U.S. Treasury Borrowing Advisory Committee

Presentation to Treasury

August 4, 2015

TBAC charge #2: Long-term issuance

Noting that long-term interest rates have declined to levels not seen since the 1960's, many observers have suggested that Treasury issue more long-term debt, relative to short-term debt, in order to protect the government against higher interest costs in the future.

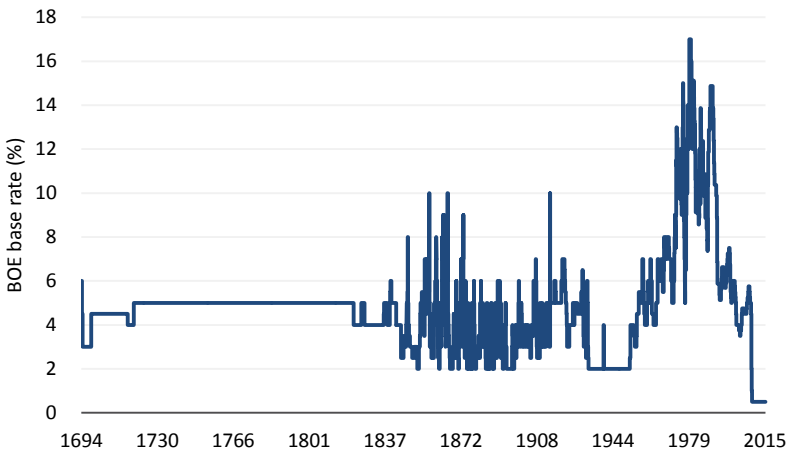
We would like the Committee to comment on this consideration as part of Treasury's broader debt issuance strategy. Please elaborate on how this fits within Treasury's mandate to fund the government at the lowest cost over time and maintain a "regular and predictable" debt issuance schedule. What are the potential benefits and risks?

Previous TBAC meetings have considered similar questions

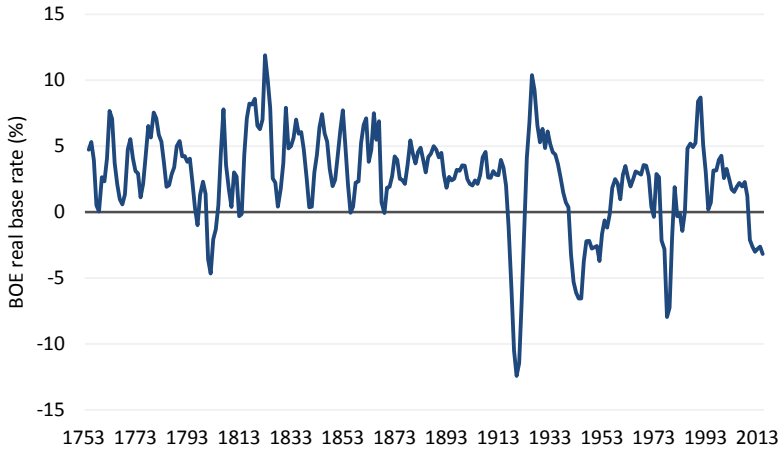
- Feb 2011: Issuing 50y coupon bonds does not lengthen duration significantly
- Aug 2011: The term premium has been positive since the 1980s, implying the lowest cost strategy would be to borrow at the short end and avoid paying the term premium
- Aug 2011: The benefits of extension do not come for free. Historical analysis suggests that shorter term funding has at many times been both cheaper and the volatility costs have not been high
- Aug 2011: Previous periods of local low points in interest rates would not have provided dramatic benefit to an extension of average maturity
- Feb 2012: With interest rate risk premium currently near all time lows, savings [from FRN] are likely to be marginal
- Feb 2015: WAM does not fully capture the structure and risks of Treasury's portfolio; the Treasury should publish other metrics to better reflect roll-over and concentration risk, and consider the portfolio WAM both gross and net of financial assets

Interest rates are low by historical standards

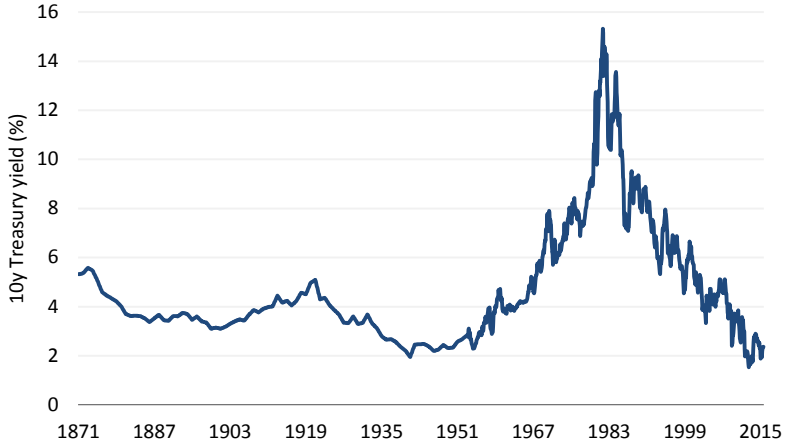
BOE base rates (1694-2015)



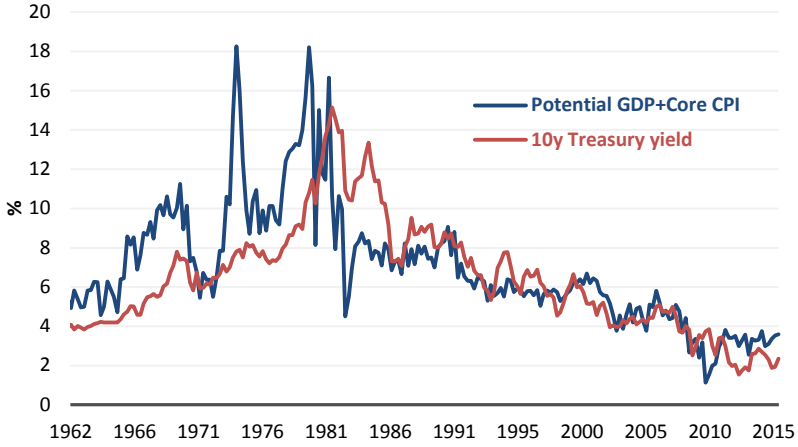
BOE real base rates (1753-2015)



10-year Treasury yields (1871-2015)



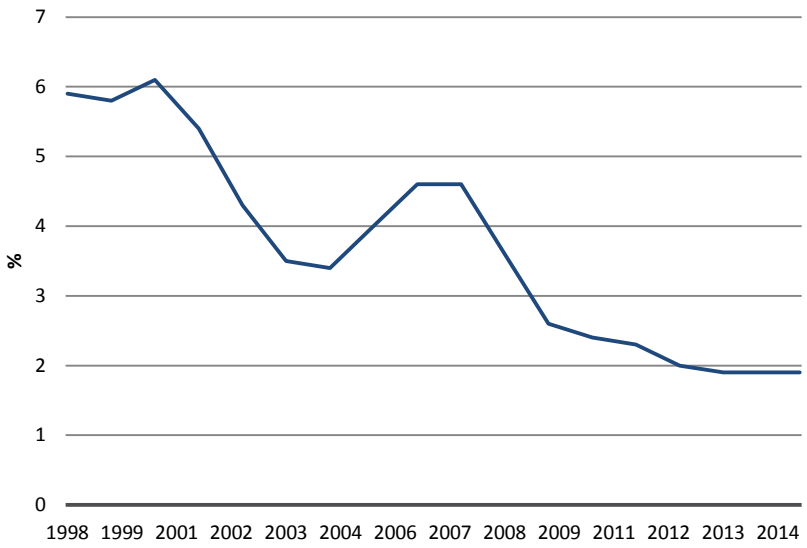
US nominal potential GDP vs. 10Y nominal Tsy yield (1962-2015)



Current Treasury issuance is skewed towards the belly of the curve

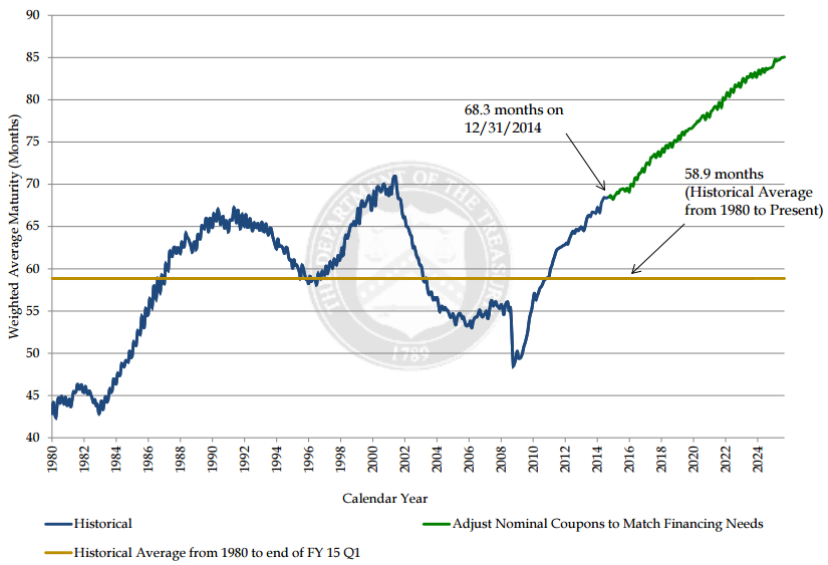
	Treasury						TIPS			FRN	Total
	2y	3y	5y	7y	10y	30y	5y	10y	30y	2y	
Jan-15	26	24	35	29	21	13		15		15	178
Feb-15	26	24	35	29	24	16			9	13	176
Mar-15	26	24	35	29	21	13		13		13	174
Apr-15	26	24	35	29	21	13	18			15	181
May-15	26	24	35	29	24	16		13		13	180
Jun-15	26	24	35	29	21	13			7	13	168
Jul-15	26	24	35	29	21	13		15		15	178
Aug-15	25	23	35	29	24	16	16			13	181
Sep-15	24	22	35	29	21	13		13		13	170
Oct-15	24	22	35	29	21	13				15	159
Nov-15	24	22	35	29	24	16		13	7	13	183
Dec-15	24	22	35	29	21	13	16			13	173
Total	303	279	420	348	264	168	50	82	23	164	2101
% Distribution	14%	13%	20%	17%	13%	8%	2%	4%	1%	8%	100%
2010	487	449	472	373	275	175		73	15	0	2320
% Distribution	21%	19%	20%	16%	12%	8%		3%	1%	0%	100%

Weighted average coupon (1998-2015)

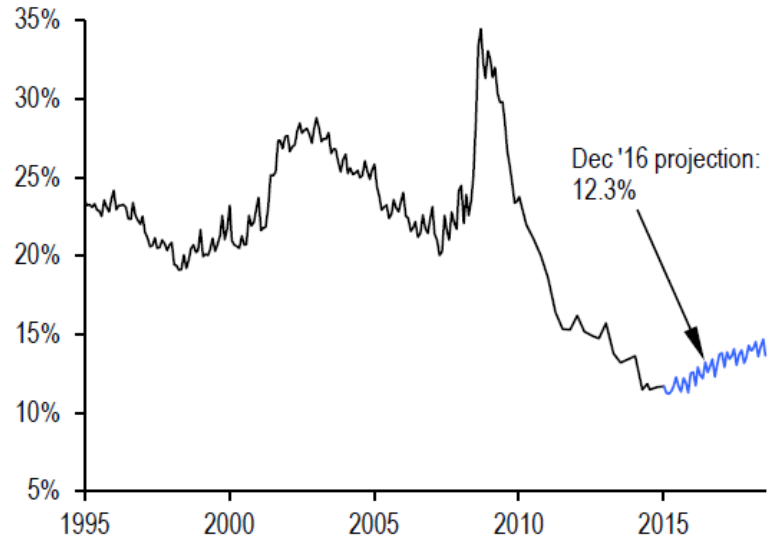


WAM has increased in recent years as the proportion of bills outstanding has declined

Average maturity of outstanding marketable Treasuries



Bills outstanding as % of marketable Treasuries outstanding



Footnote: for projections, we assume that coupon sizes remain unchanged, and that FY15 deficits total $470bn

Factors that influence Treasury yields and borrowing costs

Primary drivers

- Trend GDP growth
- Inflation
- Term premium
- Debt sustainability
- FX reserve status of the USD (50% of the debt stock is held by foreigners)

Secondary drivers

- Liquidity premium
- Transparency and predictability of issuance (homogeneity of supply / benchmark issuance)
- Broad investor base (domestic and foreign)
- High turnover; liquid repo and derivatives markets
- Primary dealer network (incentives provided to PDs when issuing debt)
- Regulatory environment

Factors that influence the optimal maturity of borrowing

Factors influencing optimal maturity

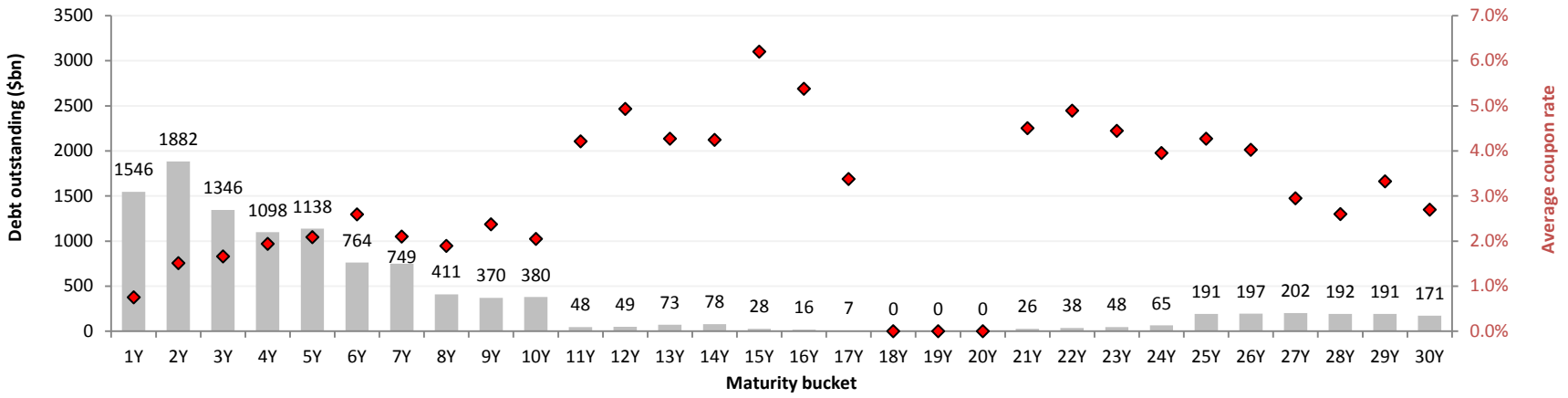
- Shape of the yield curve
- Term premium in the curve
- Matching revenues with expenses (correlation of government receipts with interest rates)
- Asset / liability matching

When should we consider extending the average maturity of debt?

- Real interest rates are low
- Term premium and/or liquidity premium is low
- Correlation between GDP growth (tax receipts) and interest rates is low…
- …or rates follow growth with a lag (i.e. probability of being in a low growth and high interest rate environment is high)
- Asset-side of the Treasury balance sheet holds long maturity assets

Maturity and issuance profile of Treasuries

Current outstanding Treasuries ($bn) and weighted average cost of funds (by maturity)



Current issuance pattern ($bn)

	Treasury						TIPS			FRN	Total
	2s	3s	5s	7s	10s	30s	5s	10s	30s	2s	
Jan-15	26	24	35	29	21	13		15		15	178
Feb-15	26	24	35	29	24	16			9	13	176
Mar-15	26	24	35	29	21	13		13		13	174
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Sep-15	24	22	35	29	21	13		13		13	170
Oct-15	24	22	35	29	21	13			7	15	166
Nov-15	24	22	35	29	24	16		13		13	176
Dec-15	24	22	35	29	21	13	16			13	173
Total	303	279	420	348	264	168	50	82	23	164	2101
% Distribution	14%	13%	20%	17%	13%	8%	2%	4%	1%	8%	100%

Issuance pattern under two scenarios (%)

	Distribution of gross issuance						
	2s	3s	5s	7s	10s	30s	Total
#2: uniform issuance	17%	17%	17%	17%	16%	16%	100%
#1: current pattern	22%	13%	22%	17%	16%	9%	100%
Difference	-5%	4%	-5%	0%	0%	7%	0%

	Annual gross issuance ($bn)						
	2s	3s	5s	7s	10s	30s	Total
#2: uniform issuance	357	357	357	357	336	336	2101
#1: current pattern	467	279	470	348	346	191	2101
Difference	-110	78	-113	9	-10	145	0

We include nominals, TIPS and FRNs in this table

Simulate cost of funds and weighted average maturity of Treasury debt over the next 30 years

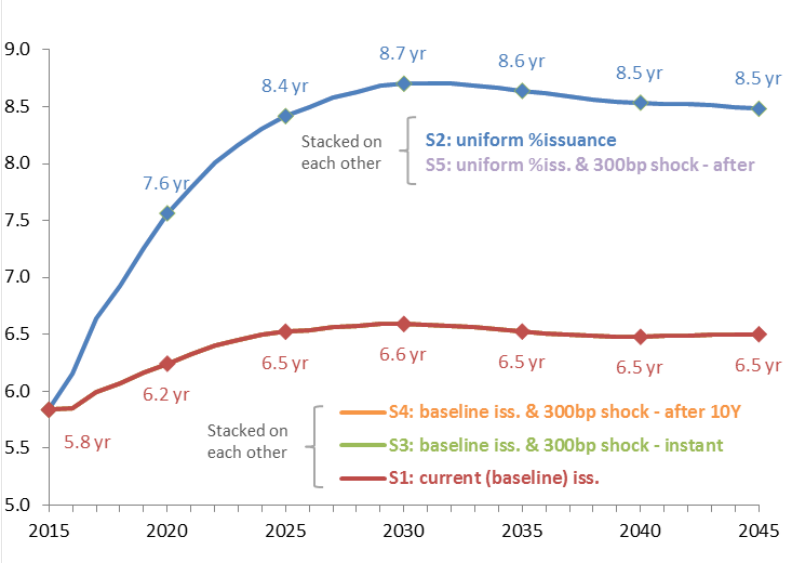
- Assumptions:
  - Interest rates increase by 100bp/year in 1Y, and 25bp/year in 30Y sector (other maturities are linearly interpolated)
  - Interest rates peak at 3%, 3.75% and 4% in bills, 10Y and 30Y sectors, respectively. Term premium settles at 100bps.
  - Ratio of bills to total Treasury debt outstanding remains constant through time
  - No rate impact from changing issuance pattern

- Scenarios:
  - **Scenario 1 (baseline):** %issuance in a specific maturity remains constant through time (23%, 15%, 21%, 16%, 16% and 9%).
  - **Scenario 2:** %issuance is uniform (17%, 17%, 17%, 17%, 16%, 16%).
  - **Scenario 3:** %issuance in a specific maturity remains constant through time, but rates are shocked instantaneously higher by 300bp relative to the base case outlined above.
  - **Scenario 4:** %issuance in a specific maturity remains constant through time, but rates are shocked higher *after 10 years* by 300bp relative to the base case outlined above.
  - **Scenario 5:** %issuance is uniform, but rates are shocked higher *after 10 years* by 300bp relative to the base case outlined above.

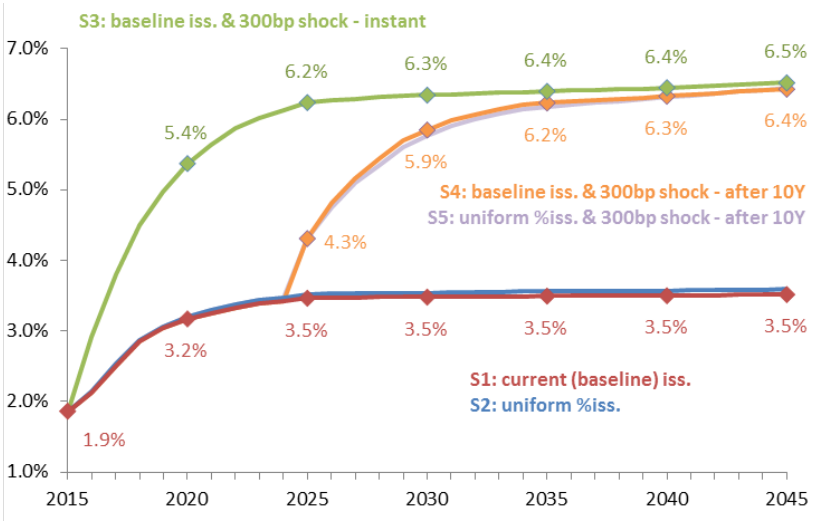
- Output: Projected "Weighted average cost of funds (WAC)" and "Weighted average maturity of outstanding debt stock (WAM)" over time

Uniform issuance extends WAM by 2 years without significantly increasing cost

Average maturity (WAM; years)



Cost of funds (WAC)



Takeaways:

- Uniform issuance results in roughly a 2Y maturity extension
- Much of the extension happens during the first 10 years

Takeaways:

- Uniform issuance increases the cost of debt very marginally (relative to current issuance)
- When rates are shocked, about 80% of the shock gets incorporated into the cost of funds within 5 years
- Cost of issuing longer maturity debt is currently low but insurance benefits appear to be marginal

Benefits and cost of extending debt maturity

Benefits

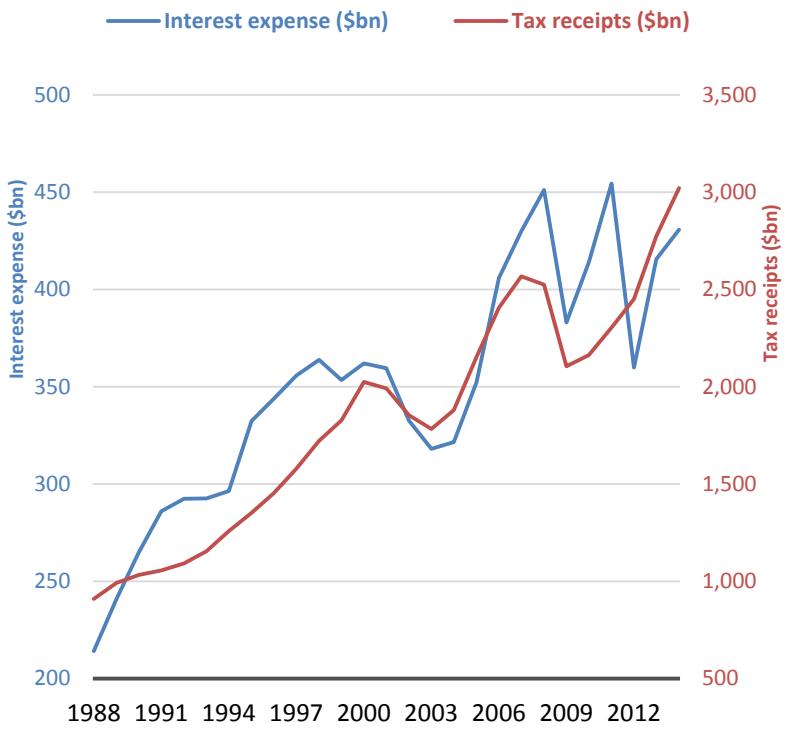
- Mitigates volatility of borrowing costs over time
- Reduces rollover risk
  - Higher cash balances will alleviate this problem
- Addresses ALM mismatch with long-maturity student loan assets held by Treasury

Cost

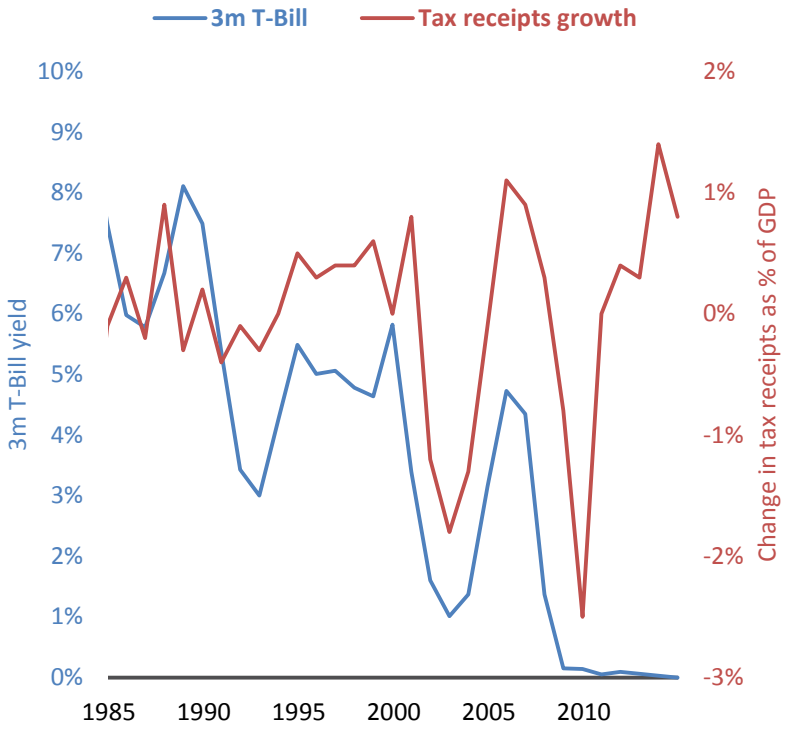
- May be expensive depending on term premium and/or liquidity premium
- Higher rates are generally accompanied by an improving economy; so tax receipts may offset interest costs of short-maturity issuance.
  - This suggests that extending maturity makes most sense when chances of stagflation are high
- Economic theory suggests that nominal interest rates should converge towards nominal GDP growth rates, and short maturity debt allows interest expense to converge more quickly towards changing nominal growth rates

Treasury receipts are correlated with front end rates

Tax receipts and interest expense

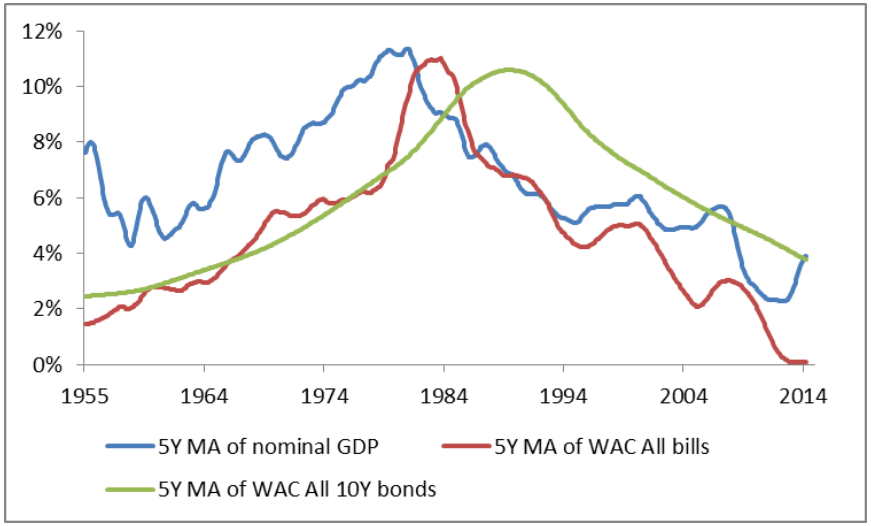


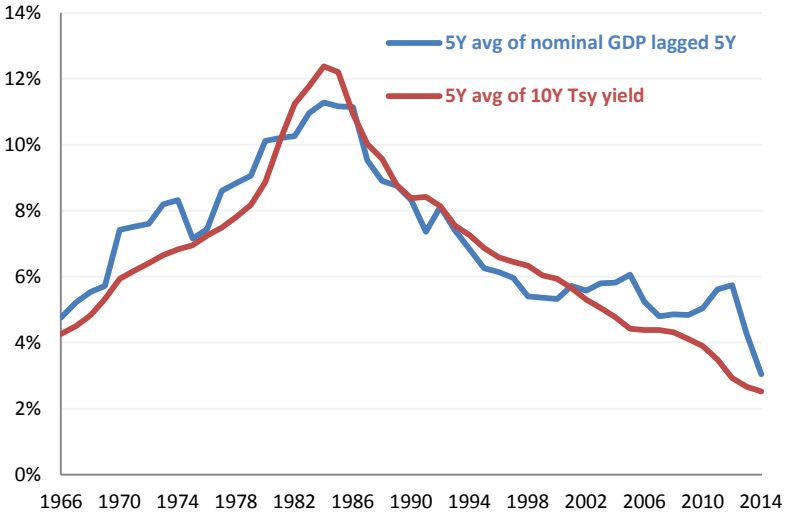
Growth in tax receipts and 3-month T-Bill yield



Historically, bill funding is more closely aligned with nominal GDP growth than 10Y Tsy funding costs since only 10% of the Tsy stock rolls over in a given year

Nominal GDP vs. 10Y Treasury yield

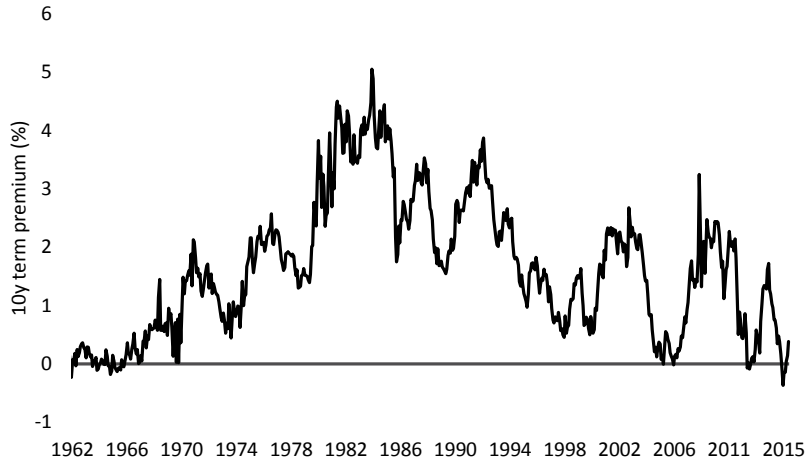




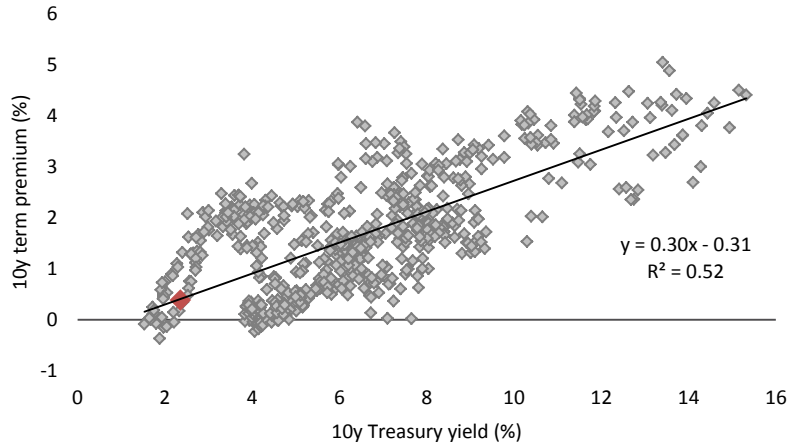
Footnotes: 1) We take 5Y MA of all series to eliminate noise in the data. 2) WAC of 10Y Tsy bonds is computed by taking the average of 10Y Tsy yields over the past 10 years under the assumption that 10% of the outstanding debt stock is rolled every year.

Negative term premia would suggest that it is cheaper to issue intermediate debt, while low long term premia reflect low cost of protection against higher rates

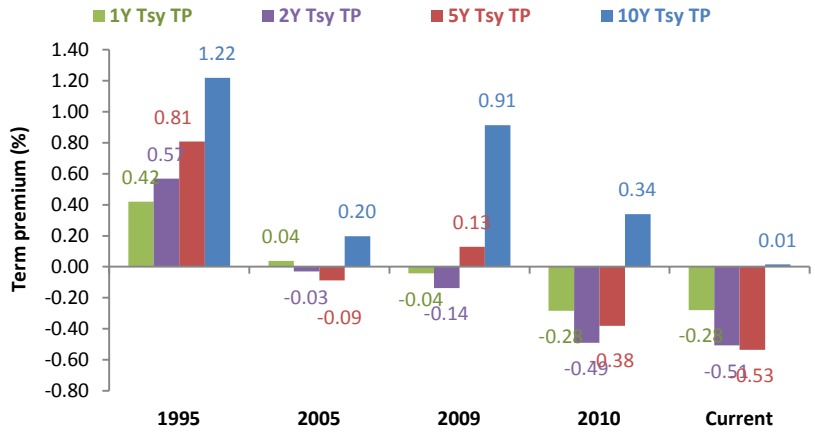
10-year ACM term premium (1961-2015)



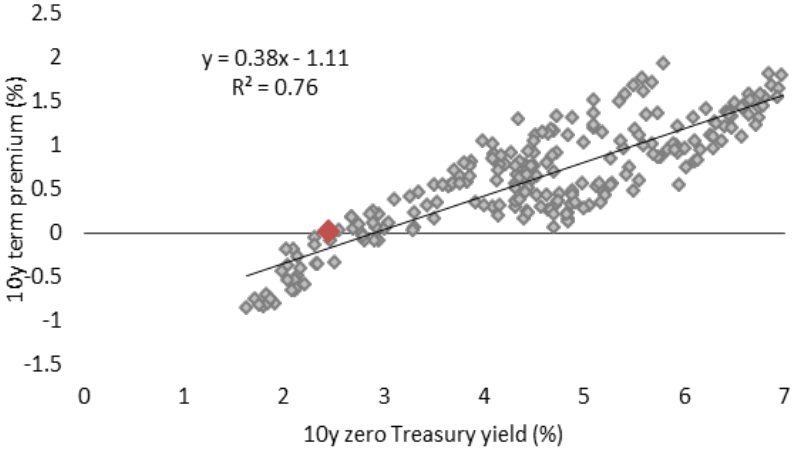
10-year ACM term premium vs. yield (1961-2015)



Kim-Wright term premium (past 20 years)



Kim-Wright term premium vs. 10-year yield (past 20 years)

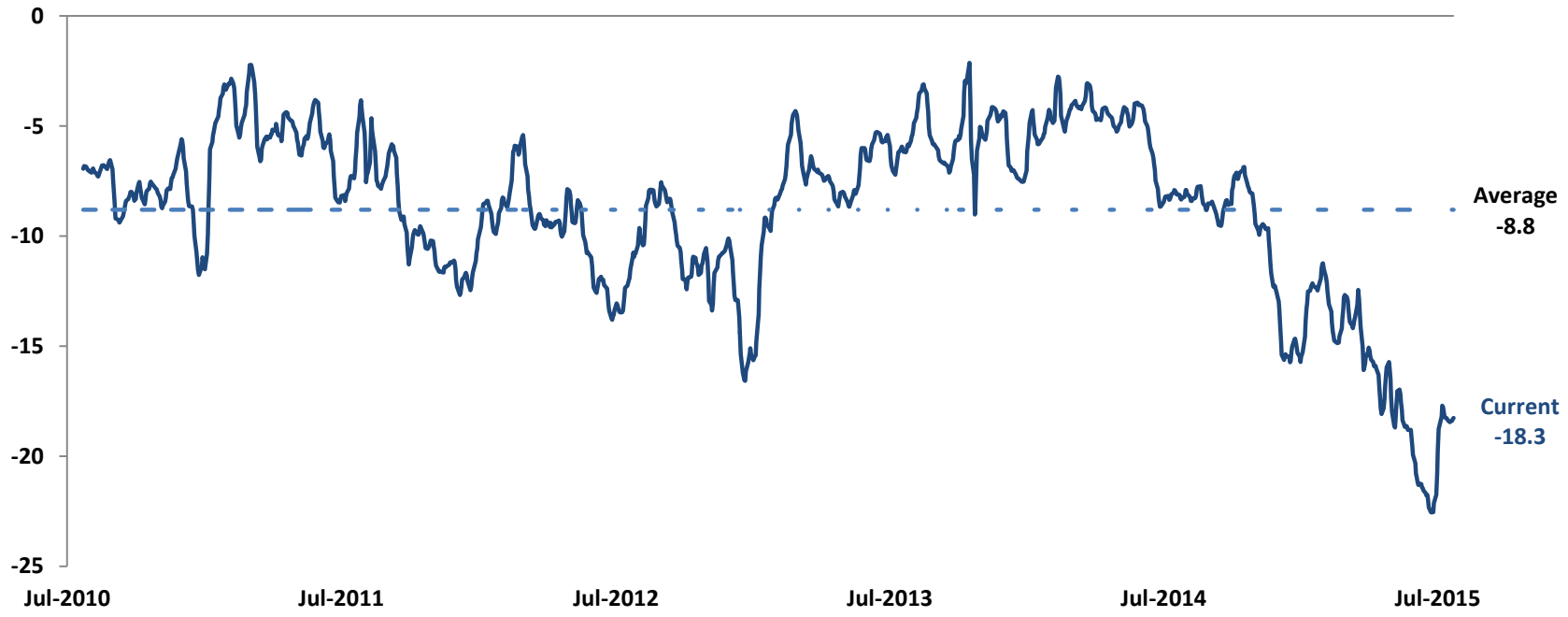


- Caveat: It is difficult to estimate term premia because it is 1) time varying, and 2) hard to distinguish between expectations of drift to forwards vs. term premium

Treasury Bills offer "liquidity premium" over same maturity Notes and Bonds

- Liquidity premium may be quantified as
  - The yield spread between bill and short-maturity bonds, or
  - The spread between hot-run and off-the-run bonds
- Eurodollar futures are all highly liquid at the front end, and so should boast only "term premium"

5-day average of richness/cheapness of bill yield relative to a Treasury par fitted curve;
averaged over 1M, 3M and 6M hot-run bills; past 5Y; bp



Simulations of 1Y and 1Yx1Y rates to test the likelihood of capturing term premium

Calibration inputs used to match averages of the past 20Y; 1Y vs 1Yx1Y swap rate

	Levels as of 6 July 2015*		Calibration inputs**	
	1Y	1Yx1Y	1Y	1Yx1Y
No. of simulations			5000 yrs	
Starting yield	0.48%	1.21%	0.50%	1.25%
20Y average yield	3.13%	3.67%	3.10%	3.66%
20Y SD of 251-day chg in yield	1.28%	1.11%	1.27%	1.14%
20Y correl of 251-day yield changes	85%		84%	
Drift of 1Y to 1Yx1Y forward over 251-days			1%	
Mean reversion			5%	5%

- Number of simulations: 5,000 years
- Assumptions
  - Zero lower bound does not apply
- Inputs
  - Drift of 1Y rate towards the 1Yx1Y forward (0% - 100%)
  - Mean reversion of 1Y and 1Yx1Y rates (5% constant) towards their past 20Y average
  - SD of 251-day change in 1Y and 1Yx1Y rates to match their past 20Y average
  - Correlation between 251-day change in 1Y and 1Yx1Y rate to match the past 20Y average
- Outputs
  - Average and SD of interest savings resulting from issuing 1Y paper vs. 2Y paper over 5,000 years
  - Probability that issuing 1Y paper will result in interest cost saving relative to issuing 2Y paper, over any 30Y period

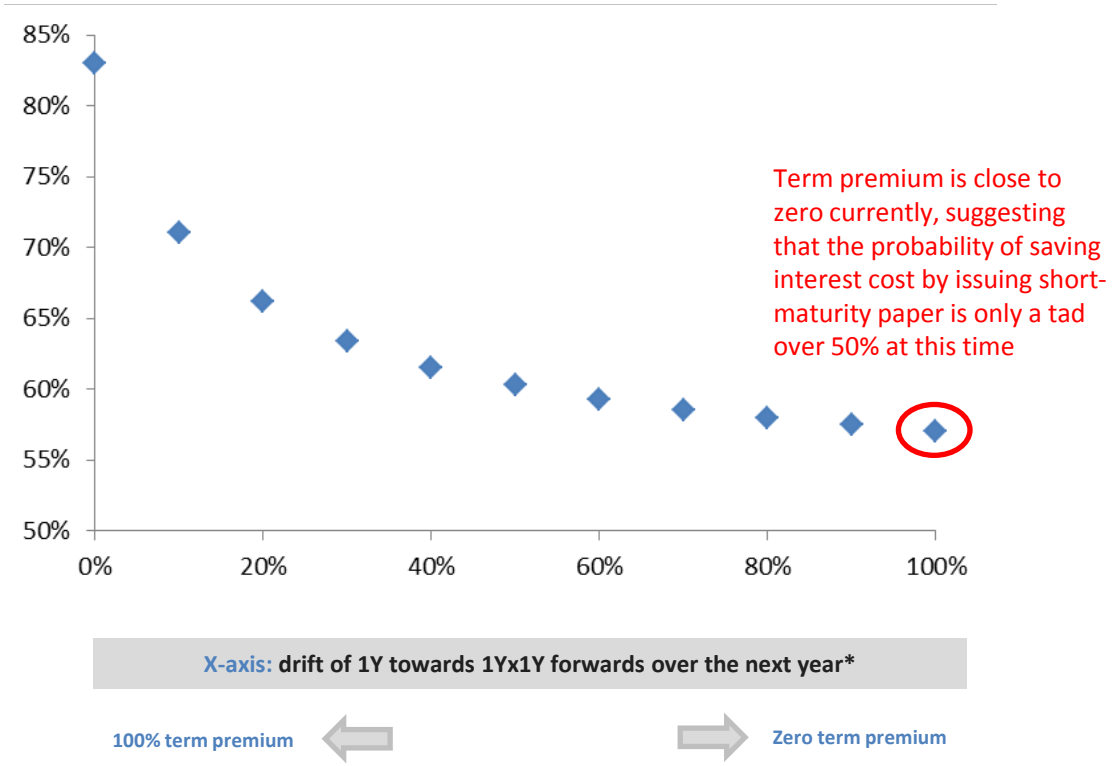
The probability of saving on interest costs over any 30 year period quickly declines as the drift of 1Y rates towards 1Yx1Y forwards increases

Simulated probability that issuing 1Y paper rather than 2Y paper will save Treasury issuance costs over the next 30 years vs. % drift of 1Y rates towards 1Yx1Y forwards

A higher number argues for issuing shorter maturity

Y-axis:
Probability that issuing 1Y paper will result in interest cost saving relative to issuing 2Y paper, over any 30Y period

A lower number argues for issuing longer maturity

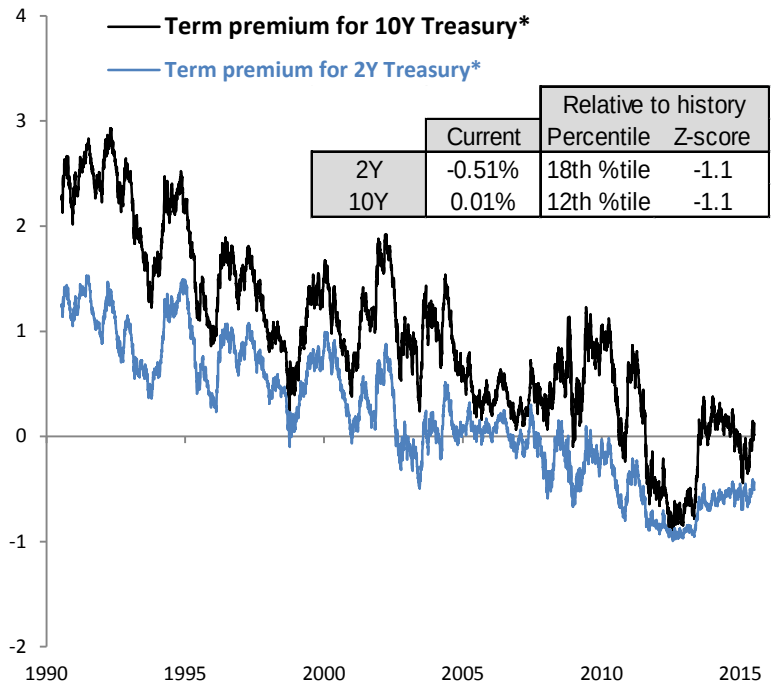


* For example, if 1Y and 1Yx1Y are currently at 3% and 3.5%, then a 20% drift suggests that one-year from now, the 1Y rate will have a mean of 3% + (3.5% - 3%) * 20% = 3.10%

Note: Contrary to intuition, the probability of saving interest cost by issuing short maturity paper is slightly higher than 50% even with zero term premium in the curve (100% drift). This is because of mean reversion in rates, which ensures that average rates in the simulation don't get too far out of line with observed 20Y average rates.

These simulation results suggest there is a benefit to issuing short term debt, however, it is not as large as it has been historically

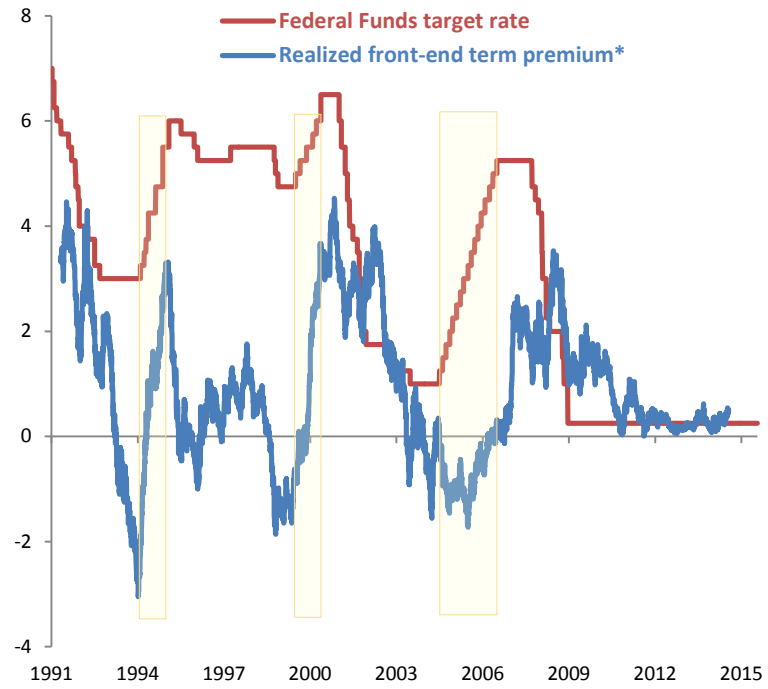
2Y Treasury term premium*



	Current	Relative to history Percentile	Z-score
2Y	-0.51%	18th %tile	-1.1
10Y	0.01%	12th %tile	-1.1

*Footnote: term premium is calculated by Don Kim and Jonathan Wright's paper *An Arbitrage-Free Three-Factor Term Structure Model and the Recent Behavior of Long-Term Yields and Distant-Horizon Forward Rates*

Realized front-end term premium* around the start of Fed tightening regimes is typically negative



*Footnote: realized front-end term premium is defined as 1Yx1Y swap rate minus realized 1Y rate after one-year

Summary and conclusions

- Interest rates are low on a historical basis, both on an absolute basis and relative to inflation and growth, and term premia are very low or negative across the yield curve.
- Higher short-term interest rates will lead to greater debt service burden, although the strong correlation between Treasury Bill yields and tax receipts helps alleviate the problem.
- Our simulations suggest that Treasury can extend WAM substantially while incurring only modest additional cost. However, insurance benefits are also low. Simulations also suggest a reduced probability of savings by issuing short.
- In the current interest rate environment intermediate issuance captures the lowest absolute term premia but longer maturities have comparable relative term premia.
- More work should be done on an asset liability framework for managing government debt and the durability of liquidity premium in the front end going forward.

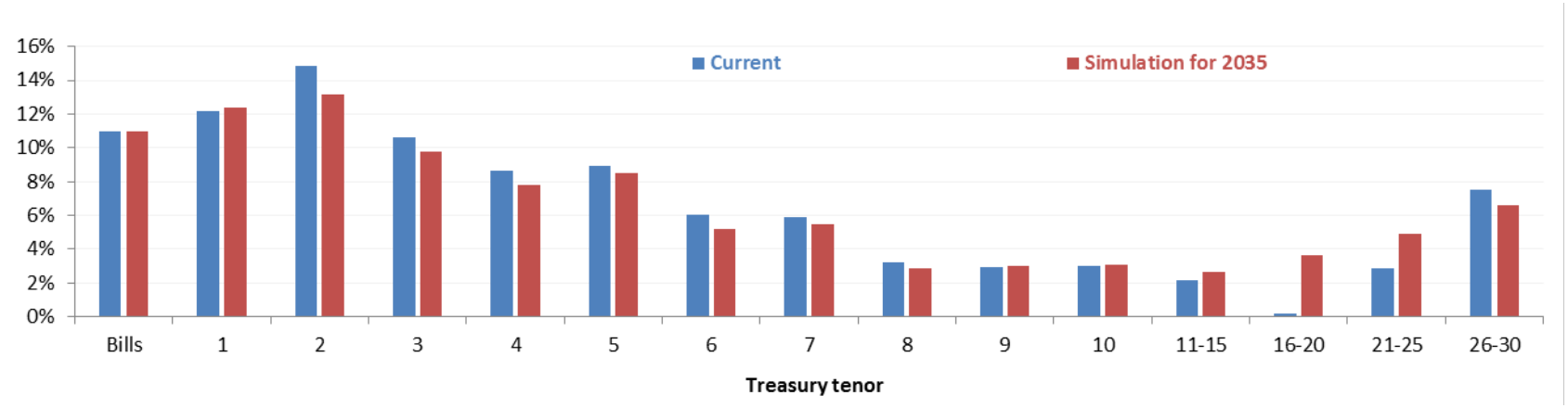
Appendix

Simulation parameters

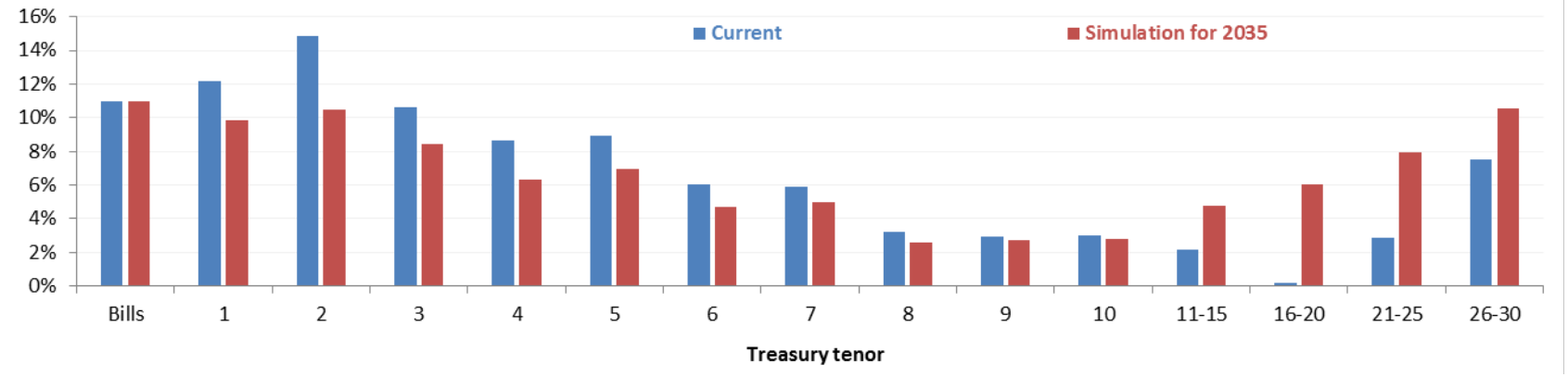
- Simulate cost of funds and weighted average maturity over the next 75 years (we only show progression over the next 30 years)
- Methodology / assumptions:
  - Interest rates increase by 100bp/year in 1Y, and 25bp/year in 30Y sector (other maturities are linearly interpolated)
  - Interest rates peak at 3%, 3.75% and 4% in bills, 10Y and 30Y sectors, respectively
  - Gross issuance in a given year = Treasuries rolling out of the 1Y bucket + CBO projections of deficit + $120bn student issuance per year (growing at a constant 3%/year)
  - Now split the gross issuance into seven maturity buckets: Bills, 2Y, 3Y, 5Y, 7Y, 10Y, and 30Y
  - First determine net issuance in Bills.
    - Assumption: Ratio of bills to Treasuries outstanding remains constant through time
    - Bills outstanding at time T+1 = Bills outstanding at time T + (Net deficit) * (Ratio of bills to total Treasuries outstanding at time T)
  - Next, determine gross issuance in the 2Y, 3Y, 5Y, 7Y, 10Y and 30Y sectors
    - **Scenario 1 (baseline):** %issuance in a specific maturity remains constant through time (23%, 15%, 21%, 16%, 16% and 9%).
    - **Scenario 2:** %issuance is uniform (17%, 17%, 17%, 17%, 16%, 16%).
    - **Scenario 3:** %issuance in a specific maturity remains constant through time, but rates are shocked instantaneously higher by 300bp relative to the base case outlined above.
    - **Scenario 4:** %issuance in a specific maturity remains constant through time, but rates are shocked higher *after 10 years* by 300bp relative to the base case outlined above.
    - **Scenario 5:** %issuance is uniform, but rates are shocked higher *after 10 years* by 300bp relative to the base case outlined above.
- Output: Projected "Weighted average cost of funds (WAC)" and "Weighted average maturity of outstanding debt stock (WAM)" over time

Simulated maturity distribution of outstanding debt for current vs. uniform issuance patterns

Scenario #1: %issuance in a specific maturity remains constant through time

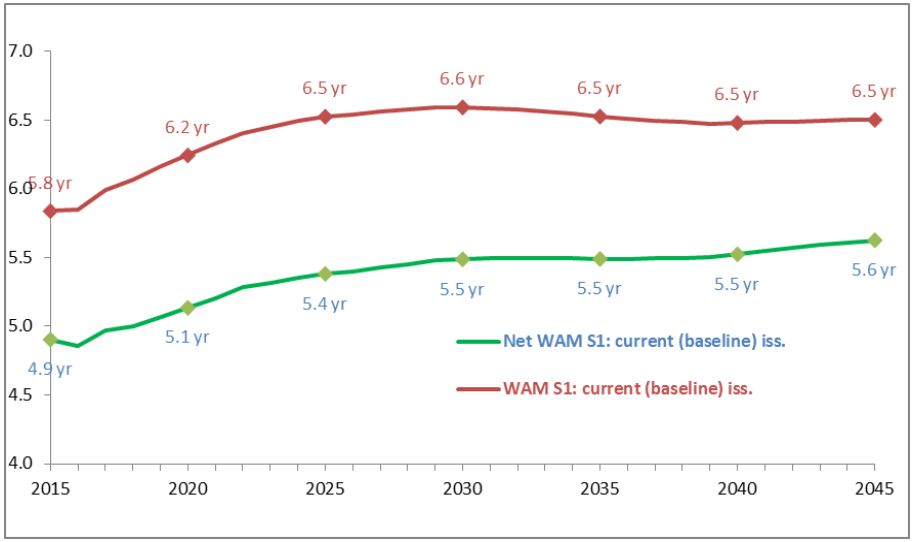


Scenario #2: % issuance is uniform

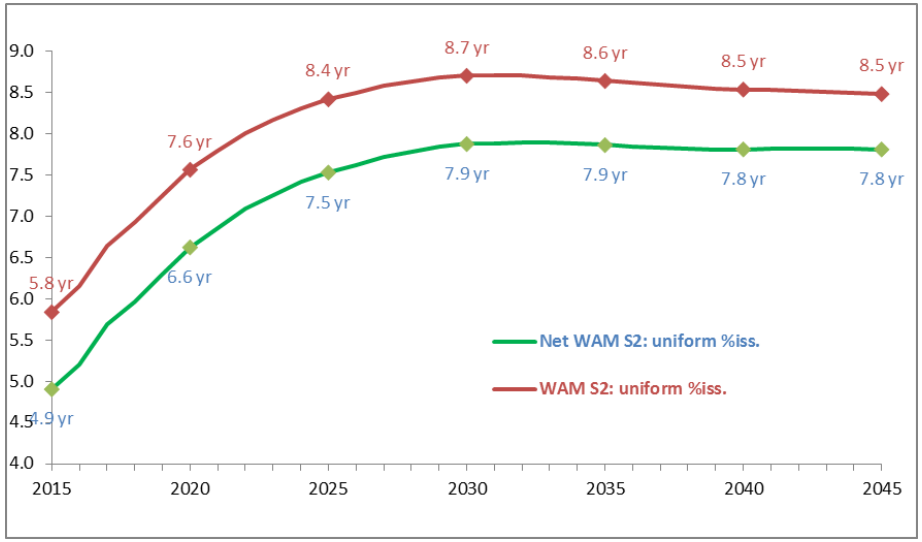


Student loan assets on the Treasury balance sheet reduce the WAM by around 1 year

Gross & net maturity (years) for baseline scenario



Gross & net maturity (years) for uniform %issuance scenario



<u>Assumptions</u>

- Student loan assets are currently at $1.175tn with net issuance of $120bn in 2016
- Net issuance grows by 3% per year indefinitely