

Appendix Charts and Tables

"Measuring Treasury Market Depth"

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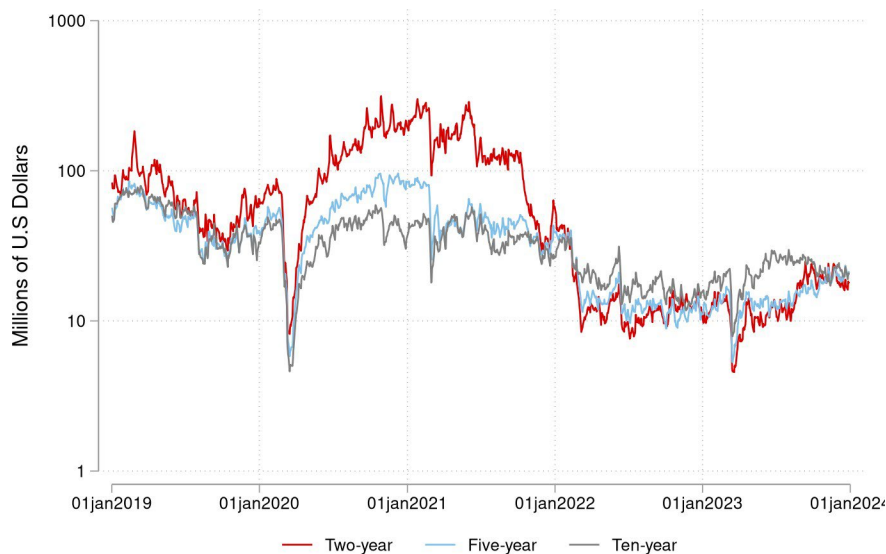
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Chart 1: Order book depth over time. The chart plots five-day moving averages of average daily depth for the on-the-run notes and bonds from January 1, 2019 to December 31, 2023. Data are for order book depth at the inside tier, averaged across the bid and offer sides. Depth is measured in millions of U.S. dollars par and plotted on a logarithmic scale. The dotted line flags May 3, 2021, when the 3-year note's tick size was halved from 1/4 of a 32nd of a point to 1/8 of a 32nd of a point.

(a) Two-, five-, and ten-year notes



(b) Three-, seven-, twenty-, and thirty-year securities

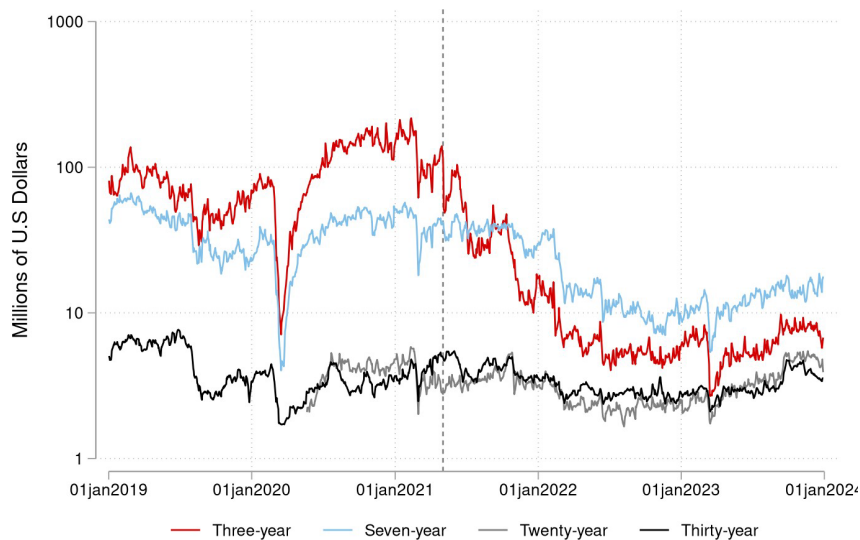


Chart 2: Bid and ask depth in 2020:H1. The chart plots average daily bid and ask depth for the on-the-run notes and bonds from January 1, 2020 to June 30, 2020. Data are for order book depth at the inside tier. Depth is measured in millions of U.S. dollars par. The twenty-year bond is excluded from this chart as it was just reintroduced in May 2020.

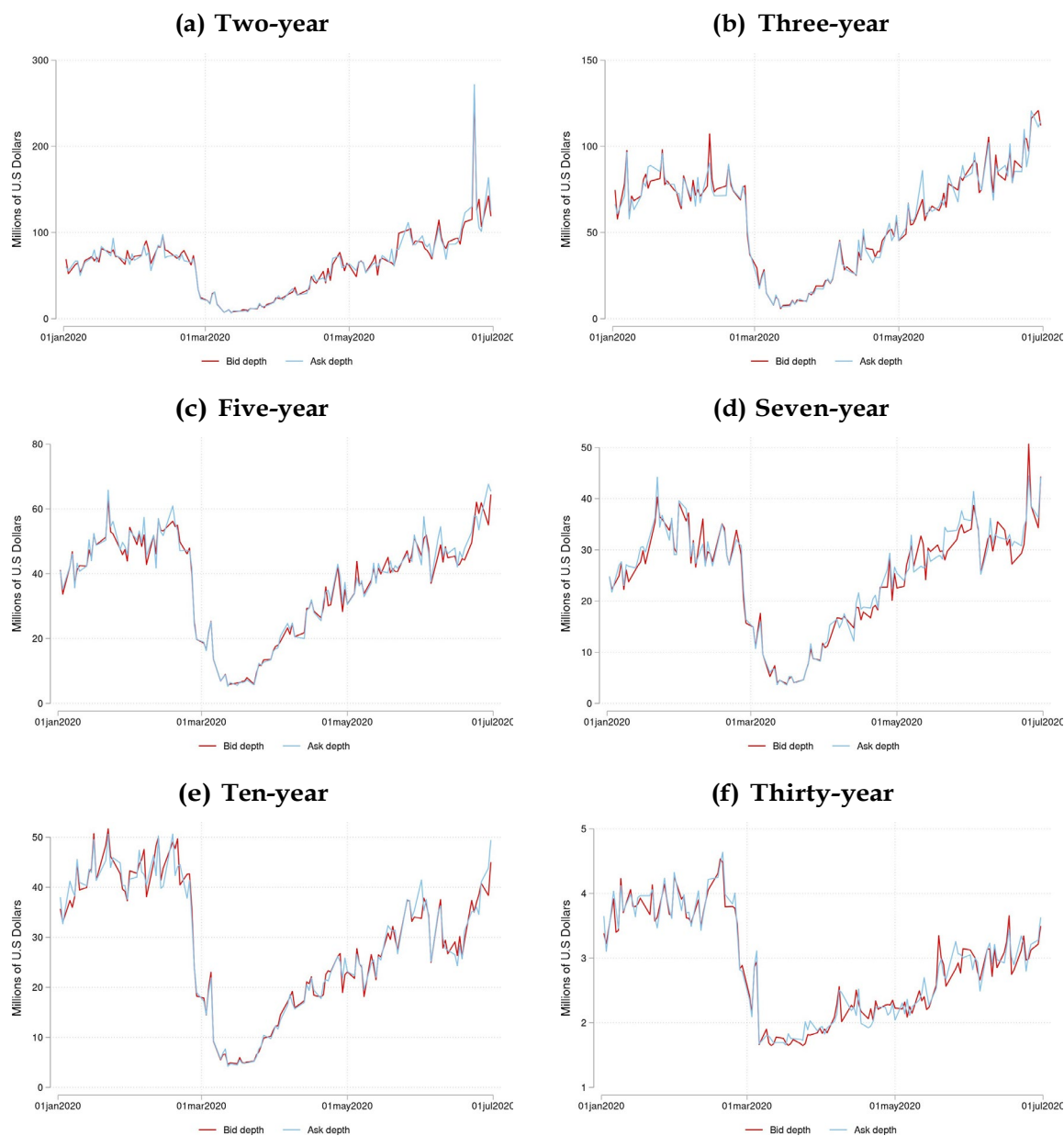
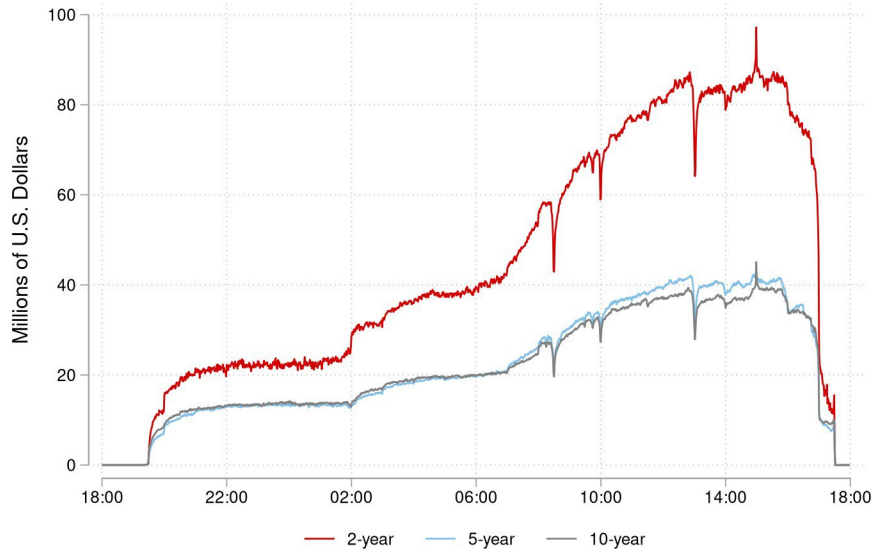


Chart 3: Intraday depth. The chart plots average depth by minute over the global trading day for the on-the-run notes and bonds. Data are for order book depth at the inside tier, averaged across the bid and offer sides, then averaged for each minute across the trading days from January 1, 2019 to December 31, 2023, when both the U.K. and the U.S. were on daylight saving time (so that time differences between Japan, the U.K. and the U.S. are constant for this analysis). The sample period for the twenty-year bond starts in May 2020, when the bond was reintroduced. Depth is measured in millions of U.S. dollars par.

(a) Two-, five-, and ten-year notes



(b) Three-, seven-, twenty-, and thirty-year securities

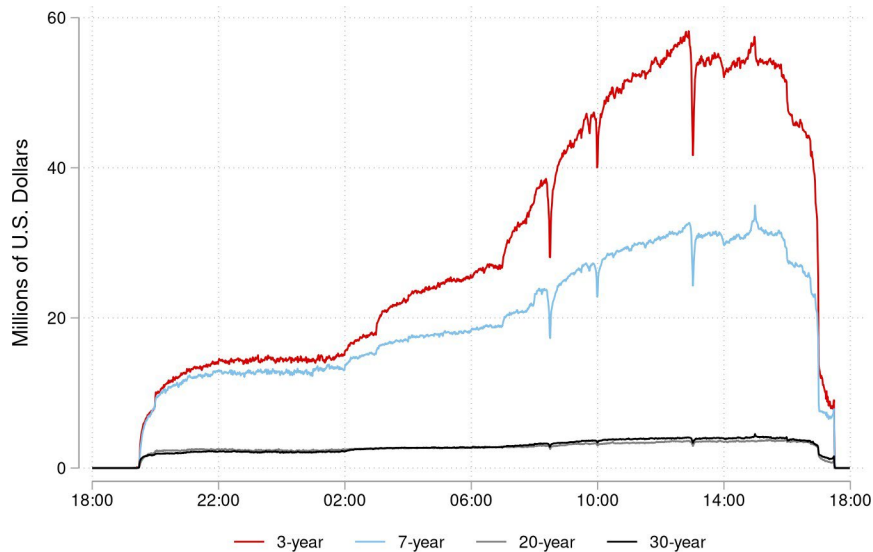


Table 1: Average depth by number of price tiers. The table reports average order book depth aggregated over one, three, five, and ten price tiers for the on-the-run notes and bonds. Depth is first averaged over each trading day and across the bid and offer sides, and then over the January 1, 2019 to December 31, 2023 sample period. The sample period for the twenty-year bond starts in May 2020, when the bond was reintroduced. Depth is measured in millions of U.S. dollars par.

	2-Year	3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
1-Tier	72	50	37	28	33	3	4
3-Tier	278	194	158	113	145	12	17
5-Tier	446	318	256	178	237	20	29
10-Tier	740	554	446	302	426	32	52

Table 2: Correlations of depth aggregated over various numbers of price tiers. The table reports correlation coefficients among average daily depth aggregated over one, three, five, and ten price tiers for the on-the-run notes and bonds over the January 1, 2019 to December 31, 2023 sample period. The sample period for the twenty-year starts in May 2020, when the bond was reintroduced. Depth is averaged across the bid and offer sides.

Panel A: Two-year

Variables	1-Tier	3-Tier	5-Tier	10-Tier
1-Tier	1.000			
3-Tier	0.938	1.000		
5-Tier	0.866	0.984	1.000	
10-Tier	0.773	0.939	0.984	1.000

Panel B: Three-year

Variables	1-Tier	3-Tier	5-Tier	10-Tier
1-Tier	1.000			
3-Tier	0.966	1.000		
5-Tier	0.931	0.993	1.000	
10-Tier	0.894	0.976	0.995	1.000

Panel C: Five-year

Variables	1-Tier	3-Tier	5-Tier	10-Tier
1-Tier	1.000			
3-Tier	0.977	1.000		
5-Tier	0.962	0.997	1.000	
10-Tier	0.939	0.987	0.995	1.000

Panel D: Seven-year

Variables	1-Tier	3-Tier	5-Tier	10-Tier
1-Tier	1.000			
3-Tier	0.978	1.000		
5-Tier	0.968	0.998	1.000	
10-Tier	0.952	0.991	0.997	1.000

Panel E: Ten-year

Variables	1-Tier	3-Tier	5-Tier	10-Tier
1-Tier	1.000			
3-Tier	0.986	1.000		
5-Tier	0.976	0.998	1.000	
10-Tier	0.960	0.991	0.997	1.000

Panel F: Twenty-year

Variables	1-Tier	3-Tier	5-Tier	10-Tier
1-Tier	1.000			
3-Tier	0.937	1.000		
5-Tier	0.875	0.982	1.000	
10-Tier	0.802	0.920	0.967	1.000

Panel G: Thirty-year

Variables	1-Tier	3-Tier	5-Tier	10-Tier
1-Tier	1.000			
3-Tier	0.979	1.000		
5-Tier	0.962	0.995	1.000	
10-Tier	0.924	0.968	0.985	1.000

Table 3: Correlations of bid vs. ask depth. The table reports correlation coefficients among average daily bid, ask, and (bid+ask)/2 depth at the inside tier for the on-the-run notes and bonds over the January 1, 2019 to December 31, 2023 sample period. The sample period for the twenty-year starts in May 2020, when the bond was reintroduced.

Panel A: Two-year

Variables	Bid Depth	Ask Depth	(Bid+Ask)/2 Depth
Bid Depth	1.000		
Ask Depth	0.968	1.000	
(Bid+Ask)/2 Depth	0.992	0.992	1.000

Panel B: Three-year

Variables	Bid Depth	Ask Depth	(Bid+Ask)/2 Depth
Bid Depth	1.000		
Ask Depth	0.985	1.000	
(Bid+Ask)/2 Depth	0.996	0.996	1.000

Panel C: Five-year

Variables	Bid Depth	Ask Depth	(Bid+Ask)/2 Depth
Bid Depth	1.000		
Ask Depth	0.990	1.000	
(Bid+Ask)/2 Depth	0.997	0.997	1.000

Panel D: Seven-year

Variables	Bid Depth	Ask Depth	(Bid+Ask)/2 Depth
Bid Depth	1.000		
Ask Depth	0.983	1.000	
(Bid+Ask)/2 Depth	0.996	0.996	1.000

Panel E: Ten-year

Variables	Bid Depth	Ask Depth	(Bid+Ask)/2 Depth
Bid Depth	1.000		
Ask Depth	0.988	1.000	
(Bid+Ask)/2 Depth	0.997	0.997	1.000

Panel F: Twenty-year

Variables	Bid Depth	Ask Depth	(Bid+Ask)/2 Depth
Bid Depth	1.000		
Ask Depth	0.918	1.000	
(Bid+Ask)/2 Depth	0.980	0.978	1.000

Panel G: Thirty-year

Variables	Bid Depth	Ask Depth	(Bid+Ask)/2 Depth
Bid Depth	1.000		
Ask Depth	0.986	1.000	
(Bid+Ask)/2 Depth	0.996	0.996	1.000

Table 4: Correlations of depth for NY vs. global trading hours. The table reports correlation coefficients between average daily depth at the inside tier averaged over New York hours and global trading hours for the on-the-run notes and bonds over the January 1, 2019 to December 31, 2023 sample period. The sample period for the twenty-year starts in May 2020, when the bond was reintroduced. Depth is averaged across the bid and offer sides.

Panel A: Two-year

Variables	All Times	7am-5pm
All Times	1.000	
7am-5pm	0.982	1.000

Panel B: Three-year

Variables	All Times	7am-5pm
All Times	1.000	
7am-5pm	0.996	1.000

Panel C: Five-year

Variables	All Times	7am-5pm
All Times	1.000	
7am-5pm	0.996	1.000

Panel D: Seven-year

Variables	All times	7am-5pm
All Times	1.000	
7am-5pm	0.993	1.000

Panel E: Ten-year

Variables	All Times	7am-5pm
All Times	1.000	
7am-5pm	0.996	1.000

Panel F: Twenty-year

Variables	All Times	7am-5pm
All Times	1.000	
7am-5pm	0.987	1.000

Panel G: Thirty-year

Variables	All Times	7am-5pm
All Times	1.000	
7am-5pm	0.995	1.000

Table 5: Correlations of tick vs. time-weighted depth. The table reports correlation coefficients between daily depth at the inside tier averaged by tick-weighting and time-weighting for the on-the-run notes and bonds over the January 1, 2019 to December 31, 2023 sample period. The sample period for the twenty-year starts in May 2020, when the bond was reintroduced. Depth is averaged across the bid and offer sides.

Panel A: Two-year

Variables	Tick-Weighted	Time-Weighted
Tick-Weighted	1.000	
Time-Weighted	0.995	1.000

Panel B: Three-year

Variables	Tick-Weighted	Time-Weighted
Tick-Weighted	1.000	
Time-Weighted	0.998	1.000

Panel C: Five-year

Variables	Tick-Weighted	Time-Weighted
Tick-Weighted	1.000	
Time-Weighted	0.996	1.000

Panel D: Seven-year

Variables	Tick-Weighted	Time-Weighted
Tick-Weighted	1.000	
Time-Weighted	0.995	1.000

Panel E: Ten-year

Variables	Tick-Weighted	Time-Weighted
Tick-Weighted	1.000	
Time-Weighted	0.995	1.000

Panel F: Twenty-year

Variables	Tick-Weighted	Time-Weighted
Tick-Weighted	1.000	
Time-Weighted	0.989	1.000

Panel G: Thirty-year

Variables	Tick-Weighted	Time-Weighted
Tick-Weighted	1.000	
Time-Weighted	0.990	1.000