Treasury Presentation to TBAC

Office of Debt Management

Fiscal Year 2020 Q3 Report

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Section I:
Executive Summary

Highlights of Treasury's August 2020 Quarterly Refunding Presentation to the Treasury Borrowing Advisory Committee (TBAC)

Receipts and Outlays through Q3 FY2020

- Through Q3 FY2020, overall receipts totaled $2,260 billion, reflecting a decrease of $351 billion (13%) on a calendar-adjusted basis compared to the same period last year due largely to the extension of tax deadlines until July. Decreases in non-withheld income and SECA taxes of $313 billion (-54%) due to tax extensions, gross corporate taxes of $77 billion (-38%) due to tax extensions as well as reduced liabilities stemming from law changes and the economic impact of COVID-19, and excise taxes of $23 billion (-31%) reflecting the fact that Health Insurance Provider fees paid in October 2018 were on moratorium in calendar year 2019 were partially offset by increases in Federal Reserve earnings of $15 billion (38%) and adjusted withheld and FICA taxes of $12 billion (1%) due to the strong growth that occurred before April 2020. FYTD 2020 receipts were 14.6% of GDP, compared to 16.4% of GDP in the same period last year.
- Through Q3 FY2020, overall outlays were $5,004 billion, reflecting an increase of $1,648 billion (49%) over the comparable period last year. Small Business Administration outlays are $537 billion higher due to subsidy estimates for the Paycheck Protection Program (PPP) and spending for the Economic Injury Disaster Loan (EIDL) program. Treasury outlays were $426 billion (73%) higher mainly due to Economic Impact stimulus payments and payments to the Coronavirus Relief Fund & Air Carrier Workers Support Fund stemming from the COVID-19 outbreak. Department of Labor outlays were $252 billion higher due to increased unemployment costs attributable to the COVID-19 outbreak. Health and Human Services spending was $226 billion (25%) higher mainly due to relief payments for hospitals as well as advance payments to fee for service Medicare providers, due to the COVID-19 outbreak as well as overall increases to Medicare and Medicaid. FYTD outlays were 32.3% of GDP, compared to 21.1% of GDP for the same period last year.

Projected Net Marketable Borrowing (FY2020)

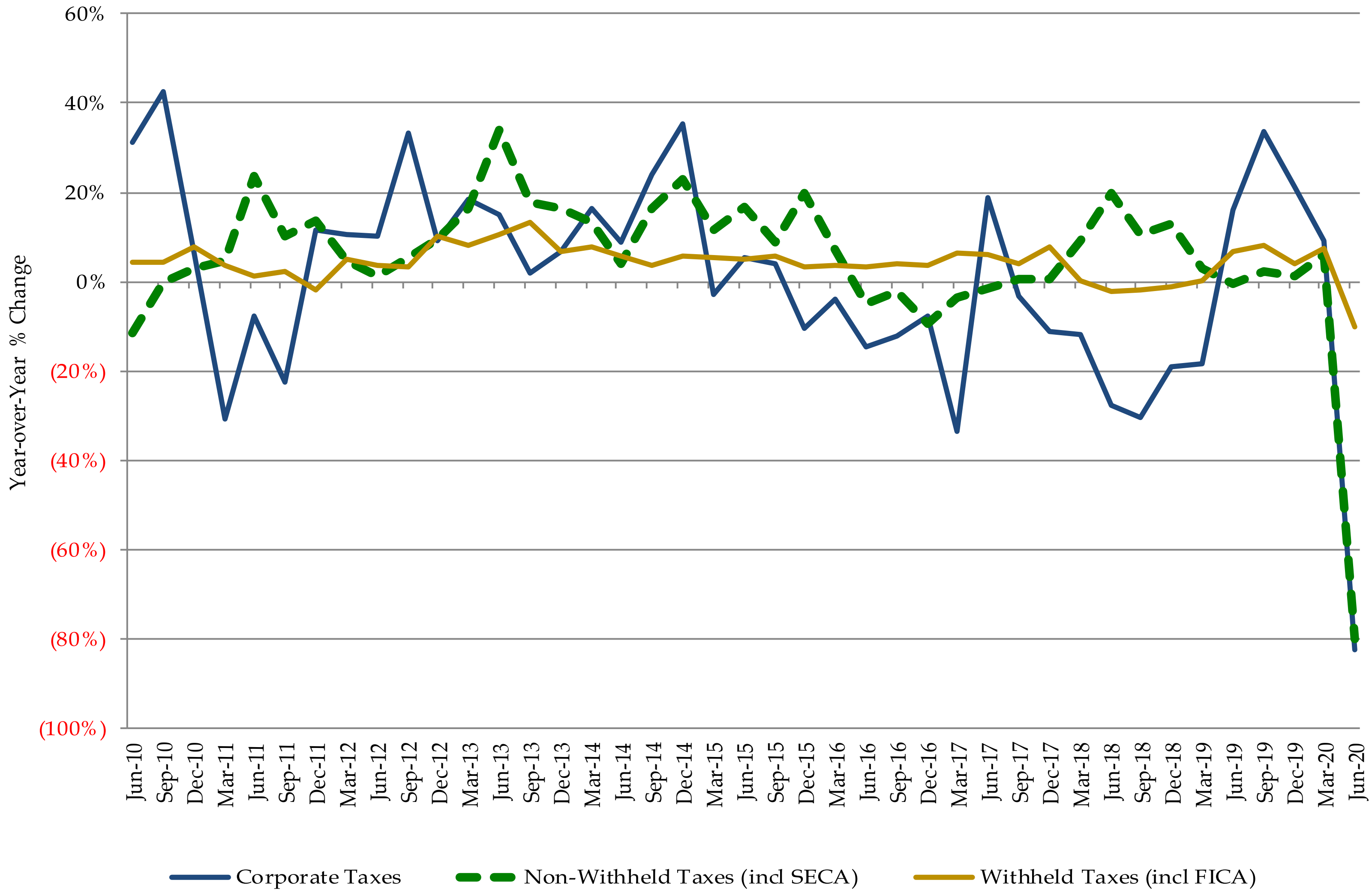
- Treasury's Office of Fiscal Projections (OFP) currently forecasts a net privately-held marketable borrowing need of $947 billion for Q4 FY2020, with an end-of-September cash balance of $800 billion. For Q1 FY2021, OFP forecasts a net privately-held marketable borrowing need of $1,216 billion assuming end-of-December cash balance of $800 billion. The aforementioned estimates reflect OFP's assumption of $1,000 billion in additional stimulus. Privately-held marketable borrowing excludes rollovers (auction "add-ons") of Treasury securities held in the Federal Reserve's System Open Market Account (SOMA) but includes financing required due to SOMA redemptions. Secondary market purchases of Treasury securities by SOMA do not directly change net privately-held marketable borrowing but, all else equal, when the securities mature and assuming the Fed does not redeem any maturing securities would increase the amount of cash raised for a given privately-held auction size by increasing the SOMA "add-on" amount.

Demand for Treasury Securities

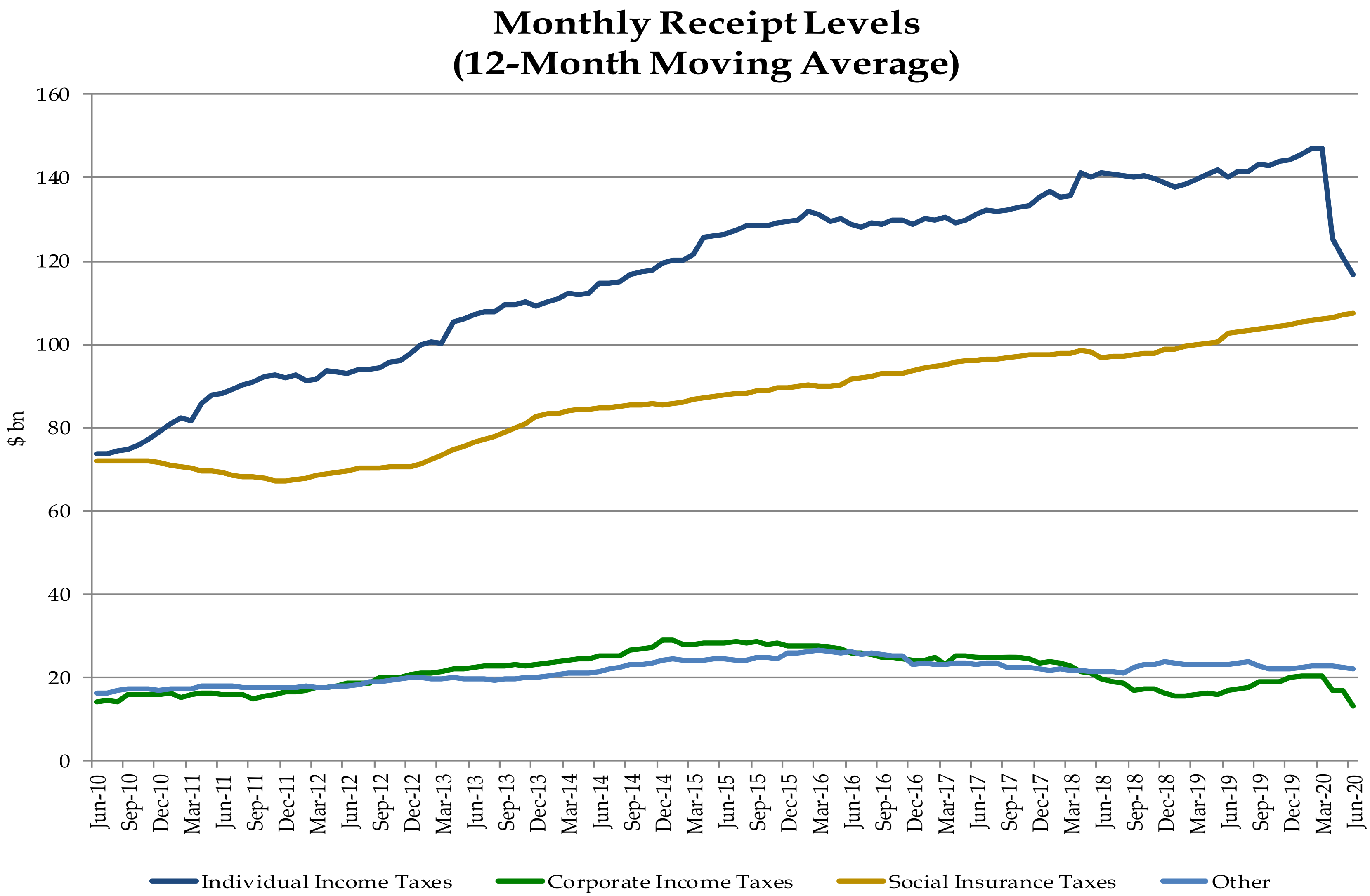
- Bid-to-cover ratios for all securities were typically within historical ranges over the last quarter.
- High demand for Treasury bills with about $2.4 trillion of net issuance from 3/31/2020 through 6/30/2020.
- Foreign demand increased.

Section II:
Fiscal

Quarterly Tax Receipts

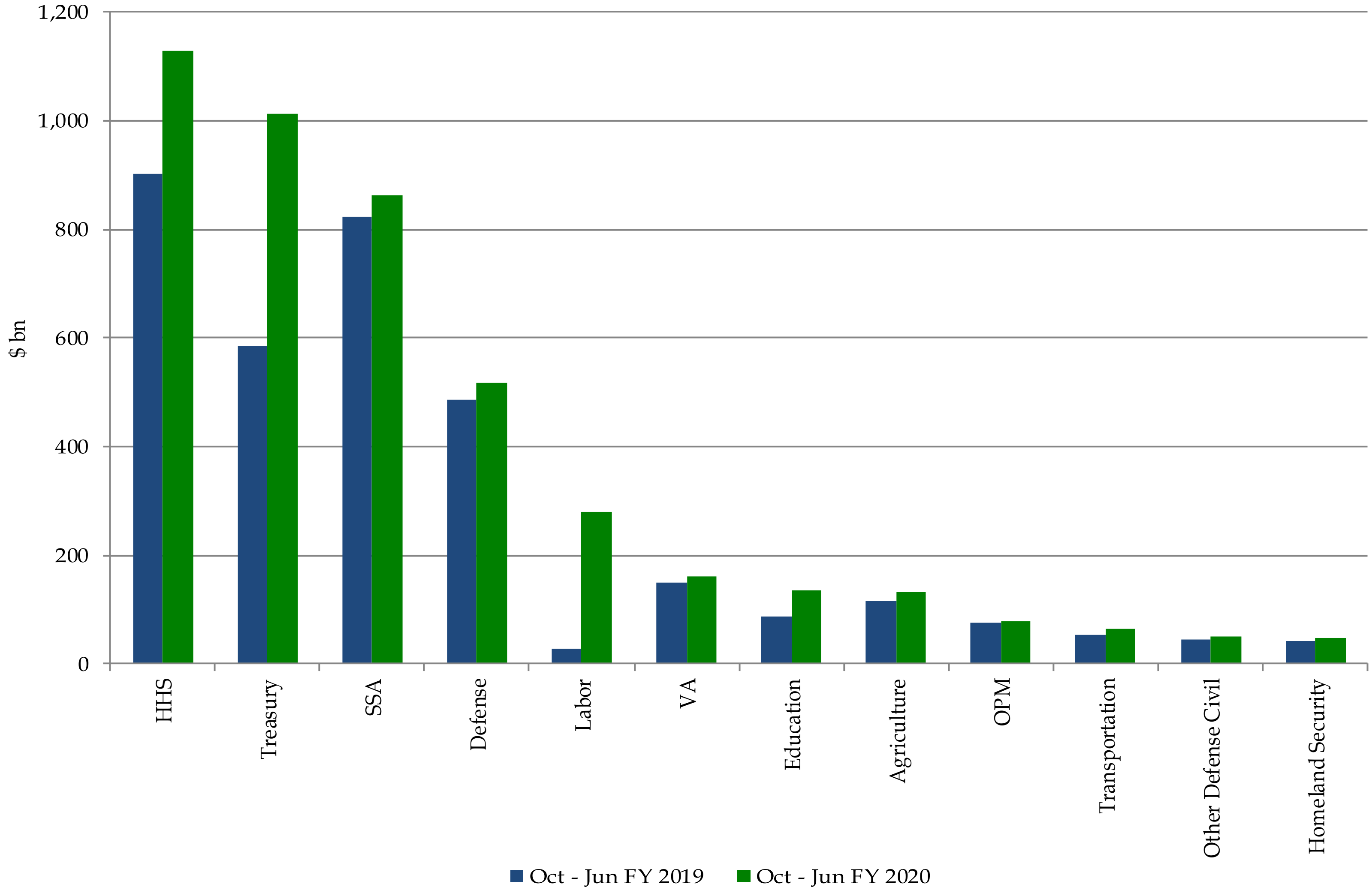


Quarterly tax receipts for Q3 FY2020 reflect adjustment of April and June 2020 tax deadlines to July 15th, 2020.
Source: United States Department of the Treasury



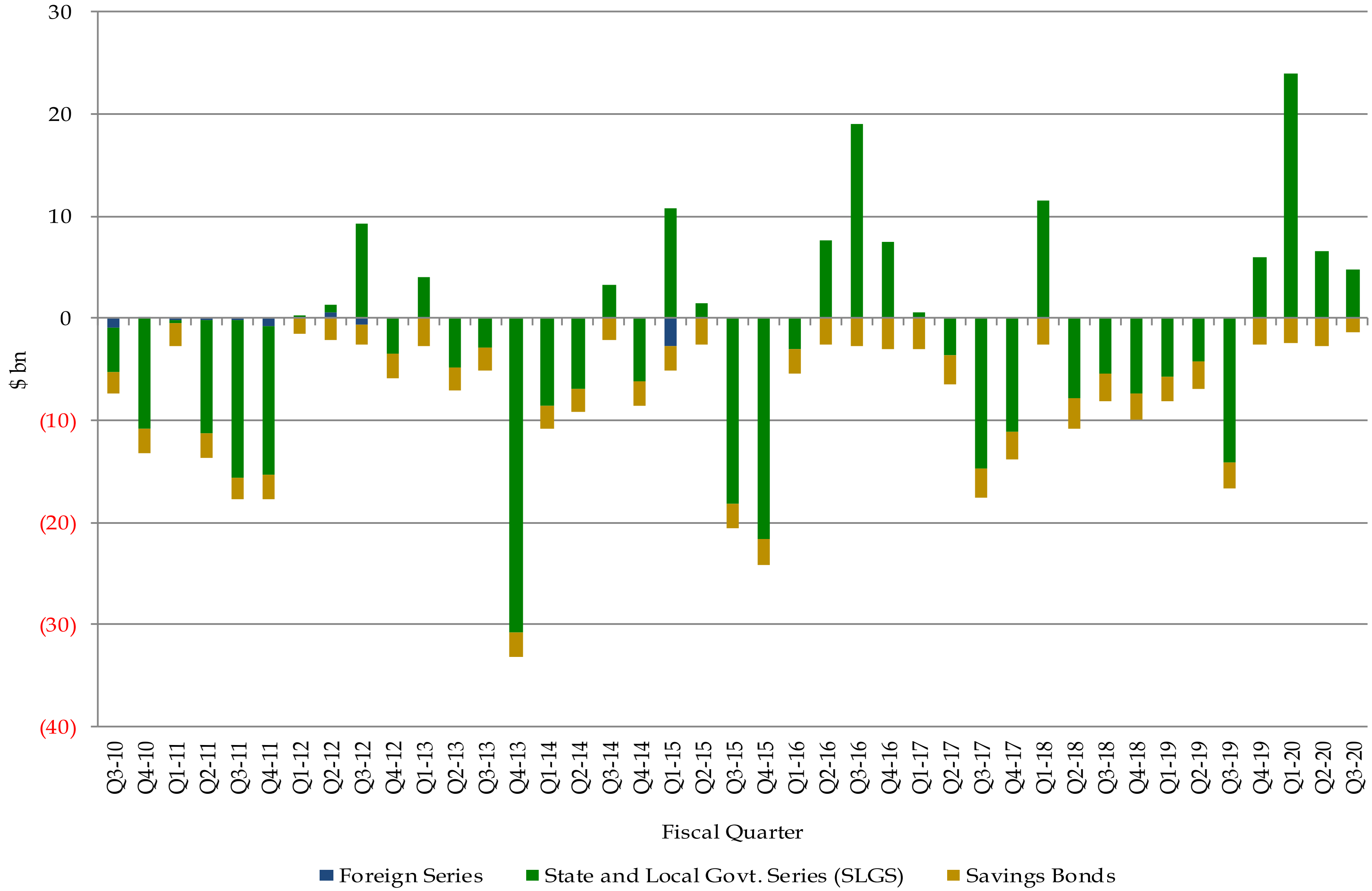
Quarterly tax receipts for Q3 FY2020 reflect adjustment of April and June 2020 tax deadlines to July 15th, 2020. Individual Income Taxes include withheld and non-withheld. Social Insurance Taxes include FICA, SECA, RRTA, UTF deposits, FUTA and RUIA. Other includes excise taxes, estate and gift taxes, customs duties and miscellaneous receipts.
Source: United States Department of the Treasury

Largest Outlays



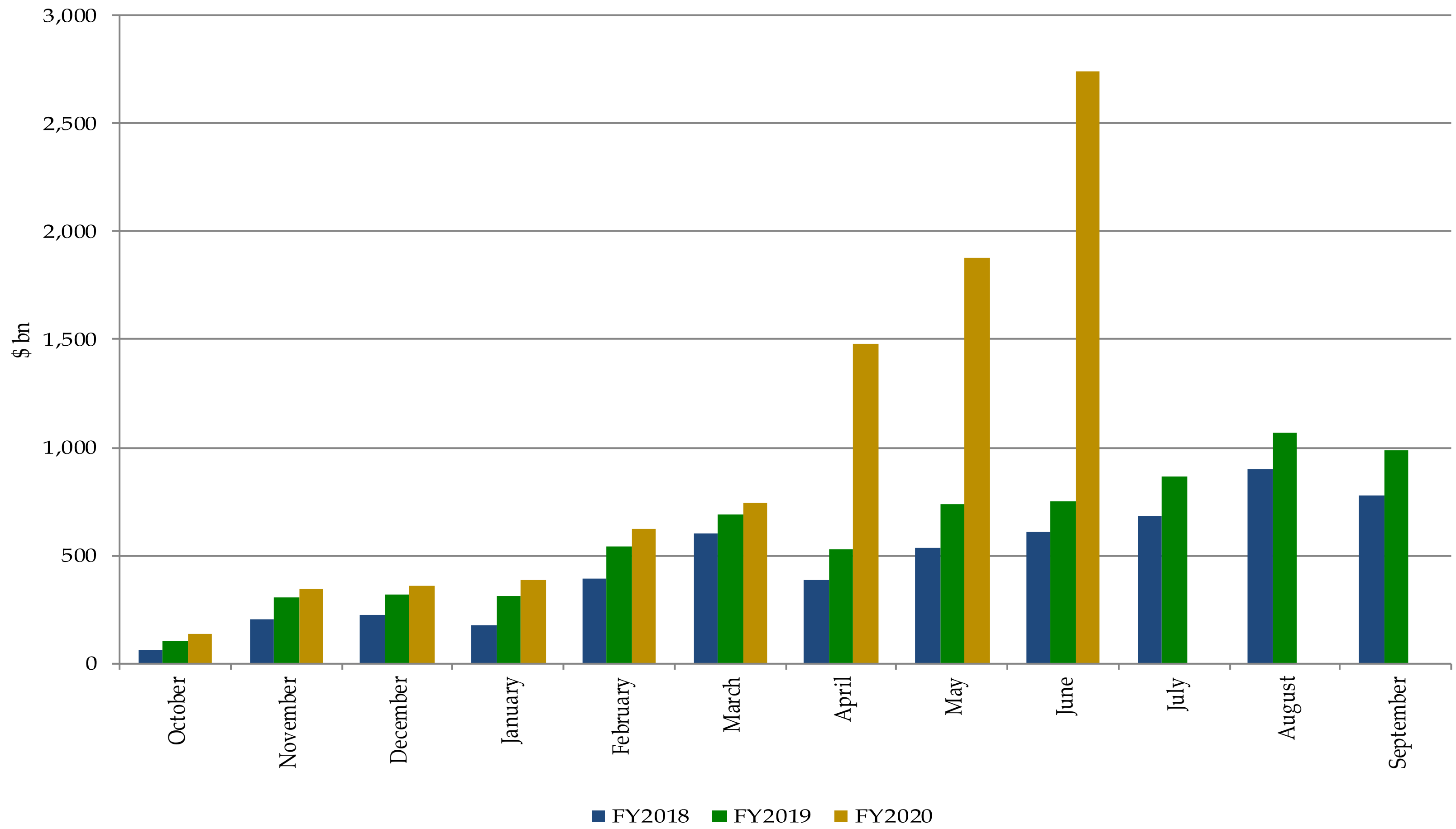
Source: United States Department of the Treasury

Treasury Net Privately-Held Nonmarketable Borrowing



Source: United States Department of the Treasury

Cumulative Budget Deficits by Fiscal Year



Source: United States Department of the Treasury

FY 2020-2022 Deficits and Privately-Held Net Marketable Borrowing Estimates, in $ billions

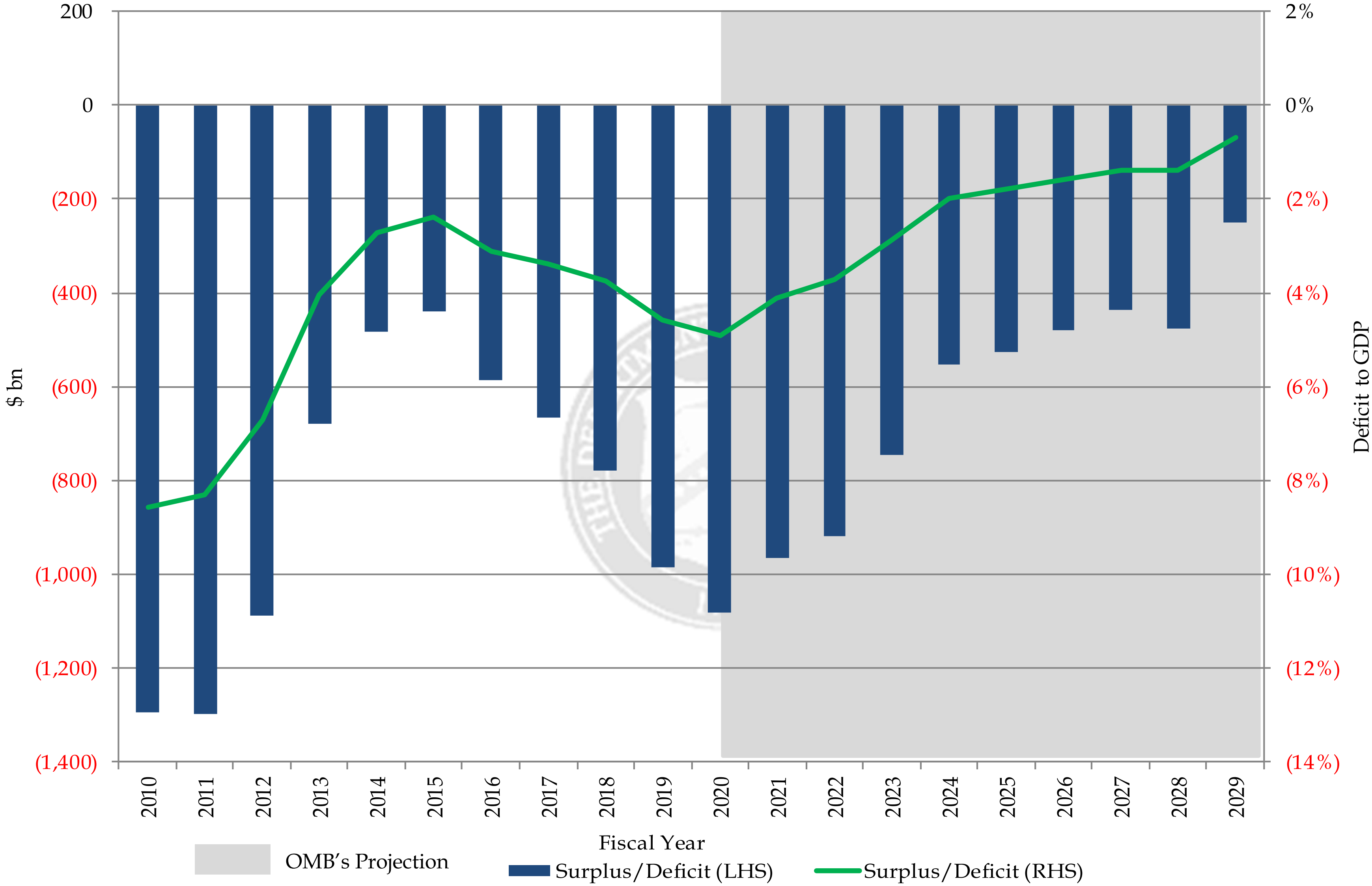
	Primary Dealers[1]	OFP[2]	CBO[3]
FY2020 Deficit Estimate	3,950		3,700
FY2021 Deficit Estimate	2,500		2,100
FY2022 Deficit Estimate	1,500		
FY2020 Deficit Estimate Range	2,950-5,000		
FY2021 Deficit Estimate Range	1,965-3,500		
FY2022 Deficit Estimate Range	1,100-2,500		
FY2020 Privately-Held Net Marketable Borrowing Estimate	4,250	4,508	
FY2021 Privately-Held Net Marketable Borrowing Estimate	2,213		
FY2022 Privately-Held Net Marketable Borrowing Estimate	1,500		
FY2020 Privately-Held Net Marketable Borrowing Range	3,120-5,600		
FY2021 Privately-Held Net Marketable Borrowing Range	1,500-3,500		
FY2022 Privately-Held Net Marketable Borrowing Range	700-2,500		
FY2020 Ending Cash Balance	1,200	800	
FY2020 Ending Cash Balance Range	731 - 1,600		
Estimates as of:	Jul-20	Aug-20	Apr-20

[1]Estimates represent the medians from the primary dealer survey in July 2020. FY2020 primary dealer borrowing estimate would be $3,825 billion if normalized for $800 billion cash balance.

[2]Treasury's Office of Fiscal Projections (OFP) borrowing estimates announced on August 3, 2020. Estimates reflect OFP's assumption of $1,000 billion in additional stimulus.

[3]CBO FY2020 and FY2021 deficit estimates are from CBO's blog "CBO's Current Projections of Output, Employment, and Interest Rates and a Preliminary Look at Federal Deficits for 2020 and 2021," April 24, 2020 @ https://www.cbo.gov/publication/56335.

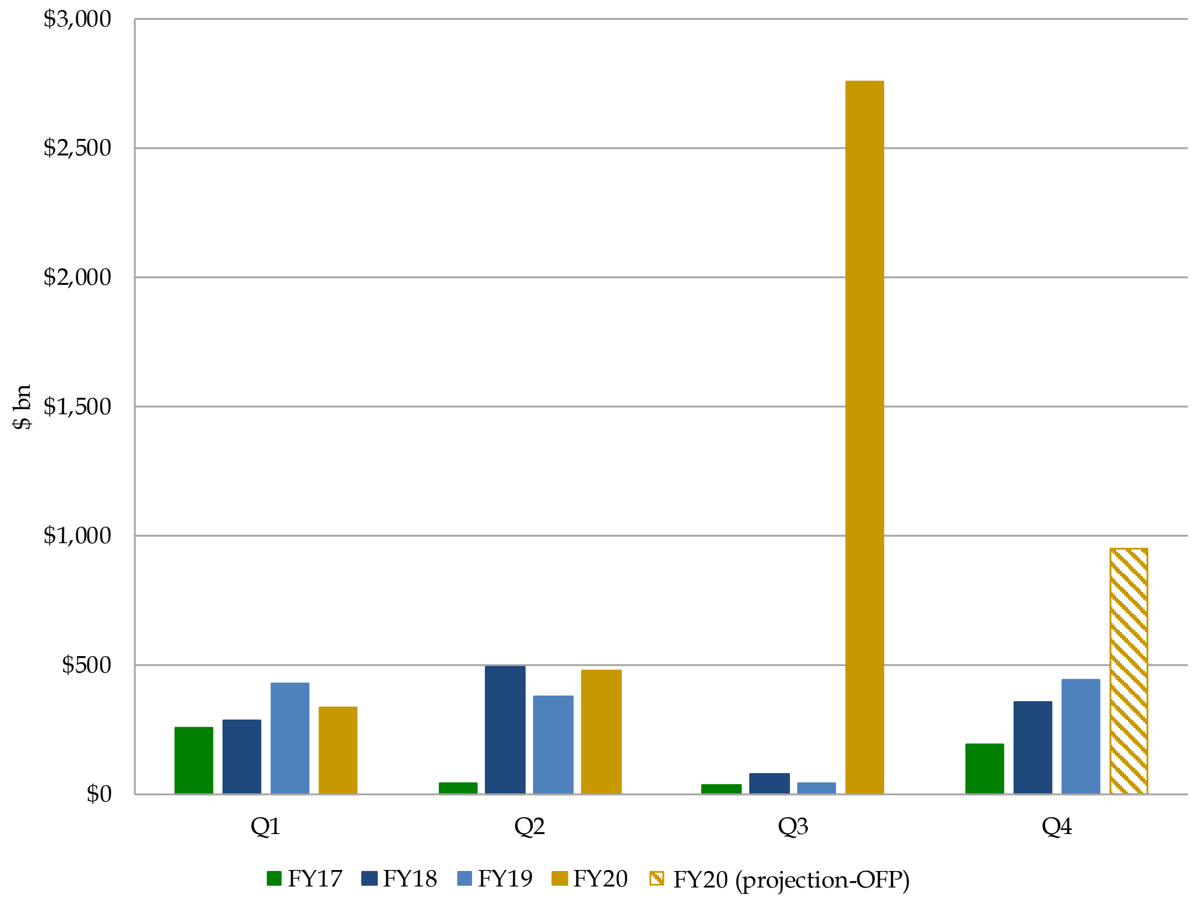
Budget Surplus/Deficit*



Projections are from OMB's Table S-10 of "A Budget for America's Future, Fiscal Year 2021," February 2020.

***OMB projections reflect pre-CARES Act forecasts and will be updated when new projections become available.**

Privately-Held Net Marketable Borrowing Outlook*



* Privately-held marketable borrowing excludes rollovers (auction "add-ons") of Treasury securities held in the Federal Reserve's System Open Market Account (SOMA) but includes financing required due to SOMA redemptions. Secondary market purchases of Treasury securities by SOMA do not directly change net privately-held marketable borrowing but, all else equal, when the securities mature and assuming the Fed does not redeem any maturing securities, would increase the amount of cash raised for a given privately-held auction size by increasing the SOMA "add-on" amount. For FY2020 and FY2021, estimates reflect OFP's assumption of $1,000 billion in additional stimulus.

Section III:
Financing

Assumptions for Financing Section (pages 16 to 21)

- Portfolio and SOMA holdings as of 06/30/2020.
- Estimates assume private announced issuance sizes and patterns remain constant for nominal coupons, TIPS, and FRNs given changes made before the August 2020 refunding, while using total bills outstanding of ~$5.08 trillion.
- The principal on the TIPS securities was accreted to each projection date based on market ZCIS levels as of 06/30/2020.
- No attempt was made to account for future financing needs.

Sources of Privately-Held Financing in FY20 Q3*^

April to June 2020	
Net Bill Issuance	2422
Net Coupon Issuance	331
Subtotal: Net Marketable Borrowing	2753
Ending Cash Balance	1722
Beginning Cash Balance	515
Subtotal: Change in Cash Balance	1207
Net Implied Funding for FY20 Q3	1546

	April to June 2020 Bill Issuance			Fiscal Year-to-Date Bill Issuance		
Security	Gross	Maturing	Net	Gross	Maturing	Net
4-Week	1,020	970	50	2,280	2,223	57
8-Week	855	685	170	1,935	1,700	235
13-Week	768	558	210	1,908	1,653	255
26-Week	660	453	207	1,668	1,419	249
52-Week	93	38	55	279	212	67
CMBs						
6-Week	870	525	345	870	525	345
15-Week	485	0	485	485	0	485
17-Week	460	0	460	460	0	460
22-Week	480	0	480	480	0	480
39-Week	70	0	70	70	0	70
Other	125	235	(110)	290	290	0
Bill Subtotal	5,886	3,464	2,422	10,725	8,022	2,703

	April to June 2020 Coupon Issuance			Fiscal Year-to-Date Coupon Issuance		
Security	Gross	Maturing	Net	Gross	Maturing	Net
2-Year FRN	62	49	13	174	135	39
2-Year	132	94	38	372	227	145
3-Year	126	70	56	354	214	140
5-Year	135	101	34	381	336	45
7-Year	114	61	53	306	179	127
10-Year	86	31	55	236	111	125
20-Year	37	0	37	37	0	37
30-Year	58	2	56	160	5	155
5-Year TIPS	32	55	(23)	64	55	9
10-Year TIPS	12	0	12	50	21	29
30-Year TIPS	0	0	0	8	0	8
Coupon Subtotal	794	463	331	2,142	1,284	858

Total	6,680	3,927	2,753	12,867	9,307	3,560

*Privately-held marketable borrowing excludes rollovers (auction "add-ons") of Treasury securities held in the Federal Reserve's System Open Market Account (SOMA) but includes financing required due to SOMA redemptions. Secondary market purchases of Treasury securities by SOMA do not directly change net privately-held marketable borrowing but, all else equal, when the securities mature and assuming the Fed does not redeem any maturing securities, would increase the amount of cash raised for a given privately-held auction size by increasing the SOMA "add-on" amount.
^An end-of-June 2020 cash balance of $1,722 billion versus a beginning-of-April 2020 cash balance of $515 billion. By keeping the cash balance constant, Treasury arrives at the net implied funding number.

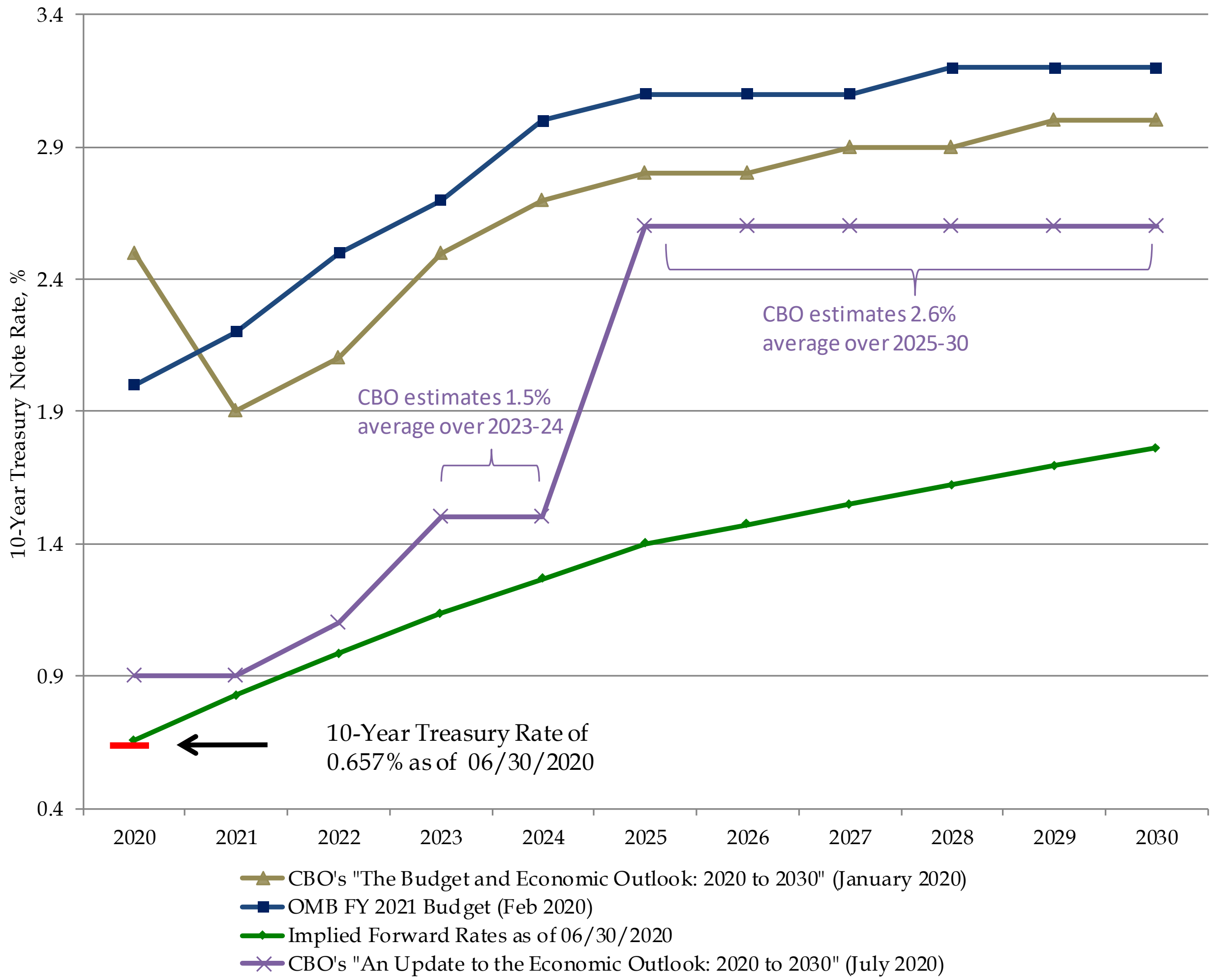
Sources of Privately-Held Financing in FY20 Q4*

July - September 2020	
Assuming Constant Coupon Issuance Sizes**	
Treasury Announced Net Marketable Borrowing***	947
Net Coupon Issuance	447
Implied Change in Bills	500

Security	July - September 2020 Coupon Issuance Gross	Maturing^	Net	Fiscal Year-to-Date Coupon Issuance Gross	Maturing	Net
2-Year FRN	68	52	16	242	187	55
2-Year	144	93	51	516	321	195
3-Year	138	56	82	492	270	222
5-Year	147	90	57	528	426	102
7-Year	132	60	72	438	239	199
10-Year	90	30	60	326	141	185
20-Year	54	0	54	91	0	91
30-Year	60	5	55	220	10	210
5-Year TIPS	0	0	0	64	55	9
10-Year TIPS	26	33	(7)	76	54	22
30-Year TIPS	7	0	7	15	0	15
Coupon Subtotal	866	419	447	3,008	1,703	1,305

* Privately-held marketable borrowing excludes rollovers (auction “add-ons”) of Treasury securities held in the Federal Reserve’s System Open Market Account (SOMA) but includes financing required due to SOMA redemptions. Secondary market purchases of Treasury securities by SOMA do not directly change net privately-held marketable borrowing but, all else equal, when the securities mature and assuming the Fed does not redeem any maturing securities, would increase the amount of cash raised for a given privately-held auction size by increasing the SOMA “add-on” amount.
** Keeping announced issuance sizes and patterns constant for nominal coupons, TIPS, and FRNs based on changes made before the August 2020 refunding.
*** Assumes an end-of-September 2020 cash balance of $800 billion versus a beginning-of-July 2020 cash balance of $1,722 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
^ Maturing amounts could change based on future Federal Reserve purchases.

Interest Rate Assumptions: 10-Year Treasury Note*

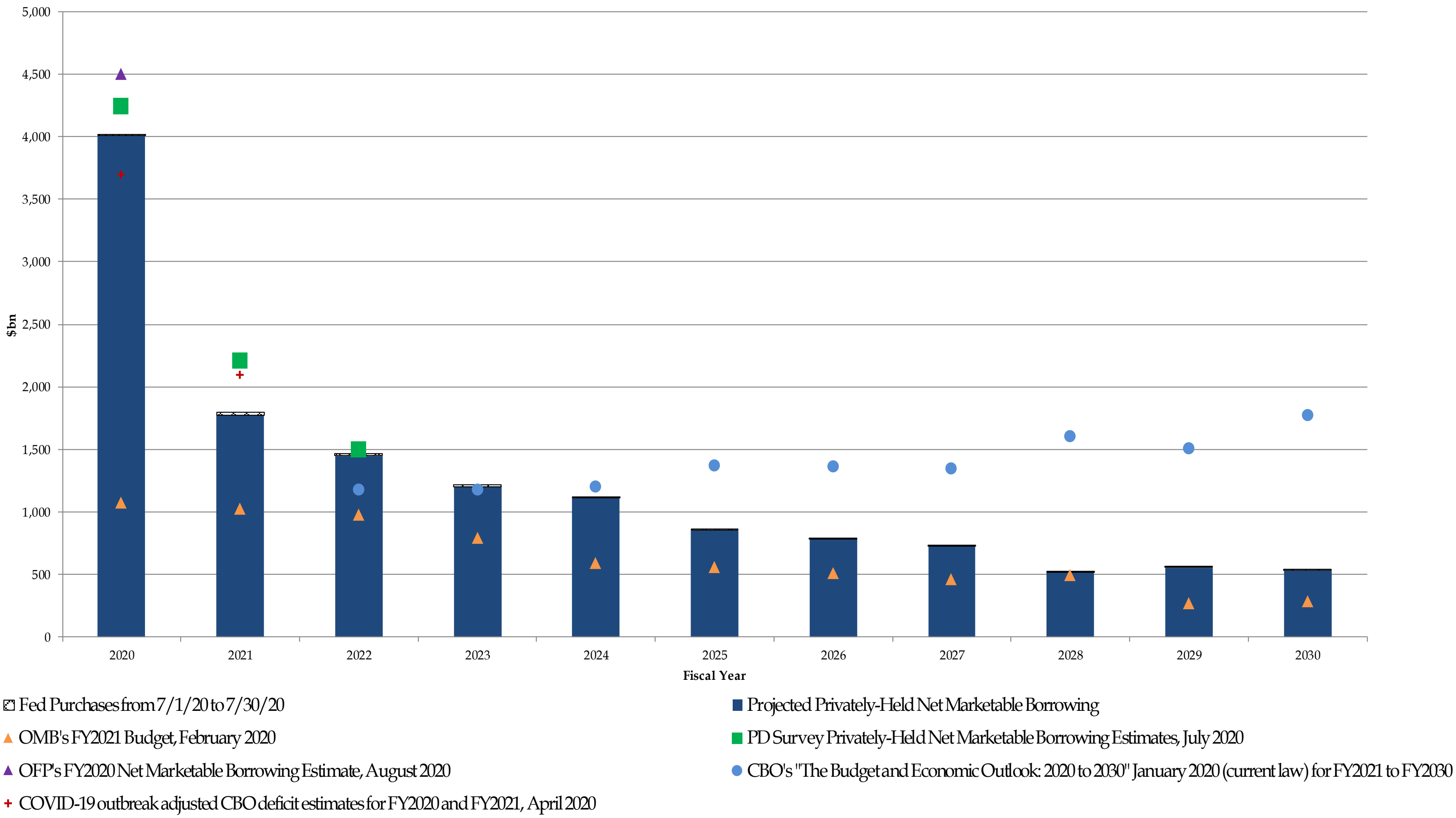


OMB's economic assumption of the 10-Year Treasury note rates reflect the calendar year average from Table S-9 of OMB's "A Budget for America's Future, Fiscal Year 2021," February 2020. CBO's January economic assumption of the 10-Year Treasury note rates reflect the fiscal year average from Table B-2 of CBO's "The Budget and Economic Outlook: 2020 to 2030," January 2020. CBO's July economic assumption of the 10-Year Treasury note rates reflect projections for 2020, 2021, 2022, and averages for the periods 2023-24 and 2025-30. The forward rates are the implied 10-Year Treasury note rates on June 30, 2020.

***Both OMB and CBO projections from January and February reflect pre-CARES Act forecasts and will be updated when new projections become available.**

Projected Privately-Held Net Marketable Borrowing

Assuming Private Coupon Issuance & Total Bills Outstanding Remain Constant as of 6/30/2020*



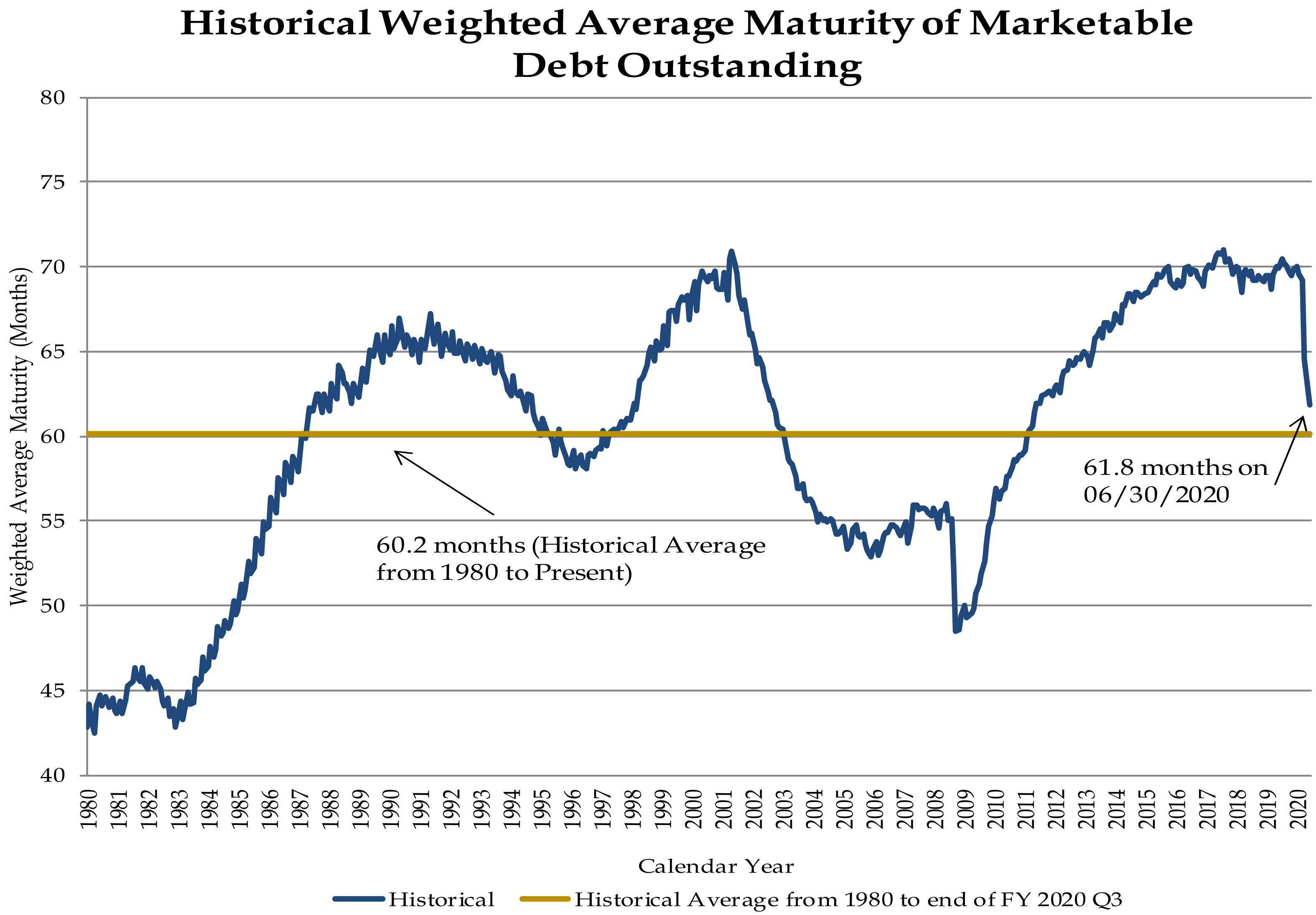
Treasury's latest primary dealer survey median estimates can be found on page 11. FY2020 primary dealer borrowing estimate would be $3,825 billion if normalized for $800 billion cash balance. OMB's projections of the change in debt held by the public are from Table S-10 of "A Budget for America's Future, Fiscal Year 2021," February 2020. CBO's current law budget projections of the change in debt held by the public for FY2022 to FY2030 are from 1-2 of CBO's "The Budget and Economic Outlook: 2020 to 2030," January 2020.

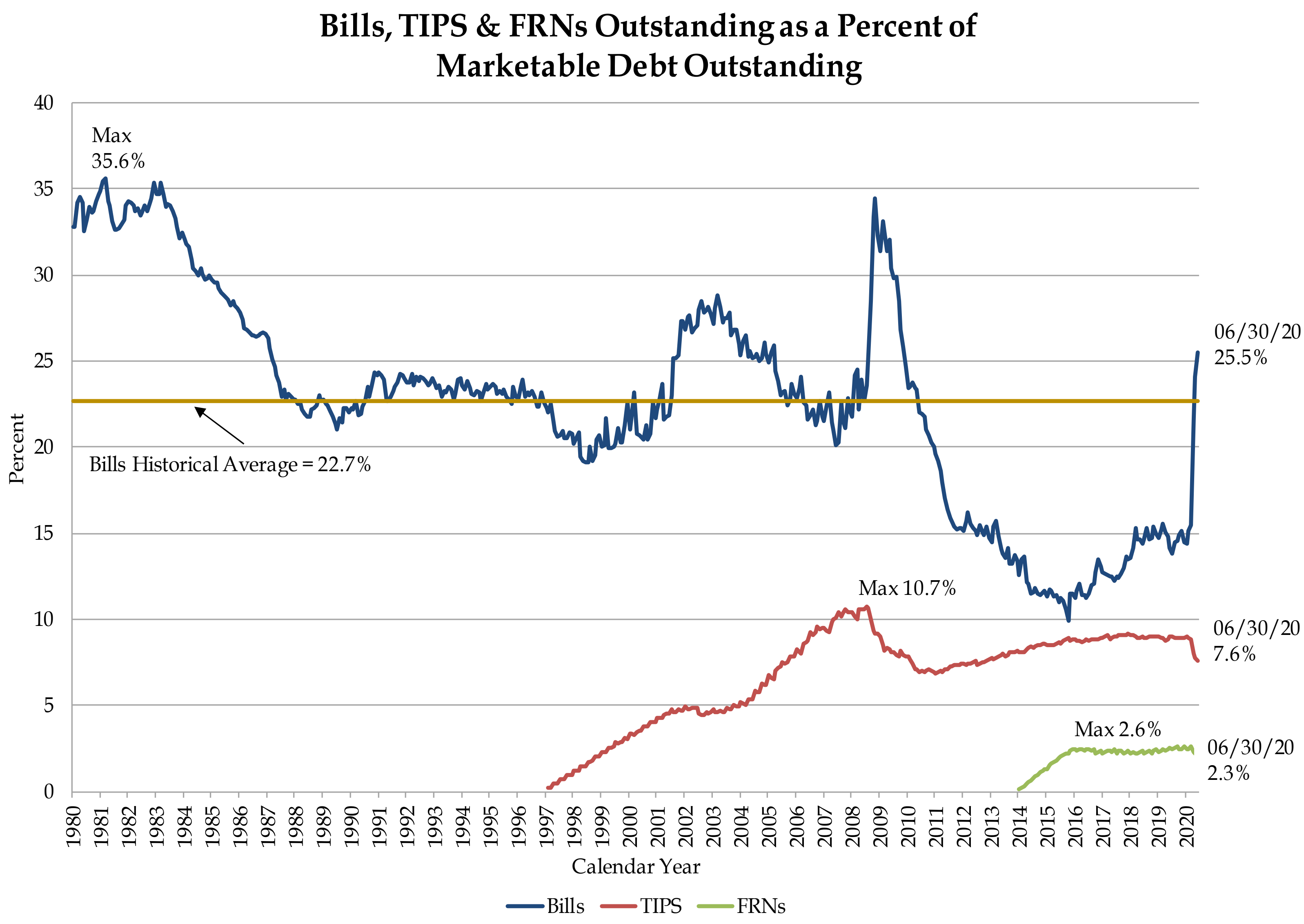
* Privately-held marketable borrowing excludes rollovers (auction "add-ons") of Treasury securities held in the Federal Reserve's System Open Market Account (SOMA) but includes financing required due to SOMA redemptions. No adjustments are made for open-market outright purchases.

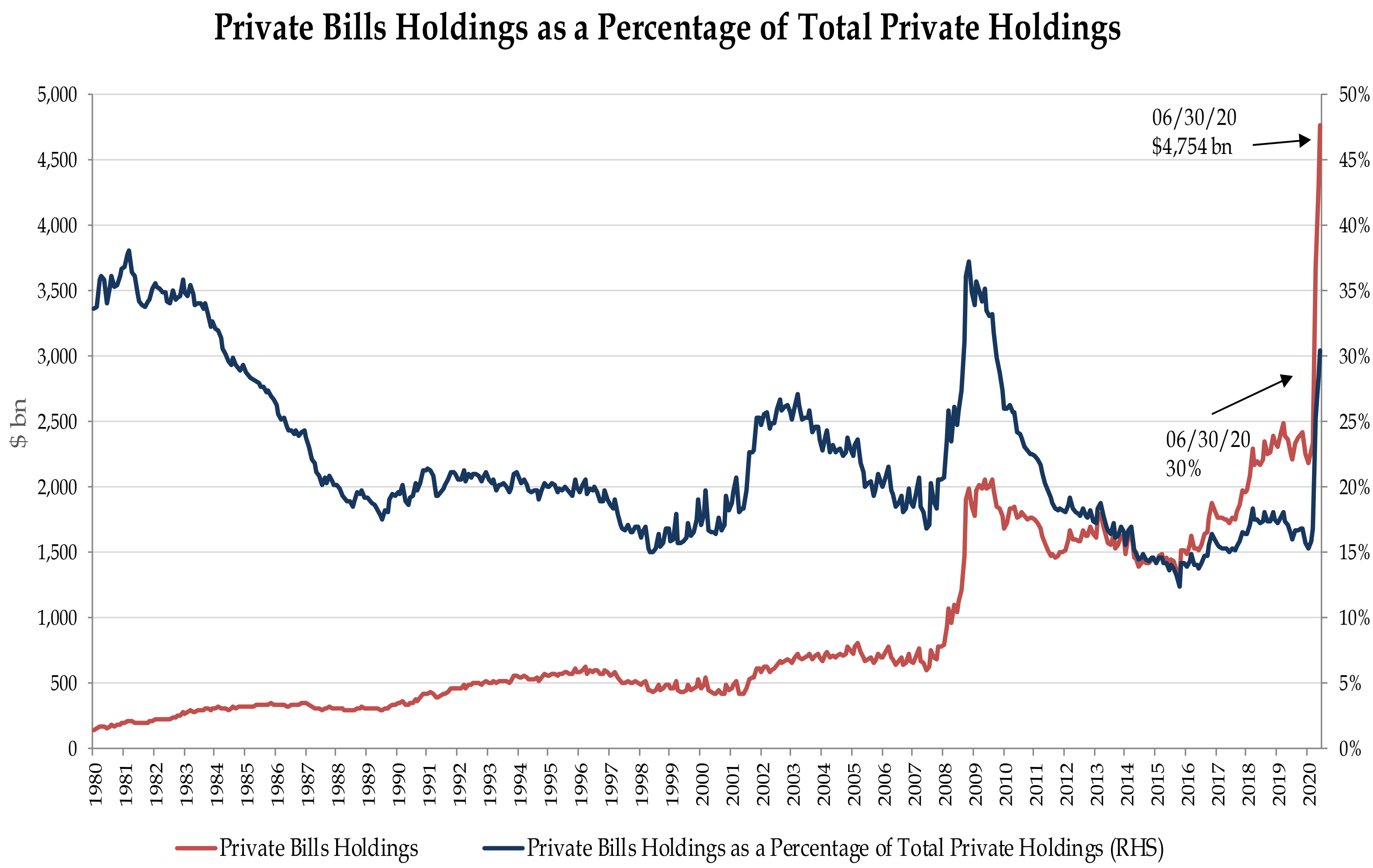
For FY2020 and FY2021, COVID-19 outbreak adjusted CBO projections are deficit estimates, which can be found in CBO's blog "CBO's Current Projections of Output, Employment, and Interest Rates and a Preliminary Look at Federal Deficits for 2020 and 2021," April 24, 2020 @ https://www.cbo.gov/publication/56335.

Both OMB and CBO projections before April 2020 reflect pre-CARES Act forecasts and will be updated when new projections become available.

Section IV:
Portfolio Metrics

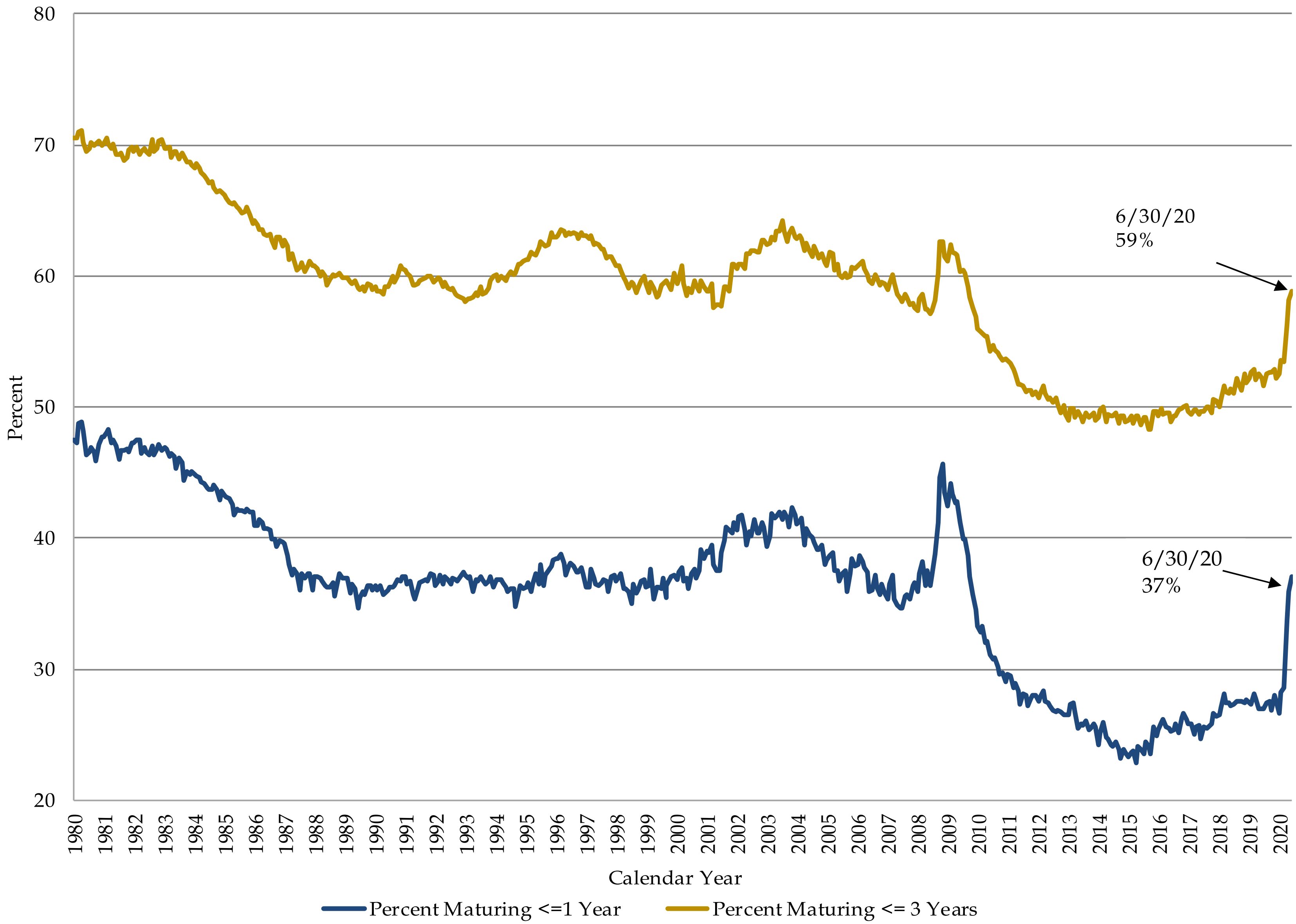

Historical Weighted Average Maturity of Marketable
Debt Outstanding
80
75
70
65
60
55
50
45
40
Weighted Average Maturity (Months)
60.2 months (Historical Average
from 1980 to Present)
61.8 months on
06/30/2020
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Calendar Year
Historical
Historical Average from 1980 to end of FY 2020 Q3


Bills, TIPS & FRNs Outstanding as a Percent of Marketable Debt Outstanding
40
35
30
25
20
15
10
5
0
Percent
Max
35.6%
Bills Historical Average = 22.7%
Max 10.7%
Max 2.6%
06/30/20
25.5%
06/30/20
7.6%
06/30/20
2.3%
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Calendar Year
Bills
TIPS
FRNs



Private Bills Holdings as a Percentage of Total Private Holdings
$ bn
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
06/30/20
$4,754 bn
06/30/20
30%
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Private Bills Holdings
Private Bills Holdings as a Percentage of Total Private Holdings (RHS)

Treasury Maturity Profile History



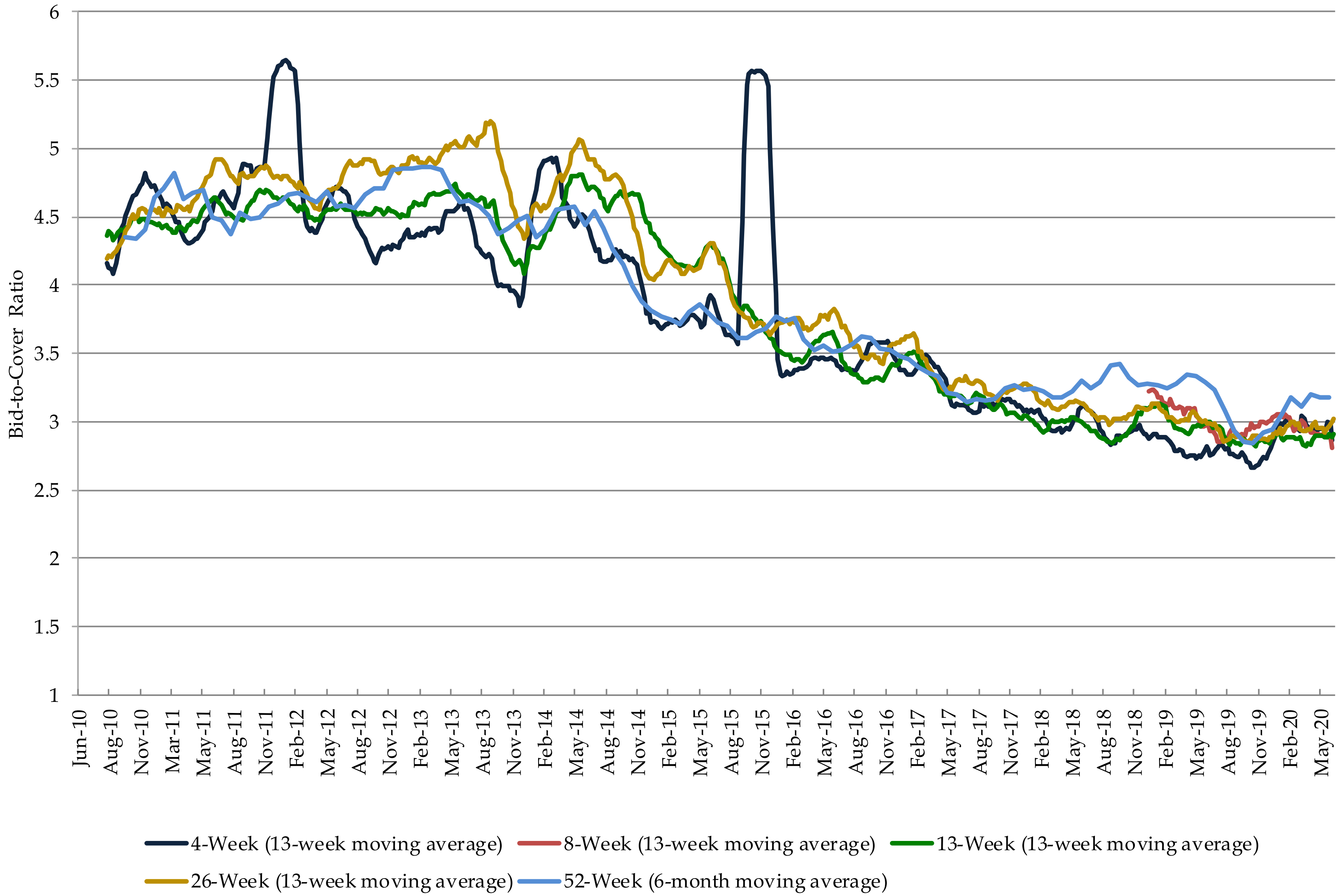
Section V:
Demand

Summary Statistics for Fiscal Year 2020 Q3 Auctions

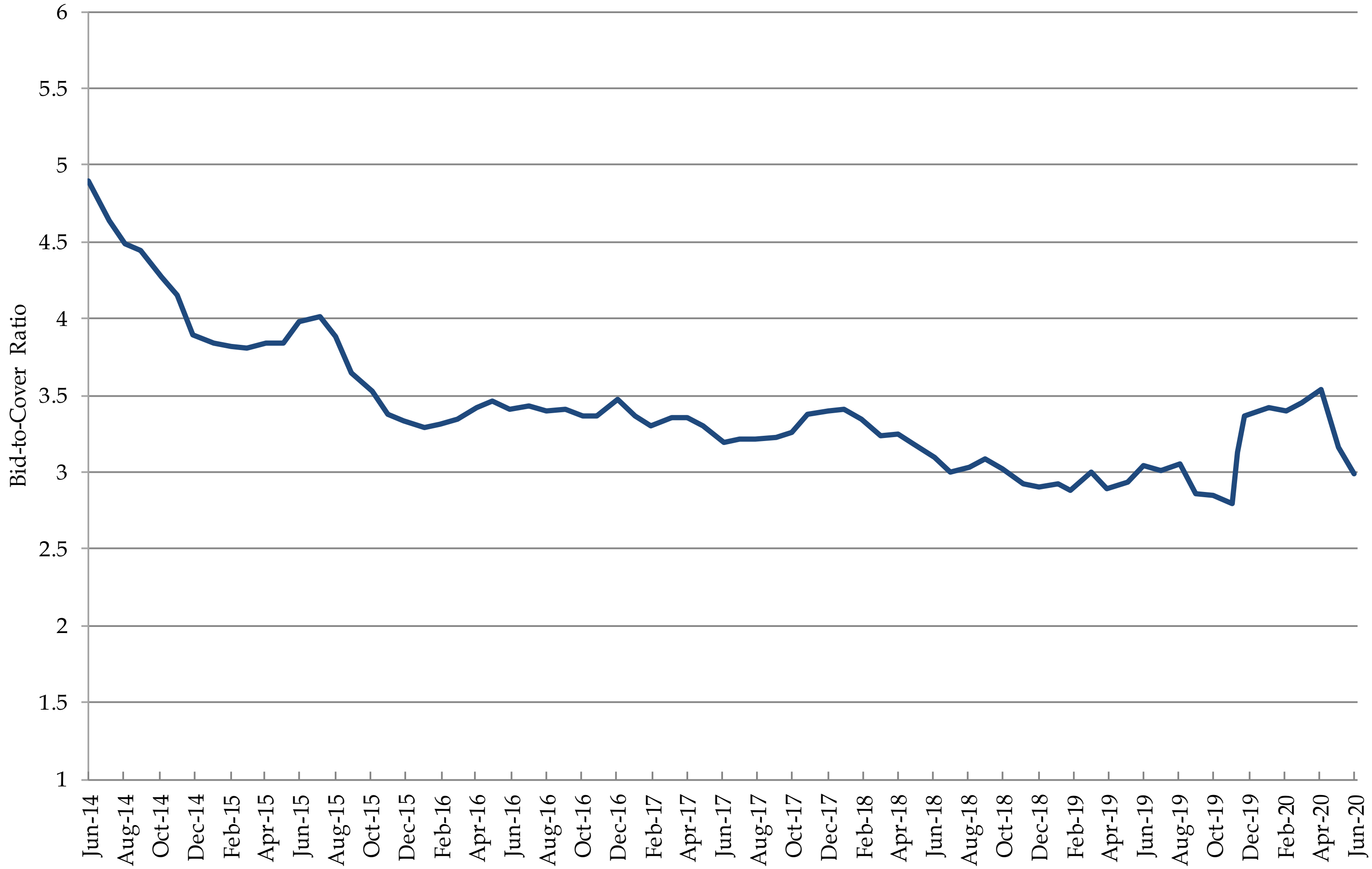
Security Type	Term	Stop Out Rate (%)*	Bid-to-Cover Ratio*	Competitive Awards ($bn)	% Primary Dealer*	% Direct*	% Indirect*	Non-Competitive Awards ($bn)	SOMA "Add-Ons" ($bn)	10-Year Equivalent ($bn)**
Bill	4-Week	0.117	2.9	1001.2	39.8	2.6	57.6	18.76	46.2	8.7
Bill	8-Week	0.138	2.8	846.3	45.0	3.5	51.4	8.69	38.9	14.6
Bill	13-Week	0.149	2.9	755.4	48.8	4.2	47.0	15.64	70.5	22.2
Bill	26-Week	0.170	3.0	656.6	48.4	4.5	47.2	12.45	61.2	38.6
Bill	52-Week	0.176	3.2	92.2	58.9	7.7	33.4	0.76	11.2	11.0
CMB	6-Week	0.126	2.9	844.8	42.3	3.3	54.5	0.16	0.0	10.4
CMB	15-Week	0.149	3.2	485.0	48.0	1.9	50.1	0.03	0.0	14.7
CMB	17-Week	0.157	3.2	494.8	51.0	4.9	44.2	0.18	0.0	17.1
CMB	22-Week	0.171	3.0	480.0	50.8	3.7	45.5	0.04	0.0	21.5
CMB	39-Week	0.175	3.2	70.0	71.5	6.8	21.7	0.01	0.0	5.5
CMB	Other	0.194	2.9	80.0	49.4	2.1	48.6	0.00	0.0	1.6
Coupon	2-Year	0.199	2.7	131.4	30.0	16.4	53.6	0.62	14.6	31.0
Coupon	3-Year	0.285	2.5	125.8	35.0	10.7	54.3	0.18	23.0	48.1
Coupon	5-Year	0.352	2.5	135.0	24.4	15.5	60.0	0.05	14.9	78.7
Coupon	7-Year	0.529	2.5	114.0	22.3	13.5	64.1	0.02	12.6	92.0
Coupon	10-Year	0.768	2.5	86.0	26.3	12.8	60.9	0.01	17.4	106.5
Coupon	20-Year	1.263	2.6	37.0	23.3	15.5	61.1	0.01	4.4	76.3
Coupon	30-Year	1.372	2.3	58.0	22.8	12.5	64.8	0.01	12.0	184.5
TIPS	5-Year	-0.529	2.8	31.9	14.7	8.5	76.9	0.12	3.5	18.5
TIPS	10-Year	-0.470	2.4	12.0	30.1	7.8	62.1	0.03	0.0	11.9
TIPS	30-Year	0.000	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0
FRN	2-Year	0.098	3.1	62.0	45.3	18.9	35.8	0.04	1.9	0.0
	Total Bills	0.145	3.0	5806.3	46.4	3.6	50.0	56.72	228.0	165.9
	Total Coupons	0.527	2.5	687.1	27.1	13.9	59.0	0.90	98.9	617.0
	Total FRN	0.098	3.1	62.0	45.3	18.9	35.8	0.04	1.9	0.0
	Total TIPS	-0.513	2.7	43.8	18.9	8.3	72.8	0.15	3.5	30.5

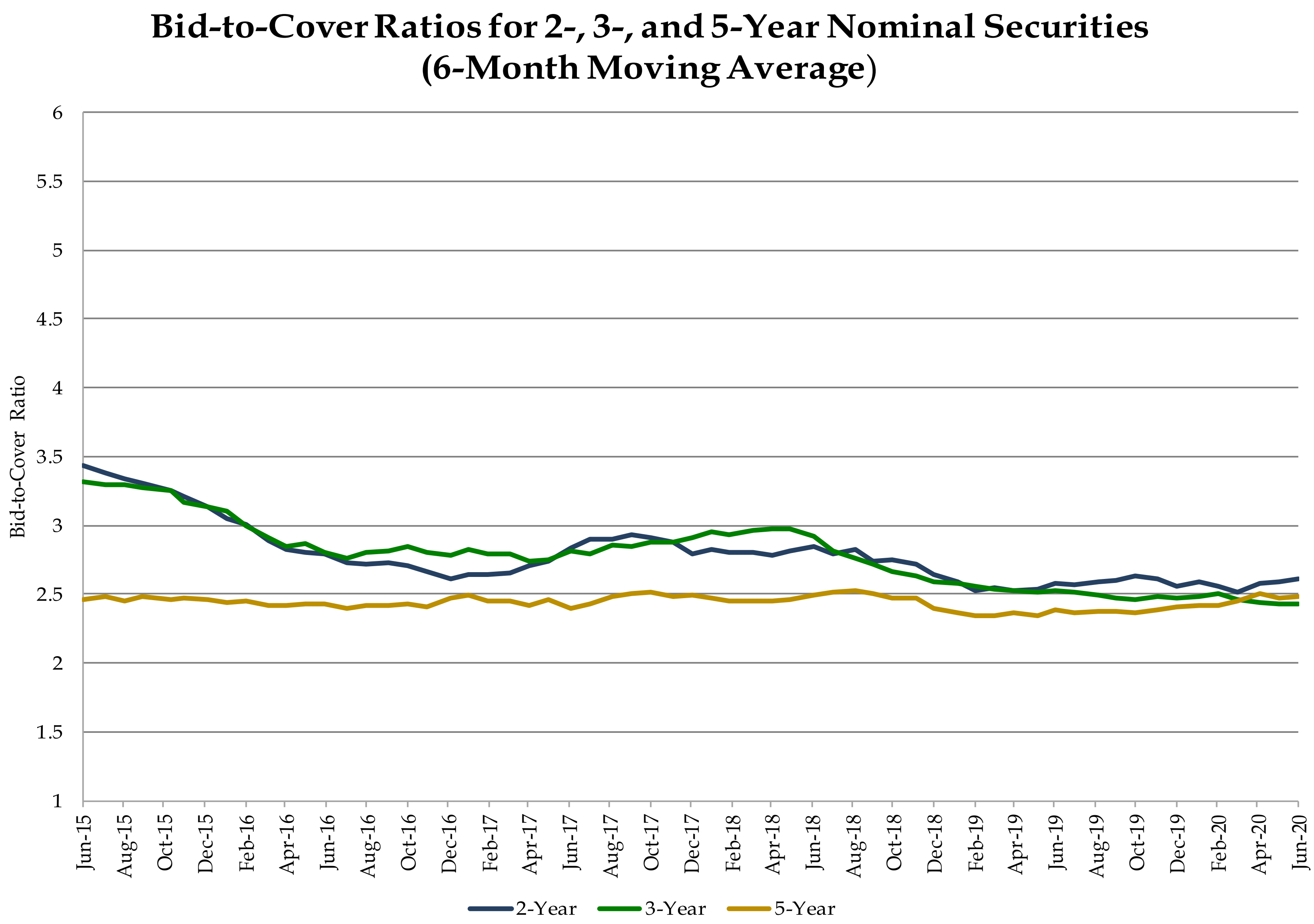
*Weighted averages of Competitive Awards. FRNs are reported on discount margin basis.
**Approximated using prices at settlement and includes both Competitive and Non-Competitive Awards. For TIPS 10-year equivalent, a constant auction BEI is used as the inflation assumption.

Bid-to-Cover Ratios for Treasury Bills

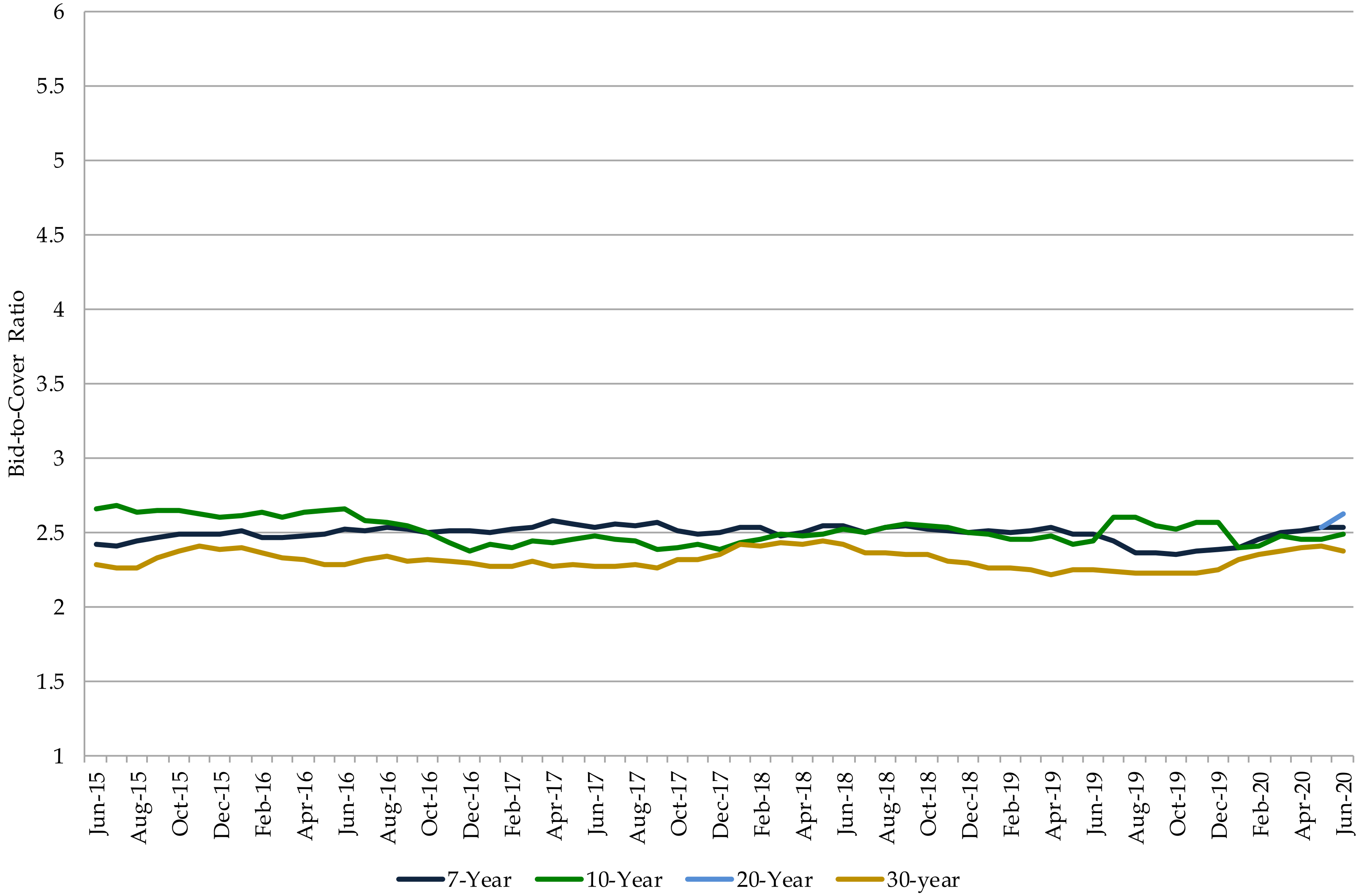


Bid-to-Cover Ratios for FRNs
(6-Month Moving Average)

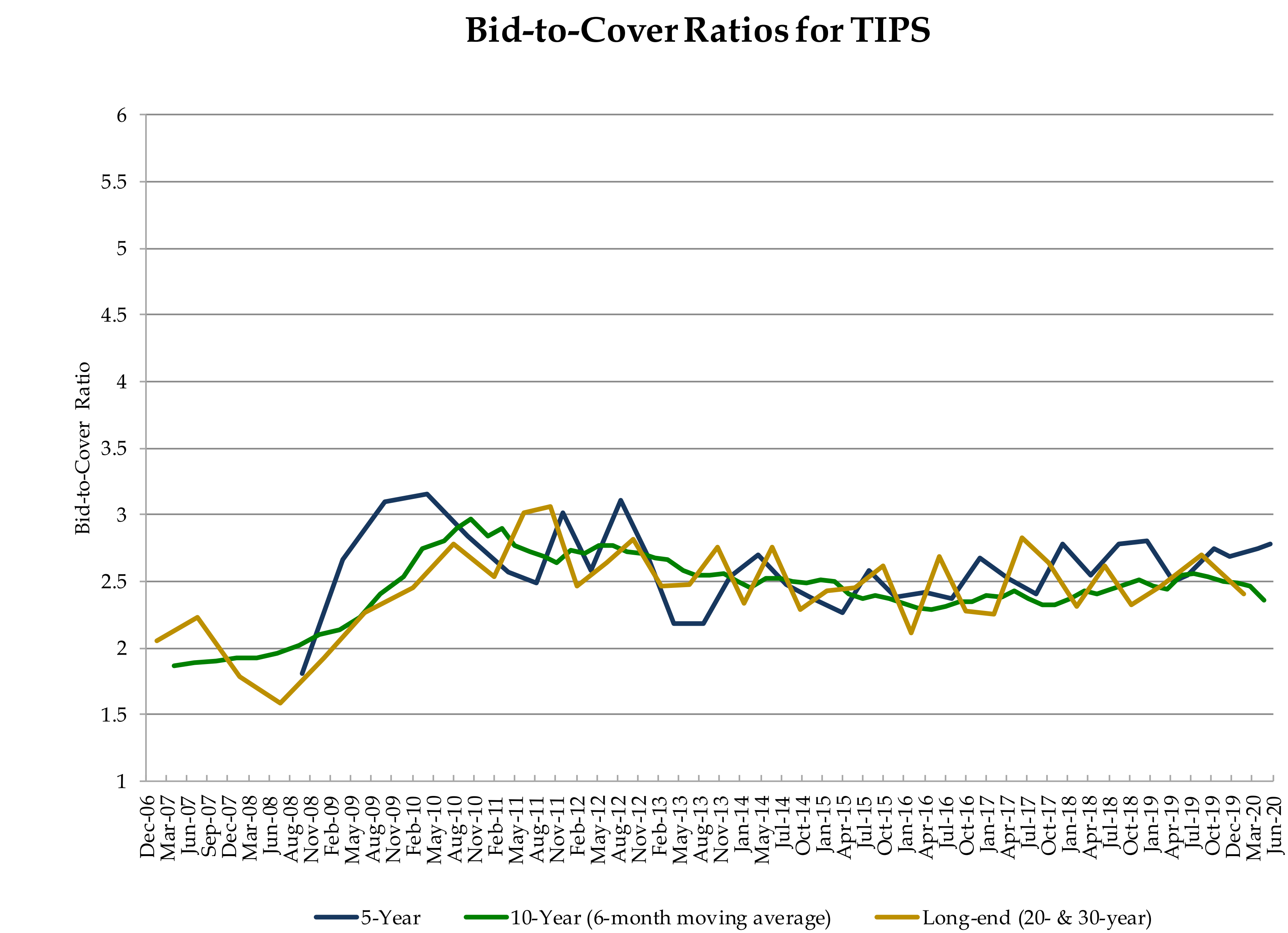



Bid-to-Cover Ratios for 2-, 3-, and 5-Year Nominal Securities
(6-Month Moving Average)
Bid-to-Cover Ratio
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
Jun-15
Aug-15
Oct-15
Dec-15
Feb-16
Apr-16
Jun-16
Aug-16
Oct-16
Dec-16
Feb-17
Apr-17
Jun-17
Aug-17
Oct-17
Dec-17
Feb-18
Apr-18
Jun-18
Aug-18
Oct-18
Dec-18
Feb-19
Apr-19
Jun-19
Aug-19
Oct-19
Dec-19
Feb-20
Apr-20
Jun-20
2-Year
3-Year
5-Year

Bid-to-Cover Ratios for 7-, 10-, 20-, and 30-Year Nominal Securities (6-Month Moving Average)*



* 20-Year bid-to-cover ratio reflects actuals instead of moving average.



Bid-to-Cover Ratios for TIPS
Bid-to-Cover Ratio
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
Dec-06
Mar-07
Jun-07
Sep-07
Dec-07
Mar-08
Jun-08
Aug-08
Nov-08
Feb-09
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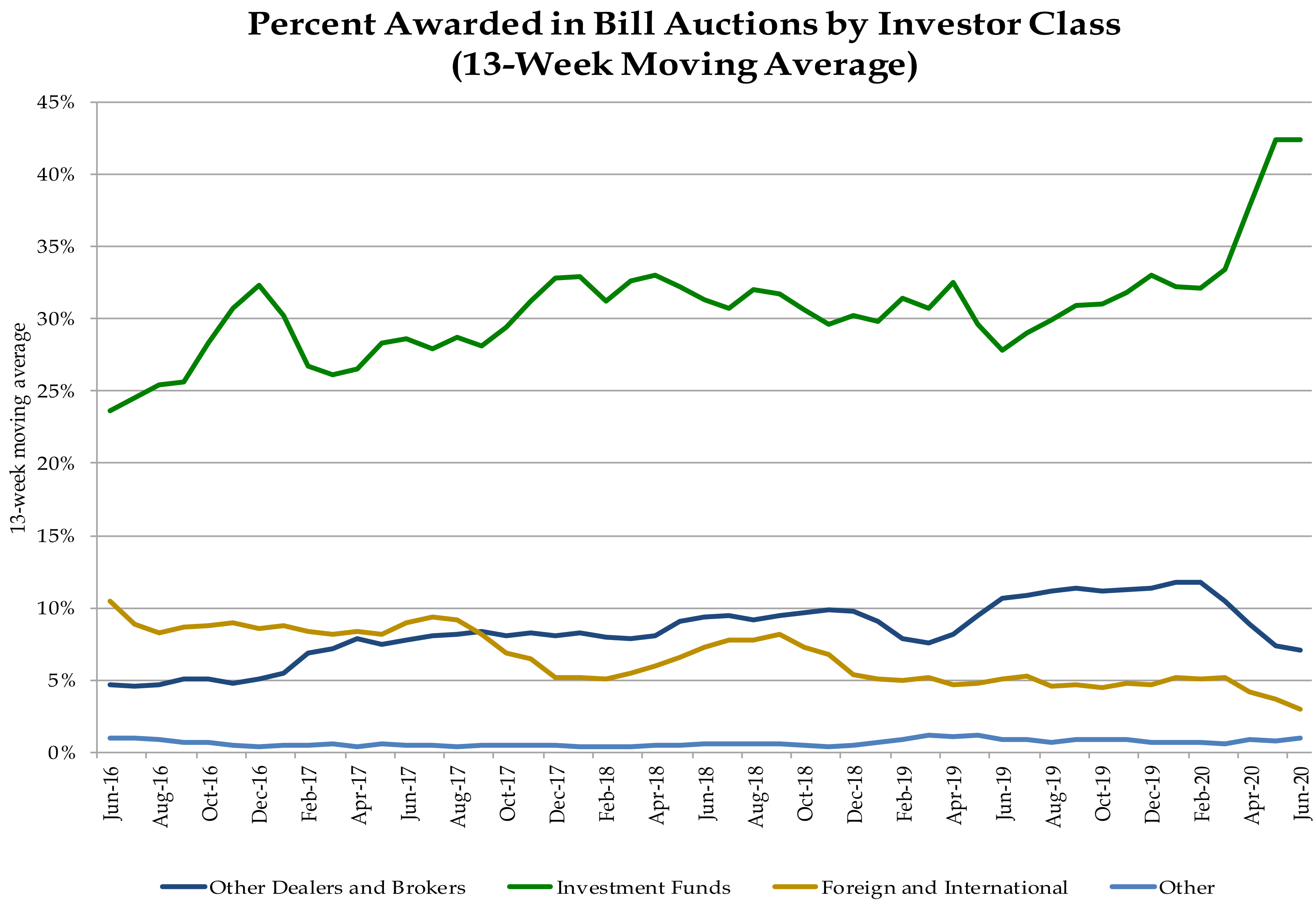
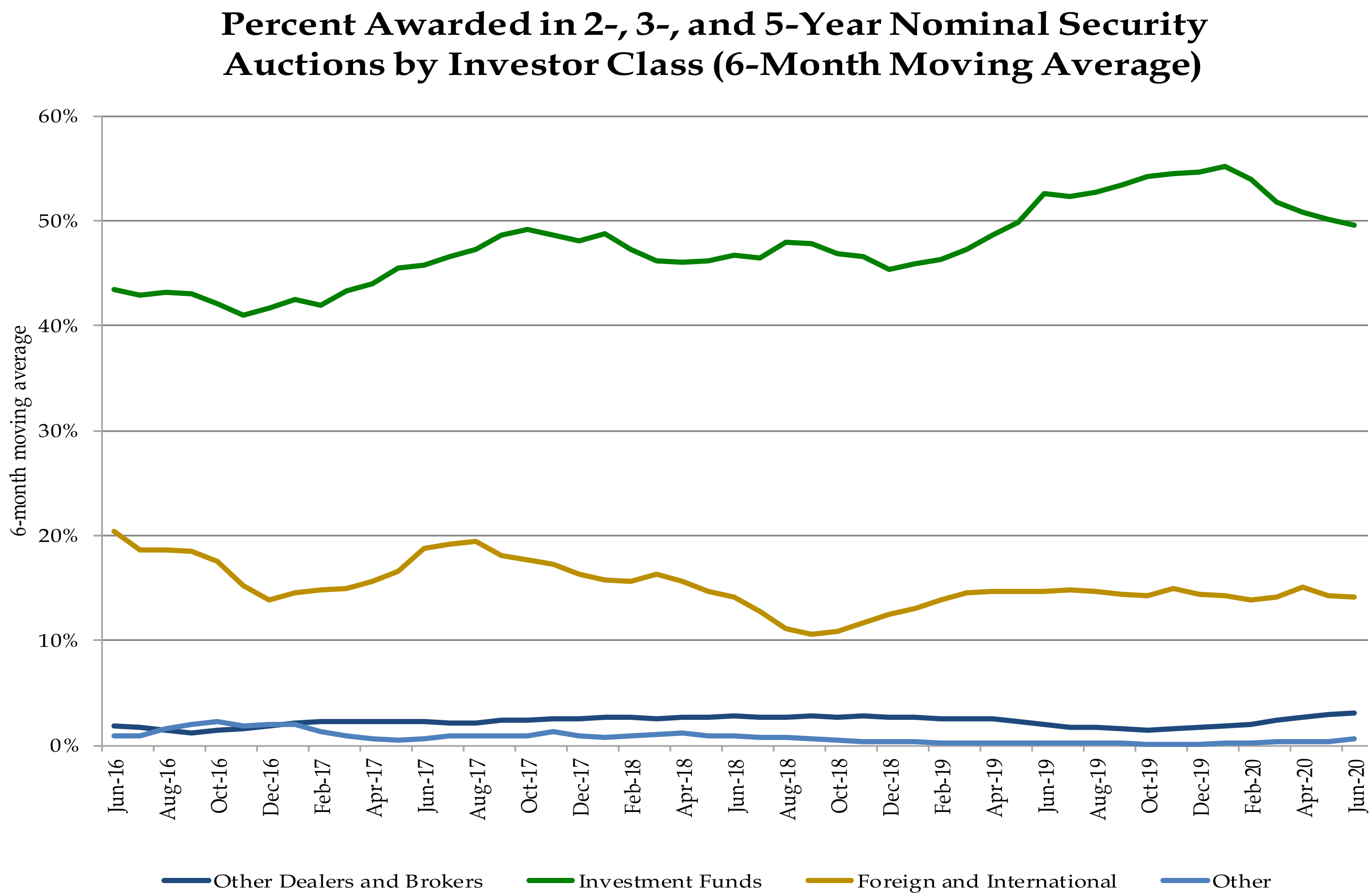
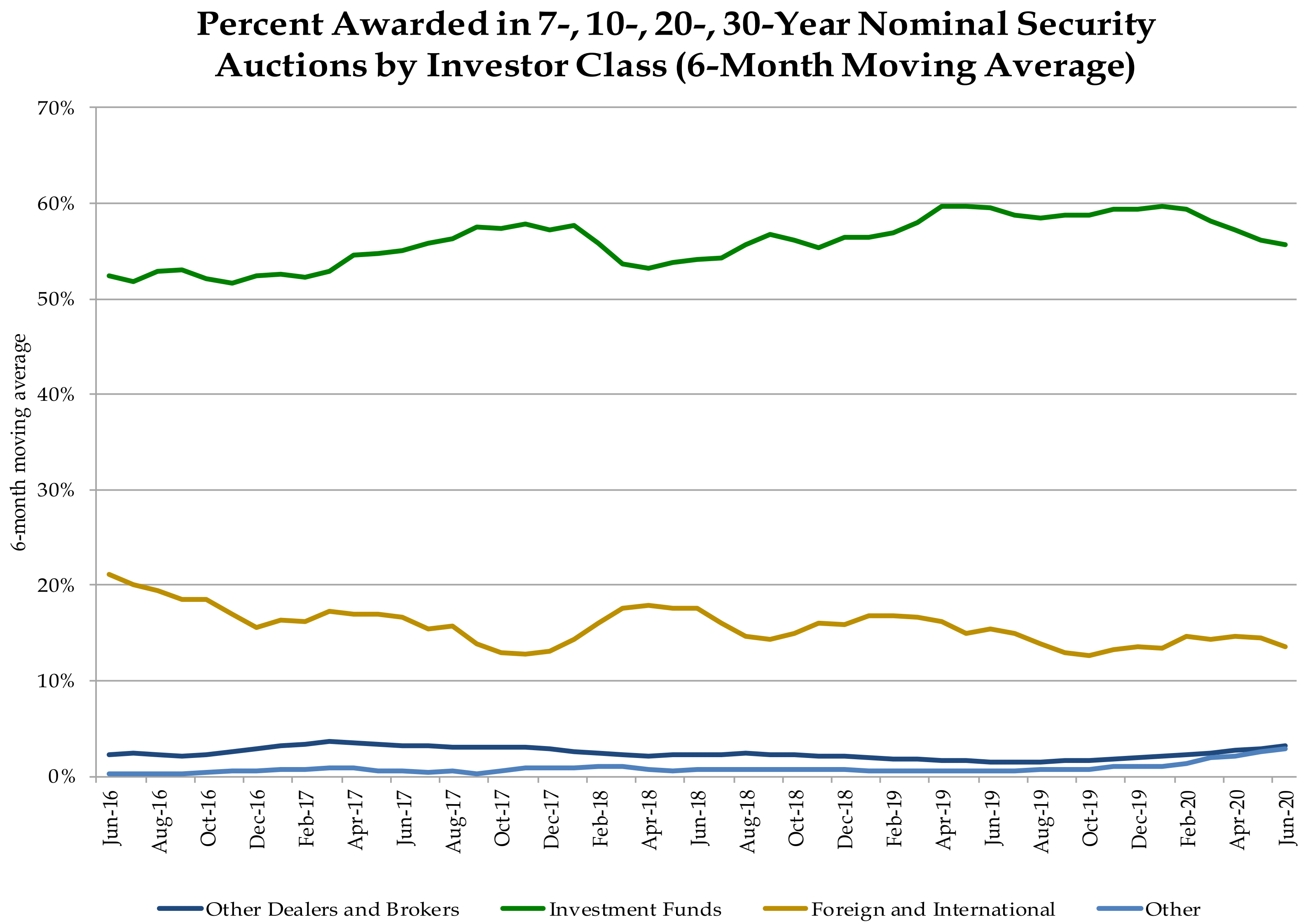
5-Year
10-Year (6-month moving average)
Long-end (20- & 30-year)



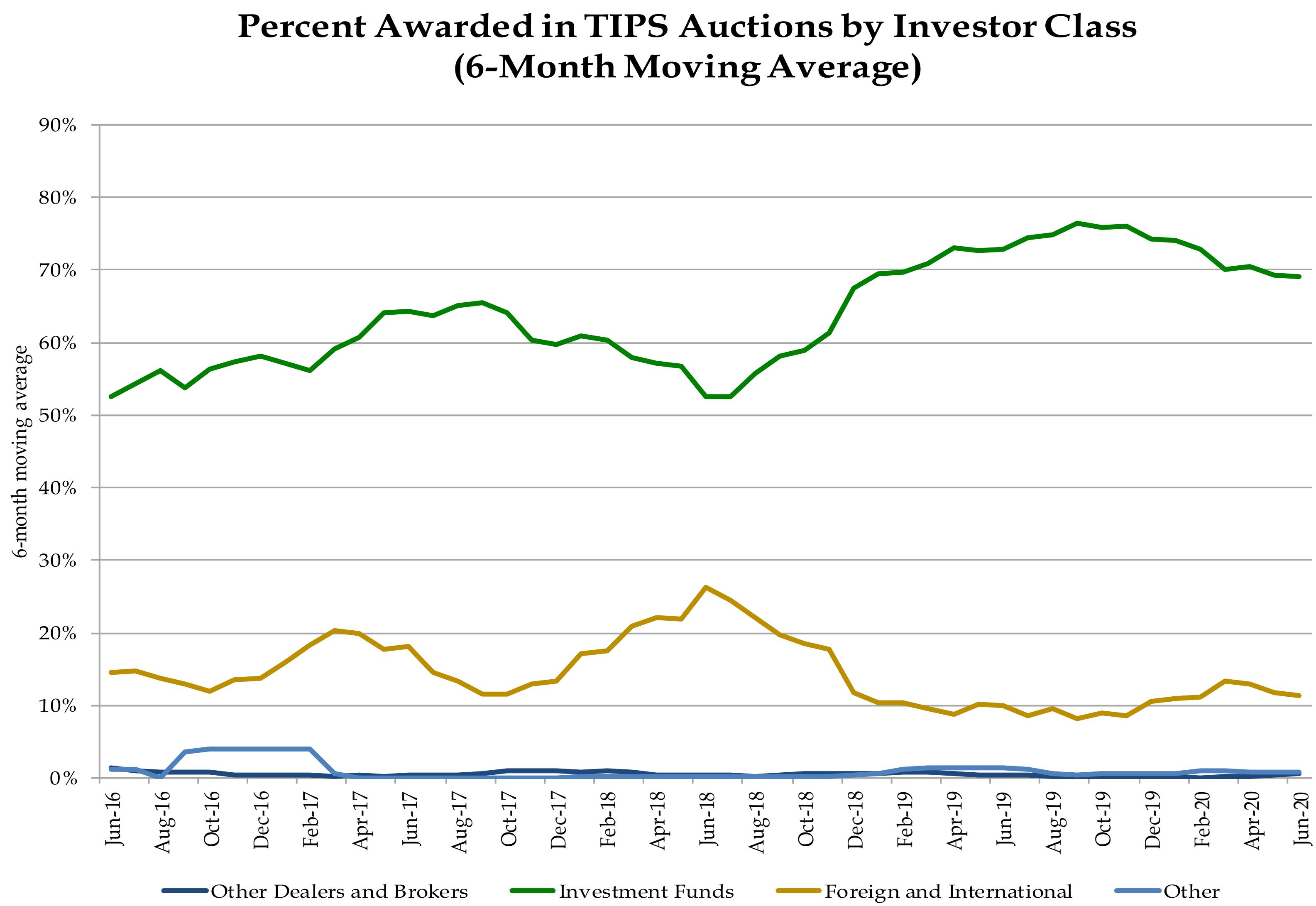
Excludes SOMA add-ons. The "Other" category includes categories that are each less than 5%, which include Depository Institutions, Individuals, Pension and Insurance.



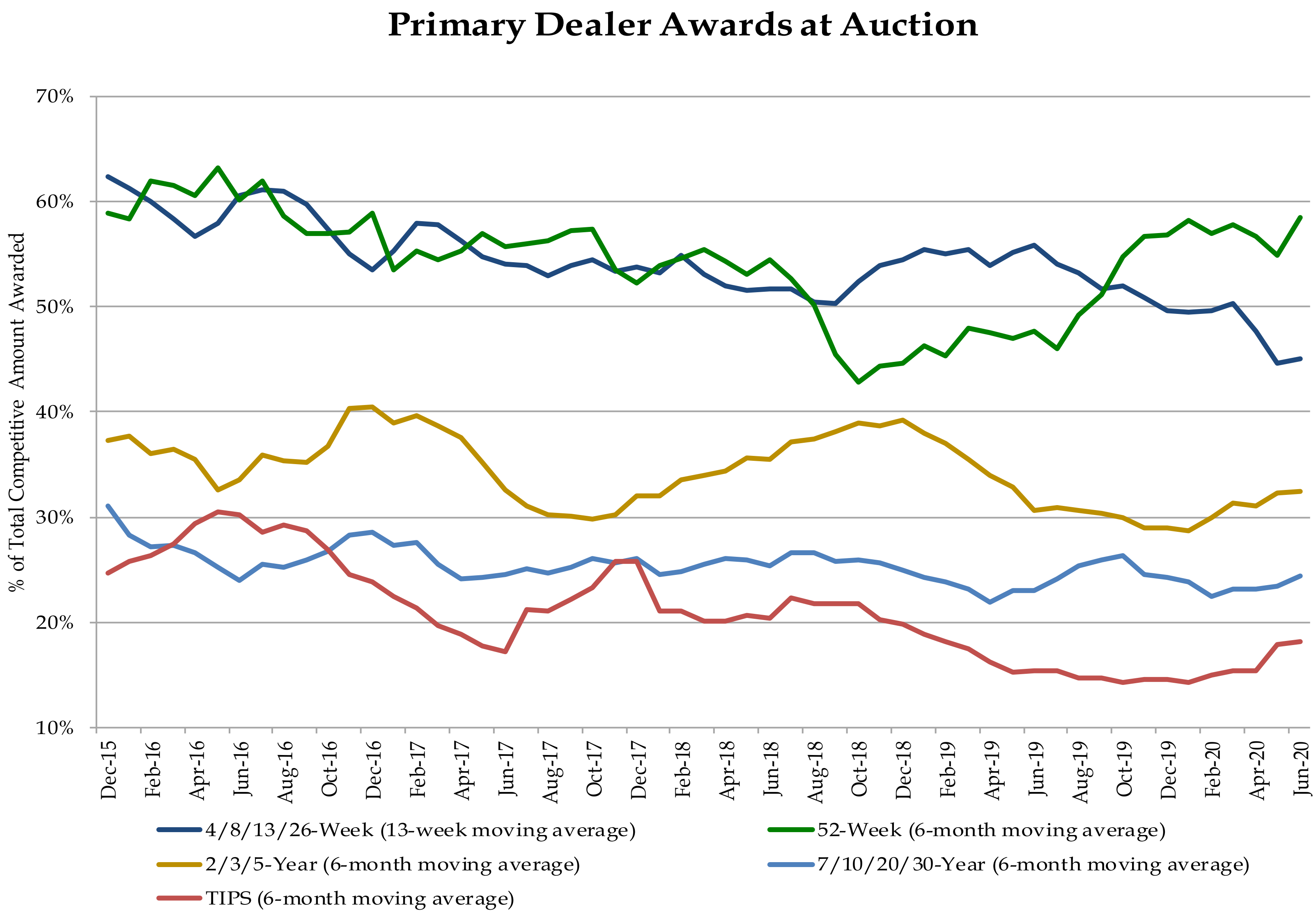
Excludes SOMA add-ons. The "Other" category includes categories that are each less than 5%, which include Depository Institutions, Individuals, Pension and Insurance.



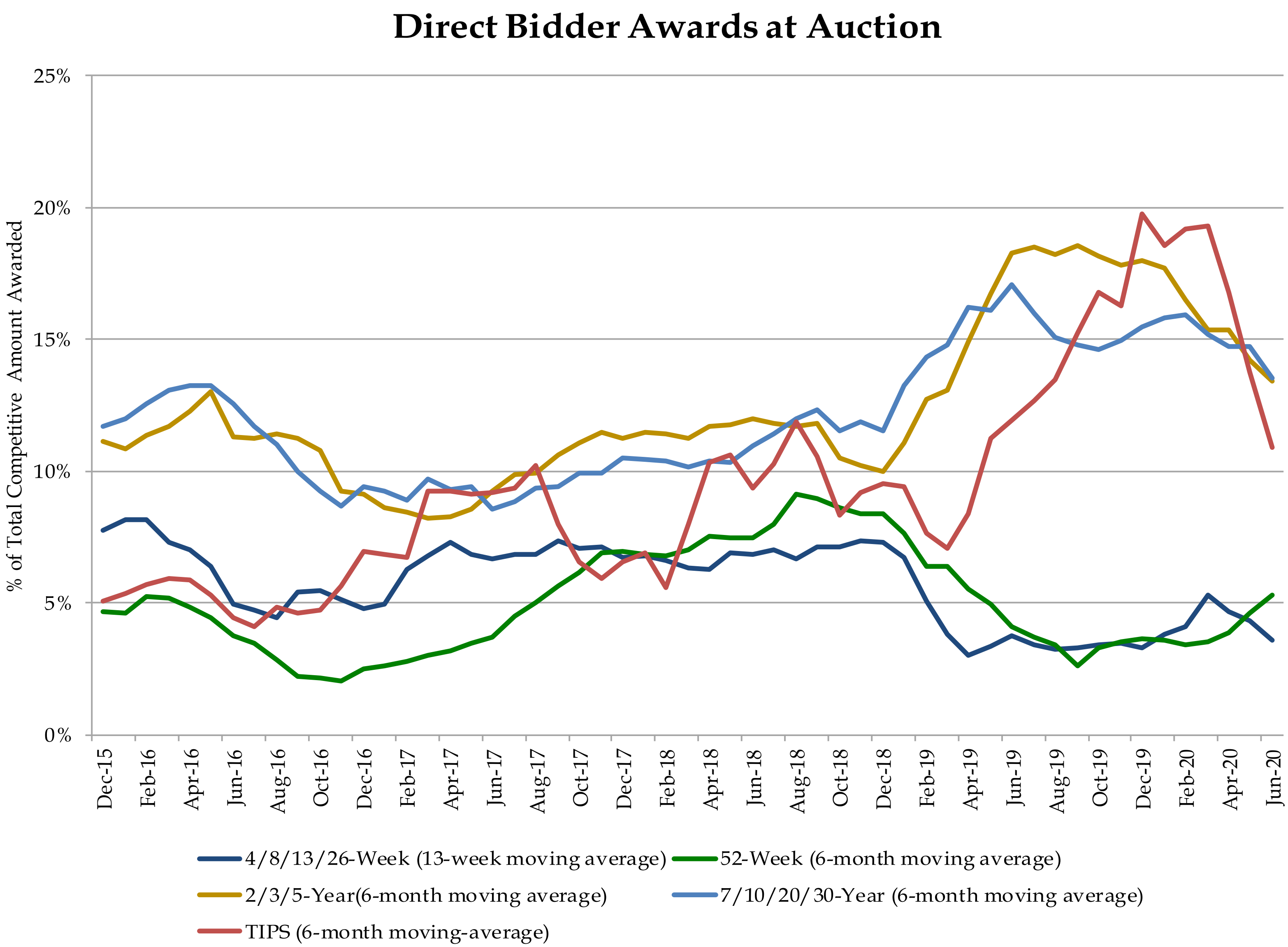
Excludes SOMA add-ons. The "Other" category includes categories that are each less than 5%, which include Depository Institutions, Individuals, Pension and Insurance.



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

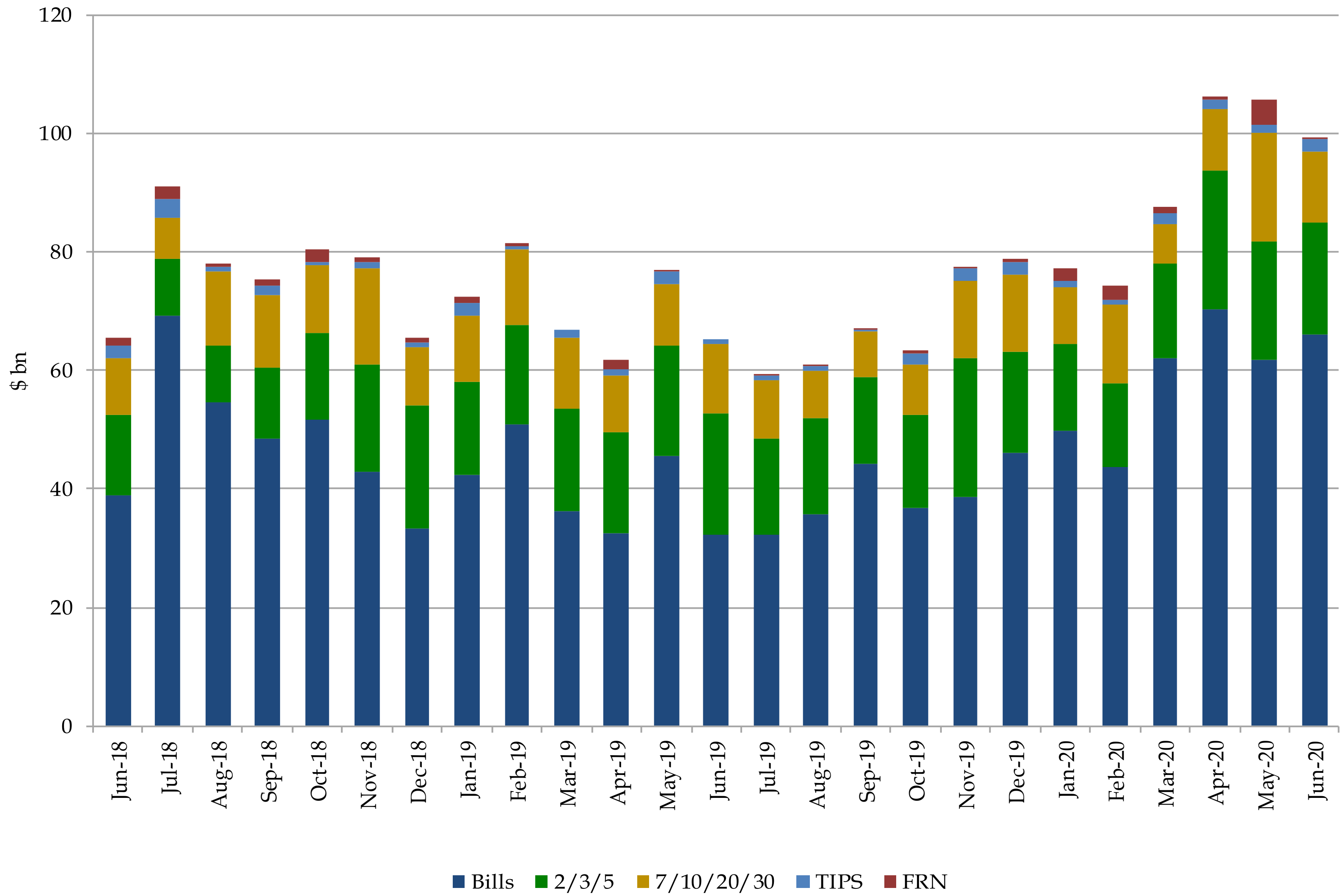


Competitive Amount Awarded excludes SOMA add-ons.



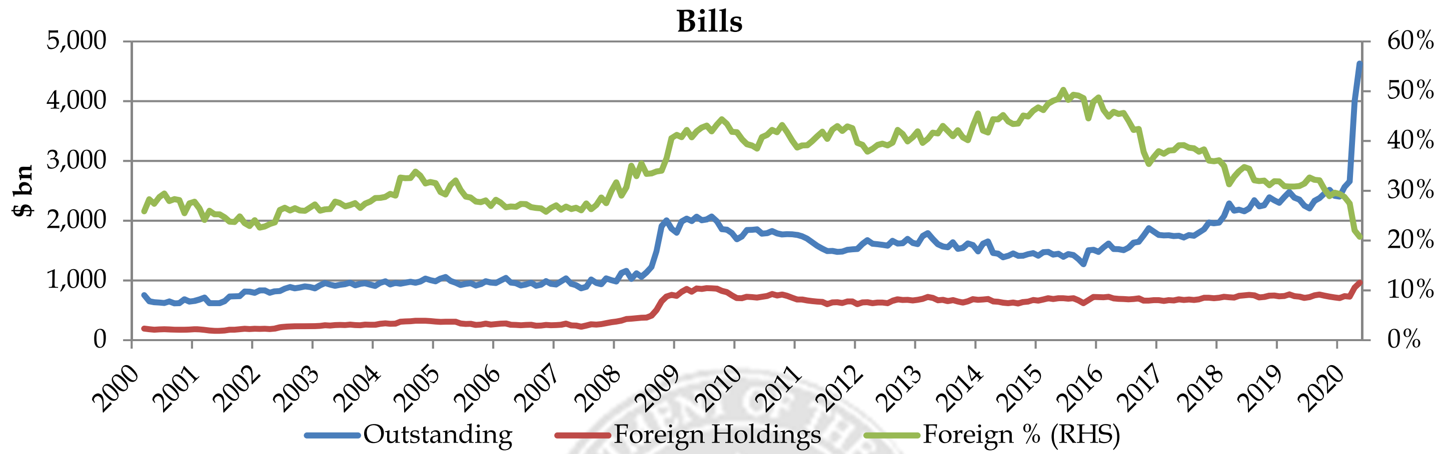
Competitive Amount Awarded excludes SOMA add-ons.

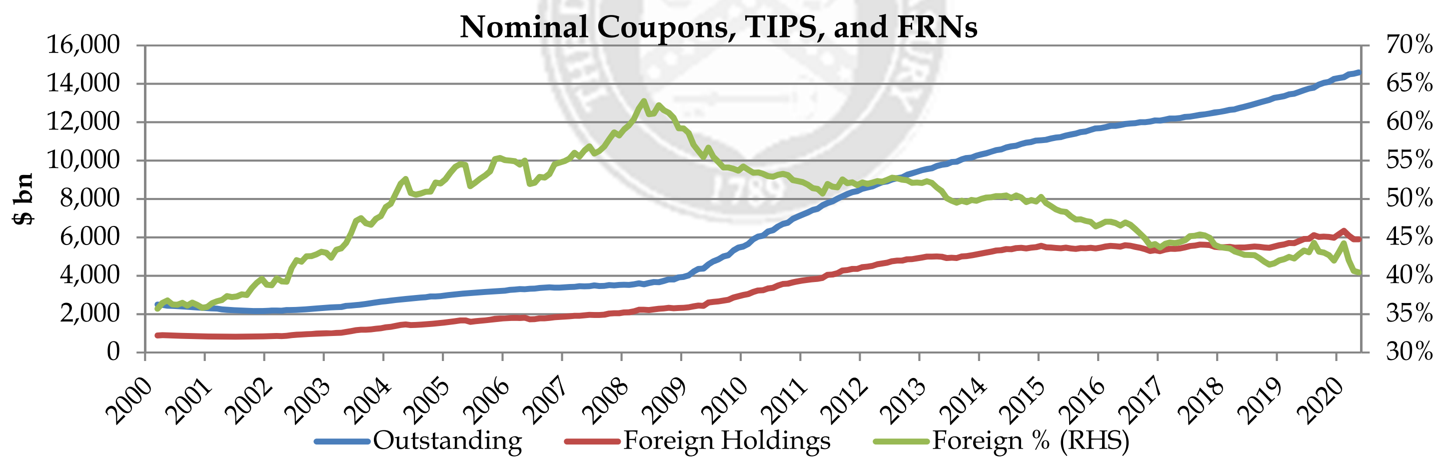
Total Foreign Awards of Treasuries at Auction, $ billions



Foreign includes both private sector and official institutions.

Total Foreign Holdings





Source: Treasury International Capital (TIC) System.
For more information on foreign participation data, including more details about the TIC data shown here, please refer to Treasury Presentation to TBAC "Brief Overview of Key Data Sources on Foreign Participation in the U.S. Treasury Securities Market" at the Treasury February 2019 Refunding.

Appendix

Projected Privately-Held Net Marketable Borrowing
Assuming Private Coupon Issuance & Total Bills Outstanding Remain Constant as of 6/30/2020*

Fiscal Year	Bills	2/3/5	7/10/20/30	TIPS	FRN	Historical/Projected Net Borrowing Capacity
2015	(53)	(282)	642	88	164	558
2016	289	(107)	515	58	41	795
2017	155	(66)	378	51	(0)	519
2018	438	197	493	45	23	1,196
2019	137	498	534	51	59	1,280
2020	2,703	519	685	46	55	4,008
2021	0	816	866	44	50	1,777
2022	0	506	882	27	32	1,447
2023	0	447	734	23	0	1,204
2024	0	282	796	35	0	1,113
2025	0	79	799	(25)	0	853
2026	0	0	788	(5)	0	783
2027	0	0	732	(1)	0	731
2028	0	0	537	(18)	0	518
2029	0	0	565	(11)	0	555
2030	0	0	532	(1)	0	531

Projections reflect only SOMA rollovers at auction of principal payments of Treasury securities. No adjustments are made for open-market outright purchases and subsequent rollovers.

*Privately-held marketable borrowing excludes rollovers (auction "add-ons") of Treasury securities held in the Federal Reserve's System Open Market Account (SOMA) but includes financing required due to SOMA redemptions.

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	4/7/2020	0.090	3.00	79.1	43.6	1.7	54.6	0.9	3.9	0.7
4-Week	4/14/2020	0.190	2.84	88.6	25.7	4.8	69.5	1.4	3.9	0.8
4-Week	4/21/2020	0.150	2.90	88.4	36.9	4.2	58.8	1.6	4.3	0.8
4-Week	4/28/2020	0.090	2.92	88.1	37.3	2.6	60.1	1.9	3.9	0.8
4-Week	5/5/2020	0.095	2.75	88.1	37.5	1.5	61.0	1.9	3.8	0.8
4-Week	5/12/2020	0.095	2.87	78.7	35.4	1.0	63.6	1.3	3.4	0.7
4-Week	5/19/2020	0.090	2.93	78.5	41.1	1.4	57.5	1.5	3.4	0.7
4-Week	5/26/2020	0.090	2.75	78.6	45.8	2.5	51.7	1.4	2.7	0.7
4-Week	6/2/2020	0.130	2.55	78.6	45.6	3.1	51.3	1.4	3.6	0.7
4-Week	6/9/2020	0.125	2.77	78.9	44.3	2.5	53.2	1.1	3.5	0.7
4-Week	6/16/2020	0.130	2.99	68.5	39.5	2.9	57.6	1.5	3.6	0.6
4-Week	6/23/2020	0.125	2.89	58.5	44.6	4.6	50.8	1.5	3.0	0.5
4-Week	6/30/2020	0.110	3.07	48.8	45.4	0.9	53.8	1.2	3.3	0.4
8-Week	4/7/2020	0.095	2.85	59.8	43.6	1.4	55.0	0.2	2.9	1.0
8-Week	4/14/2020	0.290	2.56	69.0	53.2	7.1	39.8	1.0	3.1	1.2
8-Week	4/21/2020	0.150	3.03	69.4	32.4	2.6	65.0	0.6	3.3	1.2
8-Week	4/28/2020	0.120	2.53	69.6	55.8	3.2	41.0	0.4	3.0	1.2
8-Week	5/5/2020	0.095	3.07	68.8	38.6	1.6	59.8	1.2	3.0	1.2
8-Week	5/12/2020	0.110	2.89	69.3	35.5	1.2	63.3	0.7	3.0	1.2
8-Week	5/19/2020	0.110	2.90	69.5	41.5	1.8	56.8	0.5	3.0	1.2
8-Week	5/26/2020	0.105	2.65	69.3	50.7	2.7	46.6	0.7	2.4	1.1
8-Week	6/2/2020	0.135	2.87	68.8	34.9	0.9	64.1	1.2	3.1	1.2
8-Week	6/9/2020	0.145	2.60	69.7	53.7	3.2	43.1	0.3	3.0	1.2
8-Week	6/16/2020	0.155	2.86	59.7	41.8	11.6	46.6	0.3	3.1	1.0
8-Week	6/23/2020	0.135	2.92	54.5	41.6	7.5	51.0	0.5	2.7	0.9
8-Week	6/30/2020	0.140	2.72	48.9	67.6	2.7	29.7	1.1	3.3	0.9

*Weighted averages of competitive awards.
**Approximated using prices at settlement and includes both competitive and non-competitive awards.

Bills (cont.)										
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)**
13-Week	4/9/2020	0.125	2.82	52.5	41.6	1.3	57.1	1.5	4.9	1.6
13-Week	4/16/2020	0.280	3.10	56.0	49.7	7.2	43.1	1.0	5.0	1.7
13-Week	4/23/2020	0.125	2.93	56.1	50.6	3.9	45.5	0.9	6.0	1.7
13-Week	4/30/2020	0.120	3.04	55.3	48.6	2.2	49.2	1.7	3.8	1.7
13-Week	5/7/2020	0.110	3.00	58.8	48.8	1.4	49.8	1.2	5.6	1.8
13-Week	5/14/2020	0.125	2.97	62.0	40.1	3.2	56.7	1.0	5.9	1.9
13-Week	5/21/2020	0.130	2.91	61.7	48.9	4.9	46.2	1.3	8.5	1.8
13-Week	5/28/2020	0.130	2.88	61.3	45.7	2.4	51.9	1.7	5.2	1.7
13-Week	6/4/2020	0.150	2.94	62.2	45.3	2.3	52.3	0.8	5.5	1.8
13-Week	6/11/2020	0.170	2.71	62.1	53.8	7.4	38.9	0.9	3.9	1.7
13-Week	6/18/2020	0.175	2.96	58.7	43.7	12.1	44.2	1.3	7.2	1.7
13-Week	6/25/2020	0.155	2.69	55.3	60.5	3.7	35.8	1.7	2.2	1.5
13-Week	7/2/2020	0.150	2.86	53.3	59.2	1.7	39.1	0.7	7.0	1.6
26-Week	4/9/2020	0.160	3.08	43.8	42.1	1.4	56.6	1.2	4.1	2.7
26-Week	4/16/2020	0.290	3.08	47.0	53.7	1.1	45.2	1.0	4.2	2.8
26-Week	4/23/2020	0.145	3.17	47.1	44.1	2.3	53.7	0.9	5.1	2.9
26-Week	4/30/2020	0.150	3.25	46.6	48.2	2.1	49.7	1.4	3.2	2.8
26-Week	5/7/2020	0.130	2.99	50.0	45.9	6.3	47.7	1.0	4.7	3.0
26-Week	5/14/2020	0.155	2.97	53.2	41.9	5.7	52.4	0.8	5.0	3.2
26-Week	5/21/2020	0.150	3.13	53.1	45.9	10.9	43.2	0.9	7.2	3.1
26-Week	5/28/2020	0.160	3.00	52.6	48.3	6.9	44.7	1.4	4.4	3.0
26-Week	6/4/2020	0.170	2.72	53.4	65.5	5.4	29.1	0.6	4.7	3.0
26-Week	6/11/2020	0.185	3.01	53.4	44.3	4.1	51.6	0.6	3.3	3.0
26-Week	6/18/2020	0.185	2.93	53.3	53.2	4.3	42.6	0.7	6.4	3.1
26-Week	6/25/2020	0.175	2.94	52.6	51.0	3.8	45.2	1.4	2.1	2.9
26-Week	7/2/2020	0.165	2.99	50.5	43.3	2.4	54.3	0.5	6.6	3.0
52-Week	4/23/2020	0.165	3.38	27.7	49.4	7.8	42.8	0.3	3.0	3.4
52-Week	5/21/2020	0.160	3.30	30.8	48.6	9.4	42.0	0.2	4.2	3.6
52-Week	6/18/2020	0.200	2.91	33.8	76.0	6.0	17.9	0.2	4.1	4.0

*Weighted averages of competitive awards.
**Approximated using prices at settlement and includes both competitive and non-competitive awards.

Bills (cont.)											
Issue	Term	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)**
CMB	6-Week	4/3/2020	0.080	3.07	45.0	49.9	1.9	48.2	0.0	0.0	0.5
CMB	6-Week	4/8/2020	0.095	3.15	60.0	37.4	0.6	62.1	0.0	0.0	0.8
CMB	6-Week	4/9/2020	0.160	2.65	45.0	49.0	5.4	45.5	0.0	0.0	0.5
CMB	6-Week	4/15/2020	0.190	3.12	65.0	27.7	9.0	63.3	0.0	0.0	0.8
CMB	6-Week	4/22/2020	0.120	2.89	65.0	42.7	0.4	56.8	0.0	0.0	0.8
CMB	6-Week	4/29/2020	0.085	3.22	55.0	43.0	0.7	56.3	0.0	0.0	0.7
CMB	6-Week	5/7/2020	0.115	2.74	65.0	40.2	1.7	58.1	0.0	0.0	0.8
CMB	6-Week	5/14/2020	0.110	2.93	65.0	42.6	3.5	54.0	0.0	0.0	0.8
CMB	6-Week	5/21/2020	0.105	2.90	65.0	38.1	1.6	60.3	0.0	0.0	0.8
CMB	6-Week	5/28/2020	0.120	2.83	65.0	38.4	1.0	60.6	0.0	0.0	0.8
CMB	6-Week	6/4/2020	0.135	2.83	65.0	41.6	2.8	55.6	0.0	0.0	0.8
CMB	6-Week	6/11/2020	0.165	2.70	60.0	47.1	10.8	42.2	0.0	0.0	0.7
CMB	6-Week	6/18/2020	0.150	2.82	50.0	56.5	2.1	41.4	0.0	0.0	0.6
CMB	6-Week	6/25/2020	0.125	3.20	40.0	44.7	4.7	50.6	0.0	0.0	0.5
CMB	6-Week	7/2/2020	0.130	3.27	35.0	45.4	3.2	51.4	0.0	0.0	0.4
CMB	15-Week	4/3/2020	0.125	3.06	40.0	45.0	0.5	54.5	0.0	0.0	1.2
CMB	15-Week	4/9/2020	0.200	2.79	40.0	36.2	1.6	62.1	0.0	0.0	1.2
CMB	15-Week	4/16/2020	0.165	3.32	30.0	49.4	1.7	48.9	0.0	0.0	0.9
CMB	15-Week	4/23/2020	0.105	3.10	30.0	52.7	1.6	45.6	0.0	0.0	0.9
CMB	15-Week	4/30/2020	0.115	3.05	30.0	50.3	1.8	47.9	0.0	0.0	0.9
CMB	15-Week	5/5/2020	0.115	3.35	30.0	57.5	1.8	40.6	0.0	0.0	0.9
CMB	15-Week	5/12/2020	0.125	3.00	30.0	49.4	3.5	47.1	0.0	0.0	0.9
CMB	15-Week	5/19/2020	0.140	3.51	35.0	53.6	2.5	43.9	0.0	0.0	1.1
CMB	15-Week	5/26/2020	0.140	3.04	40.0	51.6	2.4	46.0	0.0	0.0	1.2
CMB	15-Week	6/2/2020	0.165	3.06	40.0	36.3	1.2	62.5	0.0	0.0	1.2
CMB	15-Week	6/9/2020	0.170	3.25	40.0	40.2	1.0	58.8	0.0	0.0	1.2
CMB	15-Week	6/16/2020	0.180	3.50	35.0	53.7	1.4	44.9	0.0	0.0	1.0
CMB	15-Week	6/23/2020	0.170	3.25	35.0	47.6	1.7	50.7	0.0	0.0	1.0
CMB	15-Week	6/30/2020	0.150	3.35	30.0	56.7	5.1	38.2	0.0	0.0	0.9

*Weighted averages of competitive awards.
**Approximated using prices at settlement and includes both competitive and non-competitive awards.

Bills (cont.)											
Issue	Term	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)**
CMB	17-Week	4/2/2020	0.130	2.99	40.0	42.0	1.6	56.4	0.0	0.0	1.4
CMB	17-Week	4/9/2020	0.180	2.74	40.0	47.9	2.2	49.9	0.0	0.0	1.4
CMB	17-Week	4/16/2020	0.220	4.13	25.0	47.2	19.8	33.0	0.0	0.0	0.9
CMB	17-Week	4/23/2020	0.110	3.51	25.0	56.1	13.4	30.6	0.0	0.0	0.9
CMB	17-Week	4/30/2020	0.110	3.50	25.0	52.0	2.7	45.3	0.0	0.0	0.9
CMB	17-Week	5/7/2020	0.130	3.38	30.0	48.1	1.5	50.4	0.0	0.0	1.1
CMB	17-Week	5/14/2020	0.145	3.38	35.0	44.4	3.0	52.6	0.0	0.0	1.2
CMB	17-Week	5/21/2020	0.140	3.10	40.0	57.0	3.5	39.5	0.0	0.0	1.3
CMB	17-Week	5/28/2020	0.170	2.75	40.0	67.6	2.8	29.7	0.0	0.0	1.3
CMB	17-Week	6/4/2020	0.165	3.10	40.0	44.5	6.9	48.6	0.0	0.0	1.3
CMB	17-Week	6/11/2020	0.185	3.30	40.0	44.4	10.9	44.7	0.0	0.0	1.4
CMB	17-Week	6/18/2020	0.180	3.37	40.0	57.5	1.9	40.6	0.0	0.0	1.4
CMB	17-Week	6/25/2020	0.155	3.33	40.0	51.1	2.1	46.7	0.0	0.0	1.4
CMB	17-Week	7/2/2020	0.155	3.17	35.0	53.3	2.4	44.3	0.0	0.0	1.2
CMB	22-Week	4/7/2020	0.150	2.90	40.0	49.2	1.3	49.6	0.0	0.0	1.8
CMB	22-Week	4/14/2020	0.250	2.60	40.0	55.0	1.6	43.4	0.0	0.0	1.8
CMB	22-Week	4/21/2020	0.190	3.14	30.0	49.5	8.9	41.6	0.0	0.0	1.4
CMB	22-Week	4/28/2020	0.135	3.08	30.0	54.5	2.1	43.4	0.0	0.0	1.4
CMB	22-Week	5/5/2020	0.140	2.90	30.0	55.7	3.7	40.6	0.0	0.0	1.4
CMB	22-Week	5/12/2020	0.150	2.91	35.0	58.8	2.1	39.2	0.0	0.0	1.6
CMB	22-Week	5/19/2020	0.155	2.97	40.0	51.8	10.1	38.1	0.0	0.0	1.8
CMB	22-Week	5/26/2020	0.150	2.93	40.0	57.5	6.0	36.5	0.0	0.0	1.7
CMB	22-Week	6/2/2020	0.170	3.16	40.0	39.3	3.7	57.0	0.0	0.0	1.7
CMB	22-Week	6/9/2020	0.180	3.11	40.0	39.8	3.9	56.4	0.0	0.0	1.7
CMB	22-Week	6/16/2020	0.190	2.95	40.0	51.8	1.2	47.1	0.0	0.0	1.8
CMB	22-Week	6/23/2020	0.185	3.22	40.0	49.6	1.5	48.8	0.0	0.0	1.8
CMB	22-Week	6/30/2020	0.165	3.22	35.0	50.6	2.9	46.6	0.0	0.0	1.5
CMB	39-Week	4/30/2020	0.165	2.98	25.0	67.5	4.8	27.7	0.0	0.0	2.0
CMB	39-Week	5/28/2020	0.180	3.17	25.0	75.5	7.4	17.1	0.0	0.0	1.9
CMB	39-Week	6/25/2020	0.180	3.53	20.0	71.7	8.3	20.0	0.0	0.0	1.6
CMB	CMBs	4/8/2020	0.135	2.71	45.0	52.9	0.9	46.2	0.0	0.0	0.9
CMB	CMBs	4/15/2020	0.270	3.22	35.0	44.8	3.6	51.6	0.0	0.0	0.7

*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	4/30/2020	0.229	3.10	41.8	26.4	17.8	55.8	0.2	3.6	10.0
2-Year	6/1/2020	0.178	2.68	43.8	32.1	14.8	53.1	0.2	4.6	10.1
2-Year	6/30/2020	0.193	2.46	45.8	31.2	16.7	52.0	0.2	6.3	10.9
3-Year	4/15/2020	0.348	2.27	39.9	40.5	4.1	55.4	0.1	0.1	13.0
3-Year	5/15/2020	0.230	2.54	42.0	32.6	13.1	54.4	0.0	22.2	21.2
3-Year	6/15/2020	0.280	2.55	44.0	32.2	14.5	53.3	0.0	0.6	13.9
5-Year	4/30/2020	0.394	2.74	43.0	19.4	20.2	60.4	0.0	3.7	25.4
5-Year	6/1/2020	0.334	2.28	45.0	31.8	10.8	57.3	0.0	4.7	25.6
5-Year	6/30/2020	0.330	2.58	47.0	22.0	15.8	62.3	0.0	6.4	27.7
7-Year	4/30/2020	0.525	2.56	35.0	21.3	12.3	66.4	0.0	3.0	28.6
7-Year	6/1/2020	0.553	2.55	38.0	24.0	12.4	63.6	0.0	4.0	29.9
7-Year	6/30/2020	0.511	2.49	41.0	21.7	15.7	62.6	0.0	5.6	33.5
10-Year	4/15/2020	0.782	2.43	25.0	27.6	13.2	59.2	0.0	0.1	25.0
10-Year	5/15/2020	0.700	2.69	32.0	20.5	13.3	66.1	0.0	16.9	52.1
10-Year	6/15/2020	0.832	2.26	29.0	31.5	11.8	56.7	0.0	0.4	29.4
20-Year	6/1/2020	1.220	2.53	20.0	24.6	14.7	60.7	0.0	2.1	40.7
20-Year	6/30/2020	1.314	2.63	17.0	21.9	16.5	61.6	0.0	2.3	35.7
30-Year	4/15/2020	1.325	2.35	17.0	22.6	11.0	66.4	0.0	0.1	42.8
30-Year	5/15/2020	1.342	2.30	22.0	21.4	12.9	65.7	0.0	11.6	92.1
30-Year	6/15/2020	1.450	2.30	19.0	24.5	13.3	62.2	0.0	0.3	49.5
2-Year FRN	4/30/2020	0.114	3.02	22.0	31.5	17.1	51.4	0.0	1.9	0.0
2-Year FRN	5/29/2020	0.098	3.12	20.0	46.1	20.2	33.7	0.0	0.0	0.0
2-Year FRN	6/26/2020	0.080	3.16	20.0	59.6	19.6	20.8	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	4/30/2020	(0.320)	2.74	16.9	14.3	3.0	82.7	0.1	1.5	10.0
5-Year TIPS	6/30/2020	(0.766)	2.78	15.0	15.1	14.6	70.3	0.0	2.1	8.5
10-Year TIPS	5/29/2020	(0.470)	2.39	12.0	30.1	7.8	62.1	0.0	0.0	11.9

*Weighted averages of competitive awards. FRNs are reported on discount margin basis.
**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 – Treasury Financing Post COVID-19

While Treasury met the immediate financing needs related to the COVID-19 outbreak primarily through increased bill issuance, Treasury has begun shifting financing from bills toward longer-dated tenors in order to manage its maturity profile (as announced in the May Quarterly Refunding Statement). Please discuss the factors that Treasury should consider and potential approaches Treasury should evaluate as it works to manage its maturity profile.

Executive Summary

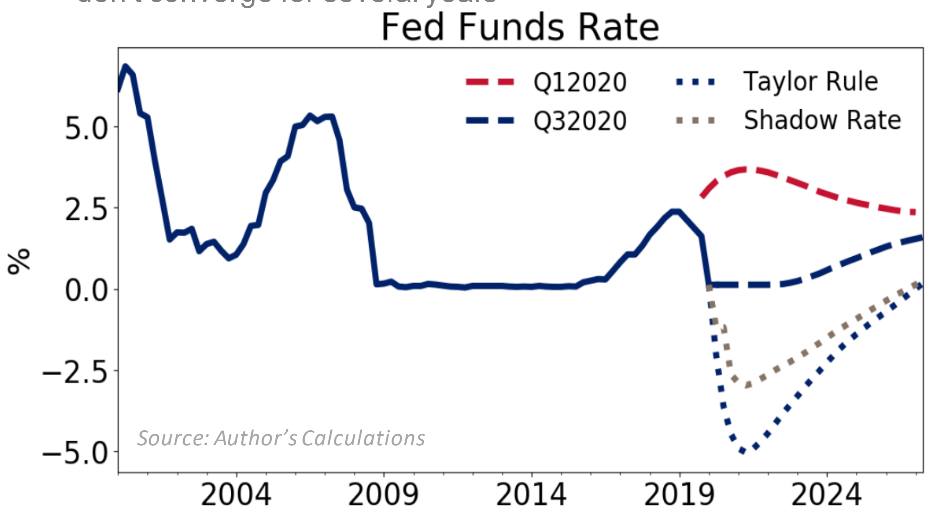
- The COVID-19 crisis led to a severe contraction in economic activity and an unprecedented fiscal and monetary policy response. The sudden shock to growth, large deficits, and interest rates constrained by the ZLB will likely cause debt/GDP and debt-service/GDP to rise in the coming years, posing a debt management challenge
- We analyze the factors that drive debt/GDP, estimating the historical factor distribution, and highlight the important contribution from debt management
- We show that close proximity to the nominal ZLB improves the cost/risk trade off for fixed rate and inflation linked issuance compared to floating rate issuance
- We consider the current low rate environment and compare estimates of term premium across the curve. We find that term premia for maturities less than or equal to 10 year are low compared to longer maturities
- We discuss the effect of the elevated size of the Fed's balance sheet on debt management. We argue that the growth in SOMA holdings increases Treasury's capacity to use T-Bill issuance as a shock absorber in the near term, but could pose a future funding risk given the Fed's incremental run-off capacity
- We discuss the effect of rising debt/GDP on Treasury yields and show that increased deficits usually correspond to increased private sector savings. The recent rise in private sector savings is the largest on record and flows associated with that savings growth should continue to support private sector demand for T-Bills
- We show that over the past 20 years, reductions in the 10 year yield can be explained largely by reductions in expected short rates and real rate risk premium while funding risk premium has exerted upward pressure (although to a smaller extent). Near the ZLB we would not expect further reductions in expected short rates, which may leave the longer maturities increasingly sensitive to supply effects

Macroeconomic Context

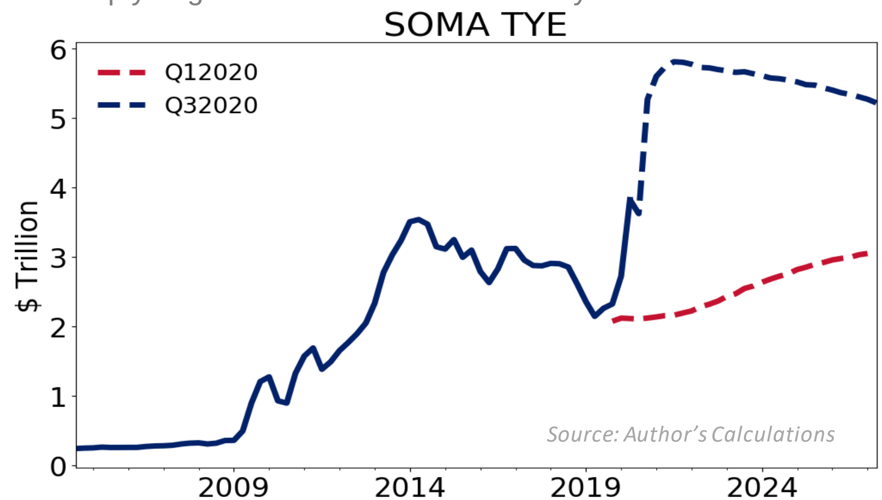
Macro Outlook Before and After COVID-19

COVID-19 caused a historic shock to deficits and growth, and is likely to lead to elevated SOMA holdings and Fed funds at ZLB for an extended period

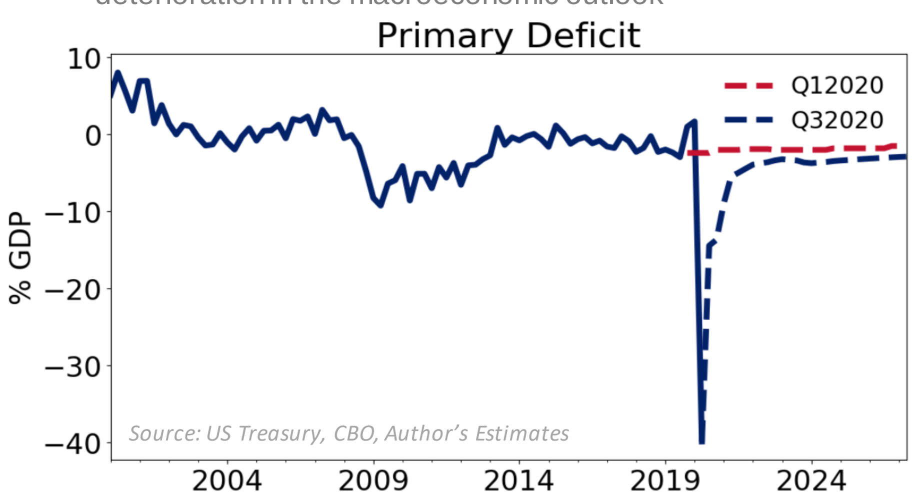
The inertial Taylor rule and the Fed funds shadow rate, an adjustment to the Fed funds rate to incorporate the effects of QE, don't converge for several years



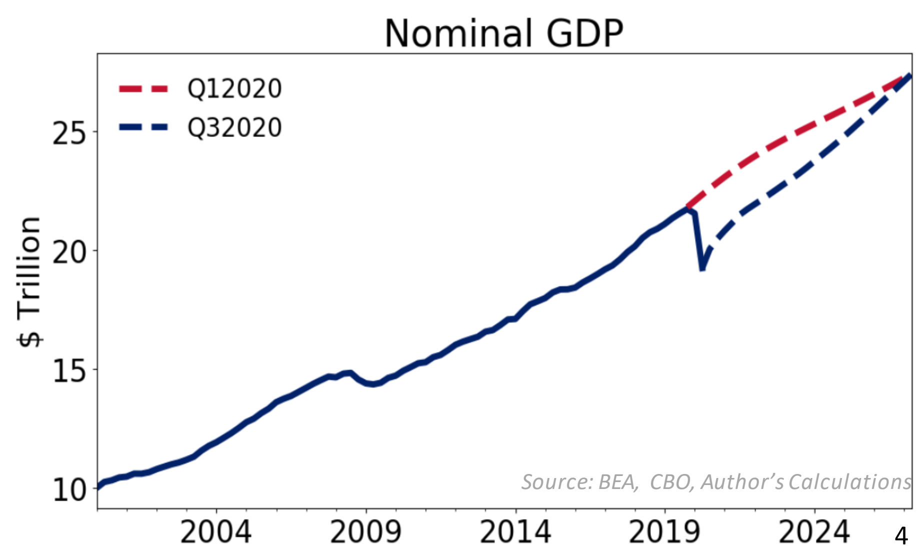
We expect significant further growth in the SOMA portfolio expressed in units of ten year note equivalents (TYE) due to deeply negative levels of the inertial Taylor rule



We update the CBO's long-term primary deficit forecast published in Jan 2020 for disaster recovery legislation and the deterioration in the macroeconomic outlook



We expect GDP returns to Q4 2019 levels at the end of 2021



Debt/GDP Factor Analysis

Debt/GDP Risk Factors

Deficits, interest rates, GDP growth, debt management, and Fed remittances are important drivers of Debt/GDP

- If we denote the nominal GDP deflator by Y, the ratio of the market value of debt to GDP by Debt^Y, the returns of Treasury debt in excess of T-Bills by $\mathrm{UST\ xs}$, and the returns of the SOMA portfolio in excess of funding costs (expressed as a % of the debt) as $\mathrm{SOMA\ xs}$ then the equation for the evolution of the ratio of debt to GDP can be written[1]

$$\frac{\Delta \mathrm{Debt}^Y}{\mathrm{Debt}^Y} = \underbrace{\underbrace{\underbrace{\text{bill yield} + \text{UST xs} - \text{SOMA xs}}_{\text{debt service cost}^2} + \text{primary deficit}}_{\text{total deficit}} - \text{gdp growth}}_{\text{growth rate of debt/GDP}}$$

- The equation predicts that changes in debt/GDP will increase with
  - Short rates (bill yield)
  - Excess returns on Treasury debt, which are driven by risk premia and price shocks
  - Primary deficits (expressed above as % of the debt), which are driven by macro factors (e.g., tax receipts, automatic stabilizers) and discretionary spending

- And debt/GDP will decrease with
  - GDP growth
  - Excess returns on the SOMA portfolio, which are also driven by risk premia and price shocks

[1] Our analysis closely follows Hall and Sargent, "Interest rate risk and other determinants of post WWII U.S. government debt / GDP dynamics", SSRN 1673451 (2010)
[2] Debt service cost as defined above explains fluctuations in debt/GDP due to consolidated Treasury/Fed asset and liability management decisions. It includes changes in the market value of the debt and hence is not equivalent to the interest expense on the debt outstanding reported by Treasury

Debt/GDP Risk Factors: Historical Analysis

Fixed rate issuance increased the level and volatility of the market value of debt-to-GDP over the past decade

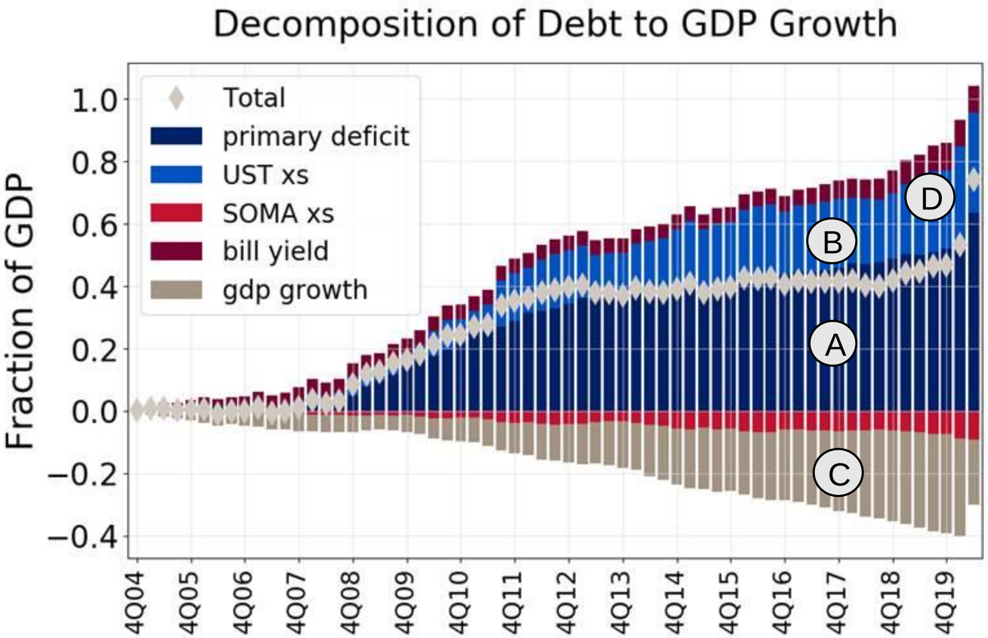
A The primary deficit has been the main driver of debt/GDP growth and the largest contributor to debt/GDP volatility

B Excess return on Treasury debt has been the second largest driver of debt/GDP growth. Cumulative excess returns on Treasury debt reflect the opportunity cost of past decisions to issue fixed instead of floating rate debt[1]

C GDP growth and SOMA portfolio remittances have reduced the debt/GDP ratio by 1.9% per annum since 2004

D Q2 2020 represents a period of extreme stress, in which every risk factor, except SOMA xs, contributed to the 25% increase in debt/GDP

E The first principal component of the debt/GDP decomposition explains 71% of total variance and highlights the relative volatility and correlation between the risk factors. Specifically, it shows that the contribution to debt/GDP from primary deficits and growth tends to be large and correlated with excess returns on Treasury securities. It is for this reason that fixed rate issuance has increased debt/GDP volatility



Source: Author's Calculations

2004-2020 Statistics	A primary deficit	B UST excess	C SOMA excess	gdp growth	bill yield	Total
Annualized Mean	4.0%	2.0%	-0.6%	-1.3%	0.6%	**4.7%**
Annualized Stdev	3.0%	3.2%	0.8%	2.8%	0.3%	**6.1%**
Risk contribution[2]	43%	24%	-6%	40%	-1%	**100%**
E First PC	1.4%	0.5%	-0.1%	1.3%	-0.1%	

[1] Here we are ignoring potential supply effects

[2] Hot Spots™ and Hedges. Robert Litterman. The Journal of Portfolio Management A Tribute to Fischer Black 1996, 23 (5) 52-75; DOI: https://jpm.pm-research.com/content/23/5/52

Proximity to the Zero Lower Bound

Review of TBAC Model Components

The TBAC model allows for simulation and optimization of Treasury debt issuance

- TBAC does not drive recommendations off one model, but instead takes into account a wide range of inputs on investor demand and market pricing
- The debt management model developed by TBAC[1,2,3,4] contains a number of key components which we briefly review below
- A simulation module consisting of:
  - A macroeconomic model for the unemployment gap, core PCE inflation, CPI, the Fed Funds target rate, the rate of change of real GDP, the potential rate of change of real GDP, and the equilibrium real rate of interest
  - A model for the nominal and real yield curve using expected Fed policy and term premium
  - A model for Treasury term premium including inflation, real rate, liquidity, and funding components
  - A model of the evolution of the SOMA portfolio including Agency MBS prices, prepayments, Fed remittances to Treasury, assumptions about SOMA reinvestment and QE
- A fiscal module for the primary budget deficit
- A debt dynamics module that projects current and future debt issuance
- An optimization module that identifies low cost strategies given risk appetite and constraints and can generate both static solutions where issuance fractions never change and dynamic solutions where issuance depends on macro variables

[1]Belton et al, [2]TBAC TIPS Charge, [3]TBAC FRN Charge, [4]TBAC SOMA Charge

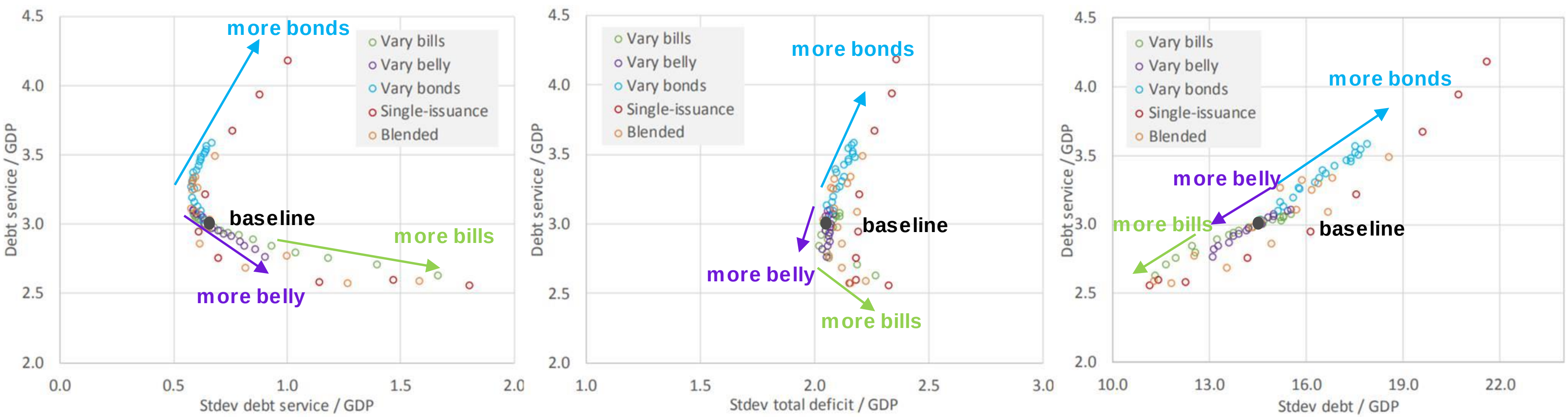
Insights from Past Debt Optimization Research

The optimal maturity structure of debt is sensitive to the choice of risk metrics and to estimates of expected cost

- Previous work[1,2] on debt optimization highlights that the optimal maturity structure of debt depends on both the degree of risk aversion (RA) of the debt manager and whether risk is better measured by the volatility of debt service/GDP, the volatility of total deficits/GDP, or the volatility of debt/GDP
    - When risk is measured by the volatility of debt service costs (left plot), increased allocation to floating rate debt at the expense of 2-, 3- and 5-year fixed rate notes is not especially attractive as it generates only modest cost savings with significant increases in risk
    - When risk is measured by the volatility of deficits (middle plot), a heavier allocation to floating rate debt is appropriate as the strategy benefits from the correlation between rates and the primary deficit
    - When risk is measured by the volatility of debt/GDP (right plot), floating rate debt is the dominant strategy because it benefits from low cost and low risk due to the correlation between rates, the primary deficit, and growth.
    - The debt/GDP dynamics equation[3] helps to build intuition for the plots below. Since bill yields are negatively correlated with primary deficits and positively correlated with GDP growth, floating rate debt reduces debt/GDP risk. Conversely, since excess returns on fixed rate debt are positively correlated with primary deficits and negatively correlated with GDP growth, fixed rate debt increases debt/GDP risk

$$\frac{\Delta \text{Debt}^Y}{\text{Debt}^Y} = \text{bill yield} + \text{UST xs} + \text{primary deficit} - \text{gdp growth}$$

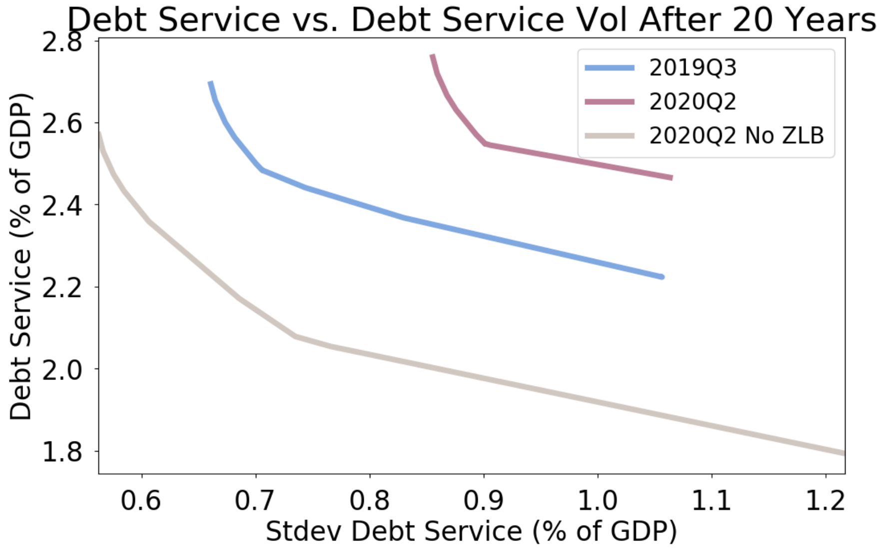
- The optimal debt structure also depends critically on estimates of term premium and its decomposition into liquidity, funding, inflation, and real rate risk premia. The results below assume an upward sloping term structure of term premia



[1] Belton et al [2] Counterfactual debt management experiments in the plots on this page ignore potential supply effects. [3] Repeated above without the complication of the SOMA portfolio

Static Optimization Results Before and After Covid-19

Increased debt, deficits, and proximity to the ZLB dominate the effect of low interest rates on the cost/risk tradeoff



Source: Author's Calculations

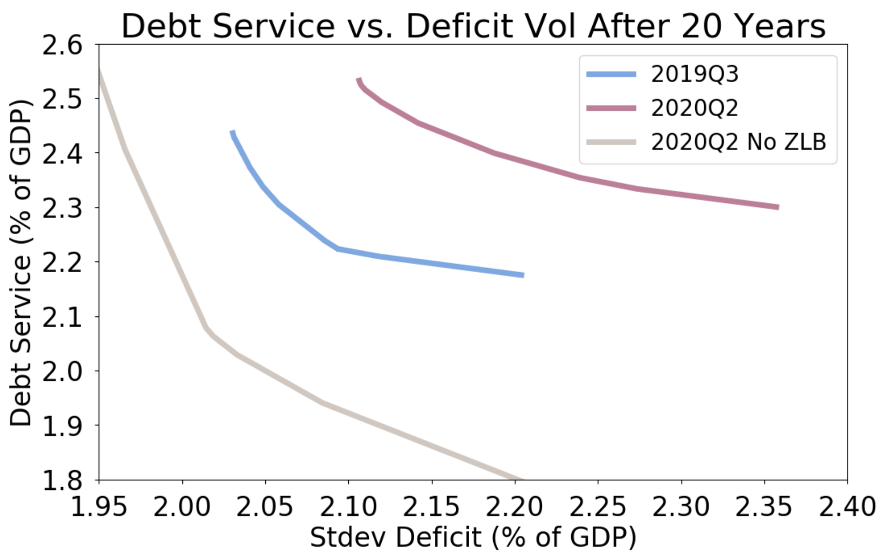
- Efficient frontiers come from minimizing the objective:
$$cost + RA \times risk$$
for different levels of risk aversion (RA)

- Cost and risk are evaluated at the simulation horizon (20 years forward)

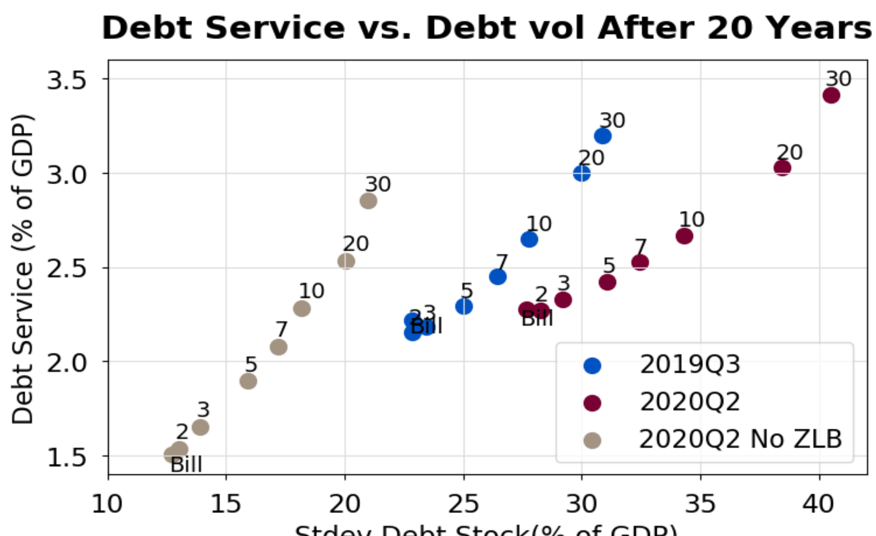
- Risk is defined to be the volatility across all simulated paths of
    - debt service / GDP (top left)
    - total deficit / GDP (bottom left)
    - debt / GDP (bottom right)

- In all cases, the post Covid-19 cost/risk tradeoff is less attractive due to increased debt, deficits, and proximity to the ZLB, i.e., the post Covid-19 frontiers are up and to the right of the pre Covid-19 frontiers

- If we remove the ZLB, the frontier shifts down and to the left



Source: Author's Calculations

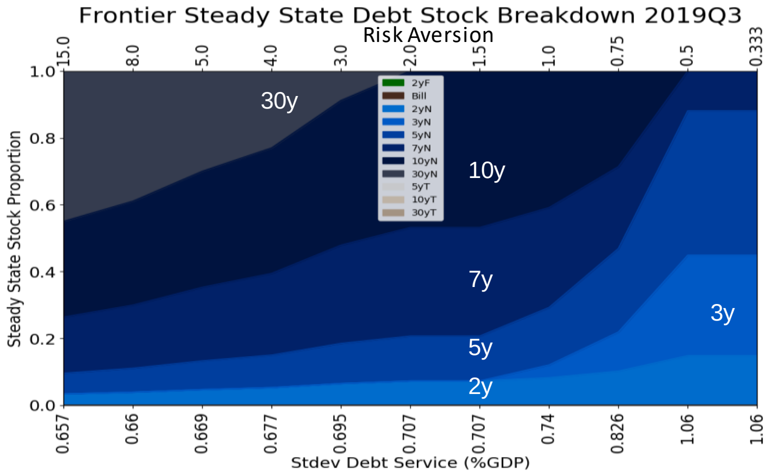


Source: Author's Calculations

Static Optimization Results Before and After Covid-19

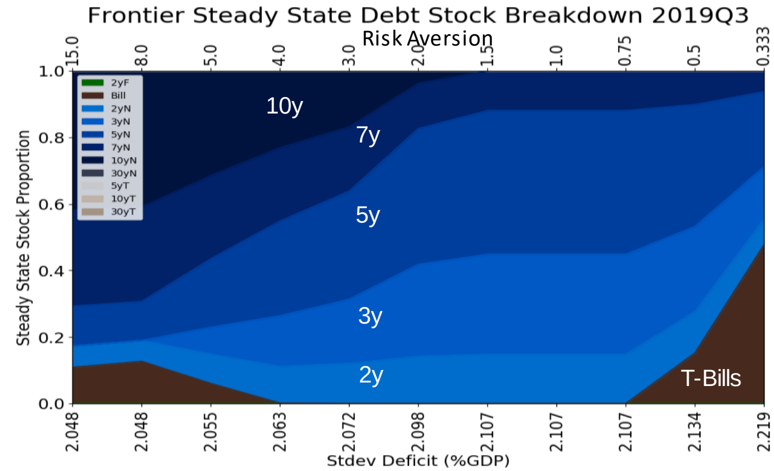
Close proximity to the ZLB favors longer maturity and TIPS issuance under debt and deficit risk metrics

For debt service/GDP volatility the pre COVID-19 optimal issuance was heavy in the belly for risk aversion (RA) less than 1.5 and heavy on long issuance for RA greater than 1.5



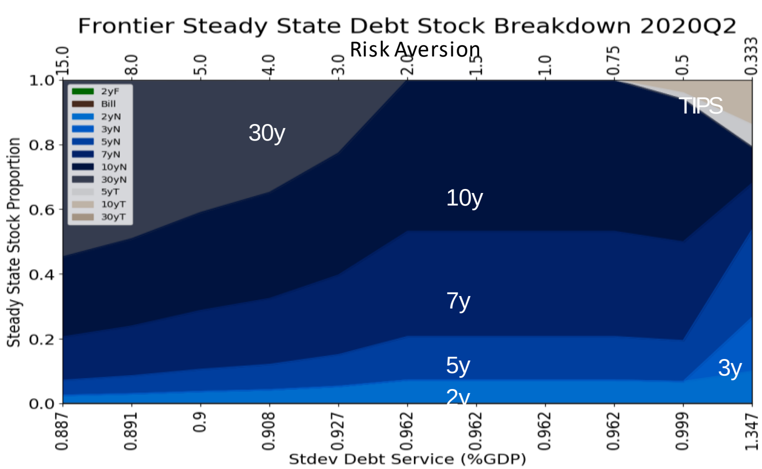
Source: Author's Calculations

For deficit/GDP volatility the pre COVID-19 optimal issuance was heavy in the belly for moderate RA and heavy on bills for low RA



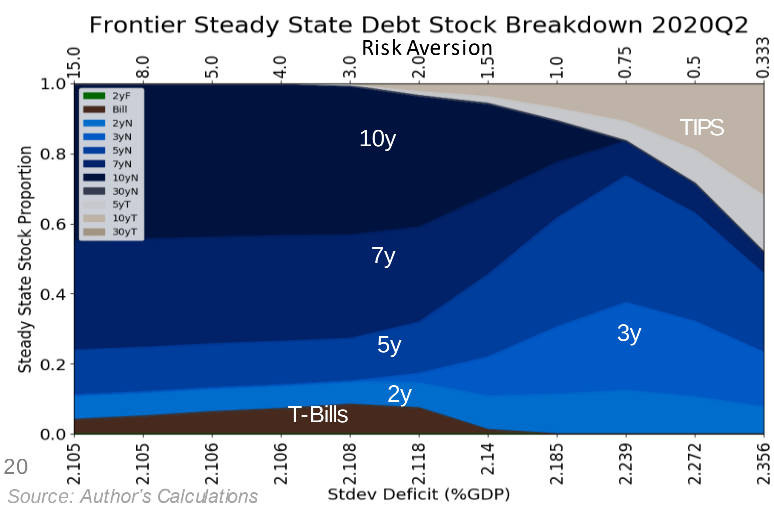
Source: Author's Calculations

For RA ≥ 1.5 the model shifts into the 7y-30y sector, for low RA the model shifts into 7y-10y year and TIPS



Source: Author's Calculations

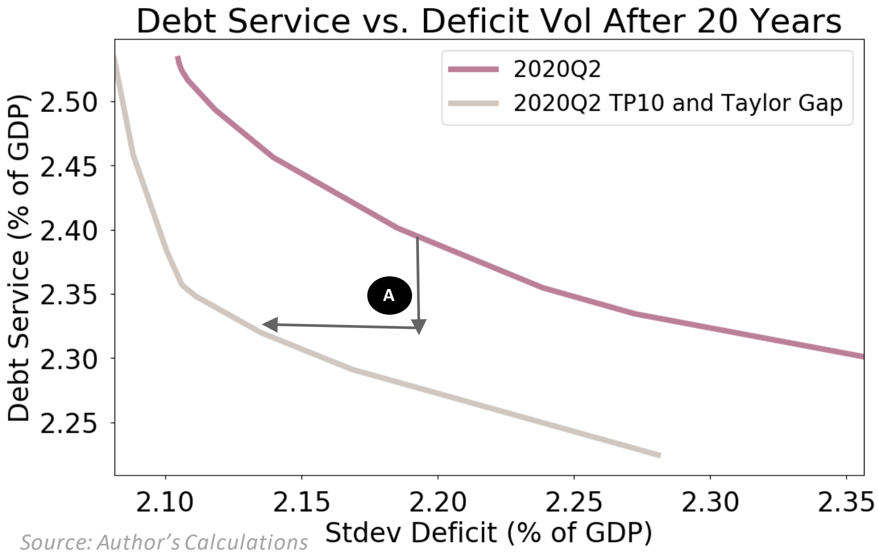
After the COVID-19 data update the model shifts out of bills into TIPS for low RA and out of 2y-5y into 7y-10y for moderate RA. The move out of bills into TIPS makes sense given how far TIPS are from the principal floor



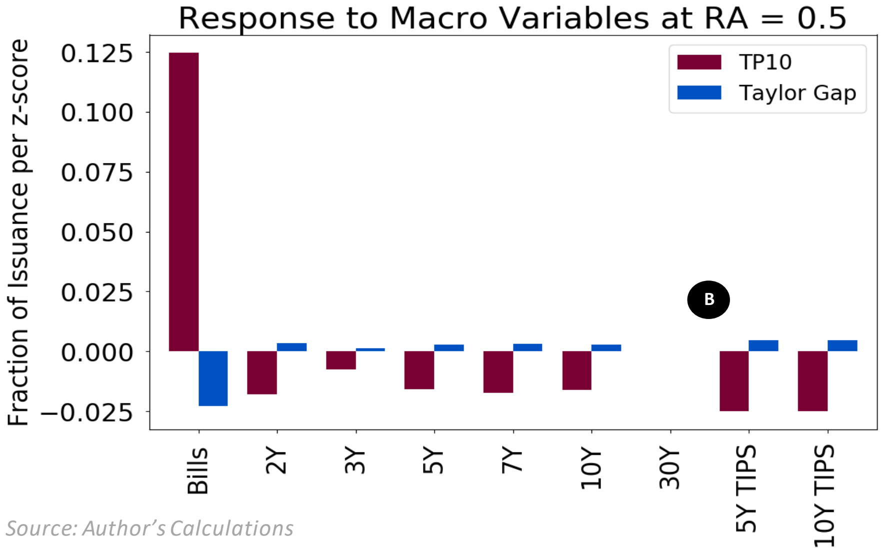
Source: Author's Calculations

Dynamic Optimization Results

Low term premium and proximity to the ZLB favors intermediate and TIPS issuance in the dynamic setting as well



Source: Author's Calculations



Source: Author's Calculations

- We introduce a new macroeconomic variable to the optimal response function to capture the effect of expected time spent at the ZLB. It is defined as

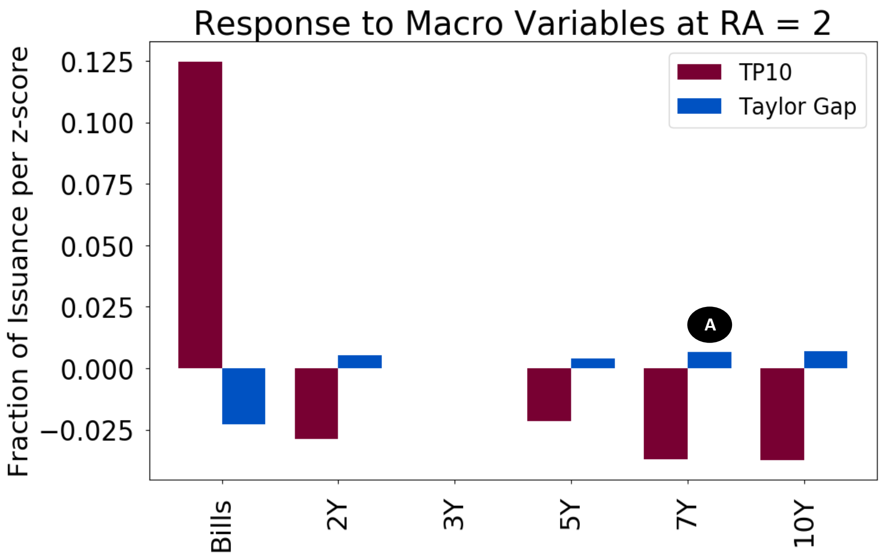
  Taylor Gap(t) = Fed Fund Rate(t) − Inertial Taylor Rule(t)

A We optimized issuance strategies, allowing issuance weights to depend on TP10 and the Taylor Gap. Dynamic optimization allows the efficient frontier to shift down and to the left.

B At the ZLB, the Taylor Gap causes the model to rotate out of bills and into intermediates and TIPS for lower levels of risk aversion

C For higher levels of risk aversion, the model rotates out of bills into intermediates,

- High TP10 pulls issuance from longer maturities into Bills



Source: Author's Calculations

Price Risk at the ZLB: Sensitivity Analysis

Sensitivity analysis highlights the increased convexity benefit of fixed rate issuance as yields approach the ZLB

- Simple sensitivity analysis may help to explain the model results based on simulations. Sensitivity analysis shows that longer maturity fixed rate debt becomes increasingly attractive as yields approach the ZLB due to price convexity
- Assuming that the Federal Reserve does not intend to take rates negative, the risk to further yield drops is limited to the current yield
- In the table below we show the expected reduction in debt/GDP from issuing an additional 5% of GDP in each maturity, under interest rate scenarios in which rates rise by 100 and 200 bp, and in which they drop by 100 bp and 200 bp, but are floored at zero. Note that this analysis assumes nothing about the likelihood of these rate outcomes

	1Y	2Y	3Y	5Y	7Y	10Y	20Y	30Y
Treasury Yield	0.13%	0.15%	0.17%	0.27%	0.45%	0.60%	1.07%	1.29%
Reduction in Debt / GDP for +200	0.10%	0.19%	0.29%	0.47%	0.64%	0.88%	1.49%	1.90%
Reduction in Debt / GDP for +100	0.05%	0.10%	0.15%	0.24%	0.33%	0.46%	0.82%	1.08%
Reduction in Debt / GDP for -100	-0.01%	-0.01%	-0.03%	-0.07%	-0.16%	-0.30%	-0.99%	-1.43%
Reduction in Debt / GDP for -200	-0.01%	-0.01%	-0.03%	-0.07%	-0.16%	-0.30%	-1.07%	-1.94%

A

Source: Author's Calculations

A The 1y-10y sector exhibits positive convexity for +-100 bp shocks, i.e., the upside benefit in rising rate scenarios outweighs the downside risk to further decrease in rates. For +-200 bp shocks, issuance in the 1y-20y sector exhibits positive convexity.

- A principal components analysis of interest rates, deficits, and GDP growth shows that a -100 bp shock has historically been accompanied by a deterioration of GDP growth by -2%, and an increase in the primary deficit of about 2.25% of GDP. In such a scenario, the limit on downside risk of fixed rate issuance near the ZLB could be a significant benefit

TIPS as an Alternative to Bills and FRNs at the ZLB

At the ZLB TIPS may retain their favorable correlation with deficits and growth better than floating rate debt

	2y FRN	Bill	2y N	3y N	5y N	7y N	10y N	30y N	5y TIPS	10y TIPS	30y TIPS
Average issuance rate	3.09	2.99	2.96	3.02	3.15	3.29	3.44	4.01	1.07	1.21	1.79
Average debt service/GDP	2.62	2.49	2.46	2.55	2.75	2.97	3.21	4.00	2.58	2.81	3.62
Standard deviation debt service/GDP	1.70	1.67	1.41	1.13	0.72	0.71	0.82	1.10	1.74	1.65	1.81
Standard deviation total deficit(%GDP)	2.35	2.34	2.15	2.09	2.11	2.11	2.14	2.29	2.42	2.31	2.43
Correlation funding cost, primary deficit (%GDP)	(0.15)	(0.15)	(0.18)	(0.11)	0.13	0.14	0.11	0.10	(0.12)	(0.16)	(0.14)

Source: Author's Calculations

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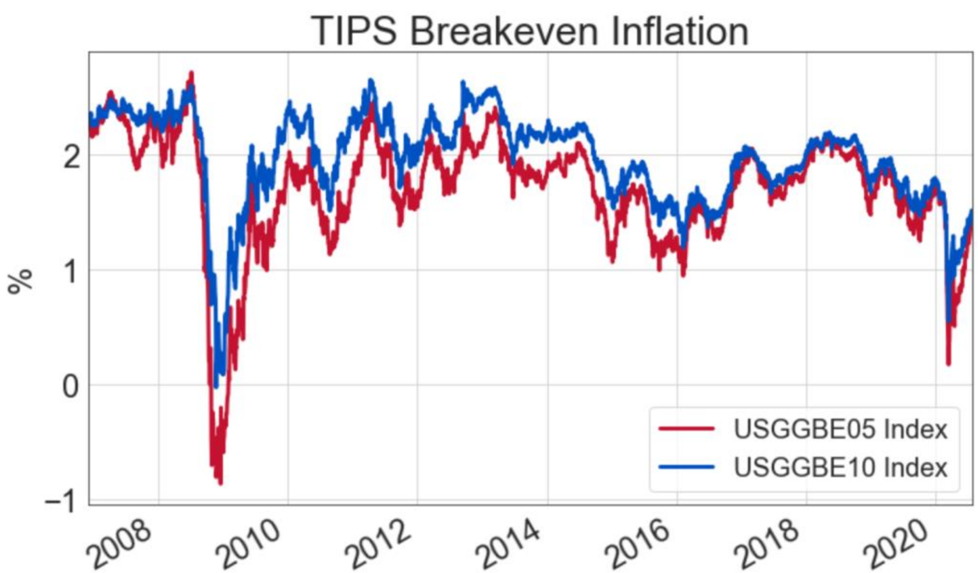


Source: Bloomberg

A In past work[1,2] we have shown that away from the ZLB TIPS, FRNS, and bill funding costs are negatively correlated with deficits and so they provide a hedge against down rate, growth, and inflation scenarios

B While TIPS are subject to a par principal floor, at current levels of break even inflation, TIPS provide some protection from rollover risk and scenarios involving weaker growth and higher deficits

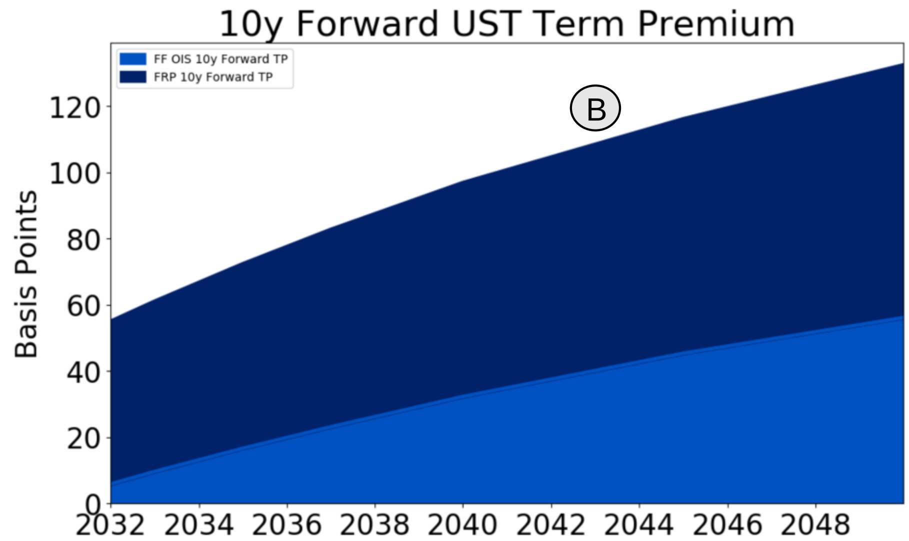
[1]TBAC FRN Charge [2]TBAC TIPS Charge

Term Structure of Interest Rates

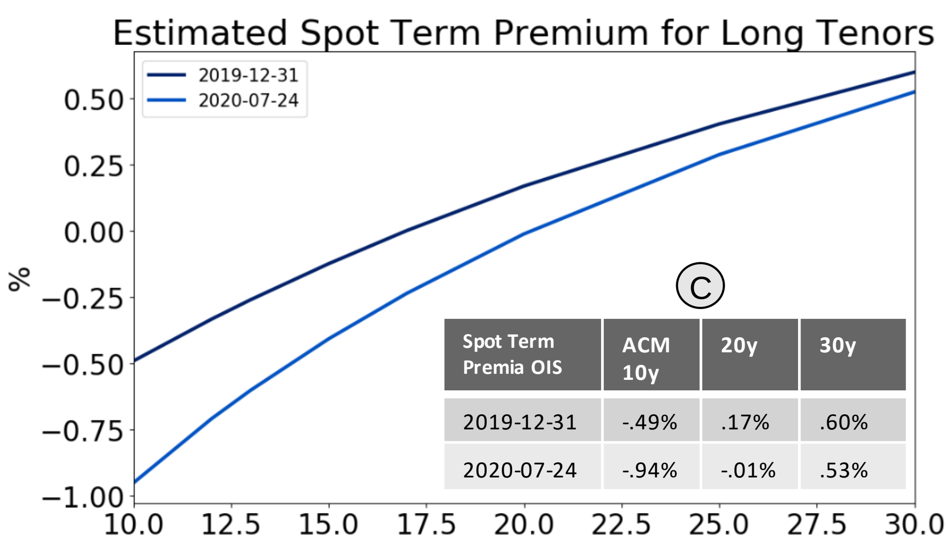
Treasury Term Premium

While the overall level of term premium has declined and appears to be at historic lows, 20 and 30 year UST term premia remain elevated relative to the 10 year maturity

- (A) Many estimates of 10 year Treasury term premium show evidence of a decline over the past decade; however, most components of term premia are unobservable and difficult to estimate ex-ante
- In prior work[1], we defined the funding risk premium (FRP) to be the observable difference in yield between on-the-run Treasuries and matched maturity Fed funds (FF) OIS swaps
- (B) While the levels of spot term premia are difficult to determine, conditional on knowing convexity adjustments and on setting reasonable restrictions on expected FOMC policy in equilibrium, forward term premia can be estimated with greater precision than spot
- (C) These observations allow us to combine the ACM term premium estimate for spot 10y TP and forward TP estimates to show that TP in 20y and 30y are 93bps and 147bps higher than 10y TP respectively. This suggests that issuance in maturities shorter than 10y is significantly less costly to Treasury

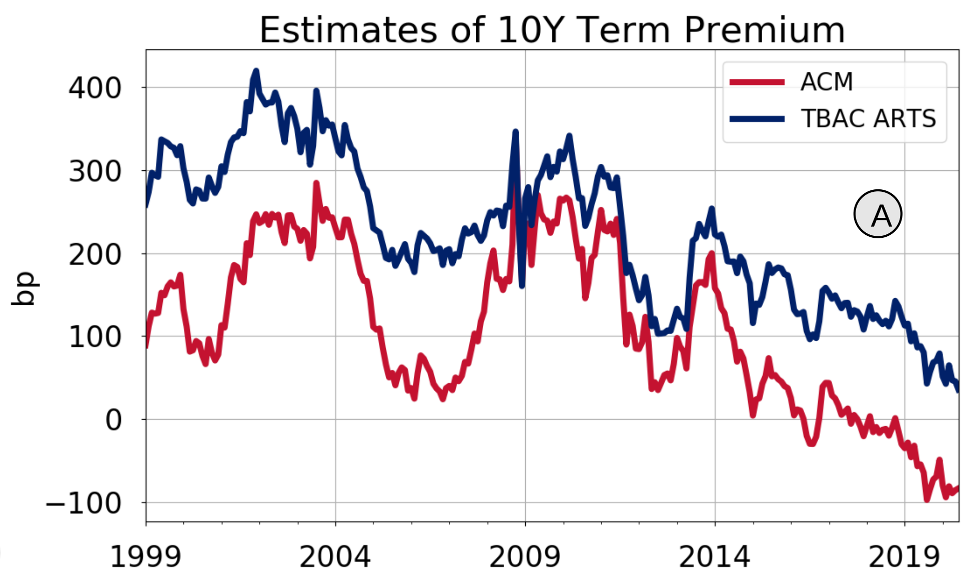


Source: Author's Calculations



Spot Term Premia OIS	ACM 10y	20y	30y
2019-12-31	-.49%	.17%	.60%
2020-07-24	-.94%	-.01%	.53%

Source: Author's Calculations



Source: TBAC ARTS, Federal Reserve

[1] TBAC FRN Charge

Forward Term Premia in the Swap Market

Ten year forward term premia in the Fed funds OIS swap market[1] are most likely positive

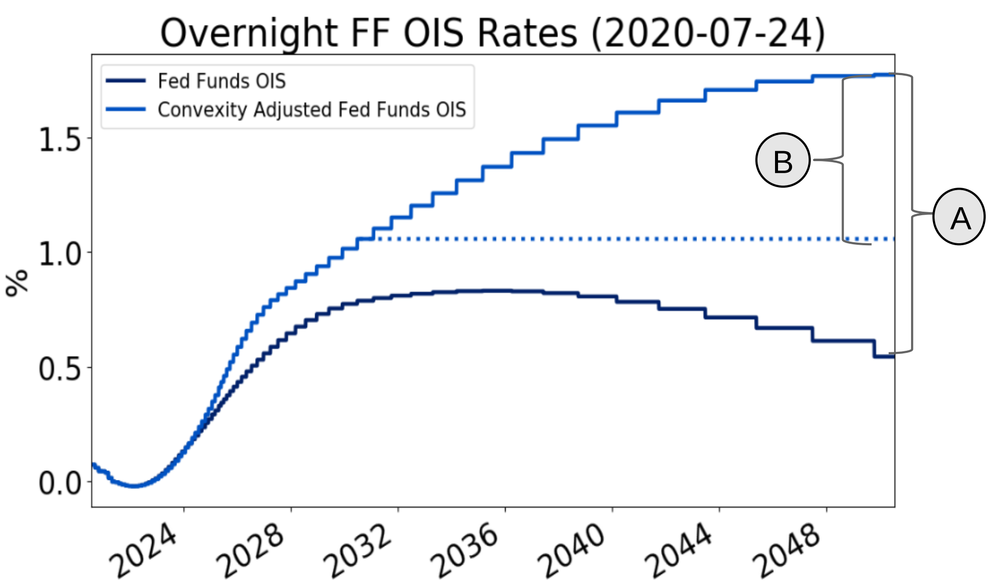
- Forward Treasury yields and Fed Fund OIS break even forward swap rates can be decomposed as

$$y(0,t,T) = \text{Expected Short Rate}(0,t,T) + \text{Term Premium}(0,t,T) - \text{Convexity Adjustment}(0,t,T)$$

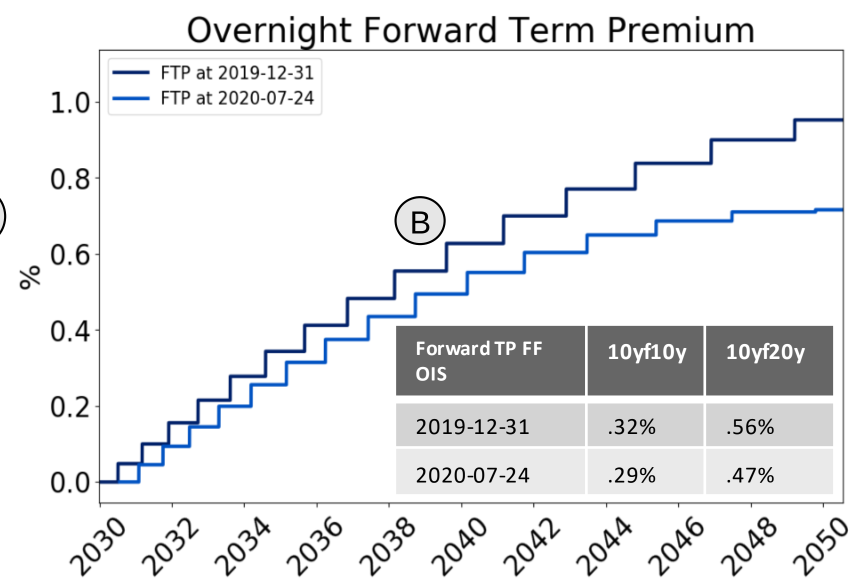
A Convexity adjustments are always positive and increase with maturity. In the plot below we use the TBAC model's assumed convexity adjustments to compute the convexity adjusted Fed funds overnight forward curve.

B Since the typical business cycle lasts approx. 10 years, it is reasonable to expect that the Fed will have reached its equilibrium funds rate 10 years from now. Therefore, it makes sense to hold the expected Fed funds rate constant after 10 years (i.e., there is no reason to expect 10 year forward hikes or cuts). This regularizing assumption allows us to estimate the forward term premium as

$$\text{Term Premium}(0,t,T) = y(0,t,T) + \text{Convexity Adjustment}(0,t,T) - \text{Expected Short Rate}(0,t,t)$$



Source: Author's Calculations



Forward TP FF OIS	10yf10y	10yf20y
2019-12-31	.32%	.56%
2020-07-24	.29%	.47%

Source: Author's Calculations

[1]Typically FF OIS swap curves are calibrated in conjunction with LIBOR (and possibly other) swap markets. Despite liquidity va riation across tenors between the different markets the joint calibration procedure, in conjunction with regularization methods, produces a robust estimate of swap rates for FF OIS swaps even for long maturities

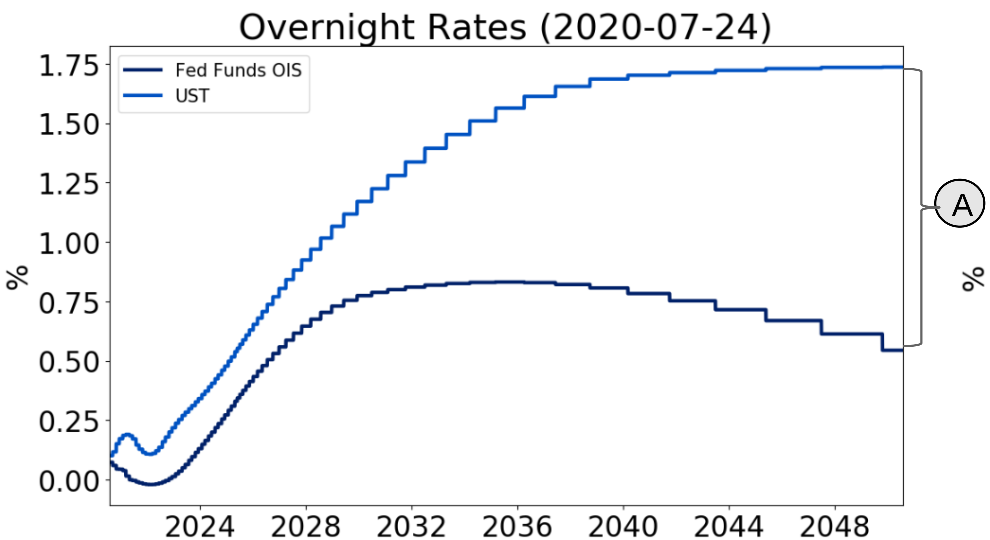
Funding Risk Premia

10 year forward 20 year UST / FF OIS asset swap spreads are elevated compared to 10 year spot spreads

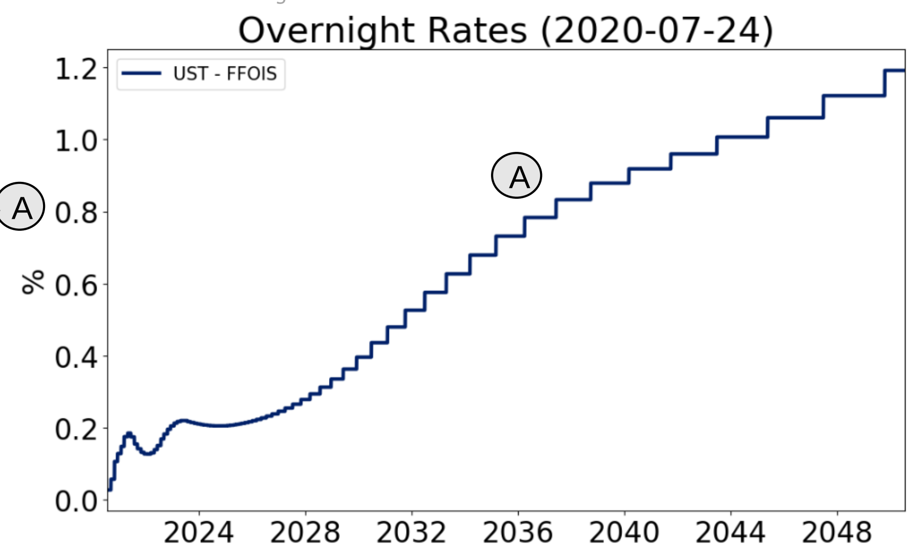
A In past work[1] we defined funding risk premia (FRP) as the difference between UST cash yields and FF OIS matched maturity swap rates. It represents the risk premia investors require for providing term funding[2].

B The difference between the 10 year forward 20 year (red-line top right) and the 10 year (blue-line top right) FRP is historically wide. This indicates that the spot 20 and 30 year FRP are currently wide relative to 10 year.

Source: Bloomberg and Author's Calculations



Source: Author's Calculations



Source: Author's Calculations

[1] TBAC FRN Charge

[2] By differencing observable Treasury yields and swap rates to estimate FRP, we are assuming that Treasury/swap convexity adjustments are close to one another and approximately cancel

The Federal Reserve's Balance Sheet

Federal Reserve Balance Sheet Expectations

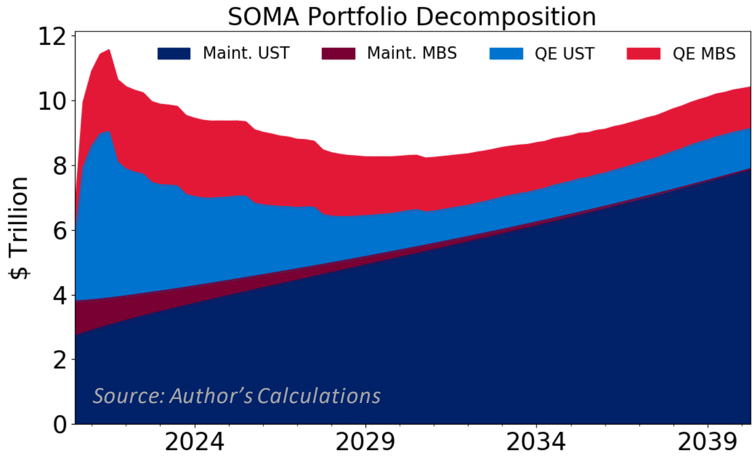
Elevated levels of the Fed's balance sheet will affect consolidated cost/risk metrics and put downward pressure on Treasury yields across the curve

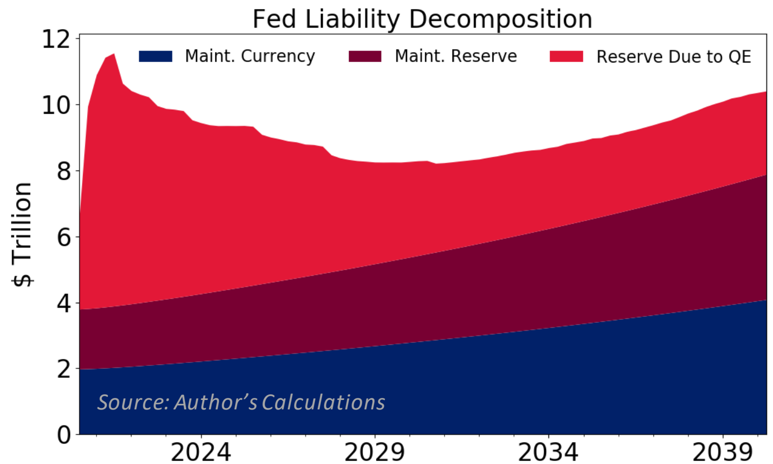
- In past work[1], we recommended focusing on the consolidated Fed and Treasury balance sheet to capture the contribution of the SOMA portfolio to debt management cost and risk metrics

- Here again, on slide 7 we showed that the Fed's balance sheet contributes directly to debt/GDP dynamics (and thus cost and risk) via remittances, but it also influences debt/GDP through indirect channels, including
  - Treasury term premia[2] - which affect debt/GDP through excess returns on the Treasury portfolio and through unemployment and output gaps (i.e., deficits and growth)
  - Treasury financing conditions and duration demand via banking sector balance sheets

- The plots below show the expected trajectory of the Fed's balance sheet in the TBAC debt management model, which incorporates QE through a reaction function that is proportional to the amount by which the Fed would like to lower the short rate below the zero bound. The plots show that QE is the main driver of expected near and medium term growth

- We have argued[1] that the Fed, in conducting monetary policy through QE, should be allowed to change the interest rate risk of outstanding debt for economic purposes; therefore, we focus on how the Fed balance sheet might affect Treasury portfolio rollover risk and Treasury's ability to use T-Bills as a shock absorber for unexpected deficit financing needs

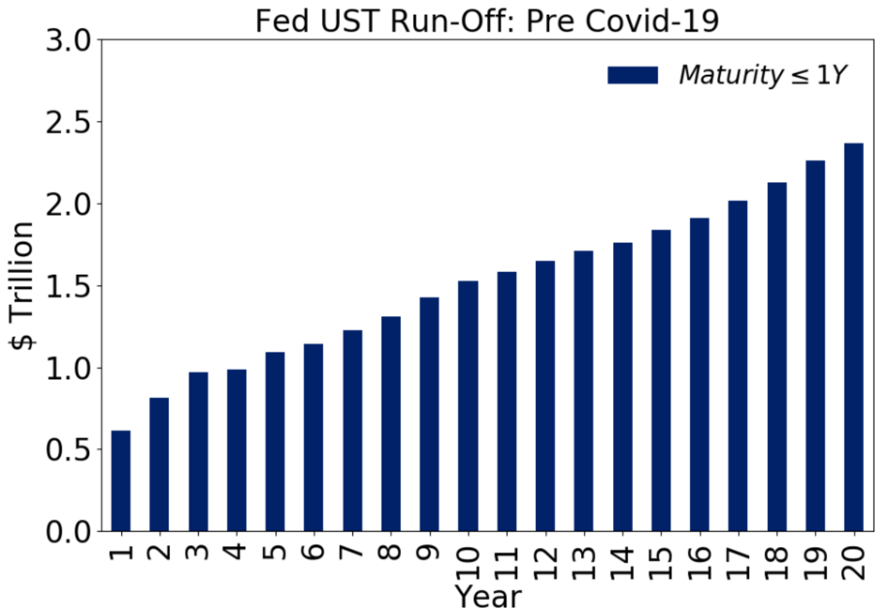




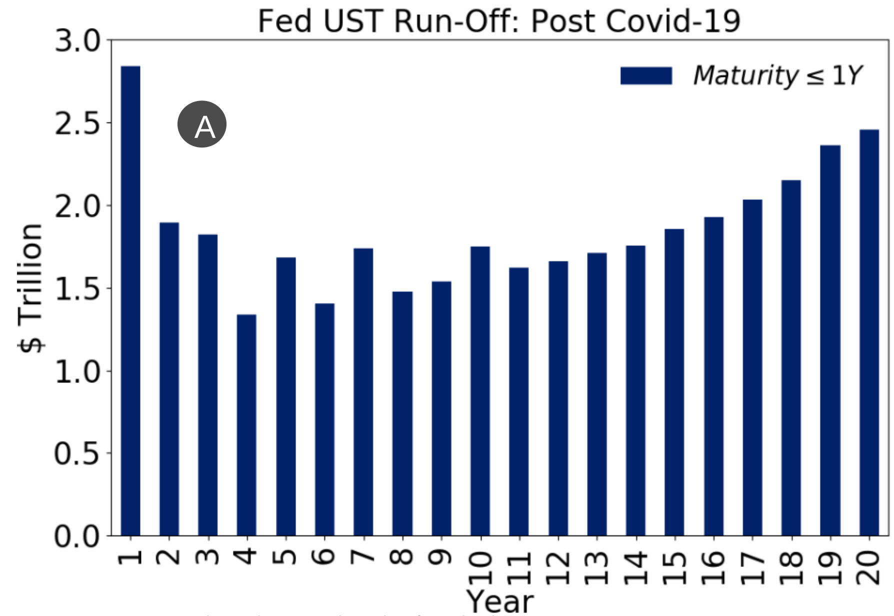
[1] TBAC SOMA Charge
[2] Cavallo et al., "Fiscal Implications of the Federal Reserve's Balance Sheet Normalization", (January, 2018). .

Fed Run-off Capacity

The capacity for run-off of the Fed's portfolio increases tactical funding risk for Treasury in the future



Source: Bloomberg and Author's Calculations



Source: Bloomberg and Author's Calculations

(A) Increased run-off capacity could pose a risk of future Treasury funding stress if the Fed were to allow its balance sheet to fall rapidly

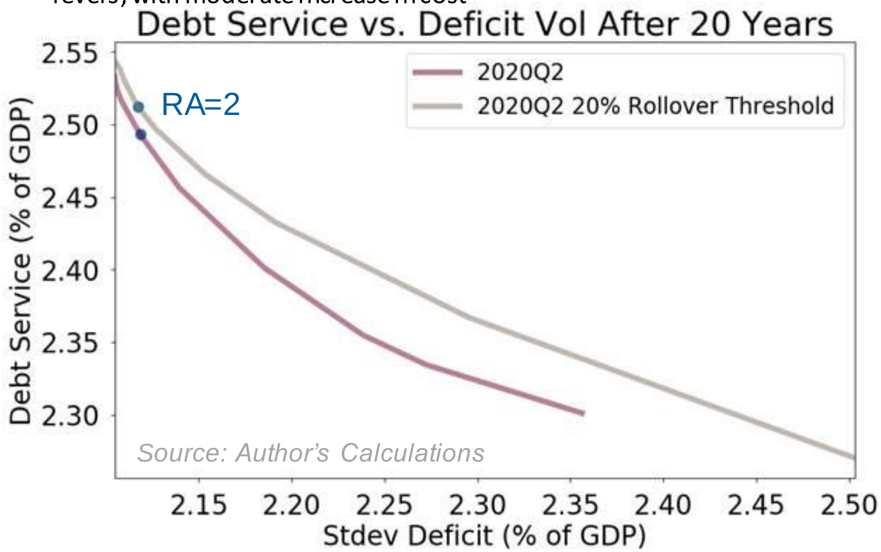
- Thus, an important consideration for debt management would be whether the Fed would impose run-off caps to make the debt management implications manageable.
- If the run-off of SOMA assets were relatively gradual and known in advance, it would allow the Treasury to maintain a "regular and predictable" issuance approach.

• Assuming additional QE, consistent with our QE reaction function and absent run-off caps imposed by the Fed, we estimate the SOMA portfolio could create incremental rollover risk of approx. 9%-14% of GDP

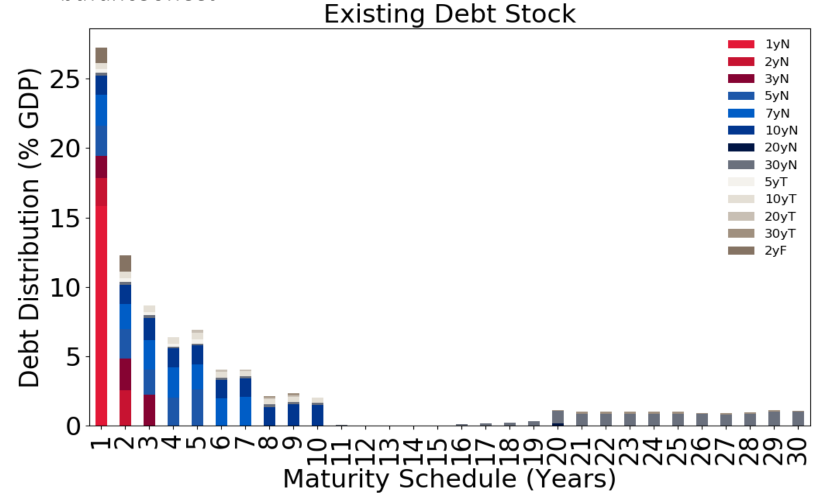
The Trade-Off Between Cost, Risk, and Rollover

Rollover risk can be efficiently reduced by increasing issuance in 7y-10y nominals and TIPS

A threshold of 20% of GDP constrains rollover to be close to current levels, with moderate increase in cost

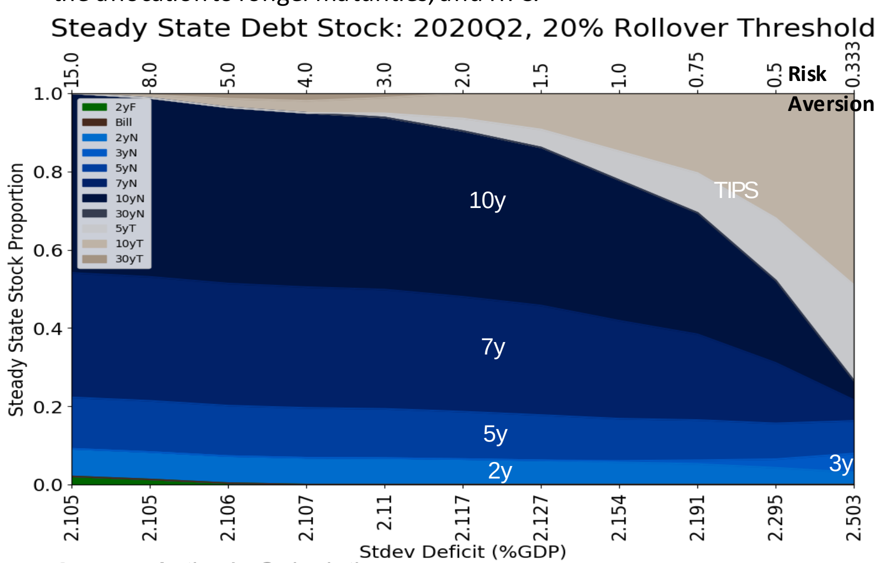


The current debt distribution excluding the contribution of the Fed's balance sheet



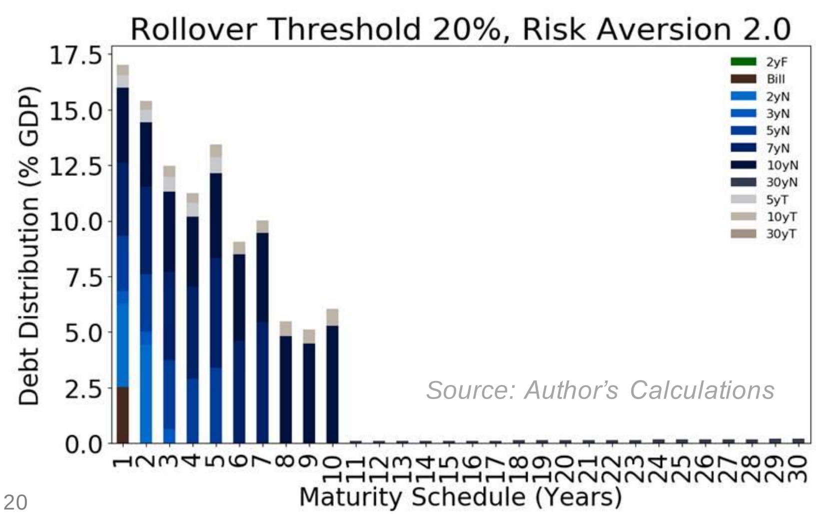
Source: Author's Calculations

Weights along the 20% rollover threshold efficient frontier highlight the allocation to longer maturities, and TIPS.



Source: Author's Calculations

Steady state debt distribution with 20% rollover threshold and risk aversion set equal to 2



Flows Affecting Treasury Financing Conditions in the Context of Large/Uncertain Deficits

Government Deficits and Private Sector Savings

Loanable funds are not finite in supply, typically deficits are mirrored by private sector savings

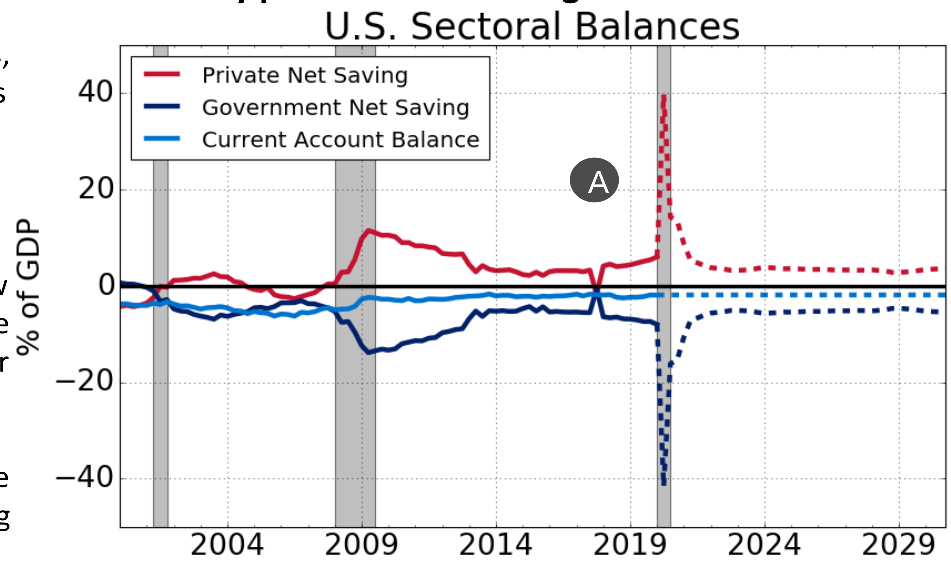
- The relationship between private sector financial savings, government deficits, and the current account balance is governed by the following macroeconomic accounting identity

$$\text{Private Net Savings} = \text{Government Deficits} + \text{Net Exports}$$

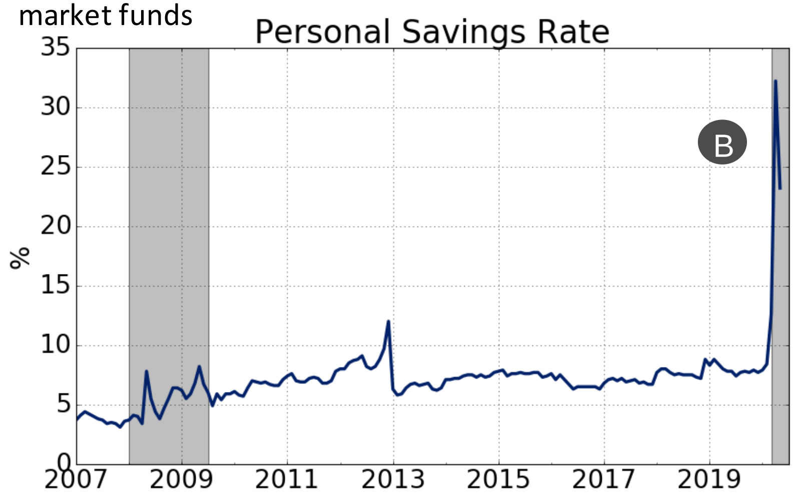
A Historically we can see that net exports exhibits a low correlation to private savings and government deficits, while private savings and government deficits are nearly mirror images of one another

B Given the severity of the economic decline and the aggressive fiscal policy response to the COVID-19 crisis, it is unsurprising that the personal savings rate rose to historically high levels

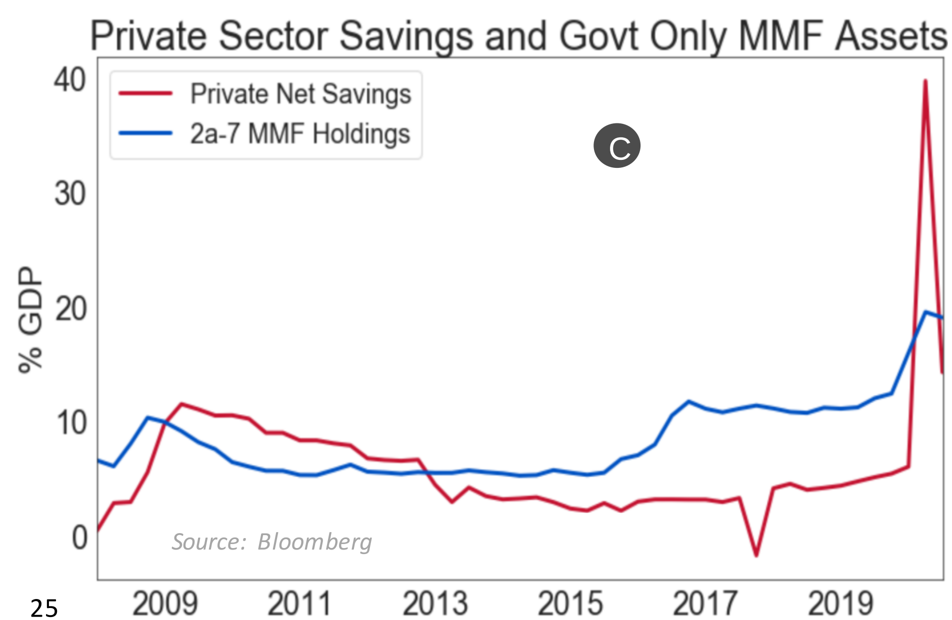
C Given our deficit/savings outlook for the remainder of 2020 and 2021, we do not expect to see rapid outflows in relatively safe financial assets such as USTs and government only money market funds



Source: Bloomberg and Author's Calculations



Source: BEA/Haver



Effect of Bank Reserves on Treasury Financing Conditions

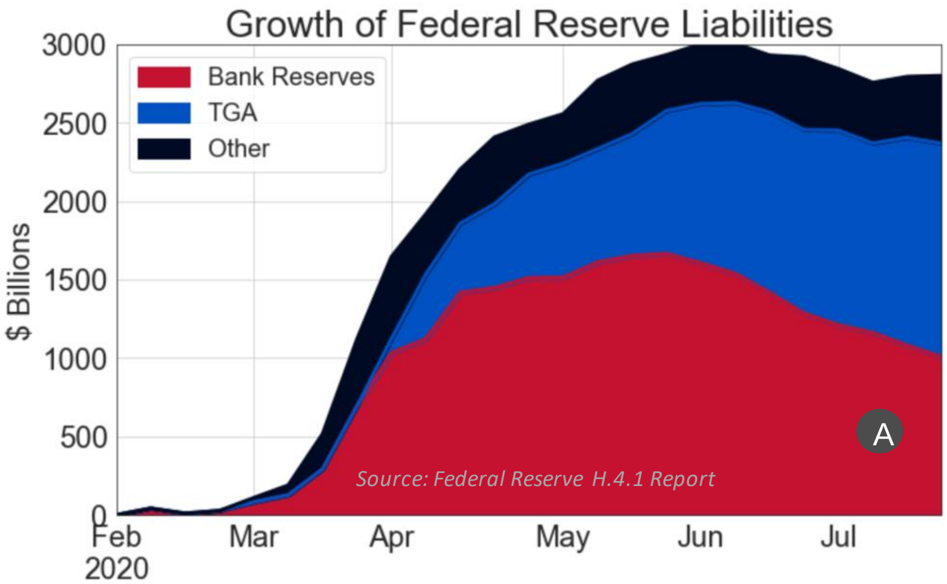
The banking sector intermediates SOMA growth, putting incremental downward pressure on Bill and Coupon yields

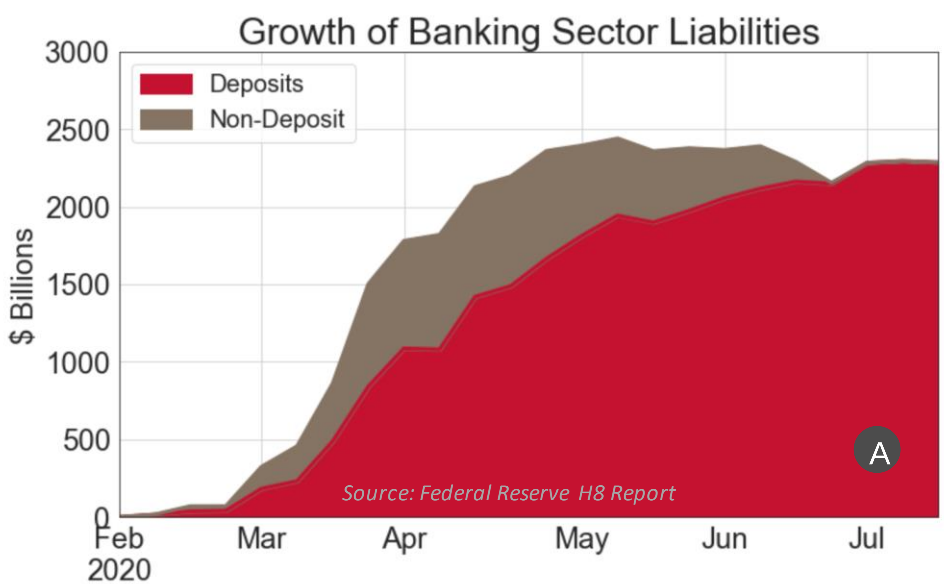
A Reserve growth due to QE significantly increased cash assets and deposits in the banking sector. Recently TGA growth has caused reserves to decline; however, reserves are likely to surpass their Q2 2020 peak as the TGA normalizes and Fed QE continues in H2 2020

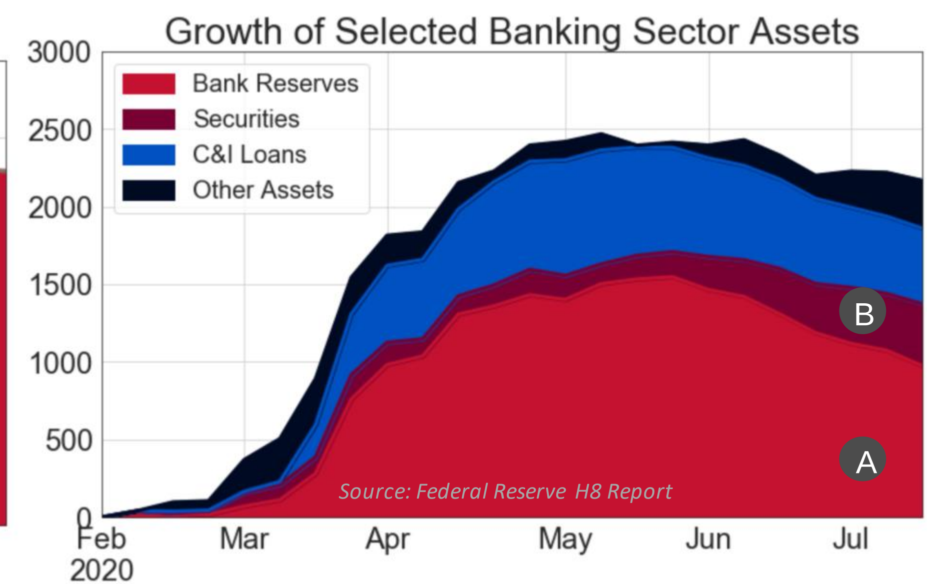
- Treasury reverse repo and T-Bills assets are highly substitutable with reserves from a capital, liquidity, and interest rate risk perspective. Large stocks of excess reserves will put downward pressure on Treasury financing rates and T-Bill yields

B Banks model deposits as partially fixed rate liabilities. Deposit growth will create HQLA duration demand, in the belly of the Treasury curve, to hedge banking sector economic value of equity (EVE) and earnings risk.

- If banks purchase the fixed rate assets from the non-bank private sector this will create additional deposits







Funding Market Response to Growth in Bank Reserves

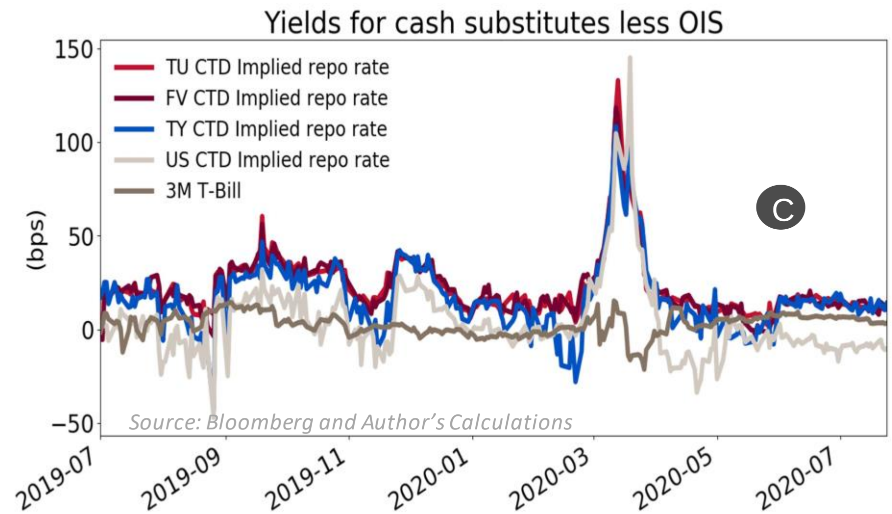
Reserve injections and 13(3) facilities stabilized funding markets overnight, term, secured, and unsecured

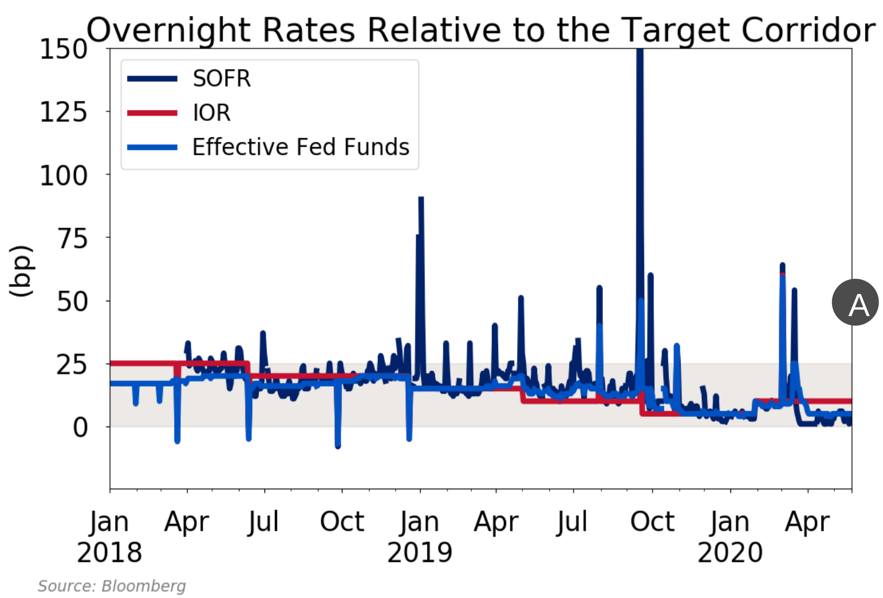
A. As the supply of reserves to banks increased, overnight secured and unsecured funding rates fell well below IOR.

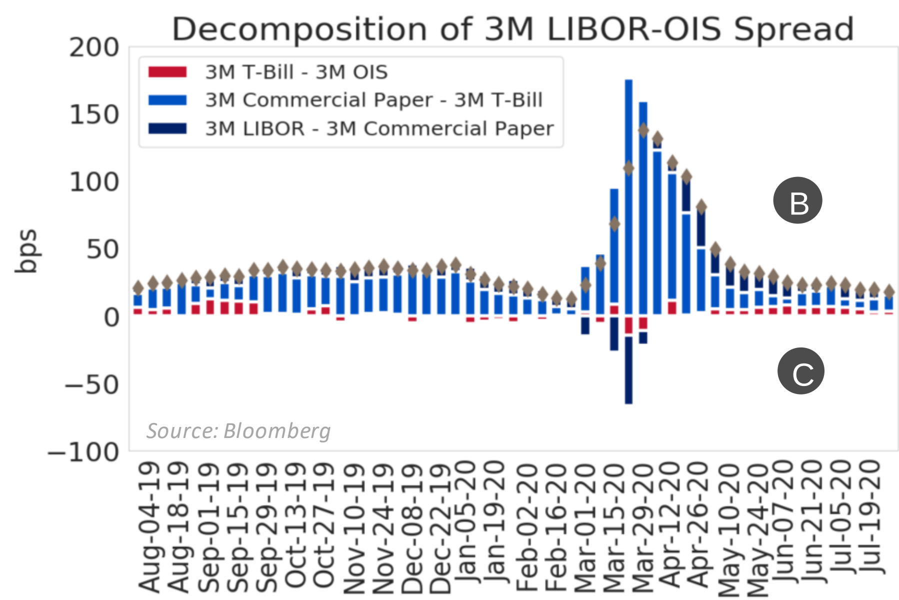
B. Term secured and unsecured money market rates normalized in response to the Fed's liquidity operations

C. Despite distress in the term Treasury financing markets and heavy T-Bill supply to support the disaster response, T-Bill yields remained low and stable.

- In the near term, reserve growth at commercial banks and lower asset volatility will support Treasury financing conditions and create incremental capacity for Treasury to use the T-Bill market as a shock absorber for unexpected financing needs







Investor Demand for Bill Issuance is Unlikely to Reverse Rapidly

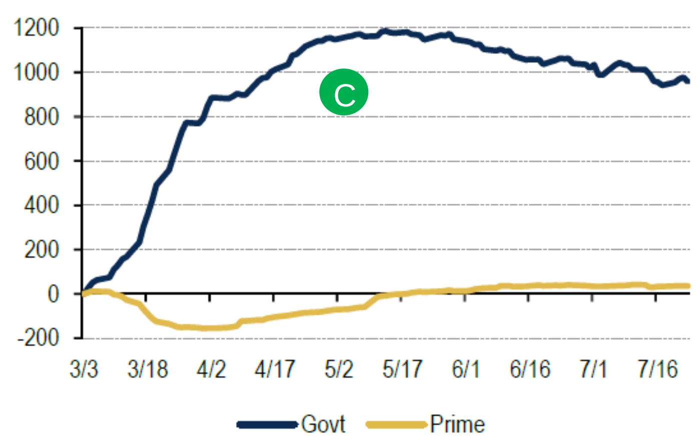
Q2 Treasury issuance was readily absorbed by the Fed, MMFs, and banks

Sectoral flows - 12-31-19 to 6-30-20

	Treasury	Fed	Banks	RoW	Row Sum
Reserves	-	(1,314)	1,314	-	-
USTs	(5,253)	1,876	187	3,191	-
Deposits	1,253	(1,253)	(2,243)	2,243	-
Tax Obligation	4,000	-	-	(4,000)	-
Other Assets	-	979	827	(1,807)	-
Other Liabilities	-	(288)	(86)	373	-
Column Sum	-	-	-	-	-
BS Size	5,253	2,855	2,328	5,807	

Sources: Federal Reserve H8 and H4 Reports, and Author's Calculations

Cumulative change in MMF assets since start March ($bn)



Bills outstanding and MMF vs Fed holdings

	Outstanding	MMF		Fed	
	$bn	$bn	%	$bn	%
Feb-20	2564	618	24%	281	11%
Mar-20	2657	832	31%	326	12%
Apr-20	4001	1694	42%	326	8%
May-20	4629	2056	44%	326	7%
Jun-20	5079	2125	42%	326	6%

Source: US Treasury, Crane Data, Federal Reserve

- In the transaction flow matrix to the left, columns represent sectors and rows represent asset/liability categories. Entries with a positive sign indicate asset growth and entries with a negative sign indicate liability growth. The columns sum to zero since asset growth must equal liability growth. The rows sum to zero since one sector's financial asset is another sector's financial liability. The matrix captures the sectoral balance sheet flows due to deficit spending and QE. It shows that

  A Continued Federal Reserve balance sheet expansion ensures ongoing demand for bills and intermediates maturities through
  - Direct purchases into the SOMA portfolio
  - Bank fixed rate liability creation which is typically hedged
  - Increased demand for yield enhancement on banking sector excess reserves

  B Deficit spending creates household financial savings and future tax liabilities resulting in at least some new Treasury demand

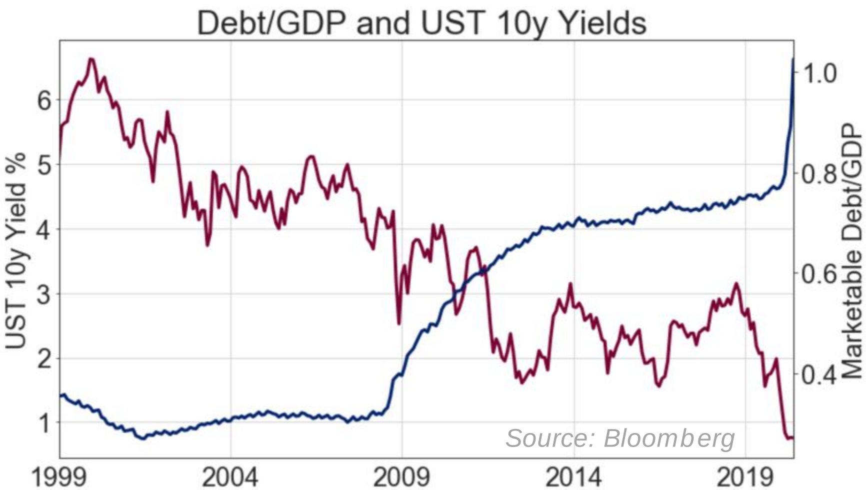
  C As evidenced by growth in money fund balances and T-Bill holdings
  - Reallocation into risk assets could impact cross-sectional term premia and asset swap spreads, but savings won't be destroyed

- In addition, the Federal reserve implements monetary policy by controlling the constellation of money market rates in the short end of the yield curve while allowing the size of their balance sheet to float. This means that there is little risk of T-Bill yields rising much above IOR, SOFR, or Fed funds effective

Supply Effects in the Longer Maturities

Longer maturity yields may become more sensitive to supply at the ZLB

Over the past 20 years, yields have fallen steadily despite rapidly growing debt/GDP and large net Treasury supply after the GFC



Heavy supply may cause the FRP to increase, particularly for longer maturities. The table below reports selected statistics for regressions on monthly data (1999-2020) of the form

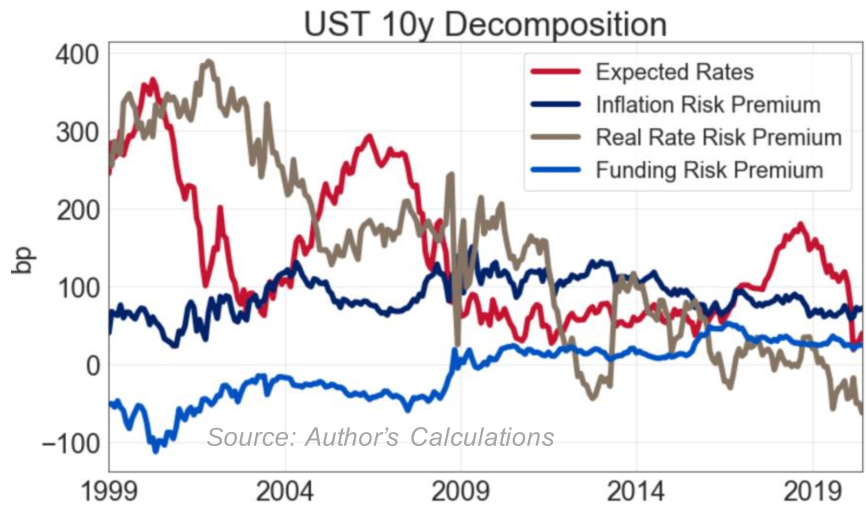
$$S_t(\tau) = \alpha + \beta \mathrm{pd}_t + \epsilon_t$$

where pd_t is the primary deficit/GDP and $S_t(\tau)$ is the τ-year LIBOR swap spread

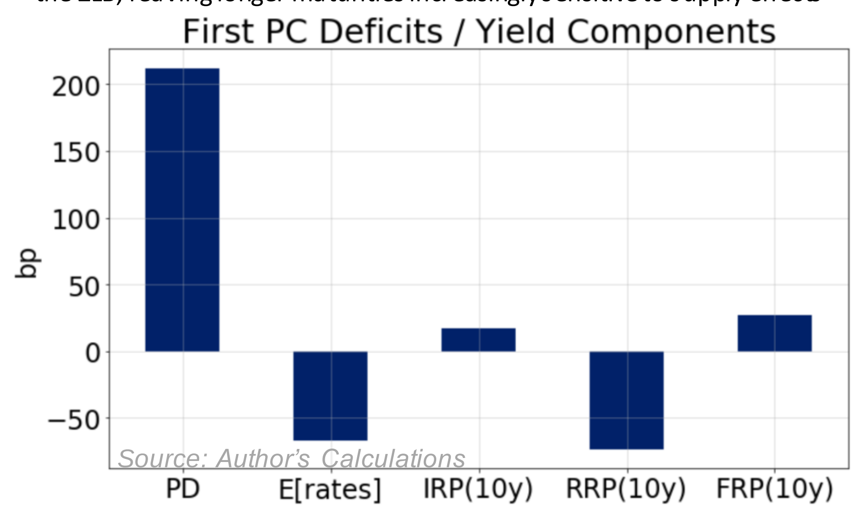
Swap Spread	Beta	t-stat	p-value	R^2
2y	0.042	3.195	0.001	0.164
5y	0.066	2.425	0.015	0.245
10y	0.102	3.290	0.001	0.410
30y	0.150	4.584	0.000	0.464

Source: Author's Calculations

Over this period, the 10y yield has decreased largely due to reductions in expected short rates and real rate risk premium. Funding risk premium has exerted upward pressure (although to a smaller extent) on the 10y yield



A weak economy tends to cause deficits to rise and rate expectations to fall. However, further reductions in expected rates may be limited near the ZLB, leaving longer maturities increasingly sensitive to supply effects



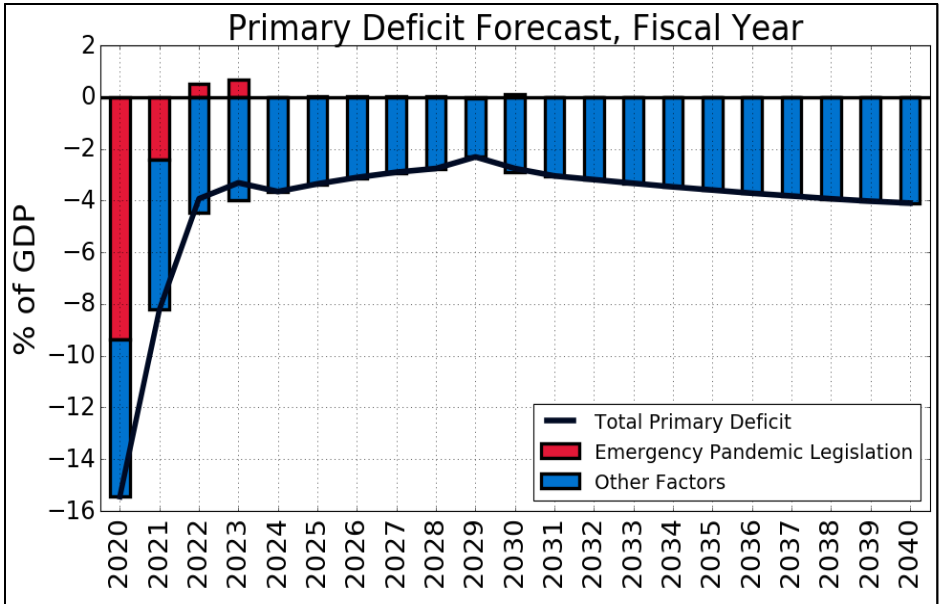
Conclusions and Recommendations

- Assuming that the Federal Reserve does not intend to take rates negative, intermediate issuance at fixed rates near the ZLB could be an attractive option to control rollover risk while hedging against rising rates.
- Increased TIPS issuance could be an effective tool to control rollover risk while hedging against weaker growth and higher deficits
- Term premia for maturities less than or equal to 10 year are low compared to longer maturities, and the 7y-10y sector offers a relatively cost effective way to reduce rollover risk
- The TBAC debt management model continues to favor short to intermediate maturity issuance for moderate levels of risk aversion. The TBAC model allows Treasury to define risk using debt service/GDP, deficit/GDP, and debt/GDP volatility. With risk defined as debt service/GDP and deficit/GDP the ZLB causes the model to increase allocations to 7y-10y nominals and TIPS for moderate to low levels of risk aversion. With risk defined as debt service/GDP, the ZLB causes the model to increase allocations to longer maturities (e.g., 30y) for higher levels of risk aversion
- Over the medium term, the Fed's balance sheet is likely to remain elevated
  - Direct purchases into the SOMA portfolio put downward pressure on risk premia improving financial and macroeconomic conditions. We reiterate our recommendation that the Fed, in conducting monetary policy through QE, should be allowed to change the interest rate risk of outstanding debt for economic purposes
  - Fed purchases are intermediated by the banking sector; therefore, QE creates excess reserve assets in the banking system. The banking sector's incentive to enhance yield on excess reserves grows with the share of the banking sector balance sheet allocated to reserves. T-Bills are highly substitutable with reserves from a capital, liquidity, and risk perspective. Thus reserve growth creates incremental capacity for Treasury to use the T-Bill market as a shock absorber for unexpected deficit financing
  - Fed balance sheet growth also creates fixed rate banking sector liabilities that lead to incremental demand for fixed rate Treasuries in the belly of the curve
  - Over the longer term, Fed balance sheet growth creates operational/rollover risk for Treasury. If desired, this risk can be mitigated efficiently by favoring intermediate maturity nominal and inflation linked issuance over T-Bills
- The emergency pandemic deficit spending in Q2 2020 coincided with a historic rise in household financial savings. Private savings, held in government only money market funds, supported Treasury financing conditions and increased the capacity for Treasury to issue T-Bills. We do not expect flows into these assets to reverse rapidly as savings should remain elevated with deficit spending over the near term
- Over the past 20 years, reductions in the 10 year yield can be explained largely by reductions in expected short rates and real rate risk premium. Funding risk premia have exerted upward pressure on long maturity yields and may be more sensitive to supply. Near the ZLB we would not expect further reductions in expected short rates, which may leave the longer maturities increasingly sensitive to supply effects

Appendix: Deficit Forecast Details

We update the deficit forecast to reflect taxes, unemployment benefits, and emergency pandemic legislation

- Forecasts produced for each of three periods, using information from CBO where applicable:
- FY2020-21: Primary deficit forecasts are based on total deficit forecasts published by the CBO in late April, which incorporate effects of major pandemic legislation and are based on updated economic projections. CBO has not yet published updated budget projections beyond FY2021
- FY2028-40: The CBO's July 2020 economic projections show unemployment converging to pre-crisis trend in 2028. We therefore view it at reasonable to use the CBO's most recent long-term primary deficit projections, published Jan 2020, for FY2028 and beyond.
- FY2022-27: CBO does not have up-to-date forecasts for these years. We allow the transition from the short-term to long-term forecasts during FY2022-27 to be guided by the path of UGAP, in the spirit of the TBAC debt optimization model. Lingering effects of pandemic legislation are then layered on.
- Annual estimates for the deficit impact of pandemic legislation are available directly from the CBO
- We interpolate annual forecasts to obtain quarterly forecasts based on considerations such as the timing of pandemic programs (e.g., expiration date of expanded unemployment benefits) and the path of quarterly unemployment



Source: CBO and Author's Calculations

Major Emergency Pandemic Legislation

	Coronavirus Preparedness and Response Supplemental Appropriations Act, 2020	Families First Coronavirus Response Act	CARES Act	Paycheck Protection Program and Health Care Enhancement Act
Passage Date	March 6, 2020	March 18, 2020	March 27, 2020	April 24, 2020
10Y Deficit Impact ($B)	8	192	1721	483

Source: CBO

Appendix: Outline of Debt/GDP Decomposition

- Assume the short rate r is generated using a single factor Vasicek model

$$\mathrm{d}r(t) = \kappa(\bar{r} - r(t))\mathrm{d}t + \sigma \mathrm{d}W(t),$$

- Then τ-maturity zero coupon bonds (ZCB) are governed by dynamics[1]

$$\frac{\mathrm{d}P(t,\tau)}{P(t,\tau)} = [r(t) + \mu(\tau)] - \sigma(\tau)\mathrm{d}W(t).$$

- Let g denote the nominal GDP growth rate, and denote the nominal GDP deflator by

$$Y(t) = \exp\left(\int_0^t g(s)\mathrm{d}s\right).$$

- Let $B(t,\tau)$ denote a payment on the debt due at time $t+\tau$, then the market value of debt and the debt/GDP ratio is given respectively by

$$D(t) = \sum_\tau B(t,\tau)P(t,\tau) \qquad D^Y(t) = \sum_\tau \frac{B(t,\tau)}{Y(t)}P(t,\tau)$$

- Let $\rho(t)$ be the primary deficit expressed in units of the debt, i.e., $\rho(t) = \frac{\mathrm{pd}(t)}{D(t)}$, then

$$\begin{aligned}
\mathrm{d}D^Y(t) &= \sum_\tau B(t,\tau)\left[\frac{1}{Y(t)}\mathrm{d}P(t,\tau) + P(t,\tau)\mathrm{d}\left(\frac{1}{Y(t)}\right)\right] + \frac{\mathrm{pd}(t)}{Y(t)}\mathrm{d}t \\
&= \sum_\tau B^Y(t,\tau)\left[\mathrm{d}P(t,\tau) - g(t)P(t,\tau)\mathrm{d}t\right] + \rho(t)D^Y(t)\mathrm{d}t \\
&= \sum_\tau B^Y(t,\tau)P(t,\tau)\left[(r(t) - g(t) + \mu(\tau) + \rho(t))\mathrm{d}t - \sigma(\tau)\mathrm{d}W(t)\right]
\end{aligned}$$

- Now define the excess returns for ZCBs to be $rx(t,\tau) = \mu(\tau)\mathrm{d}t - \sigma(\tau)\mathrm{d}W(t)$ and let the weighted average excess return for USTs be as below. Finally, add in the SOMA excess returns and the result follows

$$rx(t) = \frac{\sum_\tau D^Y(t,\tau)rx(t,\tau)}{D^Y(t)}.$$

[1] $\mu(\tau)$, is the τ-maturity ZCB term premium and $\sigma(\tau)$ is the τ-maturity ZCB price volatility

Appendix: Fed QE Reaction Function in TBAC Model

- The TBAC model[1] utilizes an inertial Taylor rule to determine the appropriate level of the Fed funds rate, which we denote FFI. The actual Fed funds rate FF is equal to FFI, but is floored at 0.125%.

- To take into account the effect of the Fed's QE program, we define the shadow Fed funds rate

  $$FFS = FF - 0.18\%\ TYE$$

  where TYE is the amount of excess duration purchased by the Fed, in 10 year Note equivalents, as a percentage of GDP. Thus, a purchase of 1% of GDP in 10 year Notes would lower the shadow Fed funds rate by 18 basis points.

- In the model, the Fed embarks on QE purchases if FFI reaches a level that is 100 bp below the current shadow Fed funds rate. The Fed purchases enough 10 year Note equivalents to get the shadow Fed funds rate 60% of the way to the inertial Taylor rule value:

  $$TYE = 0.6\left(\frac{FF - FFI}{0.18\%}\right)$$

- After the economy has recovered to a point where the inertial Taylor rule results in a rate above the shadow Fed funds rate, the Fed begins to taper. We allow Treasuries and MBS to roll off but enforce that the excess Fed balance sheet does not decrease by more than 5% in any quarter.

[1]TBAC SOMA Charge