Goldman Sachs | Commodities Research

29 October 2024 | 8:11PM GMT

Precious Analyst

The FIS-ical Drivers of Our Bullish Gold Forecast

Lina Thomas
+44(20)7051-3062 | lina.thomas@gs.com
Goldman Sachs International

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

- As the gold price keeps breaking records, we formalize our gold pricing framework, and flesh out the drivers of our bullish forecast that gold will rise about 10% to $3,000 by December 2025. Our FIS-ical model explains monthly price changes well by summing up physical gold demand from Financial and monetary authorities, Investors and Speculators.

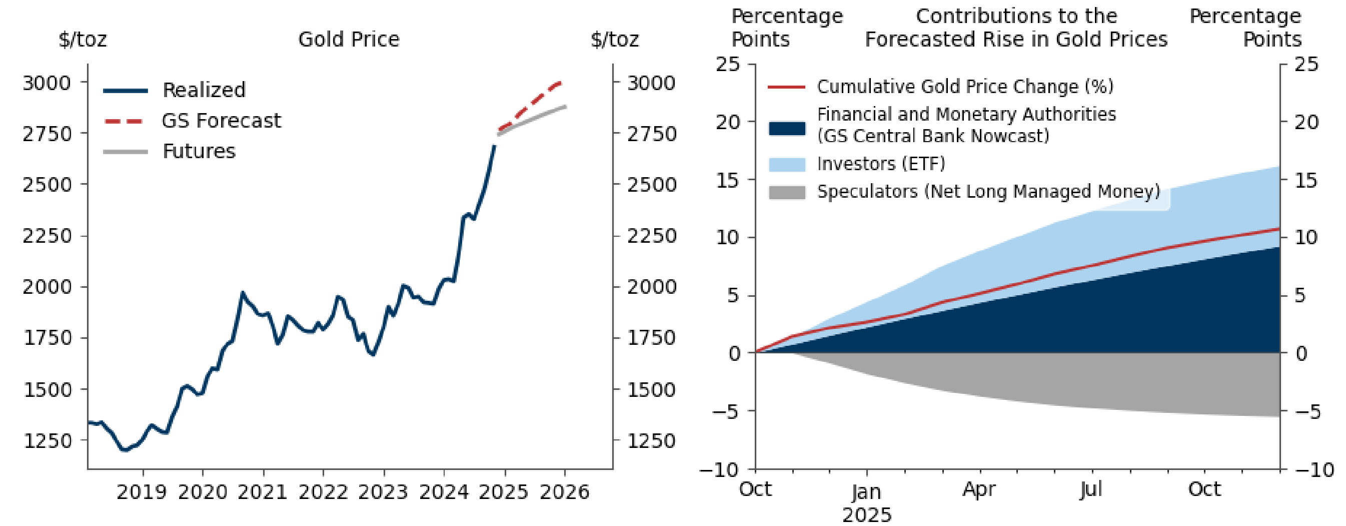
- **Financial & monetary authorities (Fear).** While the gold price-to-rates relationship remains intact in changes, the fivefold increase in our nowcast of central bank demand in the London OTC market since Russia invaded Ukraine has reset this relationship in levels. Based on our finding that fears of US financial sanctions and of shocks to US sovereign debt explain central bank gold buying well, we assume that monthly central bank purchases will moderate to a third of the elevated average pace observed since 2022—which remains structurally higher than before the freezing of Russia's reserves—by end-2025. This assumption boosts the end-2025 gold price by an additional 9%.

- **Investors (Interest rates).** The gradual boost to Western ETF holdings backed by physical gold as the Fed policy rate comes down to 3¼-½% by mid-next year is worth an additional 7% of upside by end-2025.

- **Speculators (Safe haven).** Approaching the US election, gold speculative positioning has risen to very high levels with Commodity Exchange (Comex) net managed money at percentile 93. History suggests that gold positioning tends to rise with uncertainty and when investors seek safe havens. Our assumption that positioning gradually moderates to its long-run average subtracts about 6% from our forecast by end-2025 with two-sided risks. While a potentially faster decline in positioning on a post-election reduction in uncertainty implies some tactical downside price risk, we see significant hedging value in long gold positions because of a potential escalation in trade tensions, or rises in Fed subordination risk, debt fears, financial and recessionary risks.

Exhibit 1: We Forecast the Gold Price to Rise About 10% to $3,000 by December 2025, Driven by Demand From Financial and Monetary Authorities (9%), Investors (7%), Outweighing the Drag From a Normalization in Speculative Demand (6%)

GS Gold Price Forecast and Underlying Drivers

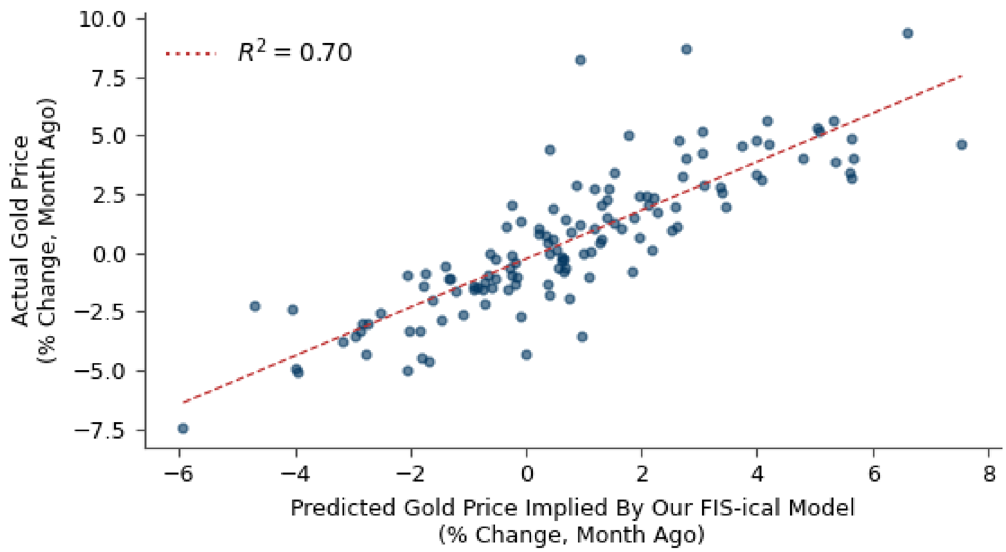


Source: US Commodity Futures Trading Commission, Bloomberg, Goldman Sachs Global Investment Research

The FIS-ical Drivers of Our Bullish Gold Forecast

As the gold price keeps breaking record highs and is up more than 30% year-to-date, we formalize our gold pricing framework. Specifically, we introduce our FIS-ical model, which explains monthly price changes well by summing up physical gold demand from **Financial and monetary authorities** (our nowcast of central banks and other institutional gold purchases on the London OTC), **Investors** (ETF Holdings), and **Speculators** (net long managed money on COMEX) (Exhibit 2). Using this model, we estimate that every 100 tonnes of additional gold demand lifts the gold price by 1.5%-2%.

Exhibit 2: Our FIS-ical Model Explains Monthly Price Changes by Summing Up Physical Gold Demand From Financial and Monetary Authorities, Investors and Speculators



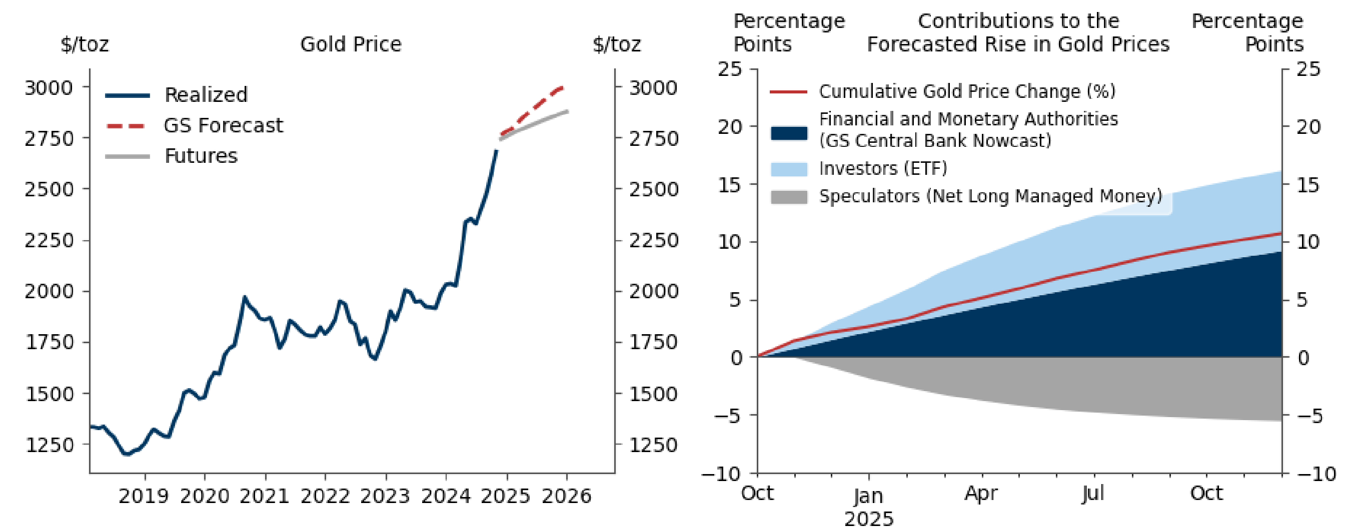
Our FIS-ical model uses an OLS regression of monthly gold price percentage changes on the combined physical gold demand from Financial and monetary authorities (our nowcast of central banks and other institutional gold purchases on the London OTC), Investors (ETF Holdings from Bloomberg's ETFGTOTL series) and Speculators (net long managed money on COMEX). The sample covers January 2014 to August 2024. We estimate that 100 tonnes of gold lifts gold prices by 1.5% - 2%.

Source: US Commodity Futures Trading Commission, Bloomberg, Goldman Sachs Global Investment Research

We flesh out the drivers of our still bullish forecast that gold will rise about 10% to $3,000 by December 2025. Structurally higher central bank demand (adding 9% by December 2025) and a gradual boost to ETF holdings as the Fed cuts the funds rate (adding 7%) outweigh the drag from our assumption that positioning gradually normalizes (subtracting 6%). Our new price forecast is slightly higher than our prior forecast for the remainder of 2024 (as prices have rallied somewhat faster than we expected), and looks for slightly slower price gains in 2025 given the recent rally and as our updated framework now formally incorporates mean-reversion in positioning (Exhibit 11).

Exhibit 3: We Forecast That the Gold Price Will Reach $3,000/toz by end-2025, Driven by Structurally Higher Central Bank Demand and a Gradual Boost to ETF Holdings as the Fed Policy Rate Comes Down, Outweighing a Normalization in Positioning

GS Gold Price Forecast and Underlying Drivers

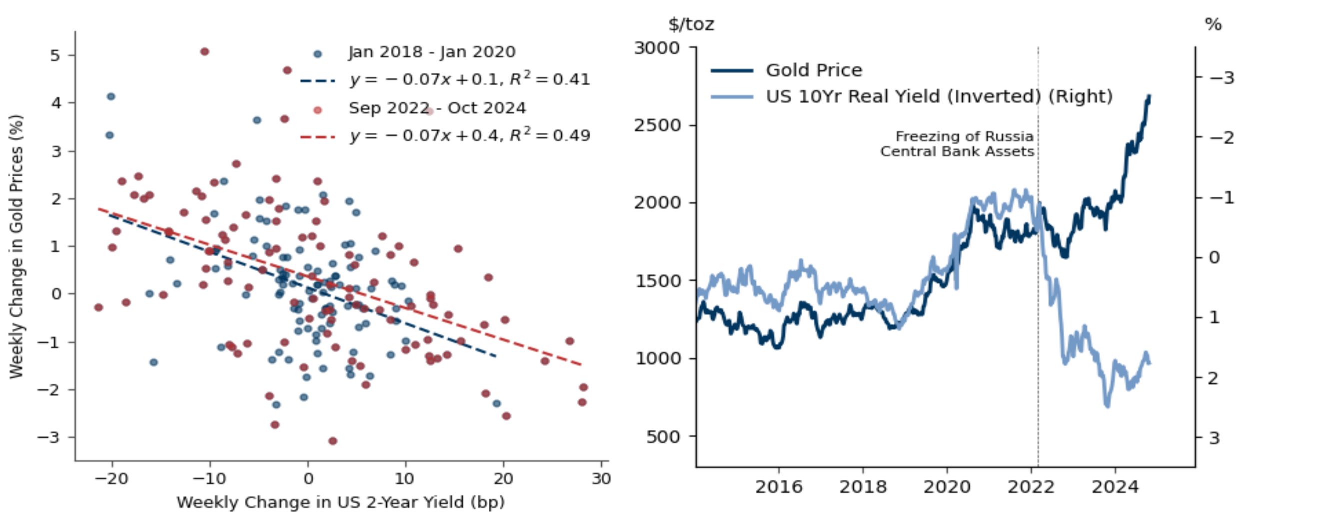


Source: US Commodity Futures Trading Commission, Bloomberg, Goldman Sachs Global Investment Research

Financial & Monetary Authorities (Fear)

While the gold price-to-rates relationship remains intact in changes, the fivefold increase in our nowcast of central and other institutional demand in the London OTC market since Russia invaded Ukraine has reset the gold price-rates relationship in levels (Exhibit 4).

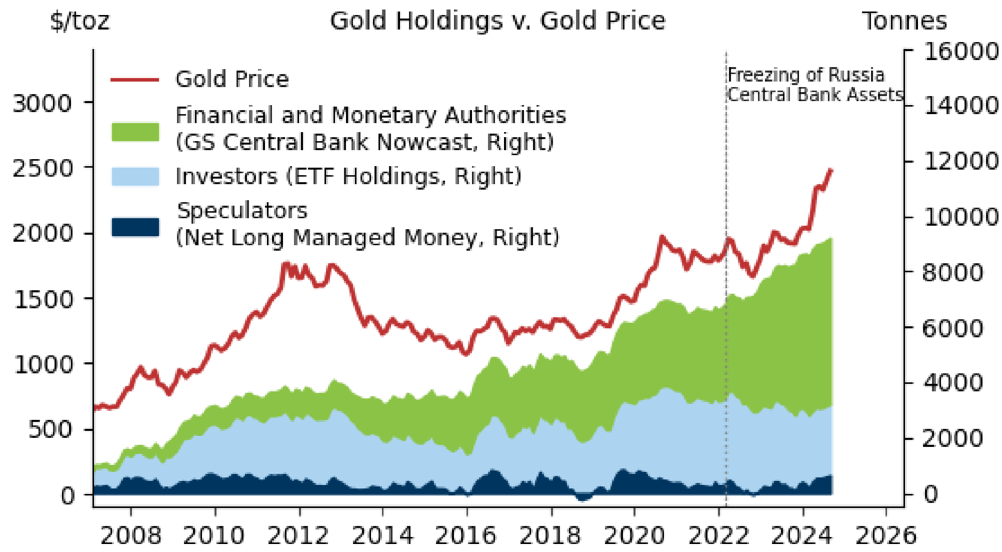
Exhibit 4: While the Gold Price-to-Rates Relationship Remains Intact in Changes, the Relationship in Levels Has Been Reset By...



Left: Scatter plot displays weekly changes in US 2-year Treasury yields (bp) vs. changes in gold prices (%). Dots represent weekly observations with two sample periods: January 2018 to January 2020 shown in blue, and September 2022 to October 2024 shown in red. The outlier weeks of March 19, 2023, corresponding to market disruptions following the Silicon Valley Bank collapse, as well as April 2024 are not plotted.

Source: Federal Reserve Board, LBMA, Goldman Sachs Global Investment Research

Exhibit 5: ... the Surge in Central Bank Gold Purchases Since 2022

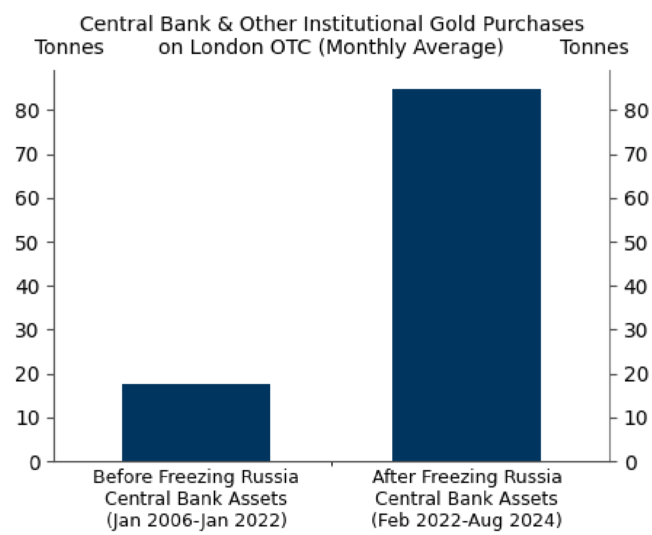


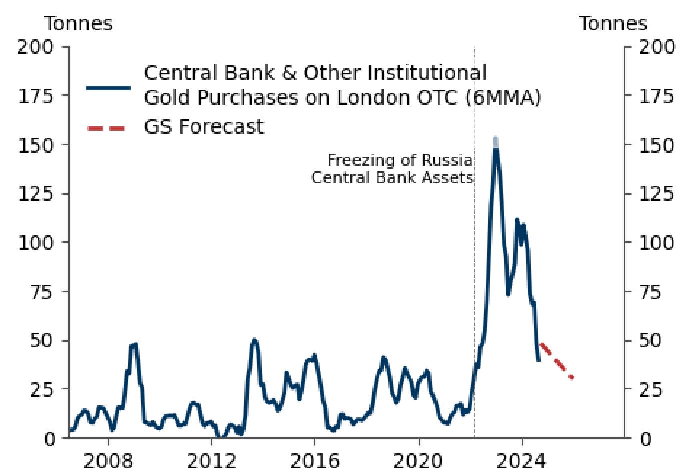
Financial and Monetary Authority Holdings are approximated by the cumulative increase in our GS nowcast of central bank and institutional gold purchases on the London OTC market. Investors' holdings are measured by the Western ETF holdings, tracked via Bloomberg's 'ETFGTOTL' series. Speculators' holdings are net long managed money positions on COMEX.

Based on our finding that fears of US financial sanctions and fears of shocks to US sovereign debt explain central bank gold buying well, we assume that central bank purchases will moderate to a monthly pace of 30 tons—about a third of the elevated 85 tons average monthly pace observed since 2022, but structurally higher than the 17 tons monthly average pace before the freezing of Russia's reserves—by end-2025. This assumption boosts the end-2025 gold price by an additional 9% (Exhibit 6).

Exhibit 6: Following the Fivefold Surge in Central Bank Gold Demand Since the Freezing of Russia's Central Bank Assets, We Assume Central Bank Purchases Will Moderate to a Monthly Pace of 30 Tons, Structurally Higher Than Pre-Freeze Levels

Financial and Monetary Authorities (Fear)





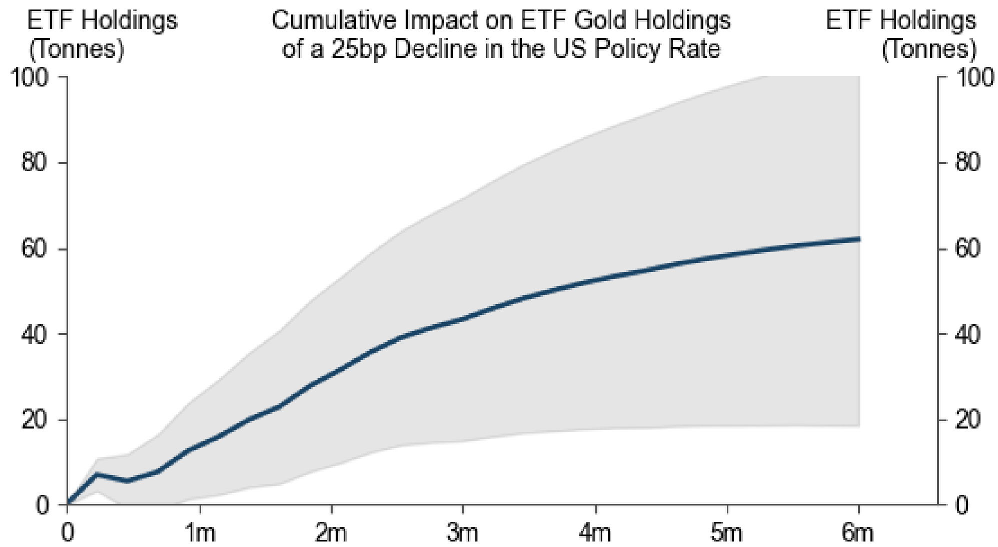
Left: Before the freezing of Russia central bank assets (Jan 2006 - Jan 2022), monthly purchases averaged 17 tonnes. After the freeze (Feb 2022 - Aug 2024), monthly purchases rose to an average of 85 tonnes. Right: We assume that central bank purchases will moderate to a monthly average pace of 30 tons—which remains structurally higher than before the freezing of Russia's reserves—by end-2025.

Source: Goldman Sachs Global Investment Research

Investors (Interest rates)

We have shown previously that the boost to Western ETF holdings backed by physical gold from Fed policy rate cuts tends to be gradual (Exhibit 7). Our economists' assumption that the Fed policy rate comes down to 3¼-½% by mid-next year is worth an additional 7% of upside to our bullish gold price forecast by end-2025 (Exhibit 8).

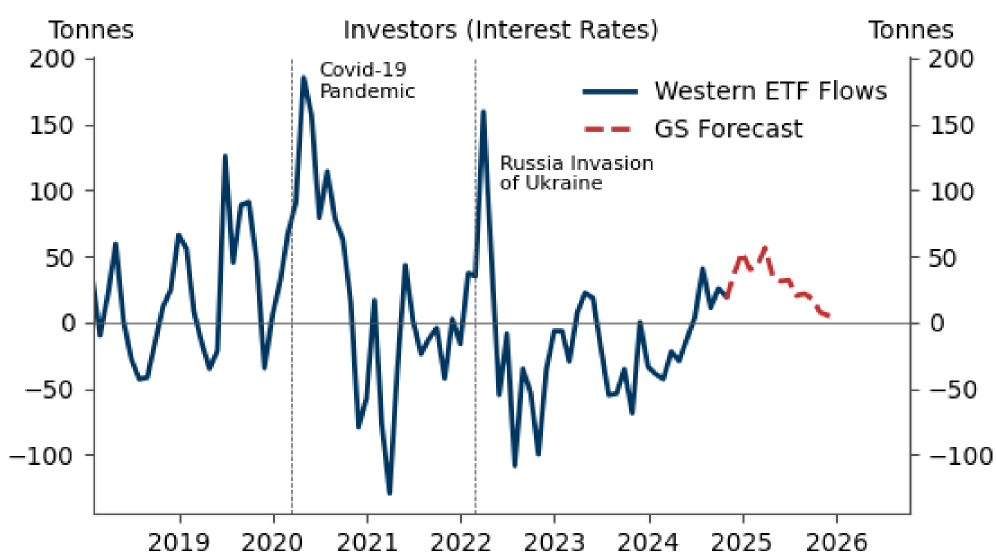
Exhibit 7: Western ETFs Backed by Physical Gold Holdings Rise Only Gradually as the Fed Policy Rate Comes Down



The chart presents the cumulative impact of a 25 basis point decline in the US policy rate on Western ETF holdings (in tonnes), using a vector autoregression model (VAR). Our analysis controls for rate expecations — proxied by the US 2-year Treasury yield. We adjust Bloomberg's ETFGTOTL series to reflect all physical ETF gold holdings in North America and Europe, based on figures from the World Gold Council. The shaded area represents the 90% confidence interval.

Source: Bloomberg, Federal Reserve Board, World Gold Council, Goldman Sachs Global Investment Research

Exhibit 8: We Forecast a Gradual Rise in Western ETF Gold Holdings as the Fed Policy Rate Comes Down

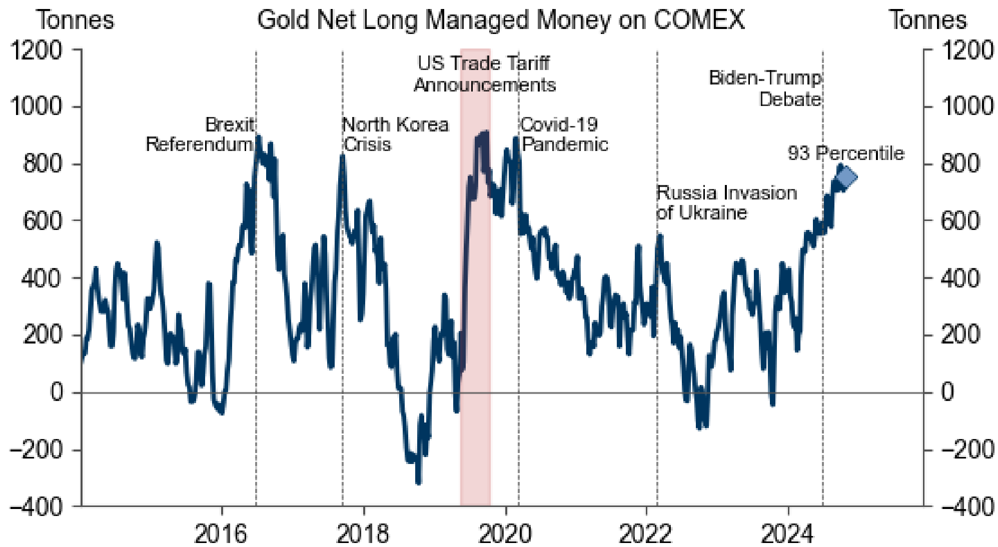


Source: Bloomberg, Goldman Sachs Global Investment Research

Speculators (Safe Haven)

Approaching the US election, gold speculative positioning has risen to very high levels with Commodity Exchange (Comex) net managed money at percentile 93 of the distribution since 2014. History suggests that gold positioning tends to rise with uncertainty and when investors seek safe havens. For instance, net long managed money rose nearly 900 tonnes from May to October 2019 amid the six US trade tariff announcements, as the pink area in Exhibit 9 illustrates.[1] However, our statistical analysis shows that positioning tends to mean-revert when uncertainty normalizes, which we incorporate into our forecasting framework.

Exhibit 9: Historically, Gold Positioning Tends to Rise During Periods of Uncertainty as Investors Seek Safe Havens



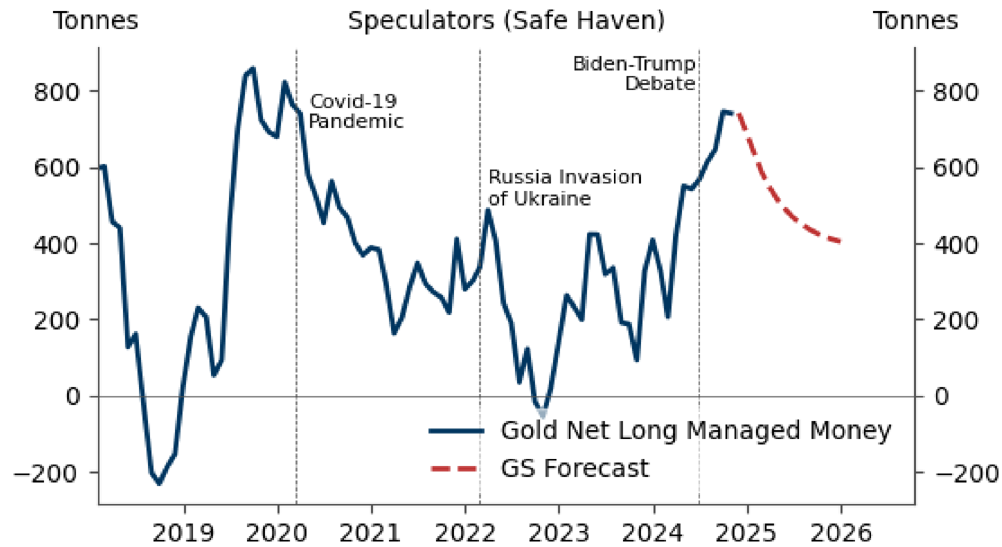
The six US tariff announcement episodes took place between May and October 2019.

Source: US Commodity Futures Trading Commission, Goldman Sachs Global Investment Research

Our assumption that positioning gradually moderates to its long-run average subtracts about 6% from our gold price forecast by end-2025 with two-sided risks. While a potentially faster decline in positioning on a post-election reduction in uncertainty implies some tactical near-term downside price risk, we still see significant hedging value in long gold positions in geopolitical or macroeconomic scenarios that are less friendly for equity-bond portfolios than our soft landing base case. These scenarios include a potential escalation in trade tensions (which coincided with rises in gold prices but drops in equity prices in 2019), or rises in Fed subordination risk, debt fears, financial and recessionary risks.

1 Using our general assumption that every 100 tonnes of additional demand increases the gold price by 1.5%-2%, we estimate that the 875 tonnes increase in net managed money between May and October 2019 would have resulted in an increase of 13% - 18%, all else equal. The gold price rose 18% during that period.

Exhibit 10: We Assume That Positioning Gradually Returns to its Long-Run Average



We forecast gold net long managed money positioning, using an AR(2) model, which predicts based on the last two months' values.

Source: US Commodity Futures Trading Commission

While our simple FIS-ical model explains gold price changes well and increases our confidence in our recommendation to maintain long gold positions, we see room to improve the model further in potential future work, whether it relates to studying other dimensions of the global supply-demand balance or refining the methodology to forecast the three FIS components.

Appendix

Exhibit 11: We Formalize Our Gold Pricing Framework with Our FIS-ical Model, and Forecast $3,000/toz by End-2025

	GS Forecasts ($/toz)	
	COMEX Gold Prior	COMEX Gold New
2024	2,395	2,407
2025	2,973	2,906
4Q24	2,693	2,740
1Q25	2,853	2,813
2Q25	2,957	2,880
3Q25	3,020	2,940
4Q25	3,063	2,990
Nov-24	2,690	2,760
Dec-24	2,750	2,780
Jan-25	2,810	2,790
Feb-25	2,850	2,810
Mar-25	2,900	2,840
Apr-25	2,930	2,860
May-25	2,960	2,880
Jun-25	2,980	2,900
Jul-25	3,000	2,920
Aug-25	3,020	2,940
Sep-25	3,040	2,960
Oct-25	3,050	2,980
Nov-25	3,060	2,990
Dec-25	3,080	3,000

Source: Goldman Sachs Global Investment Research

Disclosure Appendix

Reg AC

We, Lina Thomas and Daan Struyven, 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 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. Investment in securities market are subject to market risks. Read all the related documents carefully before investing. Registration granted by SEBI and certification from NISM in no way guarantee performance of the intermediary or provide any assurance of returns to investors. Goldman Sachs (India) Securities Private Limited Investor Grievance E-mail: india-client-support@gs.com. Compliance Officer: Anil Rajput |Tel: + 91 22 6616 9000 | Email: anil.m.rajput@gs.com. **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.