Oil Analyst

A Pessimistic Oil Market

- Following the 15% selloff in oil prices over the last 3 weeks, forward prices now look unusually low relative to consensus and our own forecasts. We analyze the selloff, the implications of the large gap between consensus expectations and forwards, and the risks to our unchanged constructive Brent forecast.
- We argue that near-term demand fears—related to US banking stress, China industrial weakness, and falling diesel margins—and financial amplification effects have driven the bulk of the recent selloff. Headlines about elevated oil supply in Russia and Iran, and fears of limited OPEC compliance to cuts have likely weighed on oil prices too, though we see these concerns as overblown. Statistically, we find that US banking stress and the OPEC cut together explain much of the daily price action over the last couple of months.
- Today's 29% gap between 12-months ahead Brent consensus expectations and the forwards ranks in the 98rd percentile vs. history. We find that future spot prices tend to end up significantly above forwards-implied levels when the consensus is above the forwards. A model using today's gap suggests that spot prices in 12 months will end up 16% above today's 12-month forwards outside a US recession, but 4% below in recession.
- Our forecast remains that Brent rises to $95/bbl by December and $100/bbl by April 2024 as we expect large deficits in H2. While above-average DM recession risk and our China oil demand nowcast point to downside risk, we still expect rising EM demand to drive ¾ of the swing from the Q1 surplus to H2 deficits averaging 1½mb/d. The risks to our view that global supply edges down in H2 are two-sided with upside risks from Russia and Iran, but downside risks from potential additional OPEC cuts in H2 if oil prices were to not rise from here.

Daan Struyven
+1(212)357-4172 |
daan.struyven@gs.com
Goldman Sachs & Co. LLC

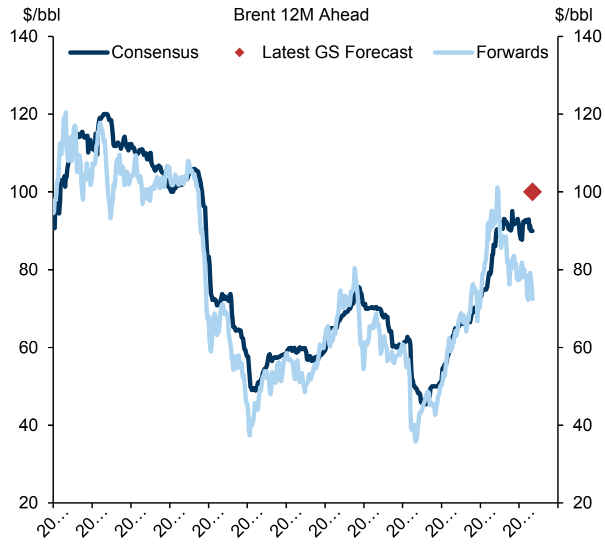
Romain Langlois
+1(212)357-6395 |
romain.langlois@gs.com
Goldman Sachs & Co. LLC

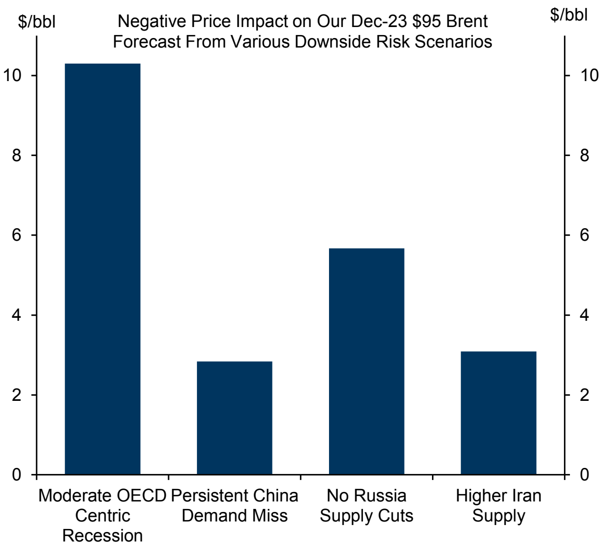
Callum Bruce, CFA
+1(212)902-3053 | callum.bruce@gs.com
Goldman Sachs & Co. LLC

Yulia Zhestkova Grigsby
+1(646)446-3905 | yulia.grigsby@gs.com
Goldman Sachs & Co. LLC

Jeffrey Currie
+44(20)7552-7410 |
jeffrey.currie@gs.com
Goldman Sachs International

The Large Gap Between Consensus Expectations and Forwards Points to a Pessimistic Market Pricing Several Downside Risks



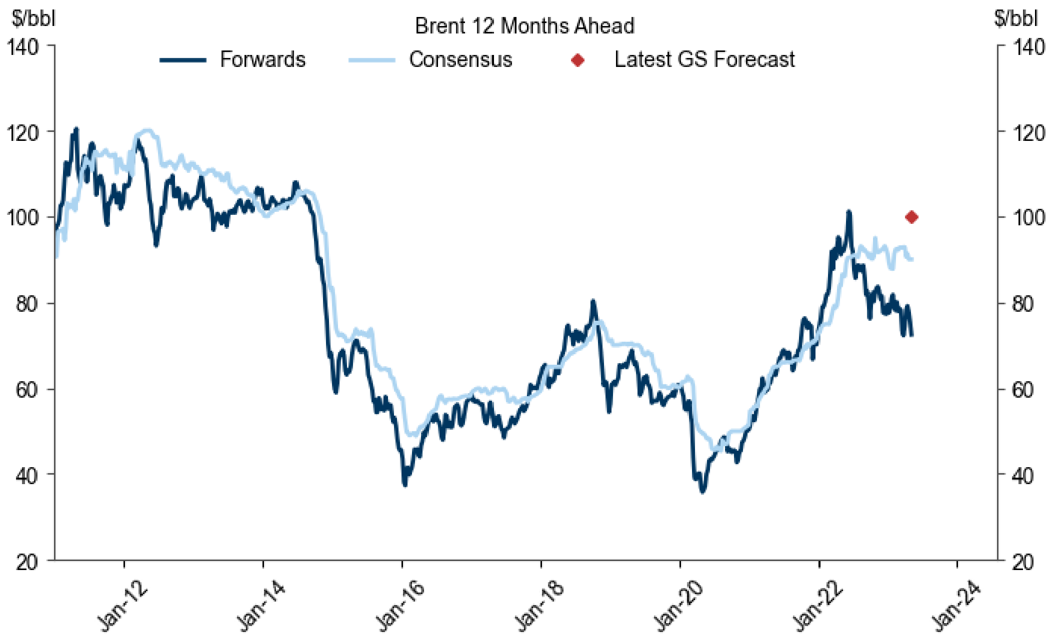


Source: Bloomberg, Goldman Sachs Global Investment Research

A Pessimistic Oil Market

Although Brent oil prices recovered modestly on Friday to $75/bbl, they remain 15% lower than 3 weeks ago. Forward prices now look unusually low compared to analysts' consensus expectations that Brent spot prices will recover to $90/bbl in 12 months, and to our own $100/bbl forecast (Exhibit 1). We analyze the drivers of selloff, the implications of this large gap between consensus expectations and forwards, and the downside risks to our unchanged constructive Brent forecast.

Exhibit 1: Oil Forwards Now Look Unusually Low Compared to Consensus Expectations



Source: Bloomberg, Goldman Sachs Global Investment Research

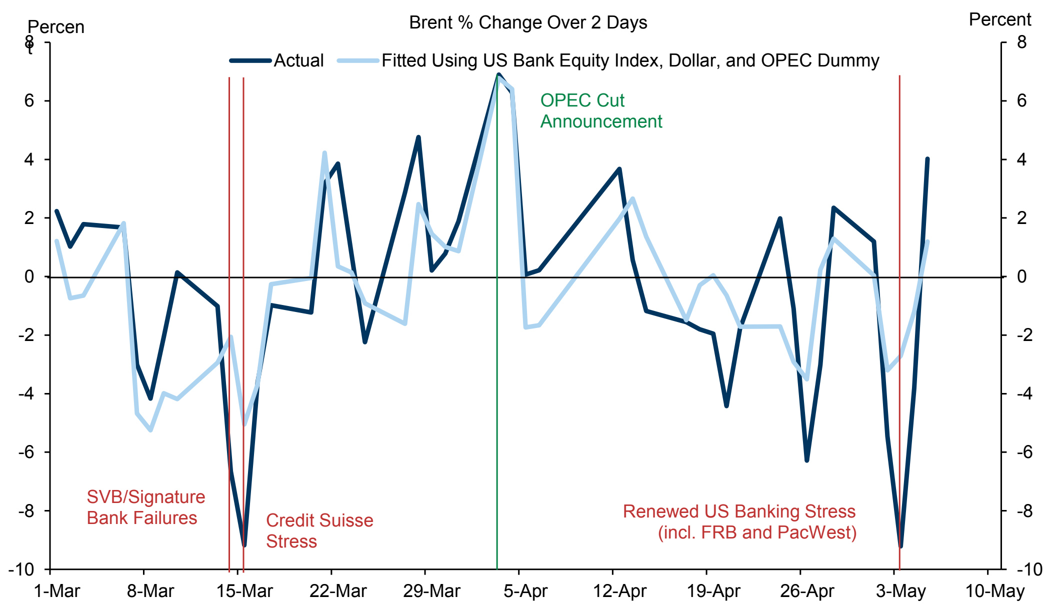
A Mostly Macro-Financial Selloff

We argue that the sharp selloff over the past 3 weeks reflects: (1) mostly recessionary fears about demand, (2) financial amplification effects, and (3) headlines about elevated oil supply in Russia, Iran, and other OPEC countries.

The substantial weakening in near-dated timespreads, our statistical analysis, and conversations with investors all suggest that near-term recessionary fears have driven much of the recent selloff.

The sharpest oil price drops have coincided with rising fears that regional banking stress will push the US in recession. Statistically, we find that US banking stress—proxied using US bank equity prices—and the OPEC cut announcement together explain much of the daily Brent price action over the last couple of months (Exhibit 2).[1] In addition to US banking stress and US debt ceiling risks, weakness in Chinese industrial data, and falling distillate cracks are also fueling concerns about demand (Exhibit 3).

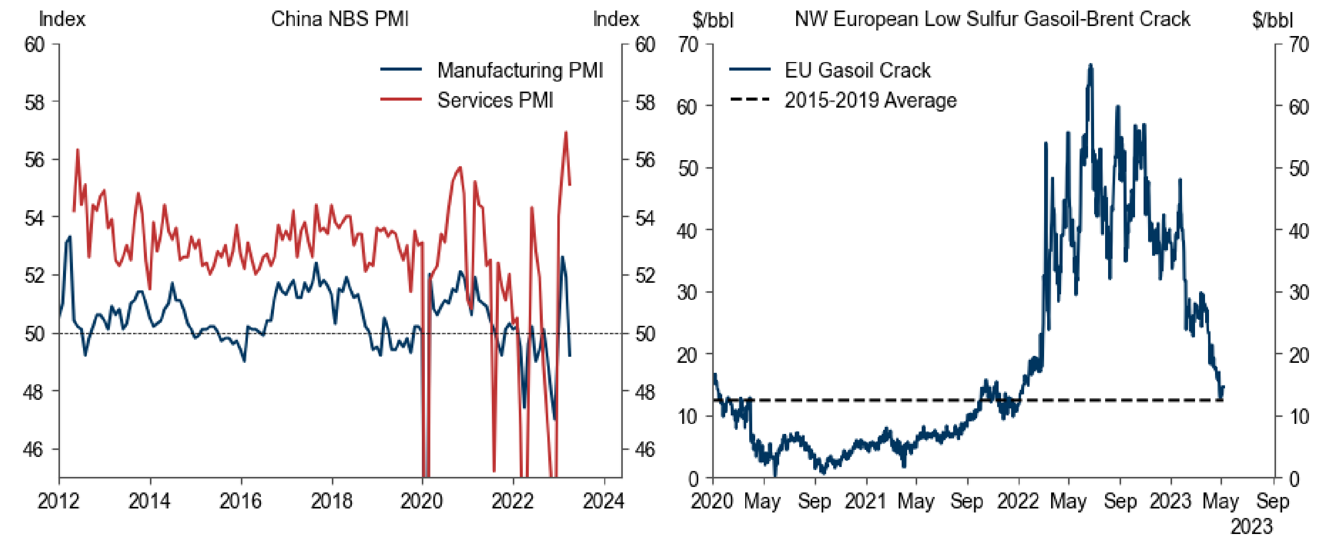
Exhibit 2: Rising Concerns About US Banks and Falling Oil Prices



Source: Bloomberg, Haver Analytics, Goldman Sachs Global Investment Research

[1] We see some analogies with the tug of war in 2010-2012 between relatively tight fundamentals and European recession risk, where fundamentals eventually prevailed.

Exhibit 3: Demand Concerns on Weak China Manufacturing Data and Falling Distillate Cracks



Source: Bloomberg, Haver Analytics, Goldman Sachs Global Investment Research

We don't think that US regional banking stress, weak China industrial data, and falling distillate cracks are harbingers for contractions in GDP or global oil demand.

Our economists see only a ¼ – ½pp growth hit from bank stress as large banks remain healthy, and Friday's data confirmed US job growth remains strong. While global industrial activity is weak, the PMIs also suggest that services activity is still expanding very rapidly in China and fairly rapidly elsewhere. Finally, we estimate that c.2/3 of the $25/bbl sell-off in European distillate cracks since January reflects factors other than demand, including 1) excessively high prices ahead of the EU Russian product embargo, 2) significant refining additions, and 3) lower-than-expected gas prices and clean tanker freight rates.

We also believe that low liquidity, the interaction of negative gamma effects in options markets and banking-stress[2], and trend-following algorithms have amplified the downward price pressure from selling by investors expecting recession. Liquidity was low at the start of last week following holidays in Asia and Europe, and the exodus of several bullish speculators following challenging recent performance.

While outsized responses to macro fears explain the bulk of the selloff, headlines about elevated oil supply in Russia and Iran, and fears about limited OPEC compliance have likely weighed on oil prices too, though we see these concerns as overblown.

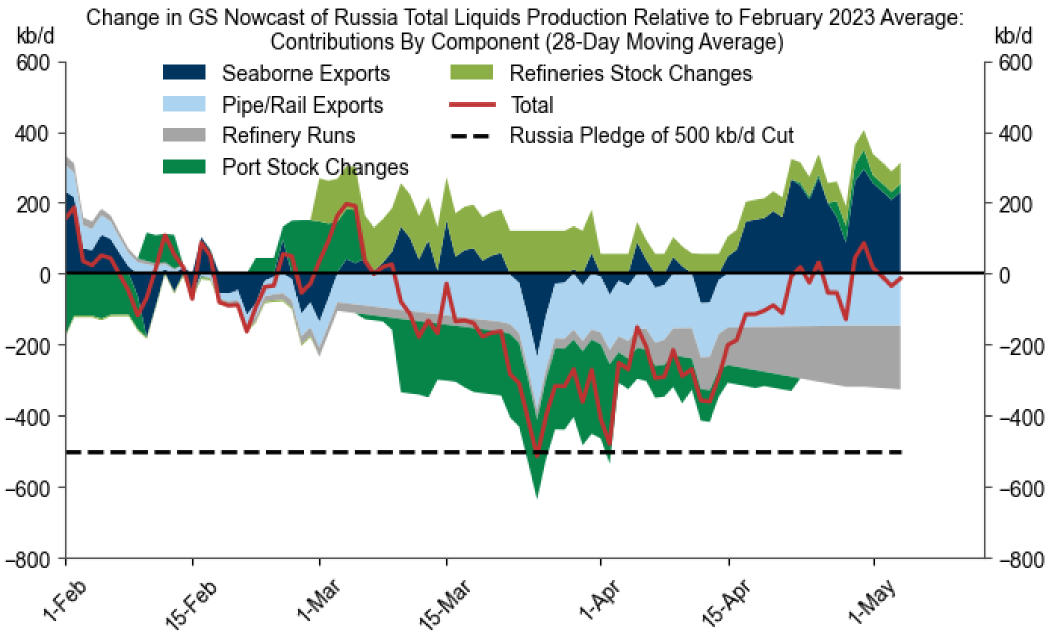
As Exhibit 4 shows, our nowcast suggests that Russia produced around 11.1mb/d of total liquids in April, about 400k/d above our forecast that Russia would fully implement its pledge to cut production by 500kb/d from February levels. While markets appear

[2] Negative gamma effects are amplification effects resulting from producer hedging flows. Hedging often takes the form of put options, where market-making banks are short puts (i.e. long oil), and delta-hedge their exposure via futures. As prices fall, the put options move more in-the-money, leaving banks under-hedged unless they sell more futures. This leads to increasing selling of futures as prices decline, reinforcing the selloff.

focused on the salient rise in seaborne crude exports, especially to India, refinery runs and pipeline exports have fallen since February.

We, do, however suspect our nowcast overstates actual Russia production for three reasons. First, industry-level data reported by Bloomberg suggest that refinery runs have now declined by around 200kb/d more than implied by our Petrologistics and IIR data due to seasonal maintenance. Second, Bloomberg has also reported a rise in the share of idled and shut-in wells to 18.1% in March, a record high since May 2022. Third, Russia may be shipping oil from underground storage which our measures of stocks in refineries and ports don't capture.

Exhibit 4: While Our Nowcast Offers No Evidence of Russia Production Cuts; We Suspect That Actual Production Has Fallen



We do not display NGLs on the chart as there were no changes in our assumed NGL production over the period.

Source: Petro-Logistics, Kpler, Industrial Info Resources, IEA, Goldman Sachs Global Investment Research

Turning to Iran, its oil minister said on Tuesday that crude oil production has reached above 3mb/d per day over the last 20 months, 250kd/above our standing 2.75mb/d forecast. Our estimation using seaborne exports suggests production jumped late last year, and has now moderated to 2.85mb/d, implying some upside risk.

Finally, a pick-up in gross exports by core OPEC countries in March and April has led to fears of limited compliance to production cuts. However, the more stable level of net exports—reflecting the large rise in imports of cheaper Russian oil—supports our view that OPEC producers will largely implement the voluntary cuts announced in April.

Mind the Gap

Following this mostly macro-financial driven selloff, forward prices now look unusually low compared to analysts' consensus expectations (Exhibit 1). In fact, today's 29% gap between 12-months ahead Brent consensus expectations (90$/bbl) and the forwards (70$/bbl) ranks in the 98rd percentile vs. history. What tends to happen to spot prices historically when the consensus is much more optimistic than the forwards?

To find out, we regress the gap between realized spot prices 12 months ahead and the forwards on the gap between 12-months ahead consensus expectations and the forwards. We express both gaps as % of the forwards, and include a constant.[3] To be clear, we don't assume that forwards are unbiased predictors of expected future spot prices.[4] Instead, we ask whether large gaps between consensus and the forwards predict larger-than-usual gaps between future spot prices and the forwards.

We find that, on average[5]:

1. Spot prices realize 4% above the consensus, and 7% above the 12-month forwards, consistent with a positive risk premium.
2. Spot prices end up significantly above forwards-implied levels when the consensus is above the forwards. Specifically, every 10% gap between the consensus and the forwards implies an additional 3% outperformance of spot versus the forwards (on top of the 6% outperformance when consensus and forwards are in line).
3. The predictive content of the consensus diminishes as the forecast horizon shortens, and disappears when the US economy ends up in recession.

What are the implications of this simple model for today's outlook? The model suggests that spot prices in May 2023 will end up 16% above today's 12-month forwards outside a US recession at 81$/bbl, but only 4% below at 67$/bbl in case of recession (Exhibit 5).

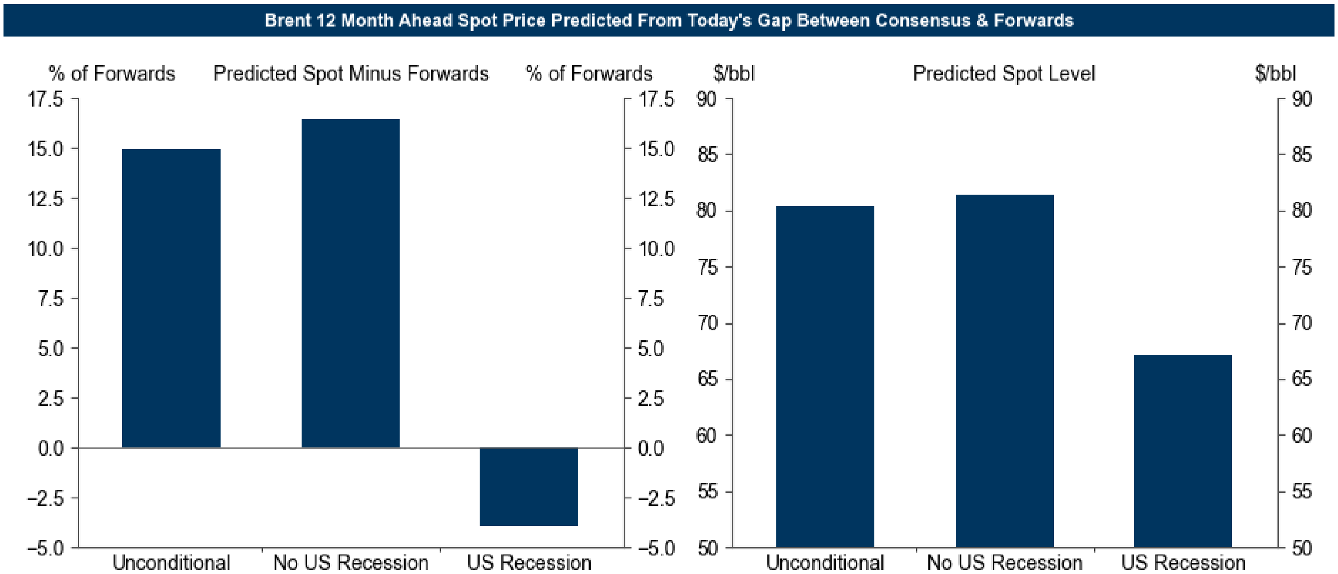
---

3 Our sample consists of weekly data from June 2006 to April 2023.

4 In principle, expected future spot prices should equal the forwards plus the positive risk premium because oil demand and oil prices co-vary positively with the overall economy. Intuitively, holding oil entails risk, and, as a reward for that risk, investors will expect the spot price to rise above the current forward price.

5 We also find that, on average, spot prices are modestly above the forwards, consistent with a positive marginal convenience yield (net of storage), and the need to incentivize production (rather than sitting on in-ground reserves which is equivalent to owning a call option with an exercise price equal to the extraction cost and the payoff equal to the spot price).

Exhibit 5: Today's Large Gap Between Consensus and the Forwards Suggests Spot Prices Will Likely End Up Well Above the Forwards



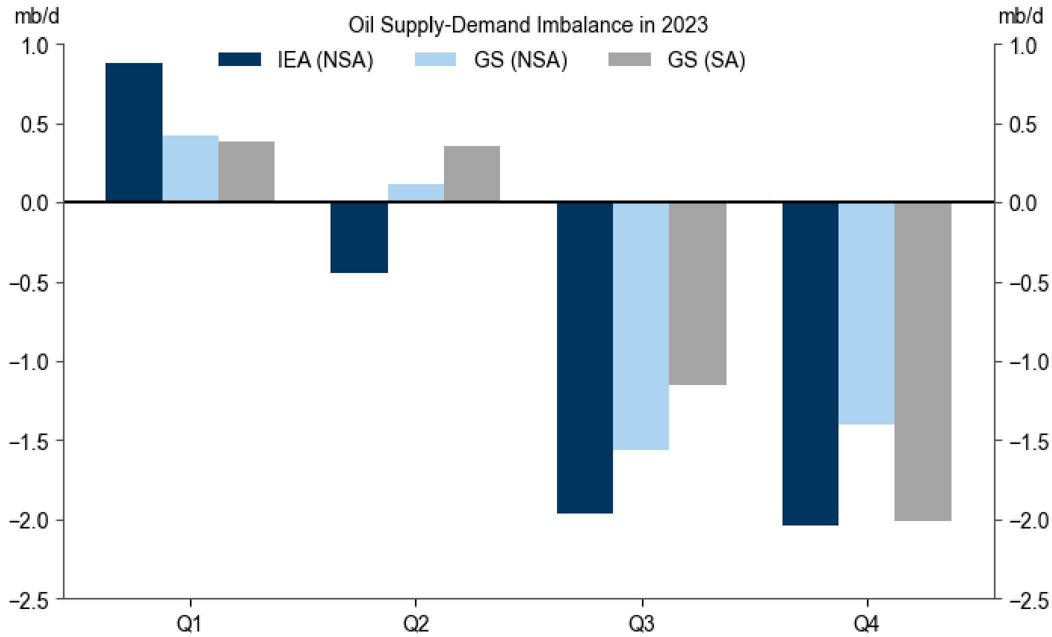
Source: Bloomberg, Haver Analytics, Goldman Sachs Global Investment Research

Some Downside Risks

We conclude by discussing why we and the consensus are more constructive on the price outlook than the forwards, and discussing the risks to our forecast that Brent rises to $95/bbl by December and $100/bbl by April 2024.

The main driver of our constructive forecast is the expected return to large and sustained deficits from June onwards, leading to inventory draws, and firming timespreads. As Exhibit 6 shows, we expect large deficits averaging 1.5mb/d in H2, and the IEA expects an even larger deficit averaging 2.0mb/d.

Exhibit 6: We Expect Deficits to Average 1.5mb/d in H2



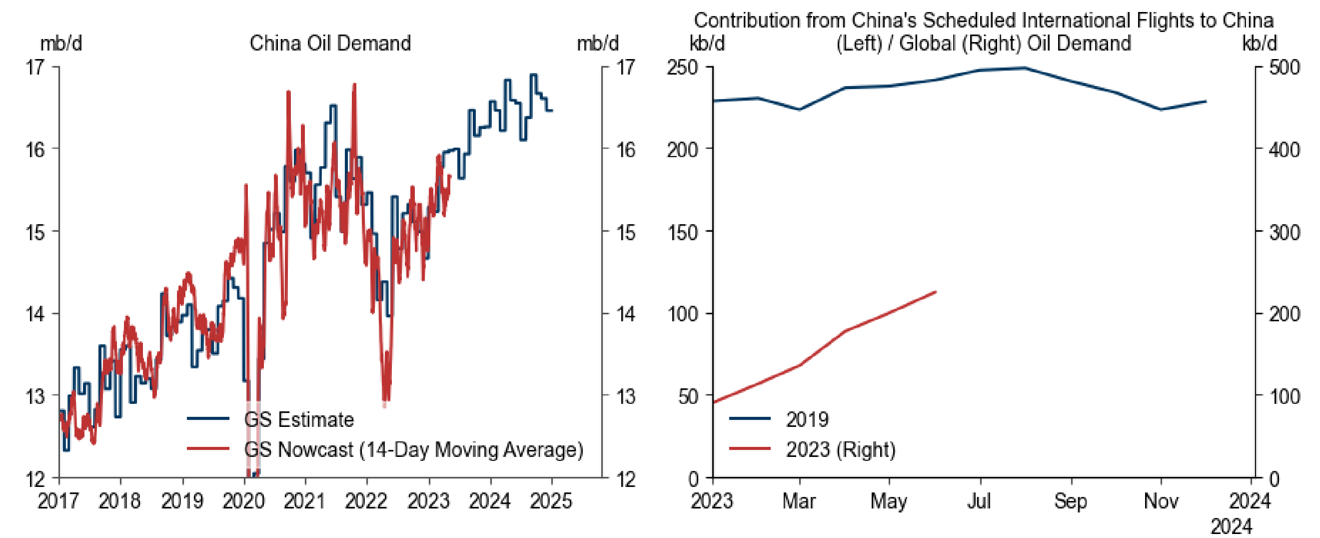
Source: IEA, Goldman Sachs Global Investment Research

Further rises in EM demand and OPEC cuts are the two key pillars behind our call for H2 deficits.

We expect rising EM demand to drive ¾ of the 2mb/d swing from a moderate surplus in Q1 to sizable deficits in H2. Although our China oil demand nowcast of 15.8mb/d is modestly below our 16mb/d April forecast, we expect China oil demand to rise further. The key reasons include strong May services PMIs and travel data, substantial remaining room for growth in the services sector—especially for international travel—, and policymakers' emphasis on the importance of services consumption such as tourism (Exhibit 7).

We also continue expect a nearly 90% implementation rate for the 1.16mb/d announced cut to OPEC+ ex Russia production. The reason is that the countries which announced an additional cut have a strong compliance track record, and had implemented nearly 90% of the October 2022 cut by January 2023.

Exhibit 7: Room for Growth in International Travel and Jet Fuel Demand

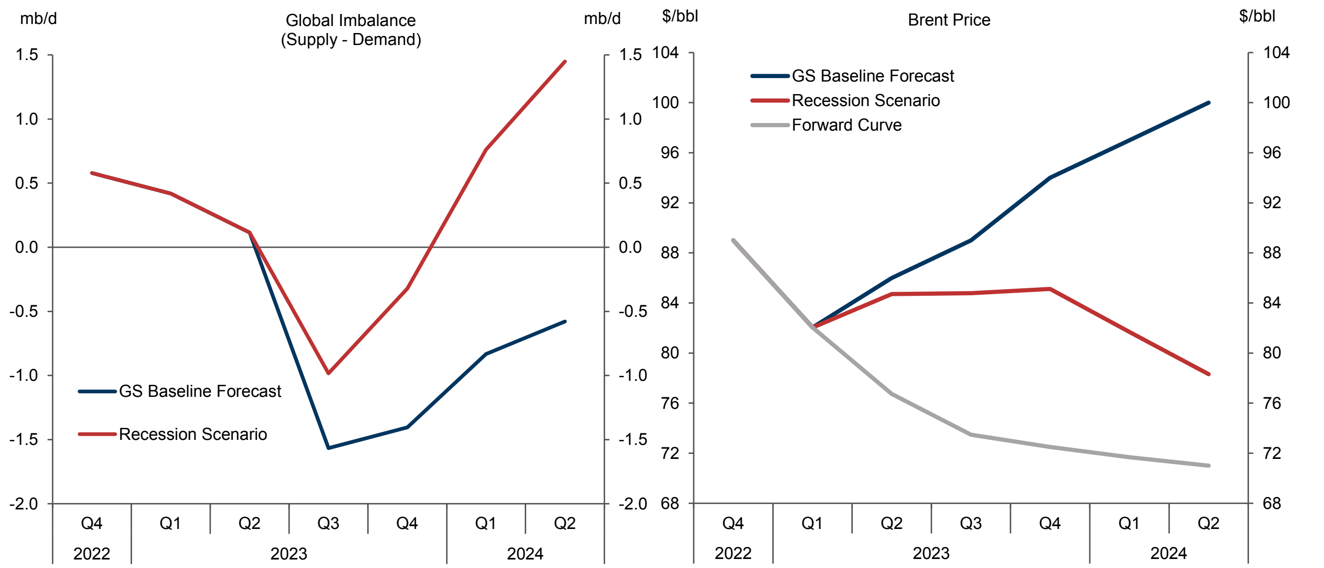


Source: ICIS, OilChem, OAG, Jodi, IEA, Bloomberg, Kpler, Goldman Sachs Global Investment Research

We next quantify the four main sources of downside risk to our December $95/bbl forecast:

- **Moderate OECD-centric recession (-$10/bbl):** This scenario assumes a moderate OECD recession starting in 2023Q3, lasting 4 quarters. It assumes a peak 4% hit to the level of GDP (relative to the GS baseline), which is slightly more moderate than the median historical recession in G10 economies, and modest spillovers to non-OECD economies. While the eventual hit to 2024Q2 prices relative to our baseline is sizable at -$22/bbl, the hit implied by our demand and pricing models to December 2023 prices is much smaller at just $10/bbl. The key reason is that spot oil markets generally price the near-term outlook for inventories, which only reach high levels after multiple quarters of demand damage. Exhibit 8 also suggests that oil markets are pricing an even more negative GDP outlook than this moderate recession (assuming the market shares our views on supply).

Exhibit 8: A Moderate OECD-Centric Recession Would Lower Brent Prices Eventually by $22/bbl

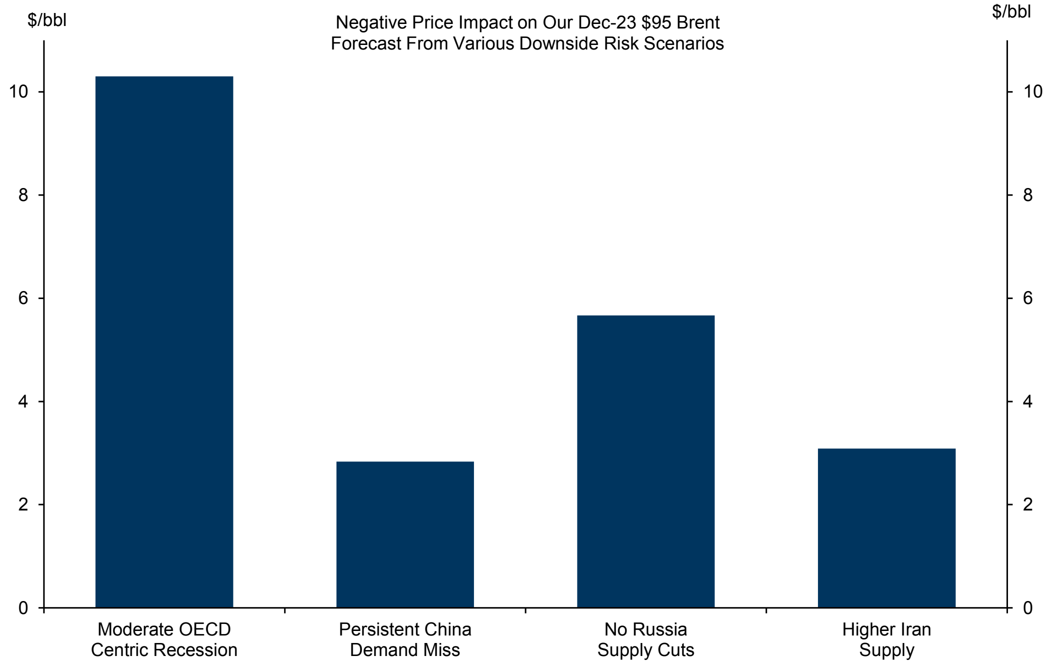


Source: Haver Analytics, Goldman Sachs Global Investment Research

- **Persistent China demand miss (-$3/bbl):** This scenario assumes that the 250kb/d miss on our China April demand forecast implied by the nowcast monthly average persists, and implies $3/bbl of downside risk to our December 2023 forecast.
- **No Russia supply cuts (-$6/bbl):** This scenario assumes that Russia keeps total liquids production flat at its February level of 11.2mb/d, and implies $6/bbl of downside risk. Our central assumption remains that Russia cuts production, largely in the context of OPEC+ coordination.
- **Higher Iran supply (-$3/bbl):** This scenario assumes that Iran production exceeds our forecast by $250kb/d from March onwards, and implies $3/bbl of downside risk.

Taken together, our analysis suggests that the forwards are broadly consistent with the market pricing in all these four downside risk scenarios together (assuming the market has the same view on the rest of the balances), without any additional OPEC cut. That seems too pessimistic too us.

Exhibit 9: Some Downside Risk To Our Constructive Brent Forecast



Source: Goldman Sachs Global Investment Research

While the market appears too pessimistic, above-average OECD recession risk does skew the risks to our demand assumptions to the downside, on net. The risks to our view that global supply edges down in H2 are two-sided with upside risks from Russia and Iran, but downside risks from potential additional OPEC cuts in H2, and any potential geopolitical disruptions.

We suspect that OPEC likely first wants to observe the impact of its fresh production cuts over the next couple of months, including at the June 4th Joint Ministerial Monitoring Committee (JMMC). However, elevated OPEC pricing power should allow the group to deliver broader or additional cuts if oil prices were to remain around or below current levels in H2.

Daan Struyven

Romain Langlois

Disclosure Appendix

Reg AC

We, Daan Struyven, Romain Langlois, Callum Bruce, CFA, Yulia Zhestkova Grigsby and Jeffrey Currie, 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

Option Specific Disclosures

Price target methodology: Please refer to the analyst's previously published research for methodology and risks associated with equity price targets.

Pricing Disclosure: Option prices and volatility levels in this note are indicative only, and are based on our estimates of recent mid-market levels(unless otherwise noted). All prices and levels exclude transaction costs unless otherwise stated.

General Options Risks – The risks below and any other options risks mentioned in this research report pertain both to specific derivative trade recommendations mentioned and to discussion of general opportunities and advantages of derivative strategies. Unless otherwise noted, options strategies mentioned in this report may be a combination of the strategies below and therefore carry with them the risks of those strategies.

Buying Options - Investors who buy call (put) options risk loss of the entire premium paid if the underlying security finishes below (above) the strike price at expiration. Investors who buy call or put spreads also risk a maximum loss of the premium paid. The maximum gain on a long call or put spread is the difference between the strike prices, less the premium paid.

Selling Options - Investors who sell calls on securities they do not own risk unlimited loss of the security price less the strike price. Investors who sell covered calls (sell calls while owning the underlying security) risk having to deliver the underlying security or pay the difference between the security price and the strike price, depending on whether the option is settled by physical delivery or cash-settled. Investors who sell puts risk loss of the strike price less the premium received for selling the put. Investors who sell put or call spreads risk a maximum loss of the difference between the strikes less the premium received, while their maximum gain is the premium received.

For options settled by physical delivery, the above risks assume the options buyer or seller, buys or sells the resulting securities at the settlement price on expiry.

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 U74140MH2006FTC160634, 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 resolution ("ACPR") and regulated by the Autorité de contrôle prudentiel et de resolution and the Autorité des marches 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 (Finansinpektionen) 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.