Interest Rates Research

Renate Marold
+1 212 526 2484
renate.marold@barclays.com

Introducing our FOMC Sentiment Indicators

Extracting sentiment from text

September 2019

Completed: 30-Aug-19, 19:46 GMT Released: 03-Sep-19, 06:00 GMT Restricted - External

This document is intended for institutional investors and is not subject to all of the independence and disclosure standards applicable to debt research reports prepared for retail investors under U.S. FINRA Rule 2242. Barclays trades the securities covered in this report for its own account and on a discretionary basis on behalf of certain clients. Such trading interests may be contrary to the recommendations offered in this report.

PLEASE SEE ANALYST CERTIFICATIONS AND IMPORTANT DISCLOSURES STARTING AFTER PAGE 25

Sentiment Indicators explain the "why" of the FOMC's stance

- Our new FOMC Sentiment Indicators are **measures of how positive/negative the FOMC describes economic and financial developments**
  - They allow us to quantify sentiment objectively over time – complementing the typical Fed watcher who relies on (subjective) expert judgement and a personal recollection of prior events
  - They have higher accuracy than word-count methods, which fail to identify that a decline in a negative measure is actually positive – and vice versa – as they ignore the context of words
- Our analysis of FOMC sentiment shows that it falls around the start of easing cycles. For example, sentiment fell sharply in the minutes *ahead of* the recent July rate cut
- Sentiment for different segments of the minutes and different topics of discussion provide **insights into the reasons behind the Fed's policy stance**
  - Unlike the 1998 cycle, when the drop in sentiment was driven by a fall in risk assets, this was not the case this time
  - Increased risks and uncertainties have suppressed sentiment, but more fundamental economic factors were at play as well
  - For example, inflation and broad activity sentiment started slipping in 2019, suggesting that these were important determinants for the July 2019 rate cut
- Our sentiment indicators, being objective and quantitative, can be used to **predict/assess the market impact of communications**, and can be extended to other FOMC texts and other major central banks

*See the appendix starting page 17 for details on the methodology

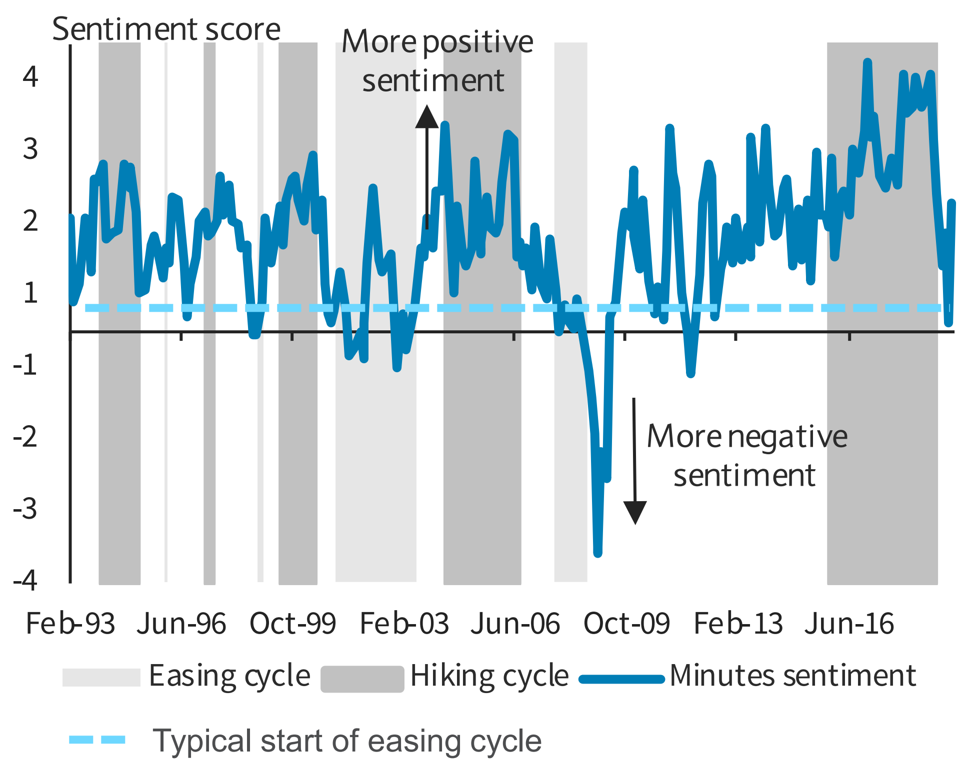
Minutes sentiment aligns with onsets of easing & hiking cycles

More negative, falling sentiment predicts easing cycles

- Using a simple rule-based regression, the sentiment level and drift predict onsets of easing cycles:
- When sentiment over three meetings averages <0.2 and drifts down, there is a >90% probability of a first ease in the cycle*
- Of the six falsely predicted cuts, two of them are on FOMC meetings before the actual cut, and two of them are when non-standard monetary policy measures were introduced

Higher sentiment predicts hiking cycles

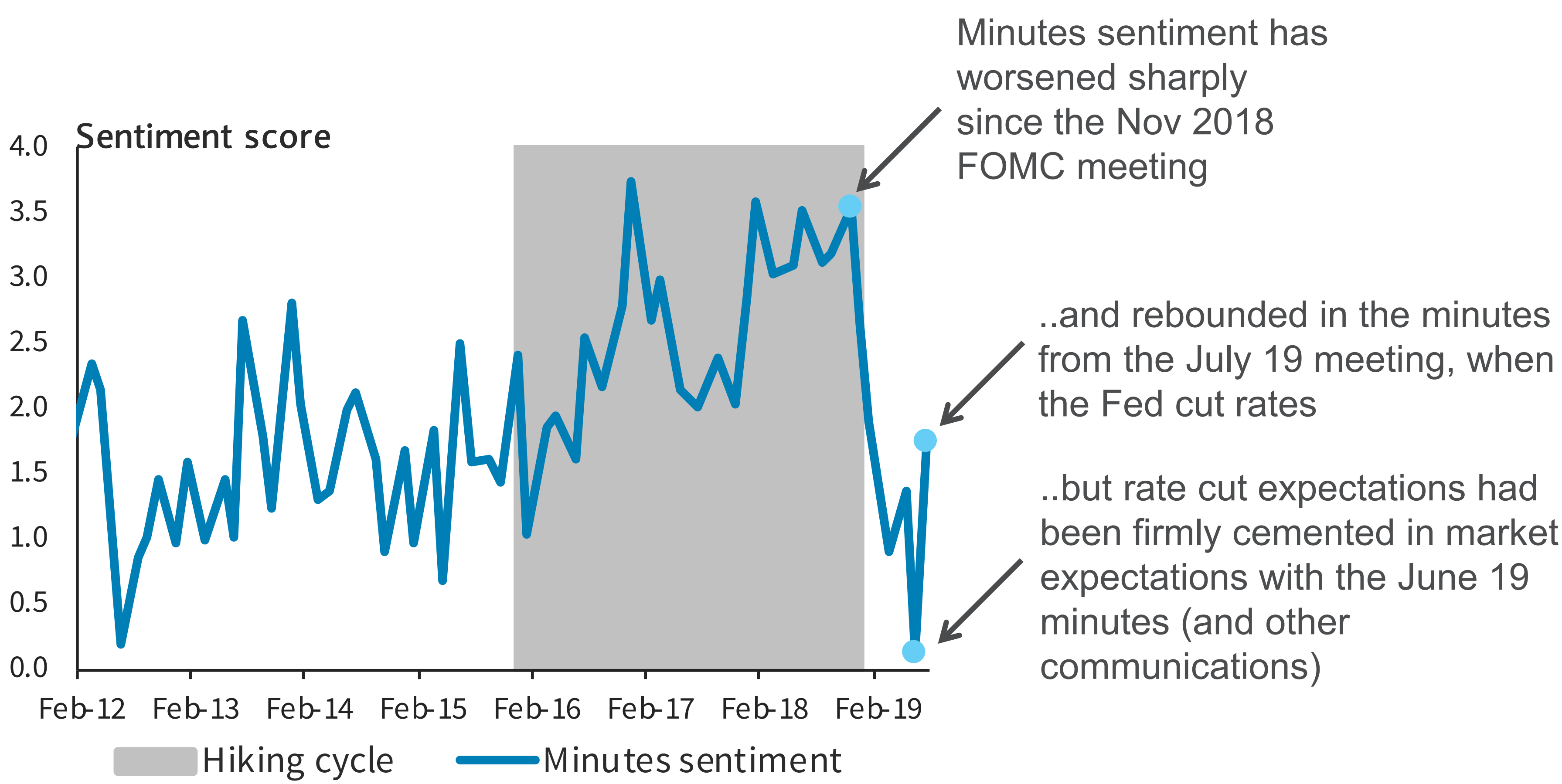
- An upward drift and higher sentiment levels accurately predict the initiation of hiking cycles
- Sentiment needs to drift up over a longer period of time before the Fed embarks on a hiking cycle; The Fed never hiked when the increase in sentiment over 5 meetings was less than 0.8, and hiked only once when the sentiment level was below 1.3



*A one unit move in sentiment represents one standard deviation. Total scores are adjusted for the length of the relevant portions of the minutes.
**We use a decision tree classifier – the model achieves a 95% accuracy score

Recent sharp deterioration, then rebound in FOMC sentiment

Sentiment rebound in July suggests Fed sees cut as a "mid-cycle adjustment"



Source: Federal Reserve, Barclays Research

Example sentiment scores from the June 2019 minutes

The June 19 minutes' fall in sentiment solidified expectations for a July rate cut

We use grammatical rules to parse sentences, detecting the context of all words that matter. We then score sentence chunks using separate dictionaries for adverbs/adjectives, verbs, and nouns

- References to **uncertainties** and **structural weaknesses** were abound:
  - *Participants judged that uncertainties and downside risks surrounding the economic outlook had increased significantly over recent weeks*. **Score: -2.2**
  - *Incoming data on shipments and orders of new capital goods looked weak and recent readings from some manufacturing surveys had dropped sharply*. **Score: -1.5**
- **Consumer fundamentals remained solid**, but FOMC participants noted **concerns about consumer spending**:
  - *… Several participants, however, noted that tariffs could eventually become a drag on consumer durables spending* **(Score: -1)** […]. *A couple of participants noted that the continued softness in the housing sector was a concern* **(Score: -1)** […]; *a couple of participants were somewhat optimistic that residential investment would pick up.* **(Score: 1)**
- Moreover, references to **inflation developments** were negative:
  - *Treasury yields fell sharply* **(Score: -1.5)** *and far-forward measures of inflation compensation dropped significantly in the United States and abroad.* **(Score: -1.5)**
  - *This increase was slower than a year earlier* **(Score: -1.5)** *, as core PCE price inflation […] moved down to 1.6 percent* **(Score: -1)***, consumer food price inflation remained well below core inflation* **(Score: -1)***, and consumer energy price inflation slowed considerably to about the same rate as inflation.* **(Score: -1.2)**

Source: Federal Reserve, Barclays Research

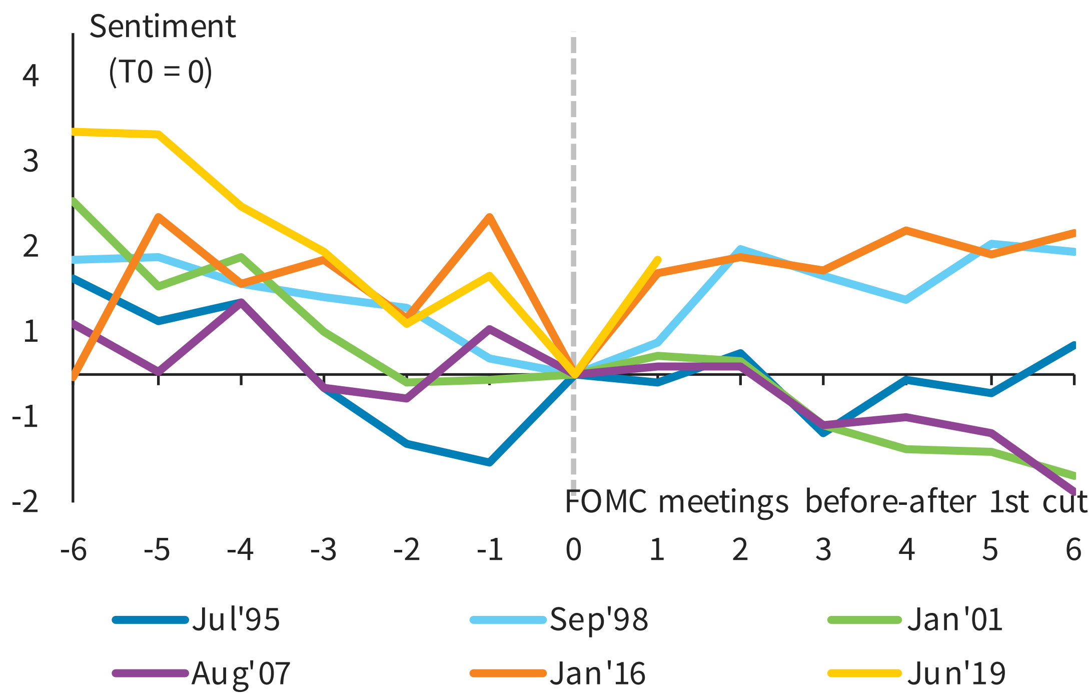
July 2019 FOMC minutes demonstrate a pickup in sentiment

- The Fed justified its policy rate cut by describing slowing **foreign economies, rising risks and uncertainties, and concerns about inflation**:
  - *Incoming data suggested that growth in the foreign economies remained subdued in the second quarter.* **Score: -1**
  - *[…] contacts recognized that some potentially sizeable downside risks remained.* **Score: -0.5**
  - *In their discussion of the business sector, participants generally saw uncertainty surrounding trade policy and concerns about global growth as continuing to weigh on business confidence and firms' capital expenditure plans.* **Score: -1.4**
  - *This increase was slower than a year earlier, as core PCE price inflation […] moved down to 1.6 percent, consumer food price inflation remained below core inflation, and consumer energy prices declined*. **Score: -4.5**
- However, the minutes also describe how US **economic data had remained resilient, downside risks had diminished**, and financial markets had held up well:
  - *Participants generally noted that incoming data over the intermeeting period had been largely positive and that the economy had been resilient in the face of ongoing global developments*. **Score: 1.8**
  - *Participants generally judged that downside risks to the outlook for economic activity had diminished somewhat since their June meeting.* **Score: 0.7**
  - *Somewhat reduced concern among market participants about important risks to the global outlook also appeared to support risk asset prices.* **Score: 2.2**

Source: Federal Reserve, Barclays Research

Restricted - External

How does recent sentiment compare with prior easing cycles?

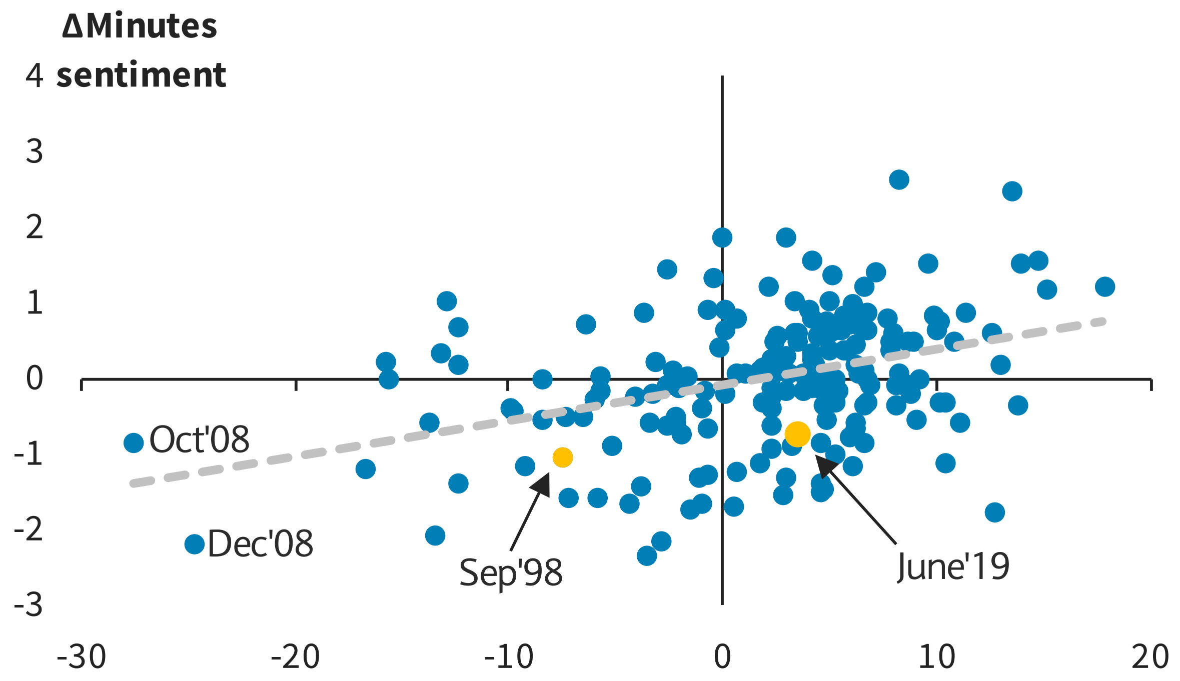


- Sentiment has typically worsened heading into easing cycles
- Sep 1998 insurance cut: sentiment improved right after the one-off ease
- Aug 2007 start of (un)conventional easing cycle: sentiment fell later in easing cycle
- Jan 2016 pause in removing policy accommodation: sentiment remained stable
- Jun 2019: Sentiment has fallen more than typical prior to easing, but a **strong rebound in sentiment suggests the Fed saw the rate cut as a "mid-cycle policy adjustment"**

Graph: Jan 2016 added for comparison. Source: Federal Reserve, Barclays Research

Did sentiment turn negative because of stock markets? No

Tighter financial conditions prompted Sep'98 "insurance cut"; not the recent cut



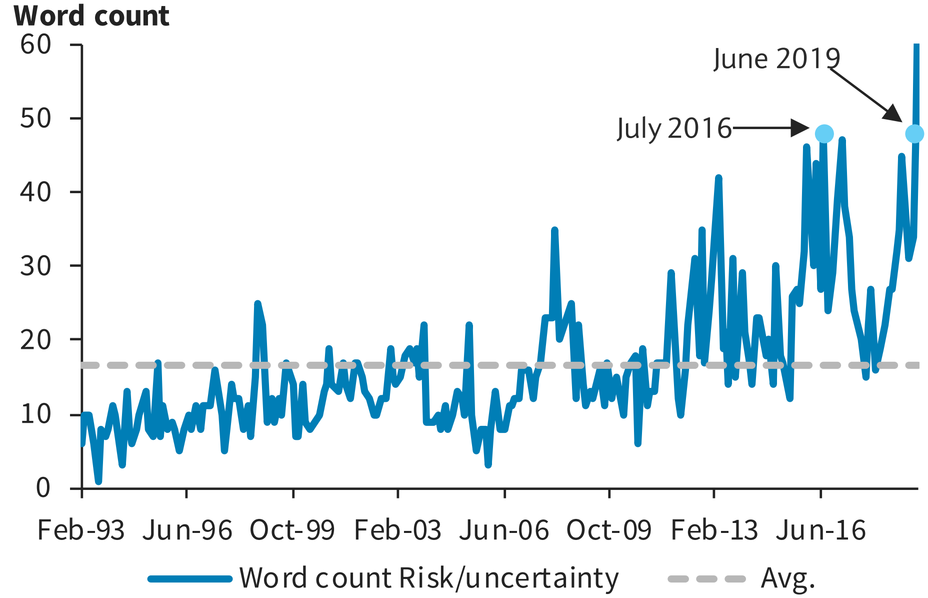
NB: Change in sentiment and S&P from 3 meetings prior

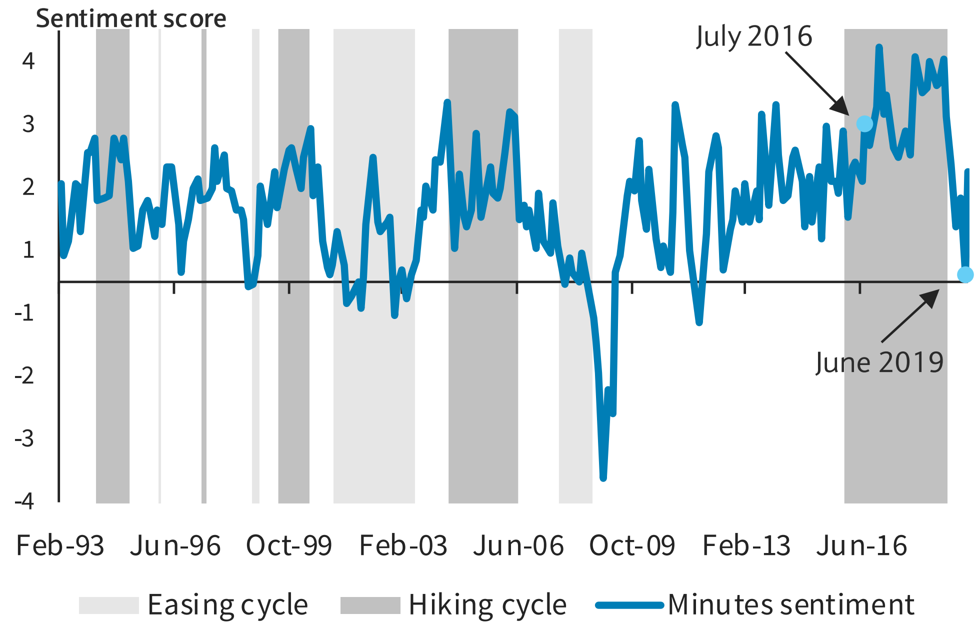
- Historically, sentiment turned more negative when the S&P fell sharply
- A tightening in financial conditions prompted the September 1998 "insurance cut"
- But in between the meetings leading up to the June 2019 FOMC meeting, the S&P actually rose
  - Tighter financial conditions cannot explain this drop in FOMC sentiment
- So which factors *did* cause the FOMC to become more negative?

Source: Federal Reserve, Barclays Research

Sentiment driven by rising risk and uncertainties, but a simple word count can be misleading

- There were 48 references to "risk" or "uncertainties" in the June 2019 minutes - similar to the July 2016 minutes' word count
  - With 70 such references in the July 2019 minutes
- However, **word count does not always accurately capture perceived higher risks or uncertainties**, let alone underlying sentiment
- The context matters:
  - The July 2016 minutes included references to, e.g., "*investors' concerns eased substantially on the* ***resolution of*** *some of the near-term political* ***uncertainty*** *in the [UK]*"; "*Participants viewed the near-term* ***risks*** *to the US economic outlook as* ***having diminished***."
  - In the July 2019 minutes, negative sentiment from references to risks was offset with positive sentiment from descriptions of e.g. strong labor markets, confident consumers, and low unemployment
- Our sentiment scores for the July 2016 and July 2019 minutes are higher than the June 2019 minutes, as they should be





Source for all figures: Federal Reserve, Barclays Research

Fed participants seemed overly optimistic in 2018, now catching up with fundamentals

A look at sentiment in different sections of the FOMC minutes

- As the "staff review" of the economic situation describes developments in economic indicators, sentiment scores from these portions should broadly follow economic indices – and they do (Fig. 1)
- From the participants' discussion of current conditions and the outlook, we can extract FOMC participants' sentiment. This also dropped off, then rebounded in the latest minutes (Fig. 2)
- Fed participants seemed overly optimistic in 2018, but their sentiment is now closer in line with fundamentals

Figure 1

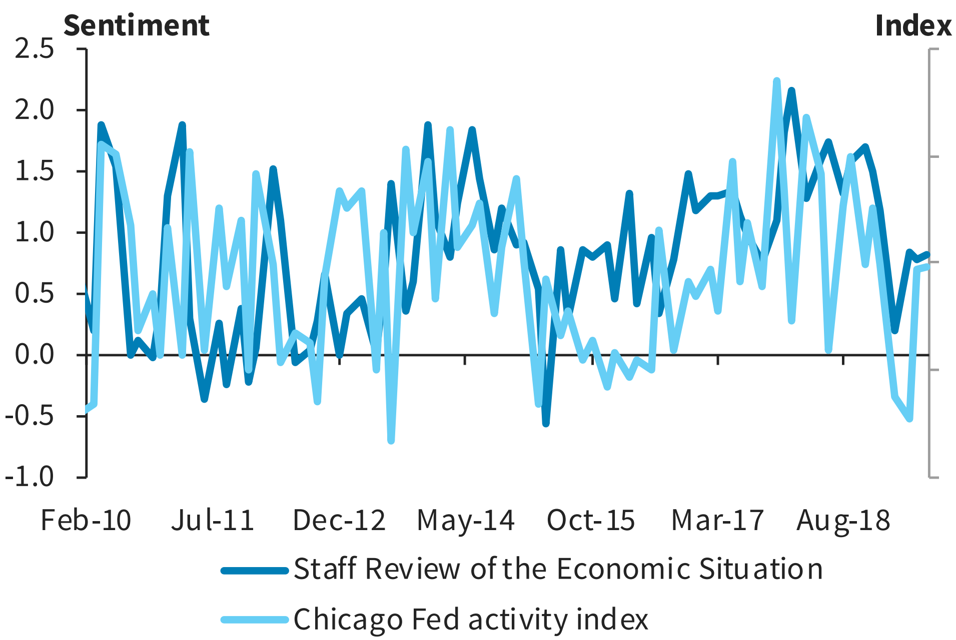
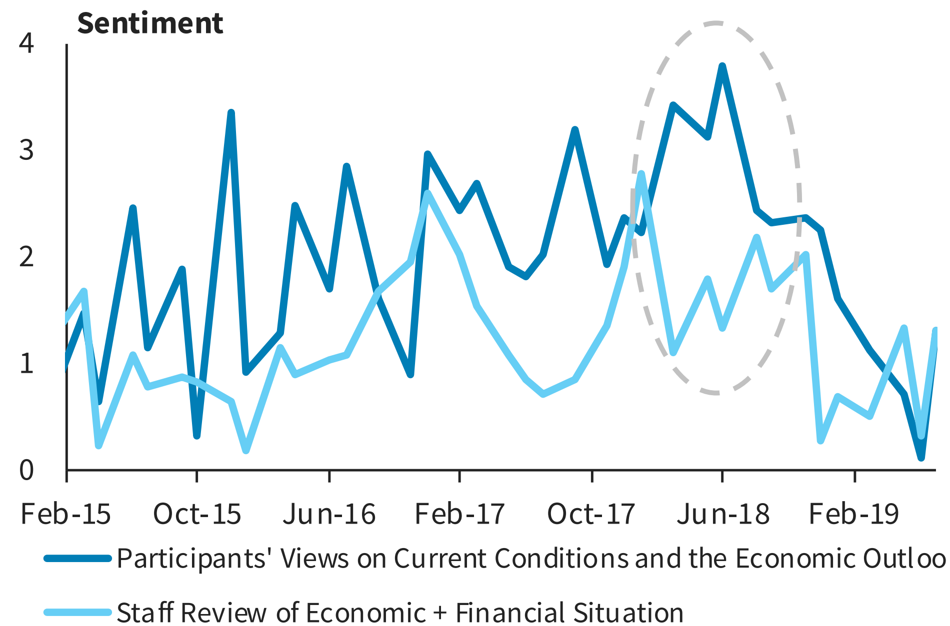


Figure 2

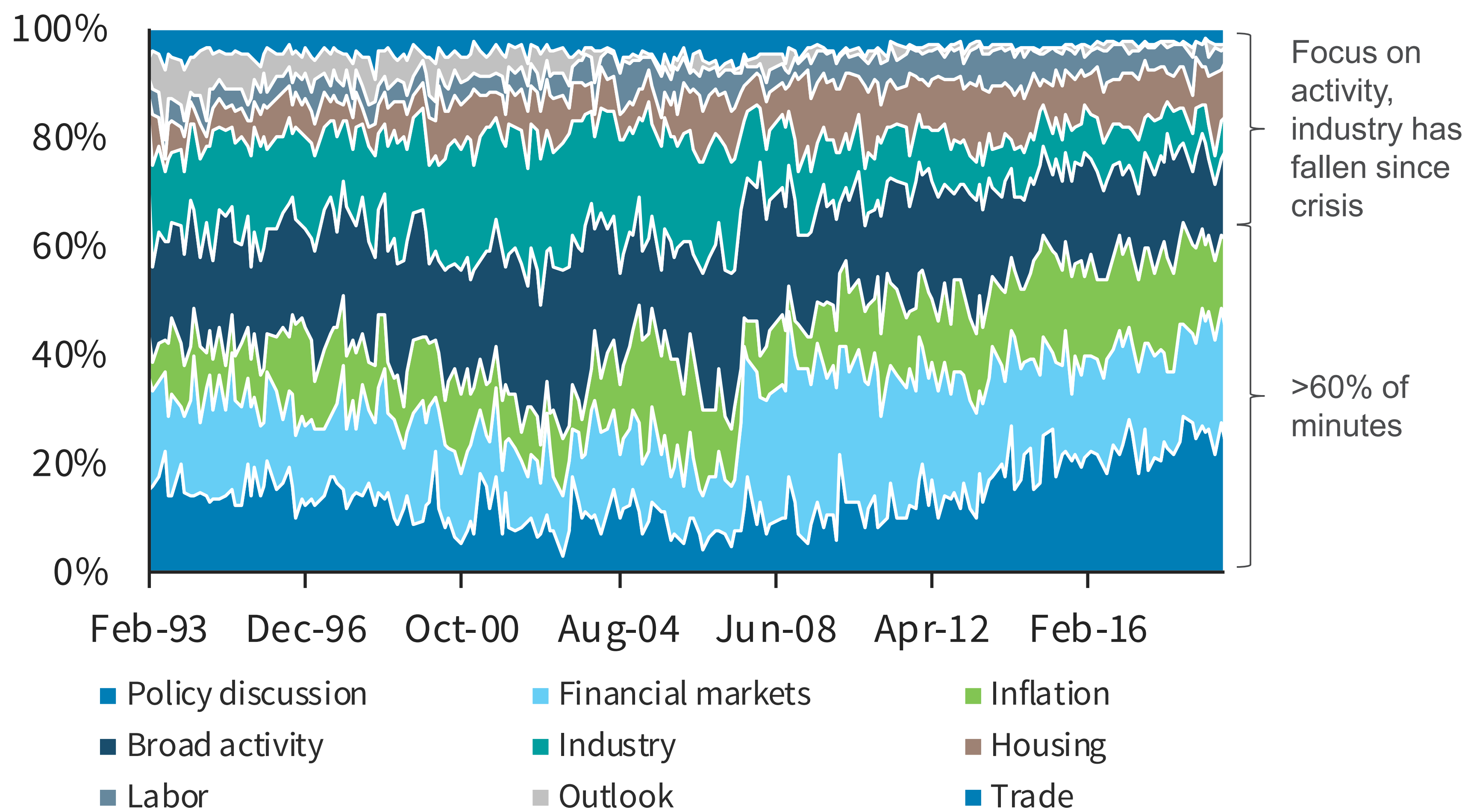


Source : Bloomberg, Federal Reserve, Barclays Research

What is the Fed worried about? A deeper dive using a topic model

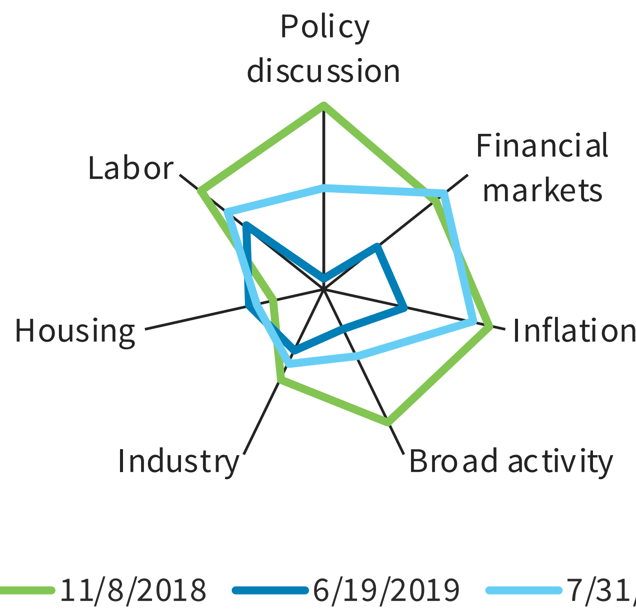
Discussion on policy, financial markets, and inflation now covers >60% of minutes

While less time is now spent discussing broad economic activity and/or industry



Source: Federal Reserve, Barclays Research

June 2019: Economic weaknesses lowered sentiment across topics



- Broad activity sentiment has slipped since Q4 2018, as the June 2019 minutes describe: "*Real GDP growth was forecast to slow to a moderate rate*"; the staff judged that "*risks to the forecast for real GDP growth had tilted to the downside*", and; "*Participants judged that uncertainties and downside risks surrounding the economic outlook had increased significantly*."
- Sentiment for inflation fell as inflation expectations slipped, e.g. from June minutes: "[*the PCE price index*] *increase was slower than a year earlier*", and; "*measures of inflation compensation* […] *decreased notably*"
- Inflation and financial market sentiment rebounded strongly after the June FOMC meeting, but sentiment for broad economic activity and in the policy discussion remains muted – due to lingering risks to the outlook

Source: Federal Reserve, Barclays Research

What were the decisive discussion topics for prior eases?

Industrial activity, on average, but inflation seems more of a deciding factor lately

Going into easing cycles, industry sentiment drops most on average…

- On average, industry sentiment falls most from three meetings prior to every first rate cut
- However, for all but the Jan 2001 first ease, a fall in sentiment for other topics seems to drive the ease
- The most prominent concern for the Jul 1995 ease was trade, and broad activity for the Sep 1998 cut
- At the onsets of the past two easing cycles, shortfalls in inflation seemed more concerning to the FOMC

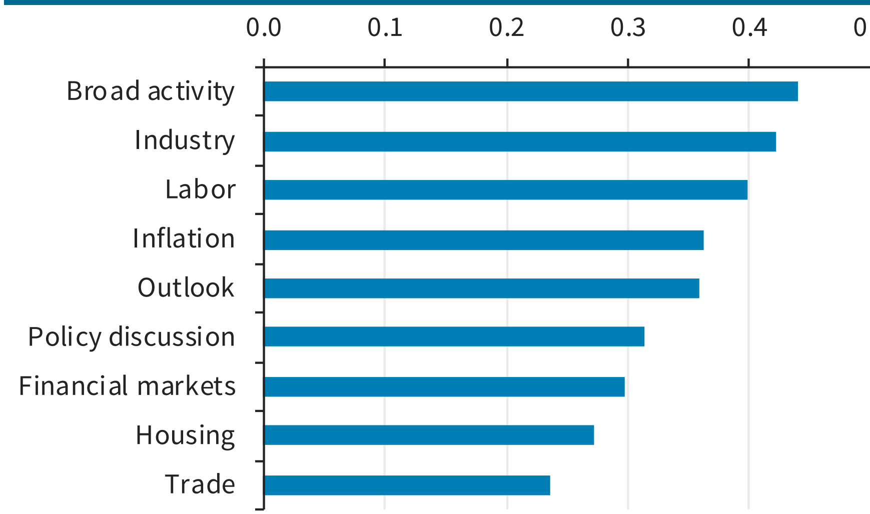
…but only in 2001 was it the deciding factor

	Jul-95	Sep-98	Jan-01	Aug-07	Jun-19	Average
Industry	-1.3	-0.7	$\boxed{-1.2}$	0.0	$\boxed{-1.9}$	-1.0
Policy discussion	-1.0	-0.2	0.8	0.0	$\boxed{-3.7}$	-0.8
Trade	$\boxed{-1.9}$	-0.9	-1.0	-0.3	0.2	-0.8
Inflation	0.8	-0.2	-0.4	$\boxed{-0.4}$	$\boxed{-3.1}$	-0.6
Labor	-1.3	-0.7	-0.4	0.2	-0.2	-0.5
Broad activity	0.5	$\boxed{-1.8}$	1.1	-0.2	-1.6	-0.4
Financial markets	-0.5	-1.1	-0.2	0.5	-0.7	-0.4
Outlook	2.9	-1.6	-0.4	-0.2	-1.1	-0.1
Housing	-0.3	0.5	0.2	0.0	0.5	0.2

Broad activity, industry sentiment

- We regress the Chicago national activity indicator (NAI) on sentiment scores per topic, and find that all topics are directionally related to national activity*
- Sentiment for broad activity and industry are most strongly related to the NAI, as they have the highest loadings
  - But all topics contribute in a positive way to explain the NAI (all loadings are positive)

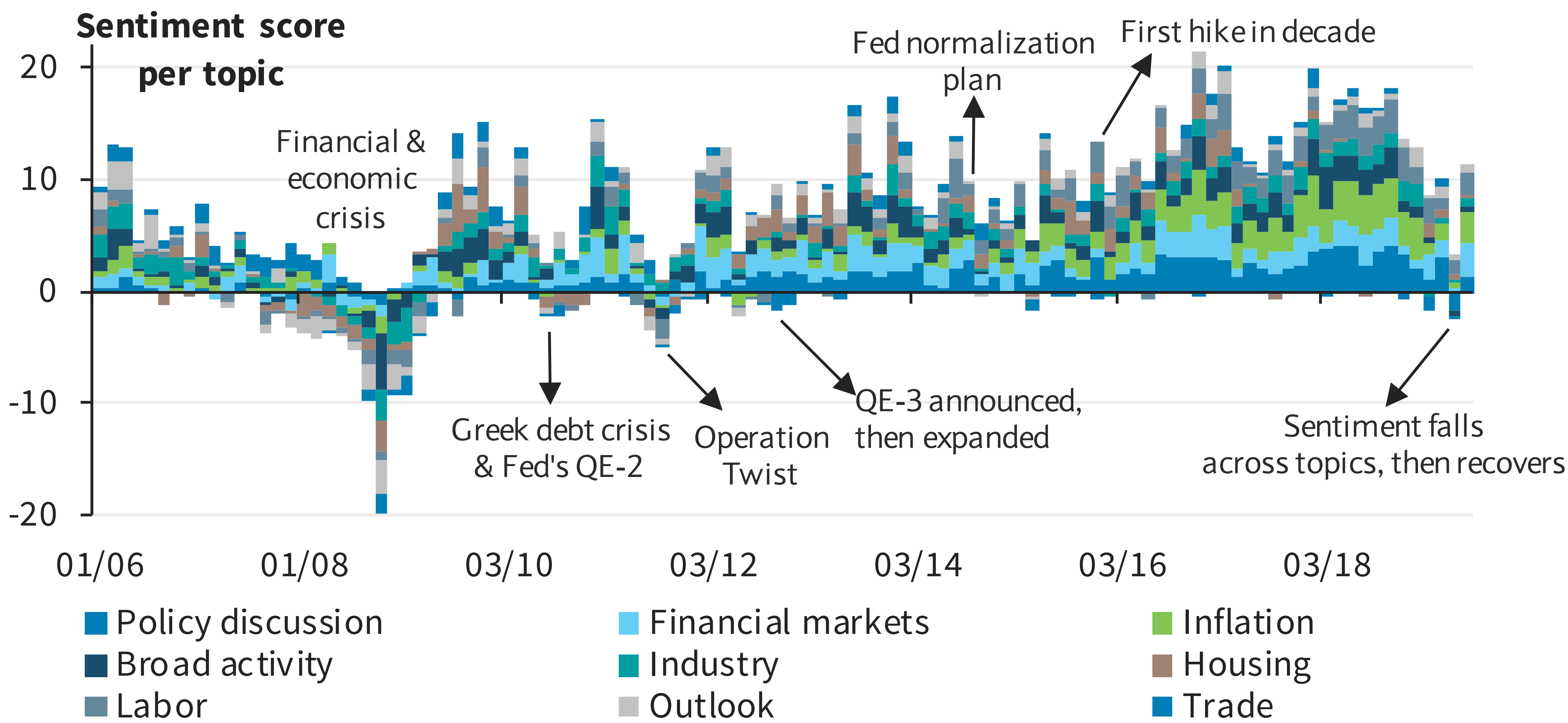
Factor loadings PLS



*We use a Partial Least Squares regression.
Source for all figures: Federal Reserve, Barclays Research

Fluctuations in sentiment align with key FOMC decisions

June'19 sentiment at levels Fed embarked on QE-measures, yet above 2008/09 crisis



Source: Federal Reserve, Barclays Research

Key takeaways from our sentiment indicators

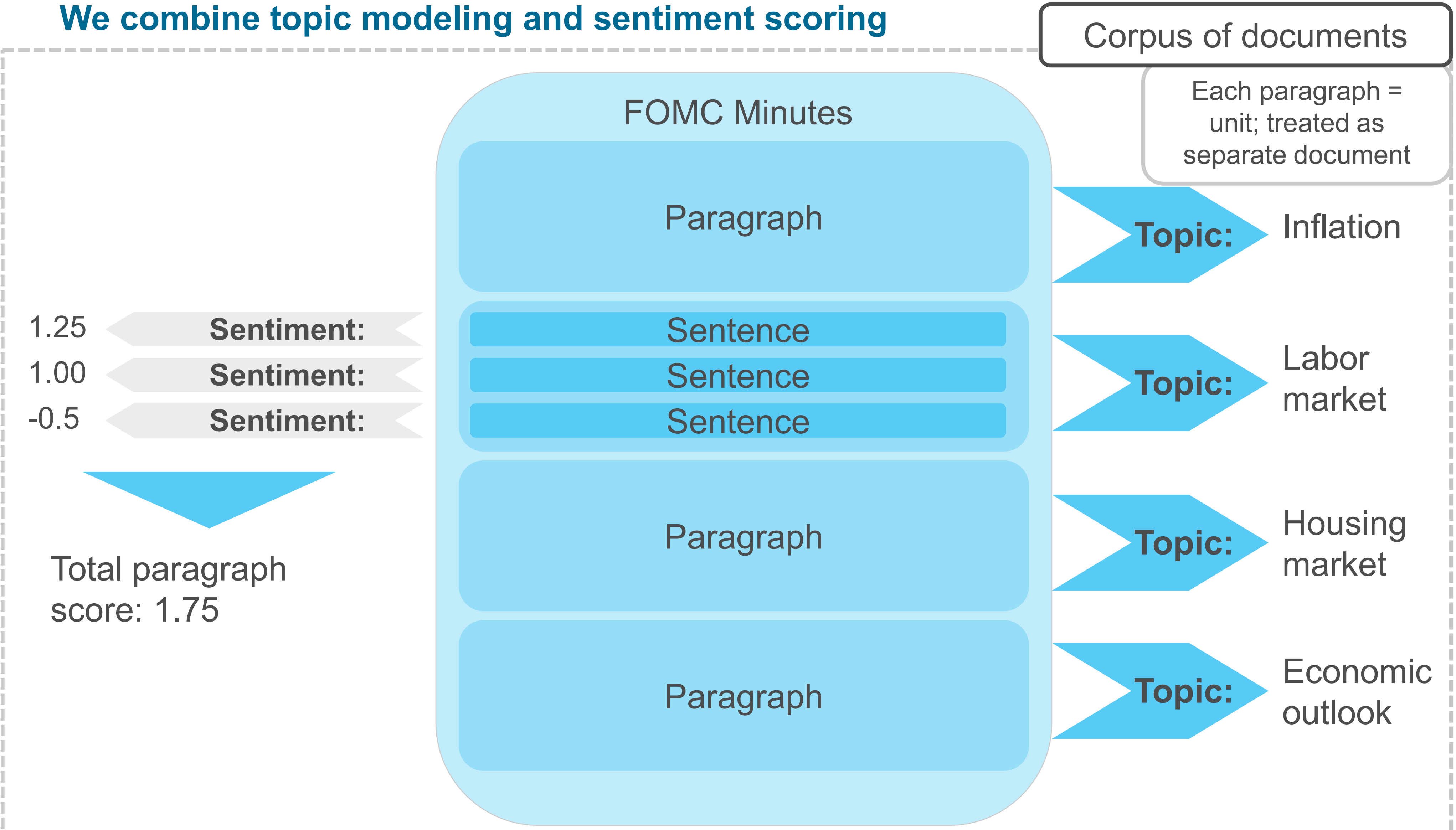
- Justifying the July 2019 rate cut was the sharp drop in FOMC sentiment from the June minutes to below the level where easing cycles are typically initiated
  - Since 1995, the Fed has consistently embarked on a full easing cycle (or the introduction of non-standard measures) with sentiment at June levels
  - Though sentiment is still far removed from the low levels during the 2008-09 crisis
- Increased risks and uncertainties suppressed sentiment during the June meeting, but more fundamental economic factors were at play as well
  - The July rate cut cannot be explained by a tightening in financial conditions, like the Sep 1998 insurance cut
  - Sentiment for different topics of discussion shows that in the June meeting minutes it worsened for the whole range of topics, especially for inflation, broad activity, industry, and financial markets
- However, sentiment from the July minutes actually rebounded
  - This is in line with the Fed's characterization of the rate cut as a mid-cycle adjustment to monetary policy, due to better news flow in the June-July intermeeting period
  - The tightening in financial conditions, the slowdown in the global economy, and rising geopolitical risks since the July FOMC meeting suggests sentiment will likely fall again
- Our economics team expects three more 25bp rate cuts this year

Appendix

Restricted - External

General approach

We combine topic modeling and sentiment scoring



Source: Barclays Research

In brief: How we construct our sentiment indicator

Two simple examples from the June 2019 FOMC minutes

- We use grammatical rules to parse sentences and score sentences in chunks
- We use self-constructed dictionaries with scores for key objects, verbs, and adverbs/adjectives

*

-1.5 | 1

However, they judged that | the **risks and uncertainties** surrounding their outlooks | particularly those related to the global economic outlook | **had intensified** in recent weeks

As expected, this sentence gets a **negative** score: -1.5 * 1 = -1.5,
…but standard word-count based score is positive (0.07*)

* | * | *

1 | 1.5 | 0.8 | -1 | -1

Job gains | have been **solid** | **on average**, in recent months, | and the **unemployment rate** | has **remained low**.

As expected, this sentence gets a **positive** score: 1 * 1.5 * 0.8 + -1 * -1 = 2.2,
…but standard word-count based score is negative (-0.04)

NB. Word-count based scores are from open-source package “TextBlob”. Scores range from -1 (more negative) to +1 (most positive)

Source: Federal Reserve, Barclays Research

BARCLAYS

Restricted - External

3 September 2019

How we construct our sentiment indicator

Sentence scores

- About 70% of sentences receive a sentiment score; other sentences do not convey sentiment
- 90% of sentence scores range between -2 and 2, with some outliers
- The more references in a sentence that are negative, the more negative the aggregate score per sentence is – and vice versa
  - For example, a negative outlier from the July 2019 minutes (score: -4.5):

-1.5	+	-1	+	-1	+	-1
This **increase was slower** than a year earlier,		as **core PCE price inflation** (which excludes changes in consumer food and energy prices) **moved down** to 1.6 percent,		consumer food price **inflation remained below** core inflation,		and **consumer energy prices** declined.

  - And a positive outlier (3.3):

1.8	+	1	+	0.5
In explaining their policy views, those members noted that **economic data** collected over the intermeeting period **had been largely positive**		and that they anticipated **continued strong labor markets and solid growth in activity**		Along with **inflation gradually moving up** to the Committee's 2 percent target.

Source: Federal Reserve, Barclays Research

Sentiment scoring: Open-source versus proprietary model

Using sentence structure

- A decline (-1) in confidence (1) → **negative score**, but…
- A decline (-1) in unemployment (-1) → **positive score**
- Detect syntagmatic structure to identify: nouns + adjectives/adverbs + verbs + negations
- Create "dictionaries" with sentiment scores for nouns, adjectives/adverbs, verbs
  - Verbs: worsen = -1; decline = -1; foster = 1; improve = 1
  - Adverbs/adjectives: strong = 1.75; sharp = 1.5; fragile = -1
  - Nouns: unemployment (rate) = -1; confidence = 1

Open-source versus proprietary model: how do models score

Example sentence	Open-source available package I	Open-source available package II	Scores of open-source packages?	Proprietary model
The employment rate declined sharply.	-0.13	0	Not all correct	-1.5
Growth declined sharply.	-0.13	0.38	Not all correct	-1.5
The unemployment rate declined sharply.	-0.13	-0.44	All incorrect	1.5
The unemployment rate rose sharply.	0.24	-0.44	Not all correct	-1.5

Source: TextBlob, Vader, Barclays Research

Sentiment scoring examples

- Ideally, the sentiment score is symmetric, where >0 means positive developments, <0 means negative developments
- Our method generates equally positive or negative scores if developments are reversed

Example sentences

- For example, a sentence with two positive developments has a positive score of 2.75
  - Job gains (1) have been strong (1.75), in recent months, and the unemployment rate (-1) has declined (-1). Score: 1*1.75 + -1*-1 = 2.75
- A sentence with the same, but negative developments has a negative score of -2.75
  - Job gains (1) have been weak (-1.75), in recent months, and the unemployment rate (-1) has increased (1). Score: 1*-1.75 + -1*1 = -2.75
- And qualifiers are taken into account as well, because they indicate when positive/negative developments are more or less strong
  - Job gains (1) have been **somewhat** (0.5) strong (1.5), in recent months, and the unemployment rate (-1) has declined (-1) **slightly** (0.5). Score: 1*0.5*1.5 + -1*-1*0.5 = 1.375

Source: Barclays Research

Topic modeling

First transform each paragraph to numerical quantity (vector)

Corpus of documents

Each paragraph = unit
→ Find most likely topic for unit

FOMC Minutes

…

…

From paragraph…

… Job gains had been strong, on average, in recent months, and the unemployment rate had declined…

…to vector with Term Frequencies…

[…,"job gains",…,"and the", "unemployment rate",…]

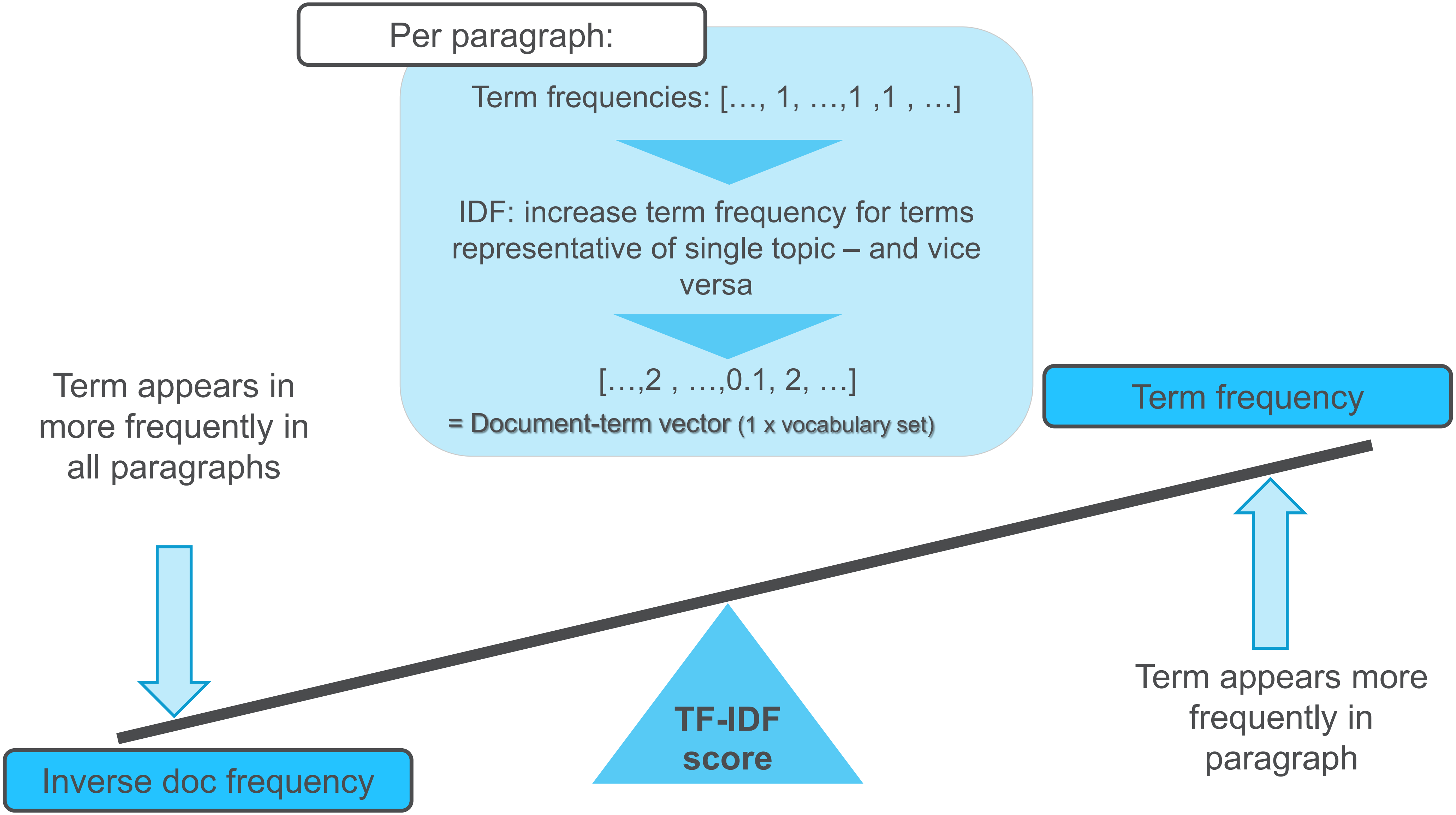
[… ,1 , … ,1 ,1 , …]

…to vector with Term Frequency-Inverse Document Frequency

Source: Barclays Research

Topic modeling

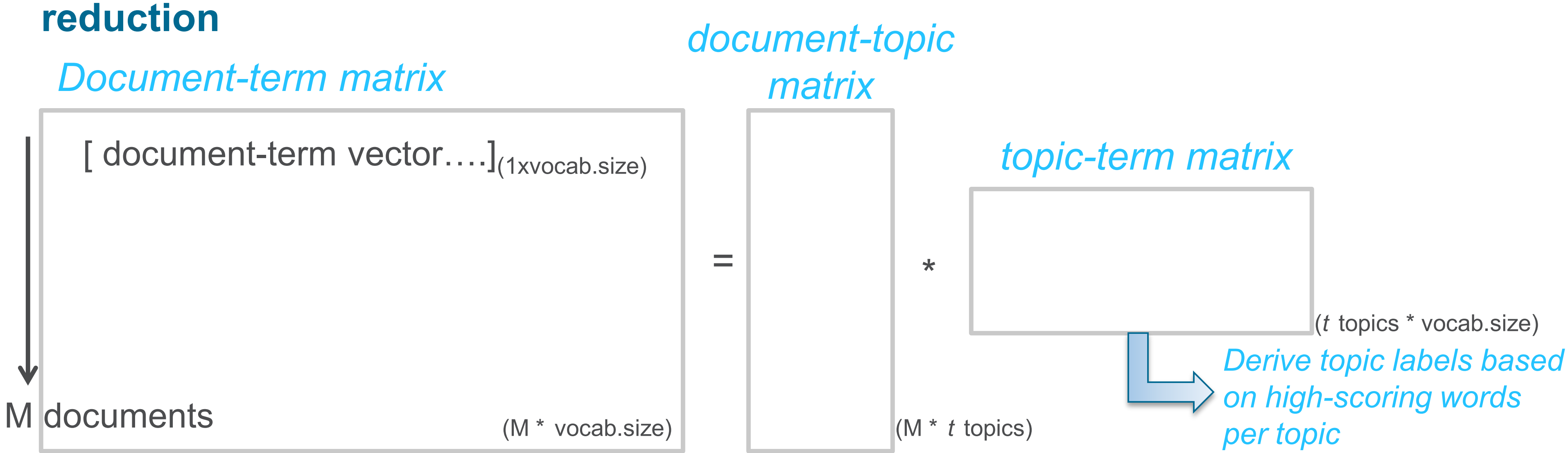
From paragraphs to Term Frequency-Inverse Document Frequency (TFIDF) vectors



Source: Barclays Research

Topic modeling

Then cluster paragraph vectors into clusters that look alike, by dimensionality reduction



- Dimensionality reduction to dimension = *t* corresponding to *t* topics
- Labels for topics are derived from word pairs most representative for each topic (from topic-term matrix)
- We used bigrams (word pairs), rather than unigrams (single words)
- We removed digits and stop words
- We optimized other parameters to create clearly distinguishable topic categories

Source: Barclays Research

Appendix

Topics and key terms per topic

- **Policy discussion:** Federal funds, target range, labor market, rate percent, path federal, stance monetary, forward guidance, maintain target, inflation pressures, run objectives, sustainable economic, monetary developments, careful consideration, economic projections, longer run, appropriate monetary, summary economic, absence shocks
- **Broad activity:** Economic activity, economic outlook, economic growth, real GDP, medium term, labor market, near term, downside risks, GDP growth, consumer spending, outlook economic, staff economic, financial markets, financial conditions, market conditions, risks economic, forecast prepared, unemployment rate, price stability
- **Housing:** Agency mortgage, mortgage backed, principal payments, agency debt, debt agency, reinvesting principal, securities agency, rolling maturing, holdings agency, single family, existing homes, sales new, home sales, housing starts, mortgage rates, sales existing, multifamily units, housing activity, housing sector, permit issuance
- **Financial markets:** Financial markets, developments financial, market operations, real estate, commercial mortgage, value dollar, foreign exchange, market rates, exchange value, currencies declined, open market, federal funds, treasury securities, financing conditions, loans banks, estate cre, corporate bonds, speculative grade, nonfinancial firms, industrial loans, consumer credit
- **Inflation:** inflation expectations, inflation compensation, measures inflation, term inflation, survey based, price inflation, consumer price, energy prices, consumer prices, price index, food energy, pce price, core consumer, inflation expectations, core pce, labor costs, months ended, finished goods, producer prices
- **Outlook:** economic financial, intermeeting ahead, discussion economic, implementation monetary, financial outlook, discussion provided, financial information, outlook implementation, information available
- **Industry:** Motor vehicles, industrial production, capital goods, business equipment, new orders, high tech, nonresidential construction, manufacturing production, capacity utilization, equipment software, shipments nondefense, national regional, manufacturing output, retail sales, vehicle assemblies, business spending, manufacturing surveys
- **Labor:** Unemployment rate, payroll employment, labor force, force participation, nonfarm payroll, participation rate, labor market, unemployment insurance, claims unemployment, initial claims, economic reasons, time economic, job openings, private nonfarm, employed time, workers employed, share workers, civilian unemployment, market conditions, private sector
- **Trade:** Trade deficit, international trade, industrial supplies, automotive products, consumer goods, goods services, deficit widened, capital goods, deficit narrowed, net exports, foreign industrial, value imports, value exports

Source: Barclays Research

Restricted - External

Analyst Certifications and Important Disclosures

Analyst Certification(s)
I, Renate Marold, hereby certify (1) that the views expressed in this research report accurately reflect my personal views about any or all of the subject securities or issuers referred to in this research report and (2) no part of my compensation was, is or will be directly or indirectly related to the specific recommendations or views expressed in this research report.

Important Disclosures: FICC

Barclays Research is produced by the Investment Bank of Barclays Bank PLC and its affiliates (collectively and each individually, "Barclays").

All authors contributing to this research report are Research Analysts unless otherwise indicated. The publication date at the top of the report reflects the local time where the report was produced and may differ from the release date provided in GMT.

Availability of Disclosures:

For current important disclosures regarding any issuers which are the subject of this research report please refer to https://publicresearch.barclays.com or alternatively send a written request to: Barclays Research Compliance, 745 Seventh Avenue, 13th Floor, New York, NY 10019 or call +1-212-526-1072.

Barclays Capital Inc. and/or one of its affiliates does and seeks to do business with companies covered in its research reports. As a result, investors should be aware that Barclays may have a conflict of interest that could affect the objectivity of this report. Barclays Capital Inc. and/or one of its affiliates regularly trades, generally deals as principal and generally provides liquidity (as market maker or otherwise) in the debt securities that are the subject of this research report (and related derivatives thereof). Barclays trading desks may have either a long and / or short position in such securities, other financial instruments and / or derivatives, which may pose a conflict with the interests of investing customers. Where permitted and subject to appropriate information barrier restrictions, Barclays fixed income research analysts regularly interact with its trading desk personnel regarding current market conditions and prices. Barclays fixed income research analysts receive compensation based on various factors including, but not limited to, the quality of their work, the overall performance of the firm (including the profitability of the Investment Banking Department), the profitability and revenues of the Markets business and the potential interest of the firm's investing clients in research with respect to the asset class covered by the analyst. To the extent that any historical pricing information was obtained from Barclays trading desks, the firm makes no representation that it is accurate or complete. All levels, prices and spreads are historical and do not necessarily represent current market levels, prices or spreads, some or all of which may have changed since the publication of this document. Barclays Research Department produces various types of research including, but not limited to, fundamental analysis, equity-linked analysis, quantitative analysis, and trade ideas. Recommendations and trade ideas contained in one type of Barclays Research may differ from those contained in other types of Barclays Research, whether as a result of differing time horizons, methodologies, or otherwise.

In order to access Barclays Statement regarding Research Dissemination Policies and Procedures, please refer to *https://publicresearch.barcap.com/S/RD.htm*. In order to access Barclays Research Conflict Management Policy Statement, please refer to: *https://publicresearch.barcap.com/S/CM.htm*.

All pricing information is indicative only. Prices are sourced from Refinitiv as of the last available closing price at the time of production of the research report, unless another time and source is indicated.

Types of investment recommendations produced by Barclays FICC Research:

In addition to any ratings assigned under Barclays' formal rating systems, this publication may contain investment recommendations in the form of trade ideas, thematic screens, scorecards or portfolio recommendations that have been produced by analysts in FICC Research. Any such investment recommendations produced by non-Credit Research teams shall remain open until they are subsequently amended, rebalanced or closed in a future research report. Any such investment recommendations produced by the Credit Research teams are valid at current market conditions and may not be otherwise relied upon.

Disclosure of other investment recommendations produced by Barclays FICC Research:

Barclays FICC Research may have published other investment recommendations in respect of the same securities/instruments recommended in this research report during the preceding 12 months. To view all investment recommendations published by Barclays FICC Research in the preceding 12 months please refer to *https://live.barcap.com/go/research/Recommendations*.

Important Disclosures Continued

Legal entities involved in producing Barclays Research:

Barclays Bank PLC (Barclays, UK)

Barclays Capital Inc. (BCI, US)

Barclays Bank Ireland PLC, Frankfurt Branch (BBI, Frankfurt)

Barclays Bank Ireland PLC, Paris Branch (BBI, Paris)

Barclays Bank Ireland PLC, Milan Branch (BBI, Milan)

Barclays Securities Japan Limited (BSJL, Japan)

Barclays Bank PLC, Hong Kong branch (Barclays Bank, Hong Kong)

Barclays Capital Canada Inc. (BCCI, Canada)

Barclays Bank Mexico, S.A. (BBMX, Mexico)

Barclays Securities (India) Private Limited (BSIPL, India)

Barclays Bank PLC, India branch (Barclays Bank, India)

Barclays Bank PLC, Singapore branch (Barclays Bank, Singapore)

Disclaimer

This publication has been produced by Barclays Research Department in the Investment Bank of Barclays Bank PLC and/or one or more of its affiliates (collectively and each individually, "Barclays"). It has been prepared for institutional investors only and not for retail investors. It has been distributed by one or more Barclays affiliated legal entities listed below. It is provided to our clients for information purposes only, and Barclays makes no express or implied warranties, and expressly disclaims all warranties of merchantability or fitness for a particular purpose or use with respect to any data included in this publication. To the extent that this publication states on the front page that it is intended for institutional investors and is not subject to all of the independence and disclosure standards applicable to debt research reports prepared for retail investors under U.S. FINRA Rule 2242, it is an “institutional debt research report” and distribution to retail investors is strictly prohibited. Barclays also distributes such institutional debt research reports to various issuers, media, regulatory and academic organisations for their own internal informational news gathering, regulatory or academic purposes and not for the purpose of making investment decisions regarding any debt securities. Media organisations are prohibited from re-publishing any opinion or recommendation concerning a debt issuer or debt security contained in any Barclays institutional debt research report. Any such recipients that do not want to continue receiving Barclays institutional debt research reports should contact debtresearch@barclays.com. Barclays will not treat unauthorized recipients of this report as its clients and accepts no liability for use by them of the contents which may not be suitable for their personal use. Prices shown are indicative and Barclays is not offering to buy or sell or soliciting offers to buy or sell any financial instrument.

Without limiting any of the foregoing and to the extent permitted by law, in no event shall Barclays, nor any affiliate, nor any of their respective officers, directors, partners, or employees have any liability for (a) any special, punitive, indirect, or consequential damages; or (b) any lost profits, lost revenue, loss of anticipated savings or loss of opportunity or other financial loss, even if notified of the possibility of such damages, arising from any use of this publication or its contents.

Other than disclosures relating to Barclays, the information contained in this publication has been obtained from sources that Barclays Research believes to be reliable, but Barclays does not represent or warrant that it is accurate or complete. Barclays is not responsible for, and makes no warranties whatsoever as to, the information or opinions contained in any written, electronic, audio or video presentations of third parties that are accessible via a direct hyperlink in this publication or via a hyperlink to a third-party web site (‘Third-Party Content’). Any such Third-Party Content has not been adopted or endorsed by Barclays, does not represent the views or opinions of Barclays, and is not incorporated by reference into this publication. Third-Party Content is provided for information purposes only and Barclays has not independently verified its accuracy or completeness.

The views in this publication are solely and exclusively those of the authoring analyst(s) and are subject to change, and Barclays Research has no obligation to update its opinions or the information in this publication. Unless otherwise disclosed herein, the analysts who authored this report have not received any compensation from the subject companies in the past 12 months. If this publication contains recommendations, they are general recommendations that were prepared independently of any other interests, including those of Barclays and/or its affiliates, and/or the subject companies. This publication does not contain personal investment recommendations or investment advice or take into account the individual financial circumstances or investment objectives of the clients who receive it. The securities and other investments discussed herein may not be suitable for all investors. Barclays is not a fiduciary to any recipient of this publication. Investors must independently evaluate the merits and risks of the investments discussed herein, consult any independent advisors they believe necessary, and exercise independent judgment with regard to any investment decision. The value of and income from any investment may fluctuate from day to day as a result of changes in relevant economic markets (including changes in market liquidity). The information herein is not intended to predict actual results, which may differ substantially from those reflected. Past performance is not necessarily indicative of future results. The information provided does not constitute a financial benchmark and should not be used as a submission or contribution of input data for the purposes of determining a financial benchmark.

United Kingdom: This document is being distributed (1) only by or with the approval of an authorised person (Barclays Bank PLC) or (2) to, and is directed at (a) persons in the United Kingdom having professional experience in matters relating to investments and who fall within the definition of "investment professionals" in Article 19(5) of the Financial Services and Markets Act 2000 (Financial Promotion) Order 2005 (the "Order"); or (b) high net worth companies, unincorporated associations and partnerships and trustees of high value trusts as described in Article 49(2) of the Order; or (c) other persons to whom it may otherwise lawfully be communicated (all such persons being "Relevant Persons"). Any investment or investment activity to which this communication relates is only available to and will only be engaged in with Relevant Persons. Any other persons who receive this communication should not rely on or act upon it. Barclays Bank PLC is authorised by the Prudential Regulation Authority and regulated by the Financial Conduct Authority and the Prudential Regulation Authority and is a member of the London Stock Exchange.

European Economic Area (“EEA”): This material is being distributed in the EEA by Barclays Bank PLC. Barclays Bank PLC is not registered in France with the Autorité des marchés financiers or the Autorité de contrôle prudential.

Americas: The Investment Bank of Barclays Bank PLC undertakes U.S. securities business in the name of its wholly owned subsidiary Barclays Capital Inc., a FINRA and SIPC member. Barclays Capital Inc., a U.S. registered broker/dealer, is distributing this material in the United States and, in connection therewith accepts responsibility for its contents. Any U.S. person wishing to effect a transaction in any security discussed herein should do so only by contacting a representative of Barclays Capital Inc. in the U.S. at 745 Seventh Avenue, New York, New York 10019.

Non-U.S. persons should contact and execute transactions through a Barclays Bank PLC branch or affiliate in their home jurisdiction unless local regulations permit otherwise.

This material is distributed in Canada by Barclays Capital Canada Inc., a registered investment dealer, a Dealer Member of IIROC (www.iiroc.ca), and a Member of the Canadian Investor Protection Fund (CIPF).

This material is distributed in Mexico by Barclays Bank Mexico, S.A.

Disclaimer (continued)

Japan: This material is being distributed to institutional investors in Japan by Barclays Securities Japan Limited. Barclays Securities Japan Limited is a joint-stock company incorporated in Japan with registered office of 6-10-1 Roppongi, Minato-ku, Tokyo 106-6131, Japan. It is a subsidiary of Barclays Bank PLC and a registered financial instruments firm regulated by the Financial Services Agency of Japan. Registered Number: Kanto Zaimukyokucho (kinsho) No. 143.

Asia Pacific (excluding Japan): Barclays Bank PLC, Hong Kong Branch is distributing this material in Hong Kong as an authorised institution regulated by the Hong Kong Monetary Authority. Registered Office: 41/F, Cheung Kong Center, 2 Queen's Road Central, Hong Kong.

All Indian securities-related research and other equity research produced by Barclays' Investment Bank are distributed in India by Barclays Securities (India) Private Limited (BSIPL). BSIPL is a company incorporated under the Companies Act, 1956 having CIN U67120MH2006PTC161063. BSIPL is registered and regulated by the Securities and Exchange Board of India (SEBI) as a Research Analyst: INH000001519; Portfolio Manager INP000002585; Stock Broker/Trading and Clearing Member: National Stock Exchange of India Limited (NSE) Capital Market INB231292732, NSE Futures & Options INF231292732, NSE Currency derivatives INE231450334, Bombay Stock Exchange Limited (BSE) Capital Market INB011292738, BSE Futures & Options INF011292738; Depository Participant (DP) with the National Securities & Depositories Limited (NSDL): DP ID: IN-DP-NSDL-299-2008; Investment Adviser: INA000000391. The registered office of BSIPL is at 208, Ceejay House, Shivsagar Estate, Dr. A. Besant Road, Worli, Mumbai – 400 018, India. Telephone No: +91 2267196000. Fax number: +91 22 67196100. Any other reports produced by Barclays' Investment Bank are distributed in India by Barclays Bank PLC, India Branch, an associate of BSIPL in India that is registered with Reserve Bank of India (RBI) as a Banking Company under the provisions of The Banking Regulation Act, 1949 (Regn No BOM43) and registered with SEBI as Merchant Banker (Regn No INM000002129) and also as Banker to the Issue (Regn No INBI00000950). Barclays Investments and Loans (India) Limited, registered with RBI as Non Banking Financial Company (Regn No RBI CoR-07-00258), and Barclays Wealth Trustees (India) Private Limited, registered with Registrar of Companies (CIN U93000MH2008PTC188438), are associates of BSIPL in India that are not authorised to distribute any reports produced by Barclays' Investment Bank. This material is distributed in Singapore by the Singapore branch of Barclays Bank PLC, a bank licensed in Singapore by the Monetary Authority of Singapore. For matters in connection with this material, recipients in Singapore may contact the Singapore branch of Barclays Bank PLC, whose registered address is 10 Marina Boulevard, #23-01 Marina Bay Financial Centre Tower 2, Singapore 018983.

This material is distributed to persons in Australia by Barclays Bank PLC. None of Barclays Bank PLC, nor any other Barclays group entity, holds an Australian financial services licence and instead relies on an exemption from the requirement to hold such a licence. This material is intended to only be distributed to "wholesale clients" as defined by the Australian Corporations Act 2001.

Middle East: Nothing herein should be considered investment advice as defined in the Israeli Regulation of Investment Advisory, Investment Marketing and Portfolio Management Law, 1995 ("Advisory Law"). This document is being made to eligible clients (as defined under the Advisory Law) only. Barclays Israeli branch previously held an investment marketing license with the Israel Securities Authority but it cancelled such license on 30/11/2014 as it solely provides its services to eligible clients pursuant to available exemptions under the Advisory Law, therefore a license with the Israel Securities Authority is not required. Accordingly, Barclays does not maintain an insurance coverage pursuant to the Advisory Law.

This material is distributed in the United Arab Emirates (including the Dubai International Financial Centre) and Qatar by Barclays Bank PLC. Barclays Bank PLC in the Dubai International Financial Centre (Registered No. 0060) is regulated by the Dubai Financial Services Authority (DFSA). Principal place of business in the Dubai International Financial Centre: The Gate Village, Building 4, Level 4, PO Box 506504, Dubai, United Arab Emirates. Barclays Bank PLC-DIFC Branch, may only undertake the financial services activities that fall within the scope of its existing DFSA licence. Related financial products or services are only available to Professional Clients, as defined by the Dubai Financial Services Authority. Barclays Bank PLC in the UAE is regulated by the Central Bank of the UAE and is licensed to conduct business activities as a branch of a commercial bank incorporated outside the UAE in Dubai (Licence No.: 13/1844/2008, Registered Office: Building No. 6, Burj Dubai Business Hub, Sheikh Zayed Road, Dubai City) and Abu Dhabi (Licence No.: 13/952/2008, Registered Office: Al Jazira Towers, Hamdan Street, PO Box 2734, Abu Dhabi). Barclays Bank PLC in the Qatar Financial Centre (Registered No. 00018) is authorised by the Qatar Financial Centre Regulatory Authority (QFCRA). Barclays Bank PLC-QFC Branch may only undertake the regulated activities that fall within the scope of its existing QFCRA licence. Principal place of business in Qatar: Qatar Financial Centre, Office 1002, 10th Floor, QFC Tower, Diplomatic Area, West Bay, PO Box 15891, Doha, Qatar. Related financial products or services are only available to Business Customers as defined by the Qatar Financial Centre Regulatory Authority.

Russia: This material is not intended for investors who are not Qualified Investors according to the laws of the Russian Federation as it might contain information about or description of the features of financial instruments not admitted for public offering and/or circulation in the Russian Federation and thus not eligible for non-Qualified Investors. If you are not a Qualified Investor according to the laws of the Russian Federation, please dispose of any copy of this material in your possession.

IRS Circular 230 Prepared Materials Disclaimer: Barclays does not provide tax advice and nothing contained herein should be construed to be tax advice. Please be advised that any discussion of U.S. tax matters contained herein (including any attachments) (i) is not intended or written to be used, and cannot be used, by you for the purpose of avoiding U.S. tax-related penalties; and (ii) was written to support the promotion or marketing of the transactions or other matters addressed herein. Accordingly, you should seek advice based on your particular circumstances from an independent tax advisor.

© Copyright Barclays Bank PLC (2019). All rights reserved. No part of this publication may be reproduced or redistributed in any manner without the prior written permission of Barclays. Barclays Bank PLC is registered in England No. 1026167. Registered office 1 Churchill Place, London, E14 5HP. Additional information regarding this publication will be furnished upon request. US35657

BRCF2242