



Quantitative Portfolio Strategy  
Research



**Albert Desclée**

+44 20 7773 3382

albert.desclee@barclays.com

Barclays, UK

**Mathieu Dubois**

+44 20 3555 0083

mathieu.dubois@barclays.com

Barclays, UK

**Jay Hyman**

+972 362 38745

jay.hyman@barclays.com

Barclays, UK

# Replicating the US MBS Index with TBA Portfolios

January 2019

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 BEGINNING ON PAGE 27.

Restricted - External

# Introduction

---

- The US MBS market represents a major asset class for USD investors, and is also significant for global fixed income investors
  - US MBS represent 28% of Bloomberg Barclays US Aggregate Bond Index
  - US MBS represent 12% of Bloomberg Barclays Global Aggregate Bond Index
- Various strategies can be considered to access US MBS, including
  - Specialist bond mandates
  - Total return swaps
  - Replicating portfolios
- MBS index replicating portfolios can be constructed in different ways:
  - MBS pools
  - TBA portfolios
- We consider TBA replication and explain
  - How a TBA portfolio can be assembled to match index exposures
  - What tracking error to expect
  - Practical considerations

---

# Overview of US MBS

# Why MBS? – A Significant Part of the Global FI Universe

- US MBS currently represent 28% of US Aggregate Index and 12% of Global Agg Index
- Among USD-denominated asset classes, US MBS have exhibited the highest Sharpe ratio over the past 20 years

## Characteristics and Performance of Major Asset Classes

	As of end Dec 2018				From Jan 1999 to Dec 2018		
	MV (USD Trn)	Avg Maturity (y)	Avg Yield (%)	Avg OAS (%)	ER over TBills (%/y)		
					Avg	StDev	S.R.
Multiverse (USD hedged)	53.2	8.7	2.31	0.76	2.81	2.65	<b>1.06</b>
Global Aggregate (USD hedged)	50.4	8.8	2.03	0.55	2.68	2.69	<b>1.00</b>
US Corporate HY	1.2	5.8	7.95	5.26	4.97	9.13	<b>0.54</b>
USD EM	1.9	8.9	6.05	3.43	7.29	9.00	<b>0.81</b>
US TIPS	1.2	7.9			3.43	5.65	<b>0.61</b>
US Aggregate	20.8	8.2	3.28	0.54	2.70	3.38	<b>0.80</b>
US Treasury	8.1	7.6	2.61		2.35	4.30	<b>0.55</b>
US Govt Related	1.3	8.1	3.34	0.73	2.63	3.41	<b>0.77</b>
US Corporate IG	5.1	10.7	4.20	1.53	3.44	5.34	<b>0.64</b>
US Fixed Rate MBS	5.9	7.2	3.39	0.35	2.71	2.62	<b>1.04</b>

Source: Bloomberg Barclays Indices, Barclays Research

Restricted - External

# Why MBS? – Attractive Risk and Return Characteristics

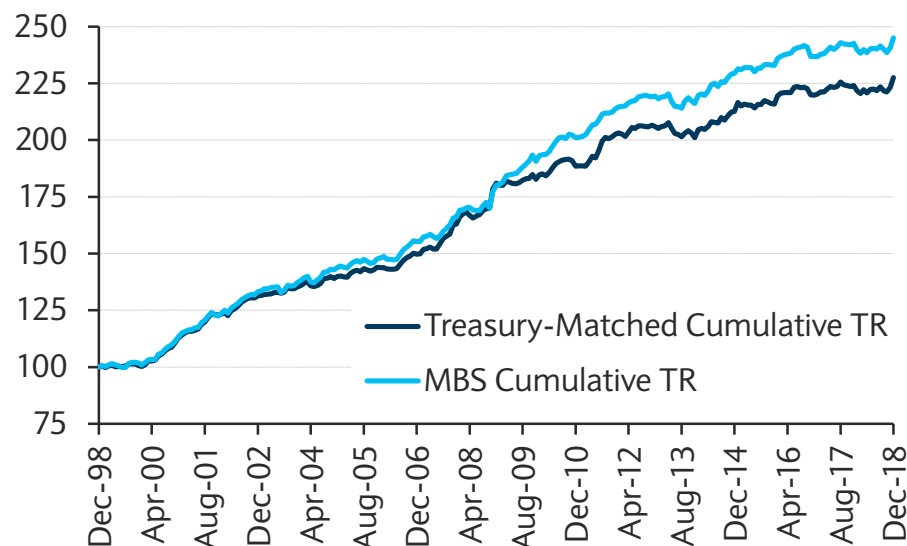
- The MBS Fixed Rate index has delivered higher returns and Sharpe ratio than duration-matched Treasuries
- The MBS index excess returns have delivered a higher information ratio than corporate credit
- Adding MBS to a Treasury portfolio can make duration more stable over time

## Excess returns over duration-matched Tsies

Jan 99 to Dec 18	Avg (%/y)	StDev (%/y)	I.R.
US Corporate HY	2.65	10.38	0.26
US Corporate IG	0.71	4.56	0.16
US Fixed Rate MBS	0.37	1.25	0.30

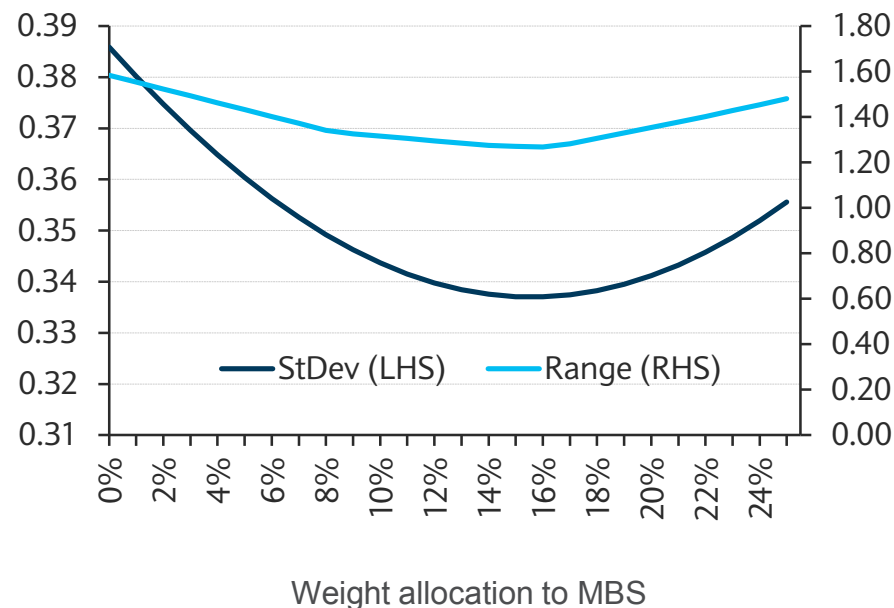
Source: Bloomberg Barclays Indices, Barclays Research

## Cumulative performance



Source: Bloomberg Barclays Indices, Barclays Research

## StDev and range of duration when MBS are added to a Treasury portfolio (Jan 99 to Nov 18)



Source: Bloomberg Barclays Indices, Barclays Research

Restricted - External

# Accessing the MBS Market

---

- Various strategies can be considered to access US MBS, including
  - Specialist bond mandates outsourced to passive or active managers
    - Requires market expertise to invest in individual pools
    - Requires operational expertise to handle prepayment cash flows
  - Total return swaps
    - OTC contract to exchange published index return for a Libor-based payment
    - No exchange of principal: unfunded transaction
    - TRS have become well accepted by a variety of market participants and are now priced on a regular basis
  - Replicating portfolios
    - MBS pools: allows good representation of seasoned mortgages, better index tracking, but requires specific back-office capabilities for handling monthly prepayment cash flows
    - TBA portfolios: rolling forward positions periodically allows full exposure to MBS returns without the need to process cash flows; low tracking error, but limited ability to track seasoned MBS

---

# TBA Portfolios

# TBA Replication

---

- TBA portfolios can track the US MBS index with limited tracking error volatility while being
  - Unfunded
  - Liquid
  - Unexposed to prepayment cash flows
- TBAs are not included in the MBS index
- TBA positions must be rolled monthly to avoid taking delivery
- Since the MBS index is rebalanced monthly, TBA roll can be synchronized with index rebalancing to keep portfolio exposures in line with the index
- TBA portfolios can track the index well while being relatively concentrated: between 15 and 25 positions
- Portfolio rebalancing includes
  - Identifying TBAs that are suitable to join the investment universe
  - Performing analysis (portfolio optimization) to control for risk and liquidity



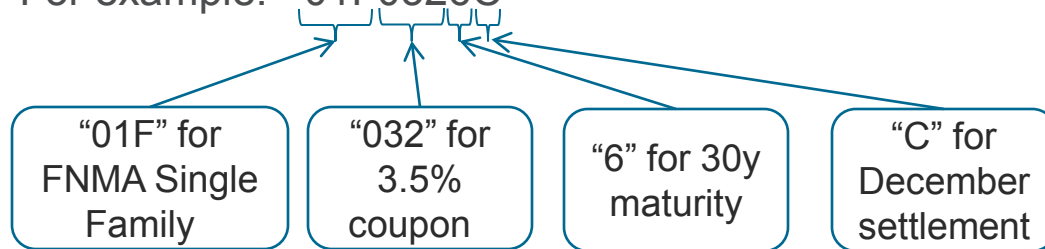
# Characteristics of TBAs

---

- TBA (to be announced) are forward contracts on mortgage securities
- Standardized terms and settlement dates
  - Deliverable terms: Agency, Maturity, Coupon
  - Monthly settlement calendar

- TBA cusips reflect these terms

- For example: 01F0326C

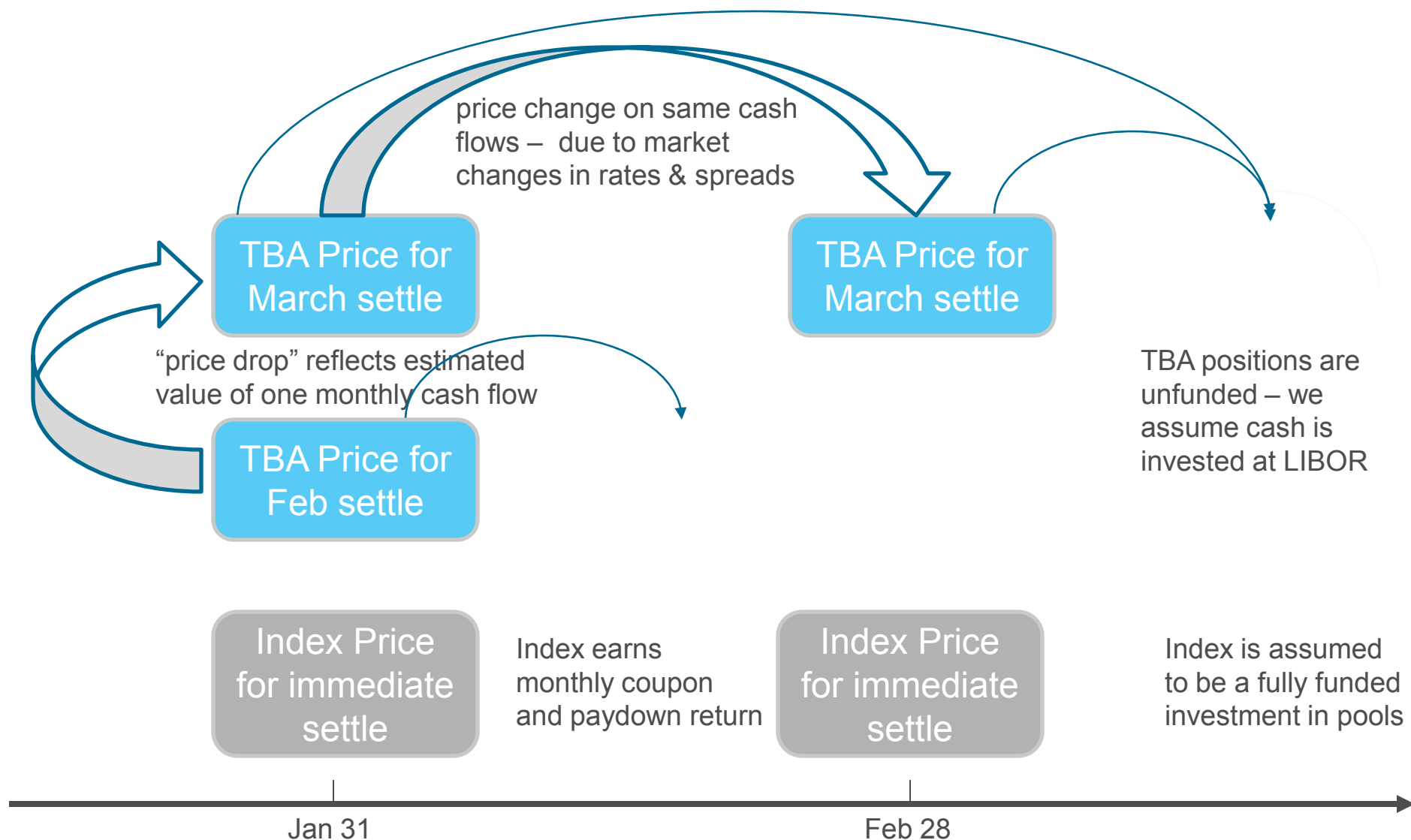


- Pool delivery can be avoided by rolling into a new TBA contract before settlement
- Price "drop" reflects the difference in carry between settling a TBA this month and settling next month
  - Settling this month allows the TBA holder to receive MBS cash flows for the coming month
  - Technical effects may also play a role as mortgage originators sell production in advance for hedging purposes

Source: Bloomberg Barclays Indices, Barclays Research

# Mechanics of TBA Replication

Three components of TBA return: cash investment, price drop, price return



Source: Barclays Research

# Selecting a TBA Universe

---

- We define a set of rules to identify a TBA investment universe that is
  - Representative of the index
  - Liquid and accessible
- In a first step, we identify significant index cells that should be represented in the portfolio
- In a second step we select TBAs in each of these cells
- Additional TBAs can be considered if relatively recent production (low WALA)
  - Negative screening ensures that securities deemed unattractive (missing analytics, very low OAS, very high WALA) are never eligible to join the portfolio
- All universe TBAs are ranked in order of attractiveness
  - Between 20 and 30 securities are typically eligible to join the portfolio at any time

Source: Bloomberg Barclays Indices, Barclays Research

# US MBS Index Overview

- The index market value is unevenly distributed across programmes and coupons

MBS index allocation (31 Dec 2018)											
Coupon		2	2.5	3	3.5	4	4.5	5	5.5	6	6.5
Market Value [%]	100.0	0.4	4.7	25.5	32.1	22.9	9.4	3.0	1.2	0.7	0.1
GNMA30	29.1		0.2	6.9	10.9	6.4	3.2	1.2	0.2	0.1	
GNMA15	0.5		0.2	0.2	0.1						
CONV30	57.0		0.3	13.2	18.7	15.4	6.1	1.8	0.9	0.6	0.1
CONV20	3.3		0.1	1.5	1.0	0.6	0.1				
CONV15	10.1	0.4	4.0	3.7	1.4	0.5	0.0				

Source: Bloomberg Barclays Indices, Barclays Research

- Intermediate coupon bonds tend to be most liquid (lowest average LCS)

Average Liquidity Cost Scores (31 Dec 2018)											
Coupon		2	2.5	3	3.5	4	4.5	5	5.5	6	6.5
	0.11	0.40	0.23	0.13	0.08	0.07	0.08	0.11	0.47	1.05	1.26
GNMA30	0.11		0.74	0.16	0.09	0.08	0.09	0.13	0.13	0.12	
GNMA15	0.34		0.72	0.16	0.09						
CONV30	0.11		0.66	0.13	0.07	0.07	0.07	0.09	0.55	1.23	1.26
CONV20	0.10		0.15	0.10	0.08	0.12	0.20				
CONV15	0.13	0.40	0.15	0.10	0.08	0.12	0.36				

Source: Bloomberg Barclays Indices, Barclays Research

Restricted - External

# What Explains Variations in MBS LCS?

- Liquidity Cost Scores (LCS) are available for all index bonds (generics) and are updated monthly
- LCS are based on Barclays trader quotes and represent the cost of a round-trip transaction
- Which bond characteristics are most closely related to LCS?
  - LCS per unit of duration is regressed on one bond characteristic at a time
  - Issue size, Weighted Average Loan Age, Distance from Par are all related to LCS
  - Distance from Par seems the most significant

## Explanatory power of isolated MBS characteristics on LCS (Dec 2018)

	Correlation	Coefficient	t-Stat
Issue Size	-34%	-0.018	-6.5
WALA	34%	0.026	6.5
Distance from Par	55%	0.014	11.8

Source: Bloomberg Barclays Indices, Barclays Research

# Rolling TBAs Can Reduce Transaction Costs

- Bloomberg provides indication of bid/ask for a broad set of TBAs
- Typical Bid/Offer spreads for current coupons:
  - One tick ( $1/32^{\text{nd}}$ ) on outright buy/sell of a TBA
  - $1/8$  of a tick on rolling same coupon forward one month
  - Total annual cost of monthly rolling =  $12 * (1/8) * 1/32^{\text{nd}} * 1\% = 5 \text{ bp/year}$
  - Cost of rolling seasoned coupons may be substantially higher
  - Rebalancing of TBA portfolio will **mostly** roll same program/coupon positions

TBA		1) Actions	
10:41			
4 TBA30	5 TBA15	6 MBS	7 Swaps
		8 Butterflies	
		2.5	3.0
FNCL	Dec	93-13+ / 14	96-18 / 18+
	Jan	93-12 / 13	96-15+ / 16+
	Feb	93-10 / 11	96-14 / 15
	Dec/Jan	01 $\frac{3}{4}$ / 01+	01 $\frac{3}{4}$ / 01 $\frac{3}{4}$
	Jan/Feb	01 $\frac{1}{2}$ / 01 $\frac{1}{4}$	01 $\frac{1}{2}$ / 01 $\frac{1}{4}$

Source: Bloomberg

# Which TBAs to Consider?

- Focus on program x coupon cells that represent more than 1.5% (or 1%) of the index (significant cells)
  - This set of cells changes slowly over time according to market conditions and net issuance
  - As of end Oct 2018, 11 cells are flagged as significant
  - 20y bonds are excluded as there is little TBA activity in that program
- Select TBA with the lowest WALA in each significant cell

Percentage of Market Value By Programme/Coupon*												
Coupon (%)	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5
Program	31st October 2014											
Conventional 15y	0.7%	<b>4.6%</b>	<b>4.0%</b>	<b>2.1%</b>	1.3%	0.7%	0.4%	0.1%	-	-	-	-
Conventional 30y	-	0.3%	<b>10.3%</b>	<b>12.0%</b>	<b>13.7%</b>	<b>8.3%</b>	<b>4.8%</b>	<b>3.3%</b>	<b>2.1%</b>	0.7%	0.1%	-
GNMA 15y	-	0.2%	0.4%	0.2%	0.1%	-	-	-	-	-	-	-
GNMA 30y	-	0.2%	<b>4.7%</b>	<b>7.1%</b>	<b>5.9%</b>	<b>4.6%</b>	<b>2.5%</b>	0.9%	0.5%	0.1%	-	-
31st October 2018												
Conventional 15y	0.4%	<b>4.1%</b>	<b>3.8%</b>	1.4%	0.5%	0.1%	-	-	-	-	-	-
Conventional 30y	-	0.3%	<b>13.4%</b>	<b>19.0 %</b>	<b>14.9%</b>	<b>5.7%</b>	<b>1.7%</b>	<b>1.0%</b>	<b>0.6%</b>	0.1%	-	-
GNMA 15y	-	0.2%	0.3%	0.1%	-	-	-	-	-	-	-	-
GNMA 30y	-	0.2%	<b>7.1%</b>	<b>11.2%</b>	<b>6.3%</b>	<b>2.9%</b>	<b>1.1%</b>	0.2%	0.1%	-	-	-

\*Eligible buckets in bold. Some buckets (green in the first period ) became ineligible in second period (red)

Source: Bloomberg Barclays Indices, Barclays Research

# Example TBAs to Consider in an Index Tracking Portfolio

- In each significant cell, select TBAs with the lowest WALA from each issuer
  - At the end of Oct 2018, the following 18 TBAs are identified
- A few additional bonds can join the portfolio if recent production (low WALA)

## TBAs to consider on 31 October 2018

Identifier	Description	Coupon	Price	WALA	WAC	WAM	OAD	OAC
02R0224C	FHLM Gold Guar Single F. 15yr	2.5	95.63	16	3.04	160	4.71	-0.11
02R0304C	FHLM Gold Guar Single F. 15yr	3	97.86	14	3.55	162	4.52	-0.32
01F0224C	FNMA Conventional Interm. 15yr	2.5	95.66	14	3.02	163	4.79	-0.14
01F0304C	FNMA Conventional Interm. 15yr	3	97.99	14	3.43	163	4.53	-0.36
02R0306C	FHLM Gold Guar Single F. 30yr	3	94.47	14	3.74	342	7.18	-0.93
02R0326C	FHLM Gold Guar Single F. 30yr	3.5	97.25	14	4.09	343	6.42	-1.28
02R0406C	FHLM Gold Guar Single F. 30yr	4	99.88	15	4.48	343	5.74	-1.53
02R0426C	FHLM Gold Guar Single F. 30yr	4.5	102.25	14	4.94	344	5.09	-1.64
02R0506C	FHLM Gold Guar Single F. 30yr	5	104.25	125	5.63	225	3.99	-0.86
01F0306C	FNMA Conventional Long T. 30yr	3	94.47	13	3.76	343	7.18	-0.95
01F0326C	FNMA Conventional Long T. 30yr	3.5	97.23	13	4.06	343	6.44	-1.27
01F0406C	FNMA Conventional Long T. 30yr	4	99.87	15	4.46	342	5.71	-1.57
01F0426C	FNMA Conventional Long T. 30yr	4.5	102.22	14	4.97	344	5.09	-1.64
01F0506C	FNMA Conventional Long T. 30yr	5	104.21	124	5.64	225	3.99	-0.85
21H0306C	GNMA II Single Family 30yr	3	95.48	13	3.47	343	6.59	-0.48
21H0326C	GNMA II Single Family 30yr	3.5	98.11	14	3.90	343	5.95	-1.02
21H0406C	GNMA II Single Family 30yr	4	100.50	14	4.40	344	4.96	-1.90
21H0426C	GNMA II Single Family 30yr	4.5	102.42	14	4.91	345	3.85	-2.12

Source: Bloomberg Barclays Indices, Barclays Research

Restricted - External



# Possible Sources of Tracking Errors

---

- Some sources of tracking error can be mitigated through careful portfolio construction:
  - Mismatches in exposures such as duration or convexity
    - Such mismatches can be associated with differences in allocation across coupon
    - Some exposure mismatches (OAC, Vega) cannot always be avoided when limiting the investment universe to liquid instruments
- Some sources of tracking error are intrinsic to TBA replication and cannot be avoided:
  - Mismatches in allocation by program and by product; for example, 20yr products don't have liquid TBAs
  - TBA vs. Seasoned:
    - Prepayment risk cannot be fully neutralized when using TBAs to proxy seasoned bonds
  - Pricing convention effect:
    - The MBS index uses same day settlement (market convention settlement discounted at Libor) while TBAs use market conventions settlement dates. MBS and TBAs do not represent the exact same cash flows
    - Large changes in Libor can create tracking error
  - Roll effect:
    - The implied financing rate of TBA is in principle short-term Libor, but this can fluctuate according to broker-dealer funding costs

# Constructing a TBA Portfolio to Track the MBS Index

- We assemble the TBA portfolio by minimizing a function that includes three terms
  1. Deviations from the index allocation along several exposure metrics
  2. Issue-specific risk
  3. Liquidity

$$\text{Min} \left\{ \sum_{i=1}^n P_i \cdot (ET_i - EB_i)^2 + C \cdot \sum_{j=1}^m w_j^2 + L \cdot \sum_{j=1}^m w_j \cdot illiqu_j \right\}$$

## Systematic risk

- Differences between the exposures of the TBA portfolio ( $ET_i$ ) and exposures of the benchmark index ( $EB_i$ )
- A penalty variable  $P$  can be associated to each net exposure

## Idiosyncratic risk

- Sum of squares of portfolio weights
- A penalty variable  $C$  reflects aversion to idiosyncratic risk

## Liquidity

- Weighted average liquidity metric
- A penalty variable  $L$  reflects aversion to illiquidity

- In addition, hard constraints apply to the maximum allocation to any bond
  - 20% for bonds expected to be liquid (rarely used)
  - 3% for bonds that are outside the key representative universe

Source: Barclays Research

Restricted - External

# Constructing a TBA Portfolio – Limiting Exposure Mismatches

- We assemble the TBA portfolio by minimizing a function that includes three terms:

1. Deviations from index allocation along several exposure metrics – as shown in example below

Exposure	Description	Aggregation	Penalty	Portfolio	Index	Deviation	Weighted Deviation
OAD	OA Duration	weighted averages for the overall portfolio	3	5.45	5.45	0.00	0.01
OAC	OA Convexity		1	-1.00	-0.74	-0.26	-0.26
OAS	OA Spread		1	0.33	0.34	-0.01	-0.01
Vega	Vega		1	-0.13	-0.11	-0.01	-0.01
Prepay Dur	Prepayment Duration		1	-0.35	-0.27	-0.08	-0.08
Coupon	Coupon		1	3.48	3.60	-0.12	-0.12
OASD	OA Spread Duration		1	5.84	5.84	0.00	0.00
KRD 02yr	Key Rate Duration 2y		1	0.52	0.53	-0.01	-0.01
KRD 05yr	Key Rate Duration 5y		1	1.32	1.36	-0.04	-0.04
KRD 10yr	Key Rate Duration 10y		1	1.98	2.06	-0.08	-0.08
KRD 20yr	Key Rate Duration 20y	1	1.42	1.41	0.01	0.01	
KRD 30yr	Key Rate Duration 30y	1	0.24	0.14	0.09	0.09	
FNMA	OASD Contribution	OASD Contribution by issuer	1	2.48	2.48	0.01	0.01
FHLMC	OASD Contribution		1	1.62	1.61	0.01	0.01
GNMA	OASD Contribution		1	1.73	1.75	-0.02	-0.02
Conventional 30y	OASD Contribution	OASD Contribution by program	1	3.57	3.59	-0.02	-0.02
Conventional 15y	OASD Contribution		1	0.54	0.50	0.04	0.04
1 <sup>st</sup> coupon	OASD Contribution	OASD Contribution by coupon	1	0.00	0.02	-0.02	-0.02
2nd coupon	OASD Contribution		1	0.19	0.20	-0.02	-0.02
3rd coupon	OASD Contribution		1	1.59	1.61	-0.03	-0.03
4th coupon	OASD Contribution		1	1.99	2.03	-0.04	-0.04
5th coupon	OASD Contribution		1	1.27	1.29	-0.02	-0.02
6th coupon	OASD Contribution		1	0.49	0.46	0.02	0.02
Sum of squared weighted deviations							0.113

Source: Bloomberg Barclays Indices, Barclays Research

Restricted - External

# Constructing a TBA Portfolio – Controlling Issue-Specific Risk

- We assemble the TBA portfolio by minimizing a function that includes three terms
  1. Deviations from the index allocation along several exposure metrics
  2. Issue-specific risk
- An **issue concentration penalty** is included in the optimization
  - Sum of squared portfolio weights (similar to Herfindahl concentration index)
  - Multiplied by a parameter that reflects aversion of concentration
- This naive approach assumes that all bonds have identical idiosyncratic risks
  - But idiosyncratic risk is often hard to anticipate when using historical data
- We prefer this approach to setting hard limits on bond weights
  - Hard limits can be arbitrary and could be gamed by the optimizer
  - In some months, hard constraints may make optimization unfeasible

# Constructing a TBA portfolio – Favouring Liquid Bonds

---

- We assemble the TBA portfolio by minimizing a function that includes three terms
  1. Deviations from the index allocation along several exposure metrics
  2. Issue-specific risk
  3. Liquidity
- The third term in our objective function relates to a weighted average liquidity metric of portfolio bonds
- We use weighted average loan age (WALA) as our liquidity metric, as recent production is typically more liquid than older production
- These metrics are proxies for Liquidity Cost Scores (LCS)
  - Barclays LCS are available for generics as opposed to TBAs
  - Our historical simulation analysis goes back to 2005, before LCS became available for MBS
  - In this analysis, we are looking to favour bonds with relatively low transaction costs, from a universe of securities that is already filtered for relevance and liquidity

# Example Portfolio – 31 Oct 2018

- The following portfolio was optimized as of 31 Oct 2018, for an index exposure of USD 100MM
- 20 positions, including 3 smaller than 1%
- 17 positions after exclusion of small positions and re-optimization
- Includes some less liquid TBAs that help reduce exposure mismatches such as OAC with the index

identifier	Description	Coupon	Price	WALA	WAC	WAM	OAD	OAC	Par
01F0304C	FNMA Conventional Interm. 15yr	3	97.99	14	3.43	163	4.53	-0.36	5,219,003
01F0404C	FNMA Conventional Interm. 15yr	4	101.49	57	4.47	117	3.23	-0.06	3,059,427
02R0304C	FHLM Gold Guar Single F. 15yr	3	97.86	14	3.55	162	4.52	-0.32	3,998,661
01F0306C	FNMA Conventional Long T. 30yr	3	94.47	13	3.76	343	7.18	-0.95	5,027,172
01F0326C	FNMA Conventional Long T. 30yr	3.5	97.23	13	4.06	343	6.44	-1.27	10,421,255
01F0406C	FNMA Conventional Long T. 30yr	4	99.87	15	4.46	342	5.71	-1.57	8,198,974
01F0426C	FNMA Conventional Long T. 30yr	4.5	102.22	14	4.97	344	5.09	-1.64	5,384,625
01F0506C	FNMA Conventional Long T. 30yr	5	104.21	124	5.64	225	3.99	-0.85	4,566,442
02R0306C	FHLM Gold Guar Single F. 30yr	3	94.47	14	3.74	342	7.18	-0.93	2,670,133
02R0326C	FHLM Gold Guar Single F. 30yr	3.5	97.25	14	4.09	343	6.42	-1.28	7,768,043
02R0406C	FHLM Gold Guar Single F. 30yr	4	99.88	15	4.48	343	5.74	-1.53	6,278,294
02R0426C	FHLM Gold Guar Single F. 30yr	4.5	102.25	14	4.94	344	5.09	-1.64	3,216,512
02R0506C	FHLM Gold Guar Single F. 30yr	5	104.25	125	5.63	225	3.99	-0.86	2,685,723
21H0226C	GNMA II Single Family 30yr	2.5	92.38	24	2.96	331	6.94	0.12	2,539,213
21H0306C	GNMA II Single Family 30yr	3	95.48	13	3.47	343	6.59	-0.48	8,033,460
21H0326C	GNMA II Single Family 30yr	3.5	98.11	14	3.90	343	5.95	-1.02	11,337,930
21H0406C	GNMA II Single Family 30yr	4	100.50	14	4.40	344	4.96	-1.90	4,642,393

Source: Bloomberg Barclays Indices, Barclays Research

Restricted - External

# Tracking Error of TBA portfolios

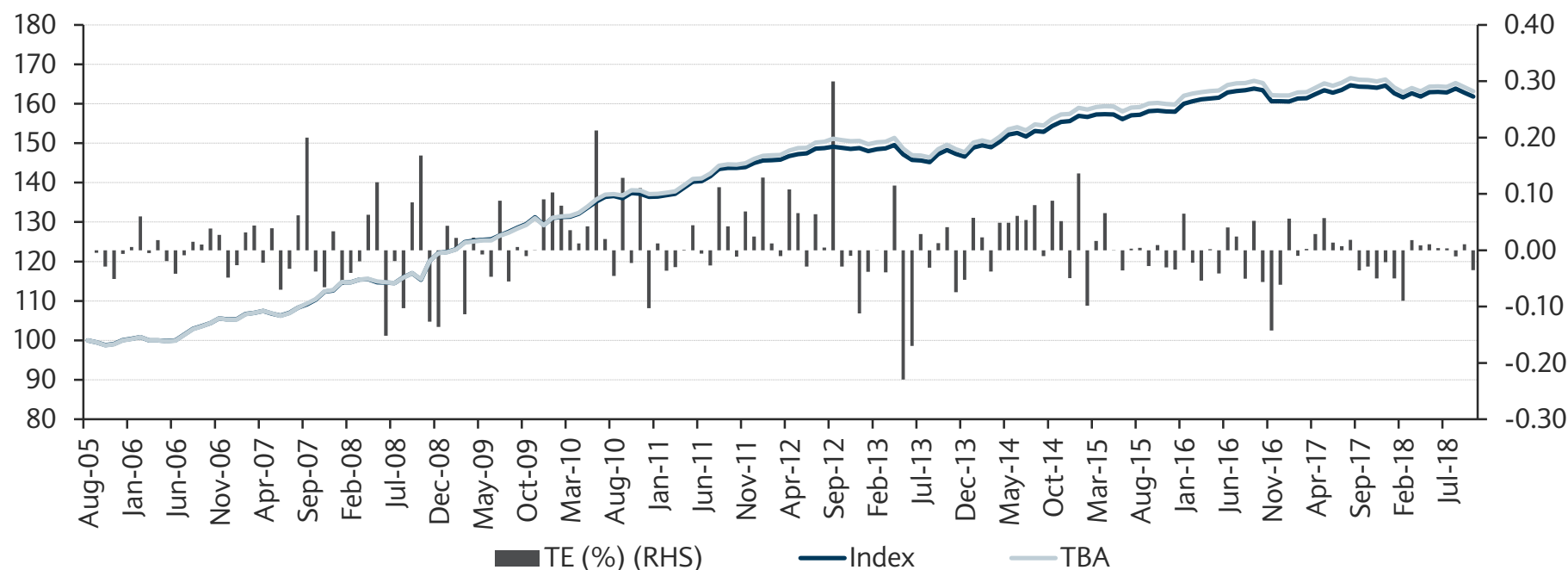
- A well-diversified TBA portfolio has performed well relative to the index over the past 13 years
- Low TEV, no significant performance bias
- Returns are pre-transaction costs; there are no constraints on portfolio turnover

## Tracking error relative to the MBS index

	TE	Number of Bonds
Average (bp/m)	0.5	24
StDev (bp/m)	7.0	
Min month	-22.9	16
Max month	30.0	30

Source: Bloomberg Barclays Indices, Barclays Research

## TBA portfolio performance



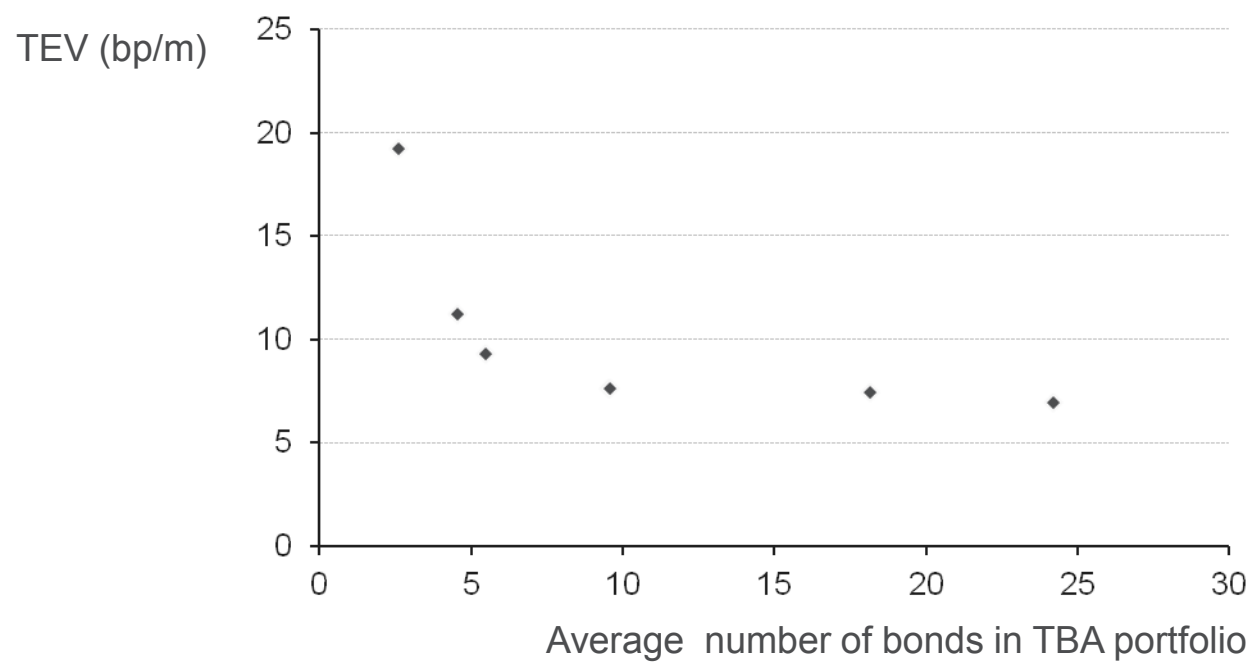
Source: Bloomberg Barclays Indices, Barclays Research

Restricted - External

# Tracking Error of TBA portfolios – Diversification and TEV

- We contrast the results of different historical simulations
  - TBA portfolios are assembled every month to track the MBS index according to different sets of parameters (for systematic as well as idiosyncratic risk and liquidity) that make portfolios more or less concentrated
- Major sources of systematic risk can be neutralized with few positions
- Beyond 10 positions, the marginal effect of diversification on TEV has been small

## Relationship between number of bonds and TEV (Jan 2005 - Oct 2018)



Source: Bloomberg Barclays Indices, Barclays Research

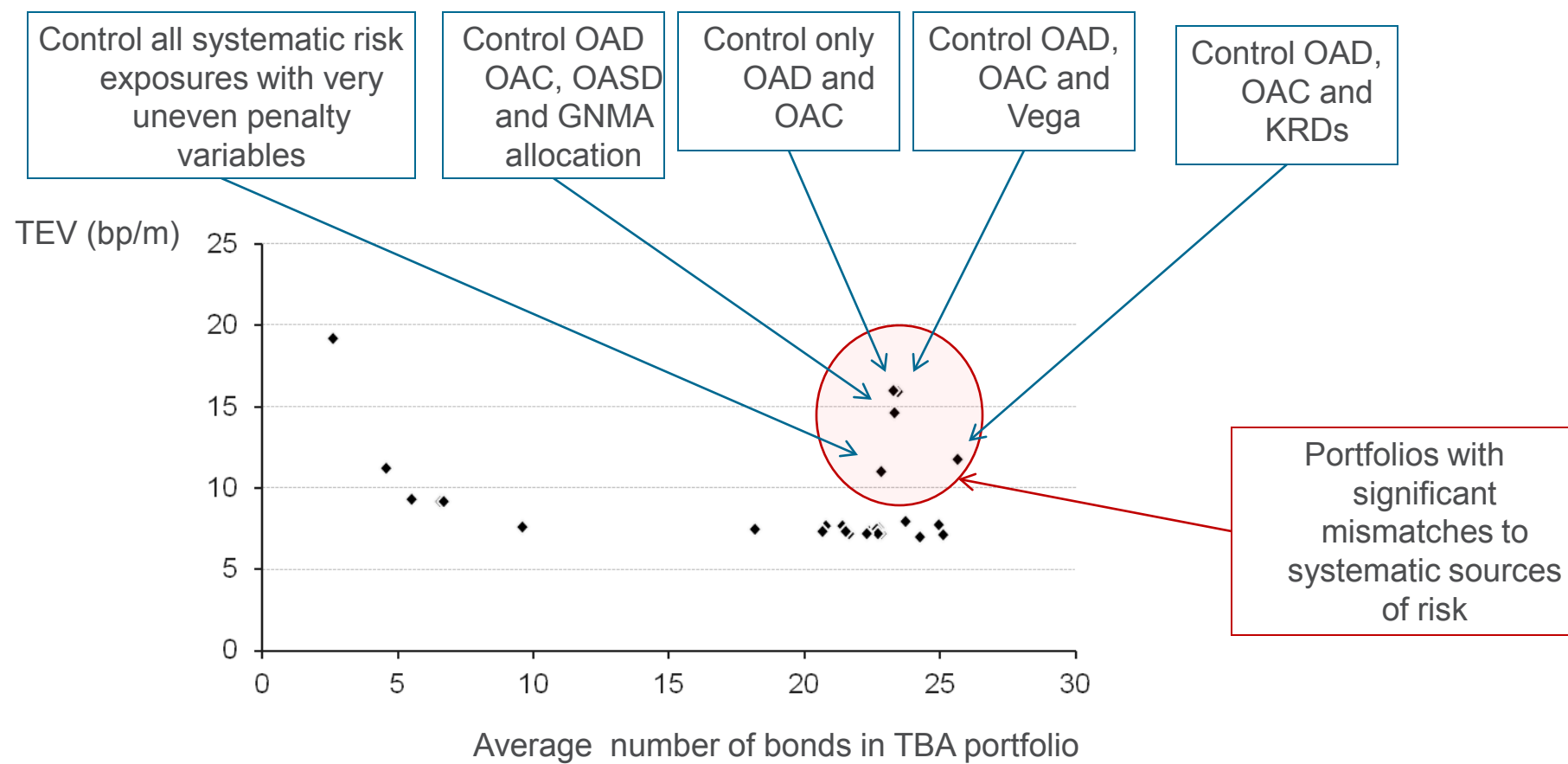
Restricted - External



# Diversification Doesn't Guarantee Low Tracking Error

- In some scenarios, some significant sources of systematic risk are ignored by setting penalty variables to zero
  - But – aversion to idiosyncratic risk ensures diversification
- In some case, tracking error remains high

## Relationship between number of bonds and TEV (Jan 2005 - Oct 2018)



Source: Bloomberg Barclays Indices, Barclays Research

Restricted - External

# Conclusion

---

- The US MBS index is an attractive asset class for fixed income investors
- Accessing the MBS index return is possible with TBA portfolios
  - A TBA replication strategy has the following characteristics:
    - Liquid
    - Unfunded
    - Low tracking error
    - No exposure to prepayment cash flows
  - But TBA portfolios must be carefully rebalanced on a monthly basis
- We suggest a quantitative methodology to maintain TBA portfolios
  - Portfolio optimization takes into account:
    - Exposure mismatches relative to the index
    - Idiosyncratic risk
    - Liquidity
- Through a back test over the past 13 years, we find that our approach has delivered low tracking error volatility

# Analyst Certifications and Important Disclosures

---

## **Analyst Certification(s)**

We, Albert Desclée, Mathieu Dubois and Jay Hyman, hereby certify (1) that the views expressed in this research report accurately reflect our personal views about any or all of the subject securities or issuers referred to in this research report and (2) no part of our compensation was, is or will be directly or indirectly related to the specific recommendations or views expressed in this research report.

## **Important Disclosures:**

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:**

To the extent that the information about the companies mentioned in this publication is sufficient to constitute a research report, for current important disclosures regarding those companies, 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>.

## **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 previous 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 previous investment recommendations published by Barclays FICC Research in the preceding 12 months please refer to <https://live.barcap.com/go/research/ResearchInvestmentRecommendations>.

# 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 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 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](mailto: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.

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.

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.

Barclays Bank PLC, Paris Branch (registered in France under Paris RCS number 381 066 281) is regulated by the Autorité des marchés financiers and the Autorité de contrôle prudentiel. Registered office 34/36 Avenue de Friedland 75008 Paris.

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

All Barclays research reports are 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.

# Disclaimer (continued)

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.

Barclays Bank PLC distributes this material in Germany.

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

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.

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.

This material is distributed in the UAE (including the Dubai International Financial Centre) and Qatar by Barclays Bank PLC.

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.

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 report, 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 either Barclays Bank PLC, Barclays Capital Inc., Barclays Capital Securities Limited or Barclays Capital Asia Limited. None of Barclays Bank PLC, nor any of the other referenced Barclays group entities, hold an Australian financial services licence and instead they each rely 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.

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. EU31226 BRCF2242

Restricted - External