Liquidity of Corporate Bonds

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Liquidity and Corporate Bonds

- In comparison, low levels of trading in corporate bond market

Q1, 2007	Amount outstanding ($ trillion)	Daily volume ($ billion)
Treasury	4.45	492
Small cap stocks (<$1 B)	1.32	14.6
Corporate	5.45	16.7

- High yield spreads relative to fundamentals
  - Huang and Huang (2003)

Rating (10 yrs)	Aaa	Aa	A	Baa	Ba	B
Yield spread (bps)	63	91	123	194	320	470
Model spread (bps)	10	14	23	57	192	388

- Credit spread changes hard to explain by theoretical variables
  - Collin-Dufresne, Goldstein and Martin (2001)
- "Excessive" short-term volatility in bond returns
  - Bao and Pan (2008)

Horizon	Daily	Weekly	Monthly
Stocks	26.78	27.39	24.27
Treasury (7 yr)	5.51	5.30	5.62
Corporate bonds	18.29	10.01	8.42

- Attributable to illiquidity?
- Without a proper measure of illiquidity, it is difficult to have a direct and serious examination of its impact on asset pricing and market efficiency

Outline:

- A simple measure of illiquidity
- Estimate bond illiquidity using transactions data (TRACE)
- Cross sectional variation of illiquidity and bond characteristics
- Time series of bond illiquidity and its commonality
- Bond yields and illiquidity
- Illiquidity and bid-ask spread

Our Measure of Illiquidity

P_t denotes the clean price of a bond:

$$P_t = F_t + u_t$$

- F_t represents the fundamental value and follows a random walk
- u_t represents impact of illiquidity and is transitory

The size of u_t quantifies illiquidity

- Transitory component u_t leads to price reversals
- Autocovariance of price changes gives an measure of illiquidity

$$\gamma = -\operatorname{Cov}[\Delta P_t, \Delta P_{t+1}]$$

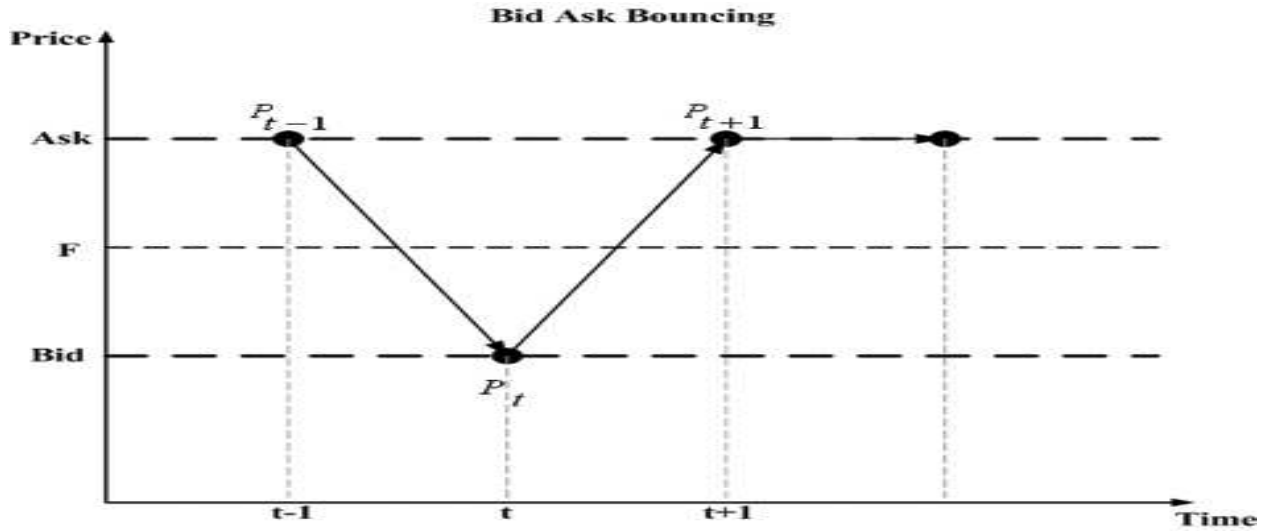
where $\Delta P_t = P_t - P_{t-1}$

- This measure of illiquidity is simple and easy to implement empirically
- It captures a salient feature of illiquidity: Lack of liquidity gives rise to transitory components in prices
  - Grossman and Miller (1988)
- Reversals are stronger for price declines than rises
  - Huang and Wang (2007)

A special case: Bid-ask bouncing (Roll (1984))

$$u_t = \frac{1}{2} S q_t$$

- S is the bid-ask spread
- q_t denotes the direction of trade t, $+1$ for buy and -1 for sell



Assuming q_t is i.i.d., we have

$$\gamma_{\text{Roll}} = \left(\frac{1}{2}S\right)^2$$

Our liquidity measure vs. bid-ask spread

- Bid-ask is a direct and potentially important indicator of illiquidity
- But it does not fully capture many important aspects of liquidity such as market depth and resilience
- The economic drivers of u_t can be much broader than bid-ask bouncing
- γ as a measure of illiquidity should better capture the impact of illiquidity on prices, above and beyond the effect effect of bid-ask spread (as captured by γ_{Roll})
- Conversely, for estimated γ, we can define "implied" spread:

  $$S_{\text{implied}} = 2\sqrt{\gamma}$$

  which can be compared with the observed bid-ask spread

Related Literature

- Estimating bid-ask spreads using variants of Roll's model
  - Edwards, Harris and Piwowar (2007) and Bessembinder, Maxwell, and Venkataraman (2006), Goldstein, Hotchkiss and Sirri (2007)
- Latent liquidity using bond holdings data on buy-side clients
  - Mahanti, Nashikkar, Subrahmanyam, Chacko, and Mallik (2008)
- Asset-pricing impact of bond illiquidity
  - Chen, Lesmond and Wei (2007) and Houweling, Mentink and Vorst (2003).

Data: TRACE 2003 – 2007

- OTC corporate bond transactions data, reported by FINRA
- Phase I: July 1, 2002 (initial issue size $>$ \$1 billion)
- Phase II: April 14, 2003 (number of bonds increases to $\sim$ 4,650)
- Phase III: February 7, 2005 ($\sim$ 99% of all public transactions)
- Our sample:
  - Drop early sample period with only Phase I coverage (2003 – 2007)
  - Drop Phase III only bonds to maintain balanced sample
  - In the sample for at least a year
  - Traded at least 75% of trading days

Table 1. Summary Statistics (Full Sample)

	mean	med	std
#Bonds	1,249		
Issuance ($ million)	867	700	680
Maturity (years)	6.84	4.43	7.14
Coupon (%)	5.88	6.03	1.90
Age (years)	4.15	3.24	2.85
Rating (1=Aaa, 21=C)	7.27	6.00	4.25
Turnover (%, monthly)	7.83	6.61	5.16
Trd Size ($ 1,000)	448	366	368
#Trades (monthly)	174	121	185
Avg Ret (%, monthly)	0.43	0.35	0.54
Volatility (%, monthly)	2.24	1.64	2.37
Price (% of par value)	103	103	11

Bond Illiquidity

Table 2. Measure of Illiquidity: $\gamma = -\mathrm{Cov}\left(P_t - P_{t-1}, P_{t+1} - P_t\right)$

	2003	2004	2005	2006	2007	Full
Using trade-by-trade data						
Mean γ	0.6546	0.6714	0.5717	0.4677	0.4976	0.5814
Median γ	0.4520	0.3928	0.3170	0.2588	0.2830	0.3598
Per t-stat $\geq$ 1.96	99.74	97.53	99.31	98.69	97.45	100.00
Robust t-stat	16.87	16.01	19.10	20.56	19.51	22.23
Using daily data						
Mean γ	1.0201	0.9842	0.9047	0.7618	0.9222	0.9080
Median γ	0.6949	0.5328	0.4558	0.4149	0.5590	0.5533
Per t-stat$\geq$ 1.96	95.35	90.64	96.04	95.50	92.63	99.36
Robust t-stat	22.03	17.22	26.81	26.13	24.92	29.13
Implied by quoted bid-ask spreads						
Mean γ	0.0455	0.0409	0.0499	0.0501	0.0510	0.0458
Median γ	0.0370	0.0299	0.0272	0.0237	0.0268	0.0302

Table 2. Estimates of γ: Individual Bonds vs. Bond Portfolios

Individual	2003	2004	2005	2006	2007	Full
Mean γ	1.0201	0.9842	0.9047	0.7618	0.9222	0.9080
Median γ	0.6949	0.5328	0.4558	0.4149	0.5590	0.5533
Per t-stat$\geq$ 1.96	95.35	90.64	96.04	95.50	92.63	99.36
Robust t-stat	22.03	17.22	26.81	26.13	24.92	29.13
Portfolio	2003	2004	2005	2006	2007	Full
Equal weighted	-0.0031	-0.0044	-0.0032	0.0007	-0.0009	-0.0023
t-stat	-0.57	-1.22	-1.18	0.64	-0.44	-1.67
Issue weighted	0.0006	-0.0039	-0.0012	0.0007	0.0003	-0.0009
t-stat	0.10	-1.00	-0.41	0.50	0.11	-0.57

Cross-Section of Illiquidity

Bond Characteristics:

- Some well-known liquidity-related bond characteristics: age, issuance
- Some bond characteristics as controls: maturity, rating
- Exposure to system risk: β's on returns to the stock market index and corporate bond index
- Idiosyncratic risk: residual volatility, firm specific and bond specific
- Bond trading activities: turnover, trade size, # of trades
- Quoted bid-ask spread: bid-ask implied γ

Bond Characteristics related to illiquidity:

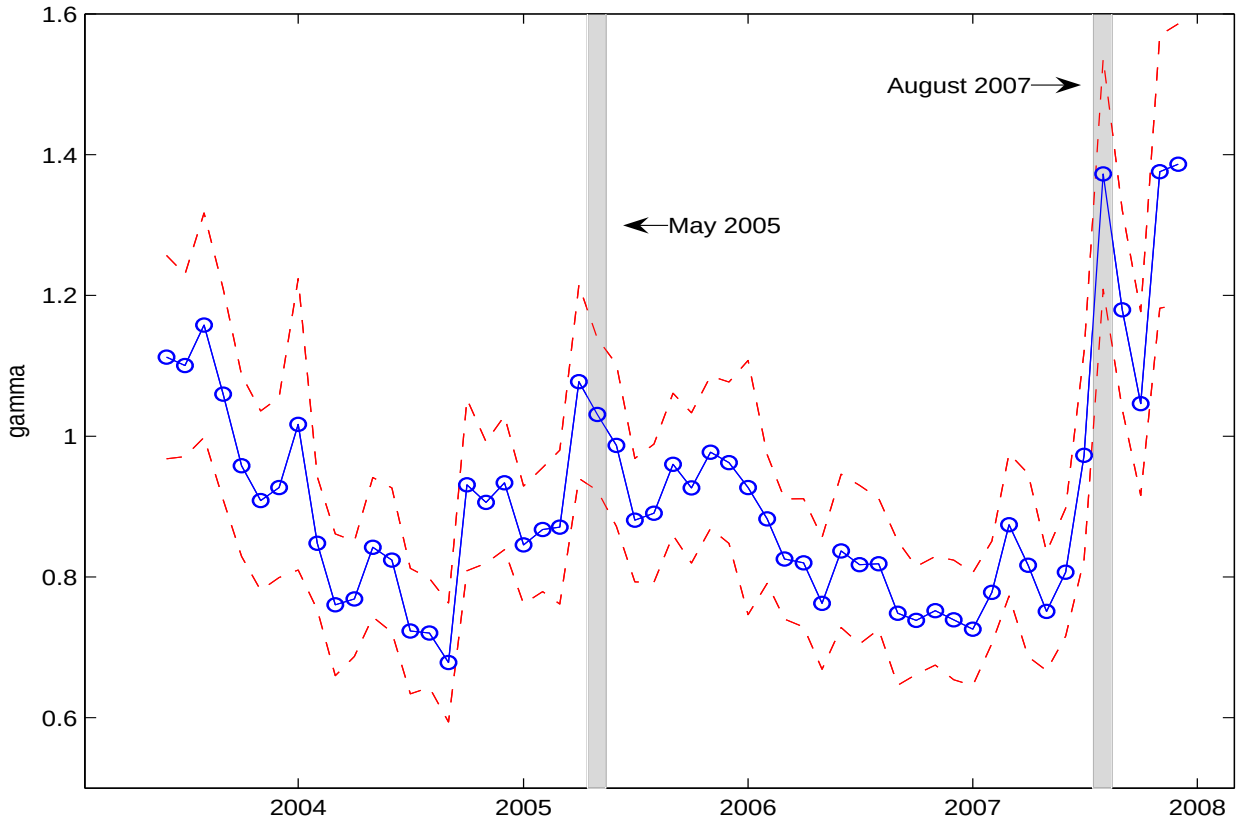
- Age (+)
- Time to maturity (+)
- Issuance size (−)
- Rating (+)
- Factor loadings
  - Stock index
  - Corporate bond index
- Residual volatility
  - Firm specific
  - Bond specific (+)
- Turnover (−)
- Trade size (−)
- No. of trades
- Quoted bid-ask implied γ (+)
- CDS dummy

Table 3: **Cross-Sectional Variation in γ and Bond Characteristics**

Cons	0.8795	0.8775	0.8671	0.8763	0.8830	0.8786	0.8948	0.9271
	[21.93]	[23.28]	[14.97]	[23.03]	[22.83]	[22.66]	[17.42]	[25.12]
Age	0.0726	0.0523	0.0517	0.0464	0.0326	0.0571	0.0722	0.0719
	[4.37]	[6.18]	[4.24]	[4.97]	[3.95]	[5.98]	[3.44]	[3.64]
Maturity	0.0708	0.0424	0.0401	0.0461	0.0481	0.0450	0.0651	0.0688
	[11.05]	[19.59]	[3.12]	[11.04]	[10.96]	[9.80]	[13.45]	[17.36]
ln(Issuance)	-0.1951	-0.1373	-0.1294	-0.1368	-0.0257	-0.1551	-0.2129	-0.2340
	[-5.87]	[-3.23]	[-5.31]	[-3.57]	[-1.05]	[-3.81]	[-6.12]	[-7.87]
Rating	0.0415	0.0164	0.0105	0.0232	0.0314	0.0190	0.0403	0.0537
	[8.05]	[3.95]	[1.58]	[3.03]	[3.35]	[2.40]	[2.77]	[6.82]
beta (stock)	0.4389	0.1536	0.24					
	[4.34]	[0.70]	[1.13]					
beta (bond)	-0.0237	0.0351	0.0307					
	[-0.90]	[0.69]	[0.59]					
sig(e)		0.4730		0.4581	0.4120	0.4397		
		[4.37]		[4.04]	[3.82]	[3.79]		
sig(e^{firm})			-0.0357					
			[-0.42]					
sig($e^{\text{firm res}}$)			0.6570					
			[11.31]					
Turnover				-0.0165				
				[-2.60]				
ln(Trd Size)					-0.2350			
					[-10.15]			
ln(#Trades)						0.0571		
						[1.66]		
Quoted BA γ							2.0868	
							[2.61]	
CDS Dummy								-0.0456
								[-1.90]
R-sqd (%)	49.11	62.68	74.46	61.79	63.86	61.46	47.43	45.61

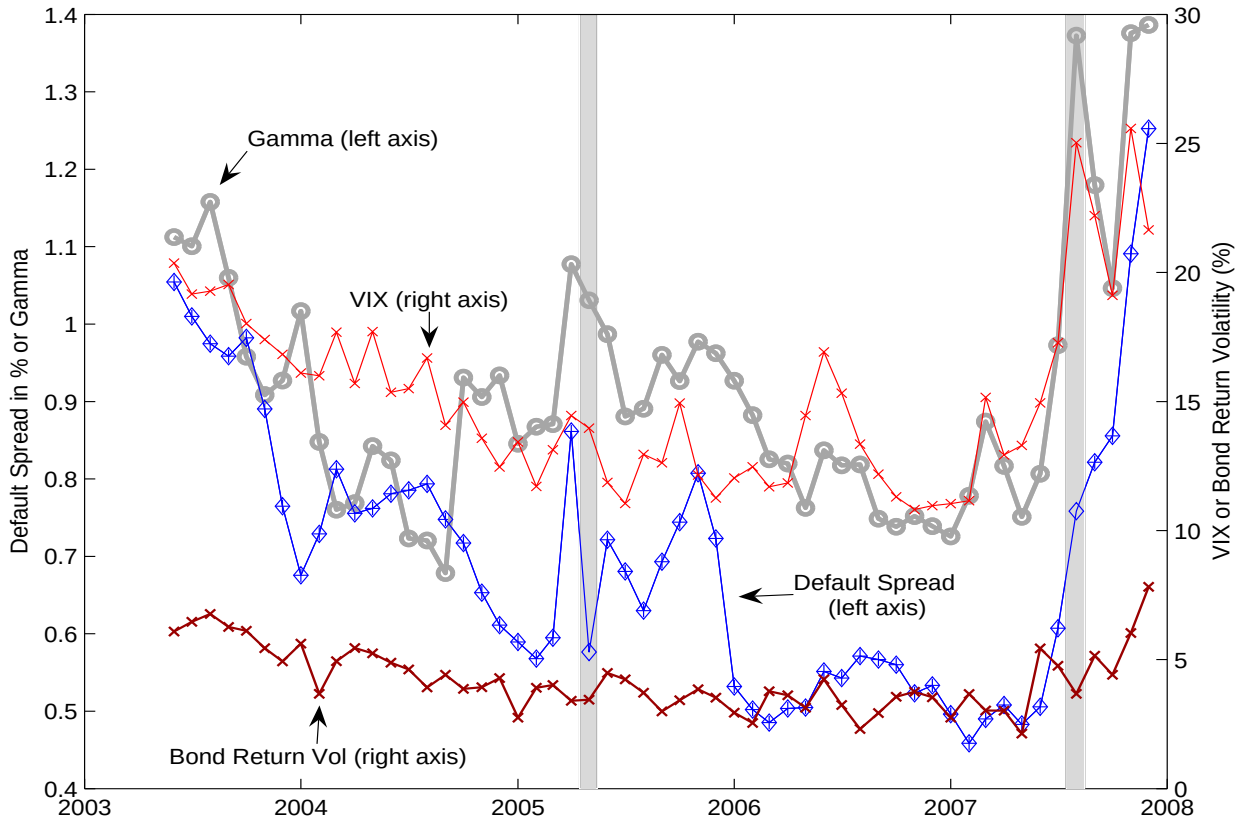
Time Series and Commonality of Liquidity

Market-wide average of bond illiquidity varies substantially



Monthly time-series of γ (daily data estimate), averaged across all bonds. The dashed lines are the upper and lower bounds of the 95% confidence interval.

Market-wide illiquidity comoves with other market variables



Monthly time-series of γ along with CBOE VIX index, default spread, and bond return volatility.

Table 4. Time Variation in γ and Market Variables

Cons	0.0035	0.0029	0.0066	0.0027	0.0159	0.0060	0.0126
	[0.30]	[0.33]	[0.53]	[0.33]	[1.11]	[0.48]	[1.51]
Bond Volatility	0.0079						0.0063
	[0.71]						[0.72]
ΔVIX		0.0312					0.0270
		[3.46]					[3.02]
ΔTerm Spread			0.1010				0.0210
			[1.57]				[0.37]
ΔDefault Spread				0.4757			0.2100
				[2.31]			[1.57]
Lagged Stock Return					-0.0125		-0.0087
					[-2.31]		[-3.07]
Lagged Bond Return						-0.0215	-0.0102
						[-3.52]	[-1.26]
Adj R-sqd (%)	-1.43	37.96	0.44	13.92	7.15	2.74	43.51

Monthly changes in γ regressed on monthly changes in bond index volatility, VIX, term spread, default spread, and lagged stock and bond returns. The Newey-West t-stats are reported in square brackets.

Bond Yields and Illiquidity

Potential determinants of bond yield:

- Fundamental risk – equity volatility (+)
- Illiquidity measured by γ (+)
- Age (+)
- Time to maturity
- Issuance size
- Rating (+)
  - A Dummy
  - Baa Dummy
  - Junk Dummy
- Callability
- Quoted bid-ask spread

Table 6: **Bond Yield Spread and Illiquidity Measure** γ

Intercept	0.7062	0.4585	-0.3343	-0.4736	-0.6808	-0.9394	-0.5688	-1.2853	0.9885	-0.3706
	[11.10]	[5.11]	[-1.12]	[-1.44]	[-1.81]	[-2.46]	[-1.54]	[-2.76]	[7.32]	[-1.41]
γ		0.4220		0.4264	0.3595	0.3863	0.3475	0.3319		0.4436
		[3.95]		[5.85]	[3.78]	[3.96]	[3.65]	[3.79]		[5.57]
Equity Vol			0.0652	0.0593	0.0588	0.0549	0.0591	0.0558		0.0582
			[3.34]	[3.03]	[3.04]	[2.96]	[3.05]	[2.94]		[3.13]
Age					0.0357	0.0506	0.0329	0.0387		
					[6.57]	[6.02]	[6.39]	[5.79]		
Maturity					0.0049	0.0007	0.0056	0.0056		
					[0.65]	[0.09]	[0.75]	[0.80]		
ln(Issuance)					0.0124	0.0289	0.0257	-0.0822		
					[0.56]	[1.48]	[0.99]	[-3.58]		
Turnover						0.0298				
						[5.51]				
ln(Trd Size)							-0.0346			
							[-1.95]			
ln(#Trades)								0.2582		
								[5.52]		
Quoted B/A Spread									-1.1296	-0.3798
									[-2.53]	[-1.30]
Call Dummy	0.0090	0.0050	-0.0630	-0.0845	-0.0442	-0.0174	-0.0447	-0.0027	-0.0171	-0.0898
	[0.10]	[0.06]	[-0.99]	[-1.49]	[-1.13]	[-0.47]	[-1.13]	[-0.08]	[-0.18]	[-1.65]
A Dummy	0.1871	0.1710	0.0371	0.0316	0.0214	0.0037	0.0296	0.0639	0.2001	0.0264
	[3.70]	[3.98]	[0.60]	[0.54]	[0.35]	[0.06]	[0.49]	[1.16]	[4.25]	[0.45]
Baa Dummy	0.7721	0.6061	0.5056	0.3757	0.3113	0.2374	0.3314	0.3750	0.9245	0.4338
	[5.62]	[6.54]	[5.22]	[3.34]	[2.83]	[1.99]	[2.96]	[3.61]	[6.12]	[4.59]
Junk Dummy	4.6684	4.0201	2.7492	2.2182	2.2279	2.1747	2.2386	2.2797	4.9757	2.2488
	[10.19]	[9.91]	[13.29]	[9.73]	[9.64]	[9.10]	[9.81]	[10.20]	[8.44]	[10.78]
R-sqd (%)	27.41	31.37	50.60	55.34	56.59	57.50	56.81	57.94	28.74	55.12

Economic significance of γ in explaining CS yield spreads:

- After controlling for rating, the slope coefficient on γ is 0.4220.
- The time-series average of the cross-sectional standard deviation of γ:

	Full	Investment	Aaa & Aa	A	Baa	Junk
std(γ)	0.9943	0.8397	0.7524	0.8155	0.9354	1.2881

- Difference in yield spreads (in bps) generated by one std difference in γ:

Full	Investment	Aaa & Aa	A	Baa	Junk
42	35	32	34	39	54

- For two bonds in the same rating category, a one std difference in illiquidity would "cause" a difference in yield spreads of over 30 bps.

Table 7: **Yield Spread and γ, for Investment Grades Only**

Intercept	0.7095	0.5172	0.5128	0.3217	0.2631	0.5182	0.2906
	[9.94]	[6.43]	[6.53]	[3.43]	[1.28]	[5.73]	[2.81]
γ		0.3548		0.3464	0.2271		0.3358
		[7.02]		[7.02]	[4.01]		[7.71]
Equity Vol			0.0101	0.0107	0.0103		0.0107
			[2.61]	[2.99]	[2.74]		[2.91]
Age					0.0186		
					[3.96]		
Maturity					0.0156		
					[3.86]		
ln(Issuance)					-0.0030		
					[-0.15]		
Quoted B/A Spread						0.7498	0.1441
						[5.12]	[1.92]
Call Dummy	-0.0070	-0.0787	0.0317	-0.0514	-0.0668	-0.0676	-0.0633
	[-0.14]	[-1.99]	[0.70]	[-1.47]	[-2.49]	[-1.48]	[-1.78]
A Dummy	0.1971	0.2029	0.1586	0.1628	0.1634	0.1923	0.1542
	[4.47]	[5.36]	[4.07]	[4.97]	[5.28]	[4.73]	[4.78]
Baa Dummy	0.7875	0.6971	0.7059	0.6264	0.5831	0.7386	0.6180
	[6.84]	[7.71]	[7.82]	[8.68]	[9.11]	[6.57]	[8.29]
R-sqd (%)	15.40	30.26	18.41	32.63	36.31	20.68	33.76

Our Illiquidity Measure γ vs. Quoted Bid-Ask Spread

For the investment-grade only sample and after controlling for rating,

- when the two variables are used separately, the slope coefficient is 0.3548 for γ and 0.7498 for the quoted bid-ask spread
- when both variables are used together, the slope coefficient is 0.3358 for γ and 0.1441 for the quoted bid-ask spread
- for this sample, the cross-sectional standard deviation is on average 0.7968 for γ and 0.1686 for the quoted bid-ask spread
- $0.3358 \times 0.7968 = 27$ bps
- $0.1441 \times 0.1686 = 2.4$ bps

Illiquidity and Bid-Ask Spread

Implied and Estimated Bid-Ask Spreads by Edwards, Harris and Piwowar (EHP 2007)

	Our period		EHP subperiod		EHP		
trade size	mean	med	mean	med	EHP size	mean	med
$\leq$ 7.5K	2.05	1.76	2.06	1.81	5K	1.50	1.20
(7.5K, 15K]	1.82	1.61	1.98	1.79	10K	1.42	1.12
(15K, 35K]	1.69	1.41	1.81	1.60	20K	1.24	0.96
(35K, 75K]	1.43	1.15	1.39	1.20	50K	0.92	0.66
(75K, 150K]	1.13	0.90	1.00	0.89	100K	0.68	0.48
(150K, 350K]	0.82	0.70	0.67	0.66	200K	0.48	0.34
(350K, 750K]	0.69	0.59	0.60	0.57	500K	0.28	0.20
$>$ 750K	0.64	0.55	0.52	0.54	1,000K	0.18	0.12

The bid-ask spreads are calculated as a percentage of the market value of the bond and are reported in percentages. The EHP bid-ask spread estimates are from Table 4 of EHP, and the EHP subperiod is Jan. 2003 to Jan. 2005.

Concluding Remarks

Our results:

- A simple and robust measure of illiquidity based on the magnitude of transitory price movements
- Strong price reversals indicates illiquidity in the corporate bond market
- The cross-sectional variation of our liquidity measure is closely related to liquidity related bond characteristics
- Comovement in illiquidity demonstrates commonality
- Our measure of illiquidity is related to bond yields

Further questions:

- Causes of illiquidity?
- Better descriptions of the transitory price component
- How illiquidity influences prices
- Any market inefficiencies?