

# ADVANCED PUBLIC FUNDS INVESTING



## WEBINAR 7 | ADVANCED INVESTMENT ANALYSIS

**Rick Phillips**

President and Chief Investment Officer | FHN Financial Main Street Advisors

February 22, 2022



## Rick Phillips

- FHN Main Street Advisors President- 2005 to Present
- Clark County Nevada Chief Investment Officer- 1998 to 2005
- City of Las Vegas Investment Officer- 1989 to 1998
- Government Investment Officers Association (GIOA) Founder
- Firm Manages and Consults on \$70+ Billion for States and Local Governments

# Fantastic Fundamentals of Treasury Programs

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1. **Detailed Asset/Liability Matching Model (aka: Cash Flow Model) is a Must**
2. **Longer Duration Will Generate More Investment Income Over the Long Run**
3. **Interest Rate Risk (WAM/Duration) Matches Cash Flow Metrics**
4. **Credit Can Enhance Income, But Duration is the Bigger Determinant of Income**
5. **You...Nor Anyone Else Can't Time the Market Accurately Over the Long Run**
6. **Limit Optionality (Callables) in the Portfolio**
7. **Do Not Let GASB 31 (mark-to-market) Drive Investment Decisions/WAM-Duration**
8. **Understand the Risks of Funds in LAIF and Other Pools**
9. **Follow GAAP (Generally Accepted Accounting Principles)**
10. **Benchmark Your Investment Program and Portfolio in Multiple Ways**
11. **Tell the Story: Provide Quality, Timely, Transparent Reporting**

# Investment Policy Objectives Should Drive Investment Program Decisions

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- 1. Safety of Principal:** Safety of principal is the foremost objective of the [entity's] investment program. Investments by the [designated official] shall be undertaken in a manner that seeks to ensure the preservation of capital in the overall portfolio. To attain this objective, diversification of security types, sectors, issuers, and maturities is necessary in order that potential losses on individual securities do not exceed the income generated from the remainder of the portfolio.
- 2. Liquidity:** The investment portfolio shall be structured to timely meet expected cash outflow needs and associated obligations which might be reasonably anticipated. This objective shall be achieved by matching investment maturities with forecasted cash outflows and maintaining an additional liquidity buffer for unexpected liabilities.
- 3. Investment Income:** The investment portfolio shall be designed to earn a market rate of investment income in relation to prevailing budgetary and economic cycles, while taking into account investment risk constraints and liquidity needs of the portfolio.

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# Polling Question

To earn CPE credits, participants must participate in at least three of the polling questions.

**What is the first analysis/modeling you should do for your investment program before you buy a bond?**

- A. Future interest rates model**
- B. Cash Flow model**
- C. Option Adjusted Spread analysis**

# The Most Important and First Analysis of Investment Programs...Cash Flow Analysis

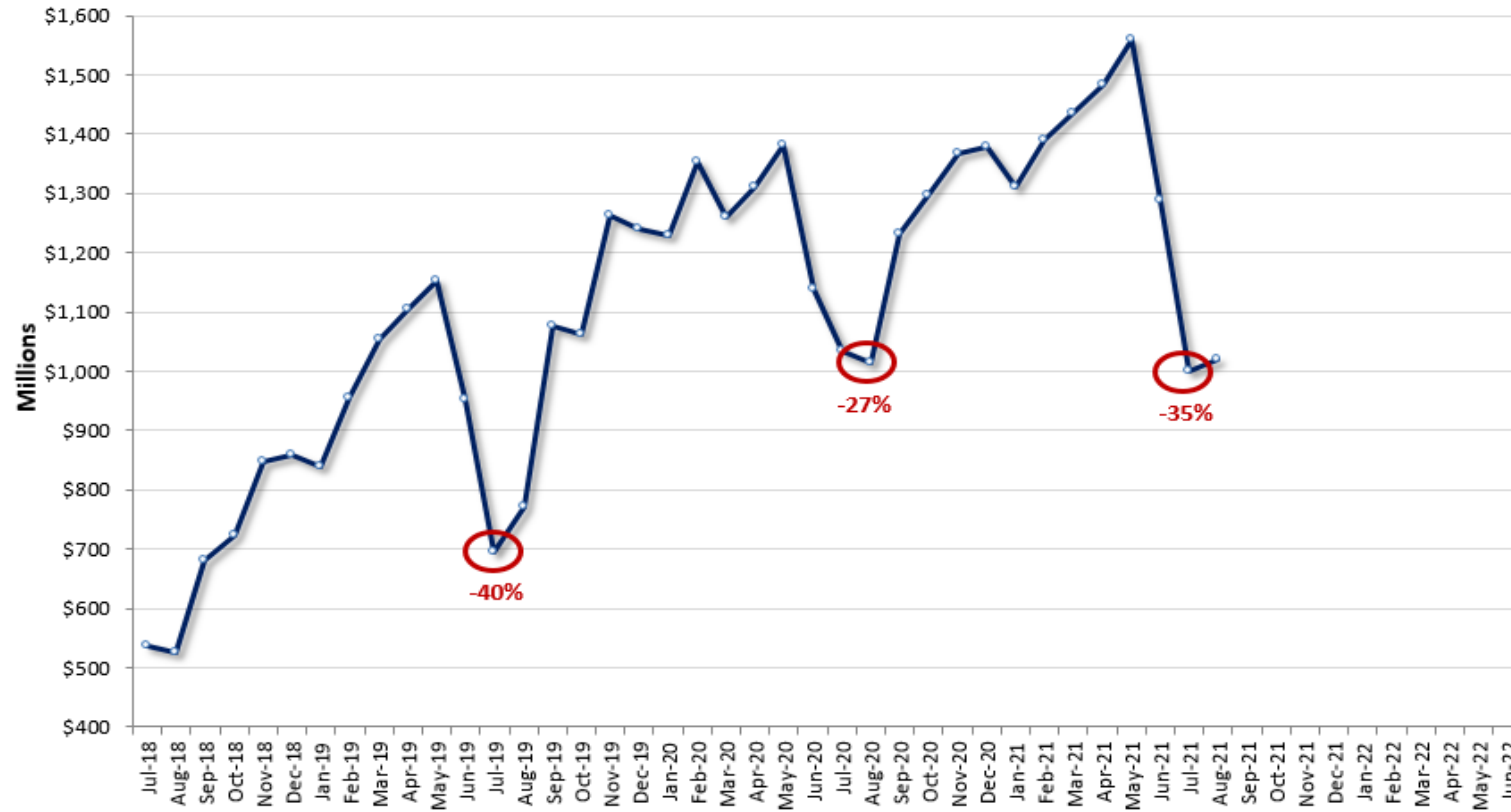
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1		INFLOWS								OUTFLOWS							
2	Date	Begin MMF	Inv Mat/Sell	Prop Tax	State Rev	Debt Svc Inflows	Wells Rev /Bus Lic	BofA Rev	Total	AP/Cont Payroll	Disb	Debt Svc	Wires/ PERS	Misc Outflow	Inv Purchase	Total	End MMF
63	8/30/21	18.4	50.0		6.5			14.9	89.8			5.8	30.1	0.2		36.1	72.8
64	8/31/21	72.8			131.5			10.1	214.4			3.0		7.5	150.0	160.5	54.0
65	9/1/21	54.0						8.0	62.0			6.5	6.5	1.8		14.8	49.4
66	9/2/21	49.4						8.0	57.4			6.0		6.0		12.0	45.4
67	9/3/21	45.4						8.0	53.4			6.0				6.0	47.4
68	9/4/21	47.4							47.4							0.0	47.4
69	9/5/21	47.4							47.4							0.0	47.4
70	9/6/21	47.4							47.4							0.0	47.4
71	9/7/21	47.4						8.0	55.4			6.0	20.0			26.0	29.4
72	9/8/21	29.4						8.0	37.4			6.0				6.0	31.4
73	9/9/21	31.4				20.0		8.0	59.4	34.0	6.0					40.0	19.4
74	9/10/21	19.4			6.5			8.0	33.9	7.0	10.0					17.0	16.9
75	9/11/21	16.9							16.9							0.0	16.9
76	9/12/21	16.9							16.9							0.0	16.9
77	9/13/21	16.9						8.0	24.9			6.0				6.0	18.9
78	9/14/21	18.9						8.0	26.9			6.0				6.0	20.9
79	9/15/21	20.9			210.0			8.0	238.9			6.0	23.0			29.0	209.9

↓  
5 Years

# Portfolio Value “Top to Bottom” Analysis #1

Historical Book Values

7/31/2021



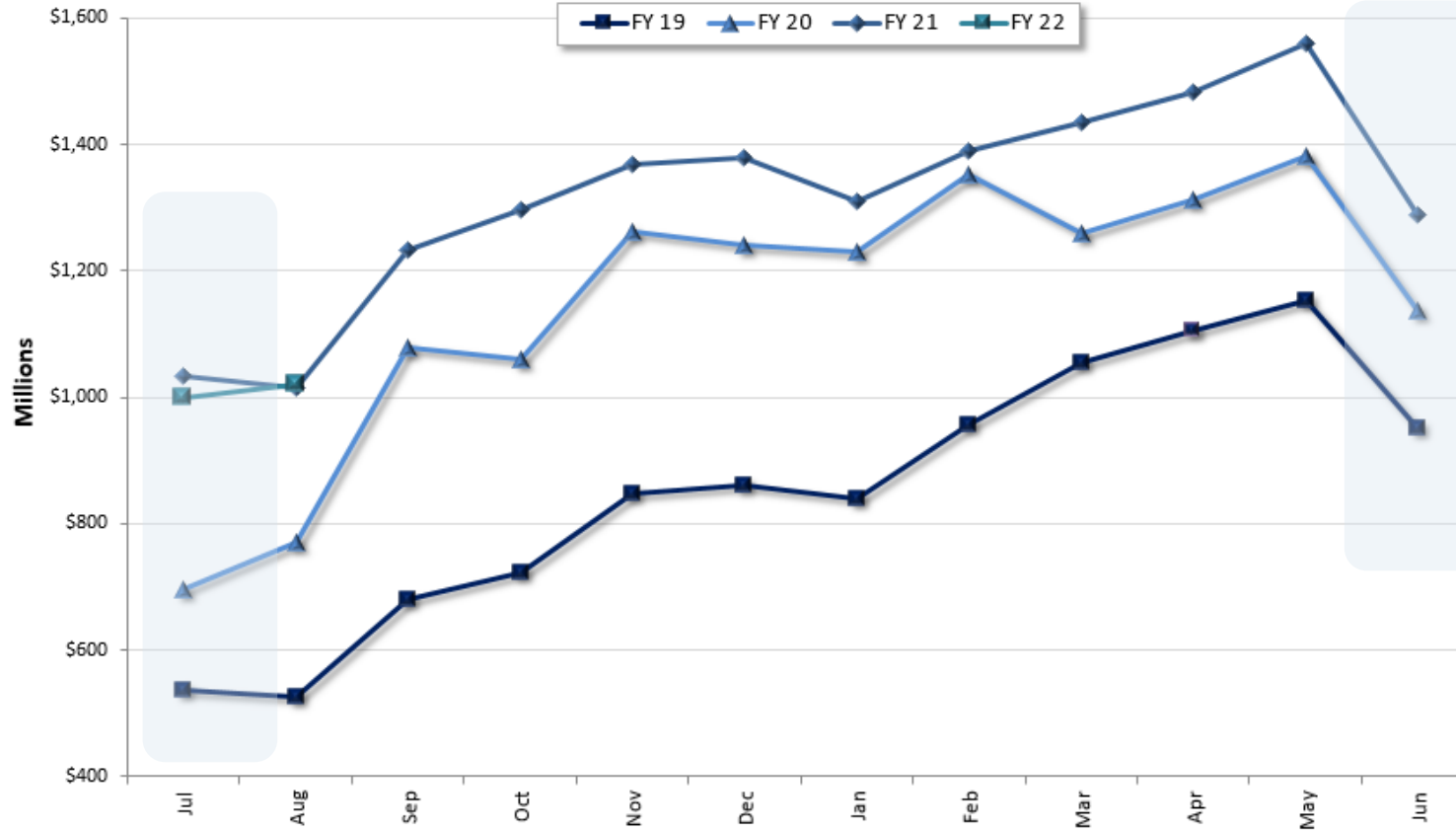
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Average
FY 2019	\$535.7	\$525.2	\$679.6	\$722.0	\$847.4	\$859.4	\$838.6	\$956.1	\$1,054.9	\$1,104.0	\$1,152.8	\$952.0	\$852.3
FY 2020	\$694.8	\$770.1	\$1,078.0	\$1,060.9	\$1,263.4	\$1,241.0	\$1,229.6	\$1,353.7	\$1,260.3	\$1,311.5	\$1,380.8	\$1,137.2	\$1,148.4
FY 2021	\$1,033.7	\$1,013.7	\$1,231.8	\$1,296.9	\$1,367.6	\$1,379.1	\$1,310.8	\$1,390.6	\$1,435.3	\$1,483.7	\$1,559.3	\$1,288.5	\$1,315.9
FY 2022	\$1,000.0	\$1,020.1											\$1,010.0

Figures in Millions, Average Monthly Book Value

# Portfolio Value “Top to Bottom” Analysis #1

Historical Book Values Per Fiscal Year

7/31/2021



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Average
FY 2019	\$535.7	\$525.2	\$679.6	\$722.0	\$847.4	\$859.4	\$838.6	\$956.1	\$1,054.9	\$1,104.0	\$1,152.8	\$952.0	\$852.3
FY 2020	\$694.8	\$770.1	\$1,078.0	\$1,060.9	\$1,263.4	\$1,241.0	\$1,229.6	\$1,353.7	\$1,260.3	\$1,311.5	\$1,380.8	\$1,137.2	\$1,148.4
FY 2021	\$1,033.7	\$1,013.7	\$1,231.8	\$1,296.9	\$1,367.6	\$1,379.1	\$1,310.8	\$1,390.6	\$1,435.3	\$1,483.7	\$1,559.3	\$1,288.5	\$1,315.9
FY 2022	\$1,000.0	\$1,020.1											\$1,010.0

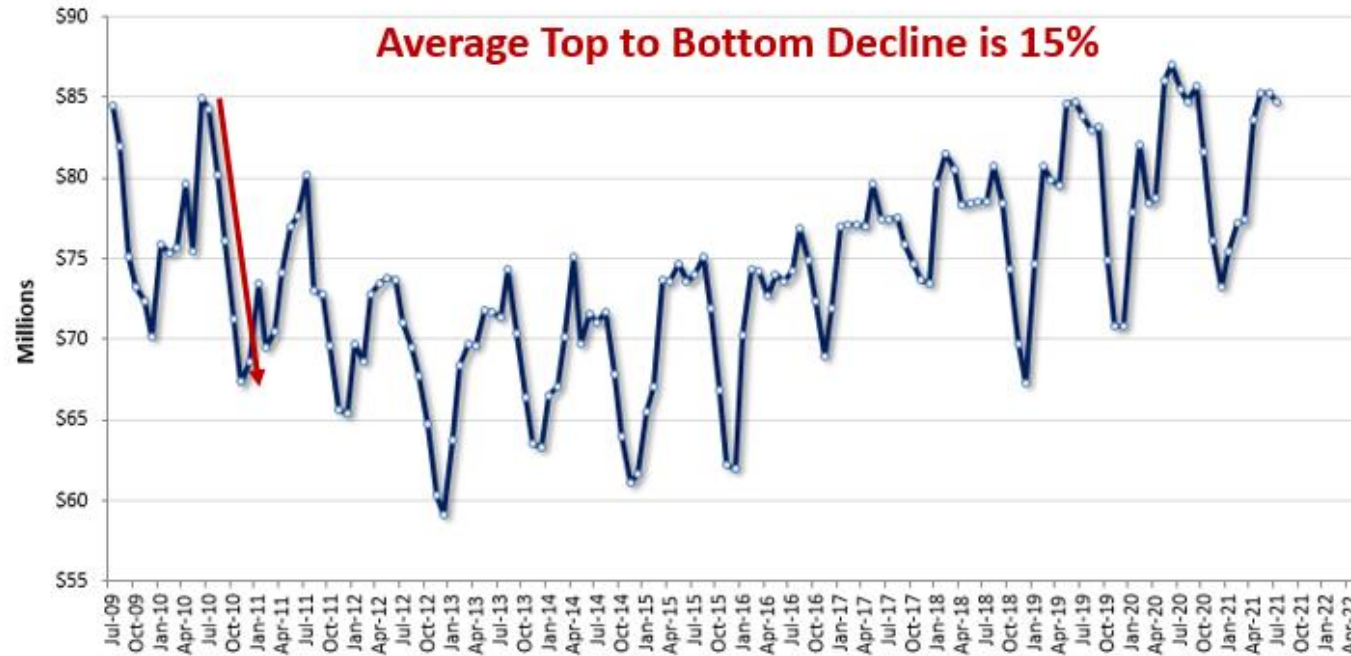
Figures in Millions, Average Monthly Book Value



# Portfolio Value “Top to Bottom” Analysis #1

Historical Book Values

7/31/2021



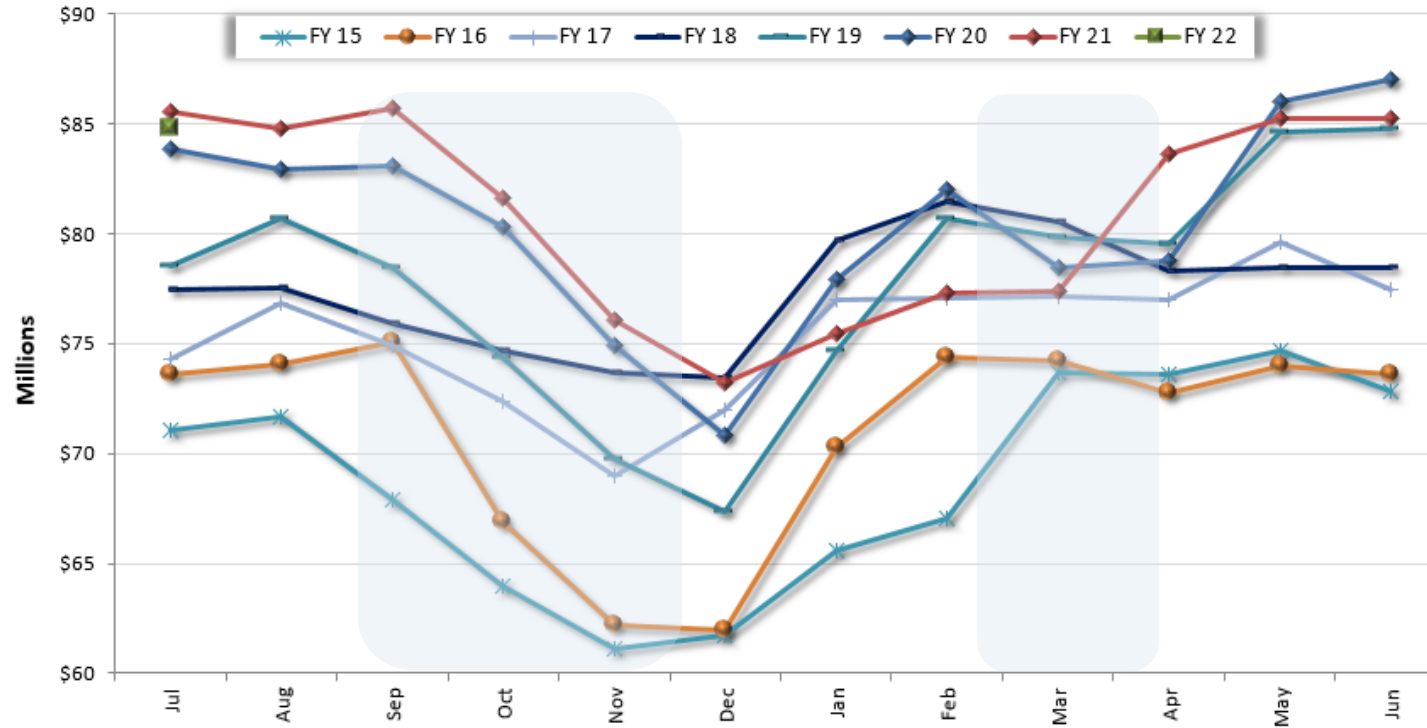
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Average
FY 2013	\$71.0	\$69.5	\$67.7	\$64.8	\$60.4	\$59.1	\$63.8	\$68.4	\$69.7	\$69.6	\$71.8	\$71.7	\$67.3
FY 2014	\$71.3	\$74.4	\$70.4	\$66.4	\$63.5	\$63.4	\$66.5	\$67.0	\$70.1	\$75.1	\$69.7	\$71.6	\$69.1
FY 2015	\$71.1	\$71.7	\$67.9	\$64.0	\$61.1	\$61.7	\$65.6	\$67.0	\$73.7	\$73.6	\$74.7	\$72.8	\$68.7
FY 2016	\$73.6	\$74.1	\$75.1	\$66.9	\$62.2	\$61.9	\$70.3	\$74.4	\$74.2	\$72.7	\$74.0	\$73.6	\$71.1
FY 2017	\$74.3	\$76.8	\$74.9	\$72.3	\$69.0	\$72.0	\$77.0	\$77.1	\$77.1	\$77.0	\$79.6	\$77.4	\$75.4
FY 2018	\$77.4	\$77.5	\$75.9	\$74.6	\$73.7	\$73.4	\$79.7	\$81.5	\$80.6	\$78.3	\$78.4	\$78.5	\$77.5
FY 2019	\$78.5	\$80.7	\$78.4	\$74.4	\$69.7	\$67.3	\$74.7	\$80.7	\$79.8	\$79.5	\$84.6	\$84.8	\$77.8
FY 2020	\$83.8	\$82.9	\$83.1	\$80.3	\$74.9	\$70.8	\$77.9	\$82.0	\$78.4	\$78.8	\$86.0	\$87.0	\$80.5
FY 2021	\$85.5	\$84.8	\$85.7	\$81.6	\$76.1	\$73.2	\$75.4	\$77.3	\$77.4	\$83.6	\$85.3	\$85.2	\$80.9
FY 2022	\$84.7												\$84.7

Figures in Millions, Average Daily Balance

# Portfolio Value “Top to Bottom” Analysis #1

Historical Book Values

7/31/2021



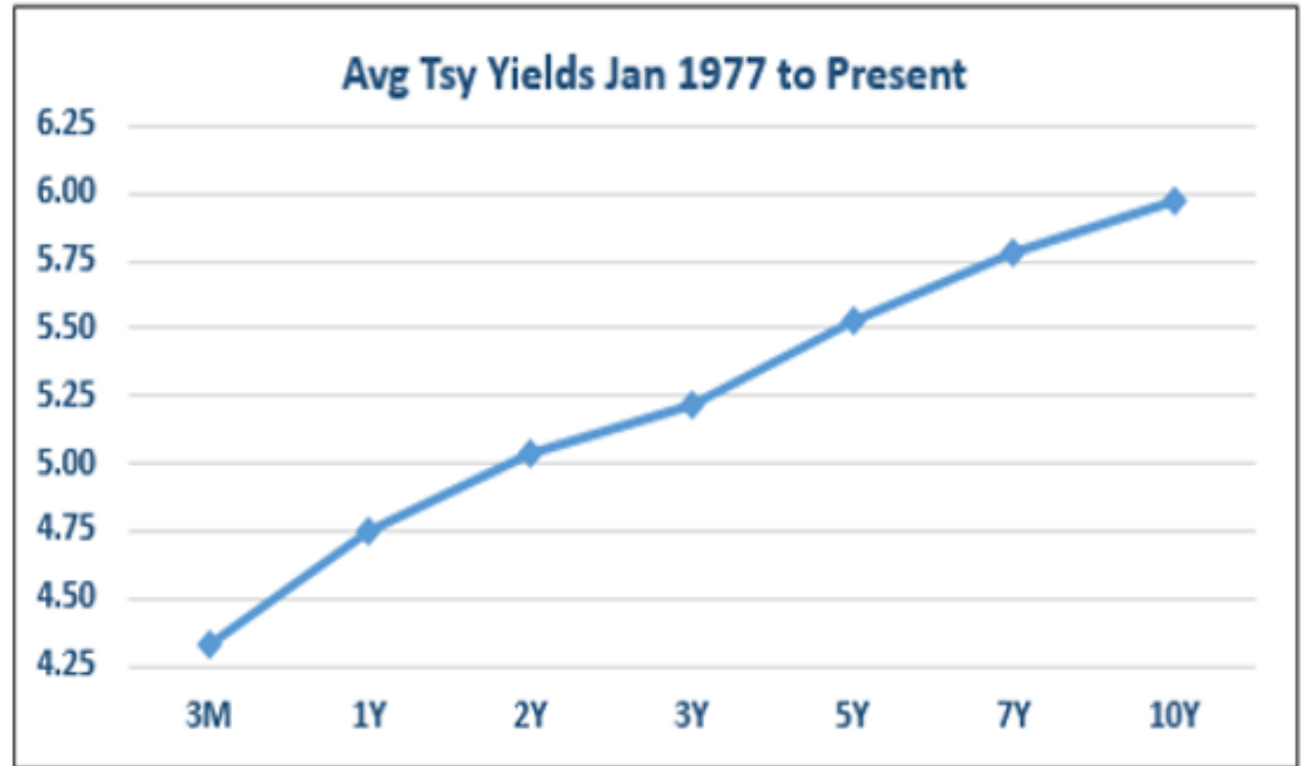
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Average
FY 2015	\$71.1	\$71.7	\$67.9	\$64.0	\$61.1	\$61.7	\$65.6	\$67.0	\$73.7	\$73.6	\$74.7	\$72.8	\$68.7
FY 2016	\$73.6	\$74.1	\$75.1	\$66.9	\$62.2	\$61.9	\$70.3	\$74.4	\$74.2	\$72.7	\$74.0	\$73.6	\$71.1
FY 2017	\$74.3	\$76.8	\$74.9	\$72.3	\$69.0	\$72.0	\$77.0	\$77.1	\$77.1	\$77.0	\$79.6	\$77.4	\$75.4
FY 2018	\$77.4	\$77.5	\$75.9	\$74.6	\$73.7	\$73.4	\$79.7	\$81.5	\$80.6	\$78.3	\$78.4	\$78.5	\$77.5
FY 2019	\$78.5	\$80.7	\$78.4	\$74.4	\$69.7	\$67.3	\$74.7	\$80.7	\$79.8	\$79.5	\$84.6	\$84.8	\$77.8
FY 2020	\$83.8	\$82.9	\$83.1	\$80.3	\$74.9	\$70.8	\$77.9	\$82.0	\$78.4	\$78.8	\$86.0	\$87.0	\$80.5
FY 2021	\$85.5	\$84.8	\$85.7	\$81.6	\$76.1	\$73.2	\$75.4	\$77.3	\$77.4	\$83.6	\$85.3	\$85.2	\$80.9
FY 2022	\$84.7												\$84.7

Figures in Millions, Average Daily Balance

# Longer Duration Will Generate More Investment Income Over the Long Run

Benchmark Treasury Modified Sharp Ratio (MSR) Analysis  
Jan 1977 to Present

Maturity	Avg Yield	Avg Duration	Modified Sharp Ratio	% Return of 10Yr / % 10Yr Risk
3 Mon T-Bill	4.32	0.25		72% / 3%
1 Yr T-Bill	4.75	1.00	0.43	80% / 12%
2 Yr T-Note	5.04	1.91	0.37	84% / 24%
3 Yr T-Note	5.21	2.78	0.32	87% / 34%
5 Yr T-Note	5.53	4.55	0.27	93% / 56%
7 Yr T-Note	5.78	6.24	0.23	97% / 77%
10 Yr T-Note	5.97	8.10	0.20	100% / 100%

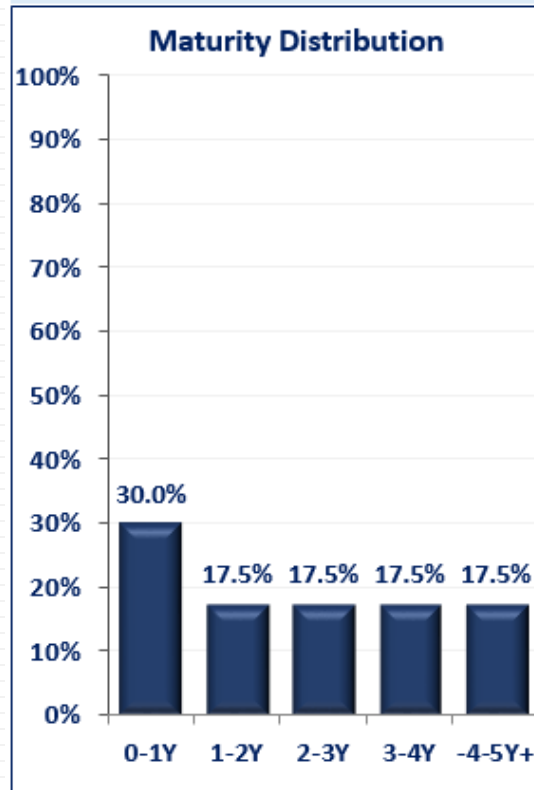


Source: Bloomberg

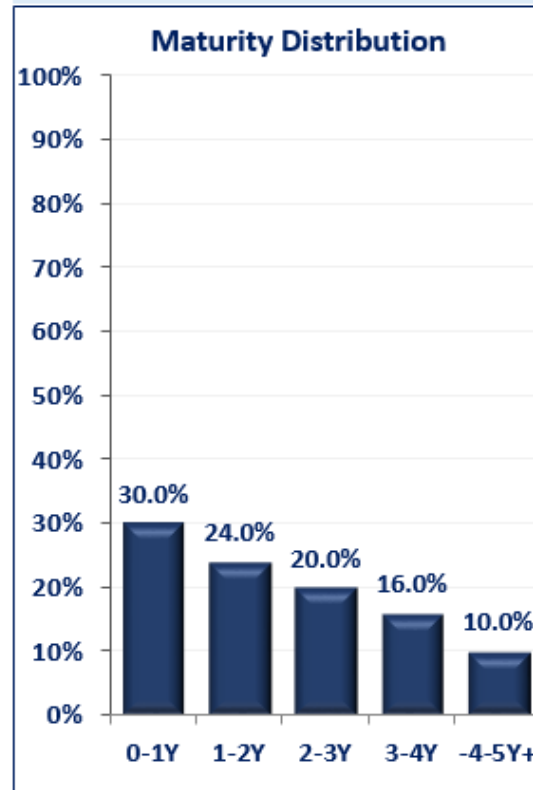
## Using Bullets, Callables, Floaters, and Step-Ups

### Proactive Management or Buy & Hold

#### Cash Flow Matching

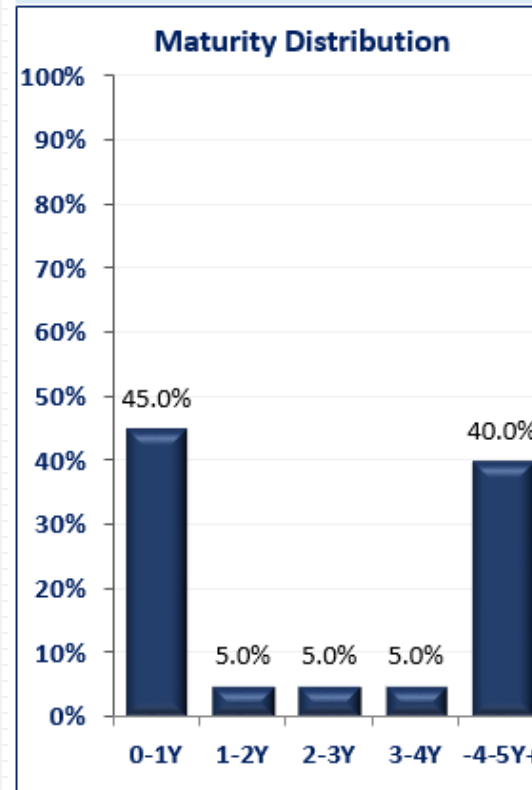


#### Index Matching

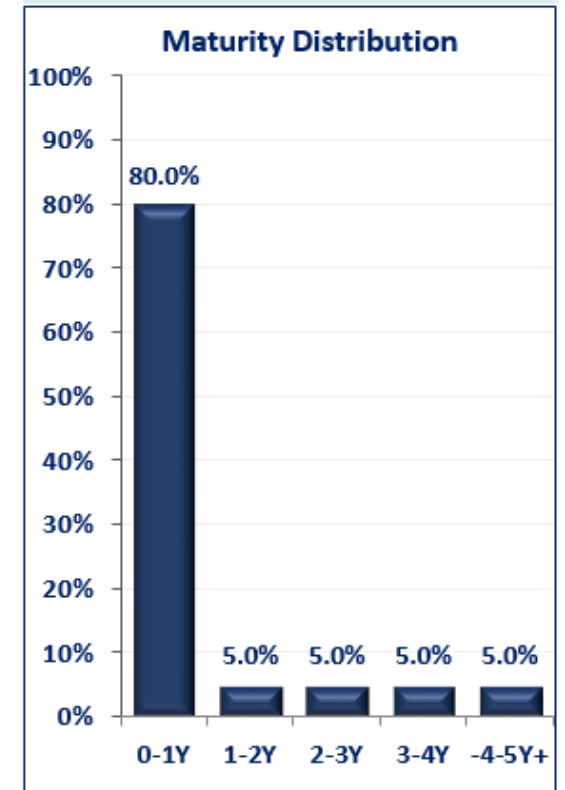


### Active Management

#### Barbell/Making Timing



#### Market Timing/Relative Value



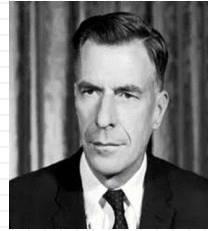
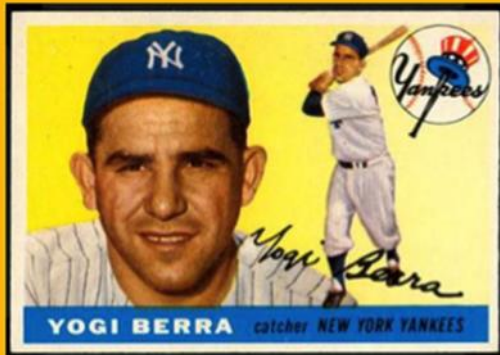
Creating a Stable'r Investment Income



# Timing the Market

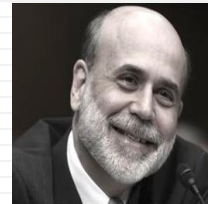


**"It's tough to make predictions,  
especially about the future."**



**"The only function of economic (and interest rate) forecasting is to make astrology look respectable."**

John Kenneth Galbraith, Economist



**"The Federal Reserve is currently not forecasting a recession."**

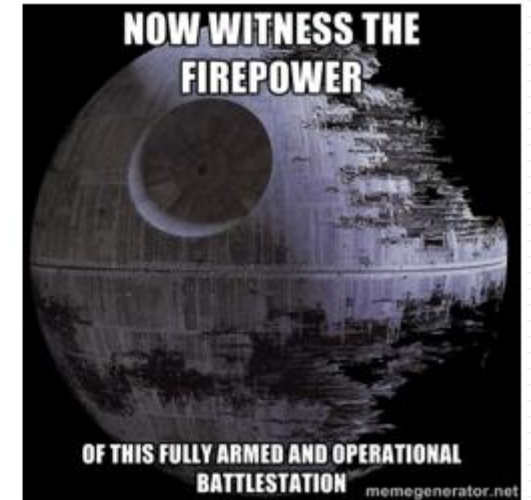
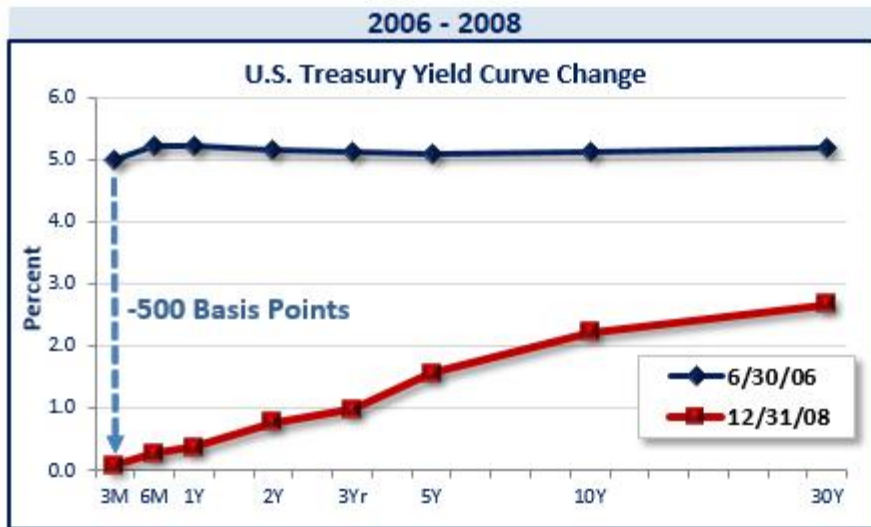
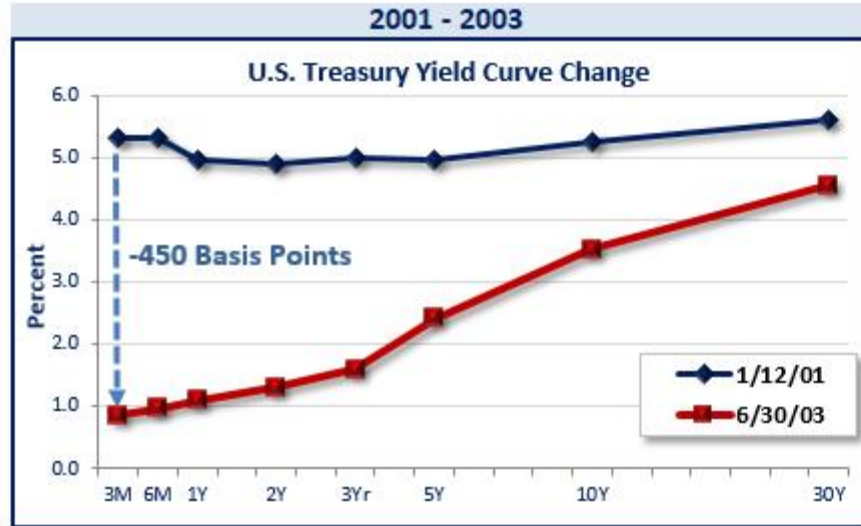
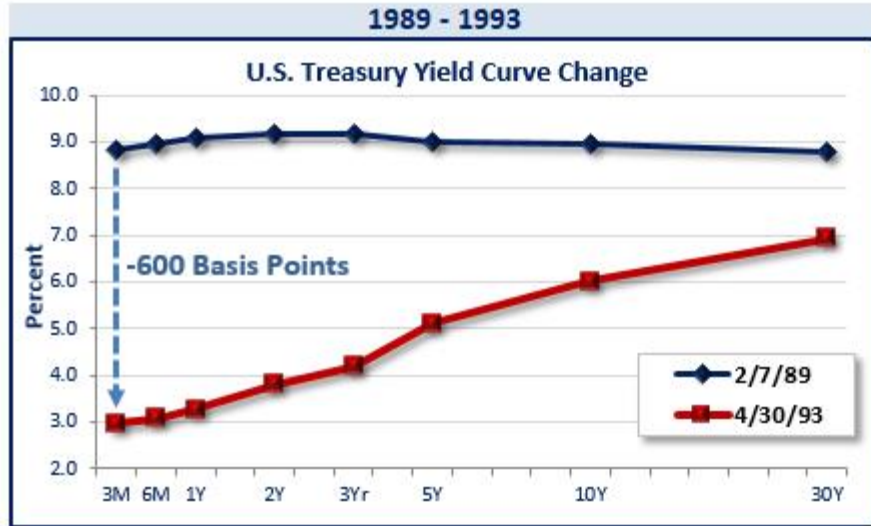
Ben Bernanke (former Fed Chair), January 10, 2008



**"Our ability to forecast is limited".**

Alan Greenspan (former Fed Chair) CNBC November 2019

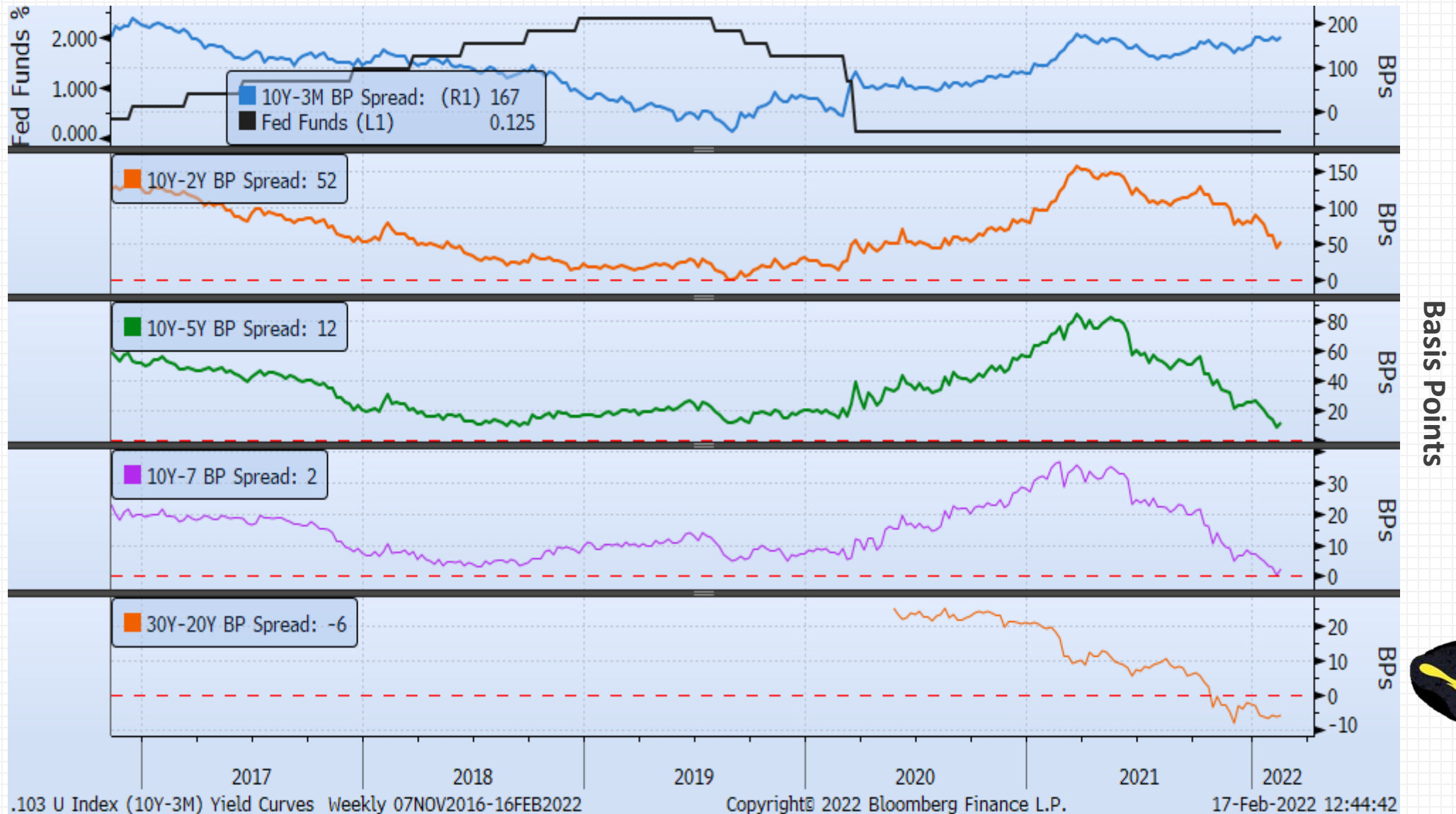
# The "Yield Curve Trap"



Now Witness the  
Firepower of a  
Fully Operational  
Flat Yield Curve

Source: Bloomberg

# First Yield Curve “Canary in the Coal Mine”?



Source: Bloomberg

.103 U Index (10Y-3M) Yield Curves Weekly 07NOV2016-16FEB2022

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17-Feb-2022 12:44:42

# What is the Market Pricing for Fed Hikes?

## Probability of Fed Hikes CME GROUP 2/17/2022

FOMC Meeting	2 Hikes .50%-.75%	3 Hikes .75%-1.00%	4 Hikes 1.00%-1.25%	5 Hikes 1.25-1.50%	6 Hikes 1.50%-1.75%	7 Hikes 1.75%-2.00%	8 Hikes 2.00%-2.25%	9 Hikes 2.25%-2.50%	10 Hikes 2.25%-2.50%	11 Hikes 2.50%-2.75%	12 Hikes 2.75%-3.00%
16-Mar-2022	62%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4-May-2022	100%	71%	15%	0%	0%	0%	0%	0%	0%	0%	0%
15-Jun-2022	100%	100%	77%	27%	0%	0%	0%	0%	0%	0%	0%
27-Jul-2022	100%	100%	95%	67%	3%	3%	0%	0%	0%	0%	0%
21-Sep-2022	100%	100%	99%	89%	57%	18%	2%	0%	0%	0%	0%
2-Nov-2022	100%	100%	99%	94%	72%	36%	9%	1%	0%	0%	0%
14-Dec-2022	100%	100%	100%	97%	86%	60%	27%	7%	1%	0%	0%
1-Feb-2023	100%	100%	100%	98%	90%	69%	39%	14%	3%	0%	0%
15-Mar-2023	100%	100%	100%	99%	95%	82%	57%	29%	9%	2%	0%
3-May-2023	100%	100%	100%	99%	96%	85%	63%	36%	14%	4%	1%
14-Jun-2023	100%	100%	100%	100%	96%	89%	71%	46%	22%	7%	2%
26-Jul-2023	100%	100%	100%	100%	95%	90%	74%	50%	26%	10%	3%

Values in Green = Probability Over 50%

Source: CME



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# Polling Question

To earn CPE credits, participants must participate in at least three of the polling questions.

**How many 25 basis point hikes will the Fed do this year?**

- A. 1 to 2
- B. 3 to 4
- C. 5 to 6
- D. 7 or more

## Securities to Match Cash Outflows:

- Bullets
- Floating Rate Notes\*
- ABS Credit Card (soft bullets)\*

## Securities to Market Time:

- Bullets
- Callables
- Floating Rate Notes\*
- Step-Ups/Step-Downs\*
- Paydowns\*(ABS/MBS/SBA)
- Bond Mutual Funds
- Floating NAV Funds
- TIPS

\* “WAM Real Estate”

# Bullet Basics: 5 Year T-Note vs 5 Year T-Strip

Bullet

T 1 1/2 01/31/27 Govt				Settings ▾	Yield and Spread Analysis	
				<input type="checkbox"/> No Notes	95 Buy	96 Sell
1) Yield & Spread		2) Yields		3) Graphs		4) Description
5) Pricing		6) Custom				
T 1 1/2 01/31/27 ( 912828Z78 )				Risk		
Price	100-00	(100.00)	Duration	4.836		
Settle	01/31/22	Maturity	Modified Duration	4.800		
			Risk	4.800		
Street Convention	1.5000	Convexity	0.259			
Treasury Convention	1.5000	DV ▾	01	480		
True Yield	1.4992	YV ▾	0.031	0.00651		
Equiv 1 ▾ /Yr Compound	1.5056	Invoice				
Japanese Yield (Simple)	1.5000	Face	1,000 M			
Mmkt (Act/360 ▾ )		Principal	1,000,000.00			
Current Yield	1.500	Accrued (0 Days)	0.00			
		Total (USD)	1,000,000.00			



Strip

S 0 02/15/27 Govt				Settings ▾	Yield and Spread Analysis	
				<input type="checkbox"/> No Notes	95 Buy	96 Sell
1) Yield & Spread		2) Yields		3) Graphs		4) Description
5) Pricing		6) Custom				
S 0 02/15/27 ( 912833PC8 )				Risk		
Price	91.0908	(91.0908092)	Duration	5.000		
Settle	02/15/22	Maturity	Modified Duration	4.954		
			Risk	4.512		
Street Convention	1.8750	Convexity	0.270			
Treasury Convention	1.8750	DV ▾	01	451		
True Yield	1.8740	YV ▾	0.031	0.00693		
Equiv 1 ▾ /Yr Compound	1.8838	Invoice				
Japanese Yield (Simple)	1.9560	Face	1,000 M			
Mmkt (Act/360 ▾ )		Principal	910,908.00			
Current Yield	0.000	Accrued (0 Days)	0.00			
		Total (USD)	910,908.00			



Source: Bloomberg

## Two Types of Options

### Calls and Puts

**When you purchase a callable bond, you are selling a call option to the issuer**

**What is the issuer's right?**

**What is your obligation?**

**How are you getting paid when you sell that option?**

# Callable Characteristics: Type Subgroups

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## Primary Items Affecting Yield/Coupon

- Level of Treasury Rates
- Number of Calls
- Volatility
- Days to Settlement/Cost of Carry
- Auction/Reverse Inquiry
- Fees



# Callable Characteristics: Number of Calls

## 5 Year Securities: Callables' Lockouts 1 Year

Instrument	Number of Calls	Yield
Treasury	0	1.95%
Bullet	0	1.98%
One-Time Call	1	2.03%
Discrete Call (quarterly)	15	2.12%
Continuous Call*	1,450	2.24%

\*10 Day Call Notice

## Are You Getting Paid Enough For the Options You're Selling?

Source: Bloomberg, FHN Capital Markets (callables: using avg spreads, 3 weeks settlement, standard fees)

# Callable Characteristics: Volatility



USSV014 BGN Curncy
Security Description: Swap

Properties
Related Instruments
Related Curves

**USD Swaption ATM %VOL 3M (OIS) 1Yx4Y** FIGI BBG007QJT583

A swaption is the option to enter into an interest rate swap. In exchange for an option premium, the buyer gains the right but not the obligation to enter into a specific swap agreement with the issuer on a specified future date. The time period between the valuation date and such date is called the expiry of the option. The length of the underlying swap is referred to as the tenor of the swaption. The coupon of the fixed leg of the swap is called the strike of the swaption.

Overview		Fixed Leg		Float Leg	
Currency	USD	Day Count	30I/360	Day Count	ACT/360
Expiry	1Y (17-FEB-2023)	Pay Freq	SemiAnnual	Pay Freq	Quarterly
Swaption Tenor	4Y (17-FEB-2027)	Bus Adj	ModifiedFollowing	Index	US0003M Index
Quote	45.77% (Black Vol)	Adjust	Accrl and Pay Dates	Reset Freq	Quarterly
Exercise	European	Roll Conv	Backward (EOM)	Bus Adj	ModifiedFollowing
Strike Type	ATM	Calc Cal	FD, EN	Adjust	Accrl and Pay Dates
Discounting	OIS	Pay Delay	0 Business Days	Roll Conv	Backward (EOM)
Style	Straddle			Calc Cal	FD, EN
Notification D...	2 Business Days			Fix Cal	EN

Price Chart | GP »



Source: Bloomberg



# Callable Characteristics: Days to Settlement/Cost of Carry

95) Actions ▾		96) Alerts ▾		97) Summary		98) Set Homepage		99) Export ▾		New Issue Monitor	
Selection		*NIM2-Agency (NIM2) ▾		1) Show Filters		2) Clear Filters		Issues ▾			
<input checked="" type="radio"/> Real Time		<input type="radio"/> Issue History		Date Range		01/15/22 📅 - 02/15/22 📅		6) Prelim Bonds   PREL			
Date ↓	Issuer	Coupon	Maturity	Spread	Curr	Outst	Book Mgr	Note			
		Fixed ▾	All ▾	All ▾	US ▾	All ▾		5			
101) 13:21	FED HOME LN BANK	2.170	03/08/27		USD	15	STONEX-sole	5-NC2 1X			
102) 9:43	FED HOME LN BANK	2.770	03/04/27		USD	35	RBCCM-sole	5-NC1MO BERM			
103) 9:19	FED HOME LN BANK	3.220	02/25/37		USD	35	JOINT LEADS	15-NC6MO INC			
104) 8:51	FED HOME LN BANK	2.375	03/08/27		USD	25	JOINT LEADS	5-NC1 BERM			
105) 8:44	FED HOME LN BANK	2.000	08/28/25		USD	50	CCB,RJA,TSI	3.5-NC1 1INC			
106) 2/14	FED HOME LN BANK	2.625	02/25/27	← 11 Days	USD	35	JOINT LEADS	5-NC1MO INC			
107) 2/14	FED HOME LN BANK	2.750	03/08/27		USD	85	JOINT LEADS	5-NC1MO INC			



Source: Bloomberg

**Generally, if a Federal Agency issues at auction, you will get a higher yield than if you do a reverse inquiry.**



**The higher the fee (selling concession) to the broker/dealer, the lower the yield to you.**

**Generally, broker/dealers make more of callables than bullets.**

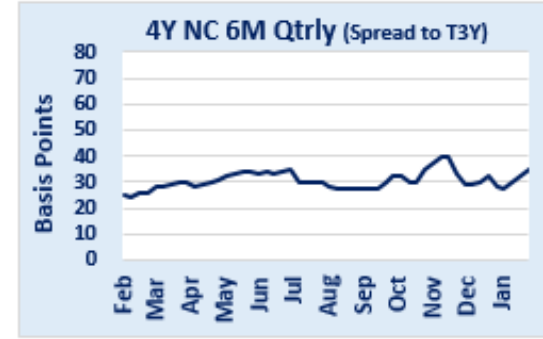
# Agency Callable Spreads



5



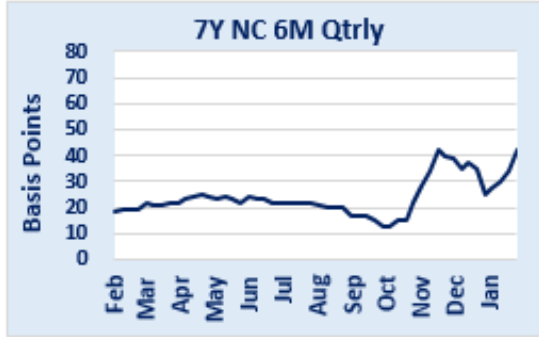
18



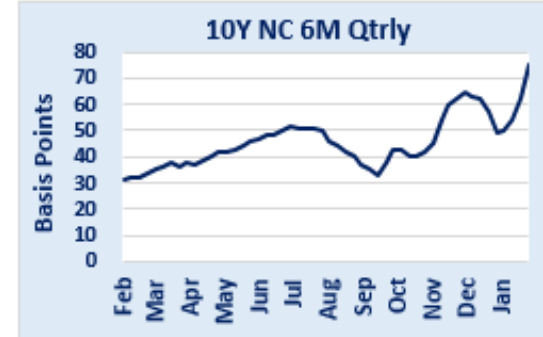
35



34



42



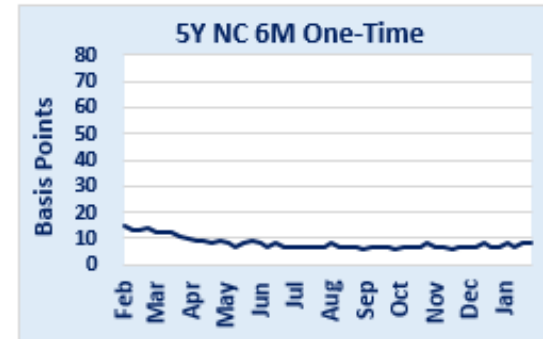
75



3



3



8

Source: Bloomberg, FHN Financial

# Duration

---

**Duration:** A measure of the timing of the cash flows, such as the interest payments and the principal repayment, to be received from a given fixed income security. This calculation is based on three variables: term to maturity, coupon rate, and yield to maturity. The duration of a security is a useful indicator of its price volatility for given changes in interest rates. There are three primary types of duration: Macaulay Duration, Modified Duration, and Effective Duration.

- **Macaulay Duration** was developed in 1938 by Frederic Macaulay, this form of duration measures the number of years required to recover the true cost of a bond, considering the present value of all coupon and principal payments received in the future. Thus, it is the only type of duration quoted in **“years”**. Interest rates are assumed to be continuously compounded.
- **Modified Duration** expands or modifies Macaulay duration to measure the responsiveness of a bond’s price to interest rate changes. **It is defined as the percentage change in price for a 100 basis point change in interest rates**. The formula assumes that the cash flows of the bond do not change as interest rates change (which is not the case for most callable bonds).
- **Effective Duration (sometimes called option-adjusted duration)** further refines the modified duration calculation and is particularly useful when a portfolio contains callable securities. **Effective duration requires the use of a complex model for pricing bonds that adjusts the price of the bond to reflect changes in the value of the bond’s “embedded options” (e.g., call options or a sinking fund schedule) based on the probability that the option will be exercised**. Effective duration incorporates a bond’s yield, coupon, final maturity and call features into one number that indicates how price-sensitive a bond or portfolio is to changes in interest rates.

Source: CDIAAC

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# Polling Question

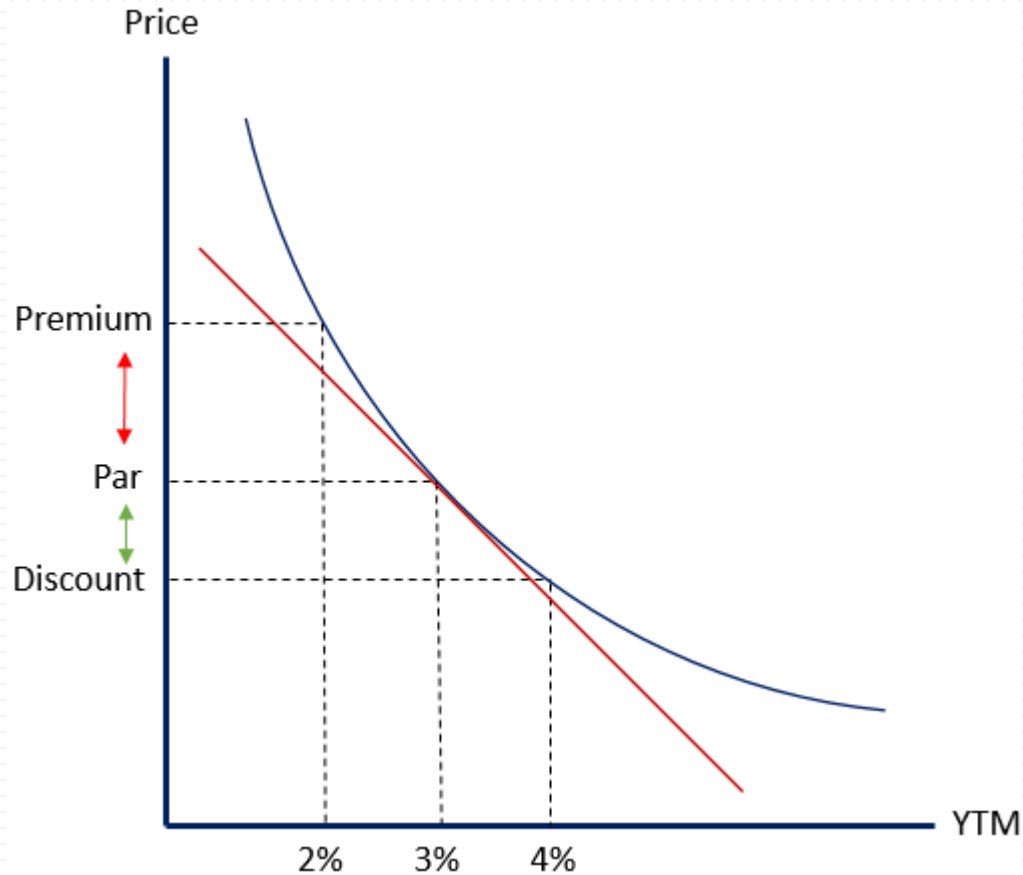
To earn CPE credits, participants must participate in at least three of the polling questions.

**Which bond (with the exact same maturities) has a higher effective duration?**

- A. 5 Year Agency Callable**
- B. 5 Year T-Note**
- C. 5 Year Zero Coupon T-Strip**

# Duration and Convexity

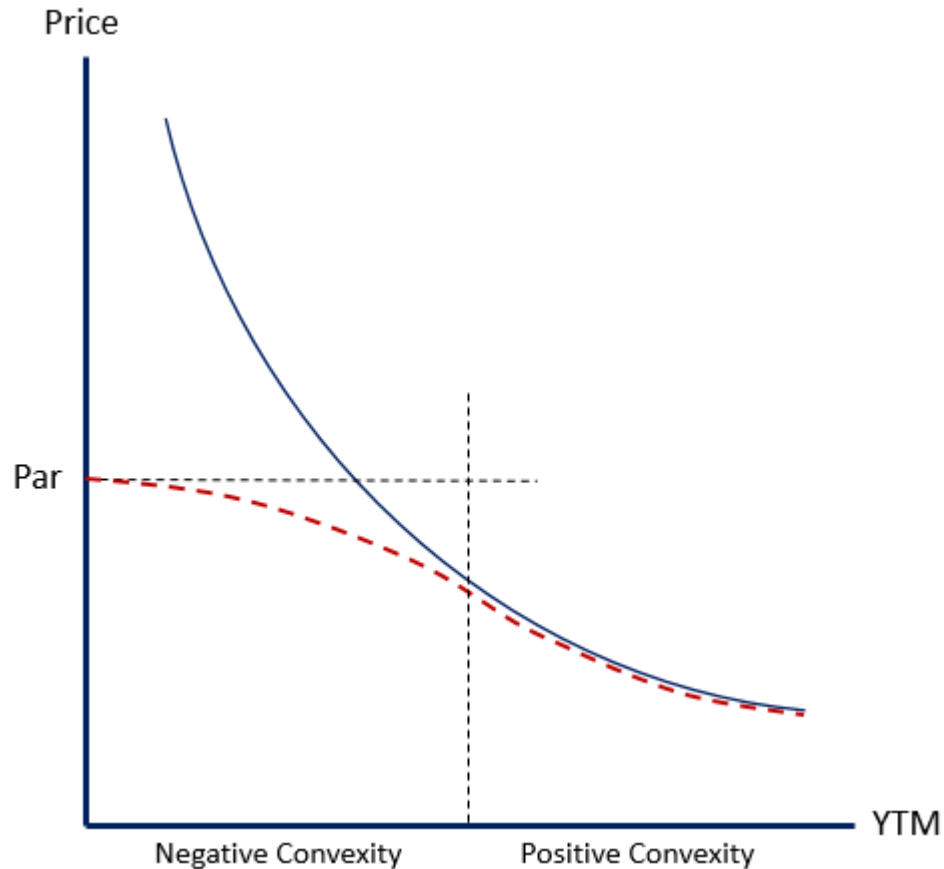
$$\Delta \text{Bond Price} \approx -\text{Modified Duration}(\Delta \text{YTM}) + \frac{1}{2} \text{Convexity}(\Delta \text{YTM})^2$$



- Because duration is a linear assumption, it miscalculates the change in the price of a bond given a change in the yield to maturity
- Duration underestimates the bond price when yields fall and overestimates the bond price when yields rise
- **Convexity** measures the curvature of the price/yield relationship of a bond
- You can better estimate the change in price, given a change in the yield to maturity, by adding a convexity adjustment to our previous formula

Source: Bloomberg, FHN Financial

# Callable Bonds and Convexity



- As interest rates drop, callable bonds become negatively convex and duration decreases
- If the bond's coupon is higher than a comparable bullet security, the issuer will call back the bond and you will have to reinvest at lower rates
- As interest rates rise, callable bonds act like normal bullet bonds and can become positively convex

Source: Bloomberg, FHN Financial



# Option Adjusted Spread (OAS)

## WHAT IS OAS?

OAS is a measure of yield spread that accounts for embedded call options in the valuation of bonds. The OAS for a bond is computed using price and projections of interest rate volatility to account for the possibility of early redemption. The OAS value is interpreted as the constant spread that can be earned on the asset compared to the risk-free option. Most commonly, the OAS is expressed as a spread over the Treasury curve.



CALIFORNIA DEBT AND INVESTMENT ADVISORY COMMISSION

CDIAC No. 20-10

## Issue Brief: Benefits and Limitations of Option-Adjusted Spread Analysis

### INTRODUCTION

Public fund managers want to ensure that their investment practices are consistent with their investment policy, and accomplish the main objectives of optimizing safety, liquidity, and return on agency assets. These goals charge public agencies with thoughtfully choosing investments that mitigate risk, ensure sufficient liquidity to meet ongoing obligations, and also generate income for the portfolio over budgetary and economic cycles. These different objectives often come into contention with one another, as assets considered the safest usually produce the smallest returns and assets with higher returns also tend to have more risk.

Option-adjusted spread (OAS) is a measure of yield spread for a bond that accounts for embedded redemption structures. OAS is an improvement on the standard calculation of yield spread for a bond because it accounts for the possibility of a change in the bond's cash flows due to changes in interest rates. This issue brief discusses what OAS is, how to interpret OAS values, modeling assumptions, and the limitations of applications of OAS in public portfolio management.<sup>2</sup>

### WHAT IS OAS?

OAS is a measure of yield spread that accounts for embedded call options in the valuation of bonds. The OAS for a bond is computed using price and projections of interest rate volatility to account for the possibility of early redemption. The OAS value is interpreted as the constant spread that can be earned on the asset compared to the risk-free option. Most commonly, the OAS is expressed as a spread over the Treasury curve.<sup>3</sup>

The main benefit and purpose of OAS is that

### EFFECTIVE DURATION

Additional benefits of OAS include applications to calculating duration for a bond in a way that accounts for an embedded option. Duration is a measure of estimating the price (market value) change in a bond given a change in interest rates. Effective duration is a byproduct of the option models that produce OAS and it accounts for ways that changes in interest rates have the potential to change a bond's cash flows. Similar to how OAS is an improved measure of yield spread, effective duration is an improvement over modified duration, as it is a more reliable indicator of a callable bond's price sensitivity to changes in interest rates.

<https://www.treasurer.ca.gov/cdiac/publications/issue-brief/2020/20-10.pdf>

Source: CDIAC

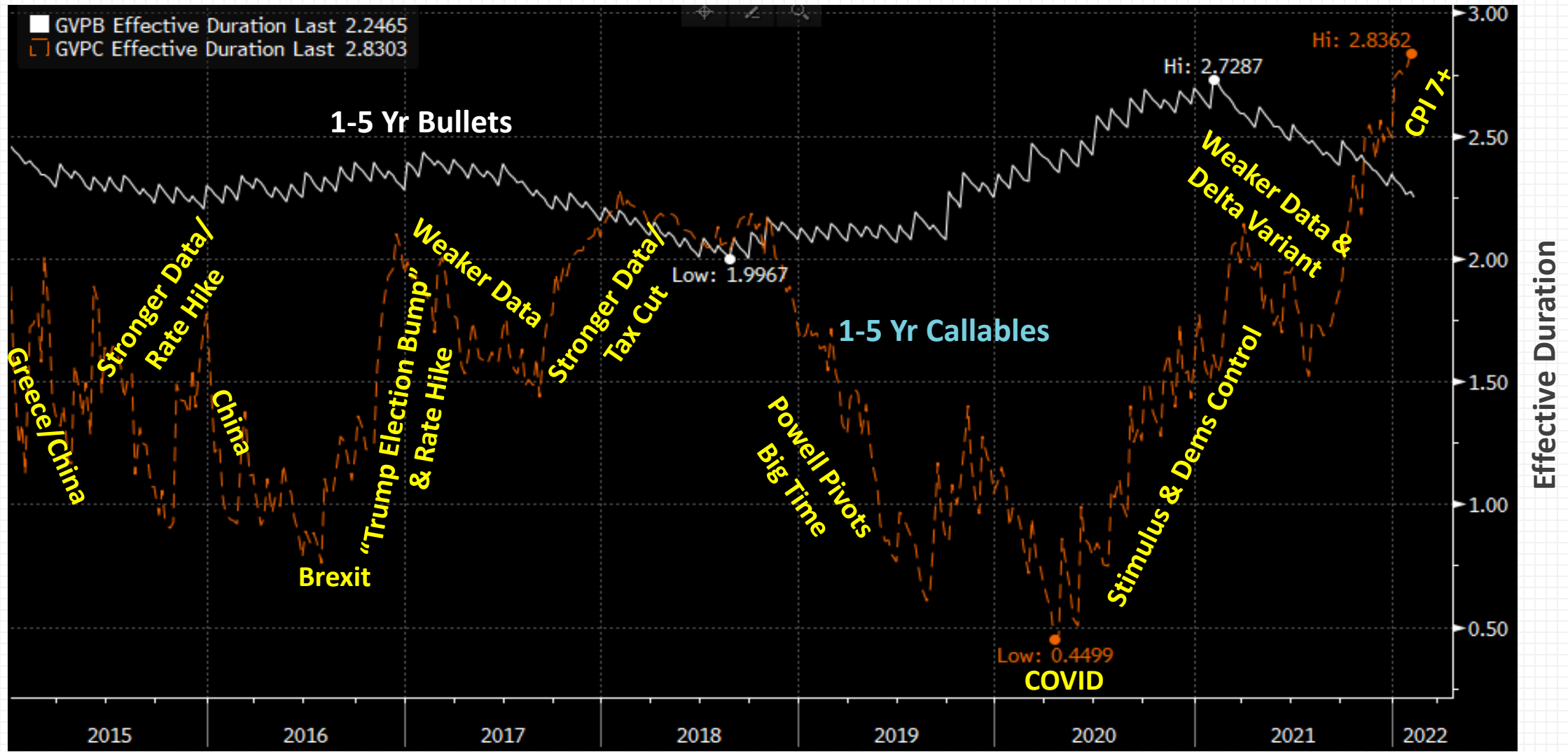


# Average Prices: 1-5Yr Callables vs. 1-5Yr Bullets



Source: Bloomberg

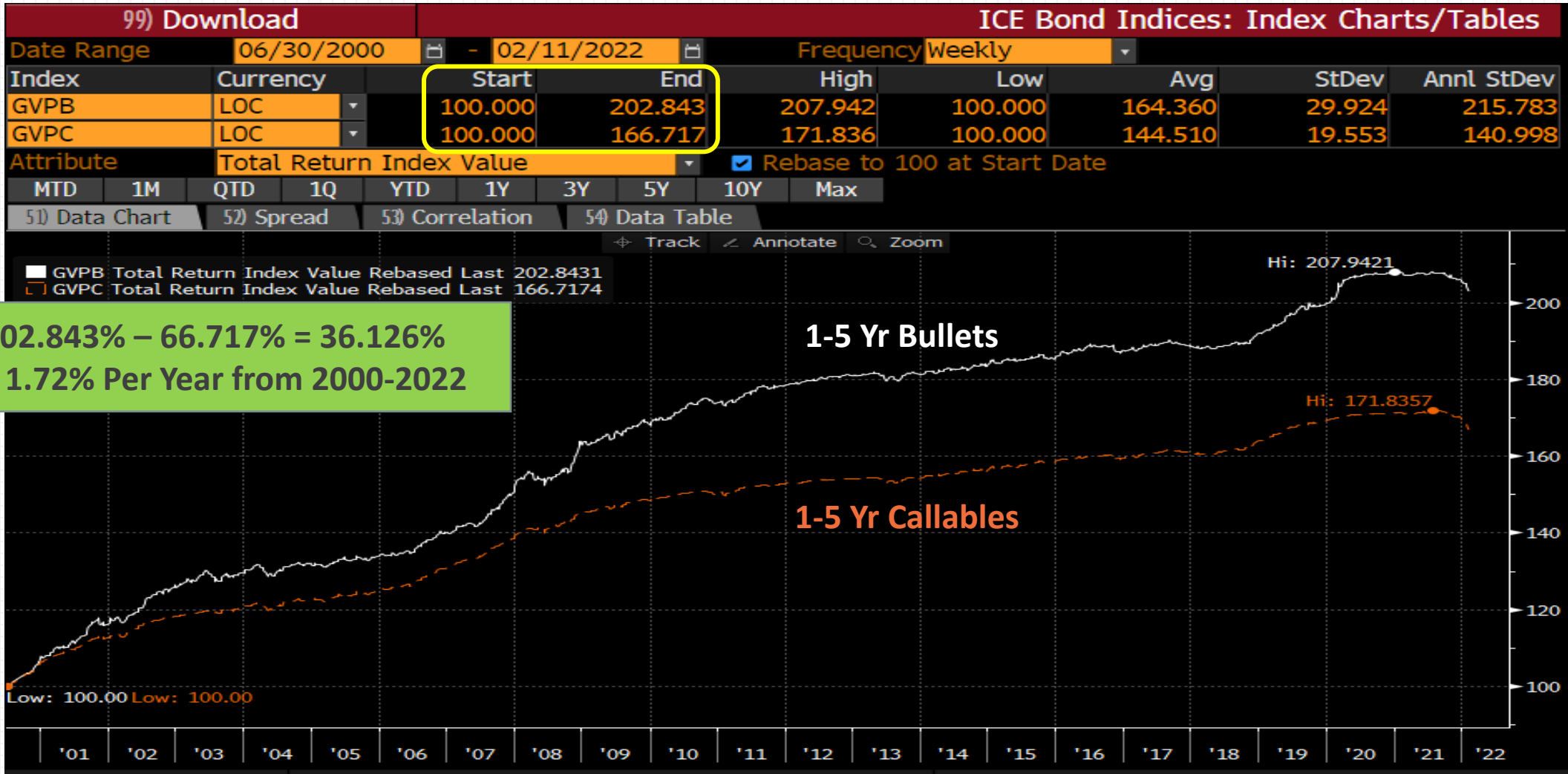
# Effective Duration: Agency 1-5Yr Bullets vs. 1-5 Yr Callables



**Avg Effective Duration: Bullets 2.31 Callables 1.54**

Source: Bloomberg

# Long Run Return: Agency 1-5 Yr Bullets vs. 1-5 Yr Callables



Source: Bloomberg

**Avg Effective Duration: Bullets 2.31 Callables 1.54**

# Total Return Comparison

## 1-5Yr Bullets

GVPB		99) Download		ICE	
ICE BofA 1-5 Year US Bullet Agency Index					
06/30/2000	-	02/11/2022	Currency	LOC	0 % Hedged
		Periodic Return	Annualized Return		
Total Return Factors					
Price Return (Local)		0.207	0.010		
Income Return (Local)		102.636	3.314		
Total Return (Local)		102.843	3.324		



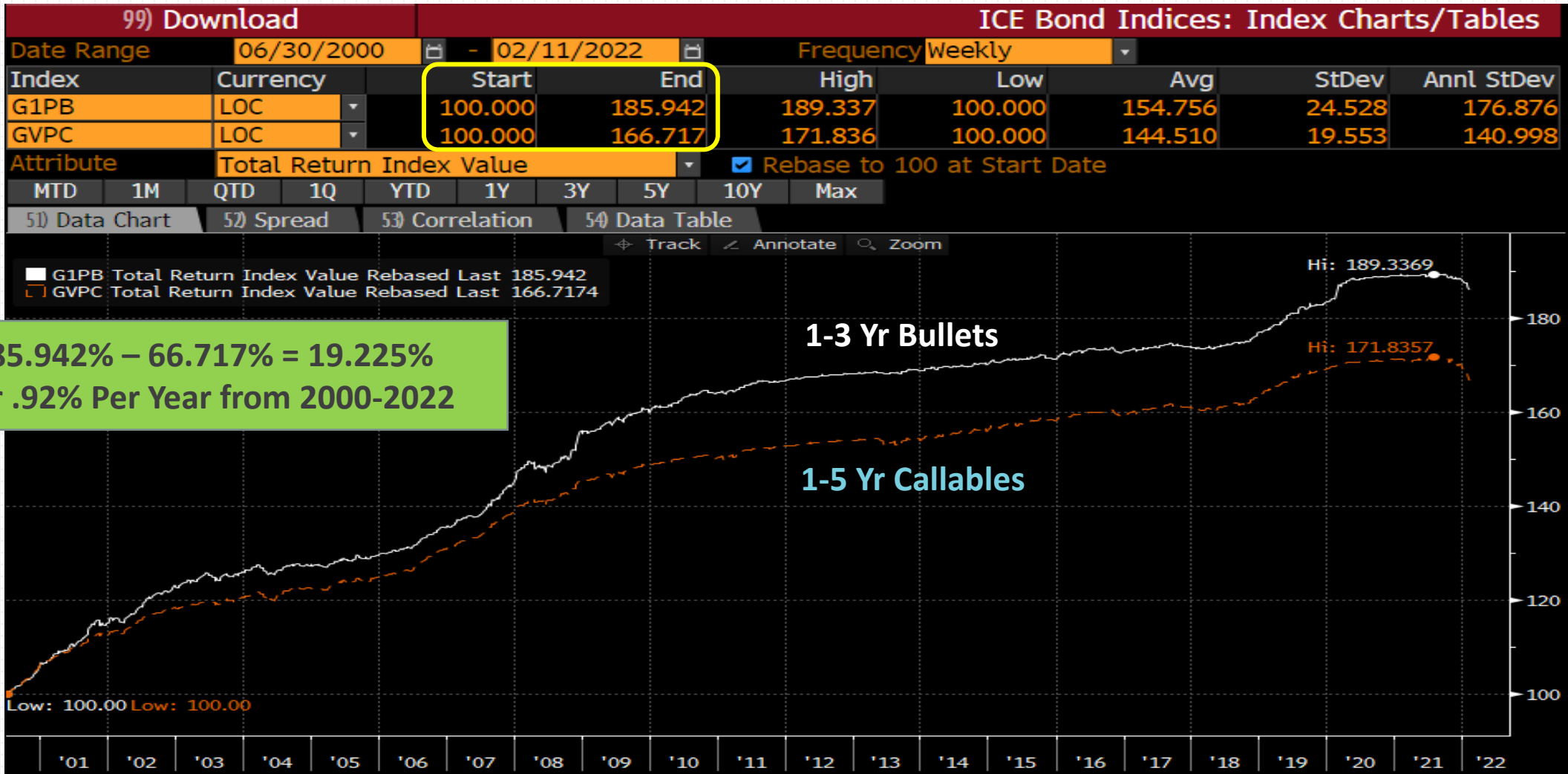
**3.324% Bullets**  
**2.391% Callables**  
**.933%**

## 1-5Yr Callables

GVPC		99) Download		ICE	
ICE BofA 1-5 Year US Non-Bullet Agency Index					
06/30/2000	-	02/11/2022	Currency	LOC	0 % Hedged
		Periodic Return	Annualized Return		
Total Return Factors					
Price Return (Local)		-1.346	-0.063		
Income Return (Local)		68.063	2.454		
Total Return (Local)		66.717	2.391		

Source: Bloomberg

# Long Run Return: Agency 1-3 Yr Bullets vs. 1-5 Yr Callables



85.942% – 66.717% = 19.225%  
 Or .92% Per Year from 2000-2022

Avg Effective Duration: Bullets 1.78 Callables 1.54

Source: Bloomberg

# Callable Characteristics: OAS

95) Actions ▾		96) Alerts ▾		97) Summary		98) Set Homepage		99) Export ▾		🔗 New Issue Monitor	
Selection		*NIM2-Agency (NIM2) ▾		1) Show Filters		2) Clear Filters		Issues & News ▾			
<input checked="" type="radio"/> Real Time		<input type="radio"/> Issue History		Date Range		01/15/22 📅 - 02/15/22 📅		6) Prelim Bonds   PREL			
Date ↓	Issuer/Headline	Coupon	Maturity	Spread	Curr	Outst	Book Mgr	Note ▲			
		Fixed ▾	All ▾	All ▾	US ▾	All ▾		1x			
101) 13:21	FED HOME LN BANK	2.170	03/08/27		USD	15	STONEX-sole	5-NC2 1X			
102) 13:11	FED HOME LN BANK	1.900	03/07/25		USD	15	STONEX-sole	3-NC1 1X			

Source: Bloomberg

# Callable Characteristics: OAS 5NC 2Y 1X

**AGENCY OPTION-ADJUSTED SPREAD**

FED HOME LN BANK FHLB 2.17 03/27 / ( / ) TRAC

Calculate **Price** **OAS (bp)** Fwd ATM Skew Adj  
 (P,0,V) **0** P) **100** **0** **-1.74** Strike **Vol** Vol  
 2.143 **37.67** 37.43  
 European call Skew Adj Exp **1.00**  
 Cusip / ID# 3130AR2W0 Option Px Value: -1.30  
 Settle **3/ 8/2022** Bench settle **2/16/2022** Vega: -0.03  
 Spread **39.3bp vs 3Y** T 1 1/2 02/15/25 Govt @99-6 1/4 ( 1.777)

2) Customize  
 Curve **I111** Semi  
 US On/Off The Run  
 Dated **2/15/2022**  
 Settle **3/ 8/2022**  
 A BMA CMT  
 Shift **+0(bps)**  
 Yield Adjust

	OAS	Option	To Call on	To
	Method	Free	3/ 8/2024	Mty
Yld		1.896	2.170	2.170
Sprd		-1.9	60.3	25.5
M Dur	3.84		1.95	4.71
Risk	3.84		1.95	4.71
Cnvx	-0.89		0.05	0.25

3) Call Schedule  
 3/ 8/24 100.00

Model **S** S=Black Swaption

	3m	6m	1y	2y	3y	4y	5y	7y	10y	20y
Yield Adjust	0.391	0.687	1.037	1.551	1.777	1.907	1.915	2.009	2.028	2.403
	-0.2	0.2	3.7	1.5	0.0	0.0	0.0	0.0	0.0	0.4

{NUM}<GO> for:  
 Tsy Curve

Source: Bloomberg



# Effective Duration Comparison

95) Actions ▾		96) Alerts ▾		97) Summary		98) Set Homepage		99) Export ▾		New Issue Monitor	
Selection		*NIM2-Agency (NIM2) ▾		1) Show Filters		2) Clear Filters		Issues ▾			
● Real Time		● Issue History		Date Range		01/17/22 📅 -		02/16/22 📅		6) Prelim Bonds   PREL	
	Date ↓	Issuer	Coupon	Maturity	Spread	Curr	Outst	Book Mgr	Note		
			All ▾	All ▾	All ▾	US ▾	All ▾		5-nc1		
101)	2/16	FED HOME LN BANK	2.250	02/24/27		USD	85	FHN-sole	5-NC1 BERINC		
102)	2/15	FED HOME LN BANK	2.770	03/04/27		USD	35	RBCCM-sole	5-NC1MO BERM		



Source: Bloomberg



# Effective Duration Comparison

5Y-NC-1M

**OPTION-ADJUSTED SPREAD ANALYSIS**  
 FED HOME LN BANK FHLB 2.77 03/27 100.041/100.069 (2.277/1.941) BVAL

Calculate **Price** **OAS (bp)** **Volatility**  
 (P,0,V)  P) 100 0) -11.20 V) 46.53

Cusip / ID# 3130AR2H3 Option Px Value: -4.60  
 Settle 3/4/2022 Bench settle 2/18/2022 Vega: -0.03  
 Spread 130.4bp vs 2Y T 0 7/8 01/31/24 Govt@98-27<sup>3</sup>/<sub>4</sub> (1.466)

2) Customiz  
 Curve I111  
 US On/Off Th  
 Dated 2/16  
 Settle 3/4  
 N None  
 Shift +0

{NUM}<GO> for:	OAS Method	Option Free	To Call on	To Mty	Yield S
3) Call Schedule			4/4/2022		
4/4/22 100.00	Yld	1.803	2.770	2.770	3m 0.365
5/4/22 100.00	Sprd	-11.6	240.5	85.1	6m 0.654
6/4/22 100.00	M Dur	1.30	0.17	4.64	1y 0.995
7/4/22 100.00	Risk	1.30	0.17	4.64	2y 1.521
8/4/22 100.00	Cnvx	-3.30	0.00	0.25	3y 1.758
					4y 1.902
					5y 1.919

5Y-NC-1Y

**OPTION-ADJUSTED SPREAD ANALYSIS**  
 FED HOME LN BANK FHLB 2 1/4 02/27 100.126/100.248 (2.120/1.994) BVAL

Calculate **Price** **OAS (bp)** **Volatility**  
 (P,0,V)  P) 100 0) -9.11 V) 35.74

Cusip / ID# 3130AQYA5 Option Px Value: -2.00  
 Settle 2/28/2022 Bench settle 2/18/2022 Vega: -0.04  
 Spread 55.6bp vs 3Y T 1 1/2 02/15/25 Govt@99-14 (1.694)

2) Customiz  
 Curve I111  
 US On/Off Th  
 Dated 2/16  
 Settle 2/28  
 N None  
 Shift +0

{NUM}<GO> for:	OAS Method	Option Free	To Call on	To Mty	Yield S
3) Call Schedule			2/24/2023		
2/24/23 100.00	Yld	1.828	2.250	2.250	3m 0.365
5/24/23 100.00	Sprd	-9.1	126.3	33.1	6m 0.654
8/24/23 100.00	M Dur	3.07	0.97	4.69	1y 0.995
11/24/23 100.00	Risk	3.07	0.97	4.69	2y 1.521
2/24/24 100.00	Cnvx	-1.38	0.01	0.25	3y 1.758
					4y 1.902
					5y 1.919

Source: Bloomberg






# Step-Ups

95) Actions ▾		96) Alerts ▾		97) Summary		98) Set Homepage		99) Export ▾		New Issue Monitor	
Selection		*NIM2-Agency (NIM2) ▾		1) Show Filters		2) Clear Filters		Issues ▾			
<input checked="" type="radio"/> Real Time		<input type="radio"/> Issue History		Date Range		01/11/22 📅 - 02/11/22 📅		6) Prelim Bonds   PREL			
Date ↓	Issuer	Coupon	Maturity	Spread	Curr	Outst	Book Mgr	Note			
		Step ▾	All ▾	All ▾	US ▾	All ▾					
101) 15:38	FED HOME LN BANK	STEP	02/28/25		USD	65	JOINT LEADS	3-NC1 BERINC			
102) 11:48	FED HOME LN BANK	STEP	02/28/24		USD	10	MTBK-sole	2-NC1 1X			
103) 11:06	FED HOME LN BANK	STEP	02/27/26		USD	15	BOSC,DW	4-NC1 1X			
104) 2/10	FED HOME LN BANK	STEP	02/28/25		USD	25	MIZ-sole	3-NC1 1X			
105) 2/10	FED HOME LN BANK	STEP	08/28/24		USD	15	JOINT LEADS	2.5-NC1 1X			
106) 2/10	FED HOME LN BANK	STEP	02/28/25		USD	15	JOINT LEADS	3-NC1 1X			
107) 2/9	FED HOME LN BANK	STEP	02/24/27		USD	25	FHN-sole	5-NC1 BERM			
108) 2/9	FED HOME LN BANK	STEP	02/28/25		USD	45	BOSC,CCB,DW	3-NC1 BERINC			
109) 2/9	FED HOME LN BANK	STEP	02/25/27		USD	25	HUNSEC,MTBK	5-NC3MO INC			


Source: Bloomberg

# 1 Time Step-Up Callable vs. Bullet

4Y Tsy T 0 1/2 02/28/26 ↑94-25+ + 11 1/4 94-23 1/4 /94-25+ 1.861 /1.843 

4Y Step-Up FHLB 1 1/2 02/27/26 ( 3130AQYW7 ) Coupon Schedule

Spread	40.890 bp vs	T 0 1/2 02/28/26	Rate(%)	Start	End
Price	100.0000	↻ 94-25+ 21:00:53	1.500	02/28/2022	02/27/2023
Yield	2.2517 Mty	1.8428 S/A	2.500	02/27/2023	02/27/2026



3Y Tsy T 1 3/8 01/31/25 ↑99-02 1/4 + 08+ 98-31 1/4 /99-02 1/4 1.731 /1.698

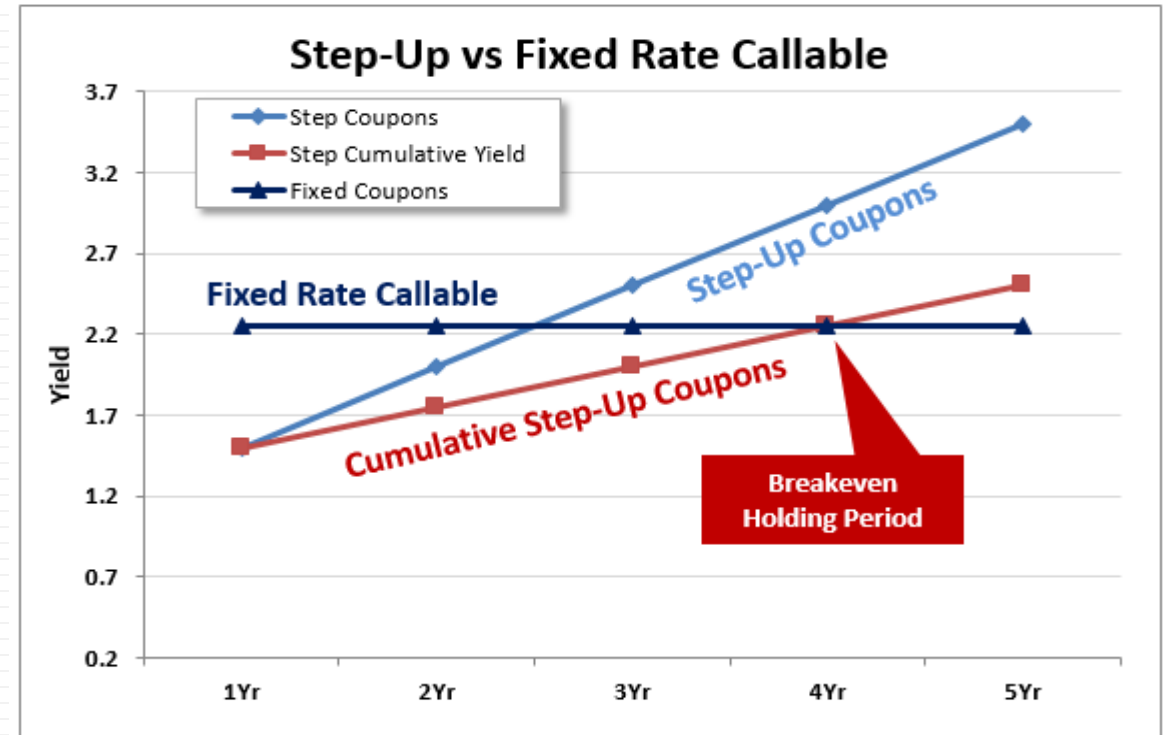
**Breakeven: 2.50% (Step Coupon) – 1.698% (3 Year Treasury) = .80% Higher In One Year from Now**

Source: Bloomberg

# 5 Year Agency Step-Up Breakeven Analysis

Coupons			
Coupon Information			
Issue Date	02/25/2022	First Coupon	Normal
1st Coupon Date	08/25/2022	Last Coupon	Normal
Observation Index	N/A	Paying Index	N/A
	Coupon	End Date	
<b>Step-Up's Coupons &gt;</b>	1.500	02/25/2023	
	2.000	02/25/2024	
	2.500	02/25/2025	
	3.000	02/25/2026	
	3.500	02/25/2027	

Step Up Analysis - 5yr Annual Steps				
Time	Step Cpns	SU Cumltv Cpn	Fixed Coupons	Var
1Yr	1.500	1.500	2.250	(0.750)
2Yr	2.000	1.750	2.250	(0.500)
3Yr	2.500	2.000	2.250	(0.250)
4Yr	3.000	2.250	2.250	0.000
5Yr	3.500	2.500	2.250	0.250



Source: Bloomberg, FHN Main Street

# Floater

95) Actions ▾		96) Alerts ▾		97) Summary		98) Set Homepage		99) Export ▾		New Issue Monitor	
Selection		*NIM2-Agency (NIM2) ▾		1) Show Filters		2) Clear Filters		Issues ▾			
● Real Time		● Issue History		Date Range		01/11/22 - 02/11/22		6) Prelim Bonds   PREL			
Date ↓	Issuer	Coupon	Maturity	Spread	Curr	Outst	Book Mgr	Note			
		Float ▾	All ▾	All ▾	US ▾	All ▾					
102) 2/9	FARMER MAC	FRN	08/18/22		USD	100	CASOAK-sole	INCREASE			
103) 2/8	FED FARM CREDIT	FRN	02/14/25		USD	100	JOINT LEADS	3-NC			
104) 2/4	FARMER MAC	FRN	02/14/29		USD	5	CASOAK-sole	7-NC			
105) 2/4	FED FARM CREDIT	FRN	02/09/24		USD	550	JOINT LEADS	2-NC			
106) 2/2	FED HOME LN BANK	FRN	04/29/22		USD	500	ACADSE-sole	3MO-NC			
107) 2/1	FED HOME LN BANK	FRN	06/24/22		USD	301.5	JOINT LEADS	5MO-NC			
108) 2/1	FED HOME LN BANK	FRN	06/30/22		USD	1000	JOINT LEADS	5MO-NC			
109) 1/21	FARMER MAC	FRN	02/02/28		USD	5	VS-sole	6-NC			
110) 1/21	FED FARM CREDIT	FRN	01/29/24		USD	325	TDSEC-sole	2-NC			
111) 1/20	FARMER MAC	FRN	01/28/30		USD	5	PIPR-sole	8-NC			
112) 1/20	FARMER MAC	FRN	01/28/31		USD	5	PIPR-sole	9-NC			
113) 1/20	FED FARM CREDIT	FRN	01/26/24		USD	100	ACADSE,MIZ	2-NC			

Source: Bloomberg

# Floater Details: 2 Year

FFCB Float 01/29/24 Cor Actions Settings Page 12/12 Security Description: Bond

Data not provided by Bloomberg... 94) No Notes 95) Buy 96) Sell

25) Bond Description 26) Issuer Description

Pages

- 11) Bond Info
- 12) Addtl Info
- 13) Reg/Tax
- 14) Covenants
- 15) Guarantors
- 16) Bond Ratings
- 17) Identifiers
- 18) Exchanges
- 19) Inv Parties
- 20) Fees, Restrict
- 21) Schedules
- 22) Coupons**
- 32) ALLQ Pricing
- 33) QRD Qt Recap
- 34) TDH Trade Hist
- 35) CACS Corp Action
- 36) CF Prospectus
- 37) CN Sec News

Coupons

Coupon Information

Benchmark	USBMMY3M	Benchmark Freq	QUARTLY
Fix Frequency	Daily	Next Coupon Date	04/29/2022
Paying Agent		Prev Coupon Date	01/28/2022
Pay Calendars	US	Cap	NaN
Refix Calendars	FD	Floor	0
First Irreg Cpn	Long First	Margin	-1.5
Last Irreg Cpn	Normal	Reset Days Prior	1
		Current Coupon	.27521
		Lockout	4
		Cpn Conv	Mod-Unadj Cpn Freq
			Quarterly

Table View Chart View

Past Coupon Resets

Accrual Start	Rate
02/15/2022	
02/08/2022	0.275212
02/01/2022	0.225146
01/28/2022	0.175091

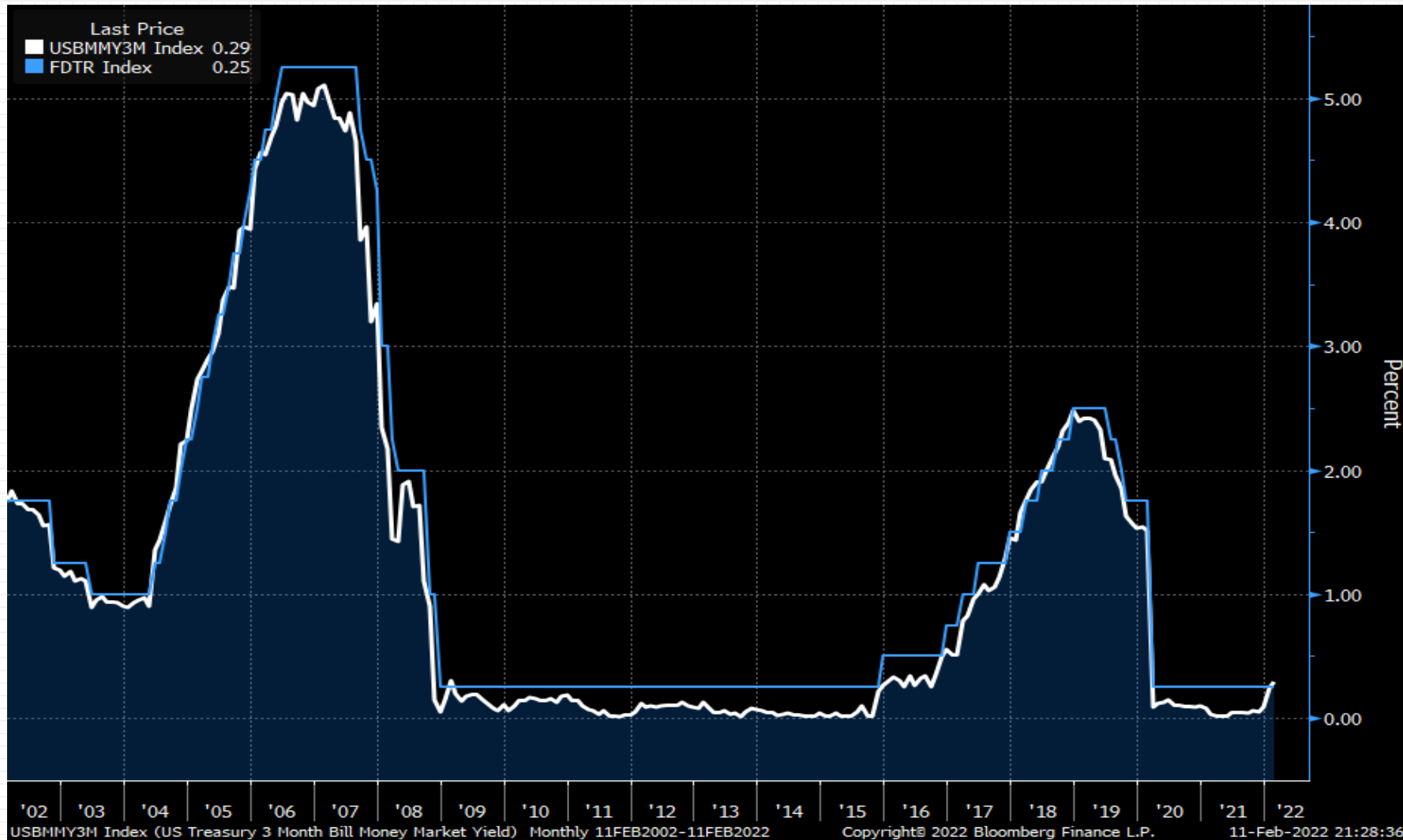
Margin History

Date	Margin

Source: Bloomberg



# USBMMY3M (US Treasury 3 Month Bill) vs. Fed Funds



**Floater Current  
Coupon  
.27%**

**2 Year Bullet  
Current Coupon  
1.55%**

**How Fast Do  
Rates Need to  
Climb to Breakeven?**

Source: Bloomberg

# Deeply Discounted Callables



Offer Size	Cusip	Ticker	Coup	Maturity	CallDate	CallType	Price	YTM	Spread	Benchmark	Deal Size	Settle
24,600,000	3130ANMH0	FHLB	1.1	8/20/2026	3/20/2022	Monthly	96.0799	2.0133	8	T 1 1/2 01/31/27	1,600,000,000	2/16/2022
1,475,000	3130APB79	FHLB	1	9/30/2026	9/30/2022	Quarterly	95.4625	2.0333	10	T 1 1/2 01/31/27	100,000,000	2/16/2022
2,125,000	3130AKYH3	FHLB	0.83	2/10/2027	5/10/2022	Quarterly	94.2333	2.0533	12	T 1 1/2 01/31/27	550,000,000	2/16/2022
4,500,000	3133EMAC6	FFCB	0.75	9/21/2027	9/21/2023	Anytime	92.9396	2.0933	16	T 1 1/2 01/31/27	105,000,000	2/16/2022
2,575,000	3135GACC3	FNMA	0.875	1/20/2028	4/20/2022	Quarterly	93.0274	2.1333	20	T 1 1/2 01/31/27	15,000,000	2/16/2022
6,750,000	3133EL5Y6	FFCB	1	3/2/2028	2/23/2022	Anytime	93.5368	2.1457	12	T 1 3/4 01/31/29	185,000,000	2/16/2022
4,000,000	3133ELA20	FFCB	1.06	5/26/2028	5/26/2022	Anytime	93.6546	2.1457	12	T 1 3/4 01/31/29	180,000,000	2/16/2022
12,500,000	3130AQZS5	FHLB	2.625	2/27/2029	5/27/2022	Quarterly	100	2.625			15,000,000	2/28/2022
2,750,000	3133ELH31	FFCB	1.45	6/11/2030	2/23/2022	Anytime	93.6352	2.2946	26	T 1 7/8 02/15/32	275,000,000	2/16/2022
21,000,000	3133EL2C7	FFCB	1.23	7/29/2030	2/23/2022	Anytime	91.7159	2.3146	28	T 1 7/8 02/15/32	380,000,000	2/16/2022
16,050,000	3134GXFJ8	FHLMC	1.29	9/9/2030	3/9/2022	Quarterly	92.2288	2.2946	26	T 1 7/8 02/15/32	25,000,000	2/16/2022
9,073,000	3133ENJS0	FFCB	2	12/30/2030	3/30/2022	Anytime	96.9008	2.3901			110,000,000	2/16/2022
21,700,000	3133ENKN9	FFCB	2.1	1/13/2031	4/13/2022	Anytime	97.5674	2.4054			50,000,000	2/16/2022
1,000,000	3130AKTV8	FHLB	1.32	1/28/2031	4/28/2022	Quarterly	91.2365	2.4146	38	T 1 7/8 02/15/32	75,000,000	2/16/2022
4,100,000	3133EL5X8	FFCB	1.35	3/3/2031	2/23/2022	Anytime	91.3935	2.4146	38	T 1 7/8 02/15/32	202,000,000	2/16/2022
12,834,000	3133ENKP4	FFCB	2.2	1/12/2032	4/12/2022	Anytime	97.7823	2.4541			50,000,000	2/16/2022
3,000,000	3134GV6A1	FHLMC	1.55	7/21/2032	4/21/2022	Quarterly	91.894	2.4346	40	T 1 7/8 02/15/32	175,000,000	2/16/2022

Source: FHN Financial

# Deeply Discounted Callables



Source: FHN Financial

# Deeply Discounted Callables—At New Issue

**OPTION-ADJUSTED SPREAD ANALYSIS**  
 FED HOME LN BANK FHLB1.1 08/20/26 95.907/96.273 (2.055/1.967) BVAL

Calculate **Price** **OAS (bp)** **Volatility**  
 (P,0,V)  P) **100.0000** **0) + 2.18** **V) 46.05**

Cusip / ID# 3130ANMHO Option Px Value: -1.46  
 Settle **8/20/2021** Bench settle **8/20/2021** Vega: -0.01  
 Spread **-77.9bp vs 5Y** T 1 ½ 01/31/27 Govt@98-1+ (1.879)

2) Customize  
 Curve **I111** Semi  
 US On/Off The Run  
 Dated **8/20/2021**  
 Settle **8/20/2021**  
 N None  
 Shift **+0(bps)**  
 Yield Spread

	OAS	Option	To Call on	To
	Method	Free	9/20/2021	Mty
Yld		0.801	1.100	1.100
Sprd		1.9	105.7	31.8
M Dur	1.67		0.17	4.85
Risk	1.67		0.17	4.85
Cnvx	-6.00		0.00	0.26

{NUM}<GO> for:  
 3) Call Schedule

Date	Amount
9/20/21	100.00
10/20/21	100.00
11/20/21	100.00
12/20/21	100.00
1/20/22	100.00
2/20/22	100.00
3/20/22	100.00
4/20/22	100.00

Model  L L=Lognormal



Source: Bloomberg

# Deeply Discounted Callables—Current Market Context

**OPTION-ADJUSTED SPREAD ANALYSIS**  
 FED HOME LN BANK FHLB1.1 08/20/26 95.907/96.273 (2.055/1.967) BVAL

Calculate **Price** **OAS (bp)** **Volatility**  
 (P,O,V)  P  O  V  
 Price: 96.07990 OAS: 0) + 9.46 Volatility: 50.20

2) Customize  
 Curve I111 Semi  
 US On/Off The Run  
 Dated 2/12/2022  
 Settle 2/15/2022  
 N None  
 Shift +0(bps)  
 Yield Spread

Cusip / ID# 3130ANMHO Option Px Value: -0.30  
 Settle 2/15/2022 Bench settle 2/15/2022 Vega: -0.01  
 Spread 9.8bp vs 5Y T 1 1/2 01/31/27 Govt@98-1+ (1.915)

{NUM}<GO> for:  
 3) Call Schedule

	OAS	Option	To Call on	To
	Method	Free	3/20/2022	Mty
3/20/22 100.00	Yld	1.942	46.988	2.013
4/20/22 100.00	Sprd	9.6	4664.8	16.7
5/20/22 100.00	M Dur	4.09	0.07	4.35
6/20/22 100.00	Risk	3.95	0.07	4.20
7/20/22 100.00	Cnvx	-0.13	0.00	0.21
8/20/22 100.00				
9/20/22 100.00				
10/20/22 100.00				

Model  L L=Lognormal

3m 0.340  
 6m 0.679  
 1y 1.011  
 2y 1.500  
 3y 1.725  
 4y 1.837  
 5y 1.854  
 7y 1.936  
 10y 1.937  
 20y 2.303

Tsy Curve

Source: Bloomberg

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# Polling Question

To earn CPE credits, participants must participate in at least three of the polling questions.

**Do you have a limit in your Investment Policy on the percentage of callables you can purchase?**

- A. Yes
- B. No
- C. Not sure



# THANK YOU

We look forward to your participation in the next webinar in this series:

***Interpreting Economic Forecasts as a Public Investment Official***



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40  
YEARS



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