US Rates Watch

Rates basics: spot vs forward

15 February 2024

Rates Research
United States

Ralph Axel
Rates Strategist
BofAS
+1 646 743 7011
ralph.axel@bofa.com

US Rates Research
BofAS
+1 646 855 8846

See Team Page for List of Analysts

Thinking about forward rates

In the rates market, the concept of spot price/yield versus forward price/yield plays a central role in investment decisions and trade evaluation. In this note we explain spot vs forwards and show how these concepts can help investors make trade decisions. We will also look at "rolldown" in this context. The main value of forwards is that: (1) they represent a threshold level at which financed trades can break even, offsetting the carry made or lost over a horizon period; and (2) they form the building blocks of term rates like the benchmark 10y rate. Forwards provide thresholds for trades and can be used to express views on specific pieces of the term structure.

Return consists of carry + price change

We take a simple example of a long 5y Treasury position where the buyer finances the position in the repo market and anticipates holding the position for 1 year. The total return has two parts: carry, which is essentially the yield of the 5y minus the repo financing rate; and the price change over the year, which is generated by yield changes in the bond market.

Repo financing can be done in the overnight repo market, where the path of overnight financing rates – and therefore carry – cannot be known in advance. Or the position can be financed in the term repo market for 1 year at a fixed 1y financing rate. This would "lock in" the carry component because total financing costs would be known. If overnight financing is used, carry over the year will depend on the path of the overnight repo rate, which is very close to the path of the overnight Fed policy rate. Regardless of financing choice, the price change at the 1y horizon remains unknown until the horizon is reached.

Forward price makes the total return 0

If the financing costs are locked up at the start, we can back out a price change that would cause the position to break even, i.e., have 0% total return over the 1 year horizon. This is the definition of today's 1y forward price of the 5y note (or its 1y forward yield). The 1y forward price depends only on the carry that is locked in for 1y. If carry is negative (today's situation), the forward price needs to be higher than spot to overcome carry, while if carry is positive, the forward price will be lower than spot. The forward price/yield is therefore a breakeven concept that starts with the formula Total Return = Carry + Price Return and solves for a total return of 0 given a known carry to the horizon. Carry and forwards are the same for the swaps curve. In swaps, the analog of the 1y forward on a 5y Treasury note would be the 1y4y swap rate, i.e., the 4y rate 1y forward.

To look at a specific example in Treasuries, we take markets from Friday February 9th 2024 in Exhibit 1.

Exhibit 1: Spot and forward levels as of Feb 9 2024, including o/n and 1y financing rates
SOFR = secured overnight financing rate = repo rate

	Spot yield	1y forward yield	Diff
5y Treasury	4.15%	3.93%	-0.22%
30y Treasury	4.38%	4.35%	-0.03%
5-30 slope	0.23%	0.42%	0.19%
overnight SOFR	5.31%		
1y SOFR	4.91%		

Source: BofA Global Research

BofA GLOBAL RESEARCH

The 5y Treasury forward yield is lower than the spot yield in Exhibit 1 because carry is negative (bond yield < financing rate) and so the Treasury needs to rally to overcome the carry loss and break even in the long position. In this case the bond needs to rally 22bp to break even. A rally beyond 22bp would be profitable. To put this into context, implied volatility markets on 5y yields for a 1-year horizon price a 1-standard deviation yield change of 65bp. This means that the forward breakeven rate is about 30% of a standard deviation yield change over the horizon. The 3bp breakeven of the 30y is only 6% of a standard deviation, which is a smaller relative hurdle. In general, we see smaller breakevens for higher duration bonds because the price sensitivity increases.

If an investor buys the 5y note at a yield of 4.15% and finances it for 1y at 4.91%, the total return of the position will be 0% if the forward yield 3.93% is realized after 1y. The Treasury note will have a 4y maturity at that time. In swaps parlance, we would say that the 1y4y Treasury forward is 3.93%. One can check this on Bloomberg's HZ1 screen by loading the T4% 1/31/2029 Treasury note, setting the horizon to 1 year away, the spot yield to 4.15%, the financing rate to 4.91% and a horizon yield of 3.935%. The same breakeven idea holds if the investor "sells short" the 5y note. In this case, the investor borrows the bond, sells it for market value, lends the cash proceeds to the repo desk against the borrowed bond, receives the 1y repo rate on the cash and pays the yield on the bond. Carry is therefore equal and opposite for a short position. In this case, the investor generally wants yields to rise, but the carry gives the short seller a buffer of 22bp. As long as the yield does not fall by more than 22bp, the short seller will have a positive total return. The 1y4y forward rate is therefore independent of whether one goes long or short, ignoring the issue of bid/offer spreads in repo markets and spot Treasury markets.

Curve trades also have forward breakevens

If instead of a single bond trade, the investor buys 5y notes and sells short 30y bonds, there is a breakeven forward for each bond. If the same 1y repo rate of 4.91% is used, then the 5y has to rally more than 22bp to make money, and the 30y has to not rally more than 3bp to make money. This means the 5-30 slope has to steepen at least 19bp over 1 year to be profitable using this financing rate. If the steepener is duration weighted, which is most common, it does not matter how the 19bp of steepening occurs (whether it was due to the 5y or 30y or both). But if the duration is not equal and opposite in 5y vs 30y, then the P&L will depend on the yield change of each bond separately, rather than just their difference. As Exhibit 1 shows, the 5-30 spot curve slope is 23bp while the forward slope 1y out is 42bp. This tells us that the 5-30 duration-weighted steepener is a negative carry trade with a 19bp threshold to break even over 1 year.

Choosing between spot and forward trade

The choice between executing a trade spot or forward comes down to one's view on the term financing rate that determines the forwards. Using the example in Exhibit 1, the 1y term financing rate is 4.91%. But the overnight repo rate is 5.31%. This reflects a market that expects the path of overnights to fall over the course of a year. If an investor thinks that overnight rates will fall even faster, i.e., the Fed will cut more than priced, then rolling the financing overnight – i.e., doing the spot trade instead of the forward – would be preferable. In other words, if one's view is that term financing rates are too high, then the spot would be attractive relative to forward. For a short duration trade, the carry has the opposite sign, and if one thinks the 1y term financing rate is too high, it would be better to lock that rate in – which is a rate the short receives – by doing the 1y forward instead of rolling a spot trade with overnight financing. For a curve trade like a 5-30 steepener, a view that 1y term financing is too high could translate into a strategy of rolling the long 5y position in overnight repo while locking up the 30y short in term financing.

As an aside, one can explicitly take a view on the 1y financing rate vs the overnight rate by doing a SOFR swap to receive 1y fixed SOFR rate and pay overnight SOFR floating. If overnight repo rates average below the 1y fixed SOFR rate of 4.91% over the year, then the total carry will be positive, and the duration impact will have no contribution if held to maturity.

Translating to the swaps curve

When an investor does a swap, they are entering a floating position and a fixed position at the same time, just like a financed Treasury position. Going long a financed 5y Treasury is analogous to receiving the 5y fixed swap rate and paying the overnight index (SOFR). Paying the overnight SOFR index is essentially the same as paying overnight repo in a financed Treasury trade. Receiving a 5y swap rate generates a yield just like a 5y Treasury. Choosing between buying a Treasury spot or forward is the same as deciding to either receive the spot 5y swap rate (and pay float) or receive the 1y4y forward swap rate. The considerations are the same: if the 1y rate in swaps (essentially 1y SOFR) is deemed too high, the spot trade would be preferable because the trader would pay the actual overnight path of SOFR over a year, which could be lower. If the 1y swap rate is considered too low, there would be a preference to receive the 1y4y rate because it locks in a low financing rate for 1y.

Forwards are building blocks of spot rates

Forwards are building blocks of the rates curve. While it is tempting to think that 10y rates are not related to the overnight rate, there is actually a very close relationship because of compounding interest combined with no arbitrage. For example, a 2y interest rate can be replicated by compounding the 1y rate and the 1y1y rate (1y rate, 1y forward). "No arbitrage" means that if the 2y rate is not equal to these compounded market rates, there will be an arbitrage opportunity that will be traded until it is gone. The 10y rate needs to be the same as the spot 1y compounded with 9 forwards: 1y1y, 2y1y, 3y1y, ..., and 9y1y. This can be broken down further into overnight rates. The 1y rate is the same as the compounded overnight rate for 1 year. This means that the path of forward overnight rates determines the entire yield curve. We discuss this in detail in US Rates Watch: The big picture for long-term interest rates. Whether those forward overnight rates represent true expectations of the Fed path or include some term premium component does not impact this relationship.

Term repo financing of Treasuries is not typically done for terms longer than around 3 months, with the average probably somewhere around 1.5 months and the max going out to 5 years in rare cases. But forwards of all kinds can easily be done on the swaps curve like a 5y rate 5 years forward (5y5y rate) or a 20y rate 10 years forward (10y20y rate) etc. This one of the advantages of the swaps market over Treasuries.

For example, the spot 10y rate can be broken into the spot 5y rate compounded with the 5y5y forward rate. If one had no view on the 5y spot rate, which is heavily influenced by the timing of Fed cuts, but a strong view on the 5y5y rate, which is much more related to where the Fed cuts down to (terminal rate), it could make more sense to trade the 5y5y forward rate rather than the 10y spot rate. With the spot 10y rate, one is effectively trading both the spot 5y rate and the 5y5y forward rate, which may not be desirable. Because forward rates are building blocks of spot rates, the forwards allow more precise targeting of views about the shape of the term structure, which often comes down to the path of Fed policy priced by markets.

Rolldown is a separate consideration

Rolldown is a scenario in which bond yields of a given maturity remain the same as time passes. For example, if the 2y note today yields 4.6% and the 3y yields 4.4%, then a rolldown scenario would have the 2y again at 4.6% next year and the 3y at 4.4%. This implies that if you buy the 3y today at 4.4%, it will yield 4.6% in one year in the rolldown scenario. In the rolldown scenario, today's 3y bond yield becomes today's 2y yield a year from now. If the rolldown scenario is achieved, the spot bond yield curve remains the same. The rolldown scenario – particularly for the front end of the yield curve – is considered a more likely outcome when the Fed is firmly on hold, unlikely today where markets can dramatically change near-term Fed expectations.

A few useful formulas can come in handy. For a 5y note, 1y rolldown = 5y spot – 4y spot, 1y carry breakeven = 5y spot - 1y4y forward, and 1y carry + rolldown = 4y spot – 1y4y forward. These relationships for 3m carry and roll become 5y spot – 4.75y spot, 5y spot – 3m4.75y forward, and 4.75y spot – 3m4.75y forward, respectively.

Conclusion

Bond positions can be financed overnight or term, and this reflects the choice of doing a spot trade or a forward trade in the Treasury market. The forward yield of a bond at a given horizon represents a breakeven level that would result in 0% total return if term financing is used to that horizon. If one has no disagreement with the market's pricing of term financing rates, then doing the forward trade could be simpler as it locks in from the beginning the cost of carry and provides a known threshold level for the price component of the trade to break even. Doing a forward trade can also express a focused view on a particular part of the term structure of interest rates. The view of forwards as breakevens and as building blocks are compatible. A long 5y5y forward position can be viewed from the financing perspective as using 5y term financing to buy a 10y bond. This effectively locks up carry for 5 years and makes the 5y5y forward rate a breakeven level for the 10y spot rate today financed for 5 years. Rolldown is a special scenario of an unchanged spot yield curve over time that makes more sense to incorporate when the Fed is firmly on hold.

Disclosures

Important Disclosures

BofA Global Research personnel (including the analyst(s) responsible for this report) receive compensation based upon, among other factors, the overall profitability of Bank of America Corporation, including profits derived from investment banking. The analyst(s) responsible for this report may also receive compensation based upon, among other factors, the overall profitability of the Bank's sales and trading businesses relating to the class of securities or financial instruments for which such analyst is responsible.
BofA Securities fixed income analysts regularly interact with sales and trading desk personnel in connection with their research, including to ascertain pricing and liquidity in the fixed income markets.

Other Important Disclosures

Prices are indicative and for information purposes only. Except as otherwise stated in the report, for any recommendation in relation to an equity security, the price referenced is the publicly traded price of the security as of close of business on the day prior to the date of the report or, if the report is published during intraday trading, the price referenced is indicative of the traded price as of the date and time of the report and in relation to a debt security (including equity preferred and CDS), prices are indicative as of the date and time of the report and are from various sources including BofA Securities trading desks.
The date and time of completion of the production of any recommendation in this report shall be the date and time of dissemination of this report as recorded in the report timestamp.

This report may refer to fixed income securities or other financial instruments that may not be offered or sold in one or more states or jurisdictions, or to certain categories of investors, including retail investors. Readers of this report are advised that any discussion, recommendation or other mention of such instruments is not a solicitation or offer to transact in such instruments. Investors should contact their BofA Securities representative or Merrill Global Wealth Management financial advisor for information relating to such instruments.
Rule 144A securities may be offered or sold only to persons in the U.S. who are Qualified Institutional Buyers within the meaning of Rule 144A under the Securities Act of 1933, as amended.
SECURITIES OR OTHER FINANCIAL INSTRUMENTS DISCUSSED HEREIN MAY BE RATED BELOW INVESTMENT GRADE AND SHOULD THEREFORE ONLY BE CONSIDERED FOR INCLUSION IN ACCOUNTS QUALIFIED FOR SPECULATIVE INVESTMENT.
Recipients who are not institutional investors or market professionals should seek the advice of their independent financial advisor before considering information in this report in connection with any investment decision, or for a necessary explanation of its contents.
The securities or other financial instruments discussed in this report may be traded over-the-counter. Retail sales and/or distribution of this report may be made only in states where these instruments are exempt from registration or have been qualified for sale.
Officers of BofAS or one or more of its affiliates (other than research analysts) may have a financial interest in securities of the issuer(s) or in related investments.
This report, and the securities or other financial instruments discussed herein, may not be eligible for distribution or sale in all countries or to certain categories of investors, including retail investors.
Refer to BofA Global Research policies relating to conflicts of interest.
"BofA Securities" includes BofA Securities, Inc. ("BofAS") and its affiliates. Investors should contact their BofA Securities representative or Merrill Global Wealth Management financial advisor if they have questions concerning this report or concerning the appropriateness of any investment idea described herein for such investor. "BofA Securities" is a global brand for BofA Global Research.
Information relating to Non-US affiliates of BofA Securities and Distribution of Affiliate Research Reports:
BofAS and/or Merrill Lynch, Pierce, Fenner & Smith Incorporated ("MLPF&S") may in the future distribute, information of the following non-US affiliates in the US (short name: legal name, regulator): Merrill Lynch (South Africa): Merrill Lynch South Africa (Pty) Ltd., regulated by The Financial Service Board; MLI (UK): Merrill Lynch International, regulated by the Financial Conduct Authority (FCA) and the Prudential Regulation Authority (PRA); BofASE (France): BofA Securities Europe SA is authorized by the Autorité de Contrôle Prudentiel et de Résolution (ACPR) and regulated by the ACPR and the Autorité des Marchés Financiers (AMF). BofA Securities Europe SA ("BofASE") with registered address at 51, rue La Boétie, 75008 Paris is registered under no 842 602 690 RCS Paris. In accordance with the provisions of French Code Monétaire et Financier (Monetary and Financial Code), BofASE is an établissement de crédit et d'investissement (credit and investment institution) that is authorised and supervised by the European Central Bank and the Autorité de Contrôle Prudentiel et de Résolution (ACPR) and regulated by the ACPR and the Autorité des Marchés Financiers. BofASE's share capital can be found at www.bofaml.com/BofASEdisclaimer; BofA Europe (Milan): Bank of America Europe Designated Activity Company, Milan Branch, regulated by the Bank of Italy, the European Central Bank (ECB) and the Central Bank of Ireland (CBI); BofA Europe (Frankfurt): Bank of America Europe Designated Activity Company, Frankfurt Branch regulated by BaFin, the ECB and the CBI; BofA Europe (Madrid): Bank of America Europe Designated Activity Company, Sucursal en España, regulated by the Bank of Spain, the ECB and the CBI; Merrill Lynch (Australia): Merrill Lynch Equities (Australia) Limited, regulated by the Australian Securities and Investments Commission; Merrill Lynch (Hong Kong): Merrill Lynch (Asia Pacific) Limited, regulated by the Hong Kong Securities and Futures Commission (HKSFC); Merrill Lynch (Singapore): Merrill Lynch (Singapore) Pte Ltd, regulated by the Monetary Authority of Singapore (MAS); Merrill Lynch (Canada): Merrill Lynch Canada Inc, regulated by the Canadian Investment Regulatory Organization; Merrill Lynch (Mexico): Merrill Lynch Mexico, SA de CV, Casa de Bolsa, regulated by the Comisión Nacional Bancaria y de Valores; Merrill Lynch (Argentina): Merrill Lynch Argentina SA, regulated by Comisión Nacional de Valores; BofAS Japan: BofA Securities Japan Co., Ltd., regulated by the Financial Services Agency; Merrill Lynch (Seoul): Merrill Lynch International, LLC Seoul Branch, regulated by the Financial Supervisory Service; Merrill Lynch (Taiwan): Merrill Lynch Securities (Taiwan) Ltd., regulated by the Securities and Futures Bureau; BofAS India: BofA Securities India Limited, regulated by the Securities and Exchange Board of India (SEBI); Merrill Lynch (Israel): Merrill Lynch Israel Limited, regulated by Israel Securities Authority; Merrill Lynch (DIFC): Merrill Lynch International (DIFC Branch), regulated by the Dubai Financial Services Authority (DFSA); Merrill Lynch (Brazil): Merrill Lynch S.A. Corretora de Títulos e Valores Mobiliários, regulated by Comissão de Valores Mobiliários; Merrill Lynch KSA Company: Merrill Lynch Kingdom of Saudi Arabia Company, regulated by the Capital Market Authority.
This information: has been approved for publication and is distributed in the United Kingdom (UK) to professional clients and eligible counterparties (as each is defined in the rules of the FCA and the PRA) by MLI (UK), which is authorized by the PRA and regulated by the FCA and the PRA - details about the extent of our regulation by the FCA and PRA are available from us on request; has been approved for publication and is distributed in the European Economic Area (EEA) by BofASE (France), which is authorized by the ACPR and regulated by the ACPR and the AMF; has been considered and distributed in Japan by BofAS Japan, a registered securities dealer under the Financial Instruments and Exchange Act in Japan, or its permitted affiliates; is issued and distributed in Hong Kong by Merrill Lynch (Hong Kong) which is regulated by HKSFC; is issued and distributed in Taiwan by Merrill Lynch (Taiwan); is issued and distributed in India by BofAS India; and is issued and distributed in Singapore to institutional investors and/or accredited investors (each as defined under the Financial Advisers Regulations) by Merrill Lynch (Singapore) (Company Registration No 198602883D). Merrill Lynch (Singapore) is regulated by MAS. Merrill Lynch Equities (Australia) Limited (ABN 65 006 276 795), AFS License 235132 (MLEA) distributes this information in Australia only to 'Wholesale' clients as defined by s.761G of the Corporations Act 2001. With the exception of Bank of America N.A., Australia Branch, neither MLEA nor any of its affiliates involved in preparing this information is an Authorised Deposit-Taking Institution under the Banking Act 1959 nor regulated by the Australian Prudential Regulation Authority. No approval is required for publication or distribution of this information in Brazil and its local distribution is by Merrill Lynch (Brazil) in accordance with applicable regulations. Merrill Lynch (DIFC) is authorized and regulated by the DFSA. Information prepared and issued by Merrill Lynch (DIFC) is done so in accordance with the requirements of the DFSA conduct of business rules. BofA Europe (Frankfurt) distributes this information in Germany and is regulated by BaFin, the ECB and the CBI. BofA Securities entities, including BofA Europe and BofASE (France), may outsource/delegate the marketing and/or provision of certain research services or aspects of research services to other branches or members of the BofA Securities group. You may be contacted by a different BofA Securities entity acting for and on behalf of your service provider where permitted by applicable law. This does not change your service provider. Please refer to the Electronic Communications Disclaimers for further information.
This information has been prepared and issued by BofAS and/or one or more of its non-US affiliates. The author(s) of this information may not be licensed to carry on regulated activities in your jurisdiction and, if not licensed, do not hold themselves out as being able to do so. BofAS and/or MLPF&S is the distributor of this information in the US and accepts full responsibility for information distributed to BofAS and/or MLPF&S clients in the US by its non-US affiliates. Any US person receiving this information and wishing to effect any transaction in any security

discussed herein should do so through BofAS and/or MLPF&S and not such foreign affiliates. Hong Kong recipients of this information should contact Merrill Lynch (Asia Pacific) Limited in respect of any matters relating to dealing in securities or provision of specific advice on securities or any other matters arising from, or in connection with, this information. Singapore recipients of this information should contact Merrill Lynch (Singapore) Pte Ltd in respect of any matters arising from, or in connection with, this information. For clients that are not accredited investors, expert investors or institutional investors Merrill Lynch (Singapore) Pte Ltd accepts full responsibility for the contents of this information distributed to such clients in Singapore.

General Investment Related Disclosures:

Taiwan Readers: Neither the information nor any opinion expressed herein constitutes an offer or a solicitation of an offer to transact in any securities or other financial instrument. No part of this report may be used or reproduced or quoted in any manner whatsoever in Taiwan by the press or any other person without the express written consent of BofA Securities.

This document provides general information only, and has been prepared for, and is intended for general distribution to, BofA Securities clients. Neither the information nor any opinion expressed constitutes an offer or an invitation to make an offer, to buy or sell any securities or other financial instrument or any derivative related to such securities or instruments (e.g., options, futures, warrants, and contracts for differences). This document is not intended to provide personal investment advice and it does not take into account the specific investment objectives, financial situation and the particular needs of, and is not directed to, any specific person(s). This document and its content do not constitute, and should not be considered to constitute, investment advice for purposes of ERISA, the US tax code, the Investment Advisers Act or otherwise. Investors should seek financial advice regarding the appropriateness of investing in financial instruments and implementing investment strategies discussed or recommended in this document and should understand that statements regarding future prospects may not be realized. Any decision to purchase or subscribe for securities in any offering must be based solely on existing public information on such security or the information in the prospectus or other offering document issued in connection with such offering, and not on this document.

Securities and other financial instruments referred to herein, or recommended, offered or sold by BofA Securities, are not insured by the Federal Deposit Insurance Corporation and are not deposits or other obligations of any insured depository institution (including, Bank of America, N.A.). Investments in general and, derivatives, in particular, involve numerous risks, including, among others, market risk, counterparty default risk and liquidity risk. No security, financial instrument or derivative is suitable for all investors. Digital assets are extremely speculative, volatile and are largely unregulated. In some cases, securities and other financial instruments may be difficult to value or sell and reliable information about the value or risks related to the security or financial instrument may be difficult to obtain. Investors should note that income from such securities and other financial instruments, if any, may fluctuate and that price or value of such securities and instruments may rise or fall and, in some cases, investors may lose their entire principal investment. Past performance is not necessarily a guide to future performance. Levels and basis for taxation may change.

BofA Securities is aware that the implementation of the ideas expressed in this report may depend upon an investor's ability to "short" securities or other financial instruments and that such action may be limited by regulations prohibiting or restricting "shortselling" in many jurisdictions. Investors are urged to seek advice regarding the applicability of such regulations prior to executing any short idea contained in this report.

This report may contain a trading idea or recommendation which highlights a specific identified near-term catalyst or event impacting a security, issuer, industry sector or the market generally that presents a transaction opportunity, but does not have any impact on the analyst's particular "Overweight" or "Underweight" rating (which is based on a three month trade horizon). Trading ideas and recommendations may differ directionally from the analyst's rating on a security or issuer because they reflect the impact of a near-term catalyst or event.

Foreign currency rates of exchange may adversely affect the value, price or income of any security or financial instrument mentioned in this report. Investors in such securities and instruments effectively assume currency risk.

BofAS or one of its affiliates is a regular issuer of traded financial instruments linked to securities that may have been recommended in this report. BofAS or one of its affiliates may, at any time, hold a trading position (long or short) in the securities and financial instruments discussed in this report.

BofA Securities, through business units other than BofA Global Research, may have issued and may in the future issue trading ideas or recommendations that are inconsistent with, and reach different conclusions from, the information presented herein. Such ideas or recommendations may reflect different time frames, assumptions, views and analytical methods of the persons who prepared them, and BofA Securities is under no obligation to ensure that such other trading ideas or recommendations are brought to the attention of any recipient of this information.

In the event that the recipient received this information pursuant to a contract between the recipient and BofAS for the provision of research services for a separate fee, and in connection therewith BofAS may be deemed to be acting as an investment adviser, such status relates, if at all, solely to the person with whom BofAS has contracted directly and does not extend beyond the delivery of this report (unless otherwise agreed specifically in writing by BofAS). If such recipient uses the services of BofAS in connection with the sale or purchase of a security referred to herein, BofAS may act as principal for its own account or as agent for another person. BofAS is and continues to act solely as a broker-dealer in connection with the execution of any transactions, including transactions in any securities referred to herein.

Copyright and General Information:

Materials prepared by BofA Global Research personnel are based on public information. Facts and views presented in this material have not been reviewed by, and may not reflect information known to, professionals in other business areas of BofA Securities, including investment banking personnel. BofA Securities has established information barriers between BofA Global Research and certain business groups. As a result, BofA Securities does not disclose certain client relationships with, or compensation received from, such issuers. To the extent this material discusses any legal proceeding or issues, it has not been prepared as nor is it intended to express any legal conclusion, opinion or advice. Investors should consult their own legal advisers as to issues of law relating to the subject matter of this material. BofA Global Research personnel's knowledge of legal proceedings in which any BofA Securities entity and/or its directors, officers and employees may be plaintiffs, defendants, co-defendants or co-plaintiffs with or involving issuers mentioned in this material is based on public information. Facts and views presented in this material that relate to any such proceedings have not been reviewed by, discussed with, and may not reflect information known to, professionals in other business areas of BofA Securities in connection with the legal proceedings or matters relevant to such proceedings.

This information has been prepared independently of any issuer of securities mentioned herein and not in connection with any proposed offering of securities or as agent of any issuer of any securities. None of BofAS any of its affiliates or their research analysts has any authority whatsoever to make any representation or warranty on behalf of the issuer(s). BofA Global Research policy prohibits research personnel from disclosing a recommendation, investment rating, or investment thesis for review by an issuer prior to the publication of a research report containing such rating, recommendation or investment thesis.

Any information relating to the tax status of financial instruments discussed herein is not intended to provide tax advice or to be used by anyone to provide tax advice. Investors are urged to seek tax advice based on their particular circumstances from an independent tax professional.

The information herein (other than disclosure information relating to BofA Securities and its affiliates) was obtained from various sources and we do not guarantee its accuracy. This information may contain links to third-party websites. BofA Securities is not responsible for the content of any third-party website or any linked content contained in a third-party website. Content contained on such third-party websites is not part of this information and is not incorporated by reference. The inclusion of a link does not imply any endorsement by or any affiliation with BofA Securities. Access to any third-party website is at your own risk, and you should always review the terms and privacy policies at third-party websites before submitting any personal information to them. BofA Securities is not responsible for such terms and privacy policies and expressly disclaims any liability for them.

All opinions, projections and estimates constitute the judgment of the author as of the date of publication and are subject to change without notice. Prices also are subject to change without notice. BofA Securities is under no obligation to update this information and BofA Securities ability to publish information on the subject issuer(s) in the future is subject to applicable quiet periods. You should therefore assume that BofA Securities will not update any fact, circumstance or opinion contained herein.

Certain outstanding reports or investment opinions relating to securities, financial instruments and/or issuers may no longer be current. Always refer to the most recent research report relating to an issuer prior to making an investment decision.

In some cases, an issuer may be classified as Restricted or may be Under Review or Extended Review. In each case, investors should consider any investment opinion relating to such issuer (or its security and/or financial instruments) to be suspended or withdrawn and should not rely on the analyses and investment opinion(s) pertaining to such issuer (or its securities and/or financial instruments) nor should the analyses or opinion(s) be considered a solicitation of any kind. Sales persons and financial advisors affiliated with BofAS or any of its affiliates may not solicit purchases of securities or financial instruments that are Restricted or Under Review and may only solicit securities under Extended Review in accordance with firm policies.

Neither BofA Securities nor any officer or employee of BofA Securities accepts any liability whatsoever for any direct, indirect or consequential damages or losses arising from any use of this information.

Research Analysts

US

Mark Cabana, CFA
Rates Strategist
BofAS
+1 646 743 7013
mark.cabana@bofa.com

Ralph Axel
Rates Strategist
BofAS
+1 646 743 7011
ralph.axel@bofa.com

Bruno Braizinha, CFA
Rates Strategist
BofAS
+1 646 743 7012
bruno.braizinha@bofa.com

Katie Craig
Rates Strategist
BofAS
+1 646 743 7016
katie.craig@bofa.com

Meghan Swiber, CFA
Rates Strategist
BofAS
+1 646 743 7020
meghan.swiber@bofa.com

Anna (Caiyi) Zhang
Rates Strategist
BofAS
+1 646 743 7021
caiyi.zhang@bofa.com