Replication of The Illiquidity of Corporate Bonds: Project Overview and Table Results

Group 10: Arthur Ji, Hantao Xiao, Hunter Young, Kathy Zhang

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Abstract

Our project set out to replicate Tables 1 (Summary Statistics) and 2 (Measure of Illiquidity) from "The Illiquidity of Corporate Bonds" by Bao, Pan, and Wang (2010). This seminal paper evaluates the impact of illiquidity on corporate bond pricing, employing a novel measure of illiquidity, γ, for each bond. Focusing on corporate bonds from 2003 to 2009, the study meticulously calculates illiquidity measures and analyzes their valuation effects.

1 Overview

In the paper, Table 1 generates summary statistics for all corporate bonds and selected samples during 2003 - 2009, and Table 2 calculates illiquidity measure γ at both individual bond level and portfolio level.

In addition to replicating the original tables, we introduced our own supplementary statistics and visualizations of calculated bond illiquidity to further elucidate the data. These enhancements aim to provide a more comprehensive view of the datasets and their implications for corporate bond illiquidity.

1.1 Data

In order to replicate and automate both tables, we leverage four data sources:

1. **WRDS BondRet dataset:** A cleaned database incorporating two feeds: FINRA's TRACE (Trade Reporting and Compliance Engine) data for bond transactions, and Mergent FISD data for bond issue and issuer characteristics, reported on a monthly basis.
2. **Daily TRACE panel data:** Maintained by a group of contributors from Open Source Bond Asset Pricing, this data includes individual level price-relevant data based on FINRA's TRACE data, reported on a daily basis.
3. **FINRA's TRACE data:** The original raw data containing individual level bond characteristics, reported on a trade-by-trade basis.
4. **MMN-corrected WRDS TRACE data:** The bond-level panel with characteristics adjusted for market microstructure noise, pulled directly from Open Source Bond Asset Pricing, reported on a monthly basis.

1.2 Replication Results

Table 1 was reconstructed using data from WRDS BondRet and the original TRACE, including all necessary summary statistics except for trade numbers and sizes, derived from the latter. For Table 2, the daily illiquidity measure leveraged the Daily TRACE panel and MMN-corrected panel, while trade-by-trade illiquidity and bid-ask spreads utilized data from the original TRACE and WRDS BondRet, respectively.

We are successful in replicating the whole process of generating the two tables, applying the filters of sample selection outlined in the paper, and generating similar results compared to the original paper. As informed by our unit tests, our results in the two tables are close to the original paper in terms of absolute values, or, at least, data trends. Additionally, we incorporated the latest data to refresh the tables, capturing recent market dynamics.

1.3 Challenges

However, challenges arose due to the limitations of the original datasets. The 2010 paper relied exclusively on TRACE data, which later research suggested might introduce bias due to short-term price reversals. Also, processing the extensive dataset of 346 million trades from 2003 to 2009 was time-intensive. To mitigate these issues, we primarily used pre-processed data from WRDS BondRet and the Daily TRACE panel, which have addressed these reversal effects. This approach, while necessary, occasionally resulted in discrepancies from the original figures due to the different data sources and the exclusion of some transactions recorded in the original TRACE data. We also employed MMN-corrected WRDS TRACE monthly bond data to reconstruct the Table 2 Panel A daily data table, which was a crucial update mentioned on open source bond asset pricing website to adjust for market microstructure noise. After MMN correction, the illiquidity measures are overall lower with higher standard deviation over years.

Updating the results to the current period revealed that the methodology's exclusion of post-Phase 3 bonds (after February 7, 2005) significantly reduced the dataset over time, and certain bond filtering indicates bonds used in 2003-2009 may lose its ability to be included for the updated table, casting doubt on the recent relevance of the illiquidity measures.

2 Tables

Original Table 1 from the paper

Table 1: **Summary Statistics**

Panel A: Bonds in Our Sample

	2003			2004			2005			2006			2007			2008			2009		
	mean	med	std	mean	med	std	mean	med	std	mean	med	std	mean	med	std	mean	med	std	mean	med	std
#Bonds	744			951			911			748			632			501			373		
Issuance	1,013	947	735	930	750	714	930	750	719	959	750	675	909	750	690	918	750	690	972	750	737
Rating	5.36	5.22	2.13	5.55	5.08	2.32	5.67	5.00	2.40	5.38	5.00	2.30	5.33	5.00	2.35	5.71	5.92	2.35	6.60	6.67	2.13
Maturity	7.38	5.21	6.87	7.68	5.16	7.28	7.19	4.62	7.31	6.58	4.36	6.94	6.54	4.27	7.06	6.25	3.75	7.05	6.61	3.66	7.37
Coupon	5.84	6.00	1.63	5.71	6.00	1.69	5.63	5.80	1.67	5.44	5.50	1.65	5.47	5.62	1.65	5.35	5.70	1.65	5.40	5.88	1.60
Age	2.73	1.94	2.68	3.21	2.41	2.91	3.93	3.25	2.90	4.52	3.87	2.71	5.46	4.61	2.83	6.42	5.66	2.93	7.23	6.50	3.03
Turnover	11.83	8.52	9.83	9.47	7.09	7.71	7.81	5.92	5.87	5.83	4.99	3.99	4.87	4.11	3.26	4.70	4.19	2.83	5.98	5.06	4.12
Trd Size	585	462	469	557	415	507	444	331	412	409	306	366	356	267	335	248	180	240	206	134	217
#Trades	248	153	372	187	127	201	209	121	316	151	110	121	148	107	129	219	144	219	408	221	511
Avg Ret	0.52	0.36	0.64	0.40	0.30	0.37	0.00	0.16	0.77	0.38	0.37	0.29	0.44	0.46	0.45	-0.40	0.36	2.89	1.07	0.80	1.83
Volatility	2.49	2.25	1.48	1.72	1.59	0.98	1.62	1.24	1.39	1.28	1.01	1.18	1.39	1.08	1.07	5.61	3.14	8.22	4.94	3.09	5.11
Price	108	109	9	106	106	9	104	103	9	102	101	9	103	101	12	102	102	16	99	102	13

Panel B: All Bonds Reported in TRACE

	2003			2004			2005			2006			2007			2008			2009		
	mean	med	std	mean	med	std	mean	med	std	mean	med	std	mean	med	std	mean	med	std	mean	med	std
#Bonds	4,161			15,270			23,415			22,627			23,540			23,442			20,187		
Issuance	453	250	540	210	50	378	176	30	353	193	31	361	203	25	391	203	17	415	239	26	470
Rating	5.31	5.00	2.62	6.46	6.00	3.26	7.37	7.00	4.00	7.17	6.00	4.26	6.77	6.00	4.20	6.80	6.00	4.36	7.96	6.67	4.74
Maturity	8.51	4.55	10.77	8.34	5.39	8.88	7.86	5.06	8.41	8.01	5.12	8.65	8.08	5.05	8.97	7.84	4.80	8.87	8.04	4.84	8.99
Coupon	6.51	6.75	1.69	5.76	5.85	1.96	5.80	5.70	2.16	5.74	5.62	2.13	5.60	5.55	2.16	5.24	5.50	2.46	5.26	5.55	2.51
Age	4.61	3.75	3.87	3.25	1.82	3.61	3.37	2.00	3.74	3.65	2.44	3.78	3.78	2.84	3.71	3.88	3.16	3.71	4.25	3.64	3.80
Turnover	5.60	3.80	5.67	4.56	2.80	5.53	3.69	2.41	3.88	3.41	2.16	3.81	3.05	1.95	3.39	2.82	1.70	3.20	3.64	2.20	4.09
Trd Size	1,017	532	1,263	534	59	991	477	55	869	509	58	903	487	49	899	386	46	761	321	48	638
#Trades	66	19	185	31	9	85	26	6	89	21	5	55	21	5	66	27	5	99	54	9	185
Avg Ret	0.62	0.37	4.07	0.49	0.28	2.96	0.10	0.21	2.26	0.84	0.53	2.06	0.38	0.48	2.02	-0.89	0.18	6.42	2.69	1.44	7.86
Volatility	2.73	2.36	2.27	1.92	1.67	1.20	2.64	1.93	2.81	2.30	1.74	2.29	2.42	1.95	2.28	9.32	5.80	11.02	9.72	5.86	13.64
Price	109	110	12	105	103	21	100	100	17	99	99	19	100	100	34	92	97	30	84	92	46

#Bonds is the number of bonds. *Issuance* is the bond's face value issued in millions of dollars. *Rating* is a numerical translation of Moody's rating: 1=Aaa and 21=C. *Maturity* is the bond's time to maturity in years. *Coupon*, reported only for fixed coupon bonds, is the bond's coupon payment in percentage. *Age* is the time since issuance in years. *Turnover* is the bond's monthly trading volume as a percentage of its issuance. *Trd Size* is the average trade size of the bond in thousands of dollars of face value. *#Trades* is the bond's total number of trades in a month. Med and std are the time-series averages of the cross-sectional medians and standard deviations. For each bond, we also calculate the time-series mean and standard deviation of its monthly log returns, whose cross-sectional mean, median and standard deviation are reported under *Avg Ret* and *Volatility*. *Price* is the average market value of the bond in dollars.

Original Table 2 in the paper

Table 2: **Measure of Illiquidity** $\gamma = -\text{Cov}\left(p_t - p_{t-1}, p_{t+1} - p_t\right)$

Panel A: Individual Bonds

	2003	2004	2005	2006	2007	2008	2009	Full
Trade-by-Trade Data								
Mean γ	0.64	0.60	0.52	0.40	0.44	1.02	1.35	0.63
Median γ	0.41	0.32	0.25	0.19	0.24	0.57	0.63	0.34
Per t $\geq$ 1.96	99.46	98.64	99.34	99.87	99.69	98.80	97.98	99.81
Robust t-stat	14.54	16.22	15.98	15.12	14.88	12.58	9.45	19.42
Daily Data								
Mean γ	0.99	0.82	0.77	0.57	0.80	3.21	5.40	1.18
Median γ	0.61	0.41	0.34	0.29	0.47	1.36	1.94	0.56
Per t $\geq$ 1.96	94.62	92.64	95.50	96.26	95.57	95.41	97.59	98.84
Robust t-stat	17.28	17.88	18.21	19.80	14.39	7.16	8.47	16.53

Panel B: Bond Portfolios

	2003	2004	2005	2006	2007	2008	2009	Full
Equal-weighted	-0.0014	-0.0043	-0.0008	0.0001	0.0023	-0.0112	-0.0301	-0.0050
t-stat	-0.29	-1.21	-0.47	0.11	1.31	-0.26	-2.41	-0.71
Issuance-weighted	0.0018	-0.0042	-0.0003	0.0007	0.0034	0.0030	-0.0280	-0.0017
t-stat	0.30	-1.14	-0.11	0.41	1.01	0.06	-1.97	-0.20

Panel C: Implied by Quoted Bid-Ask Spreads

	2003	2004	2005	2006	2007	2008	2009	Full
Mean implied γ	0.035	0.031	0.034	0.028	0.031	0.050	0.070	0.034
Median implied γ	0.031	0.025	0.023	0.018	0.021	0.045	0.059	0.026

At the individual bond level, γ is calculated using either trade-by-trade or daily data. Per t-stat $\geq$ 1.96 reports the percentage of bond with statistically significant γ. Robust t-stat is a test on the cross-sectional mean of γ with standard errors corrected for cross-sectional and time-series correlations. At the portfolio level, γ is calculated using daily data and the Newey-West t-stats are reported. Monthly quoted bid-ask spreads, which we have data for 1,032 out of 1,035 bonds in our sample, are used to calculate the implied γ.

2.1 Table 1 Summary Statistics

Table 1 provides a detailed overview of the study's sample, comprising frequently traded Phase I and II bonds from April 2003 through June 2009. As detailed in Panel A, the sample includes approximately 800 bonds annually within the specified period, though the total number fluctuates year to year. The observed increase in bond numbers from 2003 to 2004 and 2005 is likely due to NASD's expanded coverage to include Phase III bonds, whereas the decline from 2004 to 2009 can be attributed to bonds maturing or being retired. This fluctuation mirrors the trends observed in the original data.

The bonds featured in the sample are substantial, boasting a median issuance size of around $750 million, and are predominantly investment grade, with a median Moody's numeric rating between 5 and 6 throughout the years. In contrast, Panel B, covering all bonds in TRACE, presents a lower median issuance size and rating, as anticipated.

With an average time to maturity of nearly 6 years and an average age of about 4 years, the sample shows a gradual decrease in maturity and an increase in age over time, a consequence of the sample selection criteria excluding bonds issued after February 7, 2005, marking the onset of Phase III.

The criteria for selecting the bonds suggests they are traded more frequently than average. Notably, in 2008-2009, Panel B's average turnover ratio for a bond was higher, although the median was considerably lower, indicating outliers' influence on the mean. In terms of the number of trades, average trade size, and turnover ratio, the bonds in Panel A demonstrate slightly higher figures compared to Panel B, indicating enhanced liquidity.

The average return of the bonds, according to our calculation, is lower than that reported in the paper. However, the trend of average returns from 2003 to 2009 closely aligns with the original paper, showing a significant drop during the Global Financial Crisis in 2008, followed by a recovery in 2009. The volatility and price of the bonds in both Panel A and B closely resemble those in the original paper.

2.1.1 Replicate Tables 1 in the Paper, For period 2003/04-2009/06

Table 1 Panel A: Bonds in Our Sample, 2003-2009

	Year	2003	2004	2005	2006	2007	2008	2009
rating	avg	5.87	5.67	5.60	5.29	5.21	5.59	6.32
	median	6.00	5.00	5.00	5.00	5.00	6.00	6.00
	std	2.33	2.35	2.39	2.24	2.30	2.39	2.15
coupon	avg	6.14	5.85	5.65	5.48	5.48	5.61	5.77
	median	6.35	6.00	5.70	5.50	5.45	5.62	5.70
	std	1.40	1.47	1.45	1.41	1.40	1.37	1.34
issuance	avg	992.24	981.89	990.05	983.18	1001.46	1031.99	1070.58
	median	749.46	749.36	771.83	797.36	797.90	847.97	990.48
	std	735.05	712.18	696.05	658.99	675.69	705.11	725.92
age	avg	2.95	3.25	3.73	4.36	5.19	6.16	6.83
	median	2.16	2.56	3.17	3.93	4.66	5.66	6.49
	std	2.61	2.64	2.58	2.32	2.34	2.39	2.28
trade	avg	365.69	312.93	329.16	257.38	255.14	412.02	740.71
	median	233.00	205.00	195.00	183.00	175.00	252.00	408.50
	std	535.52	343.77	534.48	231.49	259.24	553.62	978.79
volatility	avg	2.29	1.69	1.27	0.85	1.00	4.10	4.15
	median	2.11	1.35	1.01	0.62	0.78	2.62	2.07
	std	1.47	5.73	1.34	1.31	1.13	4.72	5.14
prclean	avg	106.99	105.10	102.59	100.14	100.38	98.43	97.30
	median	107.20	104.76	101.65	99.96	99.89	100.25	100.78
	std	7.93	7.54	7.59	6.93	6.42	9.36	12.82
cusip	count	781.00	896.00	861.00	723.00	611.00	513.00	426.00
Avf Ret	avg	0.03	-0.09	-0.34	0.01	-0.03	-0.95	0.52
	median	-0.12	-0.12	-0.27	-0.08	0.03	-0.07	0.23
	std	0.55	0.39	0.79	1.59	0.79	13.94	2.07
Trd Size	avg	787.93	723.92	512.34	391.21	355.44	239.38	162.15
	median	426.18	370.24	289.86	244.48	203.87	129.78	87.18
	std	2219.62	5607.06	1196.91	441.52	466.74	329.47	244.95
tmt	avg	7.08	6.53	5.88	5.39	5.27	4.93	4.96
	median	4.99	4.66	4.19	3.81	3.72	3.42	3.22
	std	6.72	6.55	6.21	5.96	6.06	5.98	6.23
turnover	avg	21.90	17.57	13.13	8.29	7.23	7.30	7.96
	median	11.50	9.75	7.72	6.16	5.00	4.81	5.66
	std	49.25	38.95	27.05	9.28	8.35	8.95	7.87

Panel B: All Bonds Reported in TRACE, 2003-2009

	Year	2003	2004	2005	2006	2007	2008	2009
rating	avg	8.48	8.51	8.55	8.66	8.50	8.49	8.81
	median	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	std	4.28	4.38	4.39	4.40	4.49	4.43	4.23
coupon	avg	7.02	6.78	6.53	6.42	6.33	6.27	6.21
	median	7.00	6.88	6.62	6.46	6.25	6.15	6.15
	std	1.71	1.87	1.91	1.88	1.86	1.80	1.88
issuance	avg	503.48	539.18	578.81	596.44	632.53	714.01	735.86
	median	299.76	349.42	399.28	447.03	496.79	499.02	499.07
	std	549.51	560.12	573.61	573.27	595.74	688.38	743.56
age	avg	4.37	4.32	4.42	4.56	4.65	4.68	4.62
	median	3.77	3.24	3.42	3.62	3.77	3.80	3.66
	std	3.60	3.66	3.69	3.79	3.96	4.07	4.11
trade	avg	366.08	319.66	344.66	285.46	264.58	412.99	677.59
	median	234.00	209.00	198.00	189.00	178.00	244.00	379.00
	std	529.63	357.35	555.37	289.13	270.88	563.79	921.37
volatility	avg	3.63	3.06	2.48	1.98	2.28	8.60	10.29
	median	2.37	1.81	1.56	1.36	1.65	5.43	4.76
	std	11.35	13.36	13.87	3.05	4.43	15.86	29.13
prclean	avg	105.09	105.75	103.87	100.83	100.59	93.29	88.50
	median	106.08	105.57	103.02	100.49	100.23	98.09	95.56
	std	13.92	25.12	12.40	13.68	9.19	17.13	23.62
cusip	count	14176.00	16299.00	16848.00	16691.00	16898.00	16666.00	13974.00
Avf Ret	avg	0.29	0.04	-0.53	-0.21	-0.43	-3.09	0.60
	median	-0.07	-0.08	-0.33	-0.08	-0.12	-0.75	0.80
	std	6.48	6.78	8.45	5.88	6.79	11.51	16.17
Trd Size	avg	772.70	708.53	503.23	388.71	365.48	250.36	181.45
	median	412.47	360.02	286.11	244.22	207.20	134.48	92.11
	std	2162.02	5377.31	1147.35	435.35	475.85	339.31	269.19
tmt	avg	8.36	8.01	7.52	7.51	7.83	7.77	7.79
	median	5.54	5.58	5.45	5.37	5.41	5.11	4.99
	std	8.53	8.17	7.75	7.91	8.24	8.11	8.18
turnover	avg	16.36	15.17	12.75	10.42	9.61	114.50	672.25
	median	7.13	6.78	5.81	5.69	4.88	4.69	6.47
	std	106.16	92.74	41.05	18.44	38.88	4967.86	13561.26

2.1.2 Update Table 1 in the Paper, For period 2009/06-Present

Panel A: Bonds in Our Sample, 2003-Present

	Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
rating	avg	5.77	5.58	5.51	5.20	5.12	5.50	6.32	6.33	6.27	6.90	7.54	8.07	8.07	7.98	8.03	8.15	8.35	7.84	7.75	7.93
	median	6.00	5.00	5.00	5.00	5.00	5.00	6.00	6.00	6.00	7.00	7.00	9.00	9.00	9.00	9.00	9.00	9.00	8.00	8.00	8.00
	std	2.30	2.32	2.36	2.19	2.27	2.35	2.12	2.04	2.00	2.08	1.94	1.91	2.07	1.88	1.82	1.79	1.81	1.68	1.69	1.73
coupon	avg	6.11	5.82	5.62	5.45	5.44	5.57	5.74	5.76	5.66	5.65	5.86	6.22	6.66	6.89	7.02	7.19	7.28	6.98	6.99	7.03
	median	6.25	6.00	5.65	5.50	5.38	5.50	5.65	5.70	5.50	5.25	5.30	6.05	6.73	6.84	6.86	6.88	6.95	6.86	6.75	6.95
	std	1.39	1.46	1.44	1.39	1.38	1.35	1.30	1.24	1.22	1.35	1.44	1.50	1.59	1.64	1.59	1.46	1.16	0.98	1.01	1.00
issuance	avg	992.14	983.64	992.34	978.94	995.88	1028.14	1069.39	1096.51	1097.07	1055.62	1060.53	1075.34	1027.78	1110.08	1127.30	1206.48	1204.71	1316.64	1439.11	1557.78
	median	749.46	749.39	794.10	796.84	797.88	847.97	990.48	992.35	988.70	847.60	896.17	845.56	742.50	742.50	742.50	986.51	988.70	988.70	991.66	994.63
	std	739.38	715.84	699.03	661.55	678.07	705.64	738.85	777.99	808.56	828.13	802.21	848.51	936.00	1012.07	1030.47	1063.07	1070.93	1181.51	1278.22	1313.38
age	avg	3.03	3.31	3.78	4.43	5.26	6.22	7.18	8.26	9.20	10.39	11.59	13.16	15.43	16.74	17.98	18.99	19.82	19.67	20.62	21.61
	median	2.21	2.59	3.19	3.94	4.65	5.62	6.69	7.76	8.56	9.29	9.93	11.65	15.88	17.22	18.39	19.37	19.95	18.60	19.48	20.56
	std	2.68	2.72	2.66	2.44	2.48	2.55	2.56	2.67	2.95	3.36	3.50	3.69	3.74	3.56	3.53	3.56	3.54	2.98	3.05	2.93
trade	avg	370.17	315.29	336.98	264.07	262.81	433.83	684.85	479.06	430.55	394.82	336.98	236.85	190.99	232.50	234.09	265.02	312.63	188.67	189.84	262.05
	median	234.00	205.00	199.00	188.00	182.00	270.00	418.50	327.00	285.00	258.00	251.00	183.00	146.00	186.00	197.00	218.00	218.00	166.50	161.50	200.00
	std	545.14	347.86	545.31	234.66	261.89	567.88	841.41	538.23	589.30	615.71	337.99	177.44	128.02	162.99	176.45	198.23	351.06	106.76	111.96	218.05
volatility	avg	2.26	1.69	1.23	0.84	0.94	3.98	3.45	0.95	1.05	1.51	1.18	0.83	1.67	2.13	1.20	1.38	1.82	4.26	2.13	6.10
	median	2.09	1.34	0.98	0.61	0.77	2.61	1.65	0.76	0.54	0.60	0.38	0.53	1.70	2.35	1.17	1.35	1.74	4.54	1.44	3.37
	std	1.45	5.80	1.25	1.33	0.85	4.34	4.46	0.73	1.18	2.94	2.04	0.79	1.37	1.24	0.82	0.81	1.03	1.52	3.74	10.37
prclean	avg	106.87	104.95	102.35	99.93	100.15	98.28	100.29	106.33	106.38	108.56	109.98	114.04	117.86	120.30	120.77	115.43	119.38	128.41	130.41	112.29
	median	107.18	104.69	101.58	99.93	99.82	100.22	102.67	106.45	105.84	105.33	105.47	109.13	116.68	120.69	121.26	114.88	119.54	128.66	130.73	110.12
	std	7.86	7.48	7.37	6.80	6.21	9.30	11.04	6.24	7.37	11.17	11.73	14.44	15.59	16.28	16.77	13.62	13.97	16.51	10.98	10.15
cusip	count	755.00	870.00	836.00	703.00	590.00	491.00	419.00	327.00	271.00	217.00	160.00	98.00	62.00	48.00	46.00	46.00	40.00	32.00	30.00	29.00
Avf Ret	avg	0.01	-0.09	-0.36	0.01	-0.00	-0.95	0.51	0.11	0.19	-0.25	-0.22	1.21	0.56	0.05	-2.72	-0.89	0.97	-6.60	-0.70	-0.16
	median	-0.13	-0.12	-0.27	-0.08	0.02	-0.06	0.29	-0.02	-0.27	-0.12	-0.30	-0.22	-0.33	0.08	0.23	-0.69	1.00	0.41	-0.53	-1.59
	std	0.51	0.37	0.64	1.61	0.58	14.14	1.80	1.25	2.90	10.35	0.86	7.73	7.67	0.46	18.10	0.66	0.73	39.89	3.21	4.55
Trd Size	avg	745.33	700.37	488.03	362.75	332.32	228.88	149.71	194.48	216.24	189.29	211.82	211.95	160.34	153.19	169.81	138.45	139.79	123.18	135.05	115.73
	median	410.91	360.07	283.33	234.59	197.70	129.49	91.89	114.67	128.05	105.48	109.15	106.68	62.41	47.51	46.44	32.59	41.77	44.93	36.01	39.92
	std	2124.48	5714.12	1184.13	396.24	427.63	304.22	177.97	260.46	280.38	246.02	304.84	275.87	233.41	279.27	329.63	297.38	212.12	159.60	197.17	158.21
tmt	avg	6.80	6.30	5.66	5.12	4.97	4.65	4.58	4.63	4.60	5.33	6.68	8.33	10.69	11.34	10.69	10.60	10.42	9.89	8.89	8.06
	median	4.86	4.56	4.10	3.75	3.68	3.42	3.12	2.66	2.16	1.94	1.91	4.61	12.94	12.72	11.84	11.28	10.70	10.88	9.98	9.30
	std	6.34	6.22	5.84	5.45	5.47	5.42	5.55	5.93	6.23	7.13	7.92	8.06	7.33	6.50	6.18	5.92	4.92	3.52	3.62	3.37
turnover	avg	20.73	16.92	12.81	8.07	7.07	7.30	7.18	5.89	5.76	5.02	4.78	4.62	2.70	2.47	3.20	2.74	2.90	1.79	1.53	2.37
	median	11.20	9.49	7.53	6.03	4.90	4.79	5.06	4.23	4.15	3.42	3.23	2.49	1.73	1.46	1.56	1.50	1.56	0.89	0.85	1.13
	std	44.83	38.14	27.51	8.91	8.15	8.98	7.22	6.01	5.34	5.35	5.33	7.76	3.23	3.11	5.92	4.37	4.77	2.38	1.75	3.19

Panel B: All Bonds Reported in TRACE, 2003-Present

	Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
rating	avg	8.48	8.51	8.55	8.66	8.50	8.49	8.86	8.92	8.90	9.08	9.16	9.18	9.04	8.97	8.75	8.65	8.52	8.40	8.20	8.00
	median	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	9.00	9.00	9.00	9.00	9.00	8.00	8.00	8.00	8.00	8.00	8.00
	std	4.28	4.38	4.39	4.40	4.49	4.43	4.19	4.03	3.97	3.79	3.60	3.61	3.52	3.59	3.45	3.32	3.16	3.05	2.81	2.67
coupon	avg	7.02	6.78	6.53	6.42	6.33	6.27	6.21	6.12	5.86	5.63	5.22	4.94	4.72	4.55	4.34	4.25	4.22	4.04	3.80	3.77
	median	7.00	6.88	6.62	6.46	6.25	6.15	6.15	6.12	5.95	5.75	5.50	5.05	4.75	4.50	4.25	4.05	4.00	3.88	3.70	3.70
	std	1.71	1.87	1.91	1.88	1.86	1.80	1.89	2.03	2.24	2.33	2.42	2.35	2.18	2.06	1.96	1.79	1.66	1.63	1.68	1.66
issuance	avg	503.48	539.18	578.81	596.44	632.53	714.01	731.45	719.08	725.80	725.74	715.74	748.54	786.76	830.61	840.79	835.77	824.18	815.56	802.92	772.18
	median	299.76	349.42	399.28	447.03	496.79	499.02	498.93	498.50	499.01	499.42	499.47	500.00	591.09	598.40	599.45	599.71	599.38	599.80	599.81	598.86
	std	549.51	560.12	573.61	573.27	595.74	688.38	740.05	724.84	712.14	663.72	654.23	718.50	721.59	784.21	776.23	765.68	758.54	745.14	735.64	691.16
age	avg	4.37	4.32	4.42	4.56	4.65	4.68	4.65	4.70	4.48	4.42	4.29	4.20	4.23	4.41	4.54	4.64	4.91	4.75	4.77	5.15
	median	3.77	3.24	3.42	3.62	3.77	3.80	3.64	3.52	3.23	2.98	2.78	2.77	2.90	3.16	3.33	3.55	3.82	3.63	3.47	3.58
	std	3.60	3.66	3.69	3.79	3.96	4.07	4.14	4.33	4.38	4.46	4.50	4.45	4.43	4.47	4.59	4.54	4.70	4.84	4.97	5.18
trade	avg	366.08	319.66	344.66	285.46	264.58	412.99	601.25	451.83	385.86	349.03	308.09	229.26	196.86	232.48	219.71	225.63	272.90	269.41	184.83	236.54
	median	234.00	209.00	198.00	189.00	178.00	244.00	358.00	297.00	247.00	216.00	217.00	161.00	135.00	159.00	166.00	167.00	164.00	162.50	144.00	162.00
	std	529.63	357.35	555.37	289.13	270.88	563.79	780.40	539.20	538.36	551.75	333.52	225.78	208.37	226.09	232.08	213.48	362.68	427.97	156.43	240.00
volatility	avg	3.63	3.06	2.48	1.98	2.28	8.60	8.53	3.31	3.59	2.78	3.00	2.41	3.30	3.78	2.12	2.92	3.02	7.06	3.70	5.01
	median	2.37	1.81	1.56	1.36	1.65	5.43	3.97	2.08	2.12	1.76	1.98	1.49	1.85	2.16	1.15	1.55	1.84	4.05	1.85	3.71
	std	11.35	13.36	13.87	3.05	4.43	15.86	24.44	10.68	14.77	6.99	16.18	5.40	5.63	8.04	4.10	5.21	4.58	9.83	5.85	5.92
prclean	avg	105.09	105.75	103.87	100.83	100.59	93.29	94.36	105.01	106.69	110.09	114.10	114.33	113.97	109.59	108.65	105.43	108.44	111.45	114.43	98.70
	median	106.08	105.57	103.02	100.49	100.23	98.09	99.83	105.13	105.93	107.44	106.89	105.85	103.25	103.27	103.45	100.00	102.71	106.48	108.45	98.48
	std	13.92	25.12	12.40	13.68	9.19	17.13	21.55	16.99	25.17	72.58	267.29	258.14	611.61	448.05	59.37	69.44	64.66	56.94	32.60	18.98
cusip	count	14176.00	16299.00	16848.00	16691.00	16898.00	16666.00	16015.00	16116.00	15538.00	15977.00	15837.00	16285.00	17192.00	17476.00	19456.00	21231.00	23549.00	26800.00	28923.00	31182.00
Avf Ret	avg	0.29	0.04	-0.53	-0.21	-0.43	-3.09	1.13	0.92	0.06	0.95	0.41	0.56	-0.41	-0.03	1.85	-0.15	1.85	1.14	4.36	-3.21
	median	-0.07	-0.08	-0.33	-0.08	-0.12	-0.75	0.95	0.29	0.11	0.34	-0.22	0.19	-0.21	0.08	0.27	-0.36	0.97	0.60	0.04	-1.82
	std	6.48	6.78	8.45	5.88	6.79	11.51	12.56	6.10	12.65	8.62	6.06	7.50	5.58	8.25	5.54	6.85	8.84	9.92	9.78	12.27
Trd Size	avg	772.70	708.53	503.23	388.71	365.48	250.36	185.80	211.67	234.53	216.11	240.74	250.47	197.12	182.60	205.89	167.65	178.79	139.65	158.61	115.82
	median	412.47	360.02	286.11	244.22	207.20	134.48	100.29	118.00	132.64	115.53	118.12	129.43	84.26	66.24	53.16	37.62	42.58	34.48	38.35	32.82
	std	2162.02	5377.31	1147.35	435.35	475.85	339.31	257.99	280.02	315.01	274.91	334.69	349.16	306.88	310.00	402.56	387.08	514.44	253.89	372.11	193.14
tmt	avg	8.36	8.01	7.52	7.51	7.83	7.77	7.92	8.08	8.17	8.35	8.42	8.40	8.50	8.60	8.53	8.58	9.00	9.71	10.11	9.96
	median	5.54	5.58	5.45	5.37	5.41	5.11	5.08	5.20	5.50	5.66	5.71	5.84	5.79	5.66	5.45	5.24	5.41	5.87	6.21	6.05
	std	8.53	8.17	7.75	7.91	8.24	8.11	8.29	8.57	8.64	8.85	8.70	8.73	8.75	8.99	9.11	9.17	9.62	10.05	10.16	10.13
turnover	avg	16.36	15.17	12.75	10.42	9.61	114.50	883.88	2277.96	3467.20	493.46	50.76	inf	inf	inf	inf	inf	inf	inf	inf	inf
	median	7.13	6.78	5.81	5.69	4.88	4.69	6.00	4.86	4.86	4.34	4.59	4.52	4.17	4.19	4.04	3.97	4.17	4.71	4.50	4.72
	std	106.16	92.74	41.05	18.44	38.88	4967.86	15748.30	78470.27	72270.49	127475.42	807.63	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

2.2 Table 2 Measure of Illiquidity $\gamma = -\mathbf{Cov}(p_t - p_{t-1}, p_{t+1} - p_t)$

Table 2 summarizes the illiquidity measure γ for the bonds in our sample. **Table 2 Measure of Illiquidity** contains 3 panels: illiquidity of individual bonds, of bond portfolios and implied by quoted bid-ask spreads.

- **Panel A Individual Bonds** (The mean and average monthly illiquidity per bond per year)
  - Using trade-by-trade data
  - Using daily data
    - Using our cleaned original data
    - Using our cleaned MMN corrected data
- **Panel B Bond Portfolio**
  - **Equal-weighted:** Consider a daily portfolio composed of all bonds, with equally weighted bond returns used to calculate monthly illiquidity and median illiquidity per year
  - **Issuance-weighted:** Consider a daily portfolio composed of all bonds, with issuance weighted bond returns used to calculate monthly illiquidity and median illiquidity per year
- **Panel C Implied by quoted bid-ask spread**
  - Mean and median monthly bond bid-ask spread per year

Table 2 Panel A

During the period covered by the paper, spanning from 2003 to 2009, the illiquidity metric γ exhibited a mean value of 3.12 and a median of 0.07, with a substantial t-statistic of 17.06 using daily data. This compares to an average of 1.18 and a median of 0.56 observed in the paper. Our analysis successfully mirrored the initial decline followed by a subsequent rise in trends as documented in the original study. While other illiquidity metrics maintained a deviation within 40% when compared to the original findings, the illiquidity we recorded for 2008–2009 were significantly higher – by a factor of 3 to 4 times – potentially influenced by approximately six bonds exhibiting γ values exceeding 2000. The original study, however, did not specify an approach for managing outliers, leaving us uncertain whether these variations arise from outlier effects or inherent differences in data. In addition, our percentage of illiquidity significant at 95% level is much lower than what the paper has, suggesting that the authors might have handled outliers somewhat differently to maintain higher significance. 6 out of 8 robust t-stats are significant at 95% level in our analysis, with the overall robust t-stat = 17.6, close to the 16.53 in the paper, indicating the overall significance of the data.

To replicate the trade-by-trade table, which has the same calculation methodology but with challenges in data acquisition and processing, we streamlined the process by first refining the monthly WRDS Bond return and Open Source Bond Asset Pricing daily data. This preliminary step, essential for managing the extensive Finra TRACE data, helped us isolate the necessary records to mirror the work of Bao, Pan,

and Wang. Using specific CUSIP codes, we accessed the relevant TRACE trade data, further refining it to exclude trades that could skew results, following Alexander Dickerson's methodology.

Table 2 Panel B Bond Portfolio

For Panel B, we constructed two sets of daily bond portfolios from the same cross-section of bonds and for the same sample period, one being equally weighted and the other being weighted by issuance. After obtaining the daily portfolio returns (using Δ log bond price) and lag returns (using Δ log bond price lag), we calculated the monthly illiquidity through negative covariance of the returns and lag returns and then found the median per year for two sets of portfolios. The paper suggests that this measure implies that the transitory component extracted by the γ measure is idiosyncratic in nature and gets diversified away at the portfolio level, but a suspected systematic component is present when this aggregate illiquidity measure comoves strongly with the aggregate market condition at the time. Similar to the paper, our peak in illiquidity appeared in ∼2006–2007, and most of the portfolio illiquidity measures were not statistically significant. All measures replicate the paper within a tolerance of ±0.05 (equal-weighted), ±0.07 (issuance-weighted).

Table 2 Panel C Bid-Ask Spread

In Panel C, we computed the monthly average and median bid-ask spreads for each year, using these as proxies for implied illiquidity. The methodology involved utilizing the monthly bond return data available on WRDS to calculate the t-spreads, whereas the original authors derived their data from daily figures, potentially accounting for some differences in results. Despite these differences, by applying a factor of 5 to our findings, we were able to align our results with the original study's observed pattern of initial decline followed by an increase in illiquidity, with a tolerance level below 40%. It is noteworthy that the mean bid-ask spread for 2005 exhibited a slight increase in our table, although the median remained lower than that of the preceding year. This discrepancy underscores the influence of outliers on the mean and indicates a positive skew in the data.

2.2.1 Replicate Table 2 in the Paper, For period 2003/04-2009/06

Panel A: Individual Bonds, Trade-by-Trade Data, 2003-2009

Year	2003	2004	2005	2006	2007	2008	2009	Full
Mean illiq	1.3038	1.0196	0.6655	0.3715	0.2787	2.1214	2.4019	0.9731
Median illiq	0.3379	0.2135	0.1428	0.1196	0.1160	0.2600	0.3637	0.1861
Per t greater 1.96	88.7621	89.9867	93.4027	93.9008	93.3307	81.5528	88.4032	90.7210
Robust t stat	55.7235	1.2744	72.5386	2.4309	2.1805	31.9018	36.8252	3.1548

Panel A: Individual Bonds, Daily Data, 2003-2009

Year	2003	2004	2005	2006	2007	2008	2009	Full
Mean illiq	1.0124	1.0549	0.8511	0.4090	1.1160	13.2716	17.9805	3.1199
Median illiq	0.1186	0.0610	0.0409	0.0364	0.0650	0.2328	0.3345	0.0726
Per t greater 1.96	77.2839	77.3770	80.2972	87.9141	87.3263	67.4085	69.0074	79.6793
Robust t stat	2.5416	10.1838	4.0673	6.7154	1.8154	20.7878	1.1863	17.0572

Panel B: Bond Portfolios, 2003-2009

Year	2003	2004	2005	2006	2007	2008	2009	Full
Equal weighted	0.0061	-0.0008	0.0000	0.0010	0.0006	-0.0003	-0.0080	0.0008
EW t stat	1.4540	-0.5420	-0.2565	-0.1952	1.5554	-0.0958	-0.9542	-0.2944
Issuance weighted	0.0065	-0.0009	-0.0008	0.0001	0.0013	0.0012	-0.0175	0.0002
IW t stat	0.0406	-0.7365	-0.8902	0.1933	0.4756	-1.1784	-2.1805	-1.7069

Panel C: Implied by Quoted Bid-Ask Spreads, 2003-2009

Year	2003	2004	2005	2006	2007	2008	2009	Full
Mean implied gamma	0.0066	0.0054	0.0047	0.0043	0.0057	0.0124	0.0159	0.0066
Median implied gamma	0.0045	0.0036	0.0033	0.0031	0.0044	0.0090	0.0123	0.0042

2.2.2 Update Table 2 in the Paper, For period 2003/04-Present

Panel A: Individual Bonds, Trade-by-Trade Datas, 2003-Present

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Full
Mean illiq	1.3038	1.0196	0.6655	0.3715	0.2787	2.1211	1.7480	0.4120	0.3590	0.8183	0.2831	0.2359	0.2788	0.3038	0.1920	0.1554	0.5676	0.0417	0.1138	0.1293	0.1205	0.8229
Median illiq	0.3379	0.2135	0.1428	0.1196	0.1160	0.2600	0.2677	0.1191	0.0872	0.0734	0.0771	0.1376	0.2021	0.2076	0.1363	0.1207	0.1039	0.1105	0.0621	0.0780	0.0720	0.1627
Per t greater 1.96	88.7621	89.9867	93.4027	93.9008	93.3307	81.5528	89.6747	92.2673	90.5031	92.4376	92.1591	92.8259	99.5402	92.4906	95.3548	92.0330	88.0121	75.4530	77.9863	83.2442	72.5632	90.8115
Robust t stat	55.7235	1.2744	2.3986	2.4309	2.1805	4.2032	3.1235	1.5197	0.9935	0.7263	2.0622	0.7257	2.9091	2.3897	5.6414	0.5650	3.4344	7.7631	0.7301	16.7977	1.3198	3.8607

Panel A: Individual Bonds, Daily Data, 2003-Present

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Full
Mean illiq	1.0131	1.0708	0.8436	0.4180	1.1282	10.5194	4.0103	0.4441	0.3797	0.2672	1.3610	0.2226	0.4088	0.5588	0.2066	2.6832	0.2523	1.1915	0.1851	0.4878	1.8214
Median illiq	0.1176	0.0601	0.0395	0.0349	0.0625	0.2192	0.1827	0.0517	0.0368	0.0415	0.0310	0.0597	0.1931	0.2314	0.1441	0.1157	0.1393	0.2314	0.0818	0.1578	0.0698
Per t greater 1.96	77.8502	77.7234	80.7667	87.7888	87.9456	67.8345	73.8943	91.0076	82.6296	92.3549	89.4840	91.8605	94.9772	95.3654	97.0425	88.9105	86.4929	26.8012	73.8462	73.7654	81.8534
Robust t stat	0.4910	6.1507	2.6359	0.9841	6.5223	0.3743	15.8570	40.5960	28.7681	0.1406	3.1707	0.6050	10.2701	1.4953	17.3204	2.6228	7.2106	2.9258	1.5125	0.9367	176.4516

Panel B: Bond Portfolios, 2003-Present

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Full
Equal weighted	0.0059	0.0015	-0.0013	0.0010	0.0011	-0.0031	-0.0032	-0.0007	0.0013	0.0026	0.0013	0.0033	0.0211	0.0085	0.0050	0.0302	0.0102	0.0007	0.0058	0.0189	0.0022
EW t stat	1.5139	-0.3417	-0.7052	-0.1612	1.6158	-0.3194	-1.6198	-1.6114	0.5978	2.3197	1.5456	1.6790	2.6883	1.2802	1.7161	2.7832	2.4762	-1.1893	1.6406	1.4192	-0.5163
Issuance weighted	0.0072	-0.0010	-0.0016	0.0002	0.0015	-0.0007	-0.0074	0.0012	0.0011	0.0021	0.0013	0.0047	0.0259	0.0191	0.0205	0.0087	0.0215	0.0148	0.0181	0.0224	0.0022
IW t stat	0.0837	-0.7274	-0.5380	0.1200	0.3620	-1.0235	-1.6335	0.1826	-0.1351	1.1977	0.7017	2.0986	3.1313	2.1604	2.7049	0.9280	2.6681	-0.9091	1.5237	1.0868	-0.4640

Panel C: Implied by Quoted Bid-Ask Spreads, 2003-Present

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Full
Mean implied gamma	0.0067	0.0054	0.0047	0.0044	0.0058	0.0123	0.0124	0.0061	0.0054	0.0056	0.0052	0.0062	0.0082	0.0094	0.0072	0.0064	0.0067	0.0072	0.0045	0.0059	0.0065
Median implied gamma	0.0046	0.0036	0.0033	0.0031	0.0043	0.0089	0.0093	0.0045	0.0035	0.0037	0.0036	0.0050	0.0079	0.0086	0.0065	0.0059	0.0061	0.0056	0.0040	0.0049	0.0044

2.2.3 Table 2 Panel A Daily Data using MMN-Corrected Bond Data

Panel A: Individual Bonds, MMN-Corrected Bond Data, 2003-2009

Year	2003	2004	2005	2006	2007	2008	2009	Full
Mean illiq	1.1264	1.3510	0.4334	0.3291	0.4035	4.3871	8.4361	1.5078
Median illiq	0.1078	0.0617	0.0453	0.0457	0.0803	0.2696	0.4247	0.0784
Per t greater 1.96	71.4802	71.3777	79.9052	83.8984	88.2657	61.2684	63.1525	75.9952
Robust t stat	2.3045	10.1325	5.5754	0.4979	0.7750	10.1433	0.8237	7.2061

Panel A: Individual Bonds, MMN-Corrected Bond Data, 2003-Present

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Full
Mean illiq	1.2639	1.4954	0.4658	0.3423	0.4142	4.4183	4.6618	0.2475	0.2889	0.2801	0.1969	0.2546	0.4005	0.4696	0.1924	0.1882	0.1443	0.6999	0.0771	0.1751	1.2808
Median illiq	0.1100	0.0644	0.0462	0.0463	0.0825	0.2690	0.2273	0.0662	0.0471	0.0664	0.0607	0.1116	0.2047	0.1609	0.0863	0.0714	0.0797	0.0770	0.0278	0.0605	0.0796
Per t greater 1.96	72.1027	71.6347	79.5860	83.9946	89.8032	60.3363	70.2179	88.9231	79.5890	90.5763	82.8810	84.6400	84.2402	80.7229	80.8756	70.1657	77.9456	12.1212	66.3158	54.5455	77.3562
Robust t stat	8.0333	2.3127	4.8002	1.5020	9.3092	48.6802	50.5706	6.4627	12.2043	1.2469	0.9385	1.1688	8.5341	2.6728	6.7218	13.3750	2.9583	0.3793	3.5230	3.2977	8.6956

2.3 Monthly Bond Illiquidity Summary Statistics

By integrating the summary statistics and graphical representations of monthly bond illiquidity, we gain insight into the pronounced fluctuations in illiquidity, particularly during the 2008 sub-prime crisis. The summary statistics offer a comprehensive view of the annual distribution of illiquidity, highlighting extreme peaks of over 5000 in 2008 and over 8000 in 2009. In contrast, the third quartile remained between 1 and 2, indicating the presence of significant outliers, likely driven by a few bonds with gamma values surpassing 2000. Despite these spikes, the median values of 0.23 and 0.33 in 2008 and 2009, respectively, were considerably lower than the mean values of 13.27 and 17.98, suggesting a generally higher liquidity level during these years. Extending the analysis to 2023 revealed notable surges in illiquidity in 2018 and 2020.

The scatter plots visualize monthly illiquidity for individual bonds, with the red and purple lines delineating the mean and median annual illiquidity, respectively. These plots uncover a declining trend in monthly bond illiquidity, succeeded by a rising trend leading up to 2009, marked by exceptionally high illiquidity instances reaching up to 8000. Closer examination of the subsequent plot, which zooms in on the data, shows most values clustering in the 0-200 range. Notably, the mean illiquidity consistently exceeds the median during 2007-2009, reflecting a positive skew in the data attributed to outliers. The period post-2010 is characterized by more stable fluctuations, possibly due to a decrease in bond numbers following phase III. The MMN-corrected dataset presents a more uniform distribution, reducing outlier impact while preserving the identified trends.

Monthly Bond Illiquidity Summary Statistics Using Daily Data, 2003-2009

year	min illiq	mean illiq	q1 0.25	median	q3 0.75	max illiq	std illiq	mean t stat
2003	-129.0095	1.0124	0.0307	0.1186	0.4168	1127.4809	15.9260	2.9252
2004	-6.9843	1.0549	0.0140	0.0610	0.2430	718.6896	17.5463	3.0400
2005	-12.6456	0.8511	0.0094	0.0409	0.1718	2116.8092	29.7287	3.1092
2006	-20.1519	0.4090	0.0079	0.0364	0.1617	787.2365	9.3278	3.4375
2007	-9.3454	1.1160	0.0153	0.0650	0.2402	1764.1170	26.6052	3.2489
2008	-830.6648	13.2716	0.0595	0.2328	1.1329	5836.7472	190.9861	2.5173
2009	-202.0453	17.9805	0.0706	0.3345	2.0137	8571.4286	233.0594	2.6543

Monthly Bond Illiquidity Summary Statistics Using Daily Data, 2003-Present

year	min illiq	mean illiq	q1 0.25	median	q3 0.75	max illiq	std illiq	mean t stat
2003	-129.0095	1.0131	0.0309	0.1176	0.4071	1127.4809	16.1396	2.9296
2004	-6.9843	1.0708	0.0140	0.0601	0.2412	718.6896	17.7673	3.0512
2005	-12.6456	0.8436	0.0093	0.0395	0.1675	2116.8092	30.1023	3.1397
2006	-20.1519	0.4180	0.0078	0.0349	0.1555	787.2365	9.4784	3.4512
2007	-8.9327	1.1282	0.0149	0.0625	0.2264	1764.1170	27.0673	3.2647
2008	-284.1272	10.5194	0.0586	0.2192	1.0137	5836.7472	172.6313	2.5626
2009	-162.9935	4.0103	0.0413	0.1827	1.1041	883.5966	23.2900	2.6879
2010	-32.6263	0.4441	0.0151	0.0517	0.2429	54.3453	2.2485	3.7396
2011	-2.3940	0.3797	0.0104	0.0368	0.2169	17.5307	1.2358	3.3557
2012	-20.1613	0.2672	0.0097	0.0415	0.2195	36.9817	1.4741	3.7840
2013	-47.8704	1.3610	0.0050	0.0310	0.1716	1605.8952	41.5828	3.5638
2014	-0.6750	0.2226	0.0063	0.0597	0.2647	11.4411	0.5136	4.0144
2015	-5.3071	0.4088	0.0426	0.1931	0.5524	5.3490	0.6641	4.1939
2016	-0.5927	0.5588	0.0655	0.2314	0.6820	9.2924	0.8820	3.9617
2017	-52.2769	0.2066	0.0339	0.1441	0.3060	12.9757	2.3985	3.8839
2018	-26.5423	2.6832	0.0250	0.1157	0.3247	813.9595	37.7518	3.5731
2019	-2.8221	0.2523	0.0416	0.1393	0.3066	6.5013	0.5358	3.4018
2020	-9.7284	1.1915	0.0480	0.2314	0.8400	67.3578	4.8853	1.3364
2021	-1.2447	0.1851	0.0150	0.0818	0.2299	4.0193	0.3715	3.1882
2022	-3.8559	0.4878	0.0290	0.1578	0.4758	10.0916	1.1636	2.8679

Monthly Bond Illiquidity Summary Statistics Using MMN-Corrected Bond Data, 2003-2009

year	min illiq	mean illiq	q1 0.25	median	q3 0.75	max illiq	std illiq	mean t stat
2003	-9.1433	1.1264	0.0255	0.1078	0.3455	751.2174	16.7972	2.7336
2004	-20.0387	1.3510	0.0137	0.0617	0.2471	778.5893	21.1987	2.8324
2005	-18.1375	0.4334	0.0103	0.0453	0.1786	926.1567	12.3415	2.9953
2006	-40.3311	0.3291	0.0105	0.0457	0.1672	550.7363	7.1427	3.2997
2007	-4.4272	0.4035	0.0220	0.0803	0.2725	500.2215	6.7293	3.2232
2008	-249.7849	4.3871	0.0656	0.2696	1.1296	1084.7152	34.3248	2.2465
2009	-73.6781	8.4361	0.0866	0.4247	2.2894	925.4092	46.1308	2.3772

Monthly Bond Illiquidity Summary Statistics Using MMN-Corrected Bond Data, 2003-Present

year	min illiq	mean illiq	q1 0.25	median	q3 0.75	max illiq	std illiq	mean t stat
2003	-9.3580	1.2639	0.0264	0.1100	0.3613	767.2553	19.5645	2.7561
2004	-20.0387	1.4954	0.0141	0.0644	0.2603	778.5893	23.0873	2.8465
2005	-18.1375	0.4658	0.0105	0.0462	0.1854	926.1567	12.3580	3.0188
2006	-40.3311	0.3423	0.0109	0.0463	0.1726	550.7363	7.1426	3.3127
2007	-1.7845	0.4142	0.0230	0.0825	0.2807	500.2215	6.7189	3.2582
2008	-249.7849	4.4183	0.0654	0.2690	1.0993	1084.7152	34.9089	2.2688
2009	-73.6781	4.6618	0.0519	0.2273	1.1253	925.4092	32.3789	2.4732
2010	-6.3152	0.2475	0.0199	0.0662	0.2173	19.6215	0.7107	3.4391
2011	-11.1267	0.2889	0.0124	0.0471	0.2260	19.9247	1.0737	3.1756
2012	-1.6461	0.2801	0.0169	0.0664	0.2708	26.3509	0.8675	3.7077
2013	-3.2834	0.1969	0.0112	0.0607	0.2319	7.8376	0.4362	3.2835
2014	-0.8871	0.2546	0.0303	0.1116	0.3131	3.5000	0.4075	3.8890
2015	-8.7366	0.4005	0.0521	0.2047	0.5541	6.7399	0.8311	3.5203
2016	-4.2843	0.4696	0.0447	0.1609	0.5103	11.6422	1.0501	3.1075
2017	-0.4161	0.1924	0.0214	0.0863	0.2327	4.2988	0.4057	3.1933
2018	-2.6733	0.1882	0.0154	0.0714	0.1885	19.9444	1.0902	2.9130
2019	-0.4971	0.1443	0.0135	0.0797	0.1862	3.3472	0.3048	2.8892
2020	-9.2546	0.6999	0.0069	0.0770	0.2977	34.1160	3.3343	0.7079
2021	-0.1431	0.0771	0.0006	0.0278	0.0871	1.8462	0.1783	2.1471
2022	-2.0668	0.1751	-0.0135	0.0605	0.1995	5.4572	0.5837	1.3503

3 Visualizations (See combined plot description and observations in the previous section)

Monthly Illiquidity Per Bond and Average Illiquidity By Year

Figure 1: Illiquidity by Year with Mean Illiquidity, 2003-2009

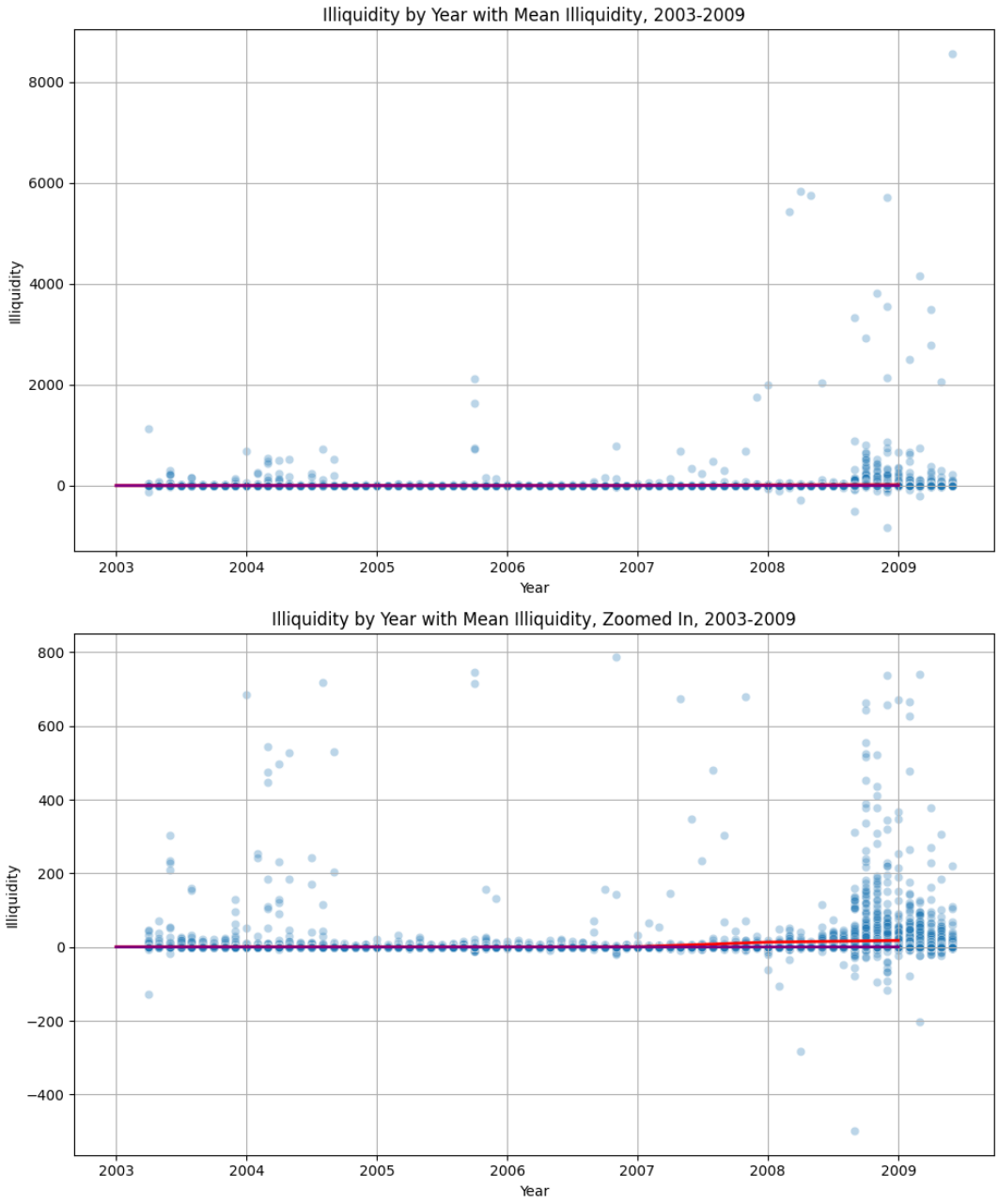
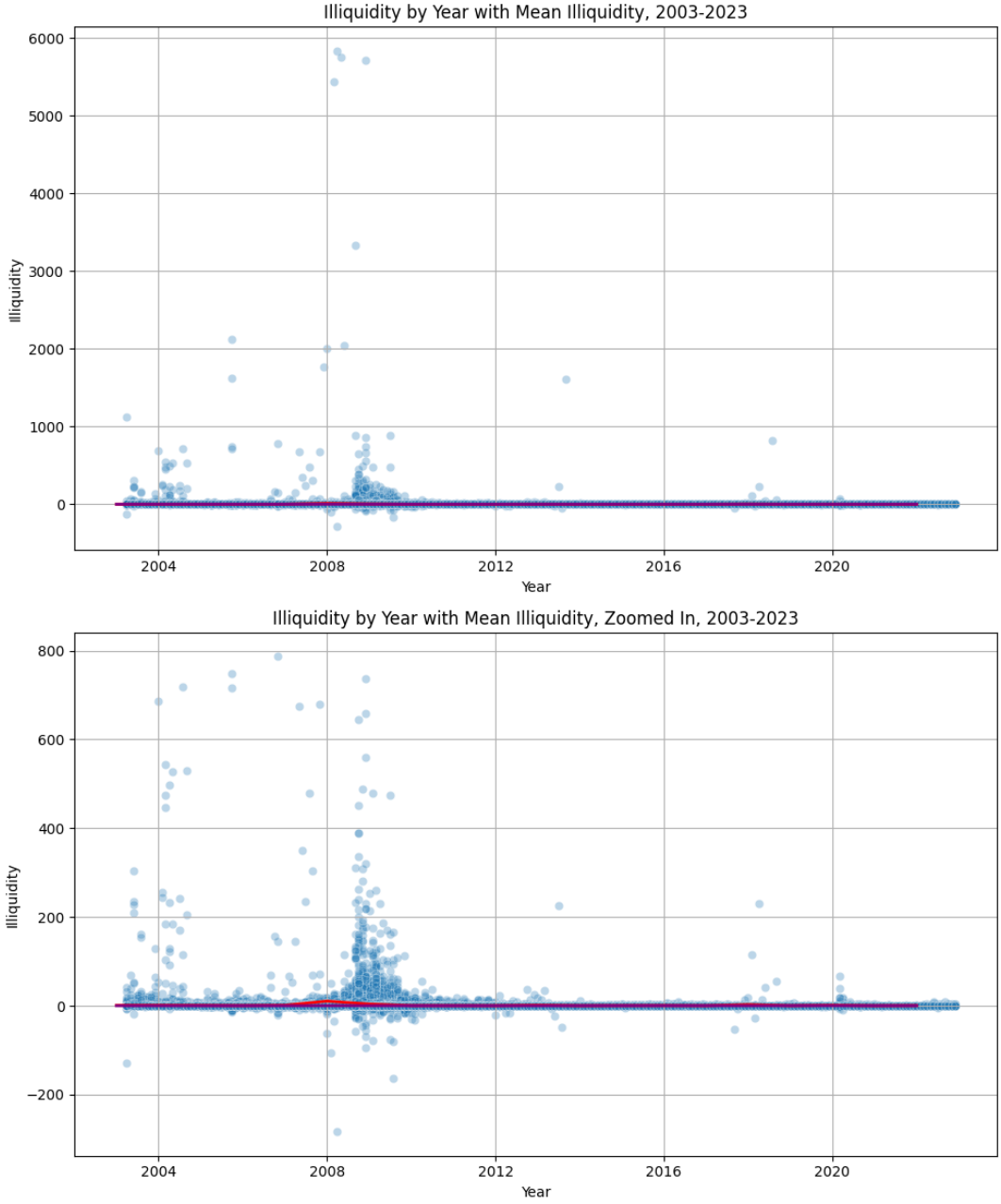
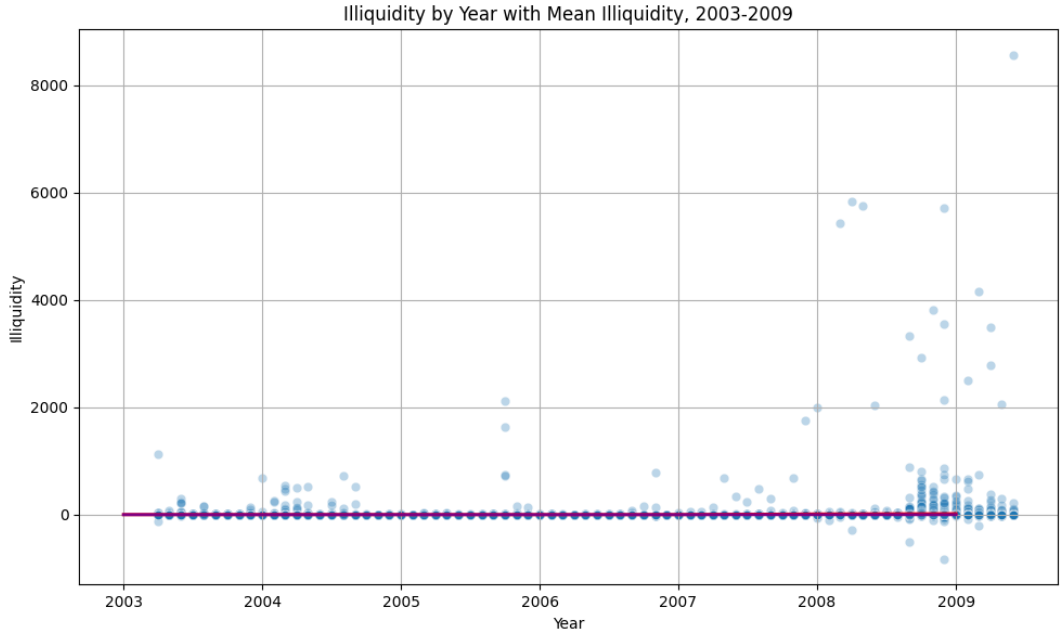


Figure 2: Illiquidity by Year with Mean Illiquidity, 2003-Present



Monthly Illiquidity Per Bond and Average Illiquidity By Year Using MMN-Corrected Data

Figure 3: Illiquidity by Year with Mean Illiquidity Using MMN-Corrected Data, 2003-2009



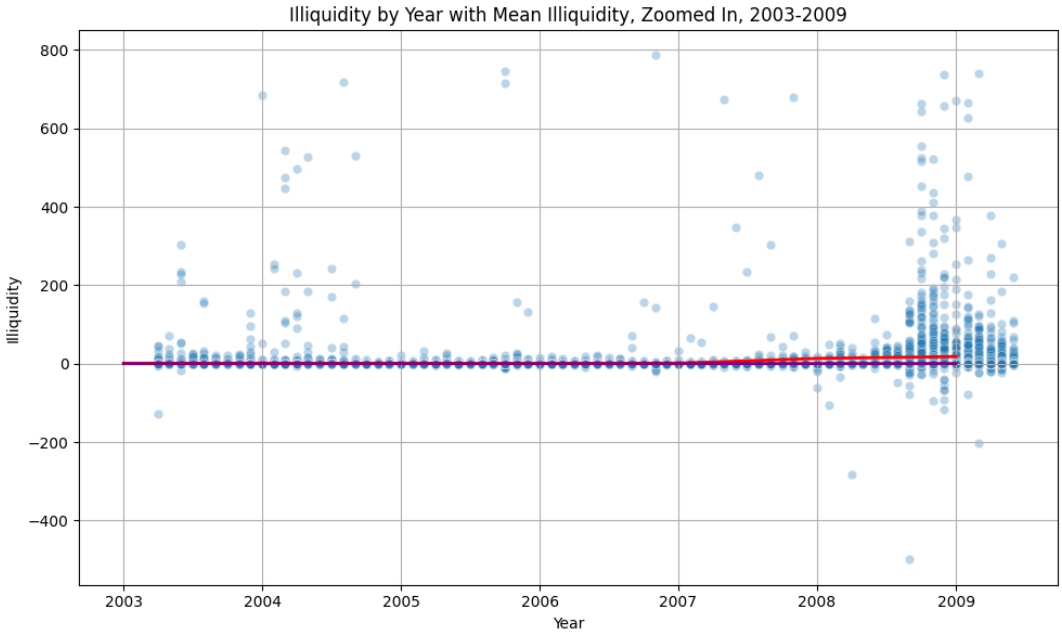


Figure 4: Illiquidity by Year with Mean Illiquidity Using MMN-Corrected Data, 2003-Present