar in scale to global household debt.[12]

NBFI leverage is highly uneven across the sector. Figure 2 provides a stylised overview of the balance sheets of the main types of entities in the NBFI sector. While insurance companies, pension funds and investment funds account for a large share of NBFI assets, most of the financial leverage is in OFIs, a group that encompasses a range of miscellaneous entities, from broker-dealers and hedge funds, to finance companies, holding companies and securitisation vehicles.[13] Looking across the G5 economies, insurance companies, pension funds and investment funds together make-up almost two-thirds of the assets of the NBFI sector, but less than one-tenth of NBFI sector debt. OFIs, on the other hand, represent one-third of the assets but have more than 90% of the debt in the NBFI sector.

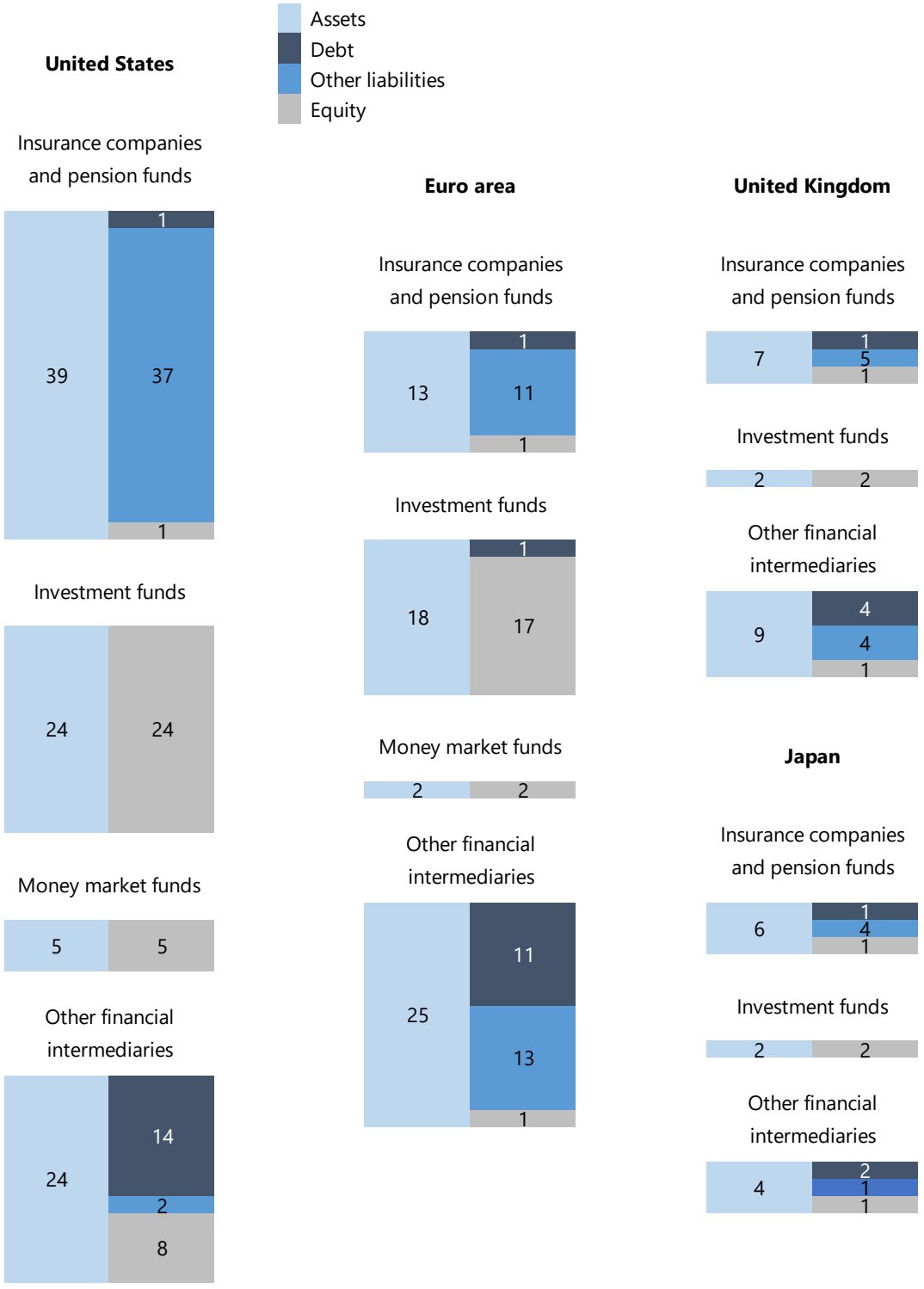
[12] The estimate for jurisdictions outside the G5 economies is calculated from partial information on non-bank entity liabilities and related assets that is grossed-up to total NBFI assets.

[13] The definition of OFIs is similar to that used in national statistics, where OFIs comprises non-bank financial corporations other than money-market funds, investment funds, insurance companies and pension funds. See European Commission, IMF, OECD, UN and World Bank (2009), *System of National Accounts 2008*. It differs from the broader OFI definition used in the FSB's Global Monitoring Reports on NBFI, where the OFI sector comprises non-bank financial corporations other than insurance companies and pension funds.

NBFI balance sheets: 2022[1]

Figure 2

USD trn



[1] NBFI excludes public financial institutions, including GSEs. The data for the United States include all hedge funds that report to the SEC, even if they are not domiciled in the United States. Data are rounded to the nearest trillion and in cases where a balance sheet item is less than $1 trillion, this is shown as $1 trillion in the diagram to indicate that the item is not zero. Debt includes borrowing via loans, long-term bonds, short-term bonds, margin loans, repos, etc.

Sources: Flow of fund accounts; FSB calculations.

Location of NBFI leverage

Data at the sector level confirms that pension funds and insurance companies as a whole have little on-balance sheet financial leverage. This borrowing represents only around 2-8% of assets for insurance companies and just 1% or less of assets for pension funds (Graph 2, panel 1). Insurance companies are required to have sufficient assets to meet their liabilities and ongoing regulatory capital requirements and debt capital will often be restricted by regulatory constraints or rating agency views.[14] Defined benefit pension funds' assets are funded by their corporate sponsor and in some jurisdictions, they are not permitted to borrow explicitly.

For OFIs, after a post-2008 global financial crisis (GFC) reduction in debt, there has been a steady increase in borrowing since 2010 and debt levels are now higher than they were before the GFC (Graph 2, panel 2). Most of this debt is bonds issued by OFI entities, though loans also make-up a significant part of the debt. Repurchase agreements (repos) are the next largest source of borrowing, followed by other types of short-term debt.

It is important to gauge the degree of OFI leverage. One way of doing this is to see how debt levels compare to the size of the balance sheet. By this metric, aggregate OFI financial leverage in the G5 economies represents around 60% of assets now compared to a peak of 70% of assets at the onset of the GFC (Graph 2, panel 3).

However, this decline in aggregate OFI leverage is largely due to a change in composition of the sector away from more highly leveraged securitisation vehicles rather than a widespread deleveraging across OFI entities. Looking at more detailed data across jurisdictions confirms that leverage across OFI entities has not changed significantly (except for real estate investment trusts (REITs)) over the past decade and a half (Graph 2, panel 4). This again suggests that there has been limited deleveraging at non-bank entities. However, the level of detail on OFI entities in each jurisdiction differs significantly, and this again highlights that data gaps that exist when trying to assess the scale of NBFI leverage.[15]

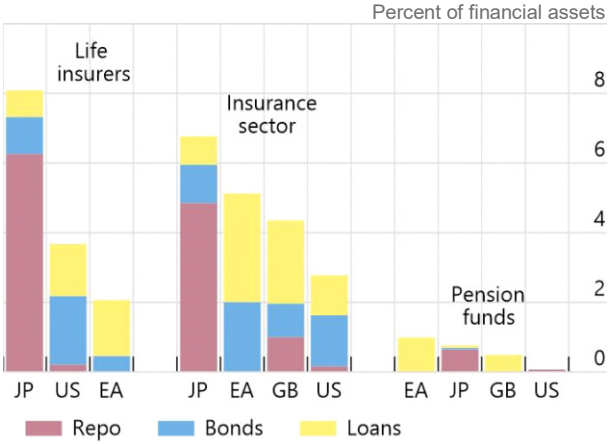
---

[14] In China, the balance of bond repurchase by insurance companies cannot exceed 20% of the institution's total assets at the end of the previous quarter by law and should be mainly used for temporary adjustments of positions and large value compensation pay-outs. This balance cannot be used for investment in fixed assets or other prohibited investments.

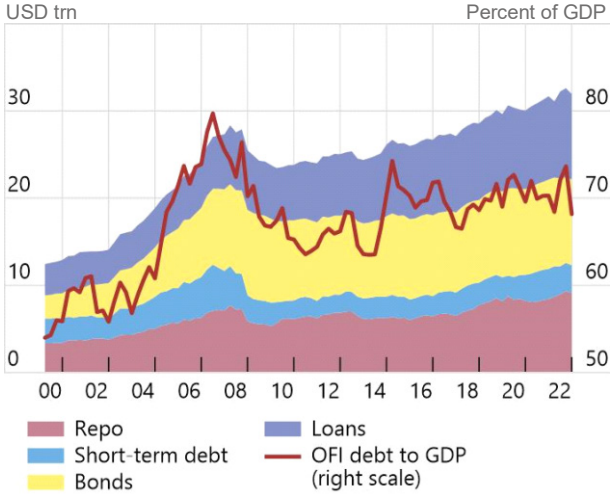
[15] For the United States, data on 6 different types of OFI entity are available: broker-dealers, finance companies; holding companies; issuers of asset-backed securities; REITs and hedge funds, as well as a residual category of other uncategorised OFIs. There are 4 types of entity for Japan (broker-dealers, finance companies, holding companies and special purpose vehicles), plus uncategorised OFIs. There are two types of entity for the euro area (finance companies and financial securitisation vehicles), plus the residual, and no detail for the United Kingdom (i.e. only the uncategorised OFIs).

Long-term investors and other financial intermediaries (OFIs)[1] Graph 2

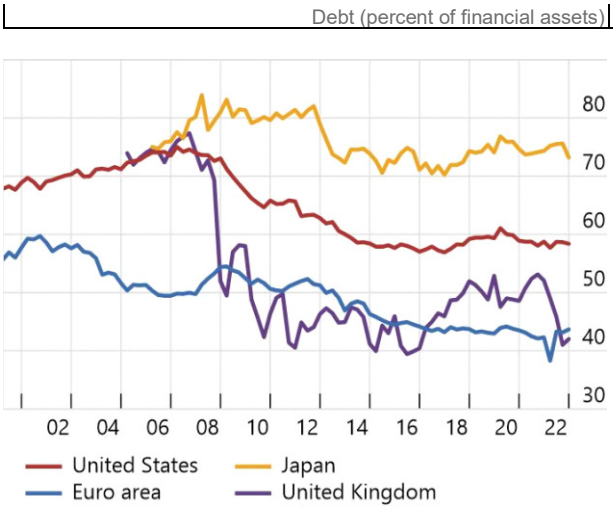
1. Long-term investors' financial leverage, Q4:2022[2]



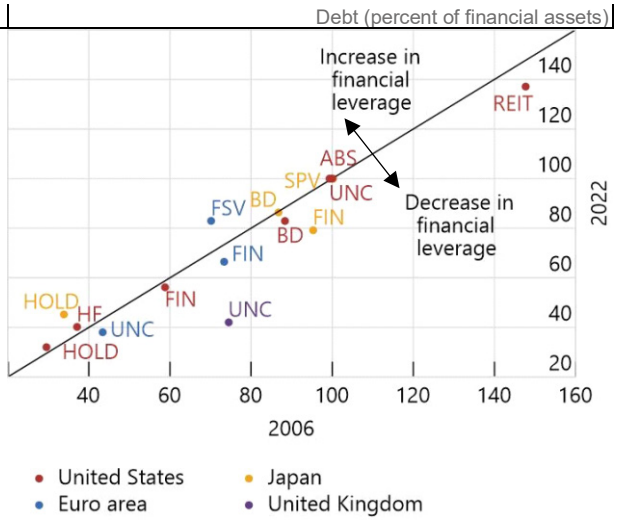
2. Aggregate G5 economy OFI debt[3]



3. OFI financial leverage by jurisdiction



4. Change in OFI financial leverage, 2006-22[4]



ABS = Issuers of asset-backed securities; BD = broker-dealers; FIN = finance companies; FSV = finance securitisation vehicles; HF = hedge funds; HOLD = holding companies; REIT = real-estate investment trusts; SPV = special purpose vehicles; and UNC = uncategorised OFIs.

[1] Other financial intermediaries (OFIs) excludes public financial institutions, including GSEs. The data for the United States include all hedge funds that report to the SEC, even if they are not domiciled in the United States. [2] In panel 1 some repo liabilities might be included in loans. The repo positions of Japanese insurers include both general collateral (GC) and specific collateral (SC) repos. These figures may not capture the borrowing undertaken via funds. [3] For the purposes of this graph, G5 economies are: the euro area, Japan, the United Kingdom and the United States. [4] In panel 4, the euro area data on the horizontal axis are for 2009 rather than 2008.

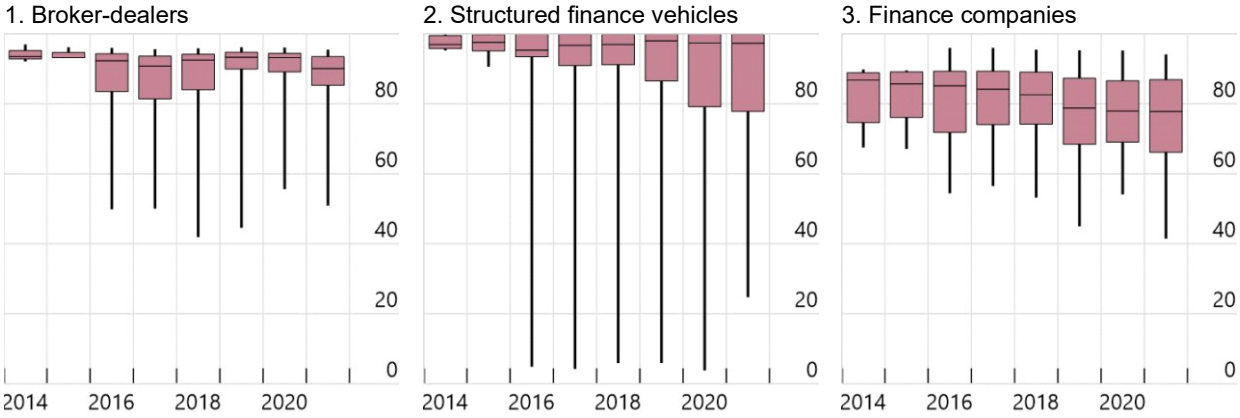
Sources: Flow of fund accounts; FSB calculations.

Data from the GMR covers a greater range of jurisdictions than the G5, albeit for a shorter period of time. It also confirms that there is little evidence of deleveraging in certain OFI entities over the past few years (Graph 3).[16] This dataset also corroborates that leverage is generally higher in OFIs than in investment funds (Graph 3).

[16] The GMR database has information on leverage at broker-dealers, structured finance vehicles, finance companies, investment funds and money market funds.

Non-bank entity leverage across jurisdictions[1]

Debt, in percent of financial assets **Graph 3**



[1] The charts show the range of ratios across jurisdictions in each year. Changes in the distribution over time might be related to changes in the sample of jurisdictions providing data. Debt is calculated as the residual of financial assets less equity.

Source: FSB Global Monitoring Report on NBFI dataset.

NBFI leverage and liquidity mismatches

As was discussed in Section 1, the combination of leverage and a reliance on short-term debt can often be pernicious. The data on the G5 economies includes a breakdown of the type of debt that the OFI entities have (Graph 4, panel 1).

The most highly leveraged entities in the dataset are REITs. As leverage is measured here by looking at financial assets only (the dataset does not have information on the non-financial, property assets held by REITs), this overstates their actual leverage. Most of the borrowing by REITs is through bonds and loans, though they also borrow using repos, creating liquidity mismatches. Broker-dealers are the next most highly leveraged entities, and they make use of significant amounts of repo funding and short-term debt.[17] Securitisation vehicles and finance companies are also relatively highly leveraged and also fund themselves with some short-term debt (e.g. short-dated bonds), though most of their borrowing is through long-term bonds. As is discussed in more detail in Section 4, hedge funds also have a significant amount of short-term debt (e.g. margin loans) and repo, though their aggregate financial leverage is not that high compared to other OFIs. Much of the remaining repo borrowing, however, appears to be in other OFIs (i.e. entities that are uncategorised by type and so where there is another data gap). In the United States at least, these entities also appear to be highly leveraged.

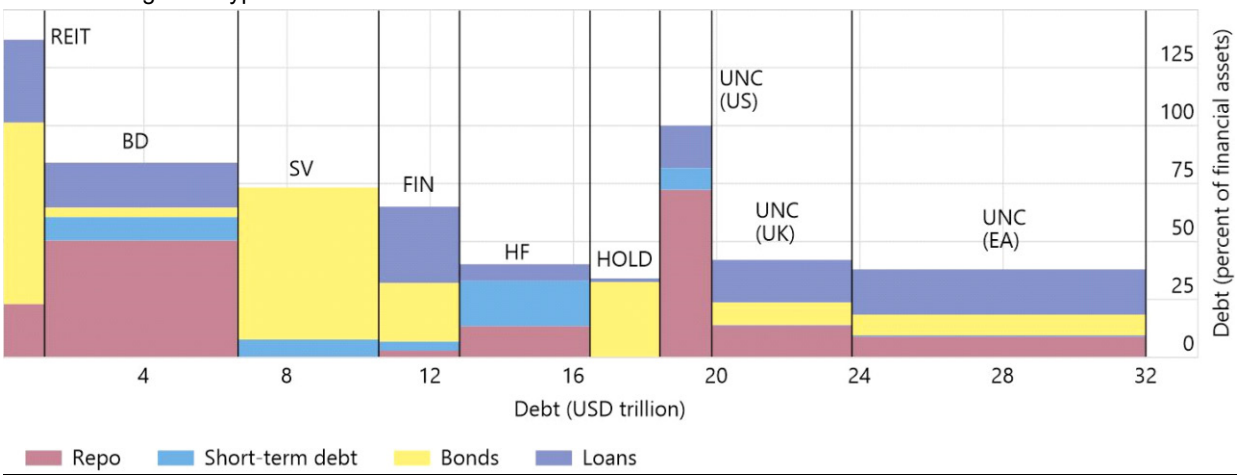
The combination of financial leverage and short-term borrowing by OFI entities is also shown in Graph 4, panel 2. Leverage is plotted on the vertical axis (debt to financial assets) while the horizontal axis shows the proportion of short-term debt (repo and short-term paper) to assets. The size of the circles on the graph is proportion to the amount of dollar debt in each OFI entity. Entities near the top-right quadrant of the graph, such as broker-dealers in Japan and uncategorised OFIs in the United States, may be more vulnerable due to their higher financial leverage and greater reliance on short-term borrowing, to the extent they have term funding mismatches or financing that is not secured with high quality collateral. Hedge funds also use a

[17] In the United States, broker-dealer loans are typically in the form of approved subordinated debt.

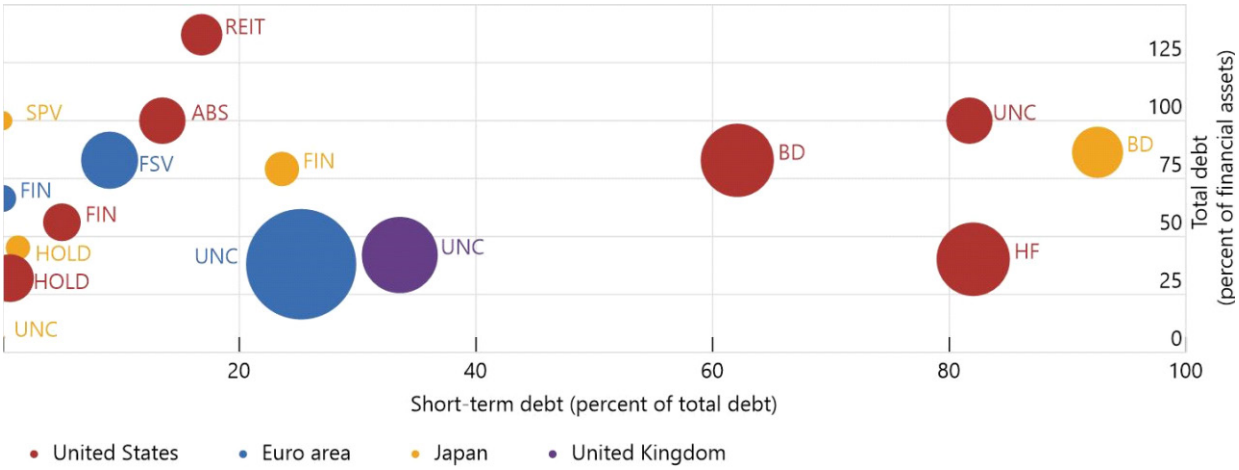
significant amount of short-term borrowing, though as mentioned above, they have less financial leverage. Still, other features of their business models may lead to vulnerabilities, as discussed in Section 4.

OFIs financial leverage by entity: Q4:2022[1,2,3] **Graph 4**

1. OFI leverage and type of debt



2. OFI leverage and use of short-term funding



ABS = asset-backed securities issuers; BD = broker-dealers; FIN = finance companies; FSV = finance securitisation vehicles; HF = hedge funds; HOLD = holding companies; REIT = real-estate investment trust; SPV = special purpose vehicles); and UNC = uncategorised OFIs (residual). SV = securitisation vehicles, which includes ABS, FSV and SPV.

[1] Other financial intermediaries (OFIs) excludes public financial institutions, including GSEs, and broker-dealers. The data for the United States include all hedge funds that report to the SEC, even if they are not domiciled in the United States. [2] Financial leverage is the ratio of debt (bonds, loans, repos and other short-term debt) to financial assets. [3] The chart shows the entities available in each jurisdictions' flow of funds dataset. [4] In panel 2, the size of the circles is proportional to the dollar amount of debt at each OFI entity.

Sources: Flow of fund accounts; FSB calculations.

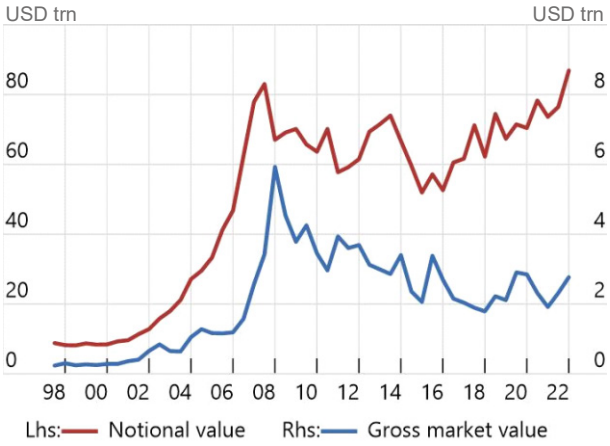
3.2. Synthetic leverage

NBFI synthetic leverage is difficult to measure at the aggregate level, highlighting another shortcoming in the data. This section looks at a few proxies and finds that synthetic leverage is likely to be high by historical standards. One proxy is the total notional amount of non-bank entities' over-the-counter (OTC) derivatives. As discussed in Section 2, the liquidity demands from synthetic leverage come from margin calls, and other payments related to derivatives positions (e.g. payments on the floating-rate leg of an interest rate swap), that depend on the combination of the notional derivatives exposure and the volatility of the underlying assets. The

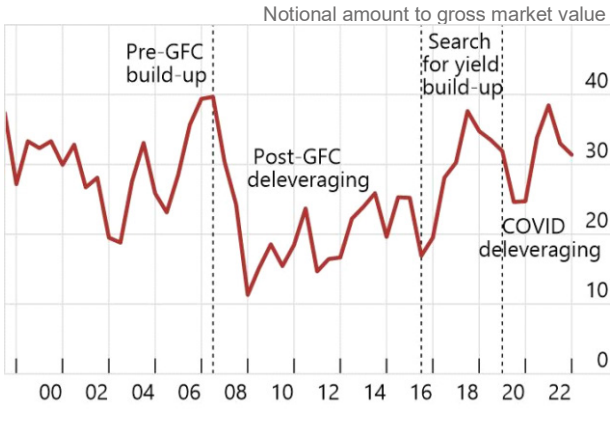
notional amount of non-bank investors' OTC derivatives has grown from less than $10 trillion at the turn of the millennium to almost $90 trillion in 2022, above the previous peak use of derivatives on the eve of the GFC (Graph 5, panel 1).[18] This suggests that liquidity demands associated with these derivatives have the potential to be large.

NBFI OTC derivatives and synthetic leverage[1] **Graph 5**

1. NBFI OTC derivatives exposures



2. NBFI synthetic leverage proxy



[1] The charts cover FX options as well as interest rate, equity and credit derivatives for non-bank entities. CCPs are excluded from the charts.
Sources: BIS; FSB calculations.

A second proxy for synthetic leverage is the ratio of the gross notional amount to the market value. Synthetic leverage comes from the fact that derivatives positions have exposure to changes in the notional amount of the underlying asset, as written in contracts, while market participants only need to put-up a fraction of that notional value in initial and variation margin. [19] The intuition behind this measure is that the denominator represents the value at which the derivative is recorded in accounts and is related to the cumulative sum of variation margin over the life of a derivative contract.[20] This proxy is high in 2022 with notional outstanding some 31 times gross market value, though the proxy has peaked at higher levels (Graph 5, panel 2). While this can only be thought of as a broad estimate of aggregate synthetic leverage, it suggests that this form of leverage could potentially pose a vulnerability for the NBFI sector. It also appears that there is a procyclical pattern in synthetic leverage, with a build-up before the GFC, another higher accumulation of synthetic leverage from 2016-18 as investors searched for yield in a period of low rates and low volatility, and a more recent post-COVID rise.

[18] The BIS also publishes statistics on exchange-traded derivatives, but these do not show how much of that activity is with non-bank entities and so they are not used in this report.

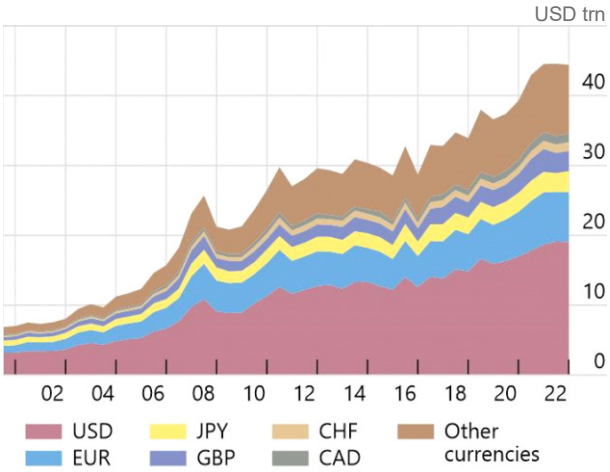
[19] See Ianiro et al (2022), Synthetic leverage and margining in non-bank financial institutions, ECB Financial Stability Review, May; Breuer (2002), Measuring off-balance sheet leverage, Journal of Banking and Finance, Vol, 26; and Breuer (2000), Measuring off-balance sheet leverage, IMF Working Paper, WP/00/202.

[20] The proxy uses market value in the denominator, which is the in-the-money component of a derivative, or its variation margin. Ideally the proxy would also include initial margin in the denominator, though this is not possible as the data are not available.

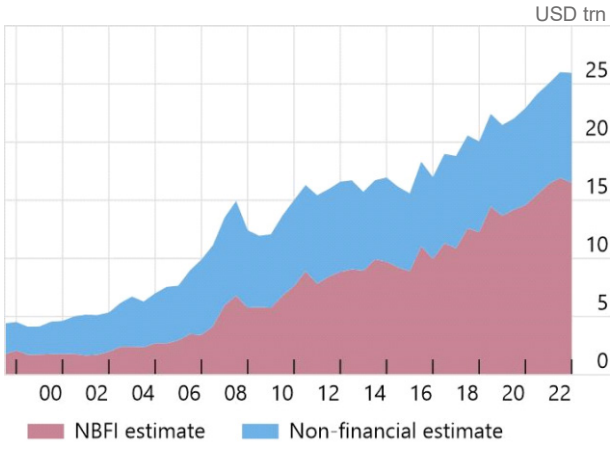
FX forwards and swaps[1]

Graph 6

1. NBFI FX forwards and swaps outstanding



2. Non-bank US dollar off-balance sheet debt[2]



[1] The charts cover FX swaps, FX forwards and currency swaps. [2] Panel 2 estimates the breakdown of non-bank USD off-balance sheet debt into the amount owed by the NBFI sector and the amount owed by the non-financial sector. This estimate is based on the assumption that all of the non-financial sector FX forwards and swaps represent off-balance sheet debt. This may underestimate the total amount of NBFI off-balance sheet debt.

Sources: BIS; FSB calculations.

Another measure of synthetic leverage is available from BIS estimates of the obligations that arise from FX swaps and forwards.[21] These derivatives create forward payments that resemble collateralised borrowing, where the received currency is the loan and the delivered currency is the collateral.[22]

Total NBFI positions in FX swaps and forwards have grown significantly over time, though this amount represents both borrowing and lending (Graph 6, panel 1). NBFI borrowing off-balance sheet can be estimated at almost $17 trillion at end-2022 using some assumptions (Graph 6, panel 2).[23] However, as this number is only for US dollar borrowing and only represents borrowing through FX swaps and forwards, rather than the total amount of off-balance sheet financial leverage, it clearly underestimates the scale of this hidden leverage.

The IOSCO investment funds statistics reports also provide data on synthetic leverage.[24] This source shows that hedge funds are a key user of leverage through derivatives (as discussed in Section 4). In addition, while investment funds have limited financial leverage, they do take on synthetic leverage, albeit not to the same extent as hedge funds. Graph 7, panel 1 shows that open-ended and closed end funds' synthetic exposure ranges from near zero to more than their

21 See Borio et al (2017), Dollar debt in FX swaps and forwards: missing global debt, BIS Quarterly Review, September.

22 This differs from many other derivatives where only initial and variation margins (based on changes in the mark-to-market value of the underlying security) are paid. The short maturity of FX swaps and forwards creates potential liquidity and maturity mismatches as a large majority of contracts have an effective maturity of less than one year.

23 The estimate for NBFI off-balance sheet financial leverage is based on the total non-bank US dollar borrowing calculated in Borio et al (2022), Dollar debt in FX swaps and forwards: huge, missing and growing, BIS Quarterly Review, December. It is then assumed that all non-financial sector FX swaps and forwards are borrowing, with the residual being the amount of NBFI borrowing.

24 See IOSCO (2022), Investment funds statistics report, January and IOSCO (2023), Investment funds statistics report, January. Note that this definition of synthetic leverage includes FX derivatives and so is not fully consistent with the aggregate proxy of synthetic leverage, which excludes the FX forwards and swaps that are classified as off-balance sheet financial leverage.

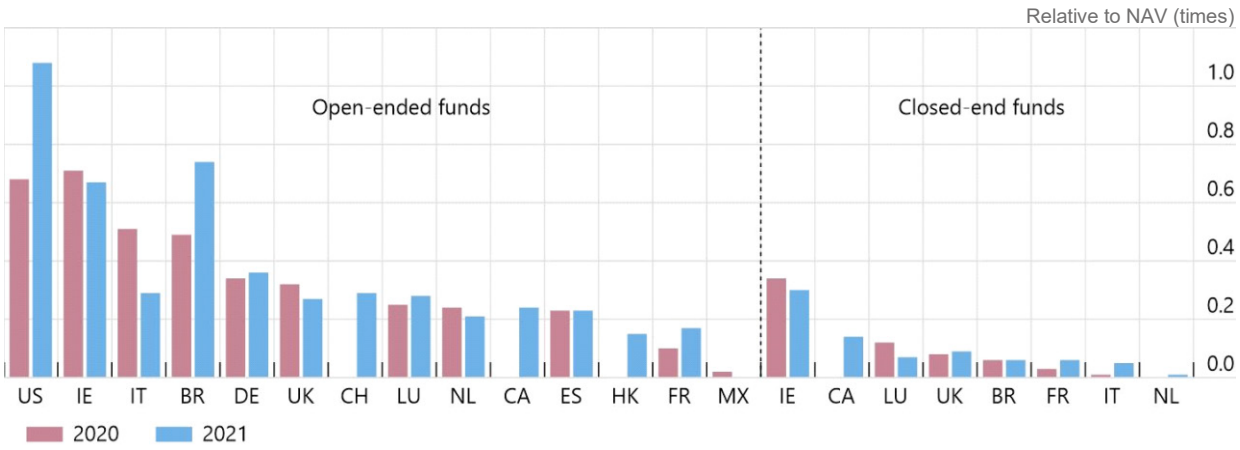
net asset value (NAV). While synthetic leverage in 2021 was similar in aggregate to a year before, it did increase notably in some jurisdictions for open-ended funds.

Other studies have assessed synthetic leverage in non-bank investors and found that this has become an important feature of the financial system, allowing investors to amplify gains at the risk of magnifying losses.[25] Research focussing on investment funds has also found that synthetically leveraged funds display higher levels of fragility since they experience larger losses when selling assets to meet investor redemptions.[26]

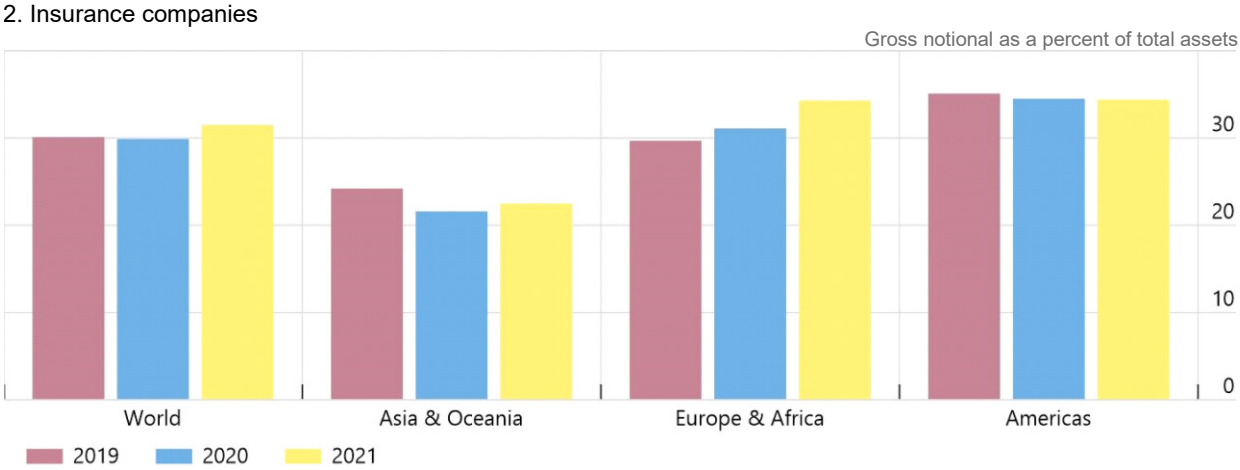
Synthetic leverage at funds and insurance companies

Graph 7

1. Investment funds[1]



2. Insurance companies



[1] The graph shows gross notional positions relative to net asset value (NAV). Data for open-ended funds in CH, CA, and HK are not available for 2020. Data for open-ended funds in MX are not available for 2021. Data for closed-end funds in CA and NL are not available for 2020.

Source: IOSCO investment funds statistics, IAIS.

Insurance companies also take-on synthetic leverage as part of their hedging of interest rate risk. Data collected by the IAIS shows that the gross notional amount of derivatives held by insurance companies is not negligible in aggregate (Graph 7, panel 2). Aggregate data suggest that the ratio of gross notional amount of derivatives relative to the assets of insurance

25 Ianiro et al (2022), Synthetic leverage and margining in non-bank financial institutions, ECB Financial Stability Review, May and IMF (2018) Global Financial Stability Report, April.

26 ESRB (2021), Synthetic leverage and fund risk-taking, September.

companies is around 30-35%.[27] However, as there is likely to be some heterogeneity in the insurance sector (given the variety of type and size of insurance companies),[28] some insurance companies might have much larger notional derivatives positions.[29] While these figures are for all types of derivatives, the IAIS also collects individual insurer qualitative data, from which it is possible to estimate that 50% of derivatives held are interest rate derivatives. These could be interest rate swaps, but also futures and options, and while the liquidity demands associated with those derivatives differ, they are typically driven by interest rate volatility.[30]

4. Hedge fund leverage and linkages with prime brokers

This section assesses hedge fund leverage and seeks to identify pockets in the sector where leverage is particularly high. It then discusses the potential for the position liquidation channel and liquidity imbalance amplification factor to operate at hedge funds.[31] It also looks at the concentration in the prime brokers providing services to hedge funds and concludes with findings on the network of interlinkages between prime brokers and hedge funds.

4.1. Leverage in hedge funds

Many hedge funds operate strategies with relatively low levels of leverage. However, some employ highly-levered, complex and concentrated investment strategies that may embed vulnerabilities that are difficult for counterparties and regulators to assess in an effective and timely manner. These more complex or concentrated portfolios may also prove difficult to unwind promptly for a variety of reasons, such as illiquid holdings and positions comprising a large share of the trading volume. While leverage is indirectly restricted through market and counterparty discipline as well as certain regulations, there is no direct limitation on hedge fund leverage in many jurisdictions. In some, such as the EU and the UK, authorities can set leverage limits on Alternative Investment Funds (including hedge funds) but there may be challenges in calibrating such limits effectively, as hedge funds use different strategies and can use the same instruments potentially for different purposes.

---

27 The market value of derivative positions, which is typically smaller than the gross notional amount, would be on-balance sheet.

28 Life, non-life, and composite insurance companies, using internal models or not, in the form of a mutual firm or not, etc.

29 In some jurisdictions, the use of interest rate derivatives is still in its initial stage due the lack of supply of derivatives. For example, in China, Treasury bond futures have 2-year, 5-year, and 10-year maturities; and, since April 2023, 30-year maturity as well. By the end of 2022 and for the Chinese insurance sector, the cumulative trading volume of Treasury bond futures was 34.4 billion yuan, and the face value of interest rate swaps was 80.9 million yuan, compared with total assets of 27 trillion yuan. With the launch of 30-year Treasury bond futures, the use of derivatives by insurance companies and pension funds in China could, however, gradually increase.

30 For the remaining derivatives, 30% is estimated to be currency derivatives, 15% equity-linked derivatives, and 5% other types of derivatives.

31 This section and the case studies in annex of this report utilise fund self-reported data. While best effort is made for cleaning and aggregating the data, the quality of the data submitted by funds cannot be guaranteed nor the direct comparability of the methods funds employ to compute their submitted metrics.

Size and concentration

The FSB Global Monitoring Report on NBFI estimates the size of the hedge fund industry at around $7.0 trillion of financial assets at the end of 2021.[32] The sector appears concentrated, mostly in terms of derivatives exposure and borrowing, but also in terms of assets under management (Graph 8).[33] This means that aggregate measures of leverage at the hedge fund sector level may not be a good indication of vulnerabilities. For example, gross measures for EU hedge funds estimate leverage as being around two times NAV. In the United Kingdom, the median gross leverage ratio is 1.7 times NAV.[34, 35] In the United States, gross notional exposure stands at 1.9 times NAV. These relatively low average/median values, however, do not reflect the high levels of leverage by certain hedge funds. Graph 8 shows that concentration in borrowing and derivative value is higher than concentration in net asset value and in assets under management. This suggests that the largest hedge funds borrow and engage in derivatives trading more than suggested by their NAV.

---

32 See FSB (2022), *Global Monitoring Report on Non-Bank Financial Intermediation: 2022*. Other estimates show a larger hedge fund industry, see for example Barth et al, *The Hedge Fund Industry is Bigger (and has Performed Better) Than You Think*, Office of Financial Research, March 2021.

33 Data used for this and other graphs in this section are not directly comparable across jurisdictions given different definitions and availability.

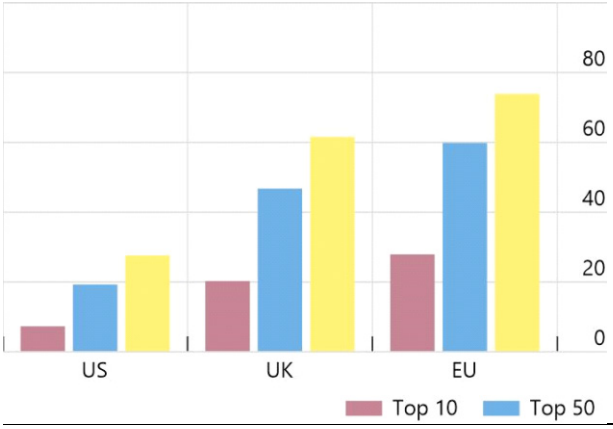
34 The Gross Method for calculating leverage under AIFMD aggregates the fund's exposures, excluding cash and cash equivalents, without accounting for hedges or netting arrangements. Derivative instruments are converted into their equivalent position in their underlying assets. Exposure from reinvestment of cash borrowings is included, as are positions within repo or reverse repo and securities lending and borrowing. This leverage is expressed as a ratio between the exposure of the Alternative Investment Fund (AIF) and its NAV.

35 UK and EU statistics are based on UK AIFMD and EU AIFMD data that include: Alternative Investment Funds (AIFs) based in the UK and the EU, AIFs with managers based in the UK and the EU, and overseas AIFs – above a threshold – that are marketed in the UK and the EU.

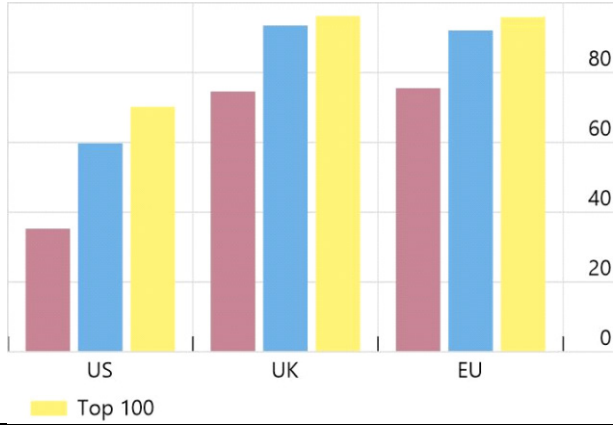
Hedge fund concentration, end 2021

In per cent **Graph 8**

Per cent NAV reported by top hedge funds[1]

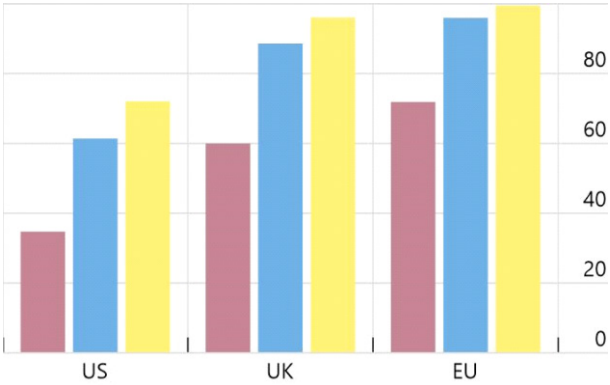


Per cent assets reported by top hedge funds[2]

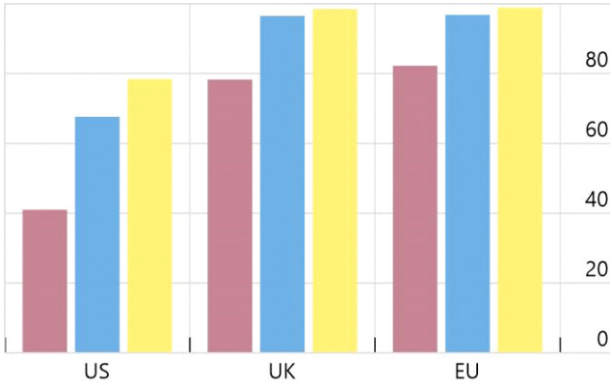


Top 10 Top 50 Top 100

Per cent borrowings by top hedge funds[3]



Per cent derivative value reported by top hedge funds[4]



[1] For U.S. hedge funds, the net asset value (NAV) of any reporting fund is equal to the gross asset value (GAV) minus any outstanding indebtedness or other accrued but unpaid liabilities. GAV is calculated in accordance with Part 1A, Instruction 6.e(3) of Form ADV. For EU/UK hedge funds, the NAV is the value of a fund's assets minus the value of its liabilities.

[2] Assets are defined differently for the EU/UK and the U.S. hedge funds. In the EU and in the UK, assets correspond to assets under management (AUM), which refers to the value of assets under management for the EU Alternative Investment Fund (AIF) and UK AIF, where calculations of the corresponding value of assets under management are made using the method set out in Articles 2 and 10 of the Regulation 231/2013. This includes all assets acquired through the use of leverage and the value of derivative instruments is converted into the equivalent position in the underlying asset based on notional amount. For U.S. hedge funds, Gross Notional Exposure is used as the most similar metric and corresponds to the gross nominal or notional value of all transactions that have been entered into but not yet settled as of the data reporting date.

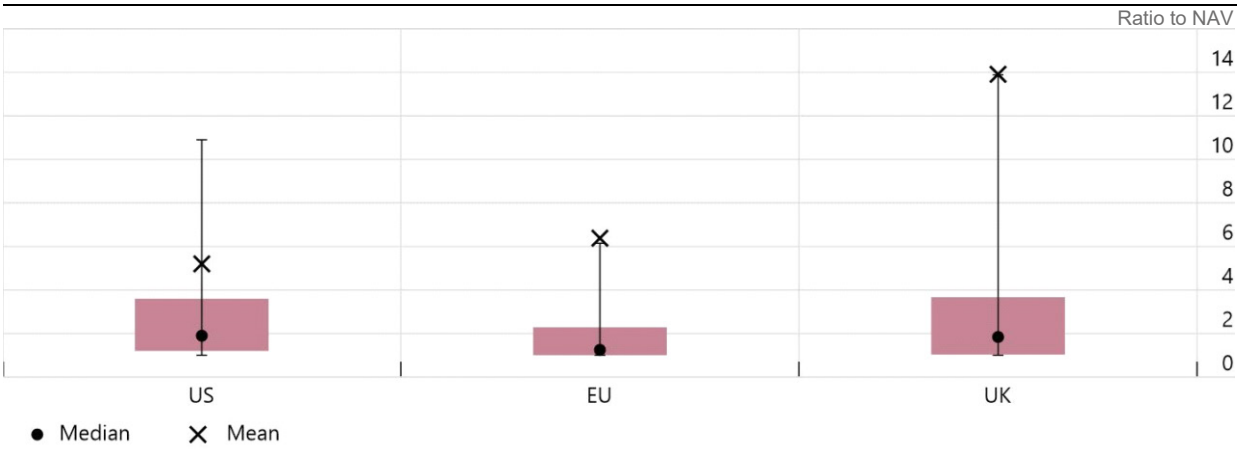
[3] For U.S. hedge funds, borrowings include secured borrowings, unsecured borrowings, as well as synthetic borrowings (e.g. total return swaps that meet the failed sale accounting requirements). For EU and UK hedge funds, borrowings correspond to the aggregate amount of EU AIF's and UK AIF's unsecured and secured borrowing, including via prime broker and repo.

[4] For U.S. hedge funds, derivative value (other than options) means gross notional value; for options, value means delta adjusted notional value; for all other investments and for all borrowings where the reporting fund is the creditor, value means market value or, where there is not a readily available market value, fair value; for borrowings where the reporting fund is the debtor, value means the value you report internally and to current and prospective investors. For EU and UK hedge funds, derivative value is the sum of all long and short derivative notional exposures reported by EU AIFs and UK AIFs and covers equity derivatives, credit default swaps (CDS), FX and interest rate derivatives (IRDs) gross exposures, commodity derivatives, and others.

Source: SEC 2022Q1 Private Funds Statistics report, available on the SEC website. UK AIFMD and EU AIFMD data that include: (i) AIFs based in the UK and the EU, (ii) AIFs with a manager based in the UK and the EU, and (iii) overseas AIFs above a threshold marketed in the UK and the EU.

Distribution of hedge fund leverage[1]

Graph 9



[1] The boxes show the 25th to 75th percentile ranges. The thin vertical lines show the range of the 10th to 90th percentile ranges. Leverage is measured by dividing AUM with NAV for EU and UK hedge funds, and by dividing GNE (including interest rate derivatives) with NAV for U.S. hedge funds. All statistics are as of end 2021.

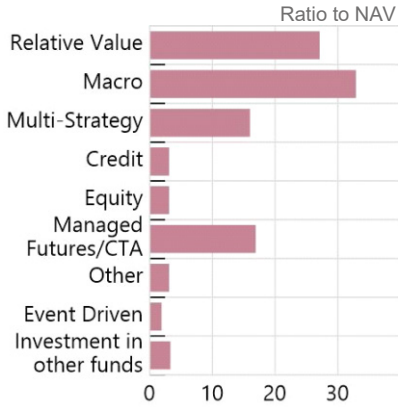
Source: SEC 2022Q1 Private Funds Statistics report. UK AIFMD and EU AIFMD data.

Graph 9 confirms that the distribution of hedge fund leverage is skewed and, while median hedge fund leverage is not high, there are hedge funds with 10 times more leverage than others. To understand why leverage is concentrated, one must look at the different strategies pursued by hedge funds. Hedge funds pursuing (global) macro strategies and relative value strategies display much higher levels of leverage in the United States, the United Kingdom and the EU (Graph 10). Note that these metrics are not directly comparable across jurisdictions due to the different reporting convention for the notional value of interest rate derivatives, which leads to significantly higher leverage ratios in the UK and EU data.

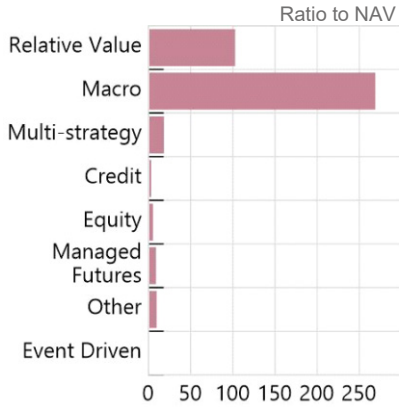
Hedge funds per strategy

Graph 10

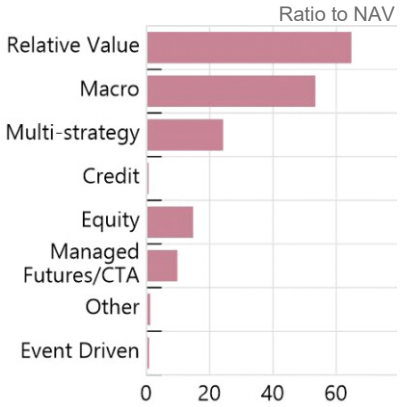
Asset-weighted average ratio of GNE[1] to NAV for U.S. hedge funds



Ratio of Aggregate Derivative Value to NAV for UK hedge funds



Ratio of Aggregate Derivative Value to NAV for EU hedge funds



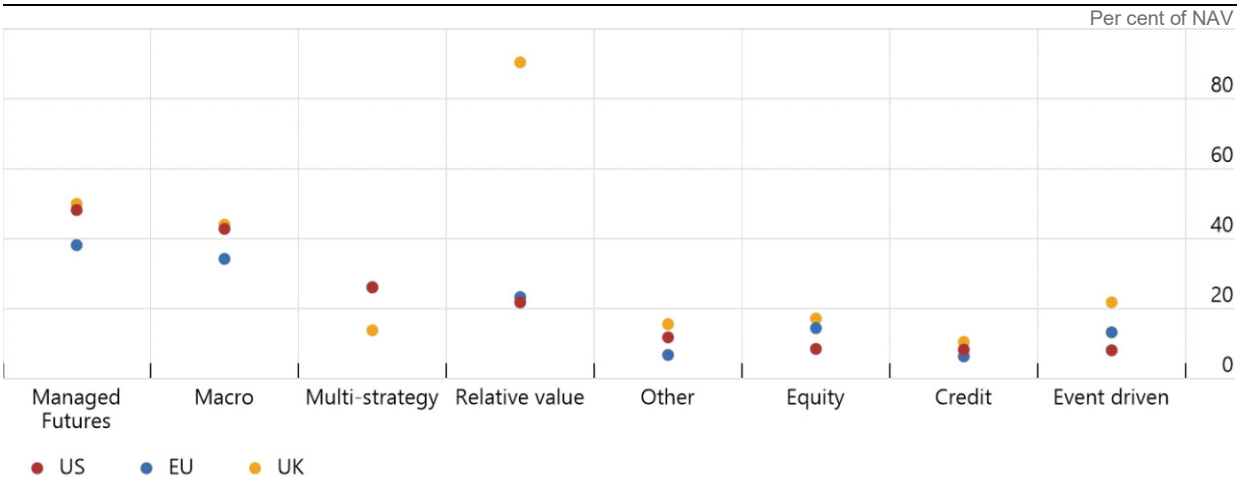
[1] GNE means Gross Notional Exposure and is the gross nominal or notional value of all transactions that have been entered into but not yet settled as of the data reporting date. For contracts with variable nominal or notional principal amounts, the basis for reporting is the nominal or notional principal amounts as of the data reporting date. The leverage metrics are not directly comparable between the United States and the European Union/United Kingdome due to the different reporting convention for the notional value of interest rate derivatives, which leads to significantly higher ratios under EU AIFMD and UK AIFMD.

Sources: SEC 2022Q1 Private Funds Statistics report; UK AIFMD and EU AIFMD 2021Q4 data.

Liquid assets

As discussed in section 2, an important vulnerability and propagation mechanism of shocks is the position liquidation channel. In aggregate, hedge funds pursuing a strategy that typically involves higher levels of leverage also hold more liquid assets – measured here as unencumbered cash – that should mitigate the risk of disorderly liquidation due to margin or collateral calls (Graph 11). The data presented below, however, only provide information at the aggregate strategy level, and the amount of unencumbered cash could vary significantly across hedge funds.[36]

Unencumbered cash per strategy[1] **Graph 11**



[1] For the US, the dots represent the asset weighted-average percent of unencumbered cash. For the UK and the EU, the dots represent the NAV-weighted average percent of unencumbered cash.

Sources: SEC 2022Q1 Private Funds Statistics report; UK AIFMD and EU AIFMD 2021Q4 data.

Section 2 identified liquidity imbalances as an amplification factor. For hedge funds, this could be triggered, for example, in the two following cases. First, if hedge fund investors' demand for liquidity rose significantly, and this led them to increasing the redemption of their hedge fund shares, it could force hedge funds to liquidate their positions. Second, for hedge funds that are trading on margin or borrowing in the repo market, if the value of their positions decreases, they may face margin calls from their prime brokers or repo counterparties. To respond to these liquidity demands, hedge funds can use their unencumbered cash positions, sell assets (and receive cash according to the time of settlement) or borrow cash via unsecured lines of credit from banks, though this seems to rarely happen.

Graph 12 displays different measures of potential liquidity sources and needs. It shows how these liquidity measures are distributed over time. Hedge fund portfolio liquidity corresponds to the percentage of value of the fund's non-cash positions that may be liquidated using good-faith estimates and assuming no fire-sale discounting. It therefore approximates the liquidity sources available to hedge funds (excluding unencumbered cash), which could be used by funds to meet their demand for liquidity. Financing liquidity shows the contractual term of a fund's total borrowing. Hedge fund investor liquidity corresponds to the term during which fund investors can redeem their shares in the funds. While these measures are not directly comparable because

[36] Jurisdictions usually collect data at fund level which should allow for a more granular assessment.

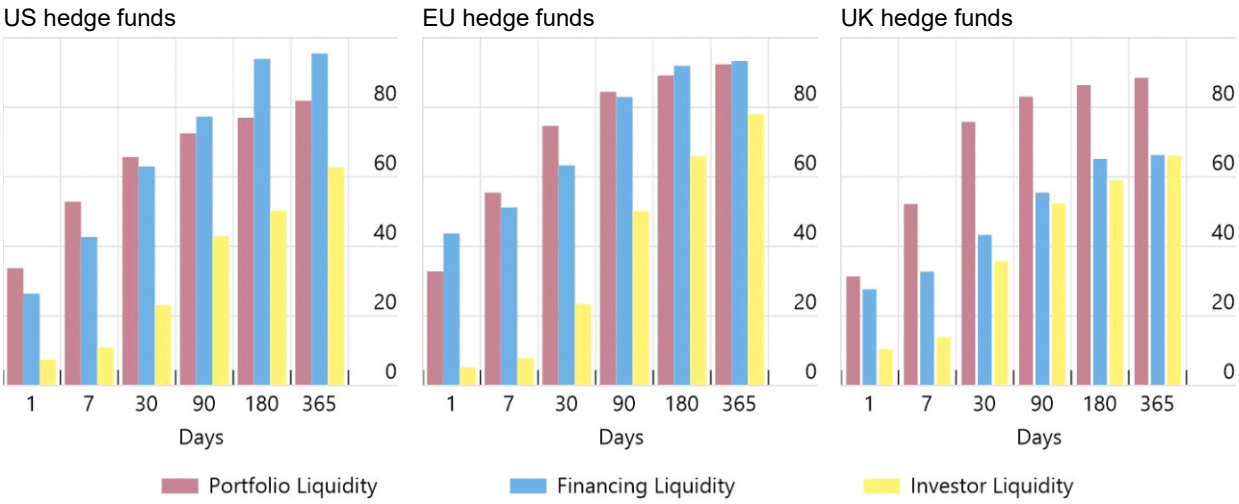
they are expressed in percentages of different denominators (i.e. NAV, non-cash positions, or total available financing) there are two important takeaways from the data.

- First, it appears that, on average, hedge funds tend not to have a liquidity mismatch between their investor and portfolio liquidity. As the data are average figures, however, funds with a liquidity shortfall will be offset by other funds with a liquidity surplus.[37]

- Second, financing liquidity might be more of a concern, given that its profile is more closely aligned with portfolio liquidity than investor liquidity is. However, because financing liquidity is expressed as a percentage of total available financing, it is not possible to make a definitive conclusion.

Potential liquidity sources and demands in hedge funds[1]

In per cent **Graph 12**



[1] For U.S. hedge funds, portfolio liquidity refers to the percentage of value of the fund's non-cash positions that may be liquidated using good-faith estimates assuming no fire-sale discounting within a set of specified periods. For EU/UK hedge funds, portfolio liquidity refers to the percentage of the fund portfolio that may be liquidated within each of the liquidity periods and does not include unencumbered cash. Financing liquidity reports the proportion of borrowing and available cash financing (including all drawn and undrawn lines of credit) among the same specified periods. This field does not distinguish between filers that agree on one-day-term loans vs. filers that agree on longer terms but are subject to daily revaluation of collateral at the discretion of their creditors. Hedge fund's investor illiquidity represents the term during which fund investors cannot redeem their shares in the funds. For EU/UK hedge funds, all metrics are weighted by fund-level NAV, i.e. funds with larger NAV have larger impact on each metric.

Sources: SEC 2022Q1 Private Funds Statistics report; UK AIFMD and EU AIFMD 2021Q4 data.

4.2. Interlinkages with prime brokers

Prime brokers as the main sources of leverage

Prime brokers provide clients, including hedge funds and other non-bank entities, with a range of services, including custody, clearing, securities lending, financing, and reporting.[38] They are the main providers of leverage to hedge funds and other non-bank entities for trading purposes

[37] See ESMA, EU Alternative Investment Funds, ESMA50-165-1032, January 2020, for a measure that adjusts for this. In addition, where portfolio liquidity is reported as a percentage of assets under management, instead of net asset value, this creates an upward bias for leveraged hedge funds.

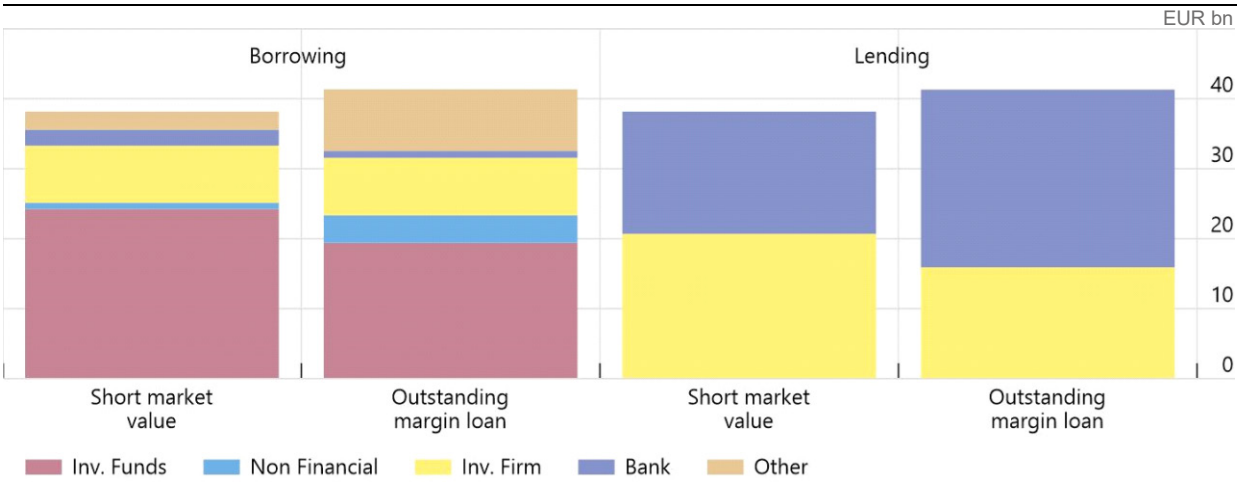
[38] This report defines prime brokerage broadly, as engagement by broker-dealers and banks with hedge funds and other leveraged NBFIs as clients or counterparties.

and often serve as their trading counterparties. Prime brokers can provide leverage via cash financing or via synthetic financing.

- Cash financing is provided through secured financing transactions. These take various forms. Margin loans provide financing for certain hedge fund long positions, using the underlying position as collateral. Short positions can be facilitated by securities financing transactions, collateralised generally by cash. Secured financing for long fixed-income positions, or the sourcing of fixed-income securities for short positions, is usually arranged through repurchase agreements. The amount of financial leverage a hedge fund obtains from its prime brokers through secured financing transactions is determined by the prime broker and financing type, subject to applicable regulations.

- Synthetic prime brokerage provides clients, including hedge funds, with long or short exposure using derivatives. For equities, this is done primarily via non-centrally cleared OTC equity total return swaps (TRS), which involve exchanging the performance of an underlying notional position for what amounts to fixed or variable interest payments, with the prime broker and hedge fund able to take either side.[39] For other asset classes, like interest rates and credit, this may be done by providing clearing services to non-bank entities in respect of their listed derivative or OTC cleared portfolios.

Prime brokers as the main source of leverage in the EU margin lending market, 2022[1] **Graph 13**



[1] Outstanding notional amounts in margin lending transactions in EUR billion. Outstanding margin loan corresponds to net cash debits and short market value corresponds to the value of the loan associated with short sales. Data as of 24 June 2022.

Source: ESMA.

As an example, the EU margin lending market (Graph 13) is dominated, on the lending side, by banks (their prime brokerage desks) and by investment firms (mostly belonging to banking groups). On the borrowing side, investment funds (including hedge funds) account for 47% of outstanding margin loans and for 63% of short market value. The collateral for these transactions is mostly equities (68%) and corporate bonds (13%). As of end-June 2022, the market covers

[39] These transactions enable the client to assume the economic exposure of a securities position without having to place that position on its own books. The regulatory (and tax) treatment of these exposures might therefore be different and advantageous for the non-bank entity taking the leverage position, as well as for the bank financing the leverage thanks to netting possibilities.

around 3,000 entities for a total amount of €80 billion. *Where does the leverage provided by prime brokers come from?*

Prime brokers fund securities financing transactions and derivatives positions using a variety of sources. As in traditional banking, the financing for a loan made by the prime broker can come from the broker's equity or from external sources, such as repo borrowing by the broker, or issuing bonds or commercial paper.

Unlike traditional banking, however, prime brokers can also use internal sources to fund client leverage, i.e. using the collateral received. Internal sources of funding are generally less costly than external sources. Prime brokers often aim to run a "matched book" in which one client borrows cash from the prime broker, providing the prime broker with collateral that it can then repledge to another client. In this case, the pledged security does not appear on the prime broker's balance sheet. Matched book transactions are commonly executed as repurchase and reverse repurchase agreements. A matched-book repo in which the prime broker charges a higher haircut than the one it pays generates a net funding source for the prime broker.

Free credit balances – cash held in a margin account beyond what is required – are another net funding source for prime brokers. Note, however, that free credit balances can be withdrawn by the client at short notice.

Unlike secured financing transactions, "synthetic" prime brokerage does not involve the exchange of cash for securities. Instead, synthetic prime brokerage uses derivatives and requires the posting or receipt of margin, based on the performance of a specified underlying security or index. The prime broker may seek to run a matched book in which it finds offsetting trades among its counterparties, profiting from the differences in terms. For unmatched trades, the prime broker may hedge the position's market risk by taking offsetting positions in the underlying securities. For example, a prime broker that sells a TRS on an underlying equity to a client – in which it pays the performance on the equity security to the client and receives interest payments – may take a long position in the equity security as a hedge. Prime brokers can also package unmatched exposures into "funding swaps" in which a counterparty provides the prime broker with matching exposures in exchange for the physical hedged positions, removing those positions from the prime broker's balance sheet.[40]

Concentration of prime brokerage services

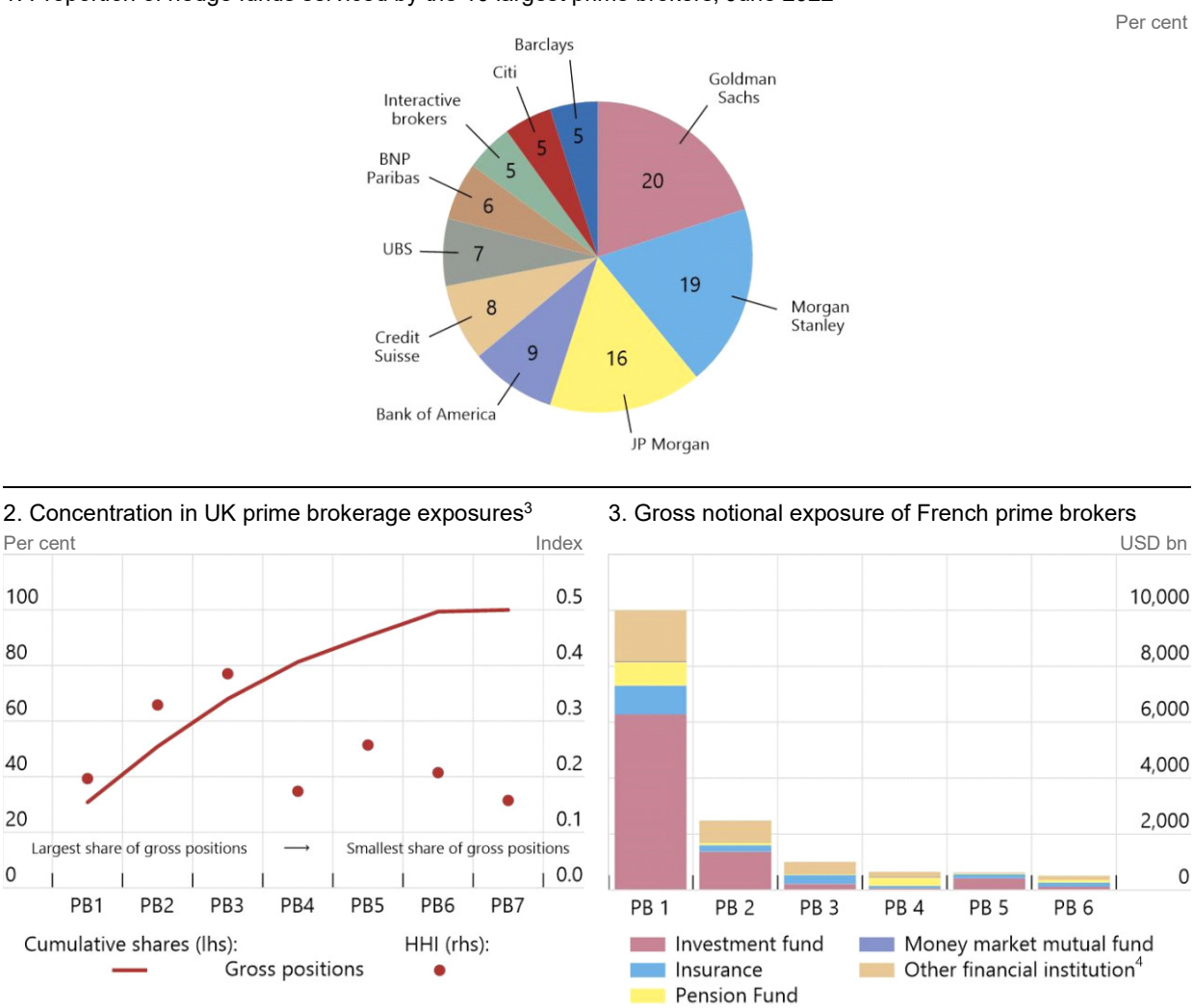
The prime brokerage sector is concentrated. First, looking at the 10 prime brokers serving the largest proportion of hedge funds globally shows that the four largest ones are headquartered in the United States. These four largest prime brokers taken together provide services to two-thirds of the hedge funds serviced by the 10 largest prime brokers globally (see Graph 14, panel 1).

[40] Banks can also enter an offsetting total return swap (TRS) with a registered security-based swap dealer, which issues commercial paper to fund the share purchases.

Concentration in prime brokerage services

Graph 14

1. Proportion of hedge funds serviced by the 10 largest prime brokers, June 2022[1]



2. Concentration in UK prime brokerage exposures[3]

3. Gross notional exposure of French prime brokers

[1] Percentage of the number of hedge funds serviced by 10 largest prime brokers. [2] The size of the dots in the right panel corresponds to the levels of aggregate margin lending/equity swap exposure to the top 25 clients. The x-axis denotes individual G-SIBs. [3] HHI means the Herfindahl–Hirschman Index. Data as of June 2022. [4] Other financial institutions (OFIs) include financial intermediaries other than credit institutions whose business is to receive deposits and/or close substitutes for deposits from institutional units (including from non-MFIs) and to grant loans and/or make investments in securities on their own account. Entities included in the OFI sector can be financial entities of non-financial companies doing cash management. Hedge funds are not included in the OFI sector in this chart but in the "investment fund" sector. Data as of end 2022 based on derivatives transactions collected under EMIR and reported to DTCC.

Sources: Convergence Inc and Reuters for Chart 1; Primer brokers supervisory data, Bank of England; EMIR; FSB calculations.

Second, in each country, a couple of prime brokers usually account for the majority of the leverage provided to hedge funds and other non-bank entities.

- In the United Kingdom (see Graph 14, panel 2), two brokers account for half of hedge fund gross exposures, and the top 3 account for around 70%, as of June 2022.[41]

[41] The Bank of England's Prudential Regulation Authority collects supervisory data for 8 subsidiaries of large non-resident banking groups. Reporting is at the subsidiary level, not at the level of the prime brokerage desk and not consolidated at the group level either. Moreover, exposure data is mixed in the sense that some prime brokers report just EMEA exposures while some others report global positions. From a product perspective, exposures are available at an aggregate level (i.e. combining derivatives, repos and securities financing transactions (SFTs)), excluding banking book credit. Exposures are provided for the 10 largest hedge funds as counterparties by means of potential exposures.

- In France (see Graph 14, panel 3), two prime brokers account for 82% of the total gross notional exposure that brokers hold with non-bank entities. Exposures are almost exclusively held over the counter (97%). More than half of the exposure is held with investment funds (55%). Prime brokers serve investment funds mainly located in Europe (64%). French funds account for 14% of exposures, slightly ahead of US (8%) and Cayman Islands (6%) where many hedge funds are registered.

Hedge fund-prime broker networks

As discussed above, the connections between hedge funds and prime brokers are composed of derivatives transactions and securities financing transactions (repurchase agreements and margin lending in particular). This set of relations is complex and, therefore, a single prime broker might not be aware of the linkages of its clients with other prime brokers (and other entities). In some jurisdictions, public authorities may be able to estimate the network from supervisory data, although there are significant operational challenges in merging different datasets.[42]

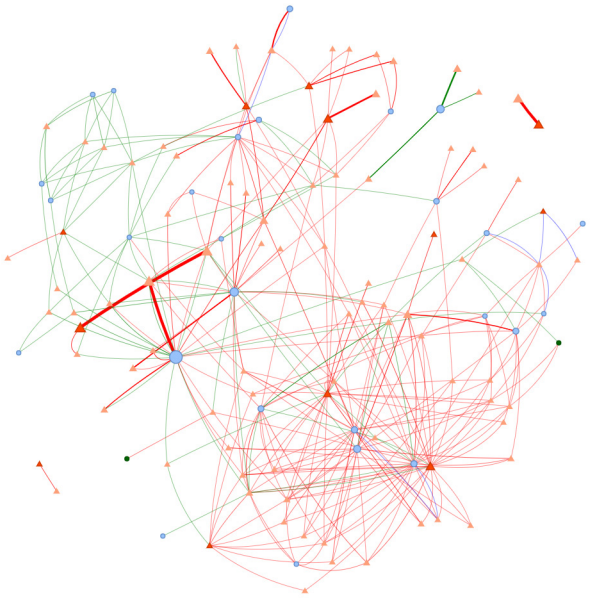
Graph 15 provides an illustration of the network of prime brokers and hedge funds in the European Economic Area and in the United Kingdom. It shows that a few prime brokers play a central role in each network and that hedge funds trade with multiple prime brokers to diversify their sources of leverage. While this use of multiple prime brokers helps diversify hedge funds' sources of financing, it may also hide the fund's total leverage from each individual prime broker.

Annexes 1 and 2 report on case studies conducted by the Bank of England and by ESMA. These studies highlight that hedge funds with the largest derivative exposures tend to use more counterparties. The Bank of England study looks specifically at total return swaps, and how these can be concentrated on specific equity stocks, which might not be traded frequently and therefore which have the potential to amplify losses if hedge funds and prime brokers were to liquidate their positions. The ESMA study looks at counterparty concentration for EU hedge funds positions on derivatives, repurchase agreements and margin lending.

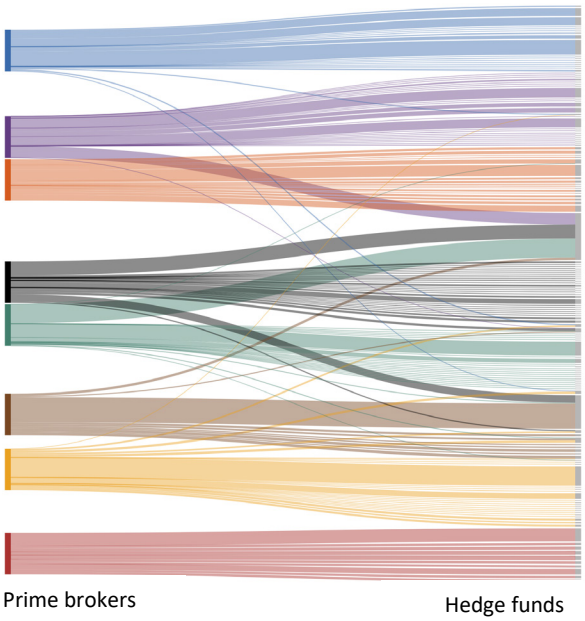
[42] See, for example, Kruttli et al, The life of the counterparty: Shock propagation in hedge fund-prime broker credit networks, *Journal of Financial Economics*, December 2022.

Hedge fund-prime broker networks **Graph 15**

EU network of prime brokers and hedge funds[1]



Pair-wise exposures between prime brokers and hedge funds in the UK[2]



[1] Blue dots are banks, red triangles are investment firms (subsidiaries of banking groups) and orange triangles are hedge funds. Red edges represent equity derivative positions, green edges repurchase agreements and blue edges margin lending. Data as of end-June 2022. Gross exposures are shown if they exceed €0.2 billion. Connections are simplified to a single edge in case the trades are reported twice. Nodes are proportional to the original sum of the edges, with a minimum size for visibility. The EU network is dominated by equity derivatives (aggregate gross notional value of around €400 billion) and to a lesser extent repurchase agreements (around €77 billion) rather than margin lending (around €7 billion). Hedge funds are found to have at least five counterparties in this simplified EU network. [2] Exposures are gross positions, measured as a percentage of total exposure. Prime brokers are on the left-hand side and hedge funds on the right-hand side.

Sources: ESMA; Bank of England.

5. Leverage, liability driven investment and long-term investors

5.1. LDI strategies

Asset-liability management and strategies to hedge interest rate risk

Pension funds[43] and insurance companies are liability-driven investors: they invest the premiums they have collected in order to be able to pay the long-term obligations they have committed to on the liability side of their balance-sheet. These liabilities can either be payments to retirees from pension funds or pay-outs to holders of life and other insurance products, triggered by policyholders' redemptions or insurance claims.

Pension funds and insurance companies can implement several different strategies in their asset-liability management, depending on the profile of their liabilities and their sensitivities to changes in interest and inflation rates. Over the last decade, several regulatory and accounting changes have been introduced to enhance the risk management of pension funds and insurance

[43] In the rest of this section, the phrase "pension funds" is used to refer to defined benefit pension funds.

companies.[44] Though the requirements vary across jurisdictions, and between insurance companies (generally more prudentially regulated) and pension funds (generally less prudentially regulated), these require the liabilities to be valued in a market consistent manner and, for insurance companies, impose the holding of sufficient capital against the realisation of interest rate risks.[45]

Insurance and pension liabilities are effectively a series of future cash payments, often over a long-term horizon (several decades), discounted with an interest rate term structure. As a result, the present value of these liabilities is highly sensitive to changes in interest rates, and so is the capital position of these entities. Conceptually, there are two main strategies that are used to immunise the capital position of these long-term investors against interest rate changes:[46]

- Cash-flow matching ("complete immunisation"): this approach consists in matching liabilities with assets whose cash-flows are identical by aligning interest rate and inflation sensitivity along the full term of the liability profile.

- Duration matching ("partial immunisation"): this approach mirrors the characteristics of the liabilities' cash flows by matching the interest rate sensitivities of assets and liabilities. If interest rates (or inflation) change then the value of assets and liabilities should remain tightly correlated, limiting increases in asset-liability mismatches. This, however, requires frequent rebalancing to deal with second order risks such as convexity. This is because spikes in long-term interest rates have more impact on the duration of liabilities than assets. However, this convexity mismatch may be less of a concern if an investor has an existing duration mismatch as it should help reduce the gap.

The cash-flow matching approach can be difficult to implement and appears to be used only by some insurance companies in a few jurisdictions.[47] The more commonly used duration matching strategy can be achieved by targeting a certain duration of bonds in asset portfolios to match the impact of interest rates on liabilities, and through using inflation-linked bonds to hedge against the impact of inflation on liabilities. However, it appears that there is still a duration mismatch between the assets and liabilities of insurance companies in some cases, though the data used to calculate the duration mismatches are not homogeneous. For example, in the EU, the median duration mismatch was at around -5 years at the end of 2022, against around -6.5 at the end of 2021.[48] The duration gap might also be a result of different investment strategies and incentives

---

44 These include, for example, the need in certain jurisdictions to recognise pension scheme obligations on the corporate sponsor's balance sheet, IFRS standards for the valuation of both assets and liabilities, and the introduction of Solvency II in Europe in 2016 for insurance companies.

45 See CGFS (2011), Fixed income strategies of insurance companies and pension funds, *CGFS papers*, July; Ito et al (2023), *Corporate pension funds' investment strategies and financial stability: lessons from the turmoil in the UK gilt market*, Bank of Japan Review, March; and Walker (2023), Good intentions in risk management and the LDI crisis, J*ournal of Risk Management in Financial Institutions*, Vol 16, issue 3, May.

46 See CGFS (2011), Fixed income strategies of insurance companies and pension funds, *CGFS papers*, July.

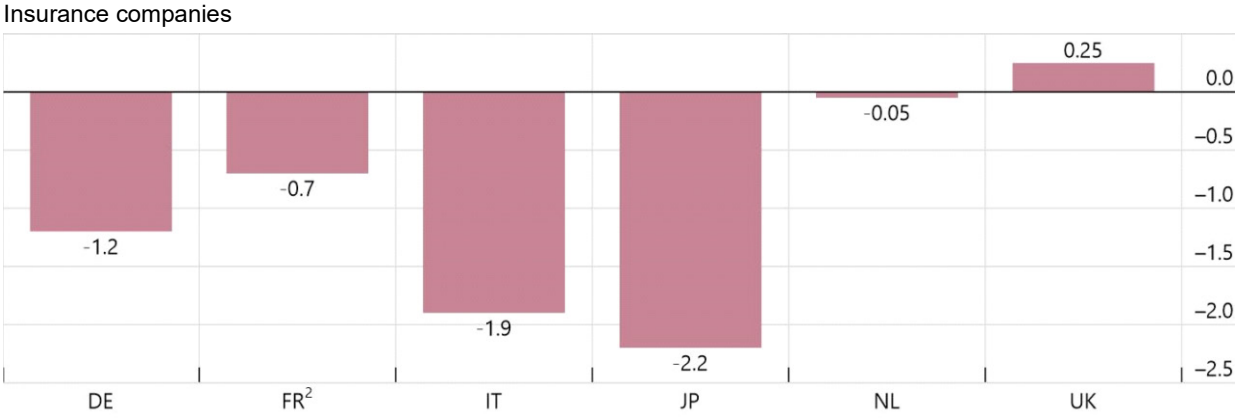
47 The Solvency II framework recognizes this cash-flow matching via matching adjustment portfolios, which are used mostly in the United Kingdom and in Spain.

48 See EIOPA (2023), Risk Dashboard, July. The figure is built on data covering the European insurance sector and is based on the modified duration of the fixed income assets and of the liabilities. The differences in underlying data and methodologies lead to a different value for the duration mismatch that those presented in Graph 16. The increase in interest rates might be a reason for insurance companies to increase the duration of their asset portfolio.

in the various jurisdictions analysed.[49] The available data show a range of mismatches across insurance sectors in different jurisdictions (see Graph 16).[50] One reason for this may be the variety of risks underwritten by insurance companies, including non-life, life and health contracts, with short, medium and long-term pay-outs.

Insurance companies' duration mismatch[1]

In years **Graph 16**



[1] A negative mismatch indicates that the duration of the liabilities is greater than that of assets. The German maturity mismatch data is for insurance companies holding interest rate derivatives and calculating their capital requirements with the standard formula, which excludes some of the largest companies. The Japanese data for insurance companies are for the top 5 entities covering 63% of the total sector assets. The UK data for life insurers are for the matching adjustment portfolios and already factor in the effect of interest rate derivatives. [2] Data for French insurance companies also includes data for French pension funds.

Sources: National authorities; FSB calculations.

Other possible explanations for the duration mismatches include: (1) a lack of availability of bonds of the required type (e.g. inflation linked) or maturity (i.e. long-dated bonds) needed to close the mismatch in some jurisdictions, though this has also been contested in the literature[51]; or (2) a deliberate choice of long-term investors due to a trade-off between matching liabilities and generating sufficient returns.

Long-term investors indeed need to enhance asset returns, particularly in the previous period of low interest rates for those that had offered guarantees to their policyholders – for example, minimum interest rates guaranteed on life insurance policies.[52] Enhancing returns is also important for defined benefit pension schemes, especially if they are in a deficit (i.e. the present value of their liabilities is larger than the current value of assets).[53] One way of increasing profitability is to take on-balance sheet leverage – borrowing through loans, repo or the issuance of bonds and then using the cash to invest in higher-yielding assets (Figure 3).

49 For example, Japan's corporate pension funds may not have regulatory incentives to reduce their duration gap but take conservative investment strategies to absorb potential risks arising from the gap.

50 There were not enough publicly available data to provide an overview of the duration mismatch in DB pension funds, though it is expected to be at least as large as that of insurance companies.

51 See Möhlmann (2021), Interest rate risk of life insurers: Evidence from accounting data, *Financial Management Association International*, vol. 50(2), pages 587-612, June.

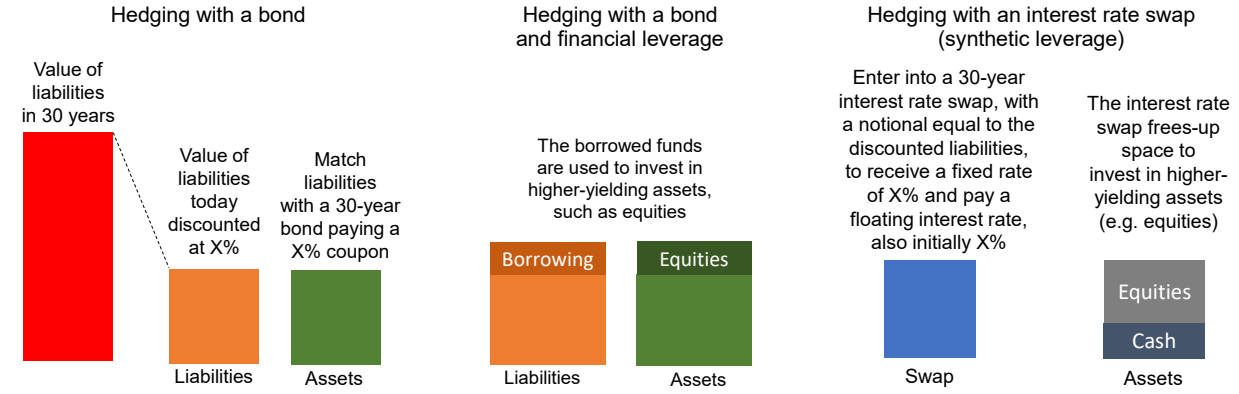
52 See CGFS (2018), *Financial stability implications of a prolonged period of low interest rates*, July. Graph 9 shows that the percentage of insurance liabilities which include guarantees can be close to 100% of total liabilities in some jurisdictions.

53 See for example Figure 2.1 in EIOPA (2019), *2019 Institutions for Occupational Retirement Provision Stress Test Report*, December, for an overview of the funding ratios in the EU.

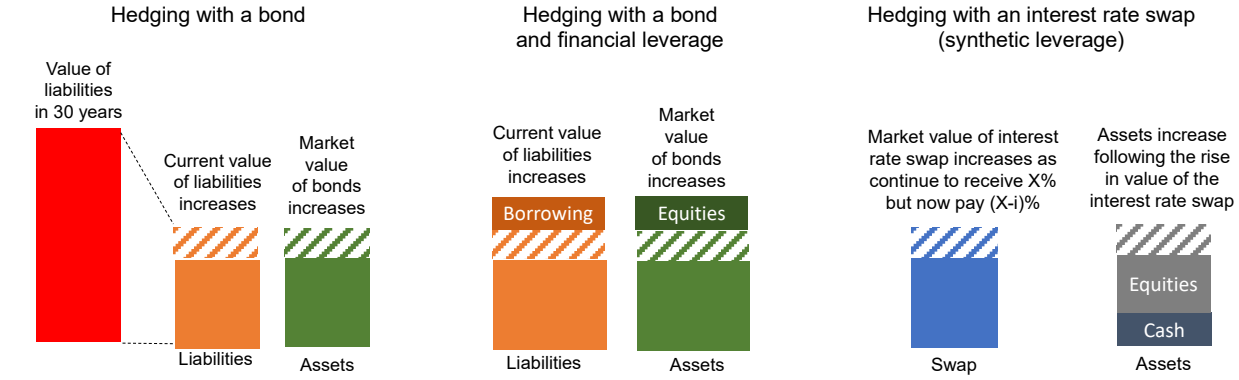
Interest rate risk hedging and leverage

Figure 3

1. Initial stylised balance-sheet with a market interest rate of X%



2. Stylised balance-sheet after a fall in the market interest rate to (X-i)%



Sources: FSB, based on BMO (2021), Liability driven investment explained.

Another way for insurance companies and pension funds to hedge their interest rate risk (including their potential duration mismatch) is by using derivatives, in particular interest rate swaps, inflation swaps or total return swaps on government bonds.[54] Hedging via derivatives is usually less costly than by holding bonds directly, and can enable a greater exposure to bonds and other assets than would be possible otherwise, hence increasing overall returns for long-term investors (see Figure 3). The capital freed-up through the use of derivatives may be used to invest in other higher yielding assets, but this also comes with additional risks, such as credit risk by investing in lower-rated bonds or in alternative assets. Long-term investors using derivatives to hedge against interest rate changes take on synthetic leverage, exposing themselves to new vulnerabilities, such as the potential liquidity mismatch between any variation margin calls and their liquid asset holdings.

It is difficult to gather data on derivative positions held by pension funds on their balance-sheets and this represents a major data gap. Looking at a global sample of large pension plans disclosing data on derivative exposures, the IMF found that the average ratio of gross notional exposure of derivatives to assets has increased over the past decade.[55] While these derivatives

[54] See BMO (2021), *Liability driven investment explained*; BlackRock (2022); and Walker (2023), Good intentions in risk management and the LDI crisis, *Journal of Risk Management in Financial Institutions*, Vol 16, issue 3, May.

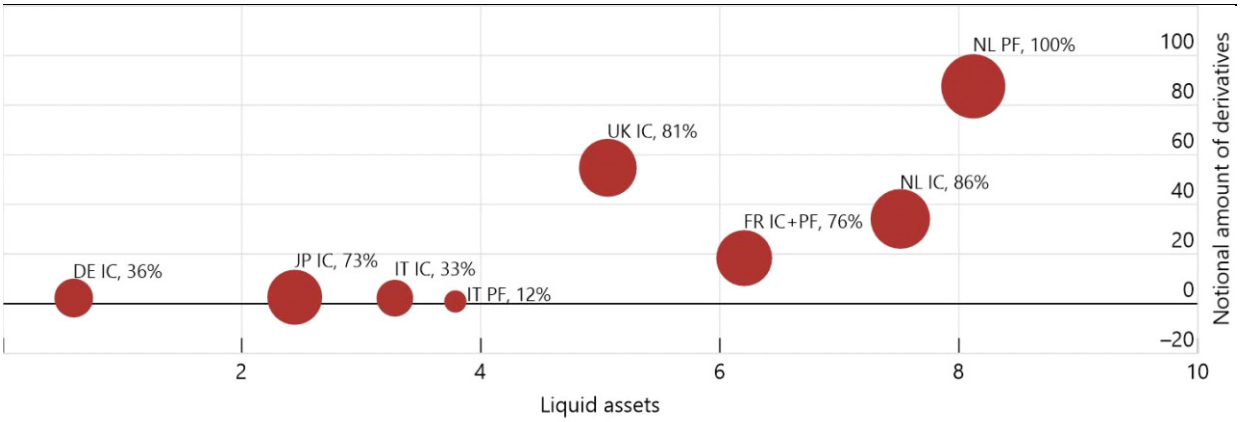
[55] See IMF (2023), *Global financial stability report*, April, chapter 2, Figure 2.4, panel 1.

may only partially relate to LDI strategies, they can still expose pension funds to similar vulnerabilities.

Although insurance companies and pension funds also hold liquid assets that they can use to pay for variation margin on interest rate derivatives, these holdings tend to be small. Insurance companies and pension funds need to optimise the amount of liquid but low-yielding assets that they hold to be in a position to pay the liabilities promised to policyholders, especially when they have given guarantees (e.g. interest rate guarantees or defined benefits). In the European Economic Area, aggregate liquid assets measured as cash, transferable deposits, and money market fund shares made up just 3.2% of insurance companies' financial assets and 1.1% of pension funds' financial assets.[56] Nevertheless, the insurance companies and pension funds sectors with the largest notional amount of interest rate derivatives tended to hold the largest amount of liquid assets, again measured by cash, deposits, and MMF shares, though it is difficult to characterise a relation given the few data points (Graph 17).[57] While not all insurance companies and pension funds hold interest rate derivatives, the entities holding such derivatives seem to represent the bulk of the sector in most jurisdictions (the size of each circle in Graph 17), which points to a concentration phenomenon.[58]

Liquid assets and interest rate derivatives[1,2]

Per cent of total assets **Graph 17**



[1] The size of the dots reflects the proportion of firms in a sector using interest rate derivatives with bigger dots indicating a higher proportion. For example, 100% of Dutch pension funds use interest rate derivatives, and 81% of UK insurers use interest rate derivatives. See also the notes to Graph 16 for information on the sample. [2] In Italy, DB pension funds play a marginal role (around 2% of total assets of the Italian pension system), following reforms in the 1990s that mandated all new funds to adopt the DC structure and prevented DB funds from enrolling new members.

Sources: National authorities; FSB calculations.

Leverage in LDI strategies used by pension funds

Pension funds have also implemented strategies to close duration mismatches and enhance returns through off-balance sheet vehicles provided by fund managers. These services are

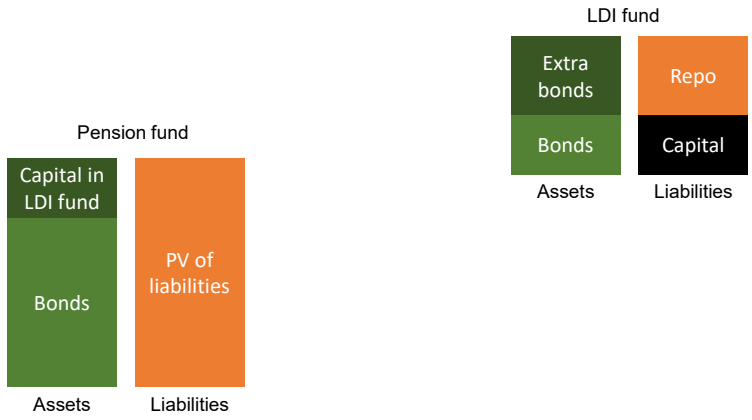
56 Figures from EIOPA Insurance statistics and EIOPA Occupational pensions statistics.

57 The comparison is done at jurisdiction-level and not at individual entity-level.

58 See Ito et al (2023), Corporate pension funds' investment strategies and financial stability: lessons from the turmoil in the UK gilt market, *Bank of Japan Review*, March, for a comparison of the Dutch, Japanese, British, and American pension fund sectors.

marketed using the term "LDI strategies".[59] Fund managers implement these LDI strategies either via collective investment vehicles (pooled LDI funds), or through single-client funds and segregated mandated accounts[60]. Instead of the long-term investor borrowing on its own balance sheet to invest in additional assets, the pension fund would invest in a separate LDI fund that would borrow, usually in repo markets, to invest in additional bonds (Figure 4).

LDI strategies and off-balance sheet leverage **Figure 4**



Sources: FSB, based on Jon Cunliffe's 5 October Letter to the Chair of the Treasury Committee of the House of Commons.

The outsourcing of an LDI strategy to a fund manager is especially attractive if the strategy is complex and involves different types of derivatives. While larger pension funds tend to use segregated mandates, smaller pension funds generally purchase shares of pooled vehicles to obtain their LDI exposure and benefit from economies of scale. In the United Kingdom, around 15% of total pension liabilities hedged using LDI strategies were via pooled LDI funds in 2021, representing 60% of the total number of LDI arrangements (the 40% remaining were done through segregated mandates and single-client funds).[61]

Using pooled LDI funds and single-client funds means that the leverage does not appear on the balance sheet of the pension fund. While the leverage of the LDI funds and of the segregated mandates can be assessed by supervisors receiving investment fund data, the pension fund leverage is – to some extent – hidden as it is difficult to associate the leverage at an LDI fund with the original long-term investor, especially in the case of cross-border investments. It is also difficult to obtain granular data on LDI fund and segregated mandate leverage in some jurisdictions and so this leverage may be hidden in those cases.

Industry reports suggest that the global size of LDI strategies (both pooled LDI funds and segregated mandates) amounts to $3.9 trillion, with the assets of these strategies almost quadrupling over the decade since 2011 (Graph 18, panel 1).[62] Estimates indicate that most of the LDI strategies are likely to be employed in the US and UK, though there are also LDI funds in the EU, mainly in Ireland, Luxembourg, and the Netherlands. Data presented in Graph 18,

59 See BMO (2021), *Liability driven investment explained*; BlackRock (2022), *LDI strategies: setting the record straight*; and Mercer (2022), UK LDI – Implications of recent events for derivatives investors in other countries.

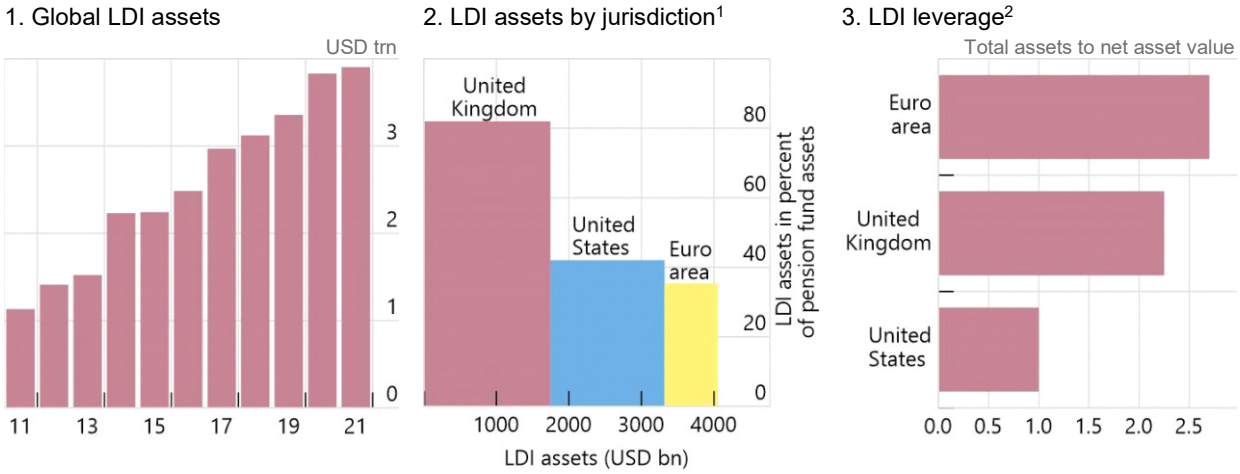
60 Or separately managed accounts.

61 See The Pensions Regulator (2022), Letter to Rt Hon Sir Stephen Timms MP, Chair of the Work and Pensions Committee, on the impact on defined benefit pension schemes of movements in financial markets, October.

62 Fidelity (2022), UK LDI market disruption – a US plan perspective, October.

panel 2, should therefore cover most of the sector using LDI strategies. ESMA work has shown that most of these EU funds' assets and liabilities are in sterling and so these funds are likely to serve UK pension funds.[63] It appears as though there is little use of LDI strategies in other FSB member jurisdictions. Supervisory monitoring indicates that a small number of asset managers manage a large majority of LDI strategies, which again points to concentration.

LDI strategies **Graph 18**



[1] Data used in panel 2 do not take account of yield moves over the course of 2022. [2] In panel 3, leverage is measured by comparing to total assets to the net asset value, which does not capture well synthetic leverage. The number for the UK is the average between 3 times leverage for pooled funds and 1.5 times leverage for segregated funds. These figures are estimates for a sample of the LDI universe.

Sources: BoE; ESMA; Fidelity; FRB; FSB calculations.

While LDI assets in the UK ($1.7 trillion) are similar in size to the US (around $1.3-1.9 trillion), they represent a much larger proportion (around 80%) of the size of the country's defined benefit pension sector than in the US (about 40%) and EU (around 35%) as is shown in Graph 18, panel 2. Although it is difficult to obtain information on leverage employed in LDI strategies, it appears as though this may be significant, at approximately 1.0-3.0 times net asset value at the aggregate level in jurisdictions (Graph 18, panel 3) – and these figures probably underestimate synthetic leverage. In the UK, market intelligence suggests that most of this leverage (around 80%) is in the form of repo borrowing, though synthetic leverage is also used. Data for the EU show that repo borrowing is also used (around 40% of total leverage) though synthetic leverage tends to be larger than financial leverage.[64] LDI strategies used in the United States tend to have little derivatives use, and where used, these derivatives often tend to be exchange traded and likely centrally cleared.

[63] ESRB (2023), *EU non-bank financial intermediation risk monitor 2023*, May.

[64] *Ibid*.

Box 1: Pension funds episode in March 2020

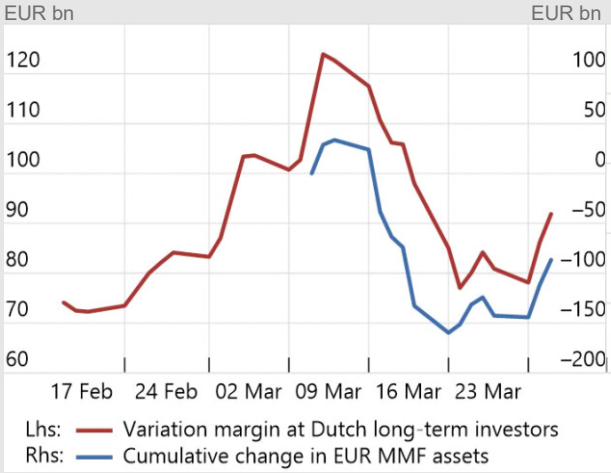
This box describes the events in March 2020 when increases in interest rates led to sharp rises in margin calls on pension funds' interest rate derivatives, held as part of their LDI strategy. The subsequent liquidity demand spilled over to money market funds, which faced significant outflows.

In mid-March, long-term interest rates started to rise, following a period where they had been on a declining trend. Pension funds that had been using synthetic leverage in their LDI strategies to hedge against falls in interest rates were faced with margin calls on their derivatives positions. ECB estimates suggest that a total of €50 billion in variation margin was paid by these long-term investors to their derivatives counterparties between 11 and 23 March.[A] More than 90% of this margin was posted by Dutch pension funds, which held around 60% of derivatives held by euro area pension funds and tended to have longer duration interest rate swaps than pension funds in other euro area countries.[B]

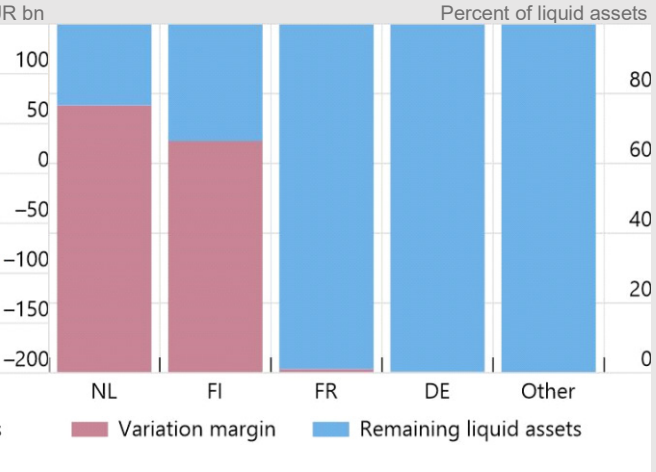
The pension funds did not have sufficient cash in bank deposits available to meet the margin calls. The pension funds generated liquidity through sales of short-term debt instruments, repo transactions and redemptions from money market funds. ECB research has shown that there were outflows from euro area money market funds in the days following the increase in variation margin (Graph A, panel 1).[C]

Margin calls and spillovers to money market funds — Graph A

1. Margin calls and money market fund flows, 2020



2. Variation margin posted by euro area long-term investors[1]



[1] Panel 2 shows the variation margin posted between 11 and 23 March 2020.

Sources: ECB Financial Stability Review, November 2020, Box 8; iMoneyNet.

While the money market funds were able to provide the liquidity to meet the margin calls in this instance, it is judged that pension funds would have faced serious difficulty in meeting margin calls if the volatility had been more severe or if it had persisted for longer.[D] Total variation margin posted by Dutch pension funds in this episode represented around 77% of their liquid assets (Graph A, panel 2). The episode also highlights the significant liquidity demands that can occur from the use of synthetic leverage. It also illustrates the potential for spillovers to occur through interconnections in the financial system.[E]

A Rousova et al (2020), Interconnectedness of derivatives markets and money market funds through insurance corporations and pension funds, *ECB Financial Stability Review*, November.

B *ibid*.

C *ibid*.

D European Commission (2020), *Report from the European Commission to the European Parliament and the Council*.

E FSB (2020), *Holistic review of the March Market Turmoil*, November.

5.2. Financial stability implications

LDI and other similar strategies using derivatives to hedge long-term investors' duration gap and interest rate risk can impact financial stability through several of the propagation mechanisms and amplification factors discussed in Section 2. Before going through each of these factors in turn, one more general lesson is that strategies that were originally intended to reduce certain vulnerabilities (e.g. duration mismatches and interest rate risks) have actually led to the development of other vulnerabilities (e.g. leverage and consequent liquidity risks).

Position liquidation channel

One key *propagation mechanism* associated with leverage is the position liquidation channel. The use of synthetic leverage through interest rate derivatives (on- or off-balance sheet) could lead to sharp increases in margin calls in the event of high volatility in interest rates or government bond yields. This is amply demonstrated by the episode involving pension funds in March 2020, when margin calls surged during the 'dash for cash' episode (Box 1). In the EU, the potential for spikes in liquidity demand should increase since the temporary central clearing exception for pension funds, included in the European Market Infrastructure Regulation (EMIR), expired in June 2023. However, as this change only applies to new derivatives contracts, the change should be gradual, and ESMA has assessed that pension funds will be largely operationally ready for the change.[65]

In addition, off-balance sheet financial leverage through LDI strategies can lead to further demand for liquidity. This was a key part of the September 2022 episode in UK gilt markets when pension funds faced collateral calls from pooled LDI funds (Box 2). Indeed, recent research has shown that LDI funds with larger repo and swap exposures before September 2022 sold more gilts during the stress episode in order to raise liquidity.[66]

---

65 See Ross (2022), Clearing obligations for pension scheme arrangements, letter to EU Commissioner for Financial Services, January.

66 Pinter (2023), An anatomy of the 2022 gilt market crisis, *Bank of England Staff Working Paper*, No 1019, March.

Box 2: UK LDI episode

A historically large increase in long-term UK government bond yields in late September 2022 resulted in a sharp, sudden increase in liquidity demand on LDI funds. In response, some pooled LDI funds sold gilts and the resulting price falls had the potential to trigger forced sales and become self-reinforcing. This downward spiral would have resulted in severe market dysfunction and threatened financial stability. This box discusses the chain of events that led the Bank of England to intervene in the gilt market to restore its functioning, and touches on some of the policy measures taken since the stress.

On Thursday 22 September, the Bank of England announced a 50 basis points rise in interest rates, consistent with its previous guidance and in line with market expectations. Sterling was broadly stable, while long-term gilt yields rose by around 20 basis points; this was in line with global yield moves on that day. The next day, the UK government announced its new "growth plan", and long-term gilt yields rose by 30 basis points, while sterling lost approximately 4% of its value against the US dollar. Gilt yields continued to rise sharply when markets re-opened on the following Monday and Tuesday, with the cumulative increase in the 30-year gilt yield from 22 to 27 September amounting to almost 150 basis points.[A] This implied a more than 35% fall in the price of the 30-year government bond over that period, a change far outside of historical averages.

The speed and scale of price movements in gilt markets were problematic for certain LDI funds as the value of their assets declined significantly, depleting their capital. In addition to adversely affecting their solvency position, the LDI funds faced calls from banks to top-up the amount of collateral they used to borrow in the repo market given the fall in the value of the gilt collateral. LDI funds also received margin calls on derivatives positions they had in place to hedge interest rate risk, though these calls appear to have represented a smaller part of their liquidity demands.

Faced with sharp liquidity demands and the threat of failure, LDI funds were required to rebalance their portfolios urgently, either by selling other liquid assets or asking their pension fund investors to provide them with capital. While this rebalancing took place for some LDI funds, others, particularly pooled funds, were not able to obtain the funds quickly enough given the speed of yield moves and the operational constraints of dealing with many pension funds that were used to recapitalising over longer time periods. This meant that LDI funds started to sell their gilts into already thin markets, pushing yields up further and risking further sales of gilts in a self-reinforcing downward price spiral. Market intelligence collected by the Bank of England suggested that LDI funds may have had to sell around £50 billion of long-dated gilts in a short space of time, relative to average trading volumes for those bonds of £12 billion per day.[B]

On Wednesday 28 September, the Bank of England announced a temporary and targeted intervention to purchase nominal long-dated gilts, starting that day and expiring on 14 October. The announcement led to a more than 100 basis point fall in 30-year gilt yields.[C] On 10 October, the Bank of England temporarily expanded the range of collateral accepted in its regular liquidity facilities, and on 11 October, it expanded its asset purchase programme to include long-term inflation-linked gilts.[D] Overall, the intervention stabilised market functioning, providing LDI funds with the time to recapitalise and strengthen their resilience. The Bank of England then ended its temporary intervention on 14 October, as planned.[E]

A Cunliffe (2022), Letter to the Chair of the Treasury Committee of the House of Commons, 5 October
B *ibid*.
C *ibid*.
D Cunliffe (2022), Letter to the Chair of the Treasury Committee of the House of Commons, 18 October.
E Hauser (2022), Thirteen days in October: how central bank balance sheets can support monetary and financial stability, Bank of England speech.

While government bonds and high credit-quality corporate bonds are sometimes considered to be liquid assets, it seems as though in practice, pension funds were often reliant on cash and

MMF shares as a source of liquidity. This is because of the speed of the events, the fact that the government bonds were affected by the events, the type of assets accepted by counterparties and central counterparty clearing houses for variation margin calls, and potentially the capacity or unwillingness of counterparties to enter repo transactions and to provide ad-hoc credit lines.

Finally, as discussed in Section 2, non-bank investors may liquidate their positions as a result of their leverage-like behaviour and convexity mismatches. This may have been an additional factor preventing long-term investors to cushion the shock in the UK gilt market in September 2022. An earlier instance of such market dynamics occurred during the 1994 US mortgage-backed securities hedging episode, when long-term yields rose very quickly in response to duration hedging.

Concentration

One factor that can *amplify* the impact of leverage on the financial system is concentration. Concentration played a role in both the UK LDI and the Dutch pensions episodes. The prevalence of LDI strategies in the UK meant that long-term investors held a greater share of government bonds than in some other countries, and their positions where concentrated in long-term inflation-linked bonds, which is a narrow segment of the market. Furthermore, the UK episode has shown that relatively small leveraged entities can lead to a significant impact on markets. Pooled LDI funds made-up around only 10-15% of the total LDI fund market, by liabilities hedged.[67] However, because positions in long-term inflation linked bonds were concentrated, within an investor base that was mostly pursuing similar LDI strategies, asset liquidations in this small part of the market had a significant impact on the price of these gilts.

In the case of the Dutch pension funds, ECB research has shown that these funds held around 60% of total derivatives held by long-term investors in the euro area because of the large size of the Dutch pensions sector. This concentration, as well as the long duration of the swaps, meant that by far the largest part of the variation margin required in the period between 11 and 23 March 2020 had to be posted by Dutch pension funds.[68]

There is also some concentration in the small number of asset managers that provide LDI strategies for long-term investors. This could introduce some vulnerabilities, for example if many funds employ similar investment strategies, which can lead to correlated behaviour in stress; or difficulties in the event of systems failures at the asset managers.

Interconnectedness

A second *amplification factor* is interconnectedness. LDI strategies give rise to several chains of connected entities. First, long-term investors facing margin calls from their synthetic leverage turn to different sources of liquidity, creating interconnectedness in the system. These long-term investors can redeem their investments in money market funds to raise liquidity. But as

---

67 See The Pensions Regulator (2022), Letter to Rt Hon Sir Stephen Timms MP, Chair of the Work and Pensions Committee, on the impact on defined benefit pension schemes of movements in financial markets, October.

68 Rousova et al (2020), Interconnectedness of derivatives markets and money market funds through insurance corporations and pension funds, ECB Financial Stability Review, November.

happened in March 2020, redemptions can lead money market funds to pullback from commercial paper markets, creating funding strains for banks and corporates that use these markets as a source of short-term funding. Repo markets have also been used by long-term investors to raise liquidity. This means that margin calls faced by leveraged long-term investors could create strains in repo markets that are widely used as a source of liquidity by many banks and non-bank investors.

A second example of interconnectedness is between pension funds and their LDI funds. In the UK gilt market episode, pooled LDI funds had planned on being recapitalised by their various pension fund investors, but operational challenges meant that the capital was available much slower than was required. This meant that the LDI funds resorted to liquidating their gilt positions to raise cash, impacting gilt markets.

A third example of interconnectedness is between LDI funds and the banks that were either counterparties in derivatives and repo markets or that served funds as their custodians. The historically large rise in long-dated UK government bond yields meant that banks had to suddenly raise variation margin to cover price movements, creating a surge in liquidity demand at LDI funds. Banks faced the real possibility of LDI funds defaulting on these margin calls, which would have left them holding significant inventories of gilt collateral during a period of market stress, and with minimum protection due to the near-zero haircuts used on repos backed by government bonds. The episode highlighted that custodians are also an important part of market infrastructure from a financial stability perspective.

6. Hidden leverage and data gaps

This section discusses the different ways in which data gaps can hide the full extent of NBFI leverage. This not only makes it difficult to properly assess the vulnerabilities associated with NBFI leverage, but it also prevents market participants and supervisory authorities from putting appropriate mitigating measures in place. This can, in turn, lead to the build-up of large and concentrated leveraged positions that can amplify the impact of shocks on the financial system.

6.1. Limited availability of data

Limits on data collection and disclosure mean that certain aspects of NBFI leverage can be hidden. There can be gaps in the supervisory data collected by authorities on non-bank investors themselves and on the transactions they are involved in. For example, authorities may be able to observe the total amount of leverage taken by hedge funds, both individually and in aggregate. However, current reporting requirements mean that in some jurisdictions authorities may be unable to see details about positions, collateral, and underlying reference assets that underpin hedge funds' leveraged investments. In some cases, the netting of exposures by asset class could potentially lead to an underestimation of total leverage in the system. This constitutes a blind spot because the vulnerabilities associated with leverage are crucially dependent on the characteristics of the borrowing and leverage arrangements.

There are also certain types of non-bank investors where very little data are collected by authorities, creating further data gaps. One example of this is family offices (see Box 3 and Annex 3). There are also data gaps for some other large non-bank entities, such as endowments

and sovereign wealth funds, which are often not subject to reporting requirements at an entity level.[69] Information on the intermediaries used by family offices is also lacking and obtaining this information might help to identify linkages and leverage.[70]

In addition to data gaps in supervisory reporting, there are also gaps in disclosure. The work on aggregate trends in leverage (Section 3) showed that only a limited number of jurisdictions collect and publish information on NBFI balance sheets that can be used to obtain sector-level estimates of financial leverage. Even if NBFI balance sheets are published, the granularity of the information varies significantly across jurisdictions. Data collected by the FSB for the GMR includes more detailed information on NBFI balance sheets, but not all FSB jurisdictions provide information on liabilities, and even when the data are provided, there is not always complete coverage of liabilities across the NBFI sector.

Aggregate data on NBFI off-balance sheet and synthetic leverage is even more difficult to find from publicly available sources. While the BIS publishes information on derivatives, it is difficult to obtain metrics on leverage from the data, and there is little information on individual jurisdictions.[71] IOSCO has started to publish data on fund leverage, but the limited time series makes it difficult to see how current leverage levels compare to the historic levels.[72] While a few jurisdictions have data on synthetic leverage at some entities (e.g. hedge funds), it is not available in many jurisdictions, let alone in a consistent data format across countries.[73]

69 Bouveret and Haferkorn (2022), *Leverage and derivatives -the case of Archegos*, May.

70 Some information might be collected via supervised prime brokers which trade with family offices.

71 See BIS derivatives statistics.

72 IOSCO (2023), I*nvestment Funds Statistics Report*, January.

73 In the European Union, ESMA publishes reports on leverage in alternative investment funds, see ESMA Market Reports.

Box 3: Family offices as an example of hidden leverage

Family offices are typically formed by high-net worth individuals belonging to the same family (though they sometimes can serve multiple families). Traditionally, the purpose of a family office is to bring under the same private structure several activities that the families need to perform while managing their assets. Those activities include wealth management, tax planning, and sometimes charity activities. As demonstrated by the Archegos episode, family offices can embed leverage and other vulnerabilities that are similar to hedge funds and can contribute to the propagation of shocks through the global financial system. This Box summarises the information gathered through several public and commercial data sources. This information is unofficial, unaudited and not possible to validate. Annex 3 provides more details.

It is challenging to obtain granular and consistent information on family offices. In contrast to hedge funds, which can be required to publicly register and to report some legal and financial information, family offices have no such obligations. Because most families rarely share the details of their operations or investments, it can be hard to track their size and strategies, including how much leverage they take on.

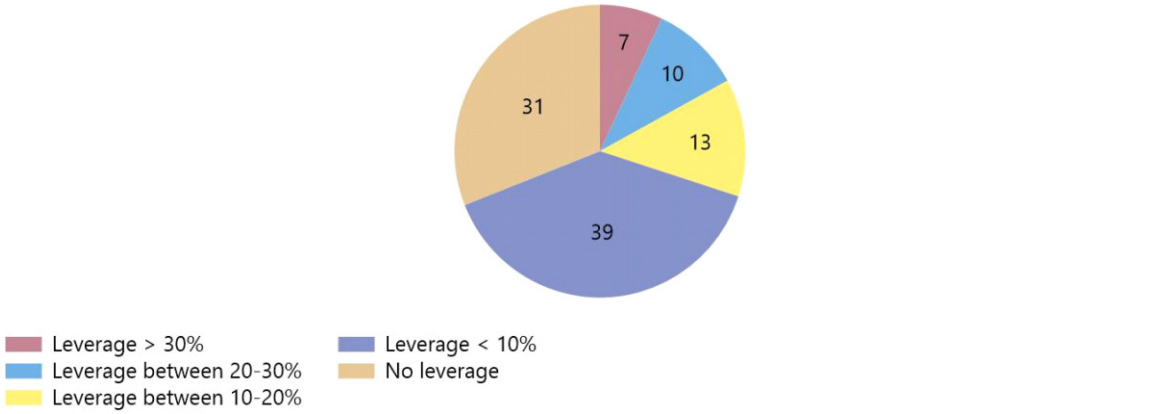
No consistent information is available on the number of active family offices, but estimates range from 7,000 to 10,000 (see Annex 3). In terms of assets under management (AUM), one estimate suggests that the family office sector is comparable to the hedge fund sector, at around $6 trillion, although estimates vary.[A]

Public reports suggest that around 5% of family office AUM is invested in hedge fund shares. The top four asset classes in which family offices invest are public equity (20-25% of AUM), private equity (10-20% of AUM), fixed income (5-10%), and real estate (15-25%) as discussed in Annex 3.

There is even less information available on the leverage taken on by family offices. According to one report, only 17% of family offices have leverage greater than 20% of their AUM, while the biggest portion of family offices has leverage below 10%.[B] In general, family offices with larger portfolios are believed to use greater leverage.[C] Information on intermediaries used by family offices (e.g. contractual obligations of trade executions on behalf of clients) is also lacking and might help in identifying linkages and leverage.

Estimated leverage in family offices **Graph B**

% of AUM



Source: Citi Private Bank (2022), Family Office Survey Report.

A Collins and Thomhave (2021), Family offices: A vestige of the shadow financial system, Institute for Policy Studies Briefing Paper, May.

B Citi Private Bank (2022), Family Office Survey Report.

C The public reports from private banks used for this information did not indicate whether this was financial or synthetic leverage.

6.2. Problems in aggregating existing data

Difficulties in aggregating existing data to obtain a comprehensive picture of NBFI exposures also allows leverage to be hidden. The build-up of similar leveraged positions by different entities is difficult to identify, as it requires the availability of comprehensive, market-wide data and in-depth analysis. This is often challenging because data may be fragmented across different market players, different reporting frameworks and different jurisdictions. An illustration of this fragmentation is the Archegos episode.[74]

Fragmentation across market players

The extent of NBFI leverage can be hidden through the fact that it is difficult for any individual entity to have a full picture of the total amount of leverage taken by its counterparties. One important example of this is the network of borrowing by hedge funds from prime brokers. In the aftermath of the global financial crisis, hedge funds diversified their counterparty networks and now generally borrow from multiple prime brokers, while prime brokers lend to a large set of hedge fund clients (as discussed in Section 4). While this diversification helps to mitigate counterparty credit risks, it also reduces transparency in important ways.

First, because prime brokers cannot see the leverage supplied by other prime brokers, no single prime broker can know the full scope and scale of any hedge fund's leveraged positions. A hedge fund might obtain a moderate amount of leverage on a particular strategy from each individual prime broker, but the total leverage obtained across all prime brokers could be substantial. This may prevent adequate risk management by the prime broker, as was the case in the well-known Archegos episode.[75] Therefore, this might lead to prime brokers providing more leverage than they would if they knew the full extent of leverage in their counterparties.

Second, an individual hedge fund is unable to know the leverage that its prime brokers are providing to other hedge funds. This introduces an additional source of hidden leverage because hedge funds may be inadvertently leveraging similar positions or exposures, and the build-up of total risk in the system may not be visible to them, creating the potential for correlated sales and deleveraging in response to shocks.

Another aspect is that it is difficult for authorities to aggregate leverage stemming from individual non-bank entities to assess leverage on an activity basis. The build-up of leverage through multiple holdings by various non-bank investors may escape the scrutiny of regulators and supervisors, as assessing leverage from an activity-based view is complex.

Fragmentation across reporting frameworks

The fragmentation of data on NBFI leverage across different reporting frameworks can also create data gaps. For example, in some jurisdictions non-bank investors – such as hedge funds

---

74 For observations on the collapse of Archegos and the use of regulatory reporting in the EU, see ESMA (2022), *Leverage and derivatives - the case of Archegos*, May.

75 See, for example, FSB (2021), *Enhancing the Resilience of Non-Bank Financial Intermediation: Progress Report*, November.

– may be regulated by several agencies, and in those cases, there is a risk that no single regulator has all the information needed to gauge an entity's leverage.

Even when data collected by different agencies is pooled, it may not be possible to obtain a complete picture of leverage. Differences in the granularity of information, combined with variations in the frequency of reporting[76], may mean that it is not possible to meaningfully combine information across reporting frameworks.

Fragmentation across jurisdictions

Cross jurisdictional analysis of NBFI leverage is also important. Leveraged non-bank entities are often global investors that are active in numerous financial instruments across multiple jurisdictions. A global fund running various strategies through a range of teams in different jurisdictions may only report the strategy that is run out of that jurisdiction to the local regulator, and an aggregation of the fund's books across jurisdictions may not be possible.

While data collected by different regulators may look similar, there are still challenges comparing and aggregating these data across jurisdictions. For instance, the definition of a particular non-bank entity can vary, the definitions of derivative exposures can diverge and the amount of detail collected can differ.[77] There could also be difficulties sharing data on individual non-bank investors across jurisdictions due to legal limitations and privacy concerns.

6.3. Difficulties in estimating meaningful measures of leverage

Another factor that impedes the identification of NBFI leverage is the lack of a comprehensive metric that can accurately capture and aggregate the total amount of leverage across all sources and types of leverage (e.g. repo, derivatives, structured products, etc.). While different forms of financial leverage can be aggregated together, it is not always clear that these can be easily combined with synthetic leverage to assess overall leverage at a non-bank entity.

Furthermore, there are different ways to assess synthetic leverage, and it is not clear that a single risk metric would adequately capture all the vulnerabilities in different derivatives strategies. These strategies can be quite complex with nonlinear payoff structures, and knowing the notional amount of a contract may not be enough to identify the fund's underlying vulnerabilities. It is therefore important to consider various leverage measures, each of which may capture different vulnerabilities and risks.

Yet another data gap results from accounting standards for netting practices. Matched book and internalised trades may leave no record of the collateral used as accounting rules may permit

---

76 Some information is provided daily while other reporting frameworks may only require monthly or quarterly data.

77 Even cash could mean different things in different jurisdictions and may be reported to regulators along with its "equivalents". For instance, currently on the U.S. SEC Form PF, "cash" category is cash and cash equivalents and includes U.S. government securities.

various netting possibilities that obscure the degree of leverage provided by prime brokers.[78] These practices could potentially hide the amount of leverage that is being used.

7. Conclusions and policy implications

Aggregate data suggest that there are pockets of high leverage in the NBFI sector. Furthermore, non-bank investors appear to be taking on increasing amounts of off-balance sheet financial leverage, and proxies suggest that aggregate synthetic leverage could be higher than average.

Amongst non-bank investors, hedge funds display high levels of synthetic leverage in aggregate, obtained through securities financing transactions and the use of derivative positions. While median levels of leverage within the hedge fund sector stand below two times NAV, there is a group of funds, typically pursuing macro and relative value strategies, with very high levels of synthetic leverage. Furthermore, only a few prime brokers provide lending to hedge funds and other non-bank investors in some jurisdictions, and they may not be able to assess the full network of exposures and leverage of their counterparties, which increases the potential for shocks to propagate through the financial system.

The way in which long-term investors have sought to reduce their vulnerability to interest rate risk has led to a rise in other vulnerabilities, such as associated leverage and liquidity risks. The use of financial or synthetic leverage to reduce duration mismatches and hedge against interest rate risk could lead to spikes in the demand for cash and, hence, the development of liquidity imbalances. Even low leverage can sometimes disrupt individual markets and have spillovers to other markets and economies when the leveraged positions are concentrated in a small number of actors and in specific market segments. As a consequence, aggregate measures of leverage can obscure vulnerabilities if they do not take concentration in exposures into account.

Significant data gaps have been identified in this report, and this prevents a full assessment of the vulnerabilities associated with NBFI leverage. Data gaps can arise due to the limited availability of data, problems in aggregating existing data to obtain a full picture of leverage, and difficulties in interpreting data to obtain meaningful measures of leverage, which can contribute to the build-up of large and concentrated positions. In addition to hampering the assessment of vulnerabilities, these gaps impede mitigating measures from being put in place by market participants and regulators.

Consideration should be given to addressing the most salient identified data gaps so that the monitoring of NBFI leverage – and their interactions with liquidity and maturity mismatches – can be improved. Measures to address data gaps should take into account the costs of such measures to market participants and authorities, as well as potential financial stability risks. Work to close data gaps could consider:

---

[78] For instance, repo and reverse repo can be reported on a net basis if conducted with a single counterparty under a master netting agreement and if the transactions have the same settlement date and satisfy other operational requirements. Further, prime brokers can net long and short exposures within individual client margin accounts. Yet, in both repurchase agreements and margin lending, the collateral could be materially different in the netted trades. Netting is also possible for derivatives contracts. Derivatives assets and liabilities can be netted if each party owes the other determinable amounts and certain conditions about the right to set off are met. Finally, cash collateral can be netted against the fair value of the derivatives contract if executed under a master netting agreement.

- Making more intensive use of data already collected on derivatives and SFTs, such as those available in trade repositories.

- Further implementation of the November 2015 FSB standards for collecting and aggregating global data on securities financing transactions by FSB member jurisdictions.[79]

- Enhancing reporting requirements for non-bank investors, especially those (in particular OFIs) that have high leverage levels.

- Changes to existing frameworks for assessing leverage to include new and consistent metrics that better capture aspects of leverage and improve the comparison of leverage across entities and jurisdictions.[80]

- Greater sharing of information between authorities and across jurisdictions (e.g. through sharing arrangements) while ensuring data confidentiality.

- Expanding disclosure requirements for financial institutions to shed light on concentrated positions.

- The collection and publication of more detailed information on NBFI financial and synthetic leverage and balance sheets in national statistics and flow of fund accounts to identify leverage dynamics at the sectoral level.

Authorities might also want to examine whether any policy responses are needed to address the vulnerabilities and amplification factors from NBFI leverage. Work is already underway at the FSB and BCBS-CPMI-IOSCO to review procyclicality in margins and one possible avenue for future work could be to build on this work to assess whether additional rules on haircuts and margins could be used to contain leverage in the financial system. FSB members may also accelerate efforts in implementing the agreed FSB minimum standards and haircut floors on non-centrally cleared securities financing transactions.[81] Another issue to consider is whether rules on risk-based leverage ratios could be extended to financial institutions that are currently not subject to such rules.[82] However, such work would be complicated by the challenges in identifying pockets of leverage, differences in leverage metrics across jurisdictions and the complexity and calibration across different types of non-bank investors, business models and investment strategies.

In addition, authorities could consider whether measures are needed to mitigate the financial stability consequences of high NBFI leverage. One area to explore is whether prime brokers' risk management of exposures to leveraged non-bank entities could be enhanced. The BCBS is

---

79 See FSB (2015), *Standards and Processes for Global Securities Financing Data Collection and Aggregation*. The FSB is implementing its 2013 policy recommendation to collect and aggregate data on SFTs at the global level, which can be used to monitor build-up of leverage and financial system interconnections through SFTs.

80 For example, measures of potential loss on the whole portfolio and estimates of potential liquidity demands.

81 See FSB (2015), *Regulatory framework for haircuts on non-centrally cleared securities financing transactions*; and FSB (2023), *Implementation of G20 Non-Bank Financial Intermediation Reforms: Progress report*.

82 In the EU the European Alternative Investment Fund Managers Directive enables authorities to apply leverage limits to investment funds. See ESMA (2021), *Guidelines on Article 25 of Directive 2011/61/EU*, June. This applies also for UK authorities.

planning to develop additional guidance for banks on their interconnections with NBFI.[83] Measures could also be considered to improve prime brokers' understanding of hidden leverage (e.g. through requirements for non-bank investors to disclose the full extent of their exposures to their prime brokers and through stress tests of prime broker exposures to non-bank investors). Another possibility could be to consider measures to abate the position liquidation channel and reduce internal liquidity imbalances in response to spikes in collateral and margin calls.

Furthermore, the solvency of LDI funds was threatened by the decline in long-term gilt prices in September 2022 and this suggests that these funds were not sufficiently resilient. This appears to have been the case especially for pooled LDI funds, which faced operational constraints when they had to ask their pension fund investors for more capital. There is already work in the EU and UK to strengthen the resilience of LDI strategies.[84] This includes recommendations that LDI funds and DB pension schemes should be able to withstand severe but plausible market stresses, meet margin and collateral calls without triggering fire sales that add to market stress, take account of the duration, liquidity and concentration of their assets when modelling their resilience to changes in interest rates, and improve their operational processes. The resilience of these funds continues to be monitored closely. Consideration could also be given to whether similar resilience standards are needed in other jurisdictions, depending on whether funds use leverage, and whether regulation could be more harmonised.

There are also lessons for stress tests by non-bank investors. Both the Dutch pensions and UK LDI episodes took place following extreme spikes in the volatility of government bond markets. More recently, the volatility in short-term US government bond markets increased to the highest level since the 1980s. This all suggests the calibration of interest rate stress tests used by investors to assess their resilience to shocks in the market may need to be made much more severe. Furthermore, contrary to other types of liquidity risks to which insurance companies and pension funds are exposed (e.g. mass lapses, claims linked to catastrophes), liquidity risk stemming from the use of LDI strategies, derivatives and repos can materialise over a very short-term horizon (1-day). This suggests the need to adapt the time horizon of stress-tests.[85]

The FSB, in cooperation with SSBs, is working on some of these issues as part of its NBFI work programme. This includes, for example, policy work to enhance the liquidity preparedness of market participants and to address gaps in regulatory reporting.[86] External liquidity imbalances could be addressed by considering how to enhance the resilience of liquidity provision in core funding markets in times of stress. For example, as noted in the recent FSB report on liquidity in core government bond markets, such work could include ways to increase the availability and use of central clearing for government bond, cash and especially repo transactions.[87] The FSB

---

83 BCBS (2022), *Basel Committee work programme and strategic priorities for 2023/24*, December. The ECB has also recently revised its supervisory expectations for prime broker risk management – see ECB (2022), *Supervisory expectations for prime brokerage services*, August.

84 See BoE (2023), *Financial Policy Summary and Record*, March; BoE (2023), *Bank staff paper: LDI minimum resilience – recommendation and explainer*, March; Central Bank of Ireland (2022), *RE: Liability driven investment funds*, November; Commission de Surveillance du Secteur Financier (2022), Communication from the CSSF on Liability Driven Investment Funds, November; ESMA (2022), *ESMA welcomes NCA's work to maintain resilience of liability driven investment funds*, November; and FCA (2023), FCA sets out recommendations for LDI managers, April.

85 For example, the time horizons considered by the IAIS to measure liquidity risks are one year, three months, and one month. See IAIS (2022, *Liquidity metrics as an ancillary indicator*, November.

86 FSB (2022), *Enhancing the Resilience of Non-Bank Financial Intermediation: Progress Report*, November.

87 FSB (2022), *Liquidity in Core Government Bond Markets*, October.

and SSBs will undertake further policy work to enhance authorities' and market participants' ability to identify and monitor risks from leverage in NBFI and to contain systemic risk associated with such leverage, drawing on the findings of this report.

Abbreviations

AIF	Alternative investment fund
AUM	Assets under management
BCBS	Basel Committee on Banking Supervision
BIS	Bank for International Settlements
CDS	Credit default swap
CPMI	Committee on Payments and Market Infrastructures
EMIR	European Market Infrastructure Regulation
ESMA	European Securities and Markets Authority
FX	Foreign exchange
GAV	Gross asset value
GFC	Global financial crisis
GMR	Global Monitoring Report on Non-Bank Financial Intermediation
GNE	Gross notional exposure
IOSCO	International Organization of Securities Commissions
IRD	Interest rate derivative
LDI	Liability-driven investment
MMF	Money market fund
NAV	Net asset value
NBFI	Non-bank financial intermediation
OFI	Other financial intermediary
OTC	Over the counter
REIT	Real estate investment trust
SEC	US Securities and Exchange Commission
TRS	Total return swap

Annex 1: Case study on leverage in the total return swaps market

This case study provides an overview of the interaction between UK alternative investment funds (AIFs)[88], and UK hedge funds in particular, with various prime brokers when trading total return swaps (TRS). After providing an overview of funds and prime brokers, the analysis looks into concentrated positions in the underlying stocks and how TRS exposures on the same underlying stock are split across counterparties. While limited to UK managed funds, which are small in comparison to some of the largest funds managed in other jurisdictions, the case study concludes with some preliminary takeaways and suggestions for further work.

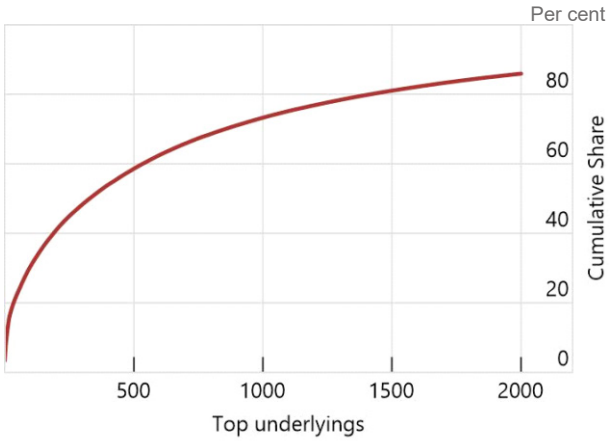
The TRS market: UK AIFs and counterparties universe

The analysis is based on a sample of funds from the information available in the UK Alternative Investments Fund Manager Directive (AIFMD) data and total return swaps (TRS) exposures reported by AIFs as of end of Q2: 2022 under the European Market Infrastructure Regulation (EMIR). AIFs included in the analysis are managed by a UK domiciled Alternative Investments Fund Manager (AIFM) with NAV above €500 million and an equity derivatives portfolio larger than €100 million. A total of 94 AIFs reporting under AIFMD fulfil these criteria at the points of their Q2 2022 AIFMD reporting, and 58 of these 94 report any TRS exposures under EMIR. Out of the 58 AIFs that constitute the sample of the analysis, 55 of these are self-labelled under AIFMD as hedge funds.

Gross notional exposure per prime brokers and underlying stocks **Graph A1.1**

Number of AIFs and AIF gross notional exposure split per number of prime brokers

Cumulative gross notional share by top underlying stock



Sources: UK EMIR data; Bank of England calculations.

As of Q2: 2022, AIFs in the sample reported TRS positions against 23 counterparties[89], with all of these being prime brokers. As Graph A1.1 (left panel) shows, only 10 AIFs deal with only one counterparty while the majority, both by number and overall gross notional exposure, deal with

88 As defined in the UK Alternative Investment Fund Managers Directive.

89 Prime brokers have been grouped to parent entities on a best-efforts basis.

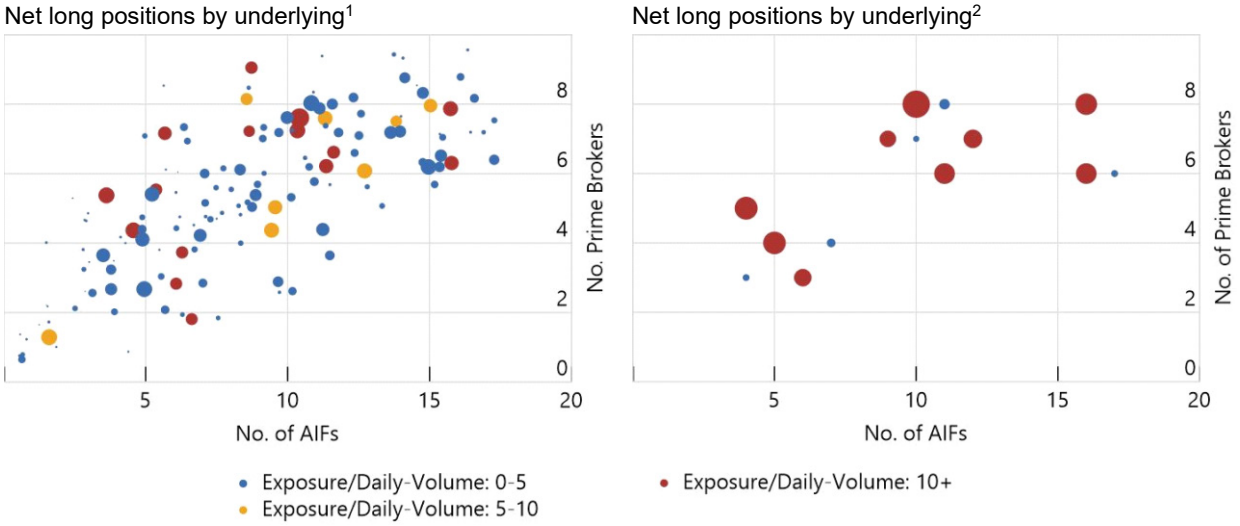
at least 4 counterparties. AIFs with larger TRS portfolios tend to transact with a higher number of prime brokers.

TRS positions are taken over a total of around 17,000 different underlying stocks, most of which are single stocks. The top-50 underlying stocks make up for around 25% of the total gross notional exposure in the sample (Graph A1.1, right panel).

Concentration in underlying stocks

Analysis of concentration in the underlying stocks can help identify which of these positions may expose market participants, both AIFs and prime brokers, to counterparty and liquidity risk. In order for concentration to have systemic relevance, the overall size of aggregated positions on a specific underlying stock has to be substantially large both in monetary terms but also with respect to the size of its average daily volumes (ADV). The ratio between the size of a TRS position and the ADV can indeed be regarded as a measure of liquidity.[90]

Number of AIFs and prime brokers per underlying stocks **Graph A1.2**



[1] Equity underlyings with gross notional > £100ml. [2] Equity underlyings with gross notional > £500ml.
Sources: UK EMIR data; Bloomberg; Bank of England calculations.

Graph A1.2 (left panel) shows the number of AIFs and counterparties linked via TRS positions (net long) to each underlying with total gross notional exposure across funds larger than £100 million. Applying a larger filter for exposures over £500 million, Graph A1.2 (right panel) highlights less than ten underlying stocks for which aggregated exposures are disproportionately large when compared to ADV. It would be difficult for any of the counterparties involved in these trades to unwind their large positions quickly under normal market conditions. While this approach provides information to assess systemic risks due to market concentration, it does not provide a comprehensive picture as other factors such as volatility of the underlying stock, the distribution of holdings across funds, the stock market capitalisation and changes in trading

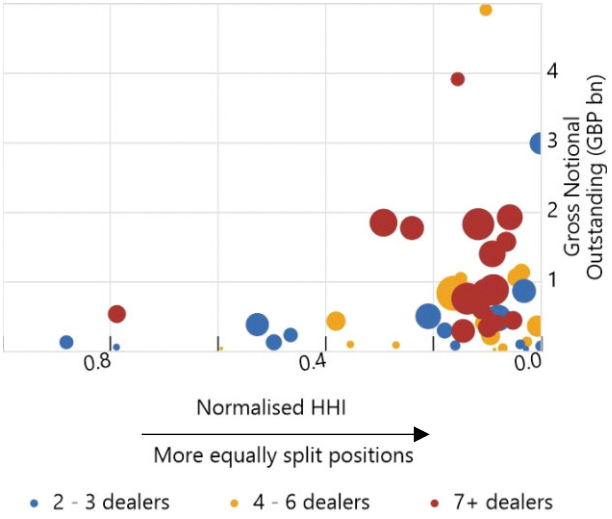
[90] The ratio can be viewed as a proxy for how long the counterparty would take to unwind positions in the event of default, although during market stress, daily volumes may be much lower than indicated by ADV.

volumes during stress would need to be taken into consideration to fully assess vulnerabilities that could potentially stem from these positions.

Splitting of counterparties

As shown in the case of Archegos[91], an entity might hold the same position across multiple counterparties. AIFs might use multiple prime brokers in order to diversify their counterparty risk or simply to obtain more competitive pricing conditions. But because of prime brokers' limited view of their clients' portfolio, this splitting of TRS positions on the same underlying across multiple brokers has the potential to allow funds to take on more leverage than they otherwise would by just relying on a single counterparty. There are also some benefits for AIFs as credit risk adjustments, including concentration add-ons, can only be applied to the exposures that the prime broker can see, which exclude those taken by the AIF with other counterparties.

Portfolio concentration across dealers **Graph A1.3**



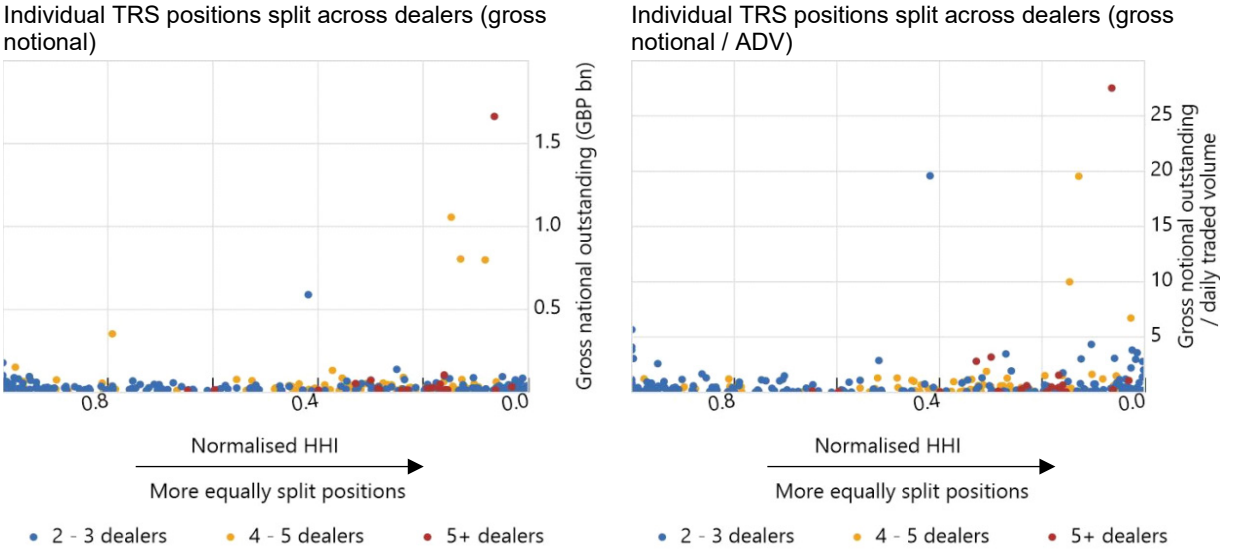
Size of dots represents the ratio between portfolio gross notional and fund NAV.
Sources: UK EMIR data; Bloomberg; Bank of England calculations.

Graph A1.3 shows how many prime brokers each fund has exposures to. Each dot represents the TRS portfolio of a single AIF. The Herfindahl-Hirschman index (HHI) provides a measure of concentration across dealers. Numbers closer to one indicate that AIFs mostly deal with few brokers. However, most portfolios have an HHI below 0.5, suggesting they tend to split their portfolio fairly evenly across prime brokers. In addition, the majority of AIFs have TRS positions with 4 or more prime brokers, and some have positions with 7 or more brokers. As the size of these dots would suggest, AIFs with the largest overall TRS exposure (relative to NAV) tend to have more prime brokers.

Next is investigated whether AIFs do actually split positions on the same underlying stocks across multiple dealers. Graph A1.4 replicates the analysis of TRS positions, but splits the data by individual underlying stock.

91 For more details please refer to ESMA publishes ex-post analysis of derivatives risks in Archegos.

TRS positions across dealers **Graph A1.4**



Sources: UK EMIR data; Bloomberg; Bank of England calculations.

Each dot represents a position held by an individual AIF on a single underlying stock. The HHI reflects how equally distributed these positions are across counterparties. Lower HHI values suggest that the position is more evenly distributed across multiple counterparties.

Graph A1.4 (left panel) shows that positions with at least 4 dealers tend to have an HHI mostly below 0.5. This seems to suggest a positive relation between the number of prime brokers used to split a position and how evenly distributed these positions are. Additionally, the same chart singles out few outlier positions (top-right) that are evenly split across at least 4 prime brokers and with a size which might be relevant from a systemic perspective. Graph A1.4 (right panel) shows that these positions are in less liquid stocks. Nevertheless, additional information would need to be considered in order to assess if and how any of these positions could pose a threat to financial stability.

Preliminary conclusions

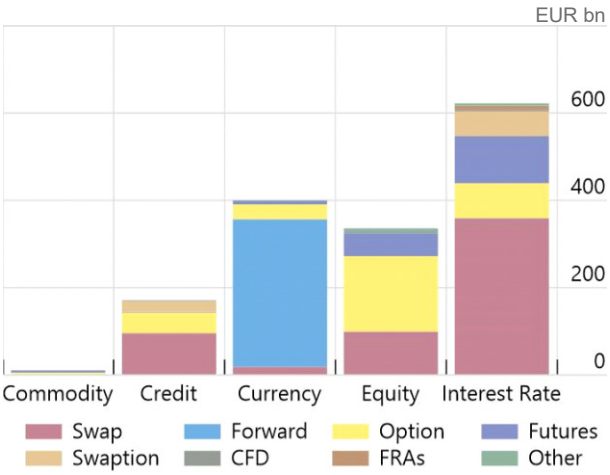
Although the sample studied here is limited to a portion of UK managed AIFs, and so does not provide a full picture of the TRS market, it still delivers some interesting findings. Concentration analysis shows some large aggregated TRS net long positions in a few stocks taken by a number of AIFs (mostly hedge funds). These positions are large compared to the liquidity of the stock (proxied by the stock's ADV), which could result in amplification of price shocks in the event of fire sales. Additionally, AIFs' TRS portfolios tend to be more evenly split across at least 4 prime brokers, and is more common for AIFs with larger TRS exposure (relative to fund NAV). Lastly, the analysis shows some outliers, where potentially large TRS positions are evenly split across multiple brokers. Nevertheless, further factors need to be considered in order to assess systemic threats and vulnerabilities to financial stability.

Annex 2: Case study on counterparties of EU hedge funds

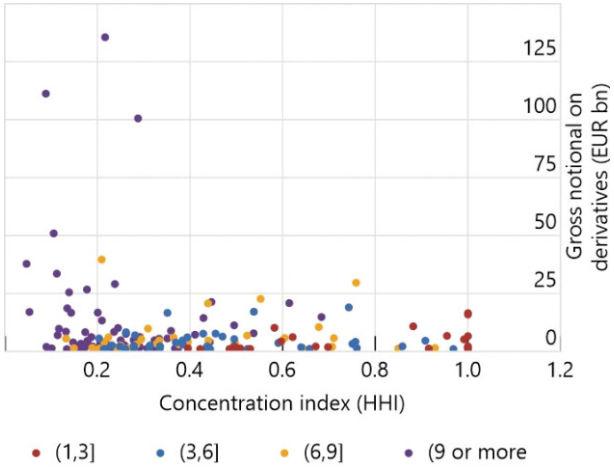
This case study looks at the counterparties of EU hedge funds in derivatives, repo and securities lending markets. This annex is based on a sample of close to 2,000 funds with NAV of €57 billion. The funds in the study are either "alternative investment funds" (AIFs) or "undertakings for collective investment in transferable securities" (UCITS) using hedge fund-like strategies.

EU hedge funds' derivatives counterparties: January 2023 **Graph A2.1**

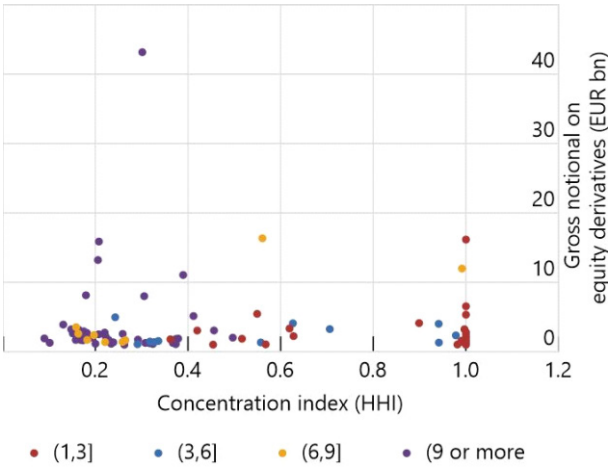
1. Hedge funds mainly exposed to IRDs, FX and equity derivatives



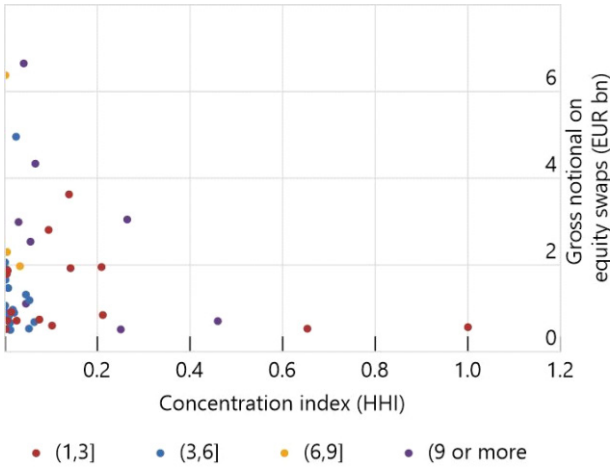
2. Less counterparty concentration for largest hedge funds



3. Less concentration for equity derivatives



4. Diversified exposure by underlying of equity derivatives



Each dot represents a hedge fund. The dots are colour-coded according to the number of dealer counterparties. Data as of 6 January 2023.
Sources: EMIR; ESMA; SFTR.

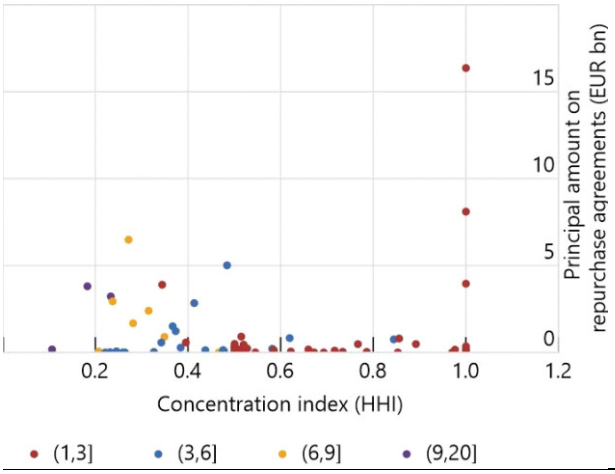
The hedge funds in the sample have significant derivatives positions, close to €1.5 trillion. These are mainly equity swaps, interest rate and foreign exchange derivatives (Graph A2.1, panel 1). Hedge funds with the largest derivative exposures tend to use more counterparties (measured as the number of dealers) and spread their exposures across counterparties (measured by a HHI concentration index), corroborating the findings in the UK in Annex 1 (Graph A2.1, panel 2). This pattern applies to both the overall derivatives exposures as well as to equity derivatives, although to a lesser extent (Graph A2.1, panel 3). Hedge funds with lower absolute exposure tend to have more concentrated exposures towards a few dealers. Hedge funds with larger

exposure to equity swaps have less concentrated exposures by underlying than hedge funds with lower exposures (Graph A2.1, panel 4).

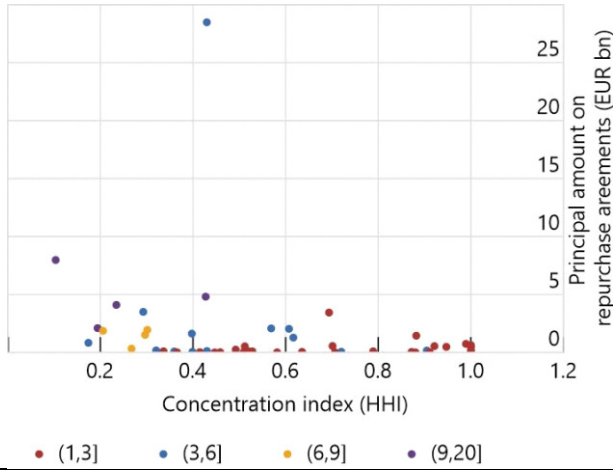
The hedge funds studied here also have a gross repo exposure of around €77 billion, mostly on the borrowing side (€55 billion, 72% of gross exposure), though their activity on the lending side is not negligible (reverse repurchase agreements account for around €22 billion). The majority of the repo activity is conducted by hedge funds under the EU AIFMD. Overall, 50% of the gross exposure is in euro and 28% in US dollars. These exposures are somewhat concentrated (Graph A2.2, panels 1-2).

EU hedge funds' repo and margin loan counterparties: January 2023 **Graph A2.2**

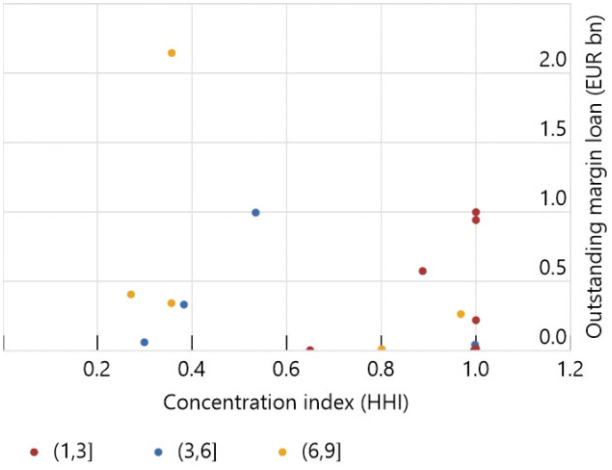
1. Some concentration in repo exposures



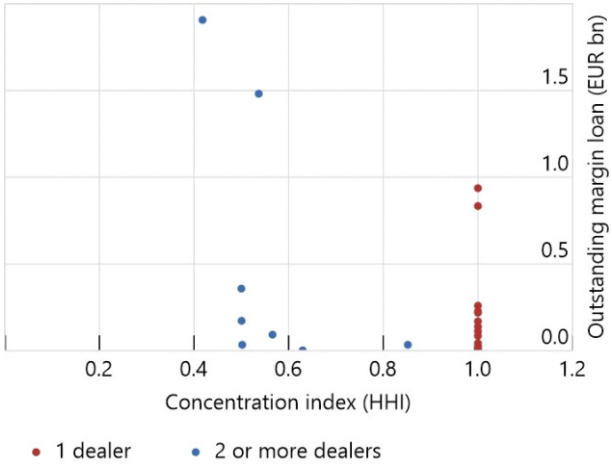
2. Counterparty repo dispersion across hedge funds



3. Prime brokers margin loan dispersion across hedge funds



4. Largest margin loans spread out



Each dot represents a hedge fund. The dots are colour-coded according to the number of dealer counterparties. Data as of 6 January 2023.
Sources: EMIR; ESMA; SFTR.

On the margin lending side, the activity of the sample hedge funds amounts to around €7 billion. One third corresponds to short positions (i.e. when prime brokers lend securities for short selling) and 88% of these loans are denominated in US dollars. Equities are mostly used as collateral. There is a high concentration from the prime broker side with three firms only accounting for 56% of total margin lending (Graph A2.2, panels 3-4).

Annex 3: Family offices

It is challenging to obtain granular and consistent information on family offices. In contrast to hedge funds, which can be required to report their size and other information regularly[92], family offices have no such obligations. Because most family offices rarely share details of their operations or investments, it can be hard to track their size and strategies, or the scale of their borrowing.[93] To investigate their structure, activities and scope, a number of different data sources have been examined. The information on family offices reported in this annex is unofficial, unaudited, and non-validated. The lack of consistency in these reports highlights the opacity and data gaps in the industry.

Reportedly, the growing concentration of wealth into a few thousand families globally has caused the family office sector to expand. Findings suggest that between one-third[94] and two-thirds[95] of family offices were created in the 2000s.

Family offices' structure and investment strategies

Family offices are typically formed by high-net worth individuals belonging to the same family, though some family offices serve several families. [96] One sources suggests that single family offices often serve families with assets greater than $150 million, while multi-family offices generally serve families with lower net worth. One report suggests that multi-family offices represent only about 20% of total family offices.[97] Traditionally, the purpose of a family office is to bring several activities – such as wealth management, tax planning, and sometimes charity-related activities – under the same structure.

As they have grown in size, some family offices have reportedly embraced riskier investment strategies.[98] One source indicates that just over one-third of family offices follow a growth strategy, however, 48% of single-family offices follow a balanced investment strategy, and 18% have a preservation strategy.[99]

Estimating the number of family offices and their assets under management

No consistent information is available on the number of family offices active around the globe. Estimates of the number of family offices range from 7,000 to 10,000.[100] Sources suggest that North America is the most popular location for family offices (estimates range from 30-60%), followed by Europe (about 10-20%), with most of the rest likely in the Asia-Pacific region, Latin

---

92 Investment fund managers with over $100m in so-called 13F securities (generally publicly listed equities)disclose their holdings of publicly listed equities via the quarterly 13-F SEC disclosure (Form 13F – Reports Filed by Institutional Investment Managers).

93 Zuckerman (2021), Family offices like Archegos take big risks like hedge funds, *The Wall Street Journal*.

94 INSEAD (2020), *Family Offices: Global Landscape and Key Trends*.

95 Campden Wealth (2022), *North America Family Office survey*.

96 Capgemini (2019), *World Wealth Report 2019*.

97 INSEAD (2020), *Ibid.*

98 Zuckerman (2021), *Ibid.*

99 See Campden Wealth (2022), Ibid and Credit Suisse (2022) *Single Family Office survey report*.

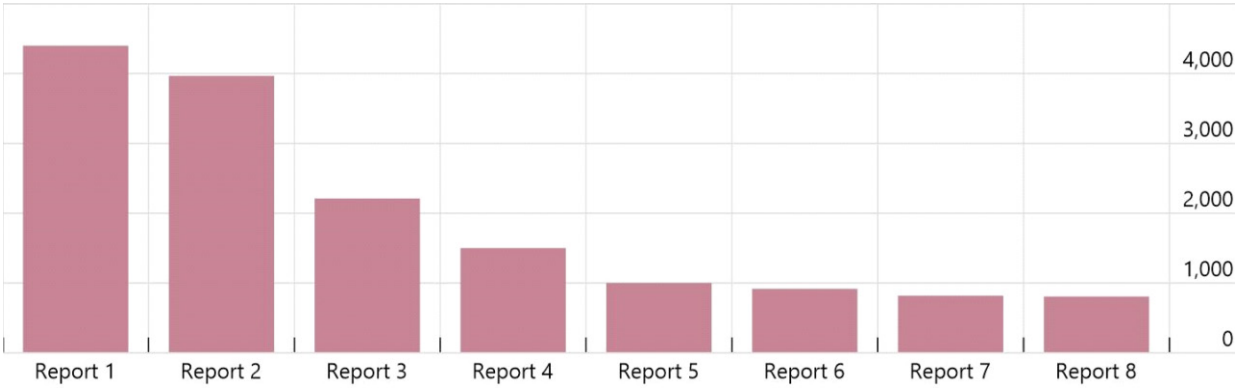
100 See Collins and Thomhave (2021), Family offices: A vestige of the shadow financial system, Institute for Policy Studies Briefing Paper, May and Campden Wealth (2022), *Ibid*.

America and the Middle East.[101] In fact, evidence suggests the number of family offices in these last three regions appears to have been growing rapidly.[102]

It is also difficult to obtain definitive data on the size of the family office sector, though as discussed in Box 3, one source estimates total AUM at approximately $6 trillion.[103] It appears as though the industry is concentrated, with one source indicating that the ten largest offices worldwide manage some $885 billion in assets.[104] The estimated average amount of AUM by a family office varies depending on the data provider (see Graph A3.1).

Average AUM by family office varies significantly according to the data provider

Average AUM by family office, 2019-2022 **Graph A3.1**



Sources: FSB calculations based on eight different reports on family offices.

The top 4 asset classes in which family offices invest are consistent across data sources (see Graph A3.2). Public equities appear to constitute the largest part of family office investment (between 20 and 30% of AUM), followed by private equity (about 10% of AUM). Several reports suggest that family offices invest around 5% of their AUM in hedge funds, which implies that there should be little double counting between the AUM of the hedge fund and family office sectors.

[101] See Campden Wealth (2022), *North America Family Office survey*, Collins and Thomhave (2021), Family offices: A vestige of the shadow financial system, Institute for Policy Studies Briefing Paper, May, Sovereign Wealth Fund Institute data on the largest family offices by total assets, Capgemini (2019), World Wealth Report 2019, Credit Suisse (2022) *Single Family Office survey* report, and Citi Private Bank (2022), *Family Office Survey Report*.

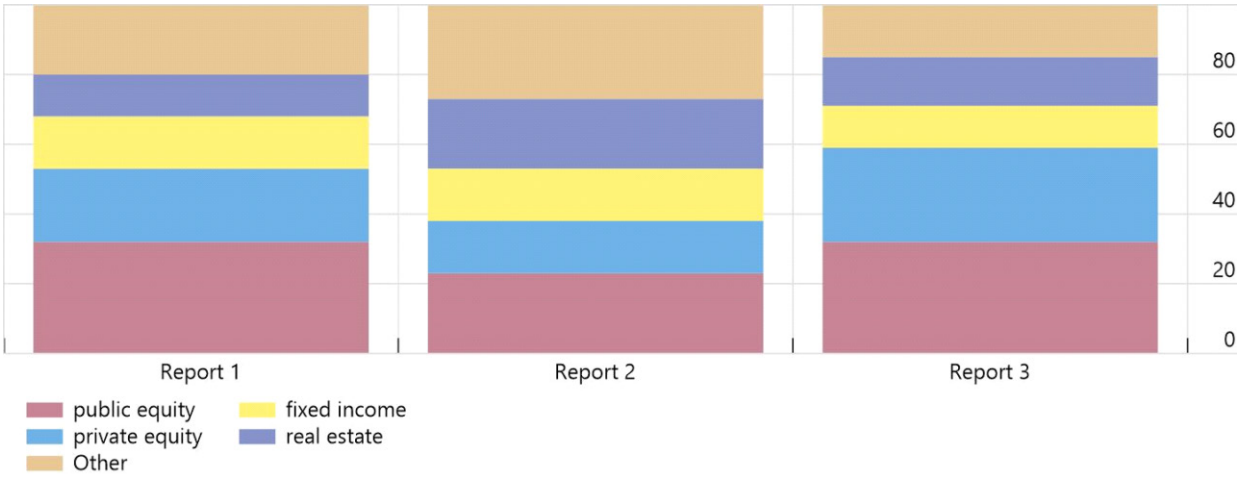
[102] Mordor Intelligence data on *Global Family Office Industry Growth, Trends, COVID-19 Impact and Forecasts*.

[103] Collins and Thomhave (2021), Family offices: A vestige of the shadow financial system, Institute for Policy Studies Briefing Paper, May.

[104] Sovereign Wealth Fund Institute data on the largest family offices by total assets.

Top 4 asset classes are public equity, private equity, fixed income and real estate

Breakdown of family office assets by asset classes, 2022 **Graph A3.2**



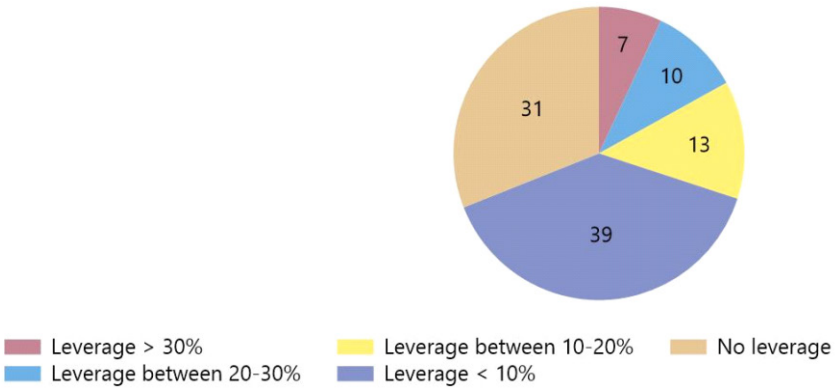
Sources: FSB calculations based on UBS (2022), *Global Family Office Report*, Citi Private Bank (2022), *Family Office Survey Report*, Campden Wealth Limited (2022), *The North America Family Office Report*, Royal Bank of Canada.

Difficulties with measuring leverage in family offices

Little information is available concerning family office assets, borrowing and derivatives, making it hard to obtain an accurate picture of family office leverage. One report estimates that 17% of family offices have leverage greater than 20% of their AUM, while the majority of family offices has leverage below 10% (Graph A3.3).[105]

Leverage might be concentrated in a few family offices

Per cent of AUM **Graph A3.3**



Source: Citi Private Bank (2022), *Family Office Survey Report*.

Because family offices are not required to report and register publicly, it is difficult to link them to observed transactions. Data on derivatives transactions rarely identify trades as being with family offices. According to EU data, exposures of family offices to derivatives appear to be quite

[105] Citi Private Bank (2022), *Family Office Survey Report*.

small (EUR 3.1 billion, including EUR 2.7 billion of equity swaps), while exposures to securities financing transactions seem insignificant. Derivative transactions in the UK involving a family office are hardly observable and are performed by a limited number of entities. In the United States, family offices engaging in securities financing and derivatives transactions are also difficult to observe, as family offices are not generally distinguished in available data and no comprehensive catalogue of family offices exists. However, the lack of information on these transactions does not necessary imply that the transactions are small in value, or that they are not conducted with major dealers and banks, as illustrated by the Archegos example.