

This report is neither intended to be distributed to Mainland China investors nor to provide securities investment consultancy services within the territory of Mainland China. This report or any portion hereof may not be reprinted, sold or redistributed without the written consent of J.P. Morgan.

14 July 2020

JPM FX - Derivatives Chartpack Notes

Smiling at vol curves

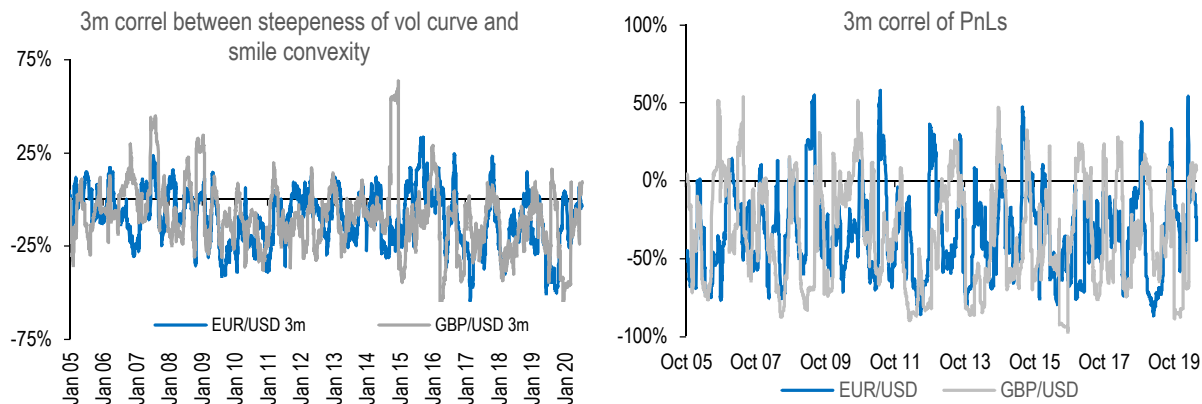
- We introduce a systematic assessment of a FX vol strategy which leverages on both smile convexity and vol curve premia. We implement the smile-adjusted calendar strategy by selling front-end strangles and buying longer-end straddles, in Vega-neutral format. Future pieces of research will investigate other “hybrid” combinations allowing more flexibility as far as directional sensitivities / portfolio Vegas are concerned.
- EUR/USD and USD/JPY are two cases that, on the back of flattish front-end curves and elevated smile convexity, favor the implementation of the delta-hedged calendar straddle vs. strangle strategy.

The cross-asset strategy team maintains a bullish stance on markets ([*Global Asset Allocation – Staying pro-risk, adding back to equity OW*](#), Kolanovic et al, 10 July), given relative cheapness of Equities over bonds, policy support and rebound in growth, unlikely to be put at risk by new lockdowns. In the FX vol space, the picture above is fully consistent with the rather steady decline of vol levels since late March, and the output of our tactical filter keeping a short-Gamma bias since May, after flashing the most extreme risk-off signals on record throughout March and into April (see for instance [here](#)). Yet, low valuations from a historical standpoint and a macro agenda that could trigger vols in the second half of the year made us support a slightly more defensive positioning, favoring RVs over outright short vol ([*RVs and vol ratio spreads still the game*](#), Jankovic, 2 July).

In this short note, we aim at shedding some light on the interplay between vol smile and term structure dynamics, for alpha generation purposes via RV structures. The two topics have been the subject of earlier research notes. Rich FX smile convexity generally supports the implementation of short-dated short-strangle / long straddle constructs, although some attention on the relative scaling of the two Vega notionals is required for allowing the strategy to stand the impact of costs ([*Softer than shadow and quicker than flies – A first glance at FX vol of vol strategies*](#), Ravagli, 2 June). Similarly, short front-end, long long-end vol steepeners, traded for instance via delta-hedged straddles typically obtain smoother performances than the short-Gamma trade outright ([*How does the correlation between spot and rates differentials impact FX vol curves*](#), Ravagli et al, 28 April). It hence appears natural to consider the combination of the two effects by twisting the calendar straddle vs. straddle trade with a smile component.

Exhibit 1. Proxies of smile and vol curve premia exhibit modest correlation over time. Correlation of the corresponding premia strategies is also contained in the long-run.

(LHS) 3m 25delta fly/ATM vs (1M vol-3M vol)/3M vol. (RHS) daily P/Ls of Vega-neutral -1m/+3m straddles vs 1m +straddle/-25D strangle.



Source: J.P. Morgan

Before showing actual backtests, we investigate the correlation between smile and term structure dynamics for FX vol surfaces, in order to assess the possible diversification benefit offered by these “hybrid” smile/curve strategies. During risk-off times, one could intuitively expect curves to invert and smiles becoming more convex, thus triggering a positive correlation between the two strategies and a doubling-up of risk when mixing them together. We start by computing the rolling correlation of ex-ante proxies of smile (3m 25delta fly/ATM) and curve premia ((1M vol-3M vol)/3M vol), for EUR/USD and GBP/USD (Exhibit 1, LHS). For both cases considered, the correlation of proxy premia is not significant over time. The ex-post measure, based on the daily PnLs of the actual strategies (Exhibit 1, RHS - Vega-neutral -1m/+3m straddles and 1m +straddle/-25delta strangle), similarly does not highlight a structurally positive correlation, strengthening the added value of combining the two risk premia together.

We then investigate actual backtests for the calendar strangle/straddle strategies. We start from the term structure benchmark and twist the short vol leg from straddle to strangle. In this introductory note, we do not address the topic of different Vega scaling, which was important for managing the impact of costs in the earlier note on smile strategies – for this purpose, we assume zero costs to start with and we’ll dig more on costs / relative scaling of Vega notionals in future publications. Backtests refer to 15-yr periods (except for USD/CNH, since January 2011), implementations are in a Vega-neutral short 25delta strangle / long straddle with -1m/+3m and -3m+1y tenors.

We start by presenting results for USD/G10 pairs (Exhibit 2). In the charts we display Sharpe ratios for three cases: a) short front-end straddle; b) straddle vs. straddle calendar steepener; c) short strangle vs. long straddle calendar steepener. As discussed, under the strong assumption of zero trading costs, results look very appealing, in that calendars typically outperform plain short-Gamma in terms of higher Sharpe ratios¹, and so do the smile-twisted calendars over the straddle vs. straddle ones. Under the zero-cost limit, playing very much at the front of the curves outperforms longer-tenor trades (although the impact of costs might prove more onerous). Also, when taking into account costs, the Vega-neutrality constraint might prove too tight, and possibly realistic implementations would require relaxing the condition in favor of more aggressive Theta-harvesting structures. With these caveats in mind, EUR/USD and USD/JPY are the two cases associated with more promising output. One thing to keep in mind is that currently depressed Sharpe ratios come on the heels of the dramatic March vol episode that slammed the recent short vol performance. The bulk of the USD pairs is still undergoing the recovery. Results for USD/CHF suffer from the January 2015 de-pegging by SNB, which severely impacted short-Gamma trades.

¹ We take the opportunity of amending an earlier calculation typo that was featured in the earlier piece on calendar strategies

Exhibit 2. USD/G10: -1m/+3m, -3m/+1y backtests produce very promising results assuming zero trading costs.

Traded daily, each calendar held until expiry of short-leg. 15 yrs-data for all currencies.

Sharpe's 1m3m case				Sharpe's 3m1y case			
ccy pair	Straddle	Calendar	Calendar + smile	ccy pair	Straddle	Calendar	Calendar + smile
EUR-USD	0.81	0.80	1.37	EUR-USD	0.65	0.83	1.06
GBP-USD	-0.13	-0.33	0.35	GBP-USD	0.04	0.12	0.50
USD-JPY	0.51	0.80	1.23	USD-JPY	0.36	0.53	0.74
USD-CHF	-0.11	-0.16	0.11	USD-CHF	-0.06	-0.10	0.01
USD-CAD	0.18	0.16	0.83	USD-CAD	0.48	0.49	0.82
USD-NOK	0.05	0.08	0.29	USD-NOK	0.14	0.13	0.42
USD-SEK	0.09	0.07	0.48	USD-SEK	0.21	0.16	0.48
AUD-USD	0.00	0.04	0.21	AUD-USD	0.13	0.23	0.35
NZD-USD	-0.14	-0.11	0.06	NZD-USD	-0.02	0.05	0.24

Source: J.P. Morgan

A similar picture emerges when looking at the USD/EM space (Exhibit 3). We stress how the results here presented are just meant to display an indicative pattern, but that the elevated Sharpe ratios discount the lack of trading costs that for EM options typically play a significant role. Nonetheless, the general conclusion of the appeal of these structures appears intact, although the added value of the smile-adjustment appears more contained with respect to the G10 case. If ever, more work will be required for guiding towards the choice of optimal tenors and Vega scaling combinations for being able to absorb the impact of costs.

Exhibit 3. USD/EM: -1m/+3m, -3m/+1y backtests produce very promising results assuming zero trading costs.

Traded daily, each calendar held until expiry of short-leg. 15 yrs-data for all currencies.

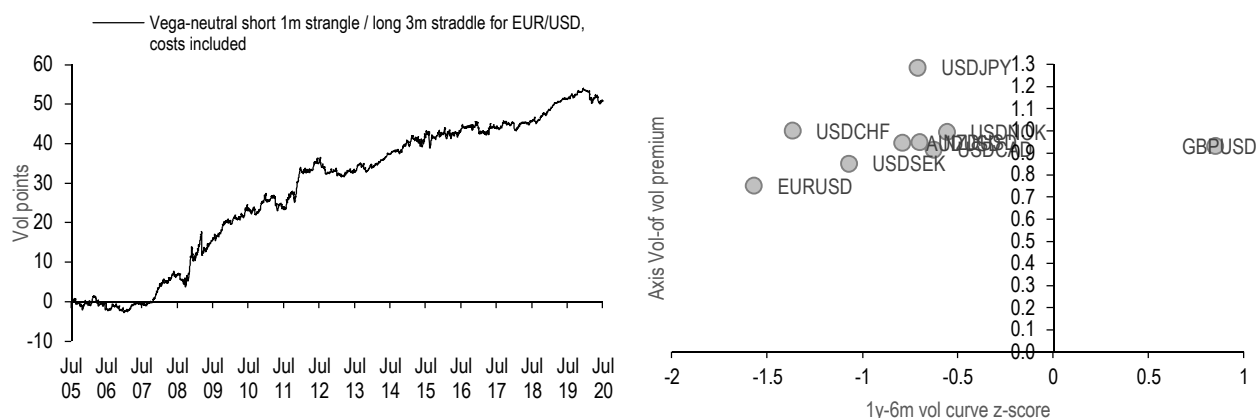
Sharpe's 1m3m case				Sharpe's 3m1y case			
ccy pair	Straddle	Calendar	Calendar + smile	ccy pair	Straddle	Calendar	Calendar + smile
USD-BRL	1.23	1.82	1.81	USD-BRL	0.90	0.91	0.98
USD-MXN	1.09	1.69	2.12	USD-MXN	0.75	1.06	0.95
USD-TRY	1.55	2.13	2.05	USD-TRY	1.08	1.39	1.30
USD-ZAR	0.76	0.91	0.36	USD-ZAR	0.74	0.90	1.17
USD-PLN	0.71	0.85	1.13	USD-PLN	0.81	0.78	0.88
USD-HUF	0.31	0.29	0.89	USD-HUF	0.53	0.46	0.80
USD-KRW	1.44	2.01	1.96	USD-KRW	0.97	1.27	0.99
USD-SGD	1.62	1.66	2.35	USD-SGD	1.40	1.58	1.85
USD-CNH	1.65	2.17	0.36	USD-CNH	0.91	0.85	1.13
USD-INR	2.92	3.89	3.90	USD-INR	1.89	2.19	2.10
USD-TWD	1.85	2.46	1.20	USD-TWD	1.13	1.24	1.17
USD-IDR	2.92	4.91	3.33	USD-IDR	1.58	2.04	1.61

Source: J.P. Morgan

Accounting for transaction costs, the Vega-neutral, smile-adjusted -1m/+3m calendar still delivers good results on EUR/USD (Exhibit 4, LHS), scooping an average of 3 vol points per year. More generally, one could think of coming up with a RV summarizing a measure of smile convexity premium with one on vol curve dislocation. Within the G10 space, a brute force comparison of implied-realized 3m vol-of-vol (former, from SABR-model calibration; latter, from 3m vol of 3m ATM vol) with 6m z-score of 1y-6m segment of vol curves (Exhibit 4, RHS), as discussed in the earlier note, points to the generalized added value of selling front-end smile convexity. GBP/USD stands out as the case offering the best added value from a vol curve perspective, with the 6m-1y segment of the vol curve made “artificially” flattish by the ~6m Brexit risk premium. One could think of taking advantage of the flatter front-end curve by selling front-end vols, without taking too much of an exposure to Brexit risk.

Exhibit 4. Long term performance proves to be attractive for the EUR/USD smile-adjusted delta-hedged calendar strategy even after accounting for costs. Current pricing of wings and shape of the vol curve favors looking at GBP/USD too.

Traded daily, each calendar held until expiry of short-leg. Transaction costs corresponding to internal J.P. Morgan pricing platform.



Source: J.P. Morgan

Consider:

- Sell 1m 25delta strangle @ 7.2 change / buy 3m straddle @ 6.65/6.85 indic. on EUR/USD, Vega-adjusted notionals, keep delta-hedged
- Sell 1m 25delta strangle @ 8.4 change / buy 3m straddle @ 8.4/8.7 indic. on GBP/USD, Vega-adjusted notionals, keep delta-hedged

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

(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.jpmm.com.

J.P. Morgan Equity Research Ratings Distribution, as of July 04, 2020

	Overweight (buy)	Neutral (hold)	Underweight (sell)
J.P. Morgan Global Equity Research Coverage	46%	39%	15%
IB clients*	53%	49%	38%
JPMS Equity Research Coverage	43%	42%	15%
IB clients*	75%	70%	58%

*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.jpmm.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.jpmm.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.

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

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 Finanzdienstleistungsaufsicht 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.jpmpil.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) 018/04/2020 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 July 04, 2020.

Copyright 2020 JPMorgan Chase & Co. All rights reserved. This report or any portion hereof may not be reprinted, sold or redistributed without the written consent of J.P. Morgan.