J.P.Morgan

24 March 2020

JPM FX - Derivatives Chartpack Notes

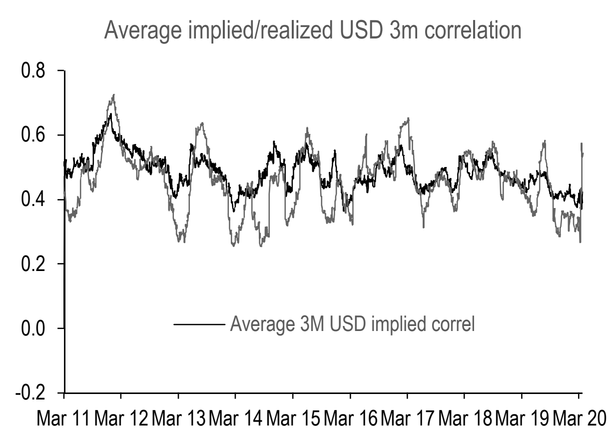
RV opportunities in the implied correlation vs. riskies space

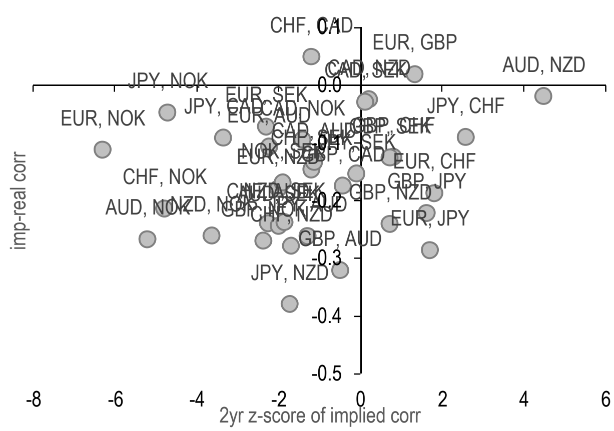
- We generally find that, unlike vol levels and Equity correlations, FX USD implied correlations are still not pricing any particular premium related to the risk-off mode as experienced by markets so far this Month.
- As an another possibility for trading high-leverage structures, we look for implied correlations that screen as expensive when compared with an alternative measure of "directionality" of risk, as expressed by the relative sign of risk-reversals prices.

FX vols spectacularly emerged from their most recent lethargic state at the end of February, with current pricing not consistent with a proper distressed market mode yet (*Not yet at distress highs in FX vol*, Sandilya, 20 March). Of course this view may come under pressure if the COVID-19 spread starts to show signs of slowing as some of the alternative data analyses show and/or if a compromise solution starts to bring parts of the economy back online (*Political choices and financial forecast, big data and early indications of US pandemic inflection*, Kolanovic & Kaplan, March 24). One thing which stuns in the FX space is the lack of repricing of USD implied correlations, at a time when all risk-measures are spiking and, as a comparison, measures of Equity implied correlations reached all-time highs in mid-March. Long USD correlation and skew positions were recommended as a hedge in a piece published this January, ahead of the market carnage that started a few weeks later (*Long USD skews and correlations offer room for playing COVID-19 hedge trades*, Ravagli, Jankovic, 27 Jan).

We can see that, at least in the G10 space (Exhibit 1, LHS chart), average pricing of 3M USD implied correlations remained fairly constant over the past month, trading at a 15 corr points discount vs realized correlation, which spiked over the past two weeks as long USD positions were supported in the risk-off correction. A more granular analysis in the 2yr z-score of implied correlations vs. correlation premium space shows several cases, amongst which NZD-JPY, NZD-CHF and GBP-USD (in the latter case, implied trails realized by 32 corr points), where current pricing of implied correlations is attractive. Keeping in mind that liquidity of correlation products might be now drier than during normal market conditions, scouting for cheap entry points in the correlation space does not look like an unrealistic task, even at this point in the COVID-19 crisis. One possibility why this might be the case is that, after a rollercoaster ride, the DXY Index is on up a mere 1.5% since mid-February, as an indication that its safe haven status might not be fully trusted by investors.

Exhibit 1. USD-correlations in the G10 space are still trading at a substantial discount vs. realized correlations.



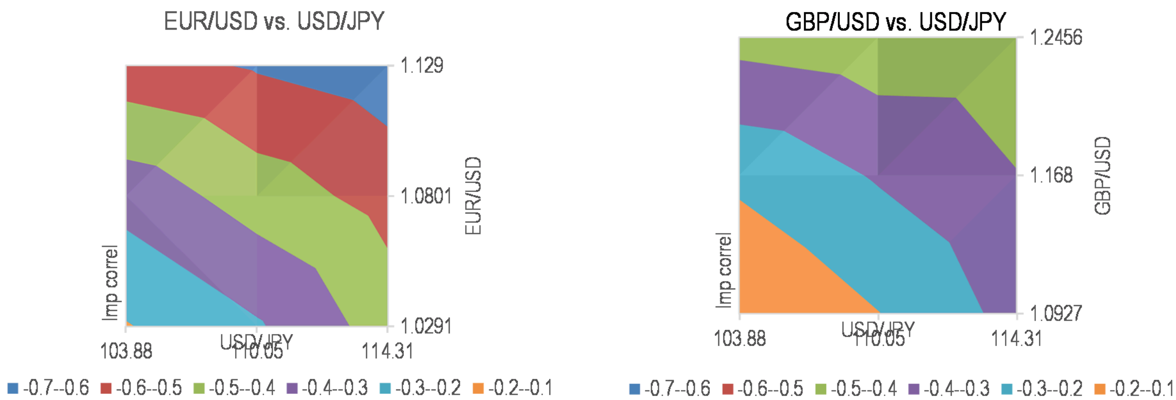


Source: J.P. Morgan, Bloomberg

We remind readers that the simplest way for estimating implied correlations is via a trigonometric identity involving ATM volatilities, as, for instance, displayed in the charts above. The actual pricing of correlation products, like corr swap, dual-digis, best/worst-of is in addition also sensitive to vol smiles. In the two following charts, we display two simplified case studies (Exhibit 2), for USD/JPY vs. EUR/USD and GBP/USD, where we consider three strikes for each pair (corresponding to 3M ATMF and +-25delta), and compute the implied correlation based on the cross-vol for the equivalent strike (as an example, for EUR/USD $K_1 = 1.0927$, USD/JPY $K_2 = 103.88$, EUR/JPY $K_{1,2} = K_1 * K_2 = 113.51$).

The resulting correlation surfaces display a marked strike-sensitivity (i.e., they do depend on the skew), as an indication that, for both buyers and sellers of correlation, the choice of the strike, as in dual-digi structures, can be optimized for reaching a desired correlation benefit. In the two cases below, however, the level of the correlation remains negative for all strikes considered, even the one where USD moves in opposite direction vs. the two other currencies (i.e., EUR/USD and USD/JPY down). After re-expressing the above in terms of USD as a common asset currency for both pairs, USD correlations are then always positive.

Exhibit 2. Two examples of implied correlation surfaces: USD/JPY vs EUR/USD and GBP/USD (3M, as of 23 March)



Source: J.P. Morgan, Bloomberg

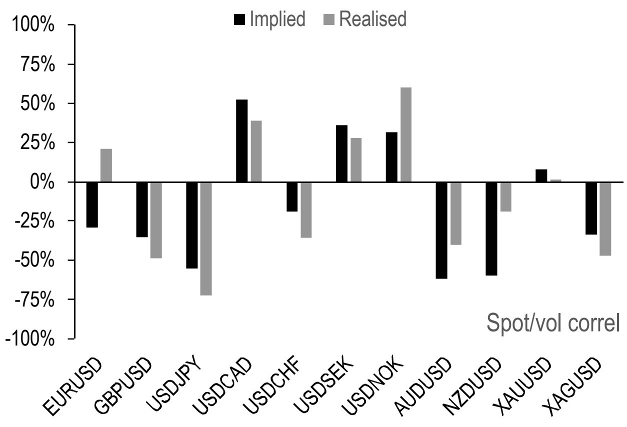
Short-correlation trades can also allow playing high-leverage structures that don't require paying excessive upfront premia. We expand on an analysis as already introduced last week (*Leveraged hedging of COVID-19 uncertainty with dual digitals*, Jankovic, Ravagli, 17 March) where we were finding substantial (short-correlation) discounts by looking for a mismatch between sign of correlation and relative sign of riskies.

In the world of pricing, skew levels are directly related to the implied spot/volatility correlations (Exhibit 3, LHS). In other words, for each pair, the sign of the riskies suggests which direction spot price should move following a rise in volatility levels. Based on the sign of riskies, we can see that now market would expect USD to rise in a higher-vol environment against all EM pairs, and all G10 pairs with the exception of CHF and JPY. This, at least, by assuming that current pricing of riskies is reflective of current dynamics and/or is not dramatically altered by excessive flows, an argument that could probably be invoked when looking at the latest USD/JPY pricing dynamics, with riskies reaching the widest level since GFC. While current vol levels are now well above long-term averages, the skew proxy would indicate where spot could move if risk conditions were to worsen further from here.

That said, for two USD/ccy pairs, one can simply compare the level of implied correlation (for simplicity, by referring to the ATM levels as discussed above) with the relative sign of USD riskies. **On the occasions where the pricing of the two USD riskies is opposite, and the implied correlation is positive (or the other way around), there is an apparent mismatch as far as directionality of risk is concerned between riskies and correls.** The apparent conundrum can be resolved by realizing that, while implied correls for two pairs tend to be positive when measured via the common currency, and are therefore representative of a general appreciation or drop of that currency, the implied move as forecast by riskies sign could be better representative of the actual correlation in the left-tail, risk-off quadrant, with higher market vols. Given that most USD correlations are positive and that the two pairs with risk-off sensitivity vs. USD are JPY and CHF, such RV opportunities can be currently found on triplets involving USD and *just one* of the two latter currencies (see Exhibit 3, RHS).

Exhibit 3. Implied vs. realized spot/vol correl for G10 currencies and precious metals. RV opportunity between pricing of riskies and of implied correls in case of a further rise in vols: cases where such RV opportunities are present are label as “RV” and drawn in blue

Implied spot/vol correl refers to: standard FX convention (left-hand side chart) and USD/VVY (right-hand side chart)



	EUR	GBP	JPY	CHF	CAD	AUD	NZD	NOK	SEK
EUR			RV	RV					
GBP			RV	RV					
JPY	RV	RV				RV	RV		RV
CHF	RV	RV			RV	RV	RV	RV	RV
CAD				RV					
AUD			RV	RV					
NZD			RV	RV					
NOK				RV					
SEK			RV	RV					

Source: J.P. Morgan

When finding such RV mismatches, one could conclude that either the price of riskies or that of correls presents an opportunity. In this piece we’ll assume that price of riskies correctly predicts spot directionality in a risk-off market, and we trade correlations accordingly, via dual-digital structures (conversely, one could be interested in trading riskies). We keep in mind the strike sensitivity of correlation surfaces as seen above, which guides in the choice of the strikes for the dual digis for maximizing correlation discounts. For instance, last week when suggesting bearish structures on EUR and GBP, we favoured closer to the money strikes on USD/JPY, implying higher premia, but better entry points in terms of higher implied correlation (as seen in Exhibit 2).

CHF/ccy USD-implied correlations are positive at present. We point out that SNB intervention, as carried out last week, might put a cap on the possible appreciation of CHF. SEK looks appealing to be included into the structure on the back of a lower vol / less explosive price action so far displayed than for other G10 pairs (most notably, NOK) and an attractive entry point in terms of implied correl (around 47% for 3M USD/CHF vs. USD/SEK correl, from ATM vols, trailing realized by just 15 corr points). The better risk tone over the past day, with lower vols and a weaker dollar, might offer a better entry point for playing the defensive structure as above. We point out that, while do not cover XAU and XAG in the RV screener above, the positive sign of the XAU/USD r/r would suggest value in considering XAU on par with JPY and CHF for offering correlation discount in dual-digital structures.

The two dual-digi structures as recommended below summarize the earlier findings on attractive high-leverage structures respectively long and short correl.

Consider:

- *Buy a 2M dual-digi GBP/USD<4% OTMS, AUD/USD <4% OTMS @ 14% (mid trades at 50% discount vs. cheapest digital)*
- *Buy a 2M dual-digi USD/CHF<1% OTMS, USD/SEK > 5% OTMS @ 6.25% (mid trades at 80% discount vs. cheapest digital)*

Global Quantitative and Derivatives Strategy
Lorenzo Ravagli, PhD AC
(44-20) 7742-7947
lorenzo.ravagli@jpmorgan.com
J.P. Morgan Securities plc
Global FX Strategy
Ladislav Jankovic AC
(1-212) 834-9618
ladislav.jankovic@jpmchase.com
J.P. Morgan Securities LLC

www.jpmorganmarkets.com

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 their analysis was made in good faith and that the views reflect their own opinion, without undue influence or intervention.

All authors named within this report are research analysts unless otherwise specified. In Europe, Sector Specialists may be shown on this report as contacts but are not authors of the report or part of the Research Department.

Important Disclosures

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 by visiting https://www.jpmm.com/research/disclosures, calling 1-800-477-0406, or e-mailing research.disclosure.inquiries@jpmorgan.com with your request. J.P. Morgan's Strategy, Technical, and Quantitative Research teams may screen companies not covered by J.P. Morgan. For important disclosures for these companies, please call 1-800-477-0406 or e-mail research.disclosure.inquiries@jpmorgan.com.

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, www.jpmorganmarkets.com.

J.P. Morgan Equity Research Ratings Distribution, as of January 02, 2020

	Overweight (buy)	**Neutral** (hold)	**Underweight** (sell)
J.P. Morgan Global Equity Research Coverage	45%	41%	15%
IB clients*	51%	47%	39%
JPMS Equity Research Coverage	43%	42%	14%
IB clients*	75%	64%	56%

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

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.

Registration of non-US Analysts: Unless otherwise noted, the non-US analysts listed on the front of this report are employees of non-US affiliates of J.P. Morgan Securities LLC, may not be registered as research analysts under FINRA rules, may not be associated persons of J.P. Morgan Securities LLC, and may not be subject to FINRA Rule 2241 or 2242 restrictions on communications with covered companies, public appearances, and trading securities held by a research analyst account.

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.

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

Any data discrepancies in this report could be the result of different calculations and/or adjustments.

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

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.

Principal Trading: J.P. Morgan trades or may trade as principal in the derivatives or the debt securities (or related derivatives) that are the subject of this report.

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 research division.

Legal entity responsible for the production of research: The legal entity identified below the name of the Reg AC research analyst who authored this report is the legal entity responsible for the production of this research. Where multiple Reg AC research analysts authored this report with different legal entities identified below their names, these legal entities are jointly responsible for the production of this research.

Legal Entities Disclosures
U.S.: JPMS is a member of NYSE, FINRA, SIPC and the NFA. JPMorgan Chase Bank, N.A. is a member of FDIC. **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. **U.K.**: JPMorgan Chase N.A., London Branch, is authorised by the Prudential Regulation Authority and is subject to regulation by the Financial Conduct Authority and to limited regulation by the Prudential Regulation Authority. Details about the extent of our regulation by the Prudential Regulation Authority are available from J.P. Morgan on request. J.P. Morgan Securities plc (JPMS plc) 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. Registered in England & Wales No. 2711006. Registered Office 25 Bank Street, London, E14 5JP. **Germany**: This material is distributed in Germany by J.P. Morgan Securities plc, Frankfurt Branch which is regulated by the Bundesanstalt für Finanzdienstleistungsaufsich and also by J.P. Morgan AG (JPM AG) which is a member of the Frankfurt stock exchange and is regulated by the Federal Financial Supervisory Authority (BaFin), JPM AG is a company incorporated in the Federal Republic of Germany with registered office at Taunustor 1, 60310 Frankfurt am Main, the Federal Republic of Germany. **South Africa**: J.P. Morgan Equities South Africa Proprietary Limited is a member of the Johannesburg Securities Exchange and is regulated by the Financial Services Board. **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/or 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 is organized under the laws of U.S.A. with limited liability. **China**: J.P. Morgan Securities (China) Company Limited has been approved by CSRC to conduct the securities investment consultancy business. **Korea**: This material is issued and distributed in Korea by or through J.P. Morgan Securities (Far East) Limited, Seoul Branch, which is a member of the Korea Exchange(KRX) and is regulated by the Financial Services Commission (FSC) and the Financial Supervisory Service (FSS). **Australia**: J.P. Morgan Securities Australia Limited (JPMSAL) (ABN 61 003 245 234/AFS Licence No: 238066) is regulated by ASIC and is a Market, Clearing and Settlement Participant of ASX Limited and CHI-X. **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. **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 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: www.jpmipl.com. For non local research reports, this material is not distributed in India by J.P. Morgan India Private Limited. **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. **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. **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. **Brazil**: Banco J.P. Morgan S.A. is regulated by the Comissao de Valores Mobiliarios (CVM) and by the Central Bank of Brazil. **Mexico**: J.P. Morgan Casa de Bolsa, S.A. de C.V., J.P. Morgan Grupo Financiero is a member of the Mexican Stock Exchange and authorized to act as a broker dealer by the National Banking and Securities Exchange Commission. **Singapore:** This material is issued and distributed in Singapore by or through J.P. Morgan Securities Singapore Private Limited (JPMSS) [MCI (P) 058/04/2019 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) [MCI (P) 070/09/2019], 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 document are to contact JPMSS or JPMCB Singapore in respect of any matters arising from, or in connection with, the document. **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 a holder of Capital Markets Services License issued by the Securities Commission in Malaysia. **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. **Dubai**: 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 - Building 3, Level 7, PO Box 506551, Dubai, UAE. **Russia:** CB J.P. Morgan Bank International LLC is regulated by the Central Bank of Russia. **Argentina:** JPMorgan Chase Bank 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")

Country and Region Specific Disclosures
U.K. and European Economic Area (EEA): Unless specified to the contrary, issued and approved for distribution in the U.K. and the EEA by JPMS plc. Investment research issued by JPMS plc has been prepared in accordance with JPMS plc's policies for managing conflicts of interest arising as a result of publication and distribution of investment research. Many European regulators require a firm to establish, implement and maintain such a policy. Further information about J.P. Morgan's conflict of interest policy and a description of the effective internal organisations and administrative arrangements set up for the prevention and avoidance of conflicts of interest is set out at the following link https://www.jpmorgan.com/jpmpdf/1320742677360.pdf. This report has been issued in the U.K. only to persons of a kind described in Article 19 (5), 38, 47 and 49 of the Financial Services and Markets Act 2000 (Financial Promotion) Order 2005 (all such persons being referred to as "relevant persons"). This document must not be acted on or relied on by persons who are not relevant persons. Any investment or investment activity to which this document relates is only available to relevant persons and will be engaged in only with relevant persons. In other EEA countries, the report has been issued to persons regarded as professional investors (or equivalent) in their home jurisdiction. **Australia:** This material is issued and distributed by JPMSAL in Australia to "wholesale clients" only. This material does not take into account the specific investment objectives, financial situation or particular needs of the recipient. The recipient of this material must not distribute it to any third party or outside Australia without the prior written consent of JPMSAL. For the purposes of this paragraph the term "wholesale client" has the meaning given in section 761G of the Corporations Act 2001. J.P. Morgan's research coverage universe spans listed securities across the ASX All Ordinaries index, securities listed on offshore markets, unlisted issuers and investment products which Research management deem to be relevant to the investor base from time to time. J.P. Morgan seeks to cover companies of relevance to the domestic and international investor base across all GIC sectors, as well as across a range of market capitalisation sizes. **Germany:** This material is distributed in Germany by J.P. Morgan Securities plc, Frankfurt Branch which is regulated by the Bundesanstalt für Finanzdienstleistungsaufsicht. **Korea:** This report may have been edited or contributed to from time to time by affiliates of J.P. Morgan Securities (Far East) Limited, Seoul Branch. **Singapore:** As at the date of this report, 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 report. Arising from its role as 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. In addition, JPMSS and/or its affiliates may also have an interest or holding in any of the securities discussed in this report – please see the Important Disclosures section above. For securities where the holding is 1% or greater, the holding may be found in the Important Disclosures section above. For all other securities mentioned in this report, JPMSS and/or its affiliates may have a holding of less than 1% in such securities and may trade them in ways different from those discussed in this report. Employees of JPMSS and/or its affiliates not involved in the preparation of this report may have investments in the securities (or derivatives of such securities) mentioned in this report and may trade them in ways different from those discussed in this report. **Taiwan**: Research 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 which may give rise to conflicts of interests, unless otherwise disclosed in the "Important Disclosures" in this material. **India:** For private circulation only, not for sale. **Pakistan:** For private circulation only, not for sale. **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). The recipient of this material must not distribute it to any third party or outside New Zealand without the prior written consent of JPMSAL. **Canada:** This report is distributed in Canada by or on behalf of J.P.Morgan Securities Canada Inc. The information contained herein is not, and under no circumstances is to be construed as an offer to sell securities described herein, or solicitation of an offer to buy securities described herein, in Canada or any province or territory thereof. The information contained herein is under no circumstances to be construed as investment advice in any province or territory of Canada and is not tailored to the needs of the recipient. **Dubai:** This report has been distributed to persons regarded as professional clients or market counterparties as defined under the DFSA rules. **Brazil:** Ombudsman J.P. Morgan: 0800-7700847 / ouvidoria.jp.morgan@jpmorgan.com.

General: Additional information is available upon request. Information has been obtained from sources believed to be reliable but JPMorgan Chase & Co. or its affiliates and/or subsidiaries (collectively J.P. Morgan) do not warrant its completeness or accuracy except with respect to any disclosures relative to JPMS and/or its affiliates and the analyst's involvement with the issuer that is the subject of the research. All pricing is indicative as of the close of market for the securities discussed, unless otherwise stated. Opinions and estimates constitute our judgment as of the date of this material and are subject to change without notice. Past performance is not indicative of future results. 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 recipient of this report must make its own independent decisions regarding any securities or financial instruments mentioned herein. JPMS distributes in the U.S. research published by non-U.S. affiliates and accepts responsibility for its contents. Periodic updates may be provided on companies/industries based on company specific developments or announcements, market conditions or any other publicly available information. Clients should contact analysts and execute transactions through a J.P. Morgan subsidiary or affiliate in their home jurisdiction unless governing law permits otherwise.

"Other Disclosures" last revised March 08, 2020.