Treasury Presentation to TBAC
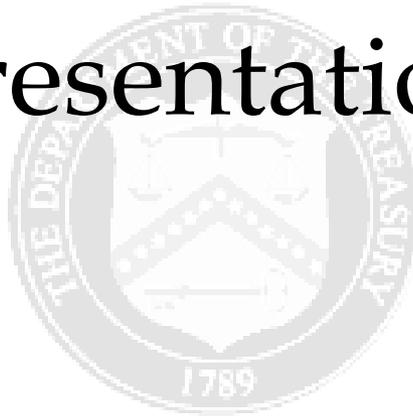
Office of Debt Management

Fiscal Year 2017 Q1 Report

Table of Contents

Section I: Executive Summary

Highlights of Treasury's February 2017 Quarterly Refunding Presentation to the Treasury Borrowing Advisory Committee (TBAC)

Receipts and Outlays
- Fiscal year-to-date receipts are $25 billion lower than the same period of the previous year, due mainly to a decrease in Federal Reserve Earnings. (In December 2015, FAST Act Legislation resulted in a one-time transfer of $19 billion from the Federal Reserve System to the Treasury.)
- In Q1 FY 2017, outlays were lower in most categories than in the same period of the previous year. After adjusting for calendar differences, however, year-over-year budget outlays were 3 percent higher.
- The main driver behind the growth in outlays were an increase in interest expense (+$15 billion) and HHS expenditures (+$14 billion).

Sources of Financing in Fiscal Year 2017
- Based on the Quarterly Borrowing Estimate, Treasury's Office of Fiscal Projections currently projects a net marketable borrowing need of $57 billion for Q2 FY 2017, with an end of March cash balance of $100 billion. For Q3 FY 2017, net marketable borrowing need is projected to be $1 billion, with an end of June cash balance of $200 billion.

Projected Net Marketable Borrowing
- Between FY 2017 and 2019 Treasury's net marketable borrowing could rise notably if the Federal Reserve allows the Treasury securities held in the SOMA portfolio to mature without reinvesting.
- As of the December 2016 Survey of Primary Dealers, the median expectation was for SOMA reinvestments to continue until June 2018.

Bid-to-Cover Ratios (BTC)
- Since October, BTC ratios for 10-year coupon securities have fallen slightly.
- BTC ratios for all other securities were stable over the October to December period.

Investor Class Allotments
- Since mid-2016, bill auction awards have been trending higher for investment funds and largely stable for other dealers and brokers and international institutions. Accordingly, bill auction awards fell for primary dealers.
- Over the same period, coupon auction awards were higher for primary dealers, lower for international institutions and largely stable for other investors.

Section II: Fiscal
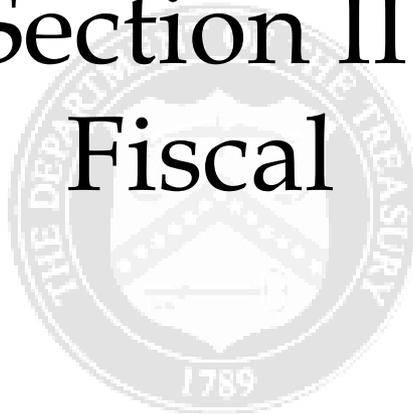
Quarterly Tax Receipts

Source: United States Department of the Treasury

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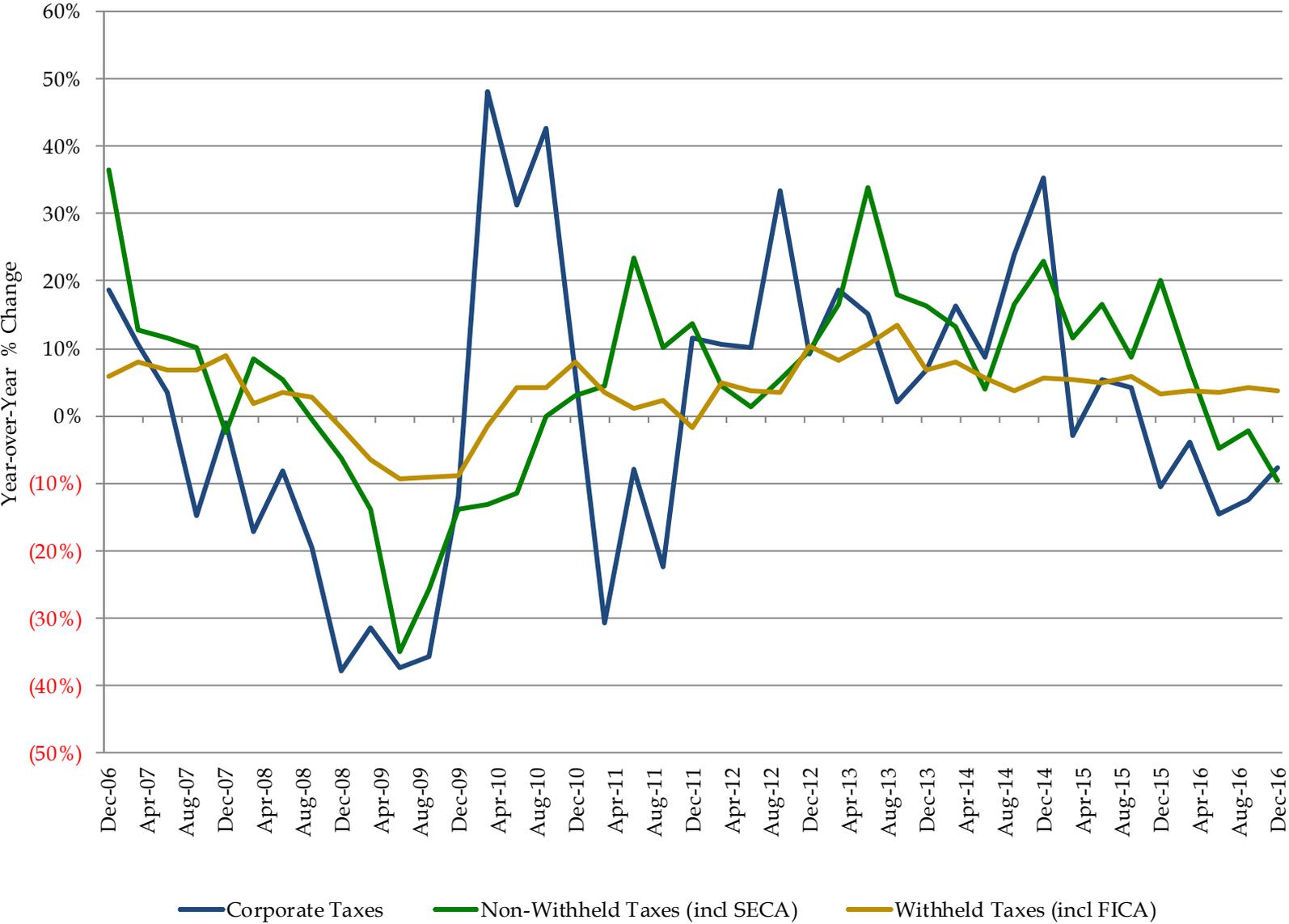
Monthly Receipt Levels
(12-Month Moving Average)
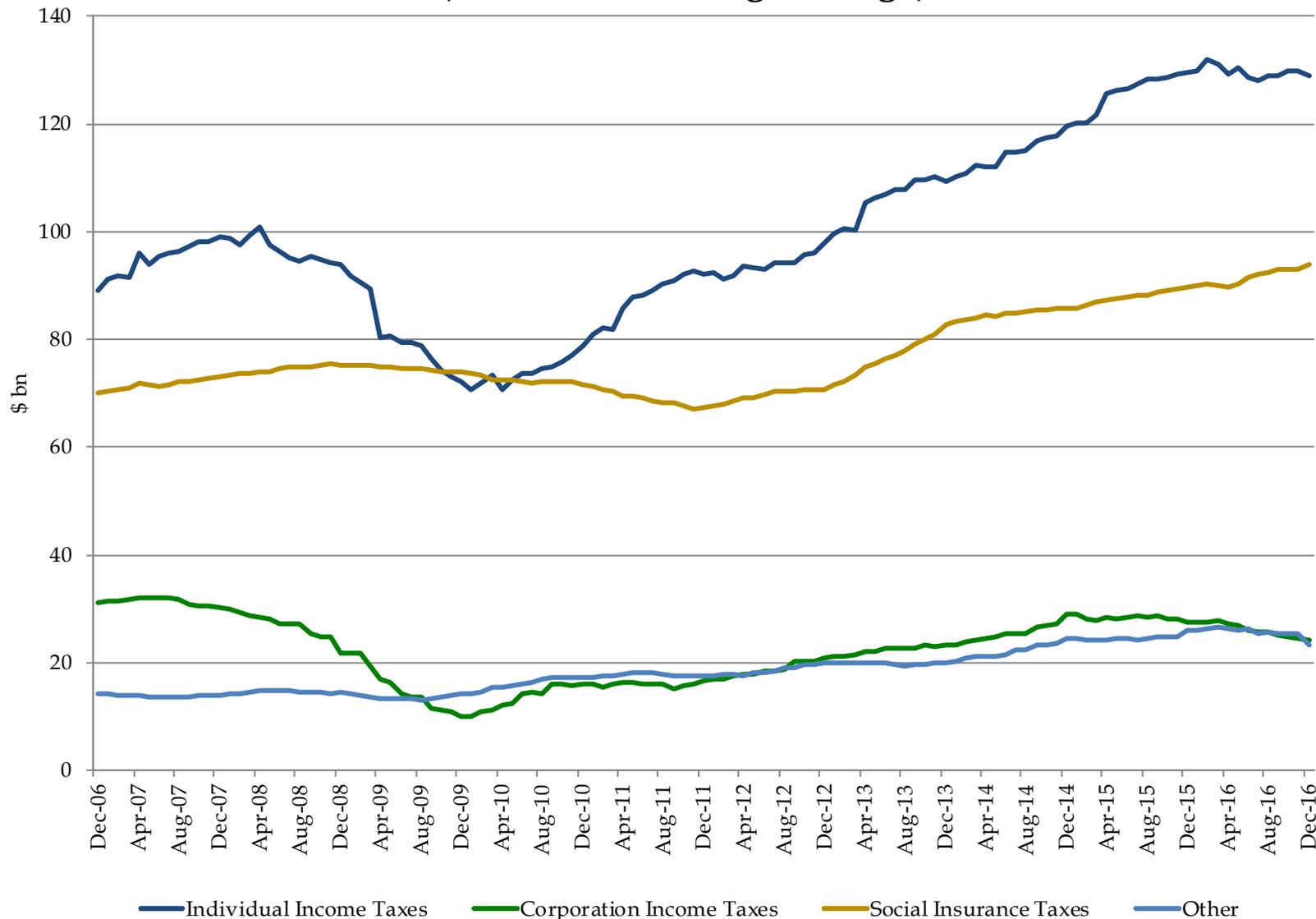
Individual Income Taxes include withheld and non-withheld. Social Insurance Taxes include FICA, SECA, RRTA, UTF deposits, FUTA and RUIA. Other includes excise taxes, estate and gift taxes, customs duties and miscellaneous receipts.
Source: United States Department of the Treasury

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Eleven Largest Outlays
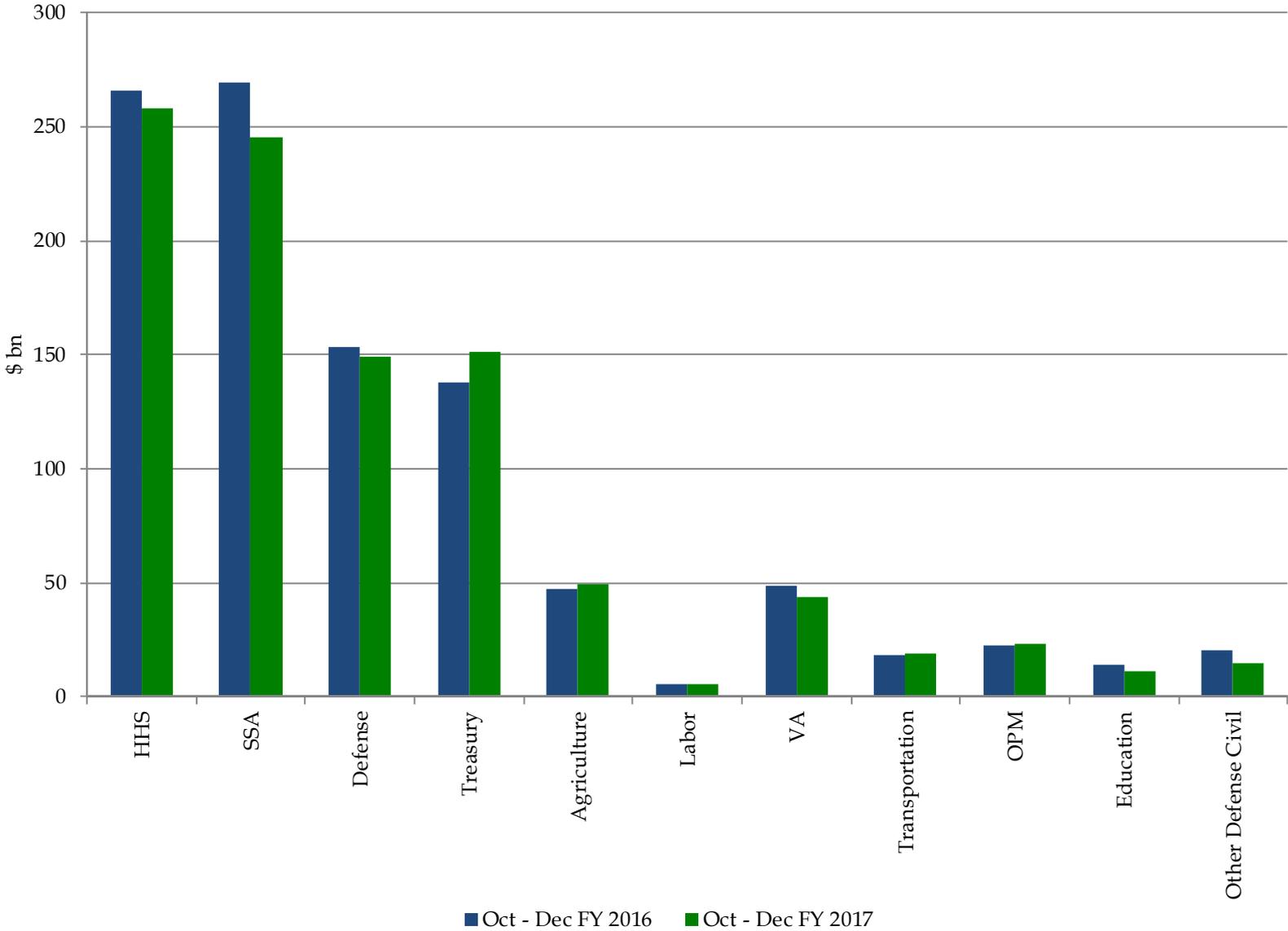
Source: United States Department of the Treasury

Treasury Net Nonmarketable Borrowing

Source: United States Department of the Treasury
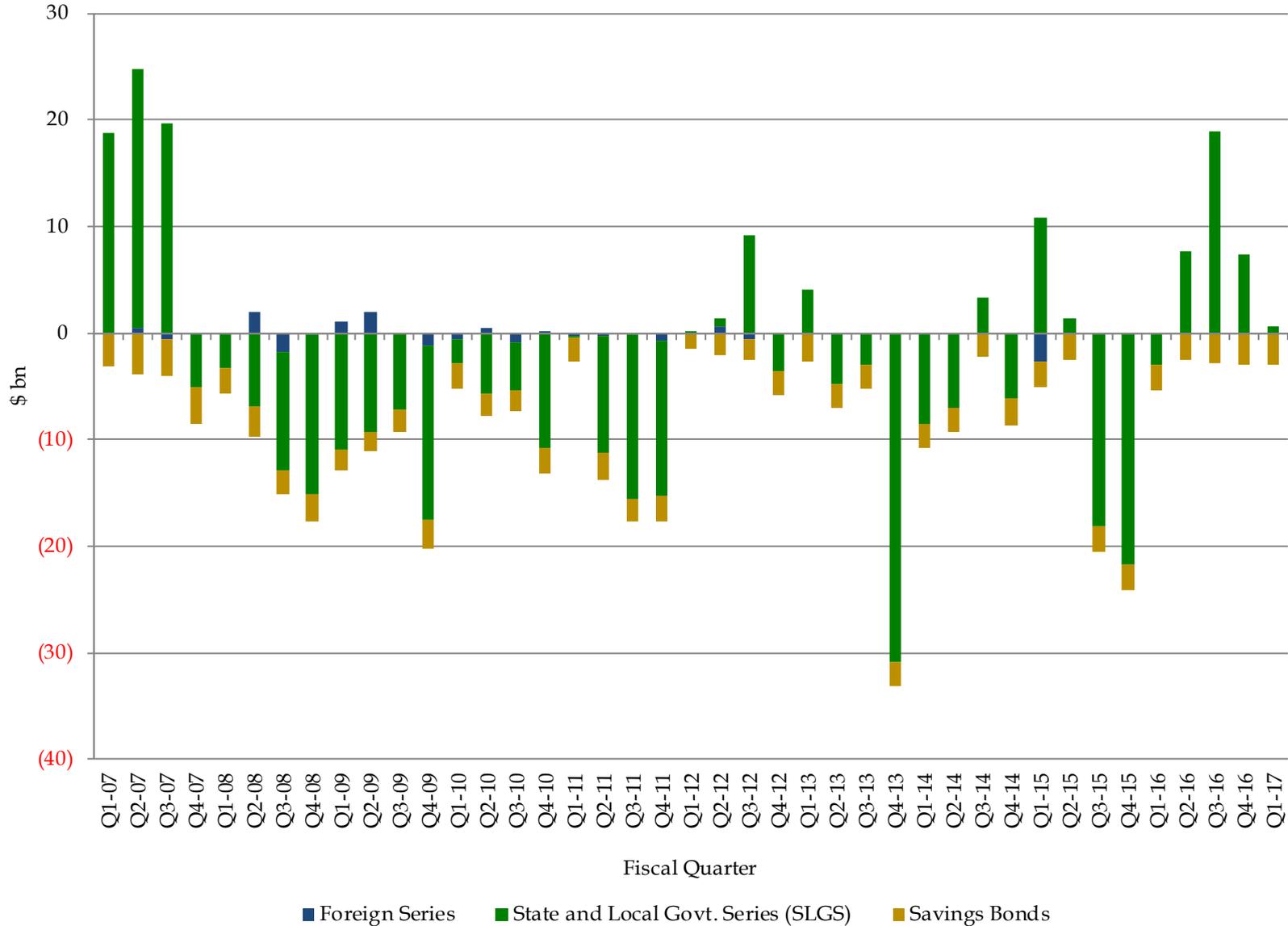
Cumulative Budget Deficits by Fiscal Year

■ FY2015 ■ FY2016 ■ FY2017

Source: United States Department of the Treasury
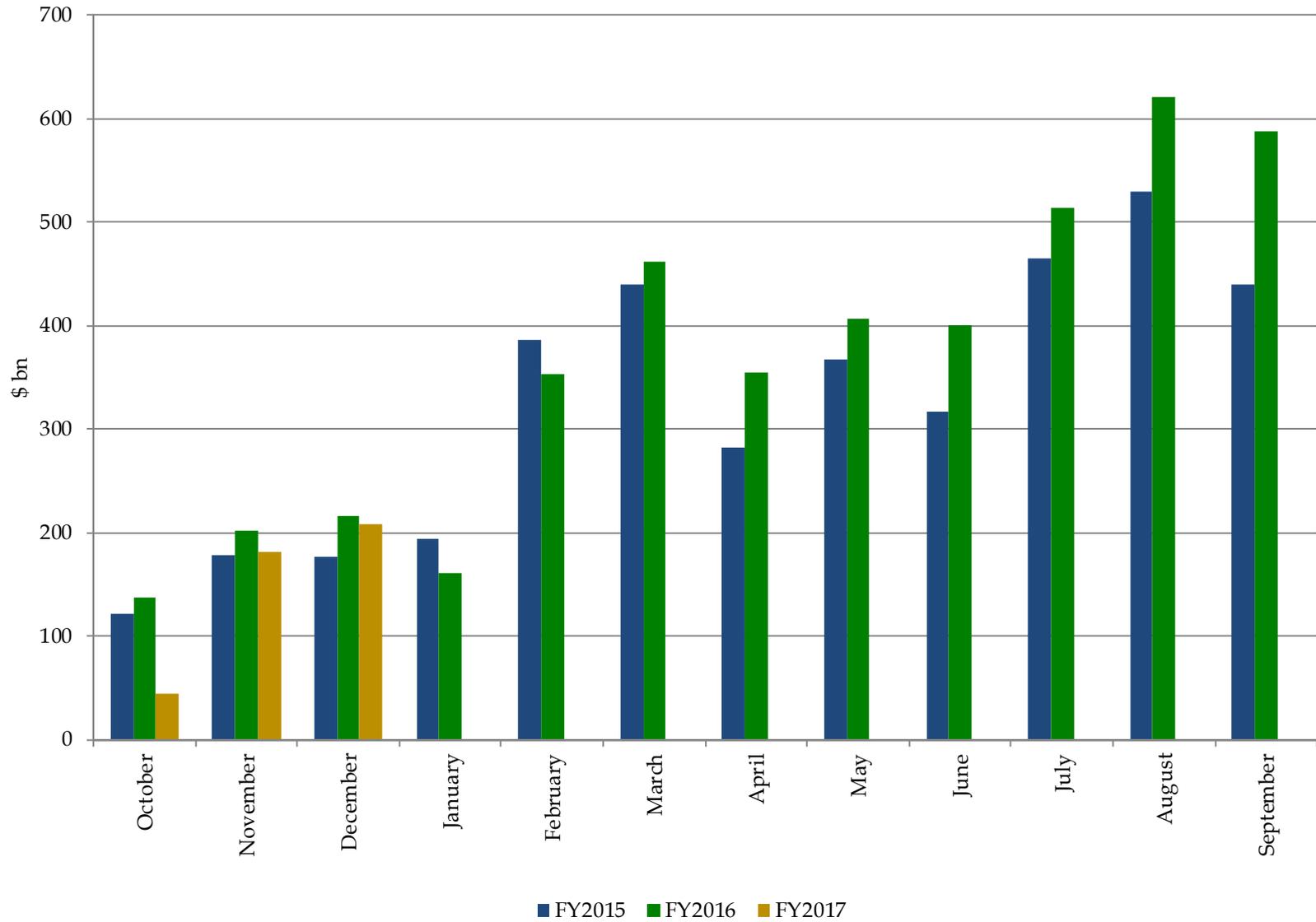
FY 2017-2019 Deficits and Net Marketable Borrowing Estimates   In $ billions

	Primary Dealers[1]	CBO[2]	CBO[3]	OMB MSR[4]	OMB[5]
FY 2017 Deficit Estimate	661	559	433	441	504
FY 2018 Deficit Estimate	771	487	383	330	454
FY 2019 Deficit Estimate	863	601	518	427	550
FY 2017 Deficit Range	525-1010				
FY 2018 Deficit Range	587-1035				
FY 2019 Deficit Range	690-1200				
FY 2017 Net Marketable Borrowing Estimate	699	670	508	573	635
FY 2018 Net Marketable Borrowing Estimate	837	578	452	436	561
FY 2019 Net Marketable Borrowing Estimate	927	676	578	534	659
FY 2017 Net Marketable Borrowing Range	535-1160				
FY 2018 Net Marketable Borrowing Range	540-1185				
FY 2019 Net Marketable Borrowing Range	700-1250				
Estimates as of:	Jan-17	Jan-17	Mar-16	Jul-16	Feb-16

[1]Based on primary dealer feedback on January 23, 2017. Estimates above are averages.

[2]Summary Table 1 of CBO's "The Budget and Economic Outlook: 2017 to 2027"

[3]Table 1 and 2 of CBO's "An Analysis of the President's 2017 Budget"

[4]Table S-11 of OMB's "The FY2017 Mid-Session Review"

[5]Table S-13 of OMB's "Budget of the United States Government, Fiscal Year 2017"

Budget Surplus/Deficit

OMB's Projection · Surplus/Deficit (LHS) · Surplus/Deficit (RHS)
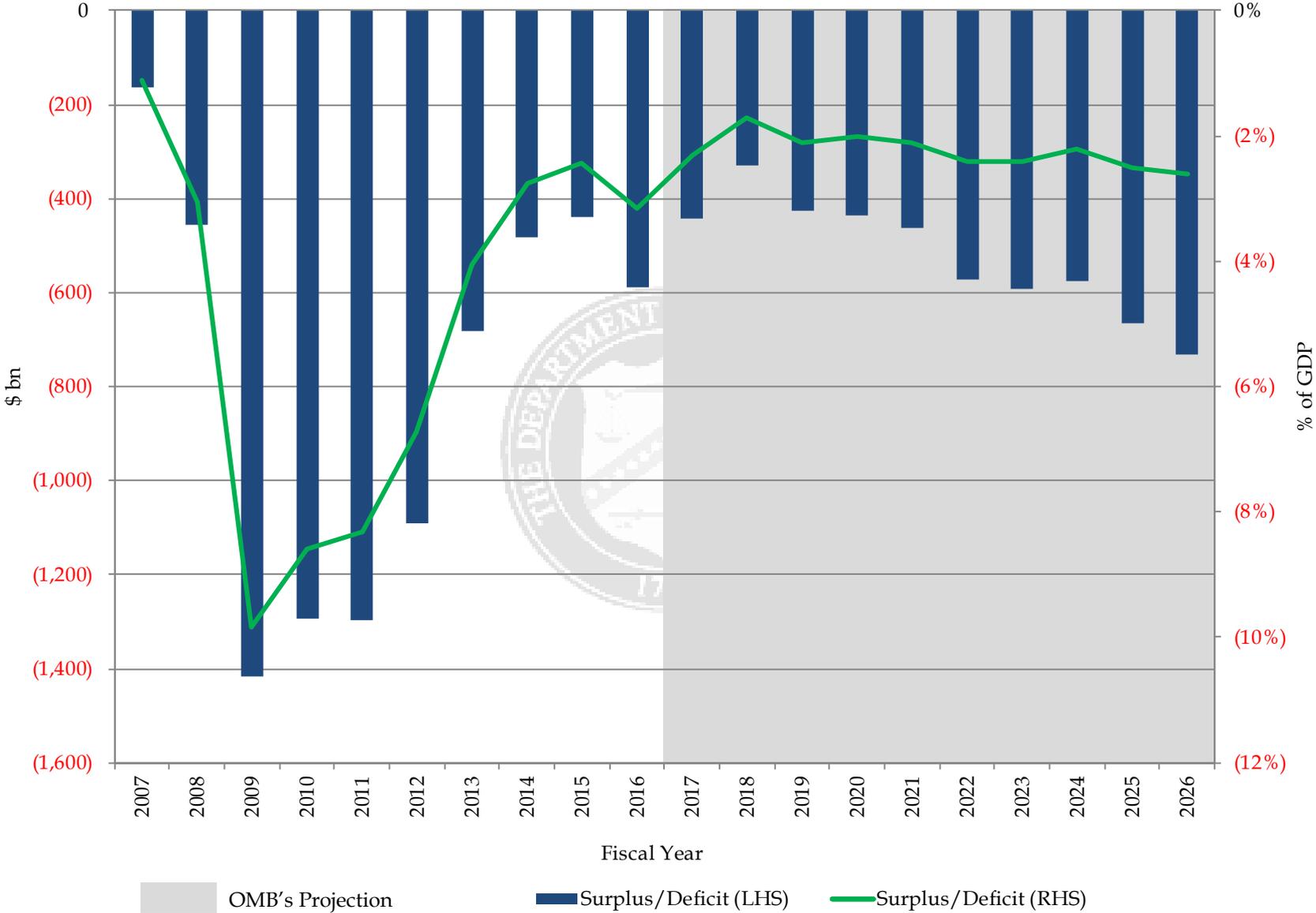
Projections are from Table S-11 of "The FY2017 Mid-Session Review."

Section III: Financing

Assumptions for Financing Section (pages 15 to 22)

- Portfolio and SOMA holdings as of 12/31/2016.
- SOMA reinvestments until June 2018, followed by SOMA redemptions until and including February 2022. These assumptions are based on Chair Yellen's December 2015 press conference and the median expectations from the December 2016 FRB-NY Survey of Primary Dealers.
- Assumes announced issuance sizes and patterns constant for Nominal Coupons, TIPS, and FRNs as of 12/31/2016, while using an average of ~$1.8 trillion of Bills outstanding.
- The principal on the TIPS securities was accreted to each projection date based on market ZCIS levels as of 12/31/2016.
- No attempt was made to match future financing needs.

Sources of Financing in Fiscal Year 2017 Q1

October - December 2016	
Net Bill Issuance	171
Net Coupon Issuance	84
Subtotal: Net Marketable Borrowing	255
Ending Cash Balance	399
Beginning Cash Balance	353
Subtotal: Change in Cash Balance	46
Net Implied Funding for FY 2017 Q1*	209

Security	October - December 2016 Bill Issuance			Fiscal Year-to-Date Bill Issuance		
	Gross	Maturing	Net	Gross	Maturing	Net
4-Week	655	610	45	655	610	45
13-Week	505	502	3	505	502	3
26-Week	427	328	99	427	328	99
52-Week	60	36	24	60	36	24
CMBs	0	0	0	0	0	0
Bill Subtotal	1,647	1,476	171	1,647	1,476	171

Security	October - December 2016 Coupon Issuance			Fiscal Year-to-Date Coupon Issuance		
	Gross	Maturing	Net	Gross	Maturing	Net
2-Year FRN	42	41	1	42	41	1
2-Year	56	57	(1)	56	57	(1)
3-Year	77	90	(13)	77	90	(13)
5-Year	74	73	1	74	73	1
7-Year	61	65	(4)	61	65	(4)
10-Year	68	23	45	68	23	45
30-Year	42	19	23	42	19	23
5-Year TIPS	14	0	14	14	0	14
10-Year TIPS	12	0	12	12	0	12
30-Year TIPS	5	0	5	5	0	5
Coupon Subtotal	452	368	84	452	368	84

	Gross	Maturing	Net	Gross	Maturing	Net
Total	2,099	1,844	255	2,099	1,844	255

*An end-of-December 2016 cash balance of $399 billion versus a beginning-of-October 2016 cash balance of $353 billion. By keeping the cash balance constant, Treasury arrives at the net implied funding number.
Gross issuance values include SOMA add-ons.

Sources of Financing in Fiscal Year 2017 Q2

January - March 2017	
Assuming Constant Coupon Issuance Sizes*	
Treasury Announced Net Marketable Borrowing**	57
Net Coupon Issuance	101
Implied Change in Bills	(44)

	January - March 2017 Coupon Issuance			Fiscal Year-to-Date Coupon Issuance		
Security	Gross	Maturing	Net	Gross	Maturing	Net
2-Year FRN	44	41	3	85	82	3
2-Year	116	105	11	172	162	10
3-Year	76	90	(14)	153	180	(27)
5-Year	152	143	8	225	216	9
7-Year	125	131	(7)	185	196	(11)
10-Year	67	22	45	135	45	89
30-Year	41	0	41	84	19	65
5-Year TIPS	0	0	0	14	0	14
10-Year TIPS	26	21	5	38	21	18
30-Year TIPS	8	0	8	13	0	13
Coupon Subtotal	654	553	101	1,106	921	185

*Keeping announced issuance sizes and patterns constant for Nominal Coupons, TIPS, and FRNs as of 12/31/2016.
**Assumes an end-of-March 2017 cash balance of $100 billion versus a beginning-of-January 2017 cash balance of $399 billion.
Financing Estimates released by the Treasury can be found here: http://www.treasury.gov/resource-center/data-chart-center/quarterly-refunding/Pages/Latest.aspx

OMB's Projection of Borrowing from the Public
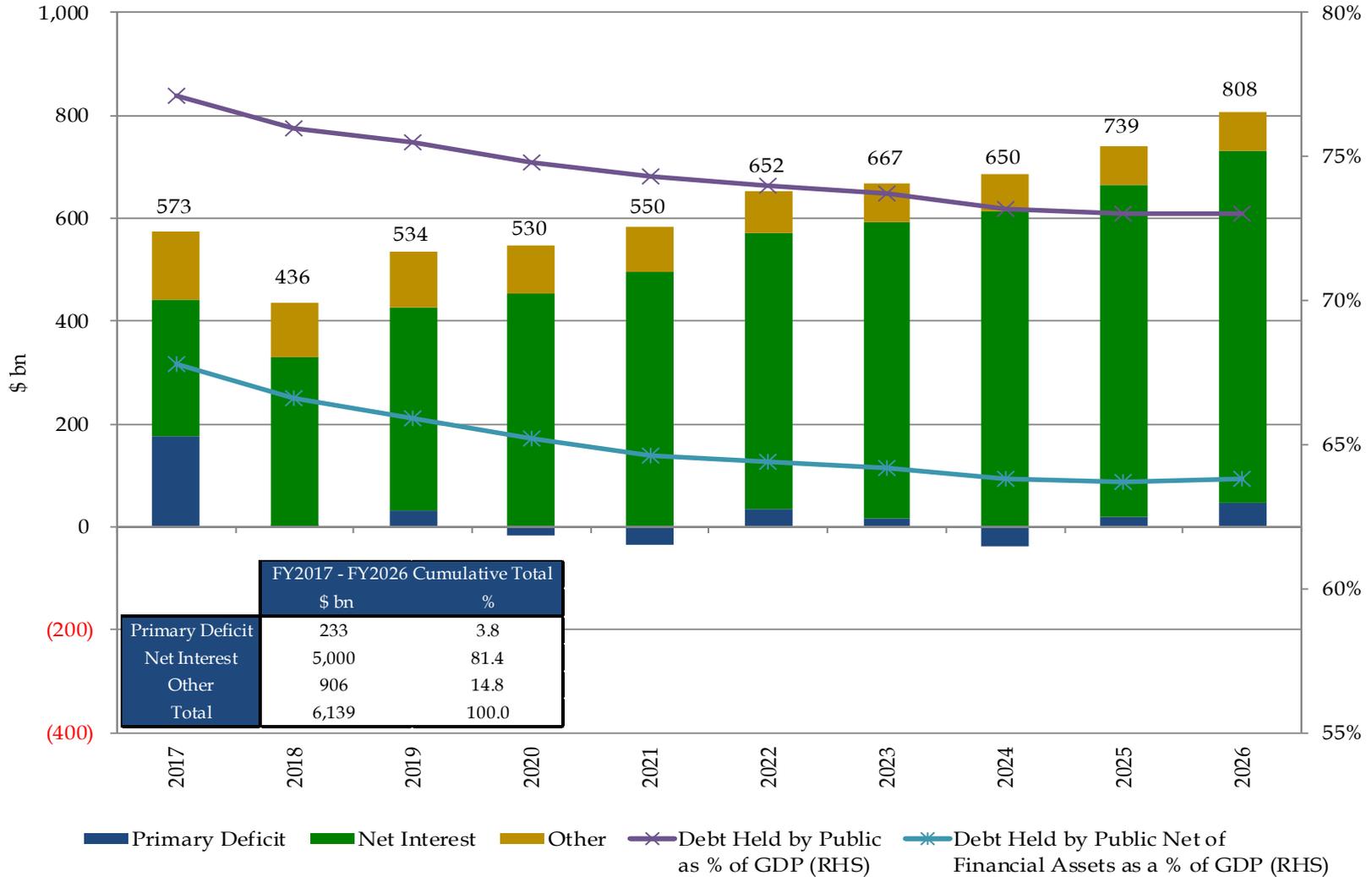
FY2017 - FY2026 Cumulative Total		
	$ bn	%
Primary Deficit	233	3.8
Net Interest	5,000	81.4
Other	906	14.8
Total	6,139	100.0

Legend: Primary Deficit | Net Interest | Other | Debt Held by Public as % of GDP (RHS) | Debt Held by Public Net of Financial Assets as a % of GDP (RHS)

Data labels (top of bars): 573, 436, 534, 530, 550, 652, 667, 650, 739, 808

OMB's projections of net borrowing from the public are from Table S-11 of "The FY2017 Mid-Session Review." Data labels at the top represent the change in debt held by the public in $ billions. "Other" represents borrowing from the public to provide direct and guaranteed loans.

Interest Rate Assumptions: 10-Year Treasury Note
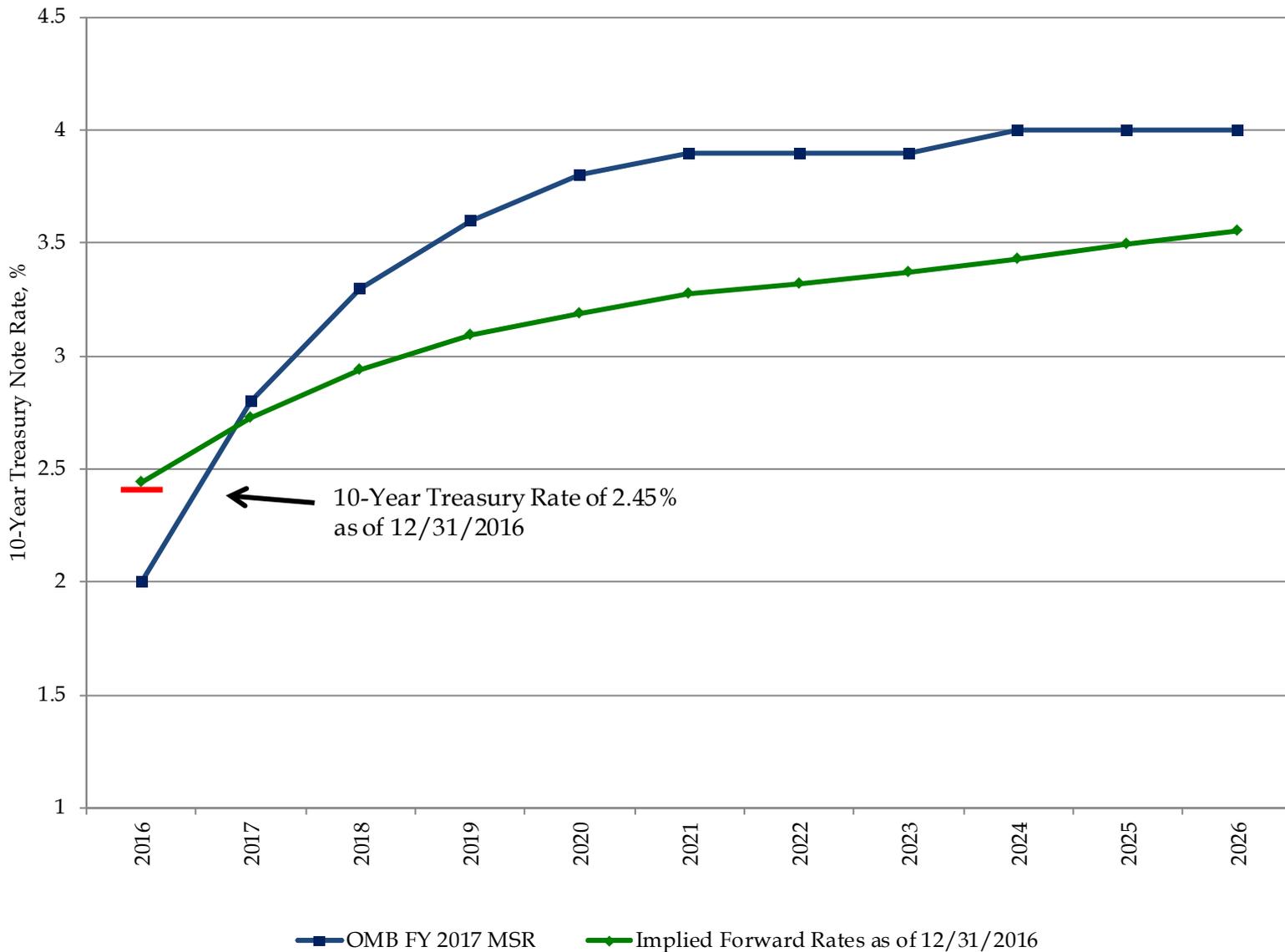
OMB's economic assumption of the 10-Year Treasury Note rates are from Table S-11 of "The FY2017 Mid-Session Review." The forward rates are the implied 10-Year Treasury Note rates on December 31 of that year.

Impact of SOMA Actions on Projected Net Borrowing Assuming Future Issuance Remains Constant

Without Fed Reinvestments ($ bn)*
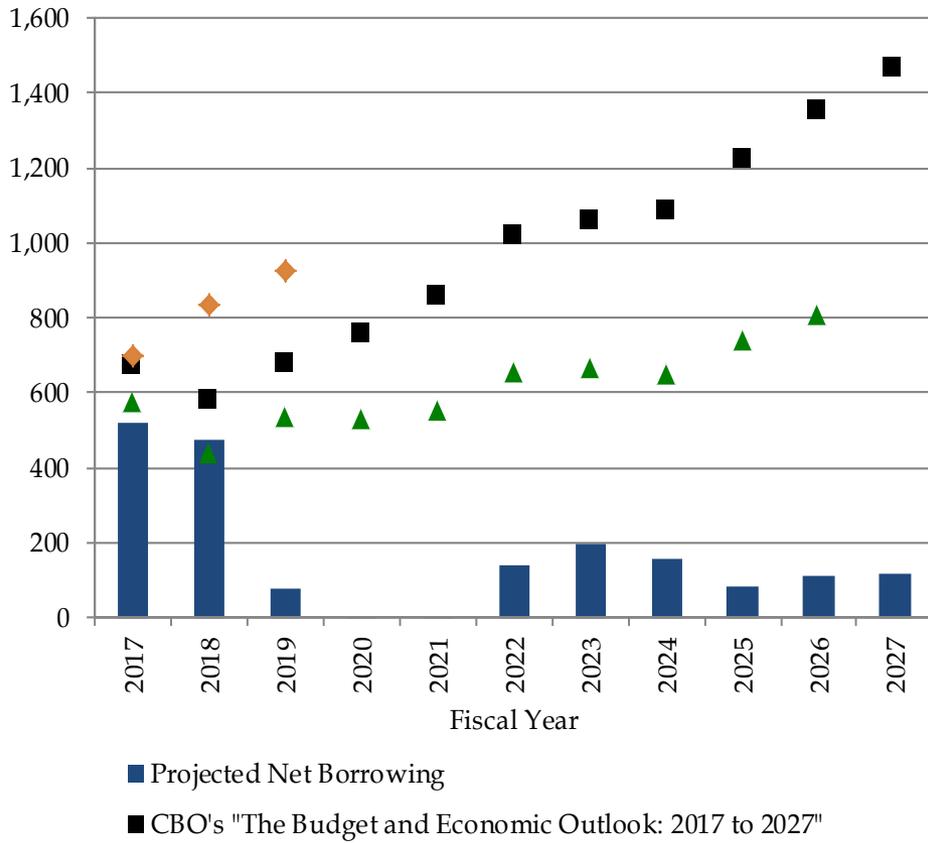
With Fed Reinvestments ($ bn)
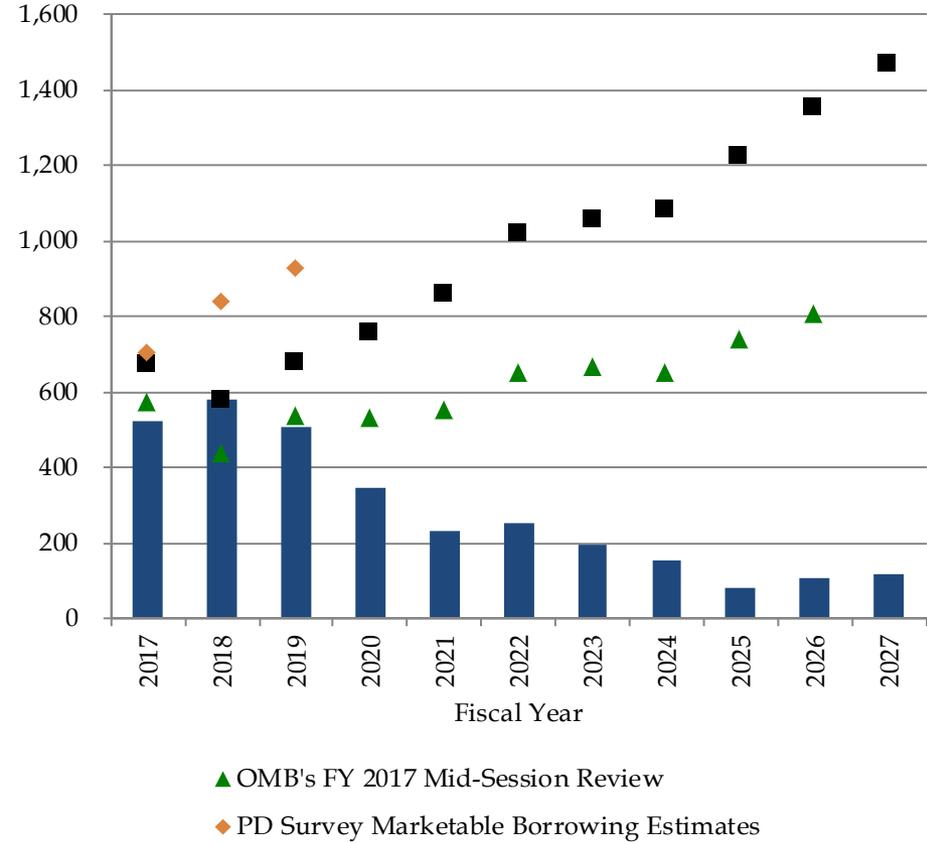
Legend (left chart):
- ■ Projected Net Borrowing
- ■ CBO's "The Budget and Economic Outlook: 2017 to 2027"

Legend (right chart):
- ▲ OMB's FY 2017 Mid-Session Review
- ♦ PD Survey Marketable Borrowing Estimates

Treasury's primary dealer survey estimates can be found on page 11. OMB's projections of net borrowing from the public are from Table S-11 of "The FY2017 Mid-Session Review." CBO's estimates of the borrowing from the public are Summary Table 1 of "The Budget and Economic Outlook: 2017 to 2027." See table at the end of this section for details.
*Does not reflect SOMA reinvestments after June 2018 and before February 2022.

Additional Funding Gap Assuming No SOMA Roll after June 2018
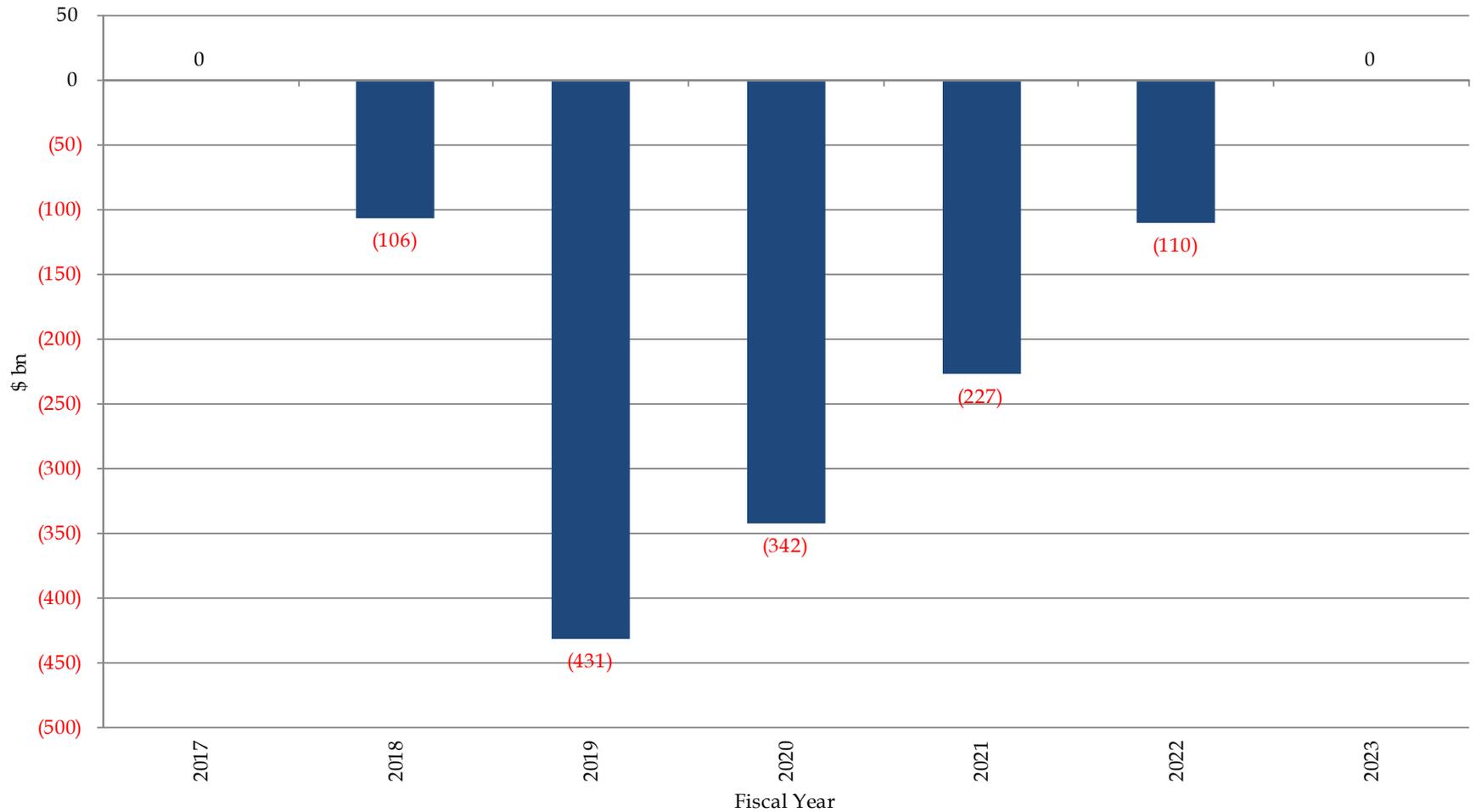
Assumes normalization will be complete by FY 2023, which implies no additional funding gap.

Historical Net Marketable Borrowing and Projected Net Borrowing Assuming Future Issuance Remains Constant, $ billions

Fiscal Year	Bills	2/3/5	7/10/30	TIPS	FRN	Historical/Projected Net Borrowing Capacity	OMB's FY 2017 Mid-Session Review	CBO's "The Budget and Economic Outlook: 2017 to 2027"	Primary Dealer Survey
2012	139	148	738	90	0	1,115			
2013	(86)	86	720	111	0	830			
2014	(119)	(92)	669	88	123	669			
2015	(53)	(282)	641	88	164	558			
2016	289	(82)	477	64	47	795			
2017	156	9	292	55	9	520	573	670	699
2018	0	121	293	56	3	473	436	578	837
2019	0	(24)	67	42	(9)	76	534	676	927
2020	0	(86)	83	15	(9)	3	530	753	
2021	0	(76)	99	(20)	0	2	550	859	
2022	0	12	142	(13)	2	142	652	1,017	
2023	0	44	157	(13)	7	195	667	1,055	
2024	0	30	136	(13)	1	154	650	1,082	
2025	0	12	123	(53)	(1)	82	739	1,220	
2026	0	(18)	174	(45)	(2)	109	808	1,352	

Net Borrowing capacity does not reflect SOMA reinvestments after June 2018 and before February 2022.
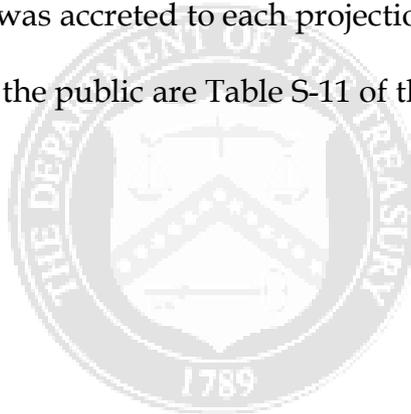Treasury's primary dealer survey estimates can be found on page 11. OMB's projections of net borrowing from the public are from Table S-11 of "The FY2017 Mid-Session Review." CBO's estimates of the borrowing from the public are from Table 1 and 2 of "The Budget and Economic Outlook: 2017 to 2027."

Section IV:
Portfolio Metrics

Assumptions for Portfolio Metrics Section (pages 25 to 30) and Appendix

- Portfolio and SOMA holdings as of 12/31/2016.
- SOMA reinvestments until June 2018, followed by SOMA redemptions until and including February 2022. These assumptions are based on Chair Yellen's December 2015 press conference and the median expectations from the December 2016 FRB-NY Survey of Primary Dealers.
- Assumes announced issuance sizes and patterns constant for Nominal Coupons, TIPS, and FRNs as of 12/31/2016, while using an average of ~$1.8 trillion of Bills outstanding.
- To match OMB's projected borrowing from the public for the next 10 years, Nominal Coupon securities (2-, 3-, 5-, 7-, 10-, and 30-year) were adjusted by the same percentage.
- The principal on the TIPS securities was accreted to each projection date based on market ZCIS levels as of 12/31/2016.
- OMB's estimates of borrowing from the public are Table S-11 of the "Fiscal Year 2017 Mid-Session Review."

Weighted Average Maturity of Marketable Debt Outstanding
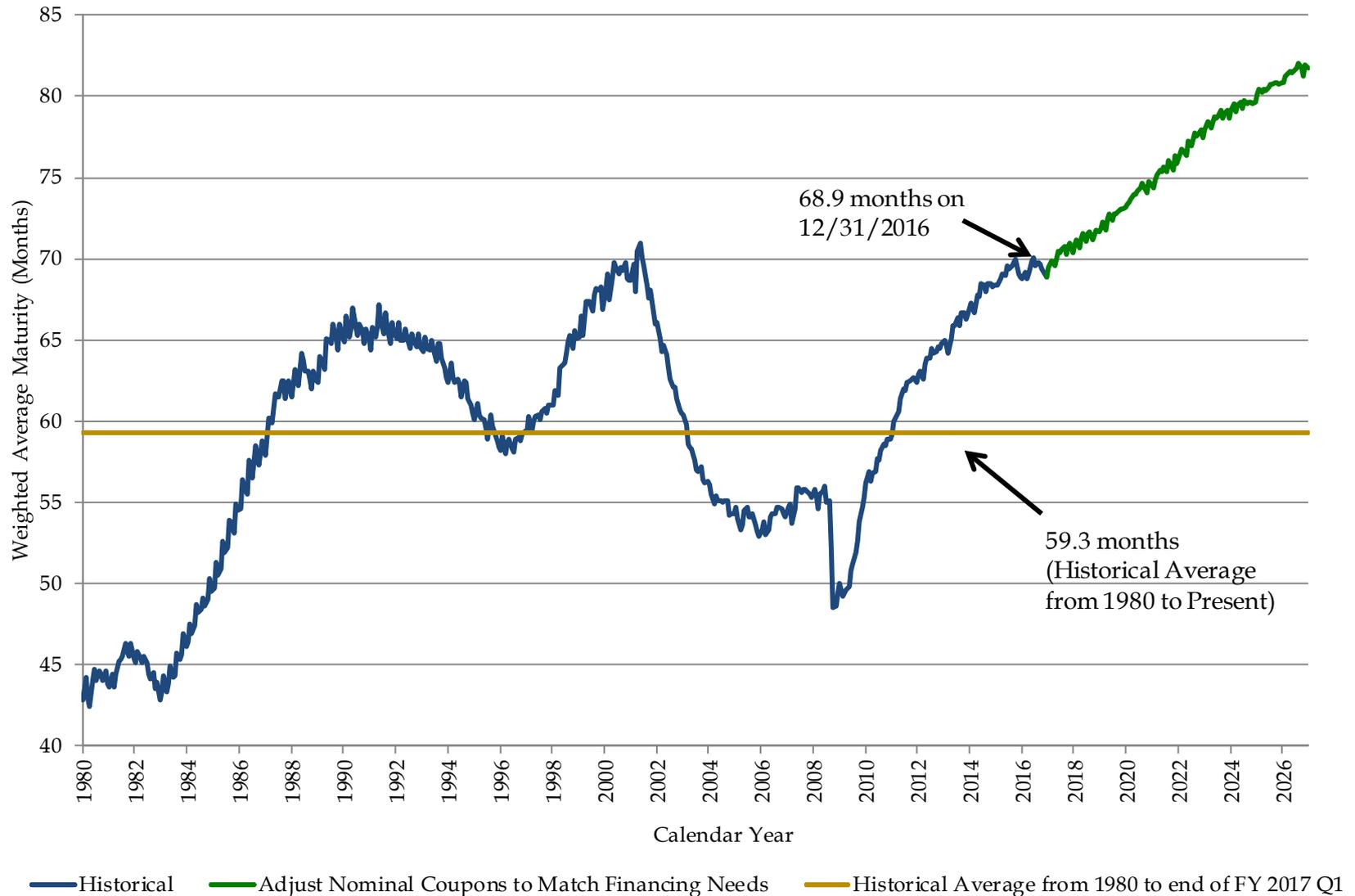
68.9 months on 12/31/2016

59.3 months (Historical Average from 1980 to Present)

Y-axis: Weighted Average Maturity (Months)

X-axis: Calendar Year

Legend: Historical — Adjust Nominal Coupons to Match Financing Needs — Historical Average from 1980 to end of FY 2017 Q1

This scenario does not represent any particular course of action that Treasury is expected to follow. Instead, it is intended to demonstrate the basic trajectory of average maturity absent changes to the mix of securities issued by Treasury.

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Projected Maturity Profile from end of Fiscal Year

Legend: ■ <= 1yr ■ (1,2] ■ (2,3] ■ (3,5] ■ (5,7] ■ (7,10] ■ > 10
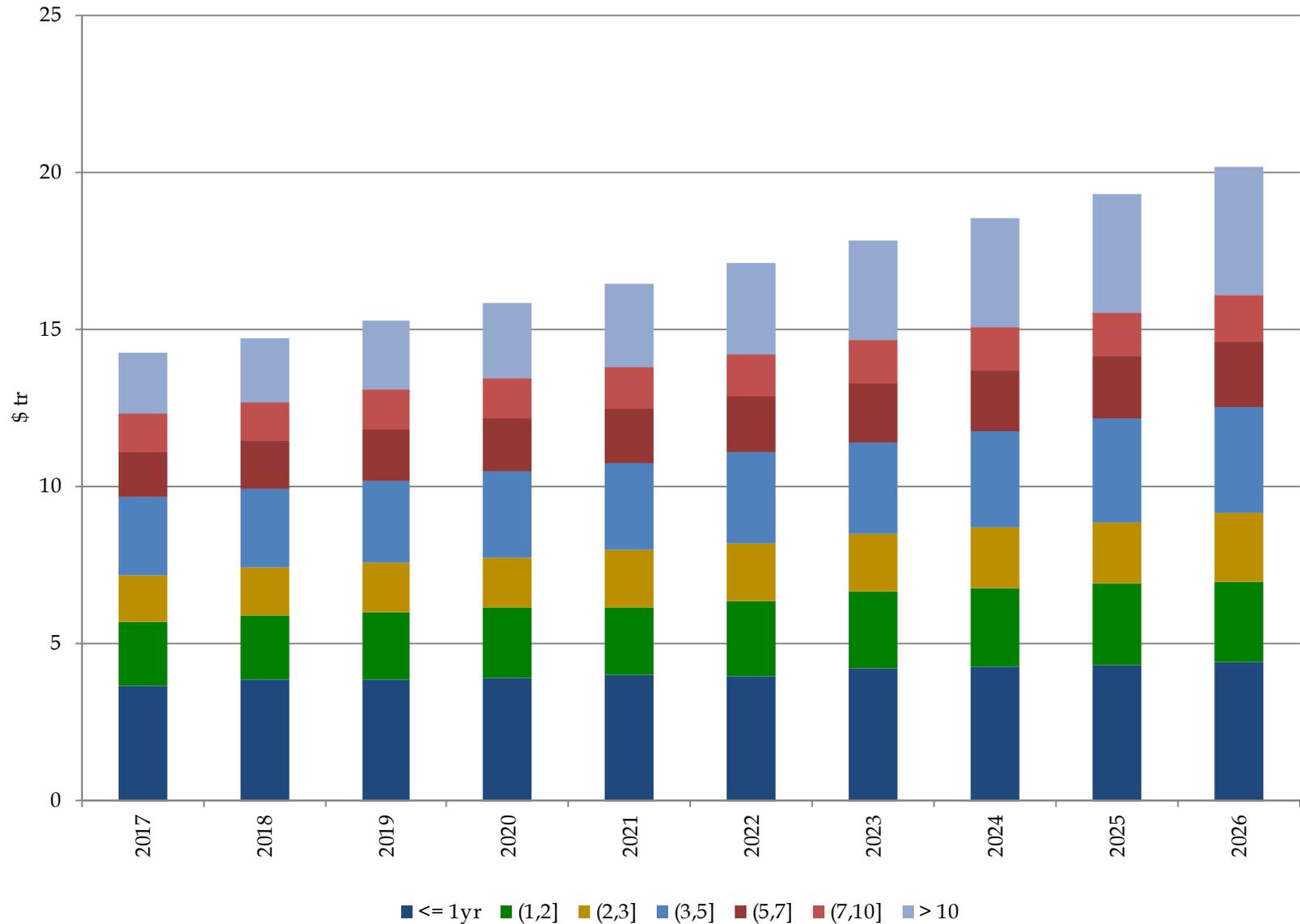
This scenario does not represent any particular course of action that Treasury is expected to follow. Instead, it is intended to demonstrate the basic trajectory of average maturity absent changes to the mix of securities issued by Treasury. See table on following page for details.

Recent and Projected Maturity Profile, $ billions

| End of Fiscal Year	<= 1yr	(1,2]	(2,3]	(3,5]	(5,7]	(7,10]	> 10	Total	(0,5]
2009	2,702	774	663	962	559	643	695	6,998	5,101
2010	2,563	1,141	895	1,273	907	856	853	8,488	5,872
2011	2,620	1,334	980	1,541	1,070	1,053	1,017	9,616	6,476
2012	2,951	1,373	1,104	1,811	1,214	1,108	1,181	10,742	7,239
2013	2,939	1,523	1,242	1,965	1,454	1,136	1,331	11,590	7,669
2014	2,935	1,739	1,319	2,207	1,440	1,113	1,528	12,281	8,199
2015	3,097	1,775	1,335	2,382	1,478	1,121	1,654	12,841	8,589
2016	3,423	1,828	1,538	2,406	1,501	1,151	1,800	13,648	9,195
2017	3,632	2,036	1,512	2,459	1,475	1,187	1,950	14,251	9,639
2018	3,870	2,016	1,555	2,479	1,533	1,200	2,065	14,718	9,920
2019	3,854	2,112	1,630	2,577	1,628	1,276	2,205	15,283	10,174
2020	3,919	2,202	1,607	2,737	1,674	1,287	2,419	15,845	10,464
2021	4,008	2,159	1,789	2,793	1,701	1,335	2,643	16,428	10,750
2022	3,966	2,398	1,829	2,884	1,800	1,333	2,906	17,116	11,076
2023	4,204	2,425	1,868	2,913	1,876	1,349	3,185	17,822	11,411
2024	4,271	2,503	1,912	3,046	1,954	1,372	3,453	18,510	11,732
2025	4,310	2,596	1,931	3,331	1,969	1,403	3,751	19,291	12,168
2026	4,403	2,578	2,171	3,387	2,073	1,484	4,044	20,141	12,540

This scenario does not represent any particular course of action that Treasury is expected to follow. Instead, it is intended to demonstrate the basic trajectory of average maturity absent changes to the mix of securities issued by Treasury. Portfolio composition by original issuance type and term can be found in the appendix (Page 44).

Projected Maturity Profile from end of Fiscal Year
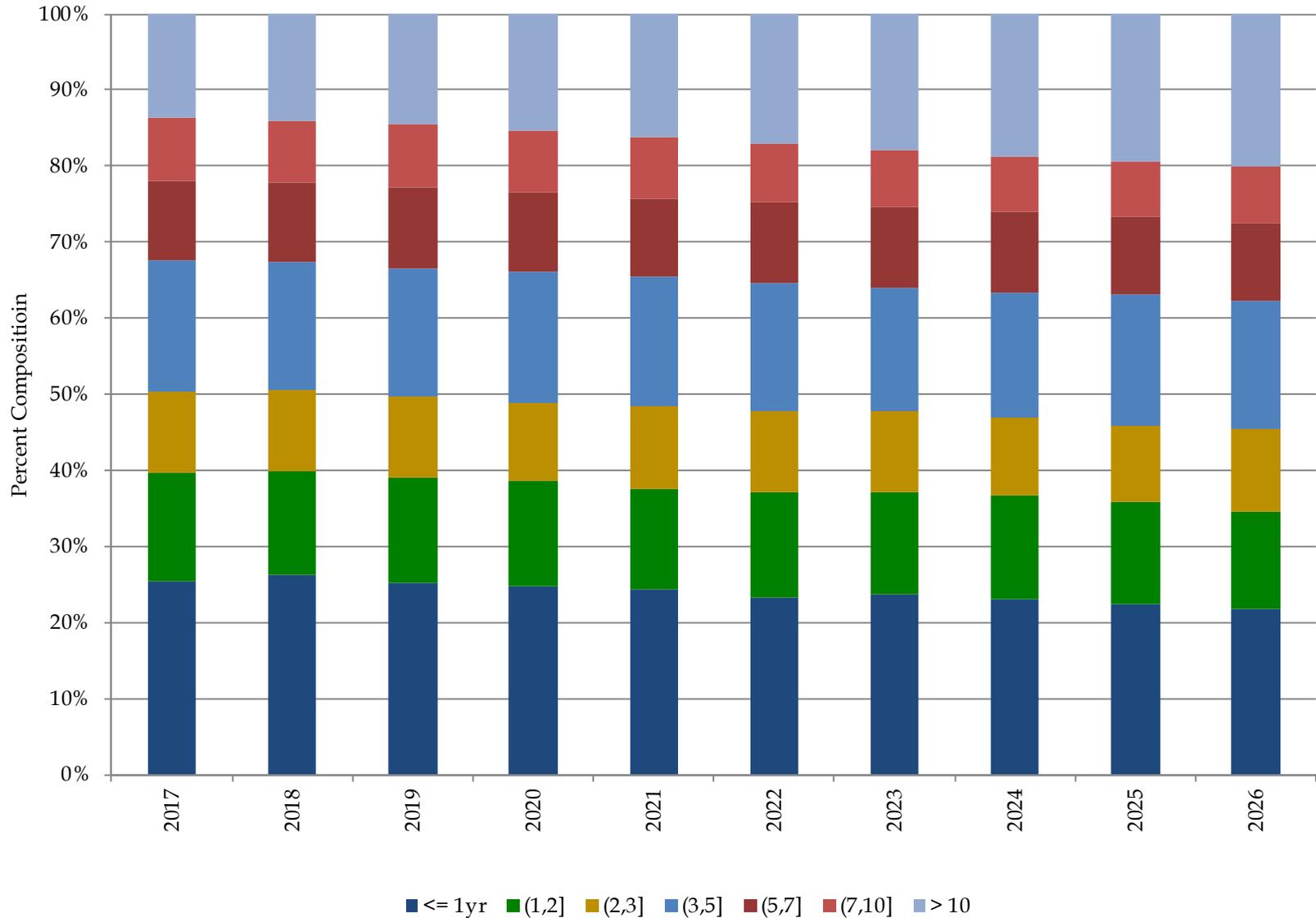
Legend: ■ <= 1yr ■ (1,2] ■ (2,3] ■ (3,5] ■ (5,7] ■ (7,10] ■ > 10

This scenario does not represent any particular course of action that Treasury is expected to follow. Instead, it is intended to demonstrate the basic trajectory of average maturity absent changes to the mix of securities issued by Treasury. See table on following page for details.

Recent and Projected Maturity Profile, percent

| End of Fiscal Year	<= 1yr	(1,2]	(2,3]	(3,5]	(5,7]	(7,10]	> 10	(0,3]	(0,5]
2009	38.6	11.1	9.5	13.7	8.0	9.2	9.9	59.1	72.9
2010	30.2	13.4	10.5	15.0	10.7	10.1	10.0	54.2	69.2
2011	27.2	13.9	10.2	16.0	11.1	10.9	10.6	51.3	67.3
2012	27.5	12.8	10.3	16.9	11.3	10.3	11.0	50.5	67.4
2013	25.4	13.1	10.7	17.0	12.5	9.8	11.5	49.2	66.2
2014	23.9	14.2	10.7	18.0	11.7	9.1	12.4	48.8	66.8
2015	24.1	13.8	10.4	18.5	11.5	8.7	12.9	48.3	66.9
2016	25.1	13.4	11.3	17.6	11.0	8.4	13.2	49.7	67.4
2017	25.5	14.3	10.6	17.3	10.4	8.3	13.7	50.4	67.6
2018	26.3	13.7	10.6	16.8	10.4	8.2	14.0	50.6	67.4
2019	25.2	13.8	10.7	16.9	10.7	8.3	14.4	49.7	66.6
2020	24.7	13.9	10.1	17.3	10.6	8.1	15.3	48.8	66.0
2021	24.4	13.1	10.9	17.0	10.4	8.1	16.1	48.4	65.4
2022	23.2	14.0	10.7	16.8	10.5	7.8	17.0	47.9	64.7
2023	23.6	13.6	10.5	16.3	10.5	7.6	17.9	47.7	64.0
2024	23.1	13.5	10.3	16.5	10.6	7.4	18.7	46.9	63.4
2025	22.3	13.5	10.0	17.3	10.2	7.3	19.4	45.8	63.1
2026	21.9	12.8	10.8	16.8	10.3	7.4	20.1	45.4	62.3

This scenario does not represent any particular course of action that Treasury is expected to follow. Instead, it is intended to demonstrate the basic trajectory of average maturity absent changes to the mix of securities issued by Treasury. Portfolio composition by original issuance type and term can be found in the appendix (Page 44).

Section V: Demand
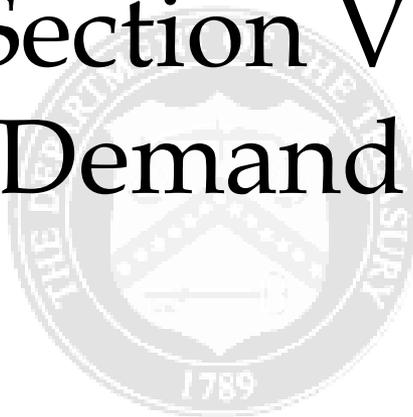
Summary Statistics for Fiscal Year 2017 Q1 Auctions

| Security Type	Term	Stop Out Rate (%)*	Bid-to-Cover Ratio*	Competitive Awards ($bn)	% Primary Dealer*	% Direct*	% Indirect*	Non-Competitive Awards ($bn)	SOMA Add Ons ($bn)	10-Year Equivalent ($bn)**
Bill	4-Week	0.333	3.4	649.0	54.4	5.3	40.3	3.9	0.0	5.6
Bill	13-Week	0.432	3.4	495.3	59.4	6.0	34.6	5.1	0.0	14.0
Bill	26-Week	0.560	3.6	417.2	44.9	2.3	52.8	4.4	0.0	23.7
Bill	52-Week	0.735	3.5	59.5	56.6	2.9	40.5	0.5	0.0	6.6
Coupon	2-Year	1.073	2.6	77.5	55.0	10.9	34.1	0.5	7.8	18.9
Coupon	3-Year	1.177	2.8	71.9	45.3	8.9	45.8	0.1	5.3	25.3
Coupon	5-Year	1.707	2.5	101.9	31.8	4.5	63.6	0.1	10.2	59.8
Coupon	7-Year	2.051	2.6	84.0	20.1	13.8	66.0	0.0	8.4	67.1
Coupon	10-Year	2.096	2.4	63.0	35.6	7.1	57.3	0.0	5.0	68.1
Coupon	30-Year	2.846	2.3	39.0	29.7	9.6	60.7	0.0	3.3	95.3
TIPS	5-Year	0.120	2.7	14.0	18.7	8.0	73.3	0.0	0.0	6.8
TIPS	10-Year	0.369	2.4	11.0	18.2	9.3	72.5	0.0	1.2	12.9
TIPS	30-Year	0.666	2.3	5.0	21.6	9.1	69.4	0.0	0.3	15.0
FRN	2-Year	0.169	3.5	41.0	57.6	0.6	41.8	0.0	0.9	0.0
Total Bills		0.436	3.5	1,620.9	53.5	4.7	41.8	13.9	0.0	50.0
Total Coupons		1.731	2.5	437.1	36.3	9.0	54.8	0.9	40.0	334.5
Total TIPS		0.302	2.5	29.9	19.0	8.6	72.4	0.1	1.5	34.7
Total FRN		0.169	3.5	41.0	57.6	0.6	41.8	0.0	0.9	0.0

*Weighted averages of Competitive Awards.
**Approximated using prices at settlement and includes both Competitive and Non-Competitive Awards. For TIPS' 10-year equivalent, a constant auction BEI is used as the inflation assumption.
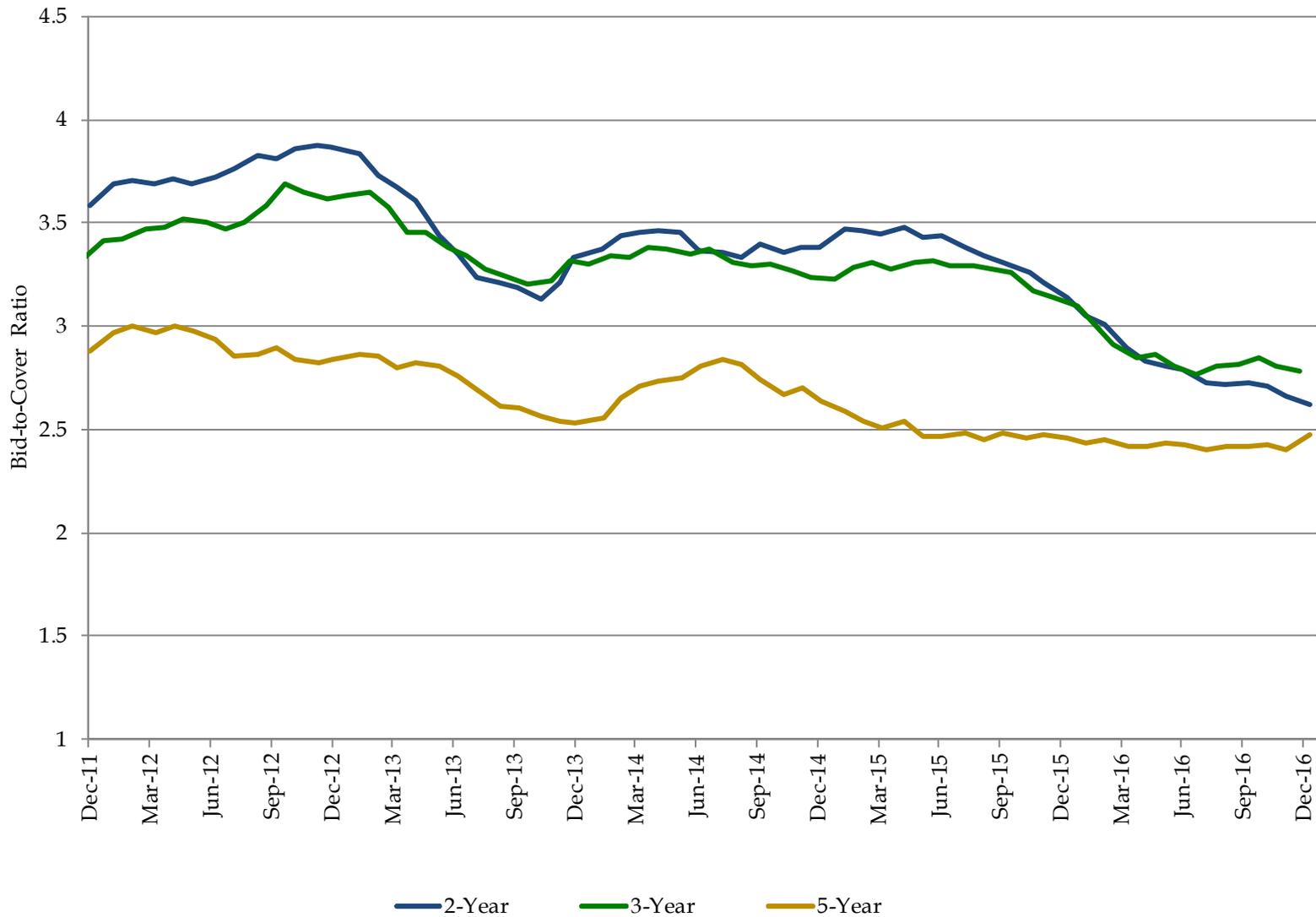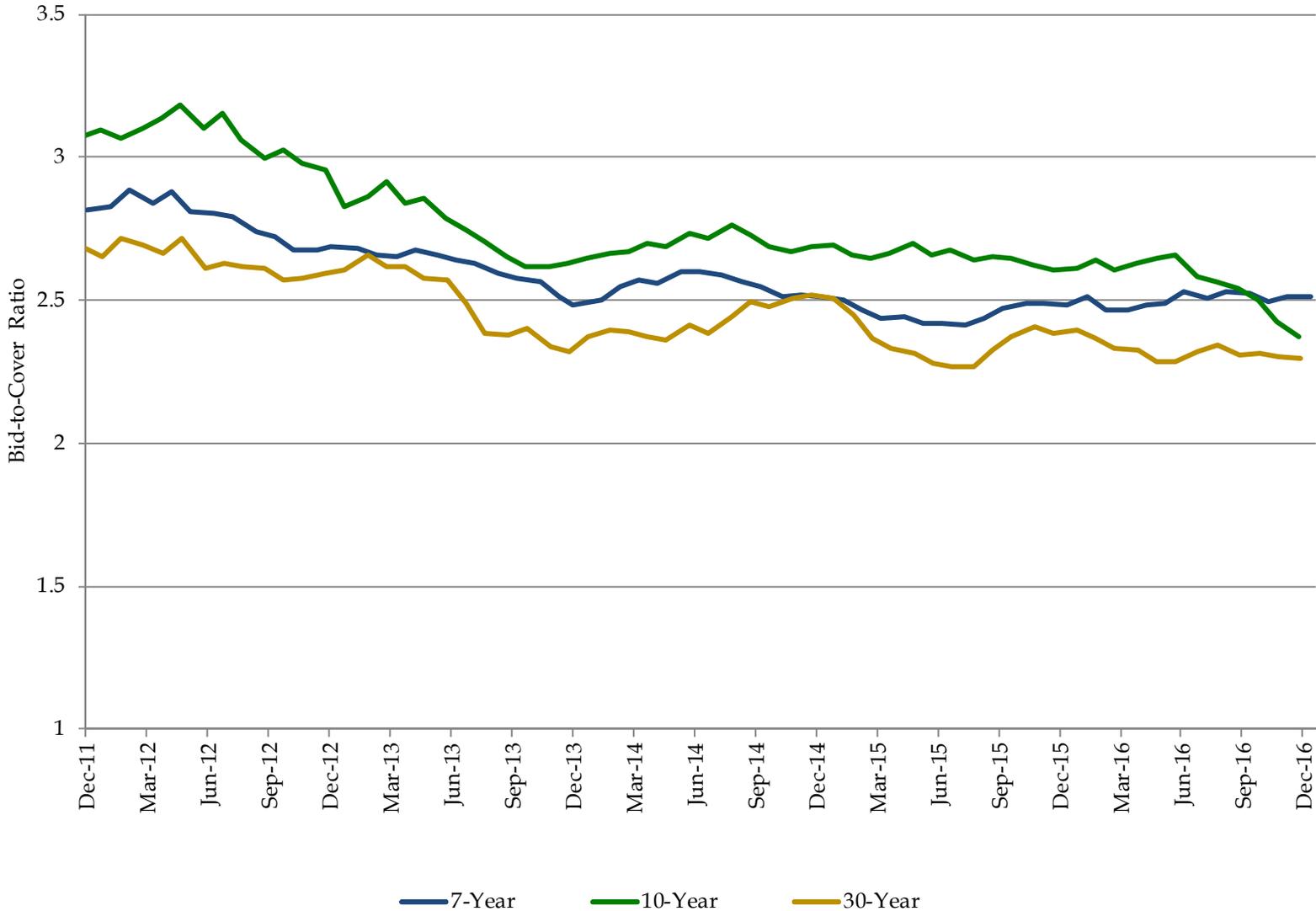
Bid-to-Cover Ratios for Treasury Bills
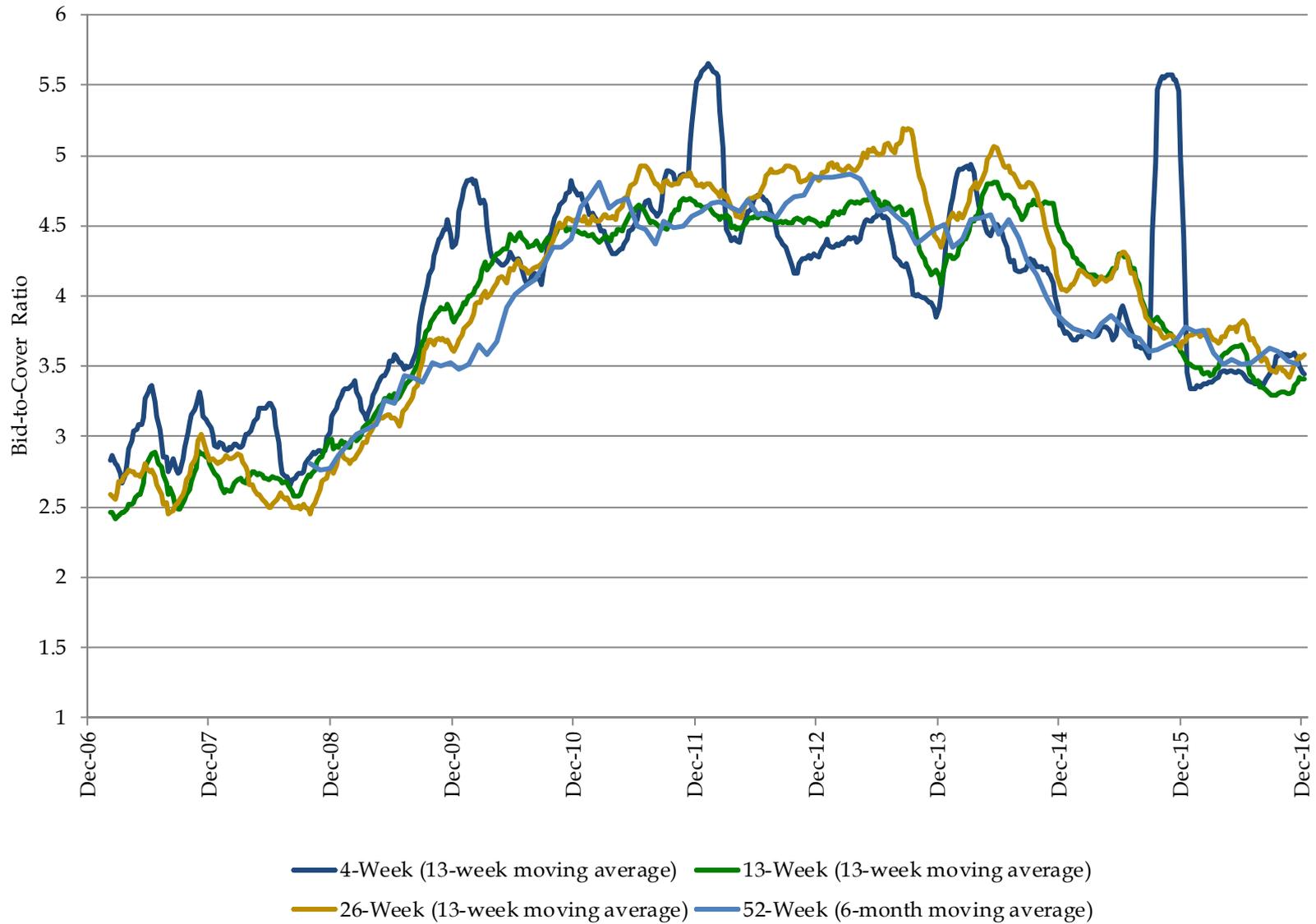
**Bid-to-Cover Ratios for FRNs
(6-Month Moving Average)**
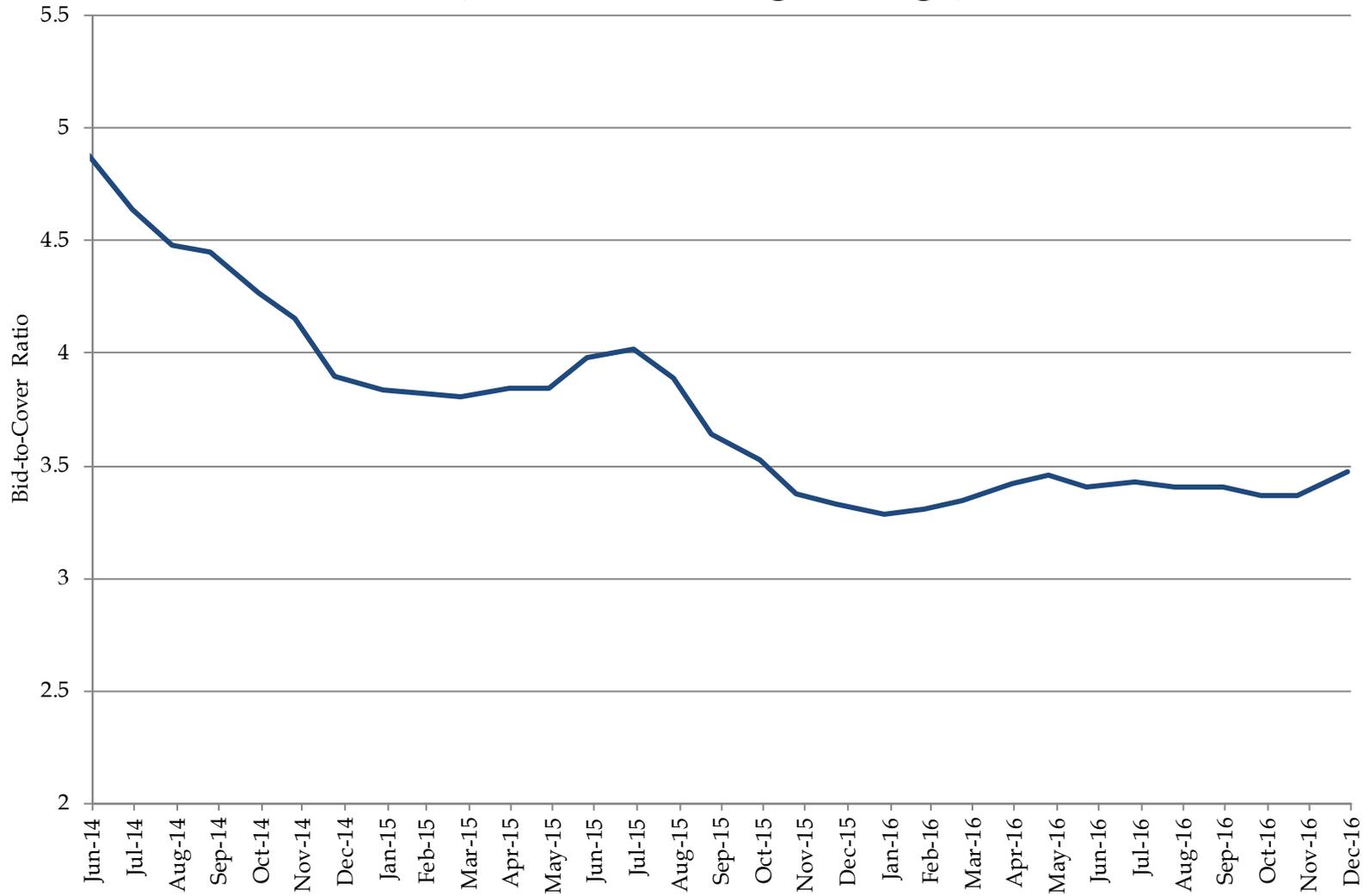
Bid-to-Cover Ratios for 2-, 3-, and 5-Year Nominal Securities
(6-Month Moving Average)

Bid-to-Cover Ratios for 7-, 10-, and 30-Year Nominal Securities (6-Month Moving Average)

Bid-to-Cover Ratios for TIPS

Legend: ◆ 5-Year — 10-Year (6-month moving average) ■ 20-Year ▲ 30-Year

35
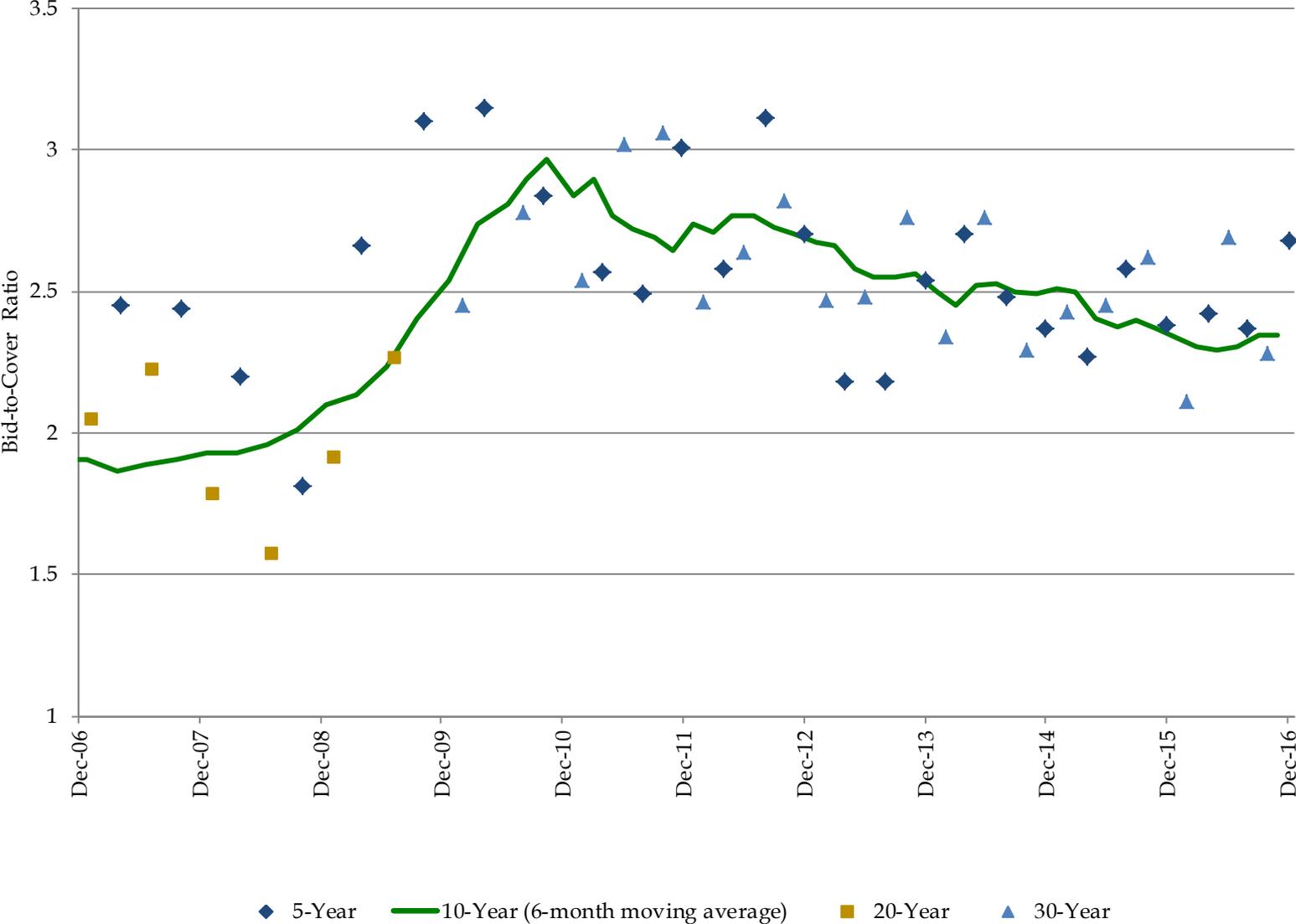
Percent Awarded in Bill Auctions by Investor Class
(13-Week Moving Average)
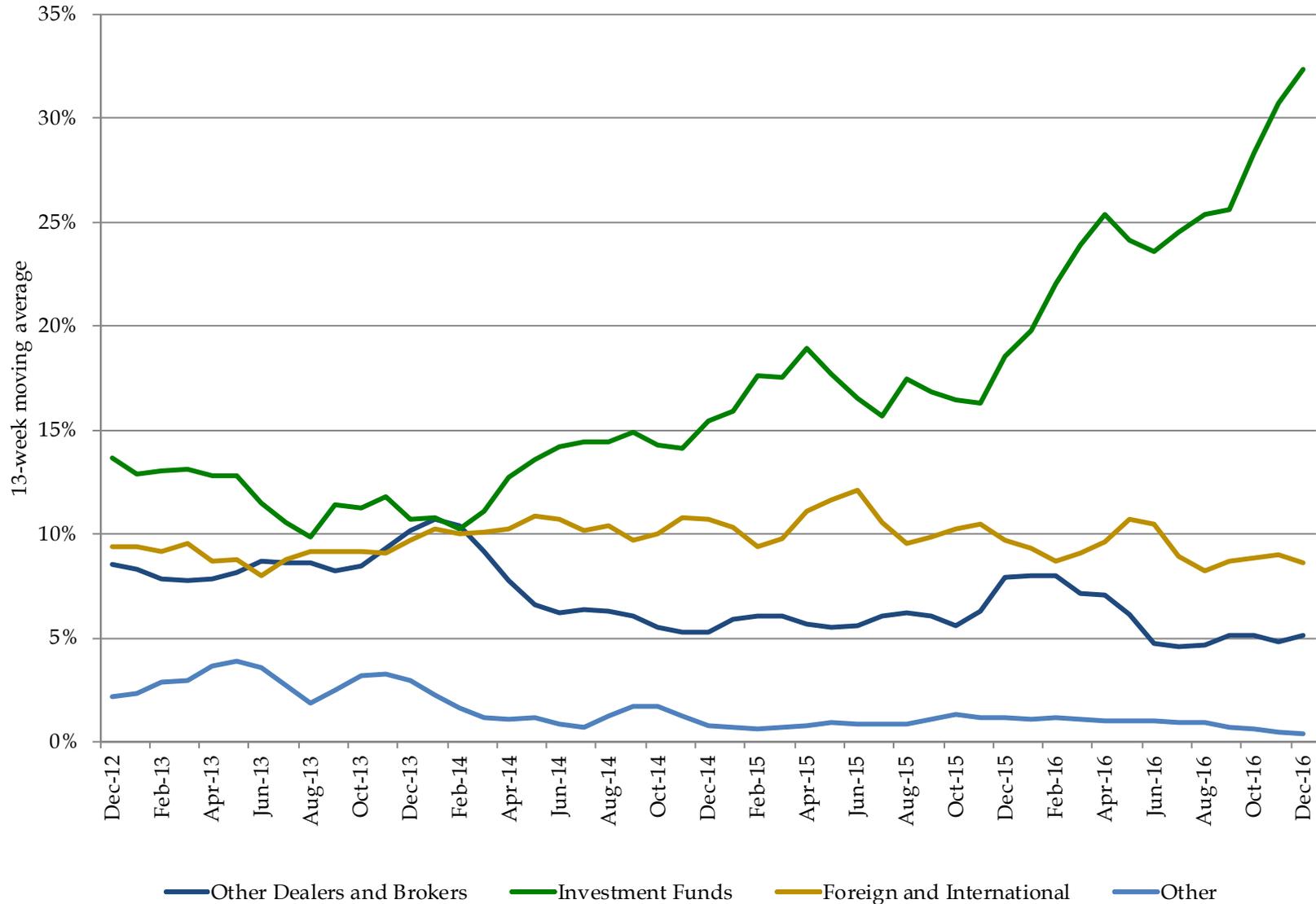
Legend: Other Dealers and Brokers — Investment Funds — Foreign and International — Other

Excludes SOMA add-ons. The "Other" category includes categories that are each less than 5%, which include Depository Institutions, Individuals, Pension and Insurance.

Percent Awarded in 2-, 3-, and 5-Year Nominal Security Auctions by Investor Class (6-Month Moving Average)

Excludes SOMA add-ons. The "Other" category includes categories that are each less than 5%, which include Depository Institutions, Individuals, Pension and Insurance.

Percent Awarded in 7-, 10-, 30-Year Nominal Security Auctions by Investor Class (6-Month Moving Average)

Other Dealers and Brokers — Investment Funds — Foreign and International — Other

Excludes SOMA add-ons. The "Other" category includes categories that are each less than 5%, which include Depository Institutions, Individuals, Pension and Insurance.
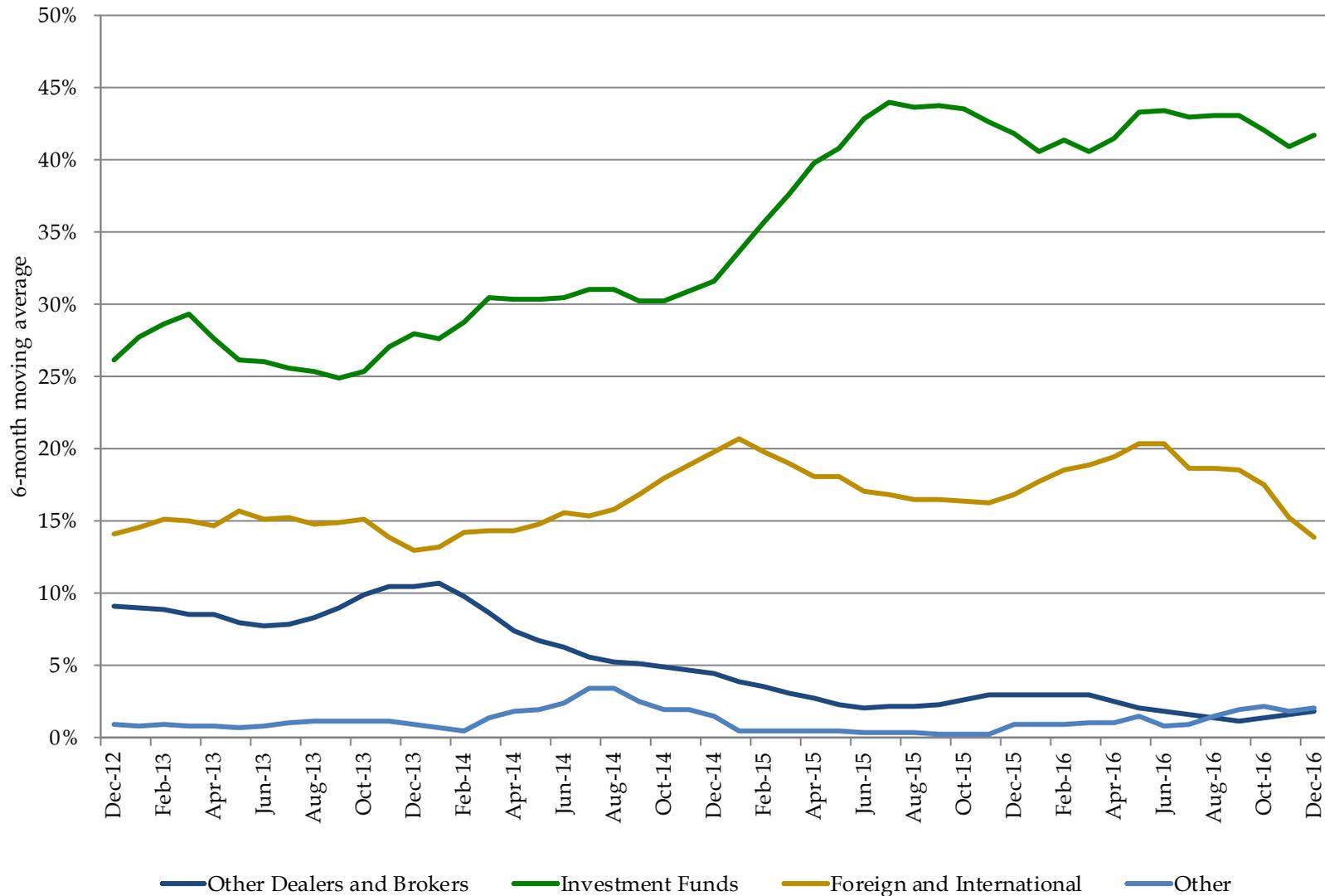
Percent Awarded in TIPS Auctions by Investor Class
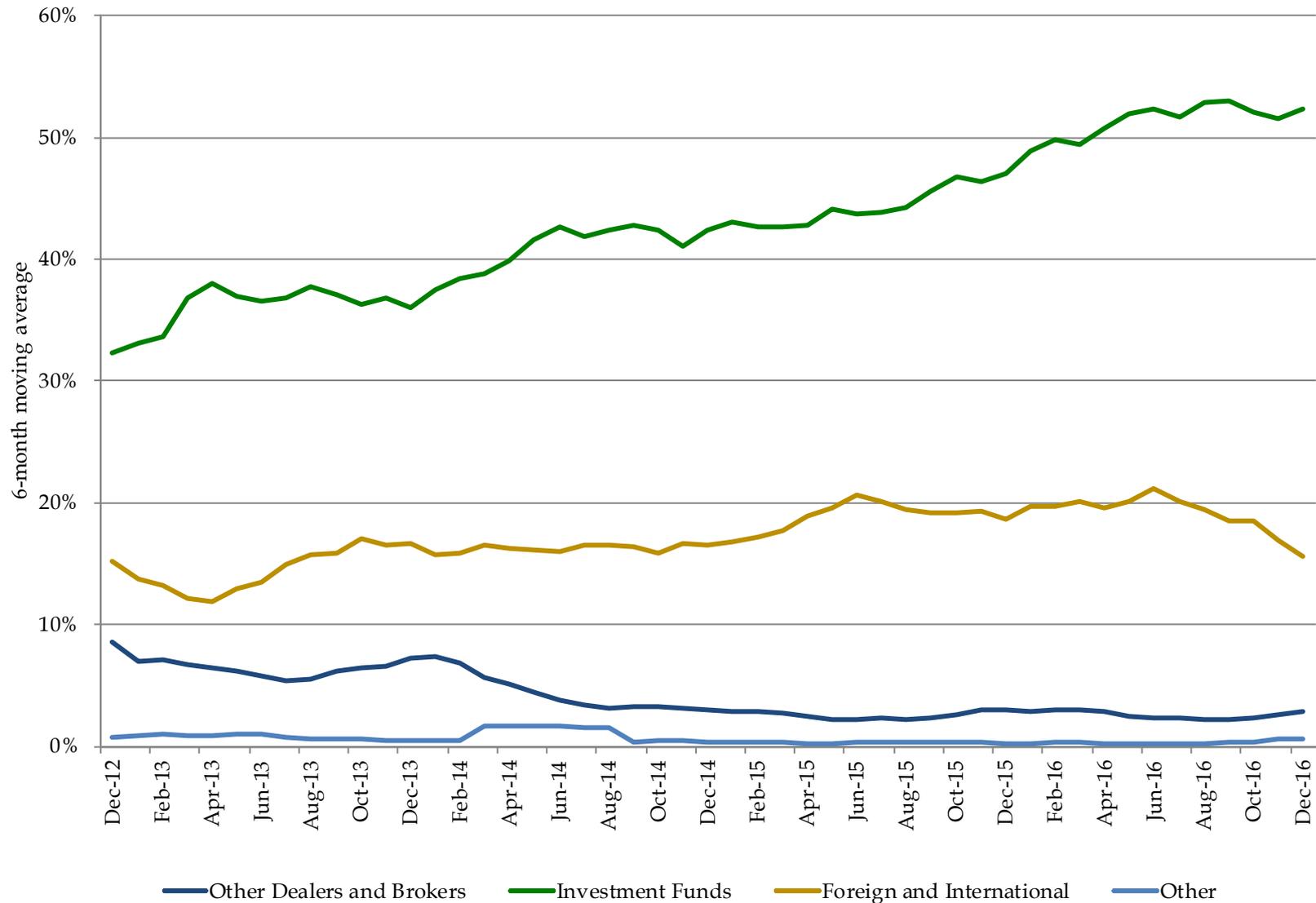## (6-Month Moving Average)
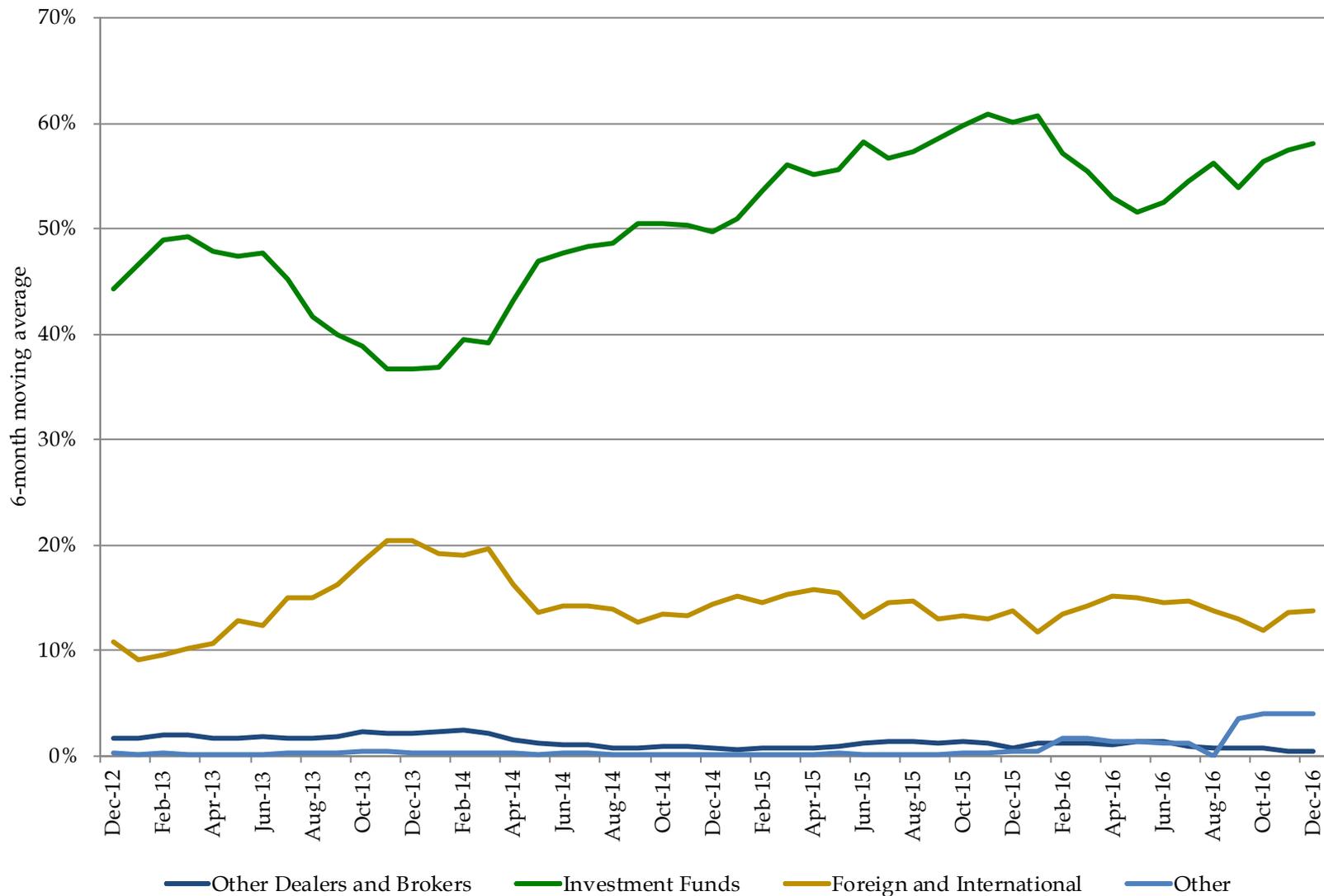
Excludes SOMA add-ons. The "Other" category includes categories that are each less than 5%, which include Depository Institutions, Individuals, Pension and Insurance.

Primary Dealer Awards at Auction

Legend:
- 4/13/26-Week (13-week moving average)
- 52-Week (6-month moving average)
- 2/3/5-Year (6-month moving average)
- 7/10/30-Year (6-month moving average)
- TIPS (6-month moving average)
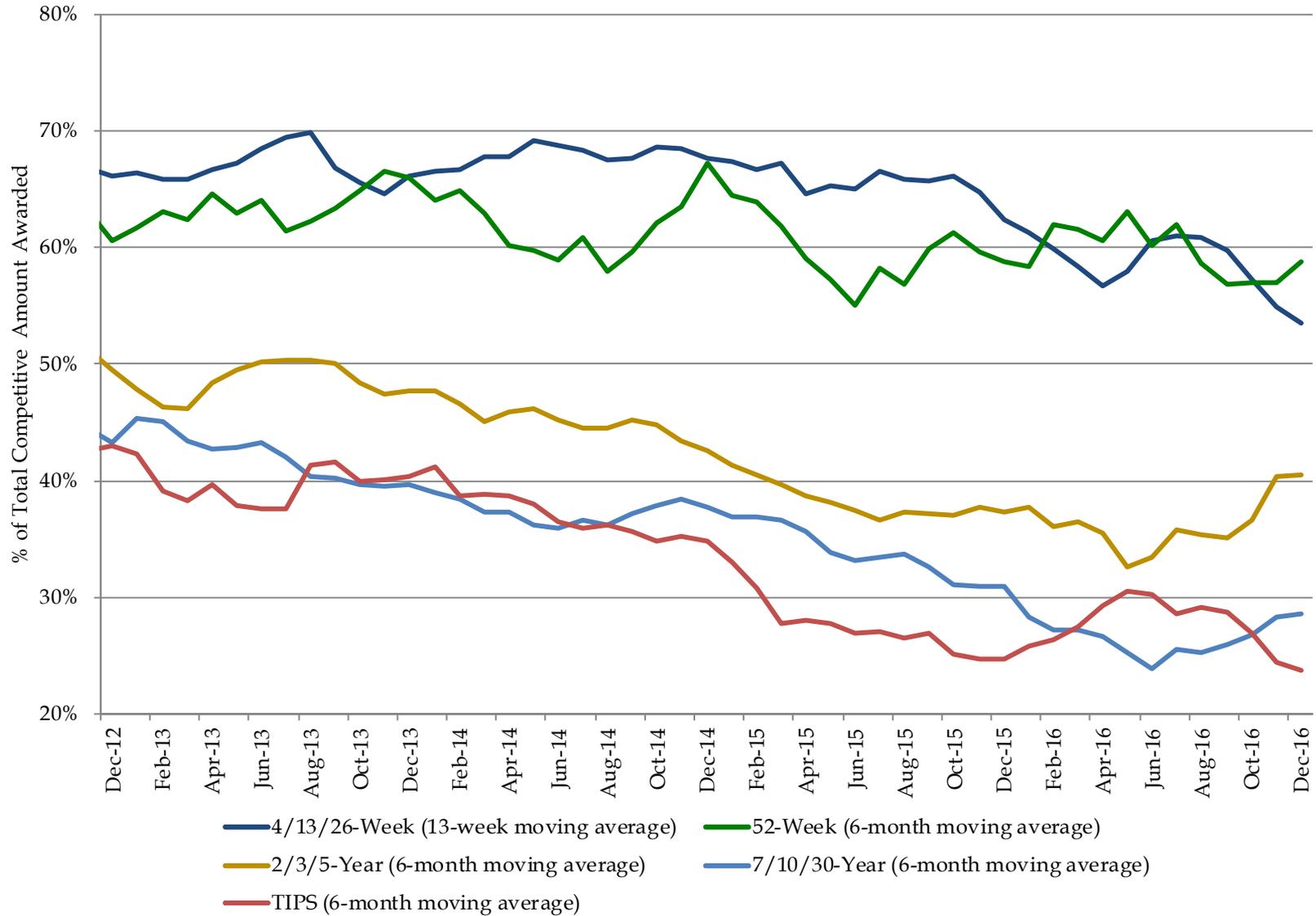
Excludes SOMA add-ons.

Direct Bidder Awards at Auction

Legend:
- 4/13/26-Week (13-week moving average)
- 52-Week (6-month moving average)
- 2/3/5 (6-month moving average)
- 7/10/30 (6-month moving average)
- TIPS (6-month-moving average)

Excludes SOMA add-ons.

41
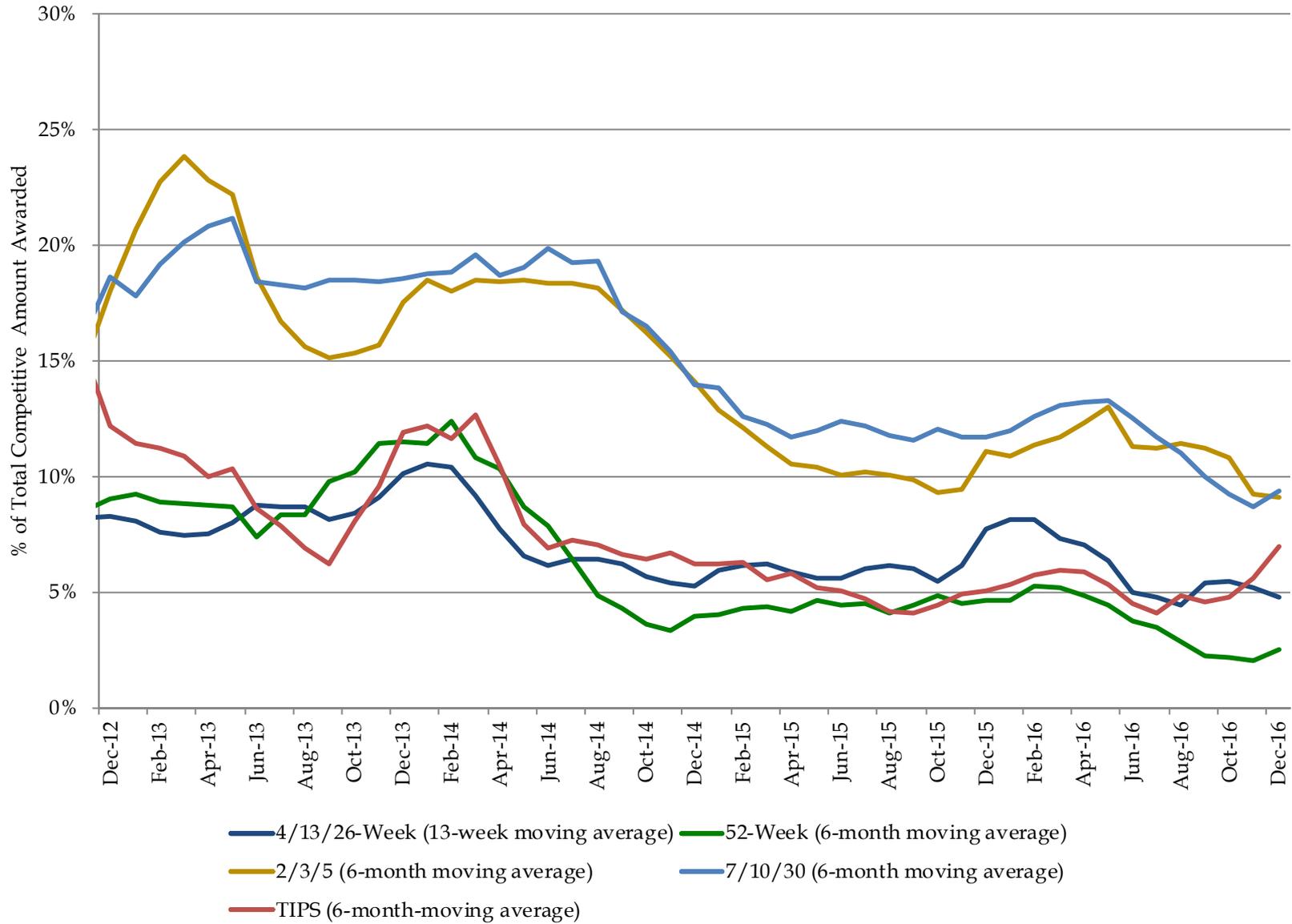
Total Foreign Awards of Treasuries at Auction, $ billions

Legend: Bills | 2,3,5 | 7,10,30 | TIPS | FRN
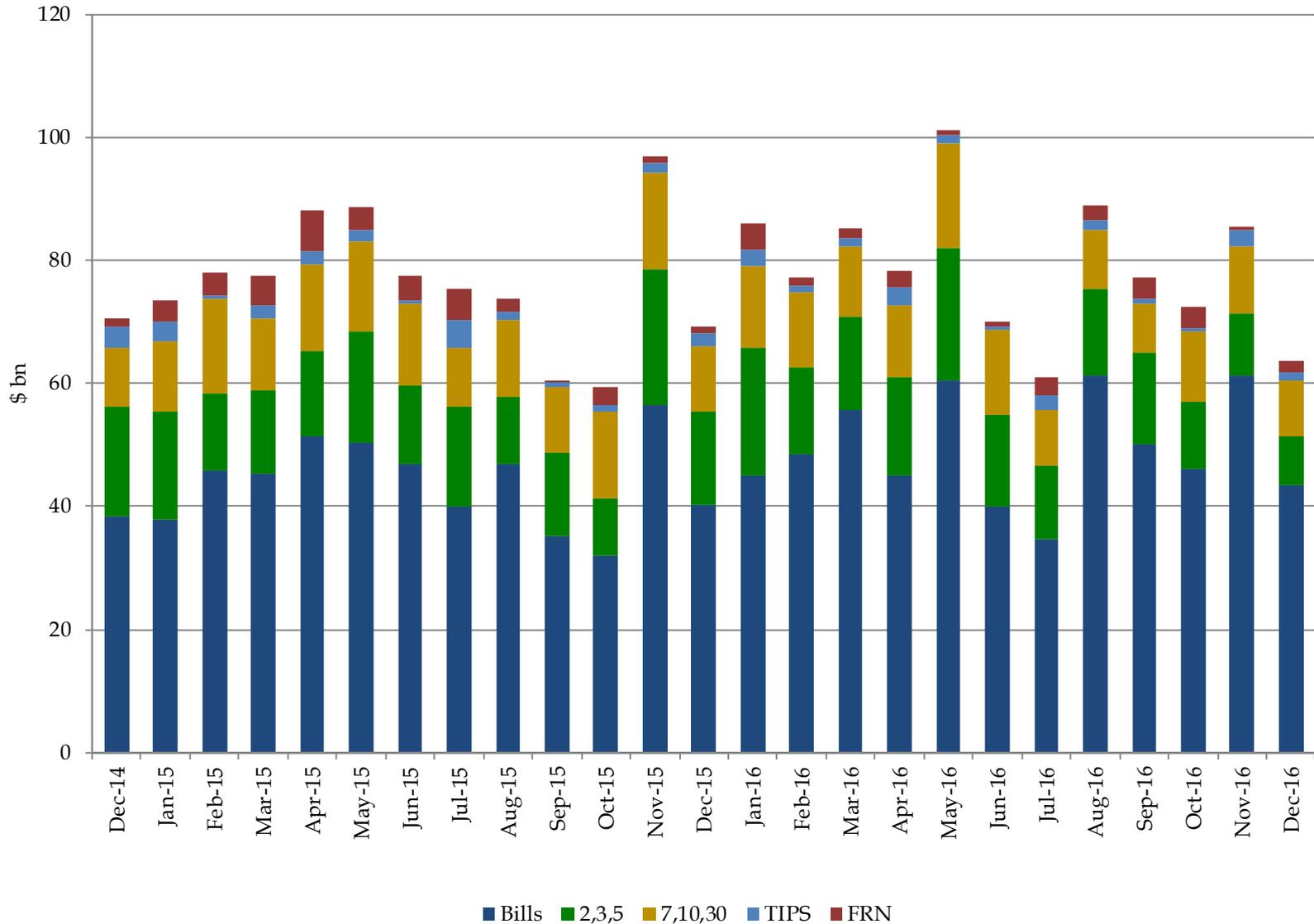
Foreign includes both private sector and official institutions.

Appendix

Projected Portfolio Composition by Issuance Type

Legend: Bills ■ | 2,3,5 ■ | 7,10,30 ■ | TIPS (principal accreted to projection date) ■ | FRN ■
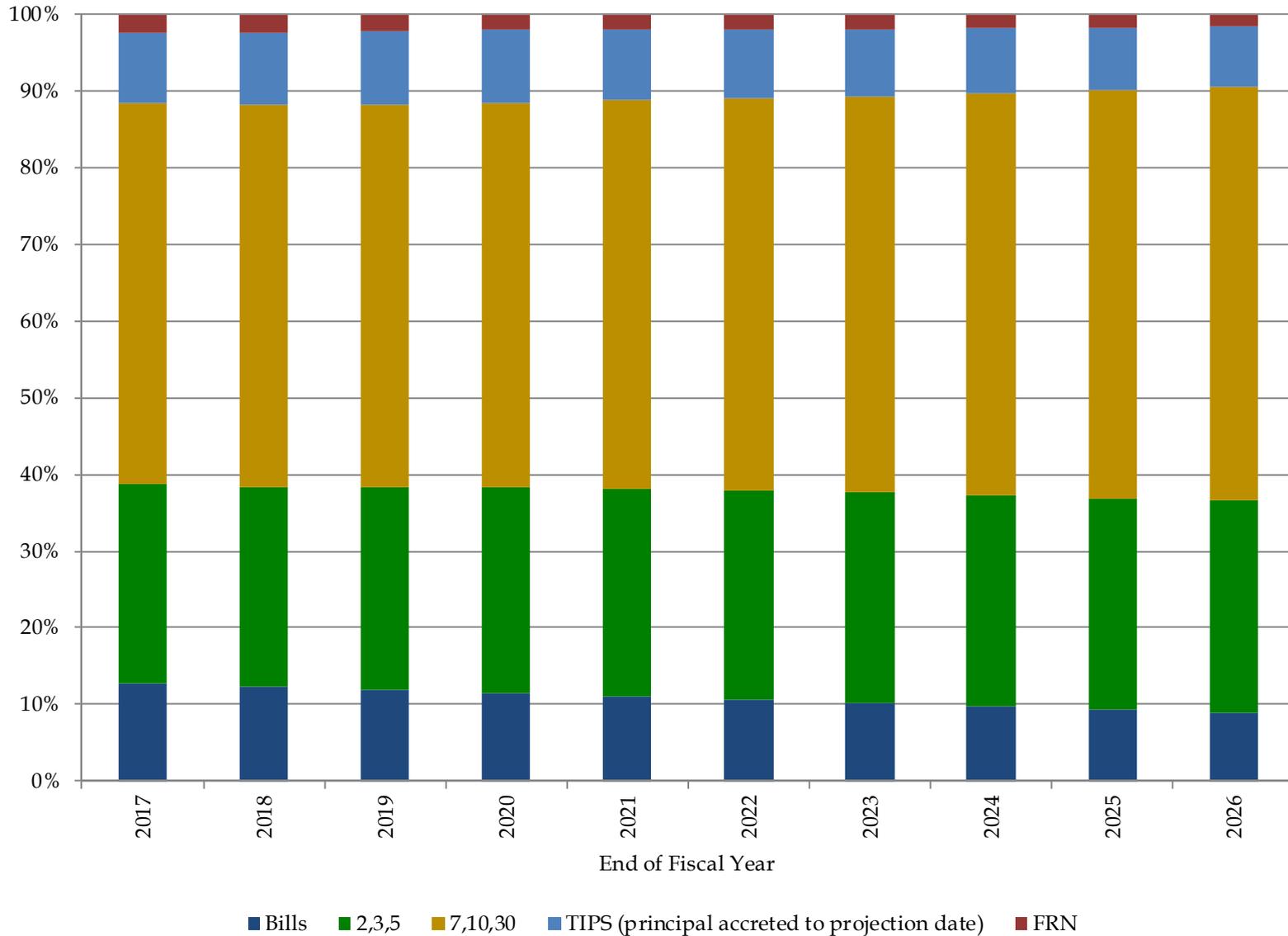
This scenario does not represent any particular course of action that Treasury is expected to follow. Instead, it is intended to demonstrate the basic trajectory of average maturity absent changes to the mix of securities issued by Treasury. See table on following page for details.

Recent and Projected Portfolio Composition by Issuance Type, Percent

End of Fiscal Year	Bills	2-, 3-, 5-Year Nominal Coupons	7-, 10-, 30-Year Nominal Coupons	Total Nominal Coupons	TIPS (principal accreted to projection date)	FRN
2009	28.5	36.2	27.4	63.6	7.9	0.0
2010	21.1	40.1	31.8	71.9	7.0	0.0
2011	15.4	41.4	35.9	77.3	7.3	0.0
2012	15.0	38.4	39.0	77.4	7.5	0.0
2013	13.2	35.8	43.0	78.7	8.1	0.0
2014	11.5	33.0	46.0	79.0	8.5	1.0
2015	10.6	29.4	49.0	78.3	8.8	2.2
2016	12.1	27.0	49.6	76.6	8.9	2.4
2017	12.7	26.2	49.7	75.9	9.1	2.4
2018	12.2	26.0	50.0	76.0	9.4	2.3
2019	11.8	26.6	49.9	76.5	9.5	2.2
2020	11.4	27.0	50.1	77.1	9.5	2.1
2021	11.0	27.2	50.6	77.8	9.2	2.0
2022	10.5	27.4	51.2	78.6	9.0	1.9
2023	10.1	27.6	51.6	79.2	8.7	1.9
2024	9.7	27.5	52.4	79.9	8.6	1.8
2025	9.3	27.6	53.2	80.8	8.1	1.7
2026	9.0	27.7	53.9	81.6	7.8	1.7

This scenario does not represent any particular course of action that Treasury is expected to follow. Instead, it is intended to demonstrate the basic trajectory of average maturity absent changes to the mix of securities issued by Treasury.

					Bills					
Issue	Settle Date	Stop Out Rate (%)*	Bid-to-Cover Ratio*	Competitive Awards ($bn)	% Primary Dealer*	% Direct*	% Indirect*	Non-Competitive Awards ($bn)	SOMA Add Ons ($bn)	10-Year Equivalent ($bn)*
4-Week	10/6/2016	0.260	4.13	39.7	44.4	4.5	51.2	0.3	0.0	0.3
4-Week	10/13/2016	0.265	3.37	39.6	60.4	7.1	32.5	0.3	0.0	0.3
4-Week	10/20/2016	0.245	3.66	44.6	42.9	8.2	48.9	0.3	0.0	0.4
4-Week	10/27/2016	0.240	3.75	49.6	46.9	4.8	48.3	0.3	0.0	0.4
4-Week	11/3/2016	0.240	3.45	54.6	43.7	5.5	50.8	0.3	0.0	0.5
4-Week	11/10/2016	0.270	3.39	64.5	50.4	1.6	48.1	0.4	0.0	0.6
4-Week	11/17/2016	0.305	3.29	64.6	64.5	5.4	30.1	0.3	0.0	0.6
4-Week	11/25/2016	0.340	3.24	54.6	63.1	1.6	35.3	0.3	0.0	0.5
4-Week	12/1/2016	0.365	3.57	43.7	45.4	9.1	45.5	0.3	0.0	0.4
4-Week	12/8/2016	0.340	3.23	44.5	63.5	5.5	31.0	0.4	0.0	0.4
4-Week	12/15/2016	0.480	3.21	44.6	67.3	6.4	26.3	0.3	0.0	0.4
4-Week	12/22/2016	0.490	3.01	54.6	60.5	5.4	34.0	0.3	0.0	0.5
4-Week	12/29/2016	0.485	3.48	49.6	50.6	6.3	43.1	0.3	0.0	0.4
13-Week	10/6/2016	0.310	3.37	41.5	62.7	3.7	33.6	0.4	0.0	1.2
13-Week	10/13/2016	0.360	3.18	41.5	57.8	5.0	37.1	0.4	0.0	1.2
13-Week	10/20/2016	0.340	3.27	41.5	57.3	5.4	37.3	0.4	0.0	1.2
13-Week	10/27/2016	0.340	3.48	40.6	59.4	16.3	24.2	0.4	0.0	1.2
13-Week	11/3/2016	0.350	3.30	41.4	79.7	5.2	15.2	0.4	0.0	1.2
13-Week	11/10/2016	0.420	3.29	41.4	64.0	3.0	33.0	0.4	0.0	1.2
13-Week	11/17/2016	0.515	3.13	41.4	49.2	5.5	45.2	0.4	0.0	1.2
13-Week	11/25/2016	0.480	3.53	38.4	60.0	3.9	36.2	0.4	0.0	1.1
13-Week	12/1/2016	0.490	3.84	34.7	59.7	5.0	35.3	0.3	0.0	1.0
13-Week	12/8/2016	0.490	3.64	33.5	52.7	9.3	38.0	0.4	0.0	0.9
13-Week	12/15/2016	0.530	3.71	33.4	53.3	6.6	40.1	0.4	0.0	1.0
13-Week	12/22/2016	0.515	3.19	33.3	57.1	7.6	35.3	0.5	0.0	1.0
13-Week	12/29/2016	0.555	3.44	32.6	55.5	1.6	42.9	0.4	0.0	1.0
26-Week	10/6/2016	0.490	3.58	35.2	47.6	2.3	50.2	0.4	0.0	2.0
26-Week	10/13/2016	0.495	3.50	35.2	40.0	2.0	58.0	0.3	0.0	2.0
26-Week	10/20/2016	0.470	3.30	35.4	44.6	2.7	52.7	0.3	0.0	2.0
26-Week	10/27/2016	0.475	3.50	34.7	50.8	5.0	44.2	0.3	0.0	2.0
26-Week	11/3/2016	0.500	3.48	35.2	54.6	1.9	43.4	0.4	0.0	2.0
26-Week	11/10/2016	0.535	3.41	35.5	47.7	1.4	50.9	0.3	0.0	2.0
26-Week	11/17/2016	0.625	3.13	35.5	41.1	2.0	56.9	0.3	0.0	2.0
26-Week	11/25/2016	0.605	3.84	32.4	44.3	0.9	54.8	0.3	0.0	1.8
26-Week	12/1/2016	0.610	4.27	28.8	33.2	2.3	64.6	0.3	0.0	1.7
26-Week	12/8/2016	0.615	3.72	27.6	53.6	3.2	43.3	0.3	0.0	1.6
26-Week	12/15/2016	0.645	3.63	27.5	34.9	2.8	62.3	0.4	0.0	1.6
26-Week	12/22/2016	0.645	3.35	27.5	56.0	2.5	41.4	0.4	0.0	1.6
26-Week	12/29/2016	0.660	3.83	26.7	31.8	1.3	66.8	0.3	0.0	1.6
52-Week	10/13/2016	0.680	3.46	19.8	53.5	2.2	44.3	0.2	0.0	2.2
52-Week	11/10/2016	0.695	3.35	19.8	63.3	1.5	35.2	0.2	0.0	2.2
52-Week	12/8/2016	0.830	3.58	19.8	53.0	5.1	41.9	0.2	0.0	2.2

*Weighted averages of Competitive Awards.
**Approximated using prices at settlement and includes both Competitive and Non-Competitive Awards.

					Nominal Coupons					
Issue	Settle Date	Stop Out Rate (%)*	Bid-to-Cover Ratio*	Competitive Awards ($bn)	% Primary Dealer*	% Direct*	% Indirect*	Non-Competitive Awards ($bn)	SOMA Add Ons ($bn)	10-Year Equivalent ($bn)*
2-Year	10/31/2016	0.855	2.53	25.8	56.2	10.1	33.7	0.2	1.6	6.0
2-Year	11/30/2016	1.085	2.73	25.8	50.8	13.4	35.8	0.2	2.8	6.3
2-Year	1/3/2017	1.280	2.44	25.8	58.0	9.3	32.7	0.2	3.5	6.5
3-Year	10/17/2016	1.045	2.92	24.0	37.7	10.1	52.1	0.0	0.0	7.8
3-Year	11/15/2016	1.034	2.69	24.0	49.7	7.6	42.6	0.0	5.3	9.6
3-Year	12/15/2016	1.452	2.65	23.9	48.5	9.0	42.6	0.1	0.0	7.9
5-Year	10/31/2016	1.303	2.49	34.0	35.4	4.9	59.7	0.0	2.1	19.3
5-Year	11/30/2016	1.760	2.44	34.0	35.7	4.5	59.8	0.0	3.6	20.0
5-Year	1/3/2017	2.057	2.72	33.9	24.5	4.1	71.4	0.1	4.5	20.6
7-Year	10/31/2016	1.653	2.49	28.0	25.3	13.2	61.5	0.0	1.7	21.7
7-Year	11/30/2016	2.215	2.68	28.0	18.0	9.4	72.7	0.0	3.0	22.4
7-Year	1/3/2017	2.284	2.54	28.0	17.0	19.0	64.0	0.0	3.7	23.0
10-Year	10/17/2016	1.793	2.53	20.0	30.6	6.6	62.7	0.0	0.0	20.0
10-Year	11/15/2016	2.020	2.22	23.0	39.2	8.3	52.5	0.0	5.0	28.2
10-Year	12/15/2016	2.485	2.39	20.0	36.5	6.0	57.5	0.0	0.0	20.0
30-Year	10/17/2016	2.470	2.44	12.0	28.5	6.1	65.4	0.0	0.0	28.2
30-Year	11/15/2016	2.902	2.11	15.0	33.1	12.5	54.5	0.0	3.3	40.7
30-Year	12/15/2016	3.152	2.39	12.0	26.8	9.3	63.9	0.0	0.0	26.4
2-Year FRN	10/31/2016	0.170	3.35	15.0	61.3	1.3	37.4	0.0	0.9	0.0
2-Year FRN	11/25/2016	0.169	3.32	13.0	48.3	0.4	51.3	0.0	0.0	0.0
2-Year FRN	12/30/2016	0.169	3.80	13.0	62.6	0.0	37.4	0.0	0.0	0.0

					TIPS					
Issue	Settle Date	Stop Out Rate (%)*	Bid-to-Cover Ratio*	Competitive Awards ($bn)	% Primary Dealer*	% Direct*	% Indirect*	Non-Competitive Awards ($bn)	SOMA Add Ons ($bn)	10-Year Equivalent ($bn)*
5-Year TIPS	12/30/2016	0.120	2.68	14.0	18.7	8.0	73.3	0.0	0.0	6.8
10-Year TIPS	11/30/2016	0.369	2.39	11.0	18.2	9.3	72.5	0.0	1.2	12.9
30-Year TIPS	10/31/2016	0.666	2.28	5.0	21.6	9.1	69.4	0.0	0.3	15.0

*Weighted averages of Competitive Awards.
**Approximated using prices at settlement and includes both Competitive and Non-Competitive Awards. For TIPS' 10-Year Equivalent, a constant auction BEI is used as the inflation assumption.

TBAC CHARGE QUESTION: OPTIMIZATION MODELS FOR TREASURY DEBT

January 2017

Charge Question

January 31, 2017

The primary objective of Treasury's debt management strategy is to finance the government's borrowing needs at the lowest risk-adjusted cost over time. To accomplish this, Treasury strives to issue debt in a regular and predictable pattern, but that approach leaves open a wide range of potential outcomes for the maturity structure of the debt. The interest expense associated with any issuance strategy will depend on a variety of factors that are not under the control of the debt manager, including the behavior of interest rates, the business cycle, and the federal government's fiscal policy. A number of countries including the United States have developed quantitative models that can assist in the evaluation of alternative financing strategies in the face of inherent uncertainty about the future. Treasury requests the Committee's input on the appropriate considerations for and use of these types of models, consistent with their ability to calculate interest expense associated with alternative issuance scenarios and to help debt managers better understand the implications of various financing choices.

Agenda

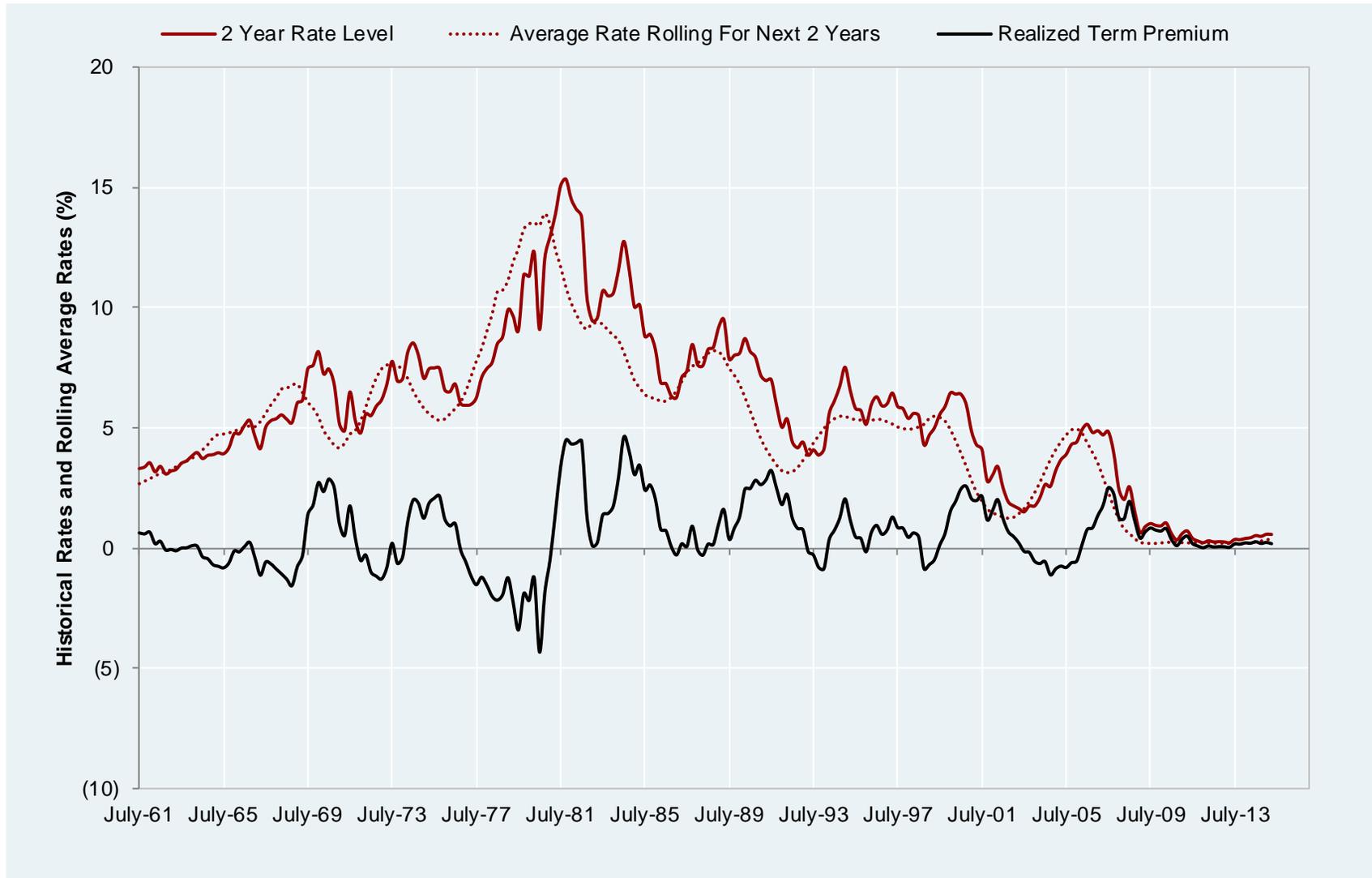TBAC CHARGE QUESTION: OPTIMIZATION MODELS FOR TREASURY DEBT

Historical US Treasury Rates By Quarter

- As background to our discussion on key components of a US debt optimization model, we consider what issuance strategies have had the lowest cost historically in the US

Historical Premium Of Issuing Term Debt Compared To Rolling Short Debt

2 Year Realized Term Premium = Spot 2 Year Rate - Average 3M Rate Rolling For Next 2 Years

Legend: 2 Year Rate Level — Average Rate Rolling For Next 2 Years — Realized Term Premium

Y-axis: Historical Rates and Rolling Average Rates (%)

X-axis: July-61, July-65, July-69, July-73, July-77, July-81, July-85, July-89, July-93, July-97, July-01, July-05, July-09, July-13

Historical Premium of Issuing Term Debt Compared to Rolling Short Debt

5 Year Realized Term Premium = Spot 5 Year Rate – Average 3M Rate Rolling For Next 5 Years

Historical Premium of Rolling Short Debt vs Issuing Term Debt

10 Year Realized Term Premium = Spot 10 Year Rate - Average 3M Rate Rolling For Next 10 Years

HISTORICAL COST OF ALTERNATIVE ISSUANCE STRATEGIES IN THE US

US Treasury Interest Expense Over Historical 5 Year Intervals

- The below table shows interest expense and average interest rate paid during 5 year intervals over the last 50 years

  - Each strategy involves the issuer maintaining a fixed amount of outstanding debt by issuing debt of a maturity M where 1/M of outstanding debt is scheduled to mature each period; in this case, interest expense will be a simple rolling average of historical interest rates

- While interest rates have oscillated, rates generally increased prior to 1981 and decreased after 1981

- Longer-term debt strategies perform better as rates increase; shorter-term strategies perform better as rates decrease

- In this dataset, the benefit of longer-term issuance in rising rate environments is small relative to its disadvantage in declining rate environments

Interest expense and average rate paid

	5 Year Interest Expense Per $100 Issued				Average % Rate Paid Over 5 Year Intervals				
	3 Month	2 Year	5 Year	10 Year	3 Month	2 Year	5 Year	10 Year	
1967-71	$28.0	$29.0	$25.7	$23.7	5.60	5.79	5.14	4.73	Rates Generally Increasing
1972-76	$30.7	$33.5	$33.4	$29.8	6.13	6.69	6.68	5.96	
1977-81	$50.5	$43.7	$40.0	$37.1	10.10	8.74	8.01	7.43	
1982-86	$44.4	$57.0	$57.9	$49.4	8.87	11.41	11.58	9.88	
1987-91	$35.2	$39.3	$45.2	$52.6	7.04	7.86	9.04	10.52	
1992-96	$21.6	$27.7	$35.3	$42.5	4.32	5.53	7.05	8.51	Rates Generally Decreasing
1997-01	$25.1	$28.2	$30.0	$34.9	5.03	5.64	6.00	6.98	
2002-06	$12.5	$15.0	$22.3	$28.7	2.50	2.99	4.46	5.73	
2007-11	$7.7	$12.5	$18.0	$23.6	1.55	2.50	3.60	4.73	
2012-16	$1.3	$2.2	$8.0	$17.6	0.26	0.44	1.60	3.53	

Agenda

TBAC CHARGE QUESTION: OPTIMIZATION MODELS FOR TREASURY DEBT

Government Debt Optimization Models

- Many sovereign debt managers utilize stochastic simulation/optimization models to help inform their decisions about debt issuance and the optimal maturity structure of government debt.
  - The Debt Management Office of Canada, UK, Sweden, Brazil, and Turkey have all published detailed working papers highlighting the key components of their models. Other countries (e.g., Denmark, Austria, Portugal and Belgium) have indicated that they utilize stochastic simulations of alternative debt management strategies.*

- The models are generally used to help quantify the tradeoffs debt managers face between the expected cost of debt issuance over time and the variability of these costs across different scenarios.

- In a survey of 71 public debt managers conducted by the US Treasury and World Bank at the 2012 Sovereign Debt Managers forum, more than half of managers said their debt strategy is supported by stochastic simulation models that quantify risk/cost tradeoffs. While the survey indicated that 100% of HIC's (high income countries) had a debt management strategy that was supported by quantitative analysis, only about one-third (37%) had published details of the model underlying their strategy.

2012 Sovereign Debt Managers forum survey results on whether the manager has a formal debt management strategy based on quantitative analysis

Bar chart:
- Yes, deterministic and stochastic: 27%
- Yes stochastic models: 29%
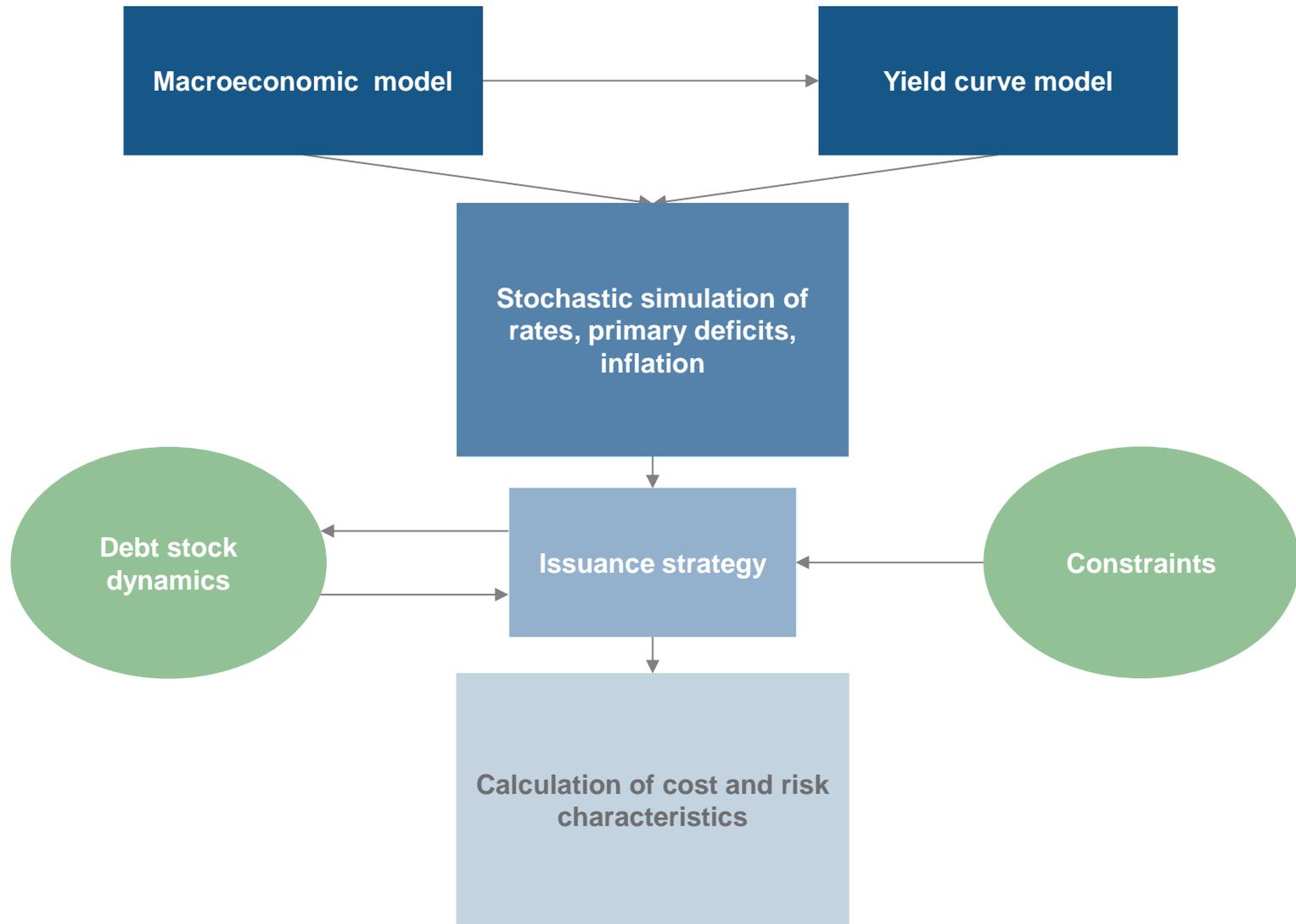- Yes, deterministic models: 31%
- No: 13%
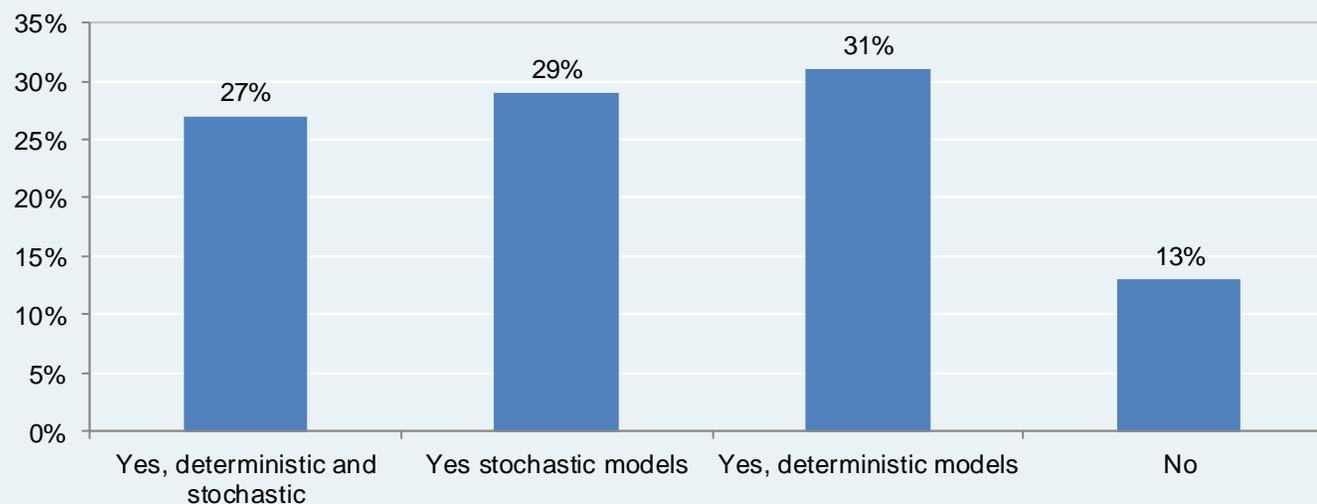
* See for example Bolder and Deeley, "The Canadian Debt-Strategy Model: An Overview of the Principal Elements", 2011; Pick and Anthony, "A Simulation model for the analysis of the UK's sovereign debt strategy", 2006; "The SNDO's Simulation Model for Government Debt Analysis", 2002 and Advances in Risk Management of Public Debt,, OECD 2005.

DEBT MANAGEMENT MODELS DEVELOPED BY OTHER COUNTRIES

Key Components Of Debt Simulation/Optimization Models

- In broad terms, the models used by debt managers (including the US Treasury) are quite similar and generally involve the following four key components:

    - A simple macroeconomic model that can be used to generate stochastic simulations of different economic and interest rate environments.

    - A term structure model for relating the yield curve to short rates.

    - An objective function of the debt manager that typically involves minimizing expected issuance costs through time subject to constraints on risk and other variables.

    - An optimization module that identifies low cost strategies given alternative risk and issuance constraints.

- The models are primarily used to quantify tradeoffs between cost and risk (i.e., an efficient frontier) rather than identifying a single optimal strategy.

Graphical Representation Of Debt Optimization Model

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┌──────────────────────┐                    ┌──────────────────────┐
│  Macroeconomic model │ ────────────────▶  │   Yield curve model  │
└──────────────────────┘                    └──────────────────────┘
              │                                        │
              └──────────────┐          ┌──────────────┘
                             ▼          ▼
                    ┌──────────────────────────┐
                    │  Stochastic simulation of │
                    │  rates, primary deficits, │
                    │         inflation         │
                    └──────────────────────────┘
                                 │
                                 ▼
   ┌──────────────┐       ┌──────────────────┐       ┌──────────────┐
   │  Debt stock  │ ◀──── │ Issuance strategy │ ◀──── │  Constraints │
   │   dynamics   │ ────▶ │                   │       │              │
   └──────────────┘       └──────────────────┘       └──────────────┘
                                 │
                                 ▼
                    ┌──────────────────────────┐
                    │ Calculation of cost and   │
                    │    risk characteristics   │
                    └──────────────────────────┘
```

Overview Of Macroeconomic And Yield Curve Models

- Macro models used by debt managers typically involve separate equations for the output gap, inflation, short term policy rates, and the primary deficit.

- A variety of yield curve models are used by debt managers to generate stochastic paths for interest rates as a function of the macroeconomic environment.
  - One shortcoming of all of the macro models used in published papers on debt optimization is the lack of any clear link between short term rates derived from the model and forward rates implied from the yield curve.
  - This disconnect is potentially important in the U.S. where most macroeconomic models currently produce a much steeper path for the funds rate than what is implied by market forward rates and estimates of the term premium   (see Chart).
  - Testing the robustness of optimization results to alternative yield curve assumptions should be a key component of debt optimization.

Projected Fed funds rate derived from a simple macroeconomic model of the US economy (%)
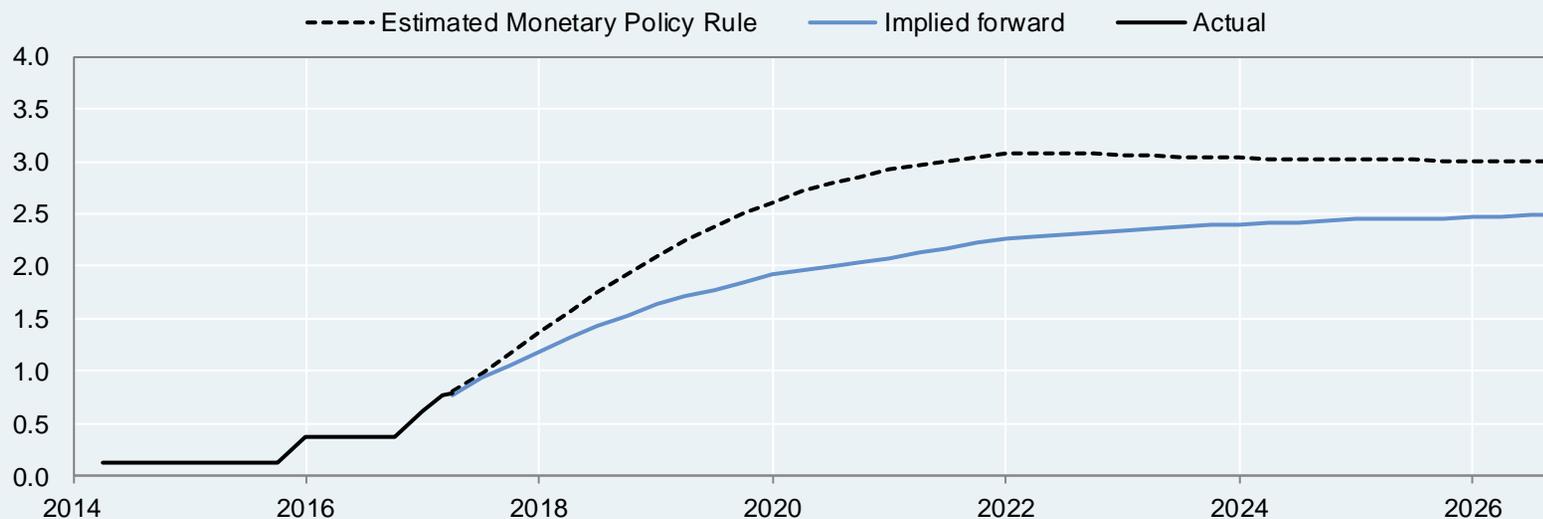
Objective Function And Risk Constraints

Objective function

- Most of the simulation/optimization models in use include an objective function that minimizes expected costs of new debt issuance over a long term horizon.
  - Expectations are taken over multiple paths for interest rates, deficits, and inflation.
  - Choice variables include allocation across different points on the yield curve usually constructed to be constant weights through time.

Constraints

- Risk constraints relate to limits on variability of either debt expense or fiscal balance.
  - Constraints based on fiscal balance incorporate correlation between rates and primary deficits and are better aligned with academic literature that highlight social welfare benefits from tax smoothing.*
  - Risk measures used are either a standard volatility measure (e.g. standard deviation of debt expense or budget) or a VAR type limit (e.g. 95% confidence interval).
  - Risk measures could also be incorporated directly into the objective function in a way that is mathematically equivalent to having them as a constraint.

- Other constraints typically considered reflect a desire for regular and predictable issuance and include:
  - Limiting the change in issuance amount for each tenor from period-to-period
  - Limiting the overall WAM
  - Maintaining a specified amount of issuance at various points on the curve (in order to support market liquidity and/or regulatory objectives).
  - An issuance penalty function that increases cost with issue size.

* See for example Barro, 1974. "Are Government Bonds New Wealth?" Journal of Political Economy 83, no.6 (November-December):1095-117

Some Differences In Models Used By Sovereign Debt Managers In Other Countries

- Many differences exist in the exact specification of costs and risks in the published models.
  - Debt costs can be measured in absolute dollars, as a percent of outstanding debt, or as a percent of GDP; costs can be discounted or undiscounted.
  - Risk can be calculated at a single point in time or averaged over all time periods (the Canadian model is one of the few that provide actual simulation results showing how the cost-risk tradeoff is impacted by alternative risk specifications).

- Countries that must take credit risk into consideration (i.e., countries with elevated public indebtedness or emerging market economies) tend to view debt management as part of an integrated asset/liability framework.

- There are variety of different approaches used to establish the initial conditions for the simulation. For example, Sweden starts with a portfolio that matches the specified strategy while the UK uses the actual portfolio as a jumping off point but sets the initial values for macroeconomic variables and the yield curve on the basis of long run historical averages.

- The issuance of foreign currency debt can create significant modelling complications.

- Differences in yield curves and yield curve models can have a significant effect on results
  - In the UK model, the optimal cost–risk tradeoff is generally achieved by skewing issuance toward long maturity Gilts. This seems attributable to an assumption that the yield curve is downward sloping at the long end of the curve.
  - In the UK model, It can take 20 years or more to achieve a steady state cost outcome. This likely reflects the inclusion of a meaningful amount of 30-year and 50-year maturities (for both nominal and inflation-linked gilts) in the issuance mix.

Key Insights On Issuance From The Published Models

- Intermediate issuance:
  - Optimization models often find the most attractive risk reduction per unit of cost by extending from bills to intermediates (e.g. 5-year); the risk reduction per unit of cost tends to be lower when extending further out the curve.
  - Optimal intermediate issuance levels appear more stable in response to changes in model parameters/risk constraints than front-end and long-end issuance.

- Bill issuance and liquidity demand:
  - Constraining the optimization to have higher levels of bill issuance (e.g., in order to meet market needs for liquidity) appears to have the largest impact on reducing 10- and 30-year issuance in debt optimization with smaller effects on intermediates.

- Constraints on debt cost volatility vs. budget volatility:
  - Setting risk constraints on the volatility of the fiscal balance rather than debt cost volatility generally results in higher levels of short term debt in the optimization; this reflects the negative correlation between interest rates and primary deficits.

- Inflation linked bonds:
  - Inflation linked bonds provide a diversification benefit and reduce volatility especially when the binding constraints are on budgetary volatility; at low target levels of volatility, the optimal issuance strategy can include substantial amounts of inflation linked bonds.

- Other constraints:
  - When issuance is constrained by a target WAM, 30-year debt has a larger weight; this reflects the fact that the marginal impact of 30-year debt on WAM is larger per unit of cost relative to 5-year and 10-year bonds.
  - The inclusion of Issuance penalties that include additional costs from issuing in large size reduces the incidence of corner solutions with debt more evenly allocated across the curve.

Agenda

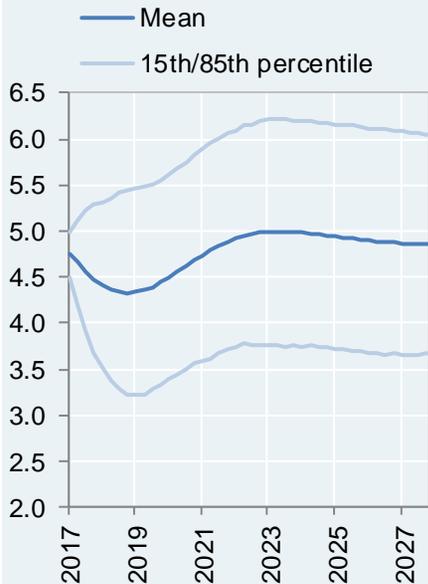TBAC CHARGE QUESTION: OPTIMIZATION MODELS FOR TREASURY DEBT

Motivation For Constructing A U.S. Debt Model

- A model allows a richer framework for considering debt management decisions than the historical exercise shown earlier
  - Simulate the range of outcomes that could take place going forward under various assumptions about the economy and interest rates
  - Measure some of the trade-offs involved in debt management decisions
  - Explore the sensitivity of those trade-offs to different assumptions about the behavior of the economy and rates

- TBAC members have been working on several different models that could be applied to the U.S. Treasury market
  - All models are a work in progress at this point
  - This presentation will show some preliminary results from one of those models
  - Those results provides an initial look at whether we see some of the same patterns that were described above for the models from other countries

- This effort should complement the work by the Office of Debt Management
  - ODM's quantitative strategies group has done extensive modeling of debt dynamics (see appendix for more detail)
  - Highly detailed models for tracking and analyzing debt characteristics, and able to do simulations to assess various debt management issues
  - Likely to be synergy between the various modeling efforts

A DEBT OPTIMIZATION FRAMEWORK FOR US TREASURIES
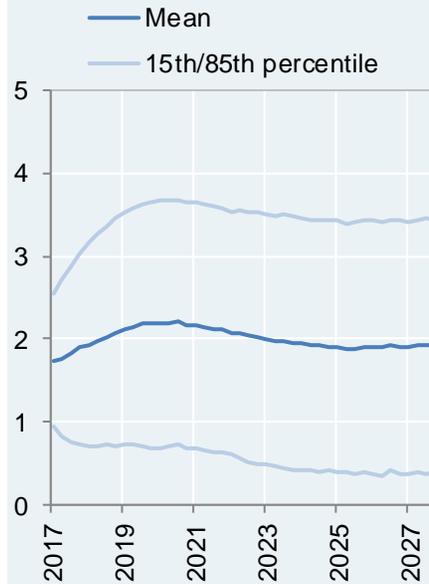
Structure Of The Model: Macro Equations

- Structure of the model involves equations for the following variables:
  - Unemployment rate (IS curve, expressed in terms of gap from full employment)
  - Inflation (Phillips curve)
  - Short -term interest rates (monetary policy rule)
  - Primary deficit (equation relating to business cycle)

- This structure describes macroeconomic dynamics in order to capture their effects on the evolution of Treasury borrowing needs and its funding rates
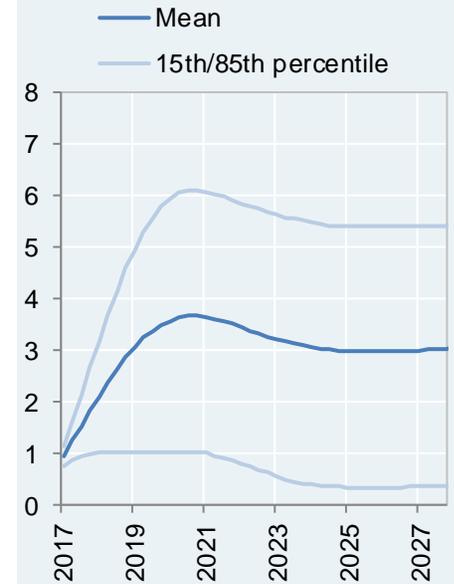 - Simulations of the model can be used to measure the uncertainty about these variables
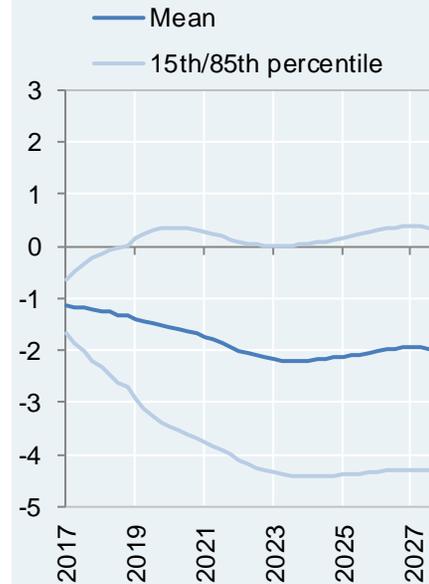
Structure Of The Model: Treasury Yield Equations

- Model explicitly focuses on the evolution of term premiums
  - Useful given the key importance of the term premium in debt management decisions

- The current version relies on a measure of term premiums from outside the model
  - Using the term premium measures from Adrian, Crump, and Moench (2013)*
  - Introduces some inconsistency with the structure of the macro equations that we assume gradually dissipates

- Macro variables in the model explain some, but not all, of the variation in term premiums
  - Rest of movements are assumed to be persistent but eventually mean-reverting

History of ACM Term Premium Measures
(pp)
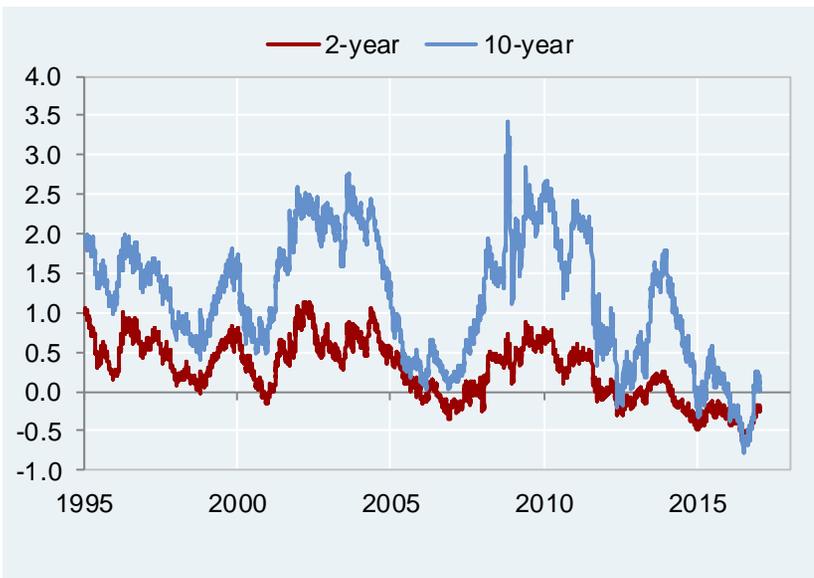
Distribution of Term Premium Measures in 10 Years
(pp)
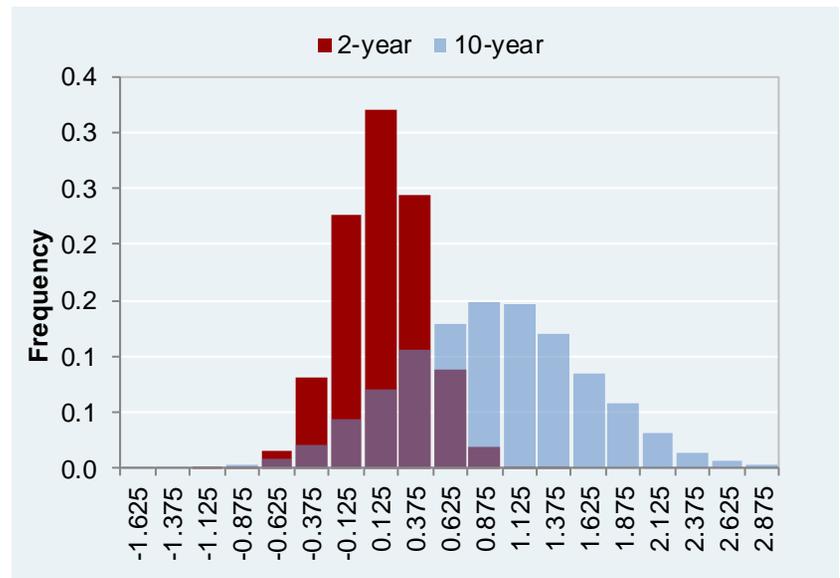
A DEBT OPTIMIZATION FRAMEWORK FOR US TREASURIES

Structure Of The Model: Other Components

- Structure captures how yield curve and deficits evolve given economic and other shocks
  - Determines the correlation of borrowing costs with deficits
  - Can run simulations for the next 10 years and beyond

- Debt stock dynamics
  - Track outstanding debt in terms of its maturity distribution and costs
  - Primary deficit and debt cost determine total budget deficit
  - Total deficit and maturing debt determine gross issuance needs

- Issuance assumptions
  - Need to make assumptions about how new issuance will be allocated across maturities
  - Here consider hypothetical issuance strategies where all debt issued at a single maturity point
  - These strategies are not realistic, but are simply intended to demonstrate trade-offs in the model
  - In running these simulations, we are ignoring constraints on issue sizes or any pressure on yields from supply

- Relevant statistics for debt management
  - We compute a variety of statistics for average debt cost and the variability of the budget under these assumptions
  - These statistics are computed for the simulated values at the end of a 10-year horizon

Relevant Statistics Under Concentrated Issuance Strategies

Macro Debt Model Simulations*

	Issuance strategy				
10-years ahead	Bills only	2y only	5y only	10y only	30y only
Average issuance rate	2.93	2.99	3.27	3.72	4.37
Average debt service / GDP	2.60	2.63	2.92	3.22	4.00
Standard deviation debt service / GDP	1.74	1.35	0.53	0.51	0.61
Standard deviation issuance rate	2.22	1.97	1.09	0.69	0.46
Standard deviation primary deficit / GDP	2.24	2.24	2.24	2.24	2.24
Correlation of issuance rate w/ primary deficit	-0.41	-0.55	-0.54	-0.15	-0.13
Standard deviation total deficit / GDP	2.37	2.48	2.50	2.52	2.59
Average WAM	1.4	2.1	3.3	5.1	23.6
Standard deviation WAM	0.1	0.1	0.1	0.3	0.4
Average WAC	2.97	3.00	3.24	3.49	4.15
Standard deviation WAC	2.04	1.61	0.61	0.26	0.17
Average debt / GDP	85	85	86	87	92
Standard deviation debt / GDP	11	12	15	16	16

*Based on simulations of 10,000 paths per issuance strategy.

Preliminary Observations From The Results

- The average cost of the debt is upward sloping in maturity of issuance
  - This pattern reflects the fact that the term premium in the model reverts to an average level that is upward sloping in maturity
  - A key issue is whether to assume this type of reversion towards historical averages
  - If the term premium instead stays closer to its current levels, long-term debt would be more attractive than suggested in the above results.

- The variation in debt cost falls notably as the maturity extends to intermediate horizons
  - This finding is similar to the result from other models—that a considerable reduction in the variability of debt cost is realized by extending from bills out to around the 5-year sector
  - The variability stabilizes and turns slightly higher at long maturities because of the variability of the term premium and the larger amount of debt that occurs when issuing at higher cost

- The correlation of rates and the economy makes issuing shorter-term debt more attractive
  - The standard deviation of the budget could be considered a more relevant measure for debt management than the standard deviation of the debt cost
  - The correlation of interest rates with the economy favors issuing shorter-term debt relative to longer-term debt under this metric
  - This pattern arises because issuing shorter term debt makes interest expense pro-cyclical, offsetting the counter-cyclical nature of the primary deficit

Agenda

TBAC CHARGE QUESTION: OPTIMIZATION MODELS FOR TREASURY DEBT

Debt Model Currently Used By US Treasury Office Of Debt Management

- QSG within the Office of Debt Management (ODM) has developed a number of quantitative models that are used in policy and market analyses

- ODM debt issuance models include the following characteristics:
  - Forward portfolio simulation for either 1yr for short term and 10yr for long term
    - Simulations are at the CUSIP-level and provides daily cash flows
  - Rates, deficits, CPI, SOMA assumptions (POMO purchases, sells, and reinvestment policy) are inputs which define a scenario
    - Daily fiscal flows projections provided from the Office of Fiscal Projections are used for short term model
    - Primary deficit, net interest, and other transactions affecting the borrowing from the public are provided by OMB and CBO's budget are used as inputs for the long term model.
  - Issue sizes constraints: lower/upper bounds, bounds on size changes, number of CMBs, issue ratios, etc.
    - Supply feedback effect on rates implicitly controlled by maximum size changes
  - Cash balance constraints: lower/upper bounds, hard targets on specific date(s), generally sufficient to cover one week of outflows, etc.
  - Optimize future issue sizes to minimize the present value of future debt-service costs
    - Linear programming problem
    - (rates, CPI, deficits, SOMA, constraints …) → Optimal-cost issuance/metrics

  - Fix market assumptions, vary constraints: see tradeoffs involved in changing policy (as embodied by constraints)
  - Fix constraints, vary market assumptions: see risk attached to a fixed policy window
  - Rate, CPI, deficit inputs may be stochastic (Monte Carlo simulation)
    - ODM has developed an internal joint nominal and real term structure model with shadow rate.
    - ODM has also implemented ACM term structure model for internal use.
    - Able to test Fed rate hike/hold scenarios as well as highly volatile rate environment.