US Treasury Market Daily

The long and short of relative value

- Treasury yields rose prior to the US open, on news that the EU and UK had reached a revised Withdrawal Agreement, but reversed somewhat on weaker-than-expected housing and manufacturing data
- Since Treasury inquired about potential 20-year issuance this sector has cheapened along the curve and appears relatively cheap after adjusting for the curve. On a bond-by-bond basis, we see the biggest cheapening having occurred in the mid-2020 sector. With the 20-year discussion just beginning, we think this sector is unlikely to retrace richer any time soon
- Longer-tenor T-bills have richened significantly since the Fed announced its T-bill purchases last week, and we find short coupons have actually outperformed bills in the process
- 10-year TIPS breakevens widen after briefly tightening through the 150.5bp Sep 3 low. The momentum divergence pattern that whipsaw created above favored support in the 140s points to a maturing tightening trend. Tactically, breakevens keep a widening bias while above 152bp

Fixed Income Strategy

Jay Barry AC
(1-212) 834-4951
john.f.barry@jpmorgan.com

Jason Hunter AC
(1-212) 270-0034
jason.x.hunter@jpmorgan.com

Phoebe A White AC
(1-212) 834-3092
phoebe.a.white@jpmorgan.com

Alix Tepper Floman
(1-212) 622-9461
alix.tepper@jpmorgan.com

Luke Y Chang
(1-212) 834-7568
luke.chang@jpmorgan.com

Natalie Matejkova
(1-212) 834-7218
natalie.matejkova@jpmorgan.com

J.P. Morgan Securities LLC

Statistics for various on-the-run Treasury yields, curve spreads, and TIPS breakevens

		Close	1d chg (bp)	WTD chg (bp)	YTD chg (bp)	3m avg	3m low	3m high	3m pctl.
Yields (%)	4wk	1.72	0.0	-2.6	-70.7	1.95	1.66	2.11	12%
	13wk	1.66	0.5	-0.5	-78.9	1.92	1.65	2.11	2%
	26wk	1.62	-0.5	-5.7	-93.0	1.88	1.62	2.09	0%
	52wk	1.59	-0.3	-7.1	-104.8	1.79	1.59	2.02	0%
	2y	1.60	1.4	-1.3	-79.3	1.62	1.39	1.89	43%
	5y	1.58	1.2	0.1	-94.0	1.55	1.31	1.86	48%
	10y	1.75	1.1	0.3	-94.4	1.71	1.46	2.08	48%
	30y	2.24	1.1	2.9	-80.4	2.20	1.94	2.61	45%
Curves (bp)	2s/5s	-2.2	-0.2	1.4	-14.7	-6.9	-13.5	-0.1	84%
	5s/10s	17.8	-0.2	0.2	-0.4	15.6	9.3	24.9	54%
	2s/10s	15.6	-0.4	1.6	-15.1	8.7	-3.7	24.8	68%
	10s/30s	48.8	0.1	2.7	14.0	48.8	43.9	55.9	40%
TIPS BEs (bp)	5y	138.7	2.9	3.7	-10.8	141.2	125.7	161.0	37%
	10y	157.8	1.2	1.7	-13.7	160.4	147.9	180.7	30%
	30y	164.0	0.9	1.6	-17.8	165.4	155.4	184.7	29%

Source: J.P. Morgan

Jay Barry
(1-212) 834-4951
john.f.barry@jpmorgan.com

Jason Hunter
(1-212) 270-0034
jason.x.hunter@jpmorgan.com

Phoebe A White
(1-212) 834-3092
phoebe.a.white@jpmorgan.com

Alix Tepper Floman
(1-212) 622-9461
alix.tepper@jpmorgan.com

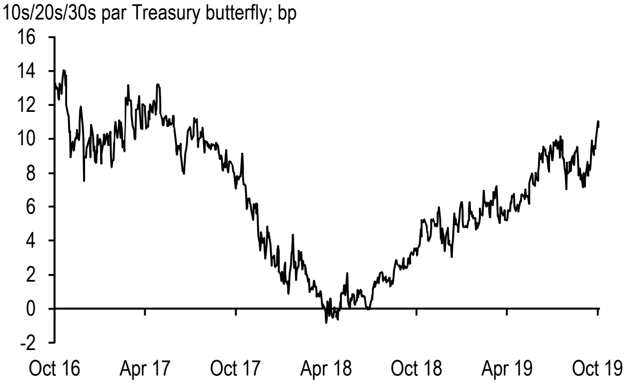
Market views

Treasury yields rose prior to the US open on news that the EU and UK had reached a revised Withdrawal Agreement. It is key that Johnson has agreed to a deal, which substantially reduces the risk of a "no-deal Brexit" (see *Brexit: Come on Arlene (apologies to Dexys)*, Malcolm Barr, 10/17/19). After this initial move higher, Treasury yields retraced lower, in large part driven by weaker-than-expected housing and manufacturing data, finishing approximately 1bp higher across the curve. **We remain neutral on duration here: though the market remains well-priced for a 25bp ease in October and position technicals are somewhat long, yields are broadly in the middle of their 3-month range.** Separately, the new October-maturity 5-year TIPS auction was well-received this afternoon, clearing 2.1bp through pre-auction levels, as end users took down 86.2% of the offering, slightly above the previous 3-auction average. In the aftermath, front-end TIPS breakevens closed 3-4bp wider on the day.

What's going on in the 20-year sector?

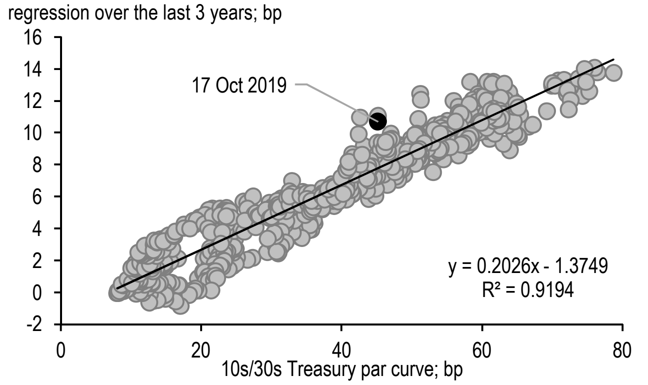
Last Friday Treasury released its primary dealer questionnaire ahead of the November refunding, and one question asked for commentary on the sources of demand for a potential 20-year bond. This question did not come entirely out of left field: TBAC's work in 2017 recommended that Treasury "consider issuing a zero coupon 50-year bond, and coupon maturities between 10- and 30-years, preferably the reintroduction of the 20-year."[1] Moreover, our own work has highlighted that market participants tend to favor a 20-year over an ultra-long (see *The (ultra) long and winding road*, 8/29/19). Thus, with Treasury's financing needs set to rise sharply as we head into the 2020s, we are not surprised that Treasury is considering a new maturity point along the curve, nor that it is interested in gathering feedback on a 20-year bond.

Exhibit 1: The 20-year sector has cheapened along the curve over the past week, and now sits at its cheapest levels since mid-2017…
10s/20s/30s par Treasury butterfly; bp



Source: J.P. Morgan

Exhibit 2: The 20-year sector has cheapened along the curve over the past week, and now sits at its cheapest levels since mid-2017…
10s/20s/30s Treasury par butterfly regressed on 10s/30s Treasury par curve (bp), regression over the last 3 years; bp



Source: J.P. Morgan

Nevertheless, this caught market participants by surprise, as the line of questioning from Treasury prior to this questionnaire indicated Treasury was once again resurrecting the idea of an ultra-long bond. As a result, the 20-year sector has

[1] https://www.treasury.gov/press-center/press-releases/Pages/sm0071.aspx

Jay Barry
(1-212) 834-4951
john.f.barry@jpmorgan.com

Jason Hunter
(1-212) 270-0034
jason.x.hunter@jpmorgan.com

Phoebe A White
(1-212) 834-3092
phoebe.a.white@jpmorgan.com

Alix Tepper Floman
(1-212) 622-9461
alix.tepper@jpmorgan.com

underperformed recently: **Exhibit 1** shows that the 20-year sector has cheapened more than 1bp over the past week on the 10s/20s/30s butterfly and now sits at its cheapest levels since mid-2017. Naturally, supply alone does not explain the behavior of the 20-year sector along the curve: the 10s/20s30s butterfly tends to be directional with the curve: the 20-year sector tends to outperform as the 10s/30s curve flattens, and vice versa, and the curve has explained more than 90% of the variation in this butterfly over the last 3 years (**Exhibit 2**). **Currently the 20-year sector appears more than 3bp cheap to the wings after adjusting for curve shape and has not appeared this cheap at any point over the last 3 years. Thus, it seems that the 20-year sector is discounting the risk that Treasury introduces a 20-year point along the curve.**

Exhibit 3: Broadly speaking, most bonds around the 20-year sector have cheapened relative to the curve over the past week, particularly bonds maturing in 2040

Yield errors, weekly changes, and 6-month statistics for Treasury bonds in the 2036-2041 sector; bp except where otherwise indicated

Maturity	Yield error	1wk chg	6m high	6m low	Percentile
Feb-36s	-2.6	0.2	-0.4	-3.0	3%
Feb-37s	-4.0	0.1	-1.9	-4.4	2%
May-37s	-3.3	0.3	-2.1	-3.8	15%
Feb-38s	-2.2	0.2	-1.4	-2.9	46%
May-38s	-1.8	0.1	-1.4	-2.8	76%
Feb-39s	-0.6	0.1	0.2	-1.5	69%
May-39s	-0.3	0.1	0.5	-1.1	68%
Aug-39s	-0.6	0.2	0.1	-1.4	66%
Nov-39s	0.4	0.4	0.8	-0.4	77%
Feb-40s	0.3	0.2	0.5	-0.5	82%
May-40s	1.3	0.4	1.4	0.2	99%
Aug-40s	1.2	0.2	1.3	0.3	98%
Nov-40s	1.8	0.4	2.3	0.9	98%
Feb-41s	1.4	0.1	1.8	0.5	94%
May-41s	1.8	-0.2	2.0	1.2	72%
Aug-41s	1.7	-0.4	2.4	1.3	40%
Nov-41s	1.5	-0.4	2.2	0.8	70%

Source: J.P. Morgan

We can observe this at a more micro RV level as well. **Exhibit 3** shows yield errors for Treasury bonds in the 2036-2041 sector, along with their week-over-week changes and statistics on these yield errors over the past 6 months. **The exhibit shows that most of the bonds in this sector have cheapened relative to our par curve over the past week. Of note, the most decisive cheapening has occurred in the mid- to late-2040 sector, where these bonds are trading at or close to their cheapest levels of the past 6 months relative to our fitted curve.** This make sense to us: Treasury's financing needs begin to increase sharply in late 2020, as the borrowing capacity it gained from large increases to 2- and 3-year notes auction sizes made in 2018 starts to fade. We tend to agree and think that any potential 20-year would not be introduced before the second half of 2020. Overall, we think this question is but the opening salvo in the discussion of a potential 20-year bond: if dealer feedback indicates there would be strong demand for this security, we think TBAC would likely be tasked with a charge on this topic at some point in early 2020. **Thus, though the 20-year sector appears cheap along the curve, and bonds in**

Jay Barry
(1-212) 834-4951
john.f.barry@jpmorgan.com

Jason Hunter
(1-212) 270-0034
jason.x.hunter@jpmorgan.com

Phoebe A White
(1-212) 834-3092
phoebe.a.white@jpmorgan.com

Alix Tepper Floman
(1-212) 622-9461
alix.tepper@jpmorgan.com

the 2040 sector in particular offer value, we think they are likely to remain cheap until the Treasury comes to an ultimate decision on this maturity point.

What's happening to short coupon/T-bill spreads?

Additionally, last Friday the FOMC also announced plans to purchase Treasury bills to maintain ample reserve balances at or above the level that prevailed in early September 2019. While T-bills are abundant at the moment, as net issuance is forecast to remain positive through late November, we continue to think the Fed will have more difficulty in sourcing T-bills in December and January when issuance turns seasonally negative (see *US Treasury Market Daily*, 10/11/19). Given that the New York Fed has already begun these purchases at an initial pace of $60bn per month, we think it is worthwhile to explore how T-bill and short coupon valuations (an alternative to T-bills for short-end investors) have evolved. We observe that T-bills have richened over the past month, especially 6- and 12-month bills which look more than 2 standard deviations rich relative to their 1-month average (**Exhibit 4**). We are not surprised that longer-tenor bills have outperformed: the money market fund community tends not to own many longer-maturity bills, and given their relative cheapness, the Fed is likely to focus its purchases in these securities.

Exhibit 4: Bills have richened over the past month, especially 6- and 12-month bills...

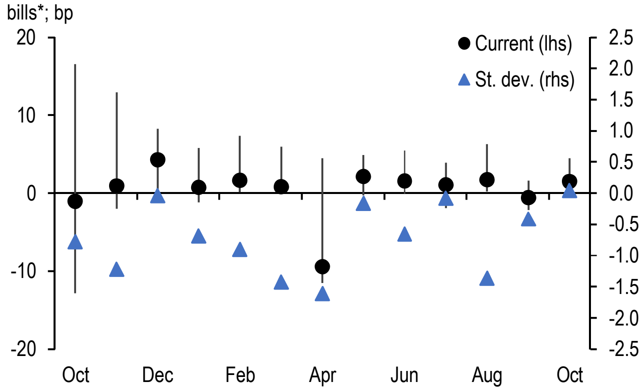
1-month statistics for T-bill spreads to OIS; bp

	Current	1m chg	1m avg	1m min	1m max	1m z-score
1m	-2.4	-15.3	-3.8	-14.2	15.5	0.2
2m	2.0	-12.8	2.7	-5.4	14.8	-0.1
3m	2.9	-8.2	6.1	-0.5	15.8	-0.7
6m	6.5	-14.2	17.2	6.5	26.4	-2.1
12m	11.9	-17.9	24.3	11.9	32.4	-2.3

Source: J.P. Morgan

Exhibit 5: ...but short coupons have actually outperformed T-bills in the process

1-month statistics for Treasury coupon matched-maturity OIS spread versus closest maturity T-bill matched-maturity OIS spread using only original 12-month bills*; bp



*Statistics for the latest 12-month bill issued in October 2019 are starting 10/3/19

Source: J.P. Morgan

Interestingly, we also find that short coupons have generally outperformed T-bills in this process (**Exhibit 5**). We think there are a couple of reasons for this. **First,** the Fed's mandate to purchase bills has created a greater bid for short duration assets, and with purchases set to consume much of the net new supply of bills in coming months, short coupons function as an attractive alternative asset. **Second, Exhibit 6** shows that dealer inventories of bills are substantially lower than inventories of short-term coupons, which are more than 2 standard deviations above their 5-year average. This glut of collateral has allowed short coupons to trade cheap to OIS in the recent past, but with bill purchases expected to take a significant amount of paper out of the money markets, it is perhaps unsurprising to see spreads collapse in this sector. **Heading into year end, with Fed purchases in full swing, T-bill issuance turning negative, and repo likely to come become less abundant, short coupons are likely to remain a viable alternative for short-end investors; thus, we think there is limited room for coups to cheapen from current levels.**

Jay Barry
(1-212) 834-4951
john.f.barry@jpmorgan.com

Jason Hunter
(1-212) 270-0034
jason.x.hunter@jpmorgan.com

Phoebe A White
(1-212) 834-3092
phoebe.a.white@jpmorgan.com

Alix Tepper Floman
(1-212) 622-9461
alix.tepper@jpmorgan.com

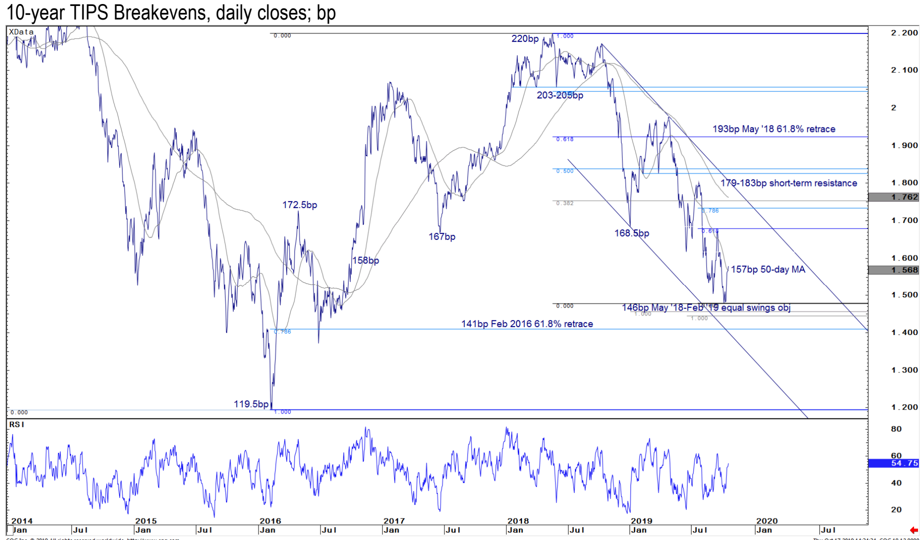
Exhibit 6: Dealer inventories of bills are low, while short-term coups appear to be in abundance
Primary dealer positions in Treasuries, 3-month change, and 5-year statistics; $bn, except for z-score

Maturity	Last	3m chg	5y avg	5y min	5y max	5y z-score
T-bills	24	13	17	-2	41	0.9
<2y	83	-11	28	-7	97	2.4
2-3y	7	-5	-1	-16	21	1.0
3-6y	33	-12	18	-9	53	1.2
6-7y	13	-5	10	-6	27	0.4
7-11y	9	2	2	-18	22	1.1
>11y	36	-7	25	8	48	1.1
TIPS	14	0	8	-1	16	1.5
FRNS	7	-5	5	-1	13	0.7
Total	**227**	**-30**	**113**	**8**	**287**	**1.7**

Source: Federal Reserve Bank of New York

Technical highlights

Exhibit 7: 10-year TIPS breakevens widen after briefly tightening through the 150.5bp Sep 3 low. The momentum divergence pattern that whipsaw created above favored support in the 140s points to a maturing tightening trend. Tactically, the market keeps a widening bias while above 152bp
10-year TIPS Breakevens, daily closes; bp



Source: J.P. Morgan, CQG

The **10-year TIPS breakevens** widening trend probes the first layer of short-term resistance at the **157bp** 50-day MA and recent hourly pivots near **160bp** (**Exhibit 6**). The latest advance unfolds after the recent tightening from the **167bp** Sep 16 high reversed just through the **150.5bp** Sep 3 trough and produced positive momentum divergences with the early-Oct lows on the daily and weekly time frames. The setup points to a maturing tightening trend. Unfortunately, the late-Sep/early-Aug price whipsaw hit the stop level for our widening trade strategy. Tactically, the renewed widening trend stays in gear while above **152bp**. The Sep rebound high stalled just below the **168bp** Jul 61.8% retrace. Medium-term resistance remains clustered at the **176.5bp** 200-day MA, **177bp** May 2018 38.2% retrace, **180bp** Jul wide, and **181bp**

Jay Barry
(1-212) 834-4951
john.f.barry@jpmorgan.com

Jason Hunter
(1-212) 270-0034
jason.x.hunter@jpmorgan.com

Phoebe A White
(1-212) 834-3092
phoebe.a.white@jpmorgan.com

Alix Tepper Floman
(1-212) 622-9461
alix.tepper@jpmorgan.com

Oct 2018 channel. We suspect that area will cap the market for a while. More substantial chart resistance rests near **200bp.** On the downside, the **148-148.5bp** Oct 3/9 lows held favored support at the **146bp** May 2018-Feb 2019 equal swings objective, **144bp** Apr-Jul equal swings target, and **141bp** Feb 2016 78.6% retrace.

Jay Barry
(1-212) 834-4951
john.f.barry@jpmorgan.com

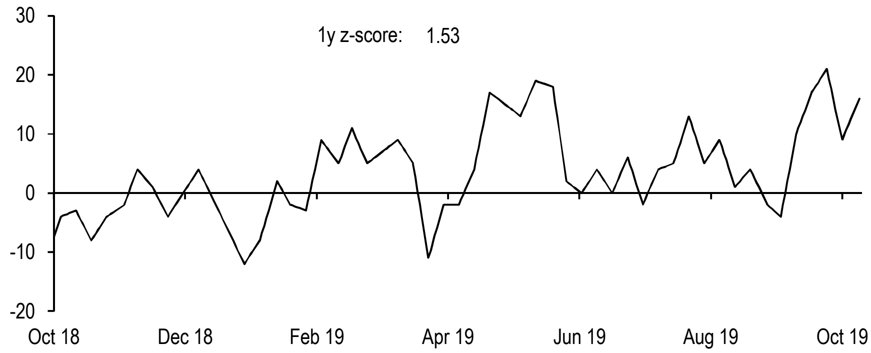
Jason Hunter
(1-212) 270-0034
jason.x.hunter@jpmorgan.com

Phoebe A White
(1-212) 834-3092
phoebe.a.white@jpmorgan.com

Alix Tepper Floman
(1-212) 622-9461
alix.tepper@jpmorgan.com

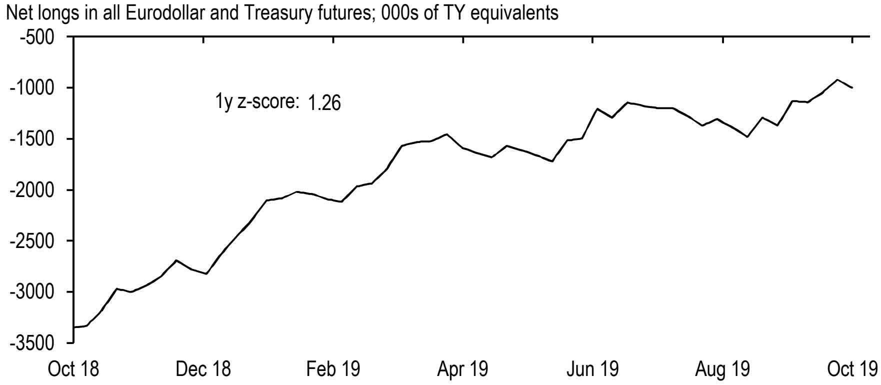
Appendix: Position technicals overview

Exhibit A1: J.P. Morgan Treasury Client Survey
Net longs; %



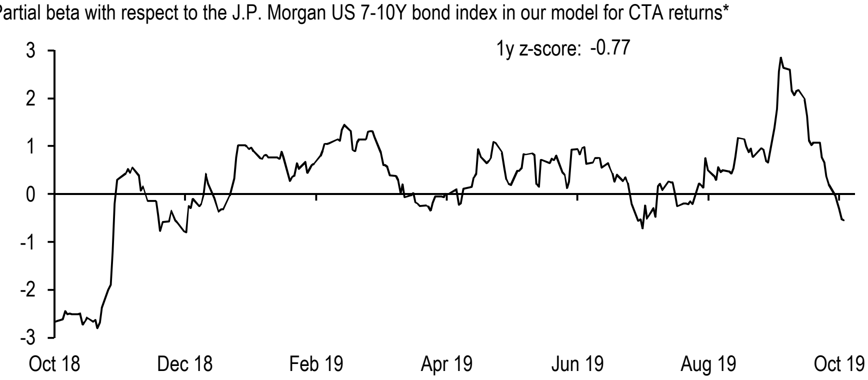
Source: J.P. Morgan

Exhibit A2: CFTC non-commercial positions
Net longs in all Eurodollar and Treasury futures; 000s of TY equivalents



Source: CFTC

Exhibit A3: CTA exposure to 10-year Treasuries
Partial beta with respect to the J.P. Morgan US 7-10Y bond index in our model for CTA returns*



* Model is a 1-month regression of daily excess returns on the CTA index versus daily excess returns on 1) J.P. Morgan US 7-10Y bond index, 2) J.P. Morgan ex-US Global Bond Index, 3) S&P500 index, 4) J.P. Morgan global cash index, and 5) Goldman Sachs Commodities Index

Source: Bloomberg, SG, J.P. Morgan

Jay Barry
(1-212) 834-4951
john.f.barry@jpmorgan.com

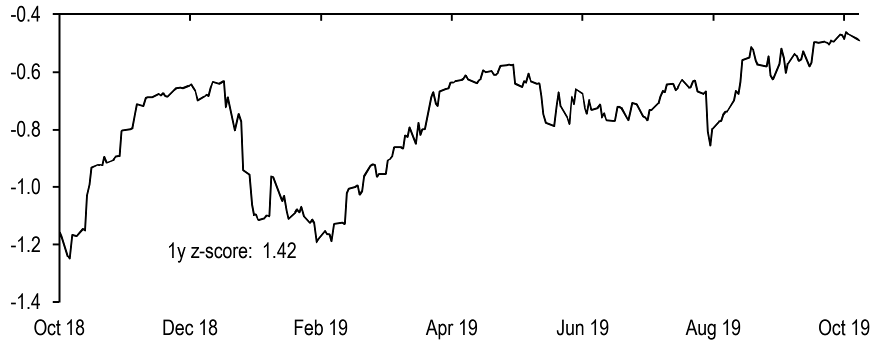
Jason Hunter
(1-212) 270-0034
jason.x.hunter@jpmorgan.com

Phoebe A White
(1-212) 834-3092
phoebe.a.white@jpmorgan.com

Alix Tepper Floman
(1-212) 622-9461
alix.tepper@jpmorgan.com

Exhibit A4: Active Core Bond Fund* Managers' exposure to 10-year Treasuries

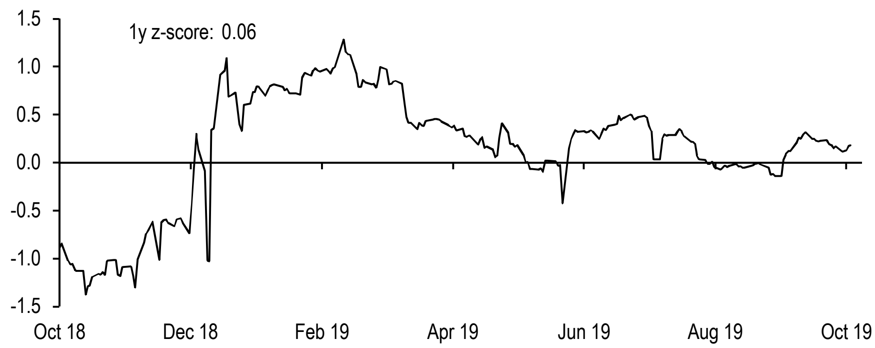
Partial beta with respect to 10-year US Treasury yields in our model for active bond fund excess returns**



* The core bond fund index is comprised of the 20 largest (by assets under management) actively-managed US core bond funds
** Model is a 3-month regression of daily excess returns on the bond fund index versus daily changes in 1) 10-year US Treasury yields, 2) 5s/30s Treasury curve, 3) constant-maturity 5-year CDX.IG spread, 4) MBS Libor option-adjusted spread, and 5) 3Mx10Y swaption volatility; Source: Bloomberg, J.P. Morgan

Exhibit A5: Macro Hedge Fund exposure to 10-year Treasuries

Partial beta with respect to the J.P. Morgan US 7-10Y bond index in our model for macro hedge fund returns*

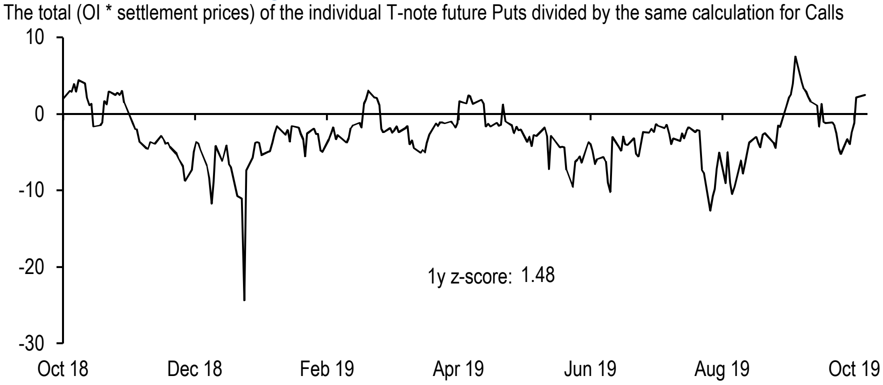


* Model is a six-week regression of daily excess returns on the HFRX Macro/CTA index versus daily excess returns on 1) J.P. Morgan US 7-10Y bond index, 2) J.P. Morgan ex-US Global Bond Index, 3) S&P 500 equity index, 4) MSCI G7 ex-US equity index, 5) J.P. Morgan global cash index, and 6) Goldman Sachs Commodities Index.

Source: Bloomberg, HFR, J.P. Morgan

Exhibit A6: T-note dollar weighed Put/Call ratio

The total (OI * settlement prices) of the individual T-note future Puts divided by the same calculation for Calls



Source: CFTC, Bloomberg, CQG, CME, J.P. Morgan

Jay Barry
(1-212) 834-4951
john.f.barry@jpmorgan.com

Jason Hunter
(1-212) 270-0034
jason.x.hunter@jpmorgan.com

Phoebe A White
(1-212) 834-3092
phoebe.a.white@jpmorgan.com

Alix Tepper Floman
(1-212) 622-9461
alix.tepper@jpmorgan.com

Analyst Certification: All authors named within this report are research analysts unless otherwise specified. 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.

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.

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.

Technical Research: Due to the nature of technical analysis, any securities mentioned in this publication may not be continuously followed by our technical analyst and may or may not be covered by our fundamental analysts. Accordingly, any analysis should be regarded as stand-alone analysis.

Other Disclosures

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

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.,

Jay Barry
(1-212) 834-4951
john.f.barry@jpmorgan.com

Jason Hunter
(1-212) 270-0034
jason.x.hunter@jpmorgan.com

Phoebe A White
(1-212) 834-3092
phoebe.a.white@jpmorgan.com

Alix Tepper Floman
(1-212) 622-9461
alix.tepper@jpmorgan.com

Hong Kong is organized under the laws of U.S.A. with limited liability. **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 October 05, 2019.