

The Credit Line

CRE: Will this time be different? (Karoui/Viswanathan)

Why the narrative has shifted from inflation hedge to financial distress

For most of 2022, the commercial real estate (CRE) market was praised for its strong fundamentals and its ability to provide multi-asset portfolios a decent hedge against rising inflation risk. One quarter into the year, the narrative has turned much more negative. The rapid run-up in CRE valuations over the past two years has made the asset class vulnerable to a higher for longer funding cost environment. This vulnerability has been further exacerbated by the downward pressure on net operating income from declining rent growth and, in some cases, rising vacancy rates. All in all, this backdrop has left CRE borrowers exposed to a higher risk of a payment shock on their liabilities, more so than households and non-financial corporations.

Not all property types are created equal

A one-size-fits-all approach to the CRE market loses sight of important fundamental nuances between the various property types. Office has been the subject of high investor focus in recent months, and rightly so, in our view. Many of this segment's fundamental headwinds preceded last year's back-up in policy rates. Other property types, however, have more favorable dynamics at play. While multifamily fundamentals have weakened over the past 6 months, the significant growth in apartments' net operating income over the prior two years raises the bar for defaults. Similarly, industrial fundamentals remain strong.

Losses and contagion: Could this time be different?

While losses on commercial real estate loan portfolios can be large, the evidence from the last two decades shows that they typically follow a multiyear process. Whether the same pattern will prevail in this cycle is, however, up for debate. The good news is that the current headwinds facing the office property sector are not symptomatic of years of loose underwriting standards as was the case pre-S&L and global financial crises. The bad news is that relative to the last two decades, the office property sector has never been as oversupplied as it is today. Coupled with elevated funding costs, this reduces borrowers' incentives to extend and modify existing loans, potentially resulting in more front-loaded losses relative to previous cycles. While smaller banks are particularly vulnerable to such a scenario, the risk of a vicious cycle of large leveraged losses and undercapitalized balance sheets is

Lotfi Karoui
+1(917)343-1548 | lotfi.karoui@gs.com
Goldman Sachs & Co. LLC

Spencer Rogers, CFA
+1(801)884-1104 |
spencer.rogers@gs.com
Goldman Sachs & Co. LLC

Michael Puempel, Ph.D.
+1(212)357-8483 |
michael.puempel@gs.com
Goldman Sachs & Co. LLC

Sienna Mori
+1(212)902-6712 | sienna.mori@gs.com
Goldman Sachs & Co. LLC

Ben Shumway
+1(801)578-2553 |
ben.shumway@gs.com
Goldman Sachs & Co. LLC

Vinay Viswanathan
+1(212)934-0799 |
vinay.viswanathan@gs.com
Goldman Sachs & Co. LLC

nevertheless low, given healthier fundamentals in other CRE subsectors and strong capital positions among the large money center banks. That said, a potentially more front-loaded path for losses could constrain risk appetite in other spread products, given the overlap with the CRE investor base.

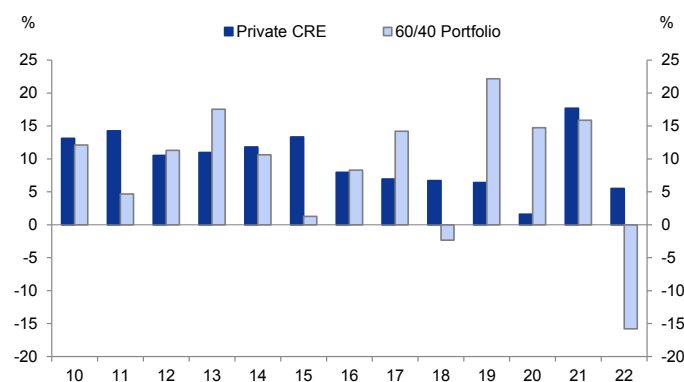
CRE: Will this time be different?

Why last year's friend has become this year's foe

Until a few months ago, the commercial real estate (CRE) market was praised for its strong fundamentals and its ability to provide multi-asset portfolios a decent hedge against rising inflation risk. As a real asset, higher CRE transaction prices are generally offset by higher rental income, driving a positive historical correlation between inflation and CRE total returns. This textbook pattern played out remarkably well in 2022, with the asset class proving to be a valuable source of diversification for multi-asset portfolios, delivering superior returns to public markets. Data collected from the National Council of Real Estate Investment Fiduciaries show CRE delivered a 5.5% total return in 2022; a significant outperformance when compared to the -15.8% vs. a 60%/40% portfolio that comprises the S&P 500 and the Bloomberg Agg index (Exhibit 1).

Exhibit 1: Private CRE vehicle outperformed the public fixed income and equity markets in 2022

Annual total returns for the NCREIF private real estate index vs. a 60%/40% portfolio that comprises the S&P 500 and the Bloomberg Agg indices

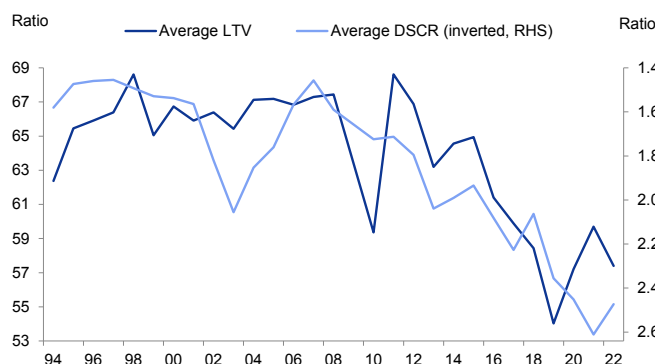


Source: Bloomberg, NCREIF, Goldman Sachs Global Investment Research

On the fundamental side, the market was also in a position of strength, at least relative to the run-up to the global financial crisis or the S&L crisis of the late 1980s. Owing to tighter underwriting standards, a tougher regulatory environment that introduced risk retention rules for CMBS issuers and affiliated parties, lower loan-to-value and higher debt service coverage ratios (Exhibit 2), credit quality notably improved in the decade that followed the aftermath of the global financial crisis. This fundamental strength has also kept delinquencies in benign territory. Using the universe of securitized commercial real estate loans in CMBS portfolios as a proxy, Exhibit 3 shows that delinquency rates have reverted to their pre-COVID lows in 2022. Granted, some of this fundamental strength mechanically reflected the tailwind from years of near-zero policy rates. Still, many of the lessons of the 2008/2009 episode appear to have been learned, especially as it pertains to underwriting standards.

Exhibit 2: Leverage on CMBS has fallen over the past decade while debt coverage has improved

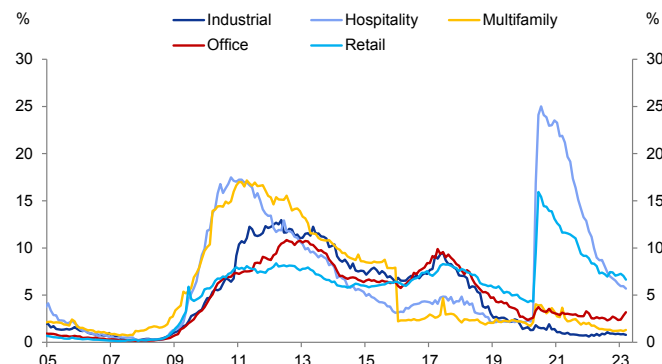
Average loan-to-value (LTV) and debt service coverage ratios (DSCR) on conduit commercial mortgage-backed securities (CMBS) by vintage year



Source: Trepp, Goldman Sachs Global Investment Research

Exhibit 3: Delinquencies remain in benign territory

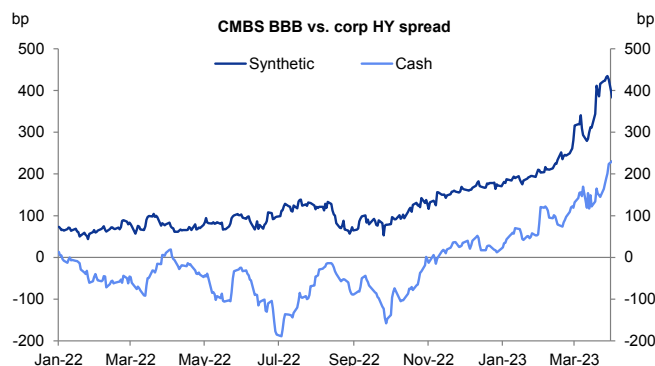
30-day delinquency rates on conduit commercial mortgage-backed securities (CMBS)



Source: Intex, Goldman Sachs Global Investment Research

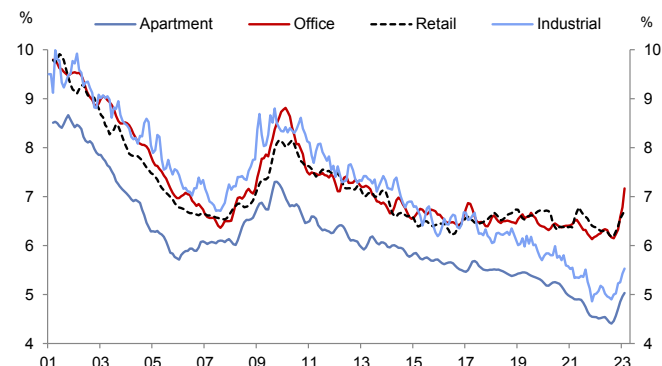
One quarter into the year, the narrative vis-à-vis the CRE market has turned much more negative (Exhibit 4). So why have the tides shifted so quickly? The rapid run-up in CRE valuations over the past two years has prompted many market participants to question the asset class's vulnerability to a higher for longer funding cost environment (Exhibit 5). Recent headlines about a few strategic defaults among office property landlords, coupled with growing downward pressure on net operating incomes (NOI) from declining rent growth and, in some cases, rising vacancy rates have further exacerbated these concerns. As we discussed a few months ago, CRE borrowers, more so than households and non-financial corporations, do face a higher risk of a payment shock on their liabilities, given the aggressiveness of this hiking cycle.

Exhibit 4: CMBS spreads have materially underperformed in recent weeks



Source: Bloomberg, Goldman Sachs Global Investment Research

Exhibit 5: The rapid run-up in CRE valuations over the past two years has many market participants questioning vulnerability to a higher for longer funding cost environment



Source: RCA, Goldman Sachs Global Investment Research

More specifically, three drivers make the transition to a higher funding cost environment more challenging in the CRE market:

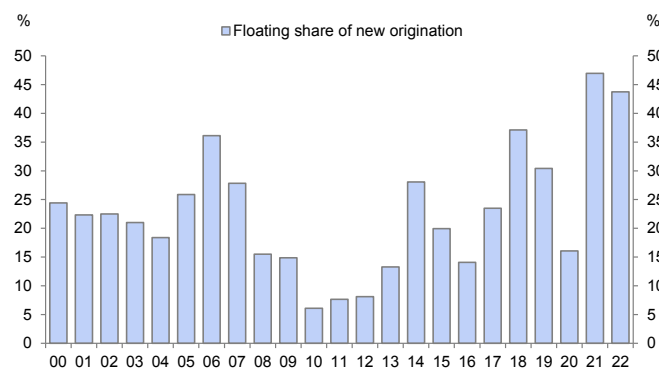
- First, although greater guardrails have been put in place to contain systemic risk, CRE borrowers have increased their exposure to floating rate liabilities over the past

few years. Using the universe of securitized commercial real estate loans in the CMBS market as a proxy, Exhibit 6 shows that the issuance of floating rate CRE loans has materially increased in recent years. While lenders often require floating rate loans to be paired with interest rate caps (tied to SOFR), borrowers are still exposed to higher rates up to the cap's strike. Perhaps more importantly, the duration of the cap is generally shorter than the duration of the mortgage at full extension, which means that hedges would need to be reset at a higher cost.

- Second, in addition to the borrowers' greater sensitivity to floating rate liabilities, near-term refinancing needs are also elevated. On our estimates, \$1.07 trillion worth of mortgage loans will come due before year-end 2024 (Exhibit 7). Unlike residential mortgages, which tend to be fully amortizing, commercial mortgages generally have balloon maturities. This means that barring a dovish pivot by the Fed in upcoming quarters, many borrowers will likely have to refinance their fixed rate loans at higher rates. And while the recent significant widening of CMBS spreads may incentivize borrowers to extend their mortgages, such a move would come at the detriment of resetting the strike of their SOFR cap higher. Coupled with the ongoing pressure on NOI growth, this will likely diminish the ability and willingness of borrowers' ability to refinance or extend loans, especially for beleaguered segments like mid- and low-tier Offices and brick-and-mortar Retail properties.
- Third, financing conditions are likely to further tighten, going forward. Banks play an instrumental role in facilitating CRE transactions. Through the end of 2022, the amount outstanding of commercial mortgage loans in the US stood at \$5.6 trillion. Over half of this stock sits directly on commercial bank balance sheets, with small banks capturing a much larger share than large banks (Exhibit 8). Small banks are particularly important to the CRE market: 70% of bank commercial mortgage holdings sit outside the top 25 largest banks (by assets). The potential for disruptions to US commercial real estate activity from a pullback in small bank credit availability is substantial, unaided by the fact that the segments most dependent on bank financing – offices and retail properties – are also facing the strongest risk of functional obsolescence. Outside of banks, the securitization market has also come under pressure, with the CMBS new issue pipeline drying up significantly. Year-to-date supply has declined materially vs. last year: -72% for conduit, -86% for single-asset/single-borrower, and -92% for CRE CLO.

Exhibit 6: The share of floating rate loans in CMBS portfolios has risen in recent years

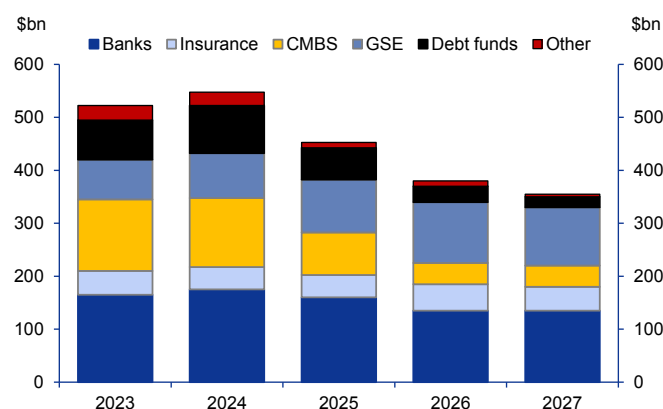
Floating rate mortgages as a share of CMBS issuance



Source: Trepp, Goldman Sachs Global Investment Research

Exhibit 7: Refinancing needs are elevated over the next two years

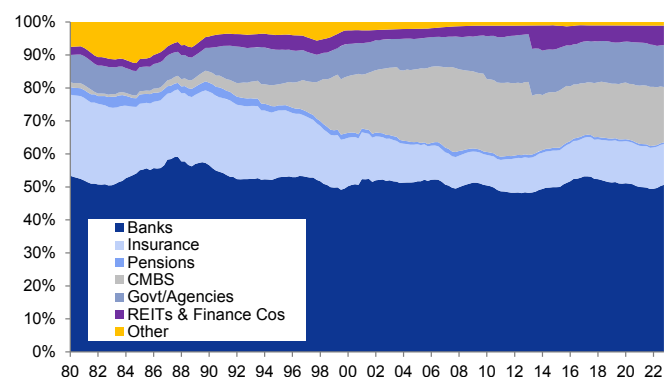
Annual maturity walls on CRE loans



Source: RCA, Goldman Sachs Global Investment Research

Exhibit 8: Over half of the CRE loans outstanding is owned by banks

Ownership structure of the CRE loan market



Source: Federal Reserve Board, Goldman Sachs Global Investment Research

Not all properties are created equal

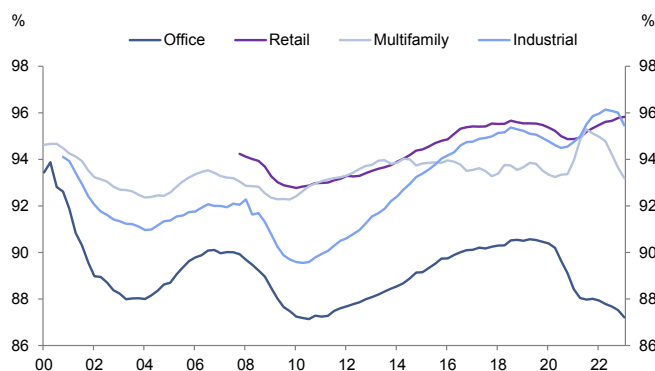
A one-size-fits-all approach to the CRE market loses sight of important fundamental nuances between the various property types, the largest being office, retail, multifamily, industrial, and lodging properties. Office has been the subject of high investor focus in recent months, and rightly so, in our view. The segment's fundamental headwinds preceded last year's increase in funding costs. As shown in Exhibit 9, occupancy rates in office properties have been declining over the last few quarters, more so than in other property types. Office utilization, a more precise measure of office attendance is also down 51% nationwide relative to the pre-COVID period, according to data collected from Kastle Systems. Data on lease absorptions, i.e., the amount of new lease inventory net of vacancies and non-renewed leases, is now deeply negative, which points to a weak demand backdrop (Exhibit 10). At the same time, rent growth has also been more mediocre than in other property types (Exhibit 11), putting downward pressure on NOI and fueling a 25% year-over-year decline in property values, according to appraisal estimates from Green Street, as well as an uptick in defaults.

Other property types have more favorable dynamics at play. Multifamily properties were a favored segment from 2020Q3 through 2022Q3 for three key factors. First, the post-GFC undersupply of housing benefited apartment property values. Second, the policy-induced shock to mortgage affordability made rental housing a more compelling option for many prospective homeowners. Third, the relatively short lease terms for apartments allowed landlords to pass higher costs through to rents as inflation ran hot. And while multifamily fundamentals have weakened over the past 6 months, as evidenced by weak absorption of new leases on the market, the significant growth in apartments' net operating income over the prior two years raises the bar for defaults. The main risk in our view is supply, particularly as new construction continues to accelerate, particularly in the Sun Belt region.

Retail properties entered the pandemic in a challenging position, as shifting consumer tastes and e-commerce were driving foot traffic away from traditional brick-and-mortar properties. While a retail default cycle has already materialized, particularly for regional malls, recent data suggests stabilization in vacancy rates and rent growth (again, Exhibits 9 and 11).

The lodging industry was similarly disrupted by the reduction in travel through the pandemic. While hotels tailored for business travel continue to struggle, many other types of hotels have seen a steady recovery in demand. Lastly, industrial properties (e.g., warehouse and logistics facilities) saw the strongest rent growth within commercial real estate. Industrial fundamentals remain strong given the lingering strength in industrial production, though the property type's cyclical nature could leave it more exposed to a growth shock.

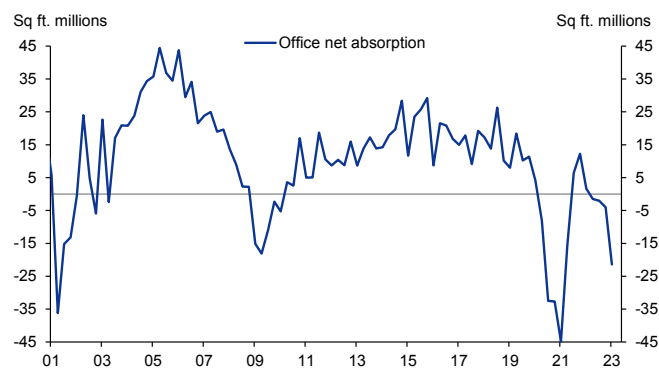
Exhibit 9: The decline in occupancy rates has been more pronounced for office vs. other types of properties



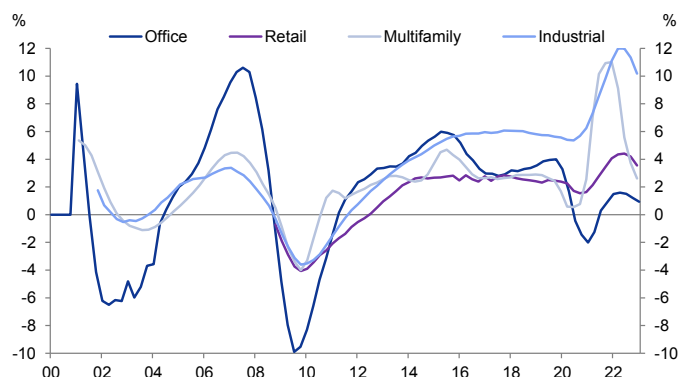
Source: CoStar, Goldman Sachs Global Investment Research

Exhibit 10: The trajectory of lease absorptions points to further spare capacity ahead for office properties

Office net lease absorptions are measured as the amount of new lease inventory net of vacancies and non-renewed leases



Source: CoStar, Goldman Sachs Global Investment Research

Exhibit 11: Rent growth has slowed down across the board

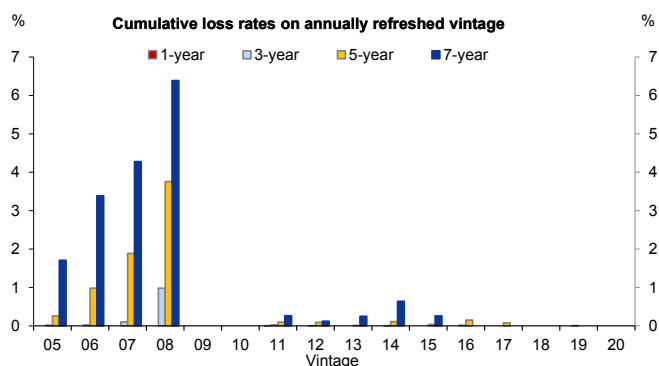
Source: CoStar, Goldman Sachs Global Investment Research

Losses: Typically, a slow burn but this time could be different

We expect delinquencies on office loans to materially increase from today's low levels, given rising interest expenses, elevated near-term refinancing needs, and declining occupancy rates, especially in the office property sector. However, the timing and the magnitude of losses stemming from delinquent CRE loans relative to previous cycles remains uncertain. The evidence from the last two decades shows while losses on commercial real estate loan portfolios can be large, they typically follow a multiyear process. Exhibit 12 shows that even following recessions, loss rates over a one-year period tend to stay muted, picking up only materially over longer horizons like 5 or 7 years. For example, losses on the 2007 and 2008 vintages of commercial loan mortgages started to accelerate almost four years later (Exhibit 13). This lag reflects the time-consuming nature of the process that takes place between the default event (i.e.: when a borrower stops servicing debt) and the collateral liquidation event (i.e.: when the collateral is liquidated). Often, borrowers and lenders are also incentivized to amend and extend the loans, which also spreads out the trajectory of losses over time.

Exhibit 12: Losses on CRE loans are typically a slow-motion process

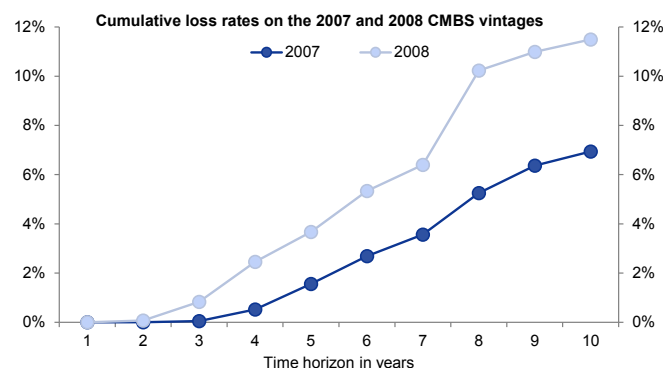
1, 3, 5, and 7-year cumulative loss rates on annually refreshed CMBS vintages



Source: Intex, Goldman Sachs Global Investment Research

Exhibit 13: Losses in the 2007 and 2008 vintages were large but played over a long timeframe

Cumulative loss rates on the 2007 and 2008 CMBS vintages



Source: Intex, Goldman Sachs Global Investment Research

Could this time be different? The good news is that the current headwinds facing the

office property sector are not symptomatic of years of loose underwriting standards as was the case in the run-up to the global financial crisis or prior to that in the late 1980s. Investors in CMBS 2.0 senior tranches also have higher loss subordination levels relative to the pre-global financial crisis period. All else equal, the higher credit quality of today's cohort of borrowers should provide a decent offset to the current long list of headwinds that are pressuring the sector. The bad news is that relative to the last two decades, the office property sector has never been as oversupplied as it is today (again Exhibit 10). As old leases expire, office landlords will likely be forced to lower rents and/or accept lower square footage from tenants, which will further pressure NOIs and create more spare capacity. The more this negative loop persists, the less incentivized borrowers are to extend and modify existing loans and the more incentivized they are to strategically default and look to liquidate their properties. Under the surface, the market will likely be bifurcated between class A/A+ properties that can still command strong NOIs, vs. class B and C which face the highest risk of obsolescence. For the lowest quality offices, the most compelling course of action may be repurposing for other usages.

Beyond losses on CRE loan portfolios, another key area of concern relates to potential contagion to other parts of credit markets. Banks have been in focus as a potential channel for contagion. Smaller banks are particularly vulnerable to losses, which will likely fuel more pressure on balance sheets and credit availability in the broader economy. That said, we think the risk of a vicious cycle of large leveraged losses and undercapitalized balance sheets that would pose a threat to financial stability is still limited, given healthier fundamentals in other CRE subsectors, strong capital positions among the large money center banks, and the ability of banks to curtail office exposure going forward. Profitability will likely be challenged but the risk of a systemic shock that would emanate from large banks is limited, in our view. That said, a more front-loaded profile for losses could (and likely will) constrain risk appetite in other spread products, given the overlap with the CRE investor base (again Exhibit 9).

Disclosure Appendix

Reg AC

We, Lotfi Karoui, Spencer Rogers, CFA, Michael Puempel, Ph.D., Sienna Mori, Ben Shumway and Vinay Viswanathan, hereby certify that all of the views expressed in this report accurately reflect our personal views, which have not been influenced by considerations of the firm's business or client relationships.

Unless otherwise stated, the individuals listed on the cover page of this report are analysts in Goldman Sachs' Global Investment Research division.

Disclosures

Regulatory disclosures

Disclosures required by United States laws and regulations

See company-specific regulatory disclosures above for any of the following disclosures required as to companies referred to in this report: manager or co-manager in a pending transaction; 1% or other ownership; compensation for certain services; types of client relationships; managed/co-managed public offerings in prior periods; directorships; for equity securities, market making and/or specialist role. Goldman Sachs trades or may trade as a principal in debt securities (or in related derivatives) of issuers discussed in this report.

The following are additional required disclosures: **Ownership and material conflicts of interest:** Goldman Sachs policy prohibits its analysts, professionals reporting to analysts and members of their households from owning securities of any company in the analyst's area of coverage.

Analyst compensation: Analysts are paid in part based on the profitability of Goldman Sachs, which includes investment banking revenues. **Analyst as officer or director:** Goldman Sachs policy generally prohibits its analysts, persons reporting to analysts or members of their households from serving as an officer, director or advisor of any company in the analyst's area of coverage. **Non-U.S. Analysts:** Non-U.S. analysts may not be associated persons of Goldman Sachs & Co. LLC and therefore may not be subject to FINRA Rule 2241 or FINRA Rule 2242 restrictions on communications with subject company, public appearances and trading securities held by the analysts.

Additional disclosures required under the laws and regulations of jurisdictions other than the United States

The following disclosures are those required by the jurisdiction indicated, except to the extent already made above pursuant to United States laws and regulations. **Australia:** Goldman Sachs Australia Pty Ltd and its affiliates are not authorised deposit-taking institutions (as that term is defined in the Banking Act 1959 (Cth)) in Australia and do not provide banking services, nor carry on a banking business, in Australia. This research, and any access to it, is intended only for "wholesale clients" within the meaning of the Australian Corporations Act, unless otherwise agreed by Goldman Sachs. In producing research reports, members of Global Investment Research of Goldman Sachs Australia may attend site visits and other meetings hosted by the companies and other entities which are the subject of its research reports. In some instances the costs of such site visits or meetings may be met in part or in whole by the issuers concerned if Goldman Sachs Australia considers it is appropriate and reasonable in the specific circumstances relating to the site visit or meeting. To the extent that the contents of this document contains any financial product advice, it is general advice only and has been prepared by Goldman Sachs without taking into account a client's objectives, financial situation or needs. A client should, before acting on any such advice, consider the appropriateness of the advice having regard to the client's own objectives, financial situation and needs. A copy of certain Goldman Sachs Australia and New Zealand disclosure of interests and a copy of Goldman Sachs' Australian Sell-Side Research Independence Policy Statement are available at: <https://www.goldmansachs.com/disclosures/australia-new-zealand/index.html>. **Brazil:** Disclosure information in relation to CVM Resolution n. 20 is available at <https://www.gs.com/worldwide/brazil/area/gir/index.html>. Where applicable, the Brazil-registered analyst primarily responsible for the content of this research report, as defined in Article 20 of CVM Resolution n. 20, is the first author named at the beginning of this report, unless indicated otherwise at the end of the text. **Canada:** This information is being provided to you for information purposes only and is not, and under no circumstances should be construed as, an advertisement, offering or solicitation by Goldman Sachs & Co. LLC for purchasers of securities in Canada to trade in any Canadian security. Goldman Sachs & Co. LLC is not registered as a dealer in any jurisdiction in Canada under applicable Canadian securities laws and generally is not permitted to trade in Canadian securities and may be prohibited from selling certain securities and products in certain jurisdictions in Canada. If you wish to trade in any Canadian securities or other products in Canada please contact Goldman Sachs Canada Inc., an affiliate of The Goldman Sachs Group Inc., or another registered Canadian dealer. **Hong Kong:** Further information on the securities of covered companies referred to in this research may be obtained on request from Goldman Sachs (Asia) L.L.C. **India:** Further information on the subject company or companies referred to in this research may be obtained from Goldman Sachs (India) Securities Private Limited, Research Analyst - SEBI Registration Number INH000001493, 951-A, Rational House, Appasaheb Marathe Marg, Prabhadevi, Mumbai 400 025, India, Corporate Identity Number U71414MH2006FTC160634, Phone +91 22 6616 9000, Fax +91 22 6616 9001. Goldman Sachs may beneficially own 1% or more of the securities (as such term is defined in clause 2 (h) the Indian Securities Contracts (Regulation) Act, 1956) of the subject company or companies referred to in this research report. **Japan:** See below. **Korea:** This research, and any access to it, is intended only for "professional investors" within the meaning of the Financial Services and Capital Markets Act, unless otherwise agreed by Goldman Sachs. Further information on the subject company or companies referred to in this research may be obtained from Goldman Sachs (Asia) L.L.C., Seoul Branch. **New Zealand:** Goldman Sachs New Zealand Limited and its affiliates are neither "registered banks" nor "deposit takers" (as defined in the Reserve Bank of New Zealand Act 1989) in New Zealand. This research, and any access to it, is intended for "wholesale clients" (as defined in the Financial Advisers Act 2008) unless otherwise agreed by Goldman Sachs. A copy of certain Goldman Sachs Australia and New Zealand disclosure of interests is available at: <https://www.goldmansachs.com/disclosures/australia-new-zealand/index.html>. **Russia:** Research reports distributed in the Russian Federation are not advertising as defined in the Russian legislation, but are information and analysis not having product promotion as their main purpose and do not provide appraisal within the meaning of the Russian legislation on appraisal activity. Research reports do not constitute a personalized investment recommendation as defined in Russian laws and regulations, are not addressed to a specific client, and are prepared without analyzing the financial circumstances, investment profiles or risk profiles of clients. Goldman Sachs assumes no responsibility for any investment decisions that may be taken by a client or any other person based on this research report. **Singapore:** Goldman Sachs (Singapore) Pte. (Company Number: 198602165W), which is regulated by the Monetary Authority of Singapore, accepts legal responsibility for this research, and should be contacted with respect to any matters arising from, or in connection with, this research. **Taiwan:** This material is for reference only and must not be reprinted without permission. Investors should carefully consider their own investment risk. Investment results are the responsibility of the individual investor. **United Kingdom:** Persons who would be categorized as retail clients in the United Kingdom, as such term is defined in the rules of the Financial Conduct Authority, should read this research in conjunction with prior Goldman Sachs research on the covered companies referred to herein and should refer to the risk warnings that have been sent to them by Goldman Sachs International. A copy of these risks warnings, and a glossary of certain financial terms used in this report, are available from Goldman Sachs International on request.

European Union and United Kingdom: Disclosure information in relation to Article 6 (2) of the European Commission Delegated Regulation (EU) (2016/958) supplementing Regulation (EU) No 596/2014 of the European Parliament and of the Council (including as that Delegated Regulation is implemented into United Kingdom domestic law and regulation following the United Kingdom's departure from the European Union and the European Economic Area) with regard to regulatory technical standards for the technical arrangements for objective presentation of investment

recommendations or other information recommending or suggesting an investment strategy and for disclosure of particular interests or indications of conflicts of interest is available at <https://www.gs.com/disclosures/europeanpolicy.html> which states the European Policy for Managing Conflicts of Interest in Connection with Investment Research.

Japan: Goldman Sachs Japan Co., Ltd. is a Financial Instrument Dealer registered with the Kanto Financial Bureau under registration number Kinsho 69, and a member of Japan Securities Dealers Association, Financial Futures Association of Japan Type II Financial Instruments Firms Association, The Investment Trusts Association, Japan, and Japan Investment Advisers Association. Sales and purchase of equities are subject to commission pre-determined with clients plus consumption tax. See company-specific disclosures as to any applicable disclosures required by Japanese stock exchanges, the Japanese Securities Dealers Association or the Japanese Securities Finance Company.

Global product; distributing entities

Goldman Sachs Global Investment Research produces and distributes research products for clients of Goldman Sachs on a global basis. Analysts based in Goldman Sachs offices around the world produce research on industries and companies, and research on macroeconomics, currencies, commodities and portfolio strategy. This research is disseminated in Australia by Goldman Sachs Australia Pty Ltd (ABN 21 006 797 897); in Brazil by Goldman Sachs do Brasil Corretora de Títulos e Valores Mobiliários S.A.; Public Communication Channel Goldman Sachs Brazil: 0800 727 5764 and / or contatogoldmanbrasil@gs.com. Available Weekdays (except holidays), from 9am to 6pm. Canal de Comunicação com o Público Goldman Sachs Brasil: 0800 727 5764 e/ou contatogoldmanbrasil@gs.com. Horário de funcionamento: segunda-feira à sexta-feira (exceto feriados), das 9h às 18h; in Canada by Goldman Sachs & Co. LLC; in Hong Kong by Goldman Sachs (Asia) L.L.C.; in India by Goldman Sachs (India) Securities Private Ltd.; in Japan by Goldman Sachs Japan Co., Ltd.; in the Republic of Korea by Goldman Sachs (Asia) L.L.C., Seoul Branch; in New Zealand by Goldman Sachs New Zealand Limited; in Russia by OOO Goldman Sachs; in Singapore by Goldman Sachs (Singapore) Pte. (Company Number: 198602165W); and in the United States of America by Goldman Sachs & Co. LLC. Goldman Sachs International has approved this research in connection with its distribution in the United Kingdom.

Goldman Sachs International ("GSI"), authorised by the Prudential Regulation Authority ("PRA") and regulated by the Financial Conduct Authority ("FCA") and the PRA, has approved this research in connection with its distribution in the United Kingdom.

European Economic Area: GSI, authorised by the PRA and regulated by the FCA and the PRA, disseminates research in the following jurisdictions within the European Economic Area: the Grand Duchy of Luxembourg, Italy, the Kingdom of Belgium, the Kingdom of Denmark, the Kingdom of Norway, the Republic of Finland and the Republic of Ireland; GSI - Succursale de Paris (Paris branch) which is authorised by the French Autorité de contrôle prudentiel et de résolution ("ACPR") and regulated by the Autorité de contrôle prudentiel et de résolution and the Autorité des marchés financiers ("AMF") disseminates research in France; GSI - Sucursal en España (Madrid branch) authorized in Spain by the Comisión Nacional del Mercado de Valores disseminates research in the Kingdom of Spain; GSI - Sweden Bankfilial (Stockholm branch) is authorized by the SFSA as a "third country branch" in accordance with Chapter 4, Section 4 of the Swedish Securities and Market Act (Sw. lag (2007:528) om värdepappersmarknaden) disseminates research in the Kingdom of Sweden; Goldman Sachs Bank Europe SE ("GSBE") is a credit institution incorporated in Germany and, within the Single Supervisory Mechanism, subject to direct prudential supervision by the European Central Bank and in other respects supervised by German Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, BaFin) and Deutsche Bundesbank and disseminates research in the Federal Republic of Germany and those jurisdictions within the European Economic Area where GSI is not authorised to disseminate research and additionally, GSBE, Copenhagen Branch filial af GSBE, Tyskland, supervised by the Danish Financial Authority disseminates research in the Kingdom of Denmark; GSBE - Sucursal en España (Madrid branch) subject (to a limited extent) to local supervision by the Bank of Spain disseminates research in the Kingdom of Spain; GSBE - Succursale Italia (Milan branch) to the relevant applicable extent, subject to local supervision by the Bank of Italy (Banca d'Italia) and the Italian Companies and Exchange Commission (Commissione Nazionale per le Società e la Borsa "Consob") disseminates research in Italy; GSBE - Succursale de Paris (Paris branch), supervised by the AMF and by the ACPR disseminates research in France; and GSBE - Sweden Bankfilial (Stockholm branch), to a limited extent, subject to local supervision by the Swedish Financial Supervisory Authority (Finansinspektionen) disseminates research in the Kingdom of Sweden.

General disclosures

This research is for our clients only. Other than disclosures relating to Goldman Sachs, this research is based on current public information that we consider reliable, but we do not represent it is accurate or complete, and it should not be relied on as such. The information, opinions, estimates and forecasts contained herein are as of the date hereof and are subject to change without prior notification. We seek to update our research as appropriate, but various regulations may prevent us from doing so. Other than certain industry reports published on a periodic basis, the large majority of reports are published at irregular intervals as appropriate in the analyst's judgment.

Goldman Sachs conducts a global full-service, integrated investment banking, investment management, and brokerage business. We have investment banking and other business relationships with a substantial percentage of the companies covered by Global Investment Research. Goldman Sachs & Co. LLC, the United States broker dealer, is a member of SIPC (<https://www.sipc.org>).

Our salespeople, traders, and other professionals may provide oral or written market commentary or trading strategies to our clients and principal trading desks that reflect opinions that are contrary to the opinions expressed in this research. Our asset management area, principal trading desks and investing businesses may make investment decisions that are inconsistent with the recommendations or views expressed in this research.

We and our affiliates, officers, directors, and employees will from time to time have long or short positions in, act as principal in, and buy or sell, the securities or derivatives, if any, referred to in this research, unless otherwise prohibited by regulation or Goldman Sachs policy.

The views attributed to third party presenters at Goldman Sachs arranged conferences, including individuals from other parts of Goldman Sachs, do not necessarily reflect those of Global Investment Research and are not an official view of Goldman Sachs.

Any third party referenced herein, including any salespeople, traders and other professionals or members of their household, may have positions in the products mentioned that are inconsistent with the views expressed by analysts named in this report.

This research is focused on investment themes across markets, industries and sectors. It does not attempt to distinguish between the prospects or performance of, or provide analysis of, individual companies within any industry or sector we describe.

Any trading recommendation in this research relating to an equity or credit security or securities within an industry or sector is reflective of the investment theme being discussed and is not a recommendation of any such security in isolation.

This research is not an offer to sell or the solicitation of an offer to buy any security in any jurisdiction where such an offer or solicitation would be illegal. It does not constitute a personal recommendation or take into account the particular investment objectives, financial situations, or needs of individual clients. Clients should consider whether any advice or recommendation in this research is suitable for their particular circumstances and, if appropriate, seek professional advice, including tax advice. The price and value of investments referred to in this research and the income from them may fluctuate. Past performance is not a guide to future performance, future returns are not guaranteed, and a loss of original capital may occur. Fluctuations in exchange rates could have adverse effects on the value or price of, or income derived from, certain investments.

Certain transactions, including those involving futures, options, and other derivatives, give rise to substantial risk and are not suitable for all investors.

Investors should review current options and futures disclosure documents which are available from Goldman Sachs sales representatives or at <https://www.theocc.com/about/publications/character-risks.jsp> and https://www.fiadocumentation.org/fia/regulatory-disclosures_1/fia-uniform-futures-and-options-on-futures-risk-disclosures-booklet-pdf-version-2018. Transaction costs may be significant in option strategies calling for multiple purchase and sales of options such as spreads. Supporting documentation will be supplied upon request.

Differing Levels of Service provided by Global Investment Research: The level and types of services provided to you by Goldman Sachs Global Investment Research may vary as compared to that provided to internal and other external clients of GS, depending on various factors including your individual preferences as to the frequency and manner of receiving communication, your risk profile and investment focus and perspective (e.g., marketwide, sector specific, long term, short term), the size and scope of your overall client relationship with GS, and legal and regulatory constraints. As an example, certain clients may request to receive notifications when research on specific securities is published, and certain clients may request that specific data underlying analysts' fundamental analysis available on our internal client websites be delivered to them electronically through data feeds or otherwise. No change to an analyst's fundamental research views (e.g., ratings, price targets, or material changes to earnings estimates for equity securities), will be communicated to any client prior to inclusion of such information in a research report broadly disseminated through electronic publication to our internal client websites or through other means, as necessary, to all clients who are entitled to receive such reports.

All research reports are disseminated and available to all clients simultaneously through electronic publication to our internal client websites. Not all research content is redistributed to our clients or available to third-party aggregators, nor is Goldman Sachs responsible for the redistribution of our research by third party aggregators. For research, models or other data related to one or more securities, markets or asset classes (including related services) that may be available to you, please contact your GS representative or go to <https://research.gs.com>.

Disclosure information is also available at <https://www.gs.com/research/hedge.html> or from Research Compliance, 200 West Street, New York, NY 10282.

© 2023 Goldman Sachs.

No part of this material may be (i) copied, photocopied or duplicated in any form by any means or (ii) redistributed without the prior written consent of The Goldman Sachs Group, Inc.