

Cross Asset Volatility

Machine Learning Based Trade Recommendations

- The **CARV** model has initiated short vol positions in SPX and GBP, and increased a long vol position in KS200. Meanwhile, it has decreased the previous long vol position on Brent, and removed the long/short vol positions on Brent, XAU and JPY (Figure 1).
- According to our VarSwap model, in addition to our previously recommended pair on NDX/SPX, we find **buying 1Y ATM var on DAX vs. selling EFA** to be also attractive (Figure 5-7). The carry appears attractive (see Figure below) and the DAX volatility will likely to be sustained given macro backdrop.
- From **RV** model (Figure 9), our recommended trade on short EMB vs. long LQD 3M ATM vol has gained ~2 vega MTM since inception (2/28). For this week, we recommend to take the profit and switch to **long 3M ATM vol on EMB and short vol on HYG**. This is a trade we recommended on mid-Feb and took off after one week, with a gain of 2.5 vega.
- Implied vol started to wobble last week at the gamma end of vol curves on still high implied vols and contained realized. Whether that dynamic has legs is anybody's question. Our FX gamma trading models are for the 2nd week materially short vol. Recall that during the COVID-19 risk off in 2020, the signal's read-through was a few weeks early. Within **USD/G10** (Figure 3), NOK, SEK vols are the richest suggesting a possible material downside pressure, but being in the eye of the storm and amid lack of visibility on the regional developments, we think that, if any, the vega tenors, e.g., 6M, may be easier to handle. Directionally same but a more conservative play would be via **short JPY vol vs long AUD vol RV**, which aims to harvest ~2vol of spread between the implied and realized vol.

Global Quantitative and Derivatives Strategy

Peng Cheng, CFA ^{AC}

(1-212) 622-5036

peng.cheng@jpmorgan.com

Ladislav Jankovic ^{AC}

(1-212) 834-9618

ladislav.jankovic@jpmchase.com

Emma Wu ^{AC}

(1-212) 834-2174

emma.wu@jpmorgan.com

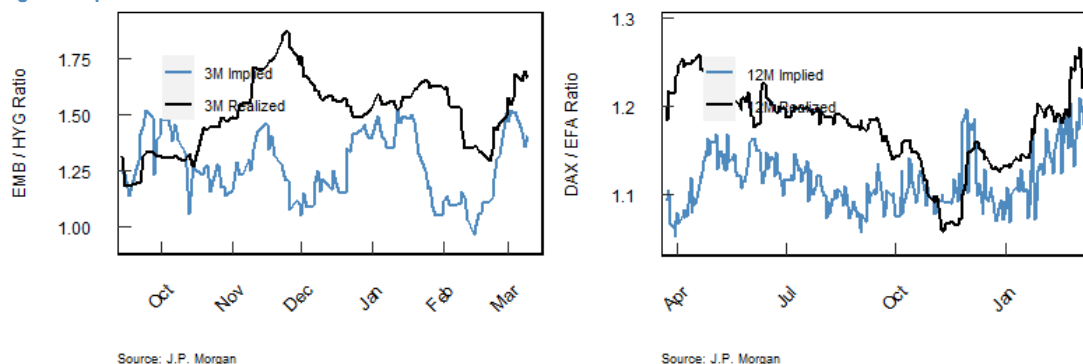
Marko Kolanovic, PhD

(1-212) 622-3677

marko.kolanovic@jpmorgan.com

J.P. Morgan Securities LLC

Figure: Implied vs. Realized Ratio EMB vs. HYG and DAX vs. EFA

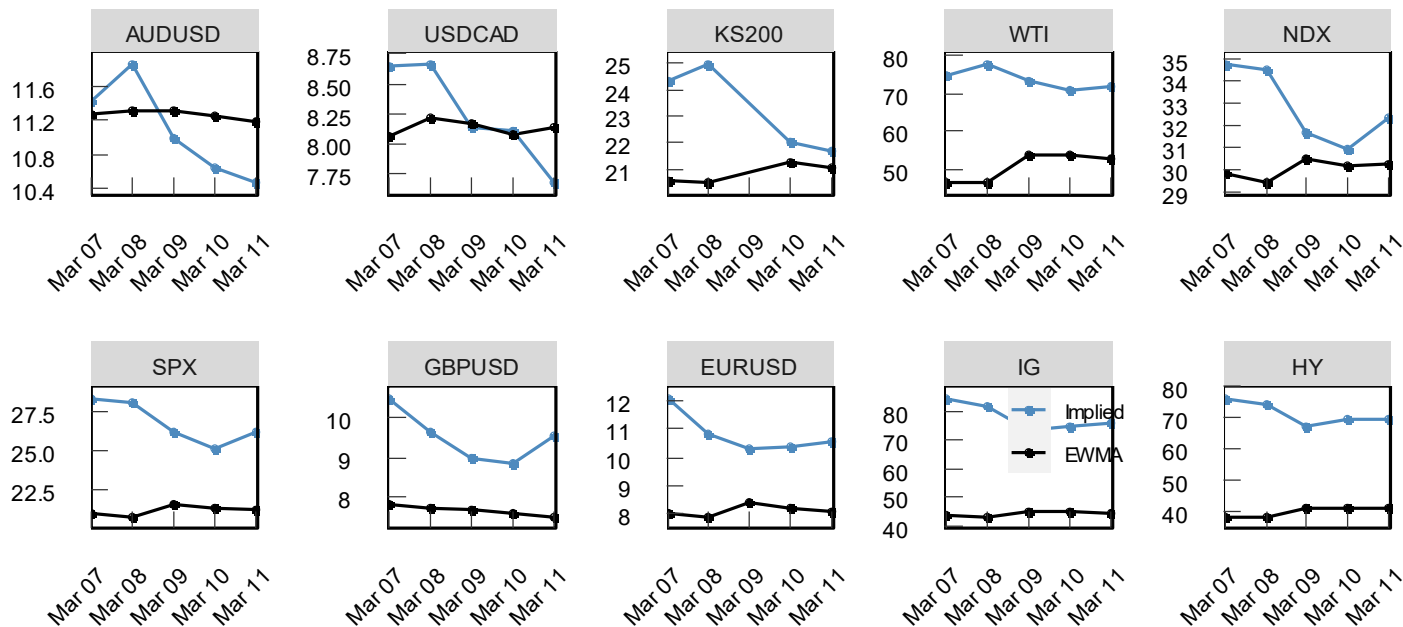


See page 10 for analyst certification and important disclosures.

J.P. Morgan does and seeks to do business with companies covered in its research reports. As a result, investors should be aware that the firm may have a conflict of interest that could affect the objectivity of this report. Investors should consider this report as only a single factor in making their investment decision.

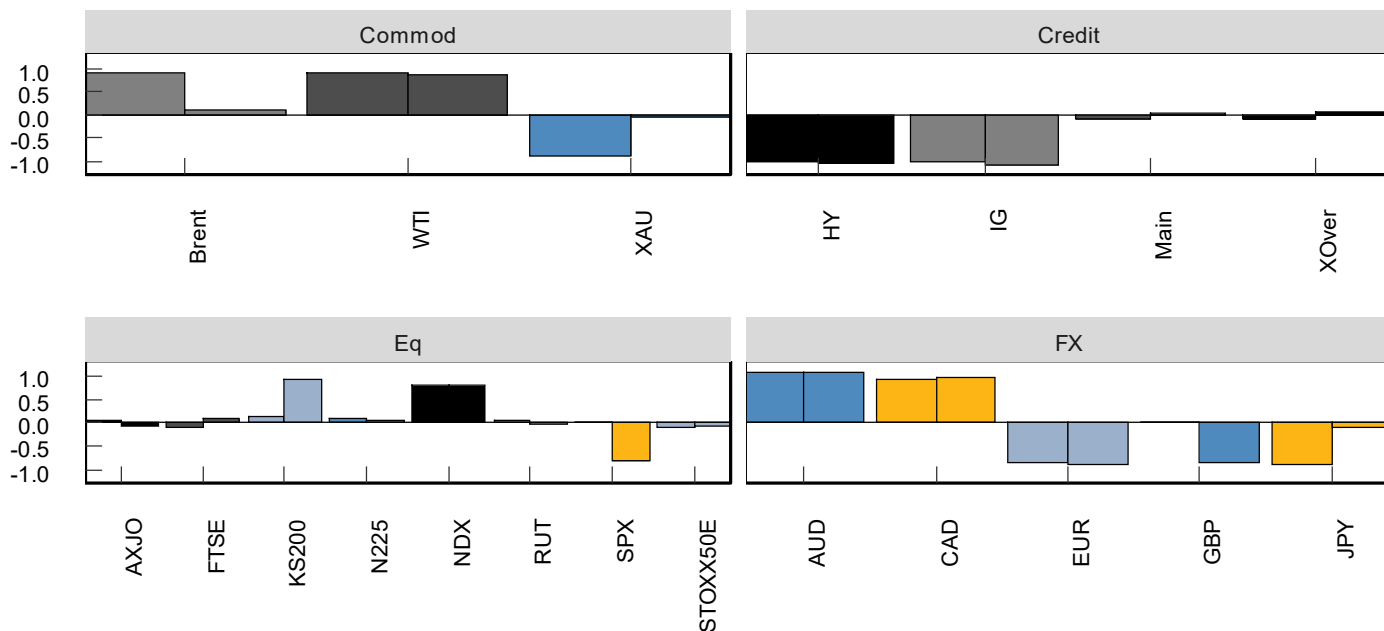
Cross Asset Relative Value Model (CARV)¹

Figure 1: Implied vs. EWMA Volatility (%) of the 5 Cheapest/Richest 1M ATM Vol (ordered from cheapest to richest)



Source: J.P. Morgan

Figure 2: Previous Week and Current Optimal Vol Portfolio Weights



Source: J.P. Morgan

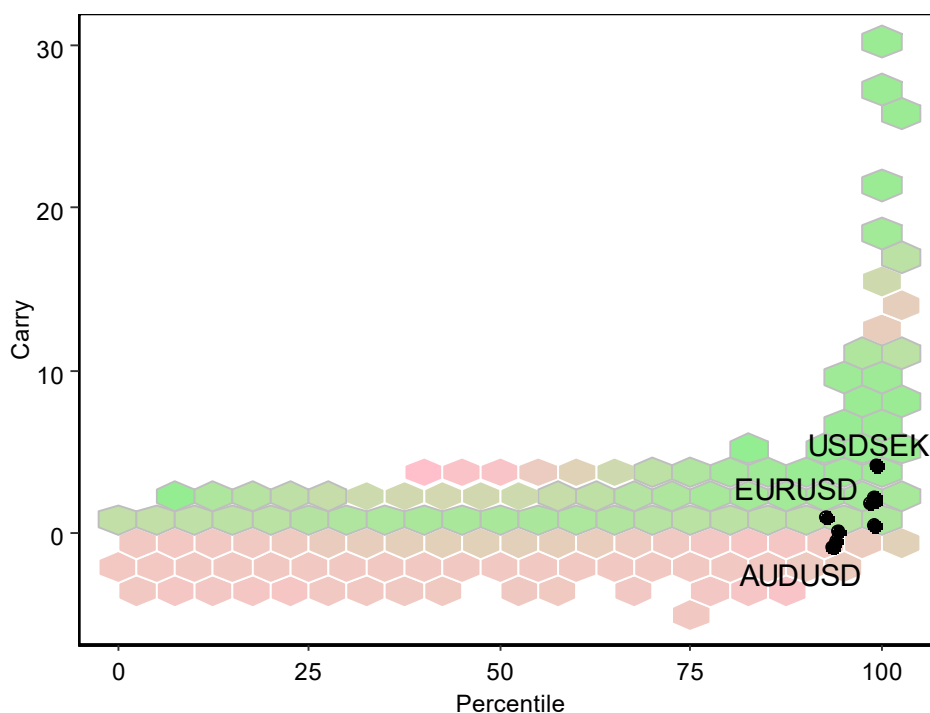
¹ Big Data and AI Strategies From Relative Value Signals to Optimal Portfolio Weights, 5 Feb 2020.

G10 FX 1M Volatility²

Figure 3: G10 Dollar Pair FX 3M Volatility Ranking 2022-03-11

	Ccy	3M ATM Implied Vol	IV Percentile(1 yr)	Short Vol Carry	Short Vol SVM Predicted Hit Ratio	Direction
1	SEK	17.11	0.99	4.16	0.96	Rich
2	NOK	14.75	0.98	1.85	0.91	Rich
3	GBP	9.56	0.99	1.97	0.88	Rich
4	JPY	7.12	0.93	0.95	0.87	Rich
5	EUR	10.58	0.99	2.21	0.85	Rich
6	CHF	7.67	0.99	0.46	0.73	Rich
7	NZD	10.56	0.94	0.16	0.45	Cheap
8	CAD	7.67	0.94	-0.50	0.13	Cheap
9	AUD	10.46	0.93	-0.84	0.08	Cheap

Source: J.P. Morgan



Source: J.P. Morgan

Green Region is Good for Selling Vol. **Red** is Good for Buying.

Direction “Rich” Means We Recommend Selling Vol.

² Big Data and AI Strategies: Enhancing FX volatility trading with machine learning, 13 Aug 2018

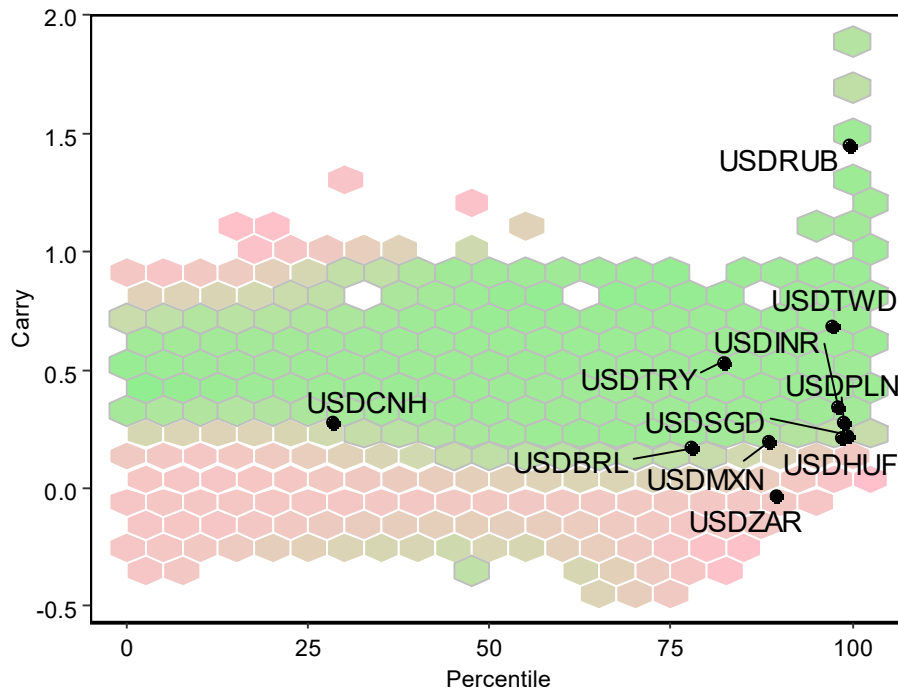
EM FX 1M Volatility³

Figure 4: EM Dollar Pair FX 3M Volatility Ranking 2022-03-11

	Ccy	3M ATM Implied Vol	IV Percentile(1 yr)	Short Vol Carry	Short Vol SVM Predicted Hit Ratio	Direction
1	TRY	38.36	0.82	0.53	0.96	Rich
2	TWD	6.09	0.97	0.68	0.95	Rich
3	RUB	121.18	1.00	1.45	0.94	Rich
4	INR	7.38	0.98	0.34	0.93	Rich
5	PLN	21.03	0.99	0.28	0.80	Rich
6	BRL	17.62	0.78	0.17	0.78	Rich
7	CNH	3.65	0.28	0.27	0.71	Rich
8	MXN	13.72	0.88	0.20	0.68	Rich
9	SGD	5.05	0.99	0.22	0.56	Rich
10	HUF	21.38	0.98	0.21	0.54	Rich
11	ZAR	16.37	0.90	-0.03	0.05	Cheap

Source: J.P. Morgan.

Note: Log Carry = $\log(IV/EMA)$, Carry = IV - EMA (see original report for details)



Source: J.P. Morgan

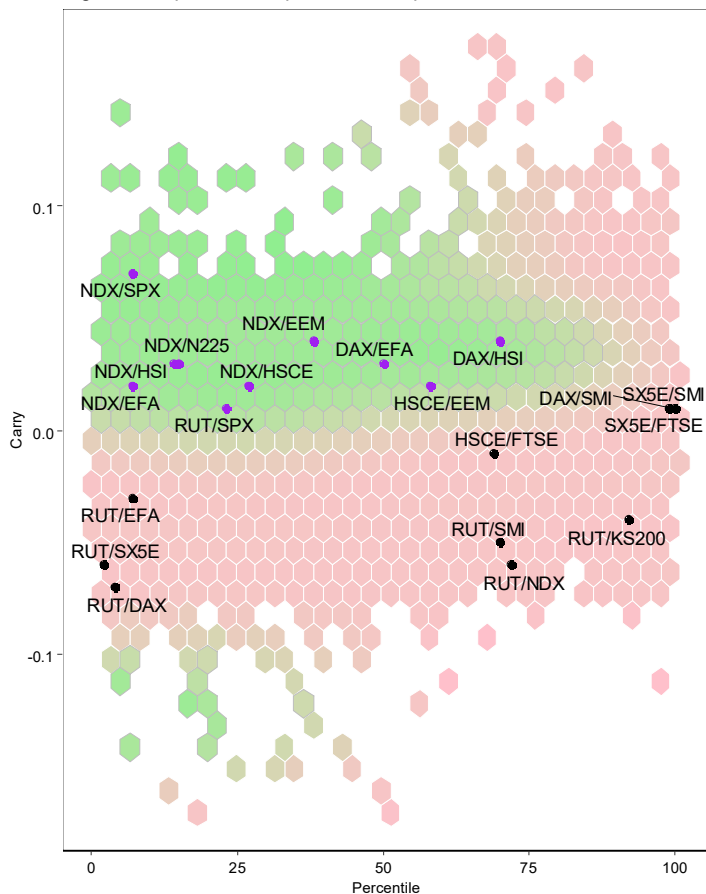
Green Region is Good for Selling Vol. **Red** is Good for Buying.

Direction “Rich” Means We Recommend Selling Vol.

³ Big Data and AI Strategies: Machine Learning to the rescue in cracking the tough EM FX volatility trading cookie, 13 Sep 2018

Equity Index 1Y Variance Swaps Relative Value⁴

Figure 5: Top 10 Decompression/Compression Variance Pairs 2022-03-11



Source: J.P. Morgan

Figure 6: Top 10 Variance Pairs for Decompression

	Long	Short	Carry	IV Percentile(1 Year)	Predicted Hit Ratio
1	NDX	SPX	0.07	7	0.99
2	NDX	N225	0.03	15	0.98
3	NDX	HSCE	0.02	27	0.98
4	DAX	EFA	0.03	50	0.98
5	NDX	HSI	0.03	14	0.97
6	RUT	SPX	0.01	23	0.95
7	NDX	EFA	0.02	7	0.93
8	NDX	EEM	0.04	38	0.92
9	DAX	HSI	0.04	70	0.91
10	HSCE	EEM	0.02	58	0.90

Source: J.P. Morgan

Figure 7: Top 10 Variance Pairs for Compression

	Long	Short	Carry	IV Percentile(1 Year)	Predicted Hit Ratio
1	HSCE	FTSE	-0.01	69	0.05
2	RUT	EFA	-0.03	7	0.04
3	RUT	NDX	-0.06	72	0.04
4	RUT	SMI	-0.05	70	0.04
5	RUT	DAX	-0.07	4	0.03
6	RUT	SX5E	-0.06	2	0.03
7	RUT	KS200	-0.04	92	0.03
8	DAX	SMI	0.01	99	0.03
9	SX5E	SMI	0.01	100	0.02
10	SX5E	FTSE	0.01	100	0.02

Source: J.P. Morgan

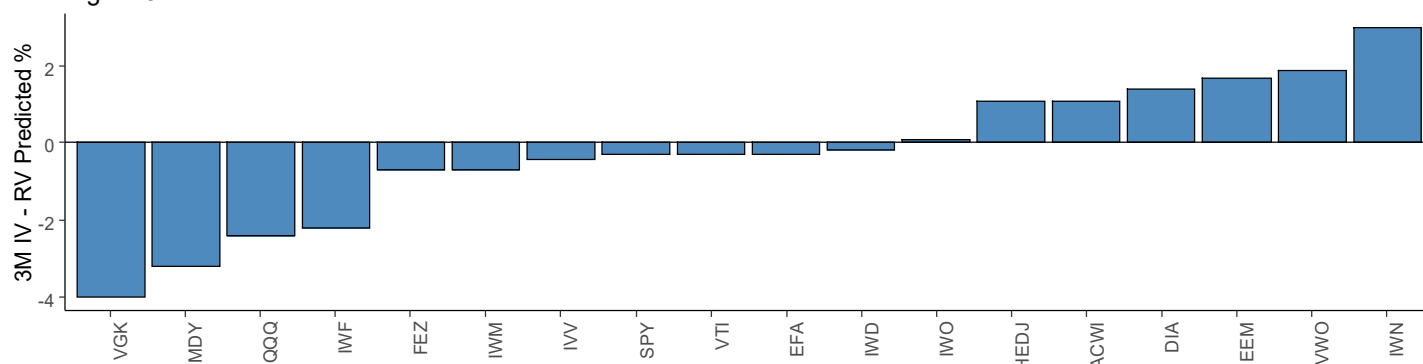
⁴ Global Equity Derivatives: A simple machine learning approach to variance pairs trading, 24 July 2018

Big Data and AI Strategies: Attractive long/short variance pairs in a machine learning framework, 15 Aug 2018

Big Data and AI Strategies: Application of support vector machine to cross-asset volatility pair trading, 02 Oct 2018

ETF Relative Value Volatility Rankings⁵

Figure 8 Relative Value ETFs: Broad



Sector

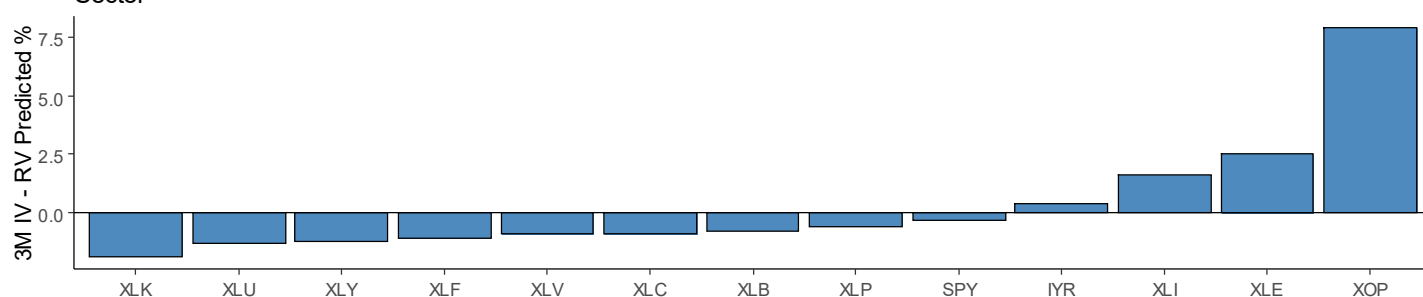
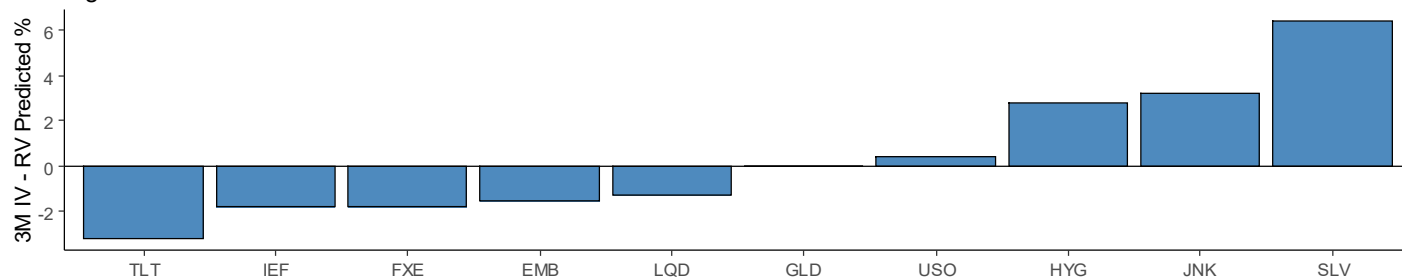


Figure 9 Relative Value ETFs: FICC



EM



Source: J.P. Morgan

⁵ Global Equity Derivatives: US ETF relative value volatility model, 27 Mar 2018

Predicted P&L from Selling Gold Vol⁶

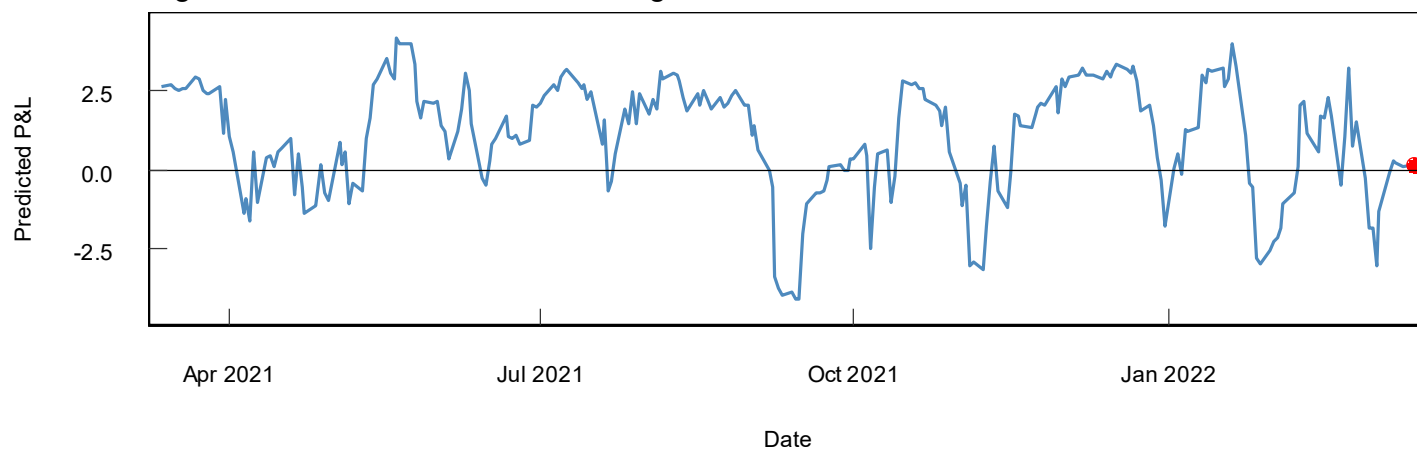
Figure 10: Gold Vol Recommendations

	Last Close Date	Expected P&L from Selling 1M Vol	Recommendation
1	2022-03-07	-0.08	Buy
2	2022-03-08	0.25	Sell
3	2022-03-09	0.22	Sell
4	2022-03-10	0.17	Sell
5	2022-03-11	0.11	Sell

Source: J.P. Morgan

*Go long volatility when expected Vol selling P&L is negative

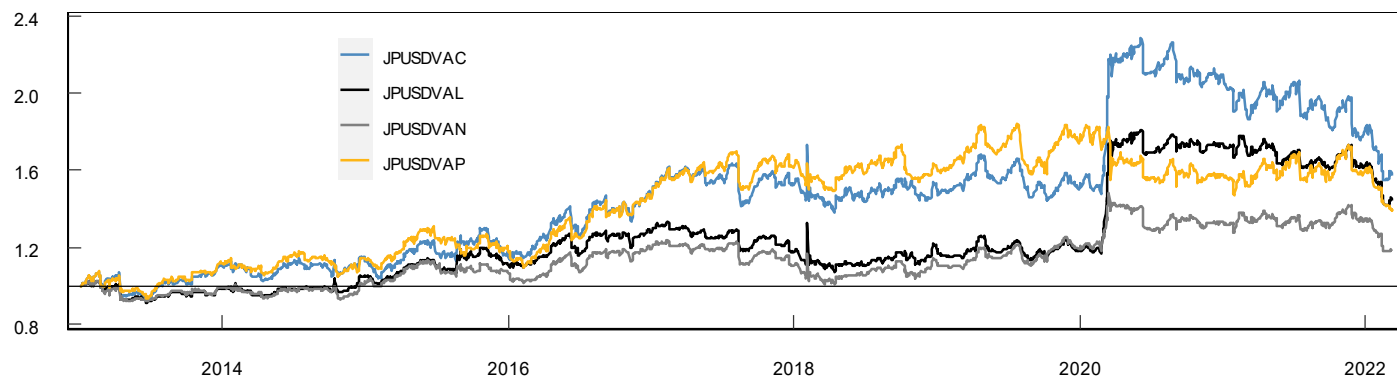
Figure 11: Predicted PnL from Selling Gold Vol



Source: J.P. Morgan

⁶ Big Data and AI Strategies: Machine learning approach to trading gold volatility, 19 Oct 2018

Figure 12: VIX Term Structure Dynamic Allocation Chart⁷



Source: J.P. Morgan

Source: J.P. Morgan

Figure 13: VIX Term Structure Dynamic Allocation Table

Bias Ticker	Short JPUSDVAP	Neutral JPUSDVAN	Long JPUSDVAL	Unconstrained JPUSDVAC
UX1	20%	20%	5%	19%
UX2	-20%	-20%	-20%	-17%
UX3	3%	-9%	19%	0%
UX4	-20%	9%	9%	0%
UX5	-0%	-0%	-0%	-0%
Net	-17%	0%	13%	3%

Source: J.P. Morgan

⁷ Big Data and AI Strategies: Dynamic VIX Term Structure Allocation Strategy, 12 Apr 2019

FX Volatility Surface Relative Value⁸

1 Month Holding Period

Positive Numbers => Positive **PnL** from going **Long** the option.

Negative Numbers => Positive **PnL** from going **Short** the option.

Figure 14: Vol Surface PnL Predictions in Basis Points 2022-03-11

	ccy	3Mp25	3Ms50	3Mc25	6Mp25	6Ms50	6Mc25	12Mp25	12Ms50	12Mc25
1	AUD-USD	1	13	13	8	19	15	17	26	19
2	USD-CAD	-8	-15	-17	-8	-12	-17	-11	-13	-19
3	USD-CHF	-21	-21	-19	-25	-25	-21	-27	-32	-23
4	EUR-USD	-19	-17	-6	-14	-16	-6	-14	-16	-8
5	GBP-USD	-11	-8	-7	-12	-12	-9	-13	-15	-10
6	USD-JPY	-21	-28	-25	-24	-32	-27	-19	-26	-23
7	USD-NOK	15	19	6	18	16	10	16	11	12
8	NZD-USD	-1	13	15	3	15	14	10	14	14
9	USD-SEK	10	8	0	12	19	12	18	27	19

Source: J.P. Morgan

⁸ Big Data and AI Strategies: Relative Value Trading on FX Volatility Surfaces, 02 July 2019

Risks of Common Option Strategies

Risks to Strategies: Not all option strategies are suitable for investors; certain strategies may expose investors to significant potential losses. We have summarized the risks of selected derivative strategies. For additional risk information, please call your sales representative for a copy of “Characteristics and Risks of Standardized Options.” We advise investors to consult their tax advisors and legal counsel about the tax implications of these strategies. Please also refer to option risk disclosure documents.

Put Sale: Investors who sell put options will own the underlying asset if the asset’s price falls below the strike price of the put option. Investors, therefore, will be exposed to any decline in the underlying asset’s price below the strike potentially to zero, and they will not participate in any price appreciation in the underlying asset if the option expires unexercised.

Call Sale: Investors who sell uncovered call options have exposure on the upside that is theoretically unlimited.

Call Overwrite or Buywrite: Investors who sell call options against a long position in the underlying asset give up any appreciation in the underlying asset’s price above the strike price of the call option, and they remain exposed to the downside of the underlying asset in the return for the receipt of the option premium.

Booster : In a sell-off, the maximum realized downside potential of a double-up booster is the net premium paid. In a rally, option losses are potentially unlimited as the investor is net short a call. When overlaid onto a long position in the underlying asset, upside losses are capped (as for a covered call), but downside losses are not.

Collar: Locks in the amount that can be realized at maturity to a range defined by the put and call strike. If the collar is not costless, investors risk losing 100% of the premium paid. Since investors are selling a call option, they give up any price appreciation in the underlying asset above the strike price of the call option.

Call Purchase: Options are a decaying asset, and investors risk losing 100% of the premium paid if the underlying asset’s price is below the strike price of the call option.

Put Purchase: Options are a decaying asset, and investors risk losing 100% of the premium paid if the underlying asset’s price is above the strike price of the put option.

Straddle or Strangle: The seller of a straddle or strangle is exposed to increases in the underlying asset’s price above the call strike and declines in the underlying asset’s price below the put strike. Since exposure on the upside is theoretically unlimited, investors who also own the underlying asset would have limited losses should the underlying asset rally. Covered writers are exposed to declines in the underlying asset position as well as any additional exposure should the underlying asset decline below the strike price of the put option. Having sold a covered call option, the investor gives up all appreciation in the underlying asset above the strike price of the call option.

Put Spread: The buyer of a put spread risks losing 100% of the premium paid. The buyer of higher-ratio put spread has unlimited downside below the lower strike (down to zero), dependent on the number of lower-struck puts sold. The maximum gain is limited to the spread between the two put strikes, when the underlying is at the lower strike. Investors who own the underlying asset will have downside protection between the higher-strike put and the lower-strike put. However, should the underlying asset’s price fall below the strike price of the lower-strike put, investors regain exposure to the underlying asset, and this exposure is multiplied by the number of puts sold.

Call Spread: The buyer risks losing 100% of the premium paid. The gain is limited to the spread between the two strike prices. The seller of a call spread risks losing an amount equal to the spread between the two call strikes less the net premium received. By selling a covered call spread, the investor remains exposed to the downside of the underlying asset and gives up the spread between the two call strikes should the underlying asset rally.

Butterfly Spread: A butterfly spread consists of two spreads established simultaneously – one a bull spread and the other a bear spread. The resulting position is neutral, that is, the investor will profit if the underlying is stable. Butterfly spreads are established at a net debit. The maximum profit will occur at the middle strike price; the maximum loss is the net debit.

Pricing Is Illustrative Only: Prices quoted in the above trade ideas are our estimate of current market levels, and are not indicative trading levels.

Disclosures

Analyst Certification: The Research Analyst(s) denoted by an “AC” on the cover of this report certifies (or, where multiple Research Analysts are primarily responsible for this report, the Research Analyst denoted by an “AC” on the cover or within the document individually certifies, with respect to each security or issuer that the Research Analyst covers in this research) that: (1) all of the views expressed in this report accurately reflect the Research Analyst’s personal views about any and all of the subject securities or issuers; and (2) no part of any of the Research Analyst’s compensation was, is, or will be directly or indirectly related to the specific recommendations or views expressed by the Research Analyst(s) in this report. For all Korea-based Research Analysts listed on the front cover, if applicable, they also certify, as per KOFIA requirements, that the Research Analyst’s analysis was made in good faith and that the views reflect the Research Analyst’s own opinion, without undue influence or intervention.

All authors named within this report are Research Analysts unless otherwise specified. In Europe, Sector Specialists (Sales and Trading) may be shown on this report as contacts but are not authors of the report or part of the Research Department.

Important Disclosures

This report is a product of the research department's Global Quantitative and Derivatives Strategy group. Views expressed may differ from the views of the research analysts covering stocks or sectors mentioned in this report. Structured securities, options, futures and other derivatives are complex instruments, may involve a high degree of risk, and may be appropriate investments only for sophisticated investors who are capable of understanding and assuming the risks involved. Because of the importance of tax considerations to many option transactions, the investor considering options should consult with his/her tax advisor as to how taxes affect the outcome of contemplated option transactions.

Company-Specific Disclosures: Important disclosures, including price charts and credit opinion history tables, are available for compendium reports and all J.P. Morgan–covered companies, and certain non-covered companies, by visiting <https://www.jpmm.com/research/disclosures>, calling 1-800-477-0406, or e-mailing research.disclosure.inquiries@jpmorgan.com with your request.

Explanation of Equity Research Ratings, Designations and Analyst(s) Coverage Universe:

J.P. Morgan uses the following rating system: Overweight [Over the next six to twelve months, we expect this stock will outperform the average total return of the stocks in the analyst’s (or the analyst’s team’s) coverage universe.] Neutral [Over the next six to twelve months, we expect this stock will perform in line with the average total return of the stocks in the analyst’s (or the analyst’s team’s) coverage universe.] Underweight [Over the next six to twelve months, we expect this stock will underperform the average total return of the stocks in the analyst’s (or the analyst’s team’s) coverage universe.] Not Rated (NR): J.P. Morgan has removed the rating and, if applicable, the price target, for this stock because of either a lack of a sufficient fundamental basis or for legal, regulatory or policy reasons. The previous rating and, if applicable, the price target, no longer should be relied upon. An NR designation is not a recommendation or a rating. In our Asia (ex-Australia and ex-India) and U.K. small- and mid-cap equity research, each stock’s expected total return is compared to the expected total return of a benchmark country market index, not to those analysts’ coverage universe. If it does not appear in the Important Disclosures section of this report, the certifying analyst’s coverage universe can be found on J.P. Morgan’s research website, <https://www.jpmorganmarkets.com>.

J.P. Morgan Equity Research Ratings Distribution, as of January 01, 2022

	Overweight (buy)	Neutral (hold)	Underweight (sell)
J.P. Morgan Global Equity Research Coverage*	52%	37%	11%
IB clients**	53%	46%	34%
JPMS Equity Research Coverage*	51%	37%	12%
IB clients**	74%	68%	50%

*Please note that the percentages might not add to 100% because of rounding.

**Percentage of subject companies within each of the "buy," "hold" and "sell" categories for which J.P. Morgan has provided investment banking services within the previous 12 months.

For purposes only of FINRA ratings distribution rules, our Overweight rating falls into a buy rating category; our Neutral rating falls into a hold rating category; and our Underweight rating falls into a sell rating category. Please note that stocks with an NR designation are not included in the table above. This information is current as of the end of the most recent calendar quarter.

Equity Valuation and Risks: For valuation methodology and risks associated with covered companies or price targets for covered companies, please see the most recent company-specific research report at <http://www.jpmorganmarkets.com>, contact the primary analyst or your J.P. Morgan representative, or email research.disclosure.inquiries@jpmorgan.com. For material information about the proprietary

models used, please see the Summary of Financials in company-specific research reports and the Company Tearsheets, which are available to download on the company pages of our client website, <http://www.jpmorganmarkets.com>. This report also sets out within it the material underlying assumptions used.

A history of J.P. Morgan investment recommendations disseminated during the preceding 12 months can be accessed on the Research & Commentary page of <http://www.jpmorganmarkets.com> where you can also search by analyst name, sector or financial instrument.

Analysts' Compensation: The research analysts responsible for the preparation of this report receive compensation based upon various factors, including the quality and accuracy of research, client feedback, competitive factors, and overall firm revenues.

Analysts' Compensation: The research analysts responsible for the preparation of this report receive compensation based upon various factors, including the quality and accuracy of research, client feedback, competitive factors, and overall firm revenues.

Other Disclosures

J.P. Morgan is a marketing name for investment banking businesses of JPMorgan Chase & Co. and its subsidiaries and affiliates worldwide.

UK MIFID FICC research unbundling exemption: UK clients should refer to [UK MIFID Research Unbundling exemption](#) for details of JPMorgan's implementation of the FICC research exemption and guidance on relevant FICC research categorisation.

All research material made available to clients are simultaneously available on our client website, J.P. Morgan Markets, unless specifically permitted by relevant laws. Not all research content is redistributed, e-mailed or made available to third-party aggregators. For all research material available on a particular stock, please contact your sales representative.

Any long form nomenclature for references to China; Hong Kong; Taiwan; and Macau within this research material are Mainland China; Hong Kong SAR (China); Taiwan (China); and Macau SAR (China).

J.P. Morgan Research may, from time to time, write on issuers or securities targeted by economic or financial sanctions imposed or administered by the governmental authorities of the U.S., EU, UK or other relevant jurisdictions (Sanctioned Securities). Nothing in this report is intended to be read or construed as encouraging, facilitating, promoting or otherwise approving investment or dealing in such Sanctioned Securities. Clients should be aware of their own legal and compliance obligations when making investment decisions.

Options and Futures related research: If the information contained herein regards options- or futures-related research, such information is available only to persons who have received the proper options or futures risk disclosure documents. Please contact your J.P. Morgan Representative or visit <https://www.theocc.com/components/docs/riskstoc.pdf> for a copy of the Option Clearing Corporation's Characteristics and Risks of Standardized Options or http://www.finra.org/sites/default/files/Security_Futures_Risk_Disclosure_Statement_2018.pdf for a copy of the Security Futures Risk Disclosure Statement.

Changes to Interbank Offered Rates (IBORs) and other benchmark rates: Certain interest rate benchmarks are, or may in the future become, subject to ongoing international, national and other regulatory guidance, reform and proposals for reform. For more information, please consult: https://www.jpmorgan.com/global/disclosures/interbank_offered_rates

Private Bank Clients: Where you are receiving research as a client of the private banking businesses offered by JPMorgan Chase & Co. and its subsidiaries ("J.P. Morgan Private Bank"), research is provided to you by J.P. Morgan Private Bank and not by any other division of J.P. Morgan, including, but not limited to, the J.P. Morgan Corporate and Investment Bank and its Global Research division.

Legal entity responsible for the production and distribution of research: The legal entity identified below the name of the Reg AC Research Analyst who authored this material is the legal entity responsible for the production of this research. Where multiple Reg AC Research Analysts authored this material with different legal entities identified below their names, these legal entities are jointly responsible for the production of this research. Research Analysts from various J.P. Morgan affiliates may have contributed to the production of this material but may not be licensed to carry out regulated activities in your jurisdiction (and do not hold themselves out as being able to do so). Unless otherwise stated below, this material has been distributed by the legal entity responsible for production. If you have any queries, please contact the relevant Research Analyst in your jurisdiction or the entity in your jurisdiction that has distributed this research material.

Legal Entities Disclosures and Country-/Region-Specific Disclosures:

Argentina: JPMorgan Chase Bank N.A Sucursal Buenos Aires is regulated by Banco Central de la República Argentina ("BCRA"- Central Bank of Argentina) and Comisión Nacional de Valores ("CNV"- Argentinian Securities Commission) - ALYC y AN Integral N°51). **Australia:** J.P. Morgan Securities Australia Limited ("JPMSAL") (ABN 61 003 245 234/AFS Licence No: 238066) is regulated by the Australian Securities and Investments Commission and is a Market, Clearing and Settlement Participant of ASX Limited and CHI-

X. This material is issued and distributed in Australia by or on behalf of JPMSAL only to "wholesale clients" (as defined in section 761G of the Corporations Act 2001). A list of all financial products covered can be found by visiting <https://www.jpmm.com/research/disclosures>. J.P. Morgan seeks to cover companies of relevance to the domestic and international investor base across all Global Industry Classification Standard (GICS) sectors, as well as across a range of market capitalisation sizes. If applicable, in the course of conducting public side due diligence on the subject company(ies), the Research Analyst team may at times perform such diligence through corporate engagements such as site visits, discussions with company representatives, management presentations, etc. Research issued by JPMSAL has been prepared in accordance with J.P. Morgan Australia's Research Independence Policy which can be found at the following link: [J.P. Morgan Australia - Research Independence Policy](#). **Brazil:** Banco J.P. Morgan S.A. is regulated by the Comissao de Valores Mobiliarios (CVM) and by the Central Bank of Brazil. Ombudsman J.P. Morgan: 0800-7700847 / ouvidoria.jp.morgan@jpmorgan.com. **Canada:** J.P. Morgan Securities Canada Inc. is a registered investment dealer, regulated by the Investment Industry Regulatory Organization of Canada and the Ontario Securities Commission and is the participating member on Canadian exchanges. This material is distributed in Canada by or on behalf of J.P.Morgan Securities Canada Inc. **Chile:** Inversiones J.P. Morgan Limitada is an unregulated entity incorporated in Chile. **China:** J.P. Morgan Securities (China) Company Limited has been approved by CSRC to conduct the securities investment consultancy business. **Dubai International Financial Centre (DIFC):** JPMorgan Chase Bank, N.A., Dubai Branch is regulated by the Dubai Financial Services Authority (DFSA) and its registered address is Dubai International Financial Centre - The Gate, West Wing, Level 3 and 9 PO Box 506551, Dubai, UAE. This material has been distributed by JP Morgan Chase Bank, N.A., Dubai Branch to persons regarded as professional clients or market counterparties as defined under the DFSA rules. **European Economic Area (EEA):** Unless specified to the contrary, research is distributed in the EEA by J.P. Morgan SE ("JPM SE"), which is subject to prudential supervision by the European Central Bank ("ECB") in cooperation with BaFin and Deutsche Bundesbank in Germany. JPM SE is a company headquartered in Frankfurt with registered address at TaunusTurm, Taunustor 1, Frankfurt am Main, 60310, Germany. The material has been distributed in the EEA to persons regarded as professional investors (or equivalent) pursuant to Art. 4 para. 1 no. 10 and Annex II of MiFID II and its respective implementation in their home jurisdictions ("EEA professional investors"). This material must not be acted on or relied on by persons who are not EEA professional investors. Any investment or investment activity to which this material relates is only available to EEA relevant persons and will be engaged in only with EEA relevant persons. **Hong Kong:** J.P. Morgan Securities (Asia Pacific) Limited (CE number AAJ321) is regulated by the Hong Kong Monetary Authority and the Securities and Futures Commission in Hong Kong, and J.P. Morgan Broking (Hong Kong) Limited (CE number AAB027) is regulated by the Securities and Futures Commission in Hong Kong. JP Morgan Chase Bank, N.A., Hong Kong (CE Number AAL996) is regulated by the Hong Kong Monetary Authority and the Securities and Futures Commission, is organized under the laws of the United States with limited liability. **India:** J.P. Morgan India Private Limited (Corporate Identity Number - U67120MH1992FTC068724), having its registered office at J.P. Morgan Tower, Off. C.S.T. Road, Kalina, Santacruz - East, Mumbai - 400098, is registered with the Securities and Exchange Board of India (SEBI) as a 'Research Analyst' having registration number INH000001873. J.P. Morgan India Private Limited is also registered with SEBI as a member of the National Stock Exchange of India Limited and the Bombay Stock Exchange Limited (SEBI Registration Number - INZ000239730) and as a Merchant Banker (SEBI Registration Number - MB/INM000002970). Telephone: 91-22-6157 3000, Facsimile: 91-22-6157 3990 and Website: <http://www.jpmpi.com>. JPMorgan Chase Bank, N.A. - Mumbai Branch is licensed by the Reserve Bank of India (RBI) (Licence No. 53/ Licence No. BY.4/94; SEBI - IN/CUS/014/ CDSL : IN-DP-CDSL-444-2008/ IN-DP-NSDL-285-2008/ INBI00000984/ INE231311239) as a Scheduled Commercial Bank in India, which is its primary license allowing it to carry on Banking business in India and other activities, which a Bank branch in India are permitted to undertake. For non-local research material, this material is not distributed in India by J.P. Morgan India Private Limited. **Indonesia:** PT J.P. Morgan Sekuritas Indonesia is a member of the Indonesia Stock Exchange and is regulated by the OJK a.k.a. BAPEPAM LK. **Korea:** J.P. Morgan Securities (Far East) Limited, Seoul Branch, is a member of the Korea Exchange (KRX). JPMorgan Chase Bank, N.A., Seoul Branch, is licensed as a branch office of foreign bank (JPMorgan Chase Bank, N.A.) in Korea. Both entities are regulated by the Financial Services Commission (FSC) and the Financial Supervisory Service (FSS). For non-macro research material, the material is distributed in Korea by or through J.P. Morgan Securities (Far East) Limited, Seoul Branch. **Japan:** JPMorgan Securities Japan Co., Ltd. and JPMorgan Chase Bank, N.A., Tokyo Branch are regulated by the Financial Services Agency in Japan. **Malaysia:** This material is issued and distributed in Malaysia by JPMorgan Securities (Malaysia) Sdn Bhd (18146-X), which is a Participating Organization of Bursa Malaysia Berhad and holds a Capital Markets Services License issued by the Securities Commission in Malaysia. **Mexico:** J.P. Morgan Casa de Bolsa, S.A. de C.V. and J.P. Morgan Grupo Financiero are members of the Mexican Stock Exchange and are authorized to act as a broker dealer by the National Banking and Securities Exchange Commission. **New Zealand:** This material is issued and distributed by JPMSAL in New Zealand only to "wholesale clients" (as defined in the Financial Advisers Act 2008). JPMSAL is registered as a Financial Service Provider under the Financial Service providers (Registration and Dispute Resolution) Act of 2008. **Pakistan:** J. P. Morgan Pakistan Broking (Pvt.) Ltd is a member of the Karachi Stock Exchange and regulated by the Securities and Exchange Commission of Pakistan. **Philippines:** J.P. Morgan Securities Philippines Inc. is a Trading Participant of the Philippine Stock Exchange and a member of the Securities Clearing Corporation of the Philippines and the Securities Investor Protection Fund. It is regulated by the Securities and Exchange Commission. **Russia:** CB J.P. Morgan Bank International LLC is regulated by the Central Bank of Russia. **Singapore:** This material is issued and distributed in Singapore by or through J.P. Morgan Securities Singapore Private Limited (JPMS) [MCI (P) 093/09/2021 and Co. Reg. No.: 199405335R], which is a member of the Singapore Exchange Securities Trading Limited, and/or JPMorgan Chase Bank, N.A., Singapore branch (JPMCB Singapore), both of which are regulated by the Monetary Authority of Singapore. This material is issued and distributed in Singapore only to accredited investors, expert investors and institutional investors, as defined in Section 4A of the Securities and Futures Act, Cap. 289 (SFA). This material is not intended to be issued or distributed to any retail investors or any other investors that do not fall into the classes

of “accredited investors,” “expert investors” or “institutional investors,” as defined under Section 4A of the SFA. Recipients of this material in Singapore are to contact JPMSS or JPMCB Singapore in respect of any matters arising from, or in connection with, the material. As at the date of this material, JPMSS is a designated market maker for certain structured warrants listed on the Singapore Exchange where the underlying securities may be the securities discussed in this material. Arising from its role as a designated market maker for such structured warrants, JPMSS may conduct hedging activities in respect of such underlying securities and hold or have an interest in such underlying securities as a result. The updated list of structured warrants for which JPMSS acts as designated market maker may be found on the website of the Singapore Exchange Limited: <http://www.sgx.com>. **South Africa:** J.P. Morgan Equities South Africa Proprietary Limited and JPMorgan Chase Bank, N.A., Johannesburg Branch are members of the Johannesburg Securities Exchange and are regulated by the Financial Services Board. **Taiwan:** J.P. Morgan Securities (Taiwan) Limited is a participant of the Taiwan Stock Exchange (company-type) and regulated by the Taiwan Securities and Futures Bureau. Material relating to equity securities is issued and distributed in Taiwan by J.P. Morgan Securities (Taiwan) Limited, subject to the license scope and the applicable laws and the regulations in Taiwan. According to Paragraph 2, Article 7-1 of Operational Regulations Governing Securities Firms Recommending Trades in Securities to Customers (as amended or supplemented) and/or other applicable laws or regulations, please note that the recipient of this material is not permitted to engage in any activities in connection with the material that may give rise to conflicts of interests, unless otherwise disclosed in the “Important Disclosures” in this material. **Thailand:** This material is issued and distributed in Thailand by JPMorgan Securities (Thailand) Ltd., which is a member of the Stock Exchange of Thailand and is regulated by the Ministry of Finance and the Securities and Exchange Commission, and its registered address is 3rd Floor, 20 North Sathorn Road, Silom, Bangrak, Bangkok 10500. **UK:** Unless specified to the contrary, research is distributed in the UK by J.P. Morgan Securities plc (“JPMS plc”) which is a member of the London Stock Exchange and is authorised by the Prudential Regulation Authority and regulated by the Financial Conduct Authority and the Prudential Regulation Authority. JPMS plc is registered in England & Wales No. 2711006, Registered Office 25 Bank Street, London, E14 5JP. This material is directed in the UK only to: (a) persons having professional experience in matters relating to investments falling within article 19(5) of the Financial Services and Markets Act 2000 (Financial Promotion) (Order) 2005 (“the FPO”); (b) persons outlined in article 49 of the FPO (high net worth companies, unincorporated associations or partnerships, the trustees of high value trusts, etc.); or (c) any persons to whom this communication may otherwise lawfully be made; all such persons being referred to as “UK relevant persons”. This material must not be acted on or relied on by persons who are not UK relevant persons. Any investment or investment activity to which this material relates is only available to UK relevant persons and will be engaged in only with UK relevant persons. Research issued by JPMS plc has been prepared in accordance with JPMS plc's policy for prevention and avoidance of conflicts of interest related to the production of Research which can be found at the following link: [J.P. Morgan EMEA - Research Independence Policy](#). **U.S.:** J.P. Morgan Securities LLC (“JPMS”) is a member of the NYSE, FINRA, SIPC, and the NFA. JPMorgan Chase Bank, N.A. is a member of the FDIC. Material published by non-U.S. affiliates is distributed in the U.S. by JPMS who accepts responsibility for its content.

General: Additional information is available upon request. The information in this material has been obtained from sources believed to be reliable. While all reasonable care has been taken to ensure that the facts stated in this material are accurate and that the forecasts, opinions and expectations contained herein are fair and reasonable, JPMorgan Chase & Co. or its affiliates and/or subsidiaries (collectively J.P. Morgan) make no representations or warranties whatsoever to the completeness or accuracy of the material provided, except with respect to any disclosures relative to J.P. Morgan and the Research Analyst's involvement with the issuer that is the subject of the material. Accordingly, no reliance should be placed on the accuracy, fairness or completeness of the information contained in this material. Any data discrepancies in this material could be the result of different calculations and/or adjustments. J.P. Morgan accepts no liability whatsoever for any loss arising from any use of this material or its contents, and neither J.P. Morgan nor any of its respective directors, officers or employees, shall be in any way responsible for the contents hereof, apart from the liabilities and responsibilities that may be imposed on them by the relevant regulatory authority in the jurisdiction in question, or the regulatory regime thereunder. Opinions, forecasts or projections contained in this material represent J.P. Morgan's current opinions or judgment as of the date of the material only and are therefore subject to change without notice. Periodic updates may be provided on companies/industries based on company-specific developments or announcements, market conditions or any other publicly available information. There can be no assurance that future results or events will be consistent with any such opinions, forecasts or projections, which represent only one possible outcome. Furthermore, such opinions, forecasts or projections are subject to certain risks, uncertainties and assumptions that have not been verified, and future actual results or events could differ materially. The value of, or income from, any investments referred to in this material may fluctuate and/or be affected by changes in exchange rates. All pricing is indicative as of the close of market for the securities discussed, unless otherwise stated. Past performance is not indicative of future results. Accordingly, investors may receive back less than originally invested. This material is not intended as an offer or solicitation for the purchase or sale of any financial instrument. The opinions and recommendations herein do not take into account individual client circumstances, objectives, or needs and are not intended as recommendations of particular securities, financial instruments or strategies to particular clients. The recipients of this material must make their own independent decisions regarding any securities or financial instruments mentioned herein and should seek advice from such independent financial, legal, tax or other adviser as they deem necessary. J.P. Morgan may trade as a principal on the basis of the Research Analysts' views and research, and it may also engage in transactions for its own account or for its clients' accounts in a manner inconsistent with the views taken in this material, and J.P. Morgan is under no obligation to ensure that such other communication is brought to the attention of any recipient of this material. Others within J.P. Morgan, including Strategists, Sales staff and other Research Analysts, may take views that are inconsistent with those taken in this material. Employees of J.P. Morgan not involved in the preparation of this material may have investments in the securities (or derivatives of such securities) mentioned in this

material and may trade them in ways different from those discussed in this material. This material is not an advertisement for or marketing of any issuer, its products or services, or its securities in any jurisdiction.

"Other Disclosures" last revised March 05, 2022.

Copyright 2022 JPMorgan Chase & Co. All rights reserved. This material or any portion hereof may not be reprinted, sold or redistributed without the written consent of J.P. Morgan.