Liquidity Risk of Corporate Bond Returns (Do not circulate without permission)

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17 February 2009

Outline

- **Explaining corporate bond returns**
- **Liquidity risk**
  - ✓ Framework
  - ✓ Data
  - ✓ Regime switch in liquidity betas
  - ✓ Nature of regimes
- **Interpretation of results**
- **Relationship to results for stocks**
- **Conclusions**

Explaining bond returns/spreads

- ***Changes in the spread*** are not explained well
  - ✓ By changes in factors affecting credit risk
    - Collin-Dufresne, Goldstein and Martin (2001)
  - ✓ R^2 of 30% to 40% only, higher for lower-rated bonds
  - ✓ Unexplained portion appears to have a common factor

- ***Hedge ratios*** from credit risk models are close to the empirically computed hedge ratios
  - ✓ Schaefer and Strebulaev (2006)
  - ✓ Unexplained portion thus most likely unrelated to credit risk

Possible explanations

- ***Liquidity and liquidity risk***
  - ✓ A burgeoning area of research but many open questions
- ***Time-varying risk-premium***
  - ✓ A less commonly adopted approach but potentially important
- ***This paper:***
  - ✓ Liquidity risk
  - ✓ Time-varying liquidity risk
  - ✓ Interpretation: Time-varying (liquidity) risk premium

Liquidity risk

- Framework based on
  - ✓ Pastor and Stambaugh (2002), Acharya and Pedersen (2005)

- Controls for interest rate and default risk
  - ✓ Fama and French (1993), Schaefer and Strebulaev (2006)

$$R_{j,t} = \alpha_j + \beta_{j,T} \times Term + \beta_{j,D} \times Def + \beta_{j,I} \times Illiqinnov + \beta_{j,BI} \times Bondilliqinnov + \epsilon_{j,t} ,$$

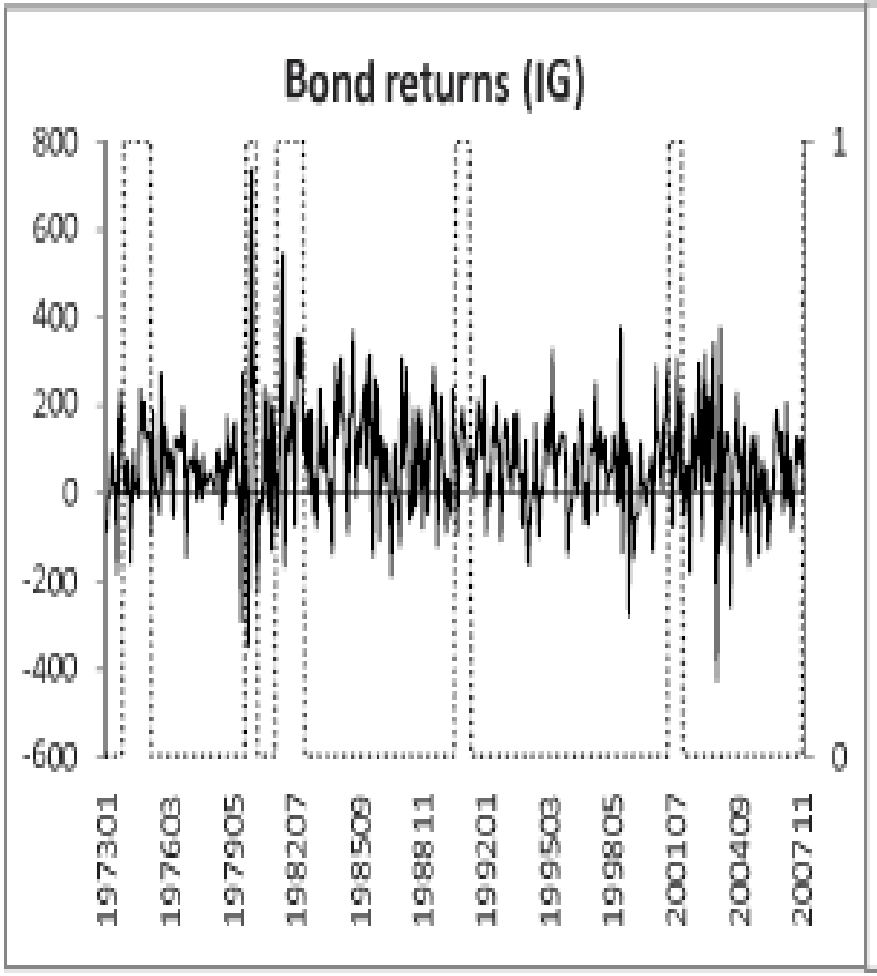
- ***Regime-switching analysis of betas***
  - ✓ Hamilton (1994)

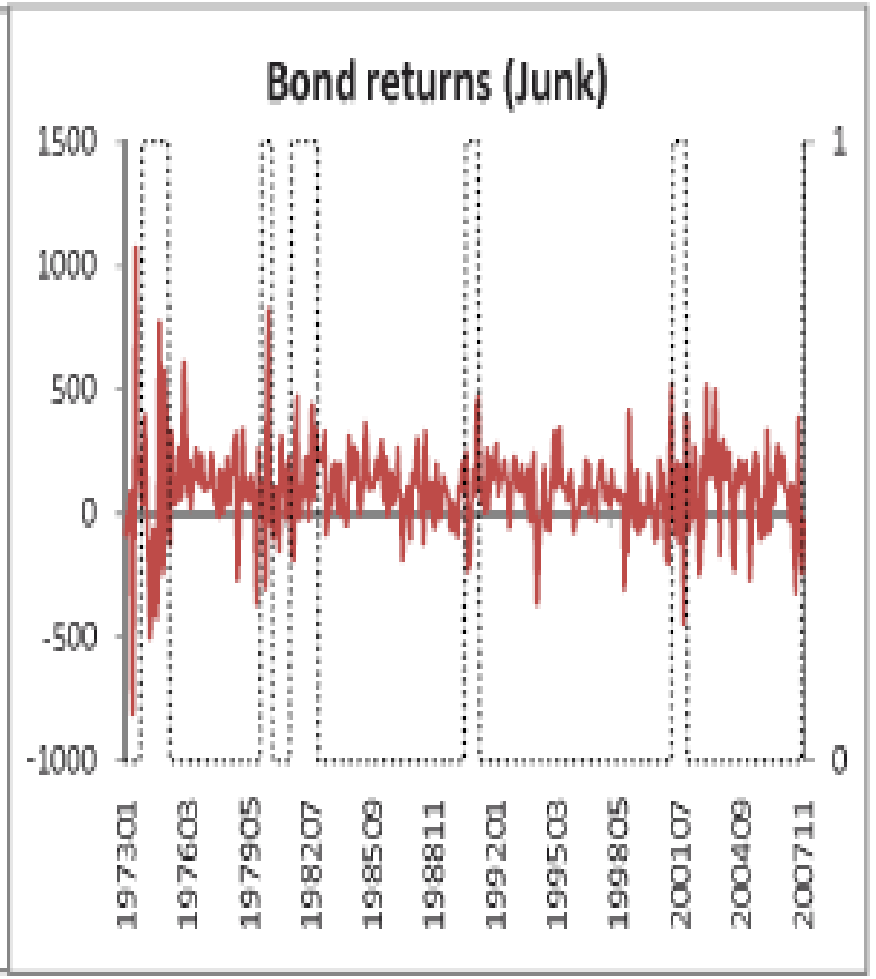
Corporate bond returns

- **Lehman Brothers Fixed Income Database** (Warga, 1998): 1971-1997
- **Merrill Lynch Fixed Income Database**

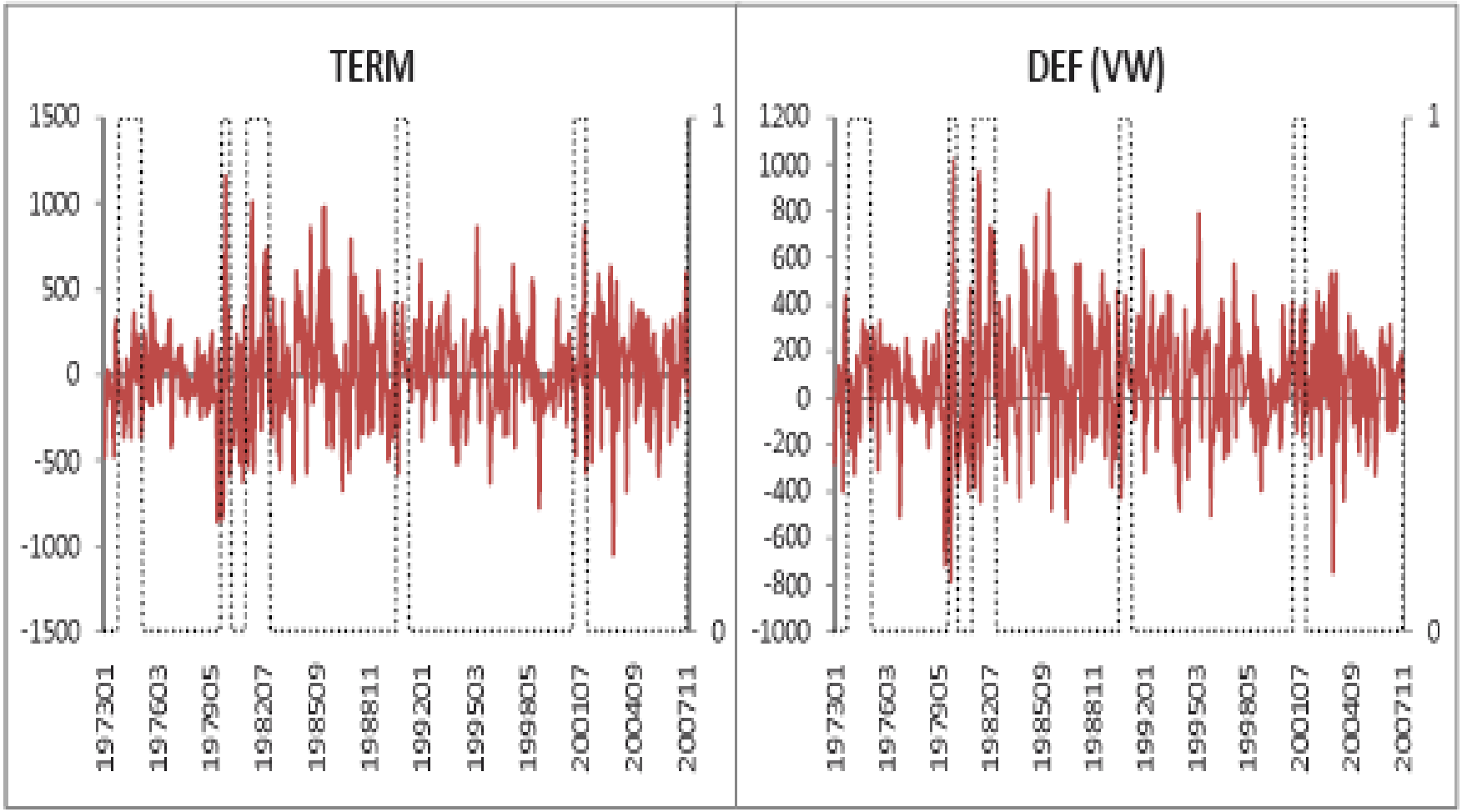
  (From Schaefer and Strebulaev): 1997-2007
- High intersection in the overlapping period
- Elimination criteria: Matrix prices; Special features; Not in Lehman Brothers bond indices
- ***Term***: Long-term govt minus one-year govt
- ***Def***: Value-wtd market of all inv grade bonds > 10yrs
  - ✓ Results robust to using junk grade bonds also
  - ✓ Also use firm-level equity returns (Schaefer, Strebulaev (2006))

IG and Junk bond returns





Term and Def risk factors



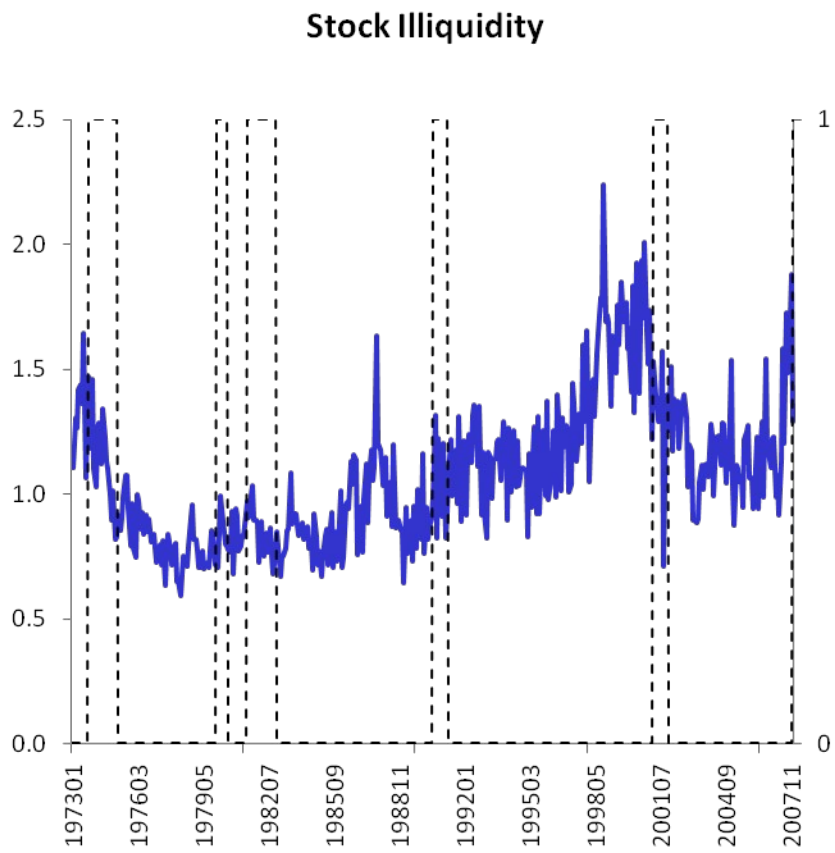
Measurement of liquidity risk

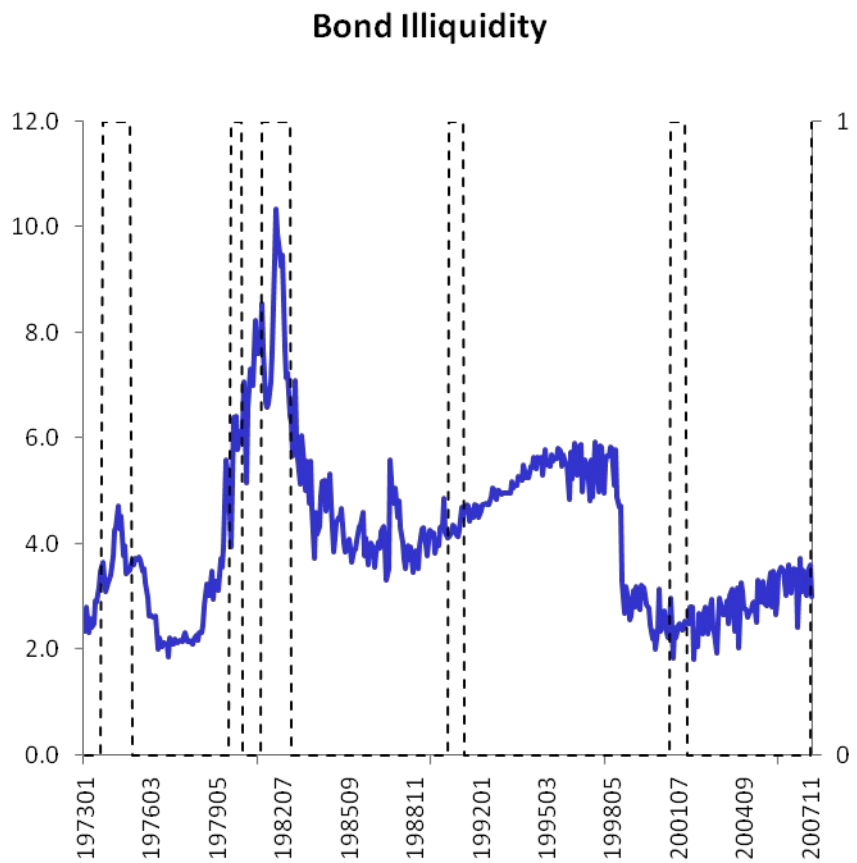
- ***Equity-market liquidity fluctuations***
  - ✓ *Illiqinnov:* AR(2) innovations in equally-weighted, monthly (average of daily) price-impact measure *ILLIQ* of Amihud (2002)
    - Acharya and Pedersen (2005), de Jong, Driessen (2005)

- ***Treasury-market liquidity fluctuations***
  - ✓ *Bondilliqinnov*: AR(2) innovations in the monthly quoted % bid-ask on off-the-run treasuries with short maturities
    - Longstaff, Mithal, Neis (2004), Goyenko (2005), de Jong, Driessen (2005)

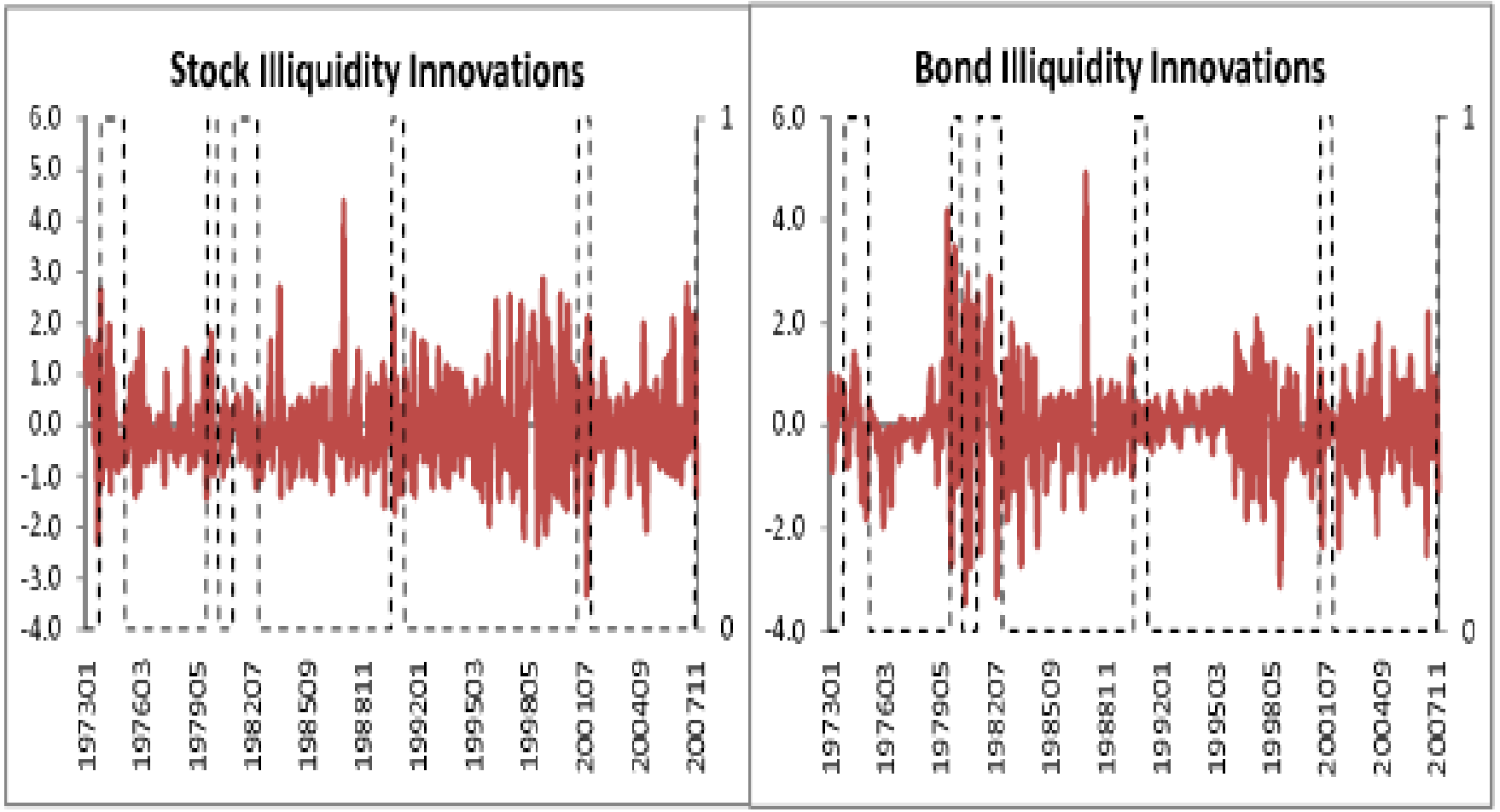
- ***Corporate bond-market factor***
  - ✓ Downing, Underwood and Xing (2005), Chacko (2005)
  - ✓ Limited data prevents significant time-series analysis

Stock and bond market illiquidity





Stock and Bond illiq innovations



Correlation amongst risk factors

	TERM	DEFAULT	ILLIQINNOV	BONDILLIQINNOV
TERM	1			
DEF	0.801	1		
ILLIQINNOV	-0.005	-0.079	1	
BONDILLIQINNOV	-0.055	-0.030	0.085	1

Summary of bond returns

Credit Rating	N	Mean	Std.Dev	Median	Min	Max
AAA	415	67.2	134.5	63.0	-535.4	736.8
AA	409	72.6	146.0	71.3	-414.7	772.3
A	415	72.1	152.5	73.8	-466.4	667.5
BBB	413	73.5	152.0	77.5	-500.2	745.7
BB	405	89.2	167.7	90.8	-670.1	850.0
B	405	99.4	221.7	108.7	-804.0	1069.7
CCC & Below	369	160.3	332.0	148.6	-905.0	1069.7
Not rated	289	87.9	169.8	81.4	-598.0	791.3
IGRADE	1652	71.4	146.3	71.4	-535.4	772.3
JUNK	1468	109.6	235.5	102.3	-905.0	1069.7

Unconditional liquidity risk

	Coefficients						t-Stat					
Rating	α	β_t	β_d	β_i	β_{bi}	Adj-Rsq	α	β_t	β_d	β_i	β_{bi}	N
AAA	27.22	-0.07	0.54	30.42	-1.85	0.83	9.17	-5.22	30.70	2.08	-0.29	415
AA	34.81	-0.01	0.50	3.85	-13.54	0.78	9.46	-0.56	23.00	0.21	-1.71	409
A	30.91	-0.03	0.56	3.39	-20.29	0.82	8.98	-1.76	27.21	0.20	-2.74	415
BBB	32.73	-0.08	0.57	-8.27	-32.43	0.72	7.63	-3.84	22.13	-0.39	-3.51	413
BB	58.62	-0.10	0.45	-135.17	-75.62	0.39	8.27	-2.81	10.60	-3.82	-4.99	405
B	72.78	-0.11	0.43	-219.35	-88.97	0.22	6.90	-2.26	6.76	-4.13	-3.92	405
CCC & below	143.18	-0.19	0.33	-291.96	-78.41	0.06	7.90	-2.21	3.14	-3.22	-2.06	369
Unrated	63.35	-0.03	0.32	-17.69	-46.08	0.23	5.06	-0.30	2.49	-0.33	-2.27	289

Economic magnitude *small*

- ***IG and Junk differences significant, except for Def***

	Ratio to $\sigma_{returns}$ of			
Rating	σ_t	σ_d	σ_i	σ_{bi}
AAA	17.81%	104.58%	4.29%	0.59%
AA	2.16%	96.76%	0.54%	4.33%
A	6.13%	107.41%	0.48%	6.49%
BBB	16.79%	109.00%	1.16%	10.38%
BB	18.21%	85.84%	19.04%	24.20%
B	16.56%	81.70%	30.90%	28.47%
CCC & below	17.98%	63.36%	41.13%	25.09%
Unrated	6.13%	62.09%	2.49%	14.74%

- ***IG:*** Effect of liquidity risk of the order of 10 bps in returns
- ***Junk:*** Of the order of 60 bps in returns

Time-varying betas

- ***Estimate a Markov regime-switching model***
  - ✓ ***Regime-shift absent in IG, but strong in Junk betas***

$$\text{Regime 1: } R_{Junk,t} = \alpha^1_{Junk} + \beta^1_{Junk,T} Term_t + \beta^1_{Junk,D} Def_t + \beta^1_{Junk,I} Illiqinnov_t + \beta^1_{Junk,BI} Bondilliqinnov_t + \epsilon^1_{Junk,t}$$

$$\text{Regime 2: } R_{Junk,t} = \alpha^2_{Junk} + \beta^2_{Junk,T} Term_t + \beta^2_{Junk,D} Def_t + \beta^2_{Junk,I} Illiqinnov_t + \beta^2_{Junk,BI} Bondilliqinnov_t + \epsilon^2_{Junk,t}$$

Markov switching probability for state transition:

$$P(s_t = 1 \mid s_{t-1} = 1) = p$$
$$P(s_t = 2 \mid s_{t-1} = 2) = q$$

Liquidity beta changes substantially

Regime 1						
	Investment Grade		Junk Grade		Parameters	
	Coeff	t-stat	Coeff	t-stat		
Constant	29.48	11.41	80.49	11.11	p	0.907
Term	-0.05	-2.03	-0.03	-0.52	q	0.896
Def	0.45	15.65	0.31	4.02	ρ_{s_1}	0.319
Illiqinnov	16.85	1.73	-68.19	-2.54	ρ_{s_2}	0.016
Bondilliqinnov	-10.96	-1.94	-30.04	-2.02		
σ_i	23.85		68.66			
Regime 2						
	Investment Grade		Junk Grade			
	Coeff	t-stat	Coeff	t-stat		
Constant	32.97	8.72	66.53	4.21		
Term	-0.05	-3.50	-0.12	-2.04		
Def	0.57	32.85	0.43	5.86		
Illiqinnov	9.78	0.55	-309.92	-4.72		
Bondilliqinnov	0.50	0.07	-86.47	-2.96		
σ_i	46.42		200.71			

But primarily for Junk bonds

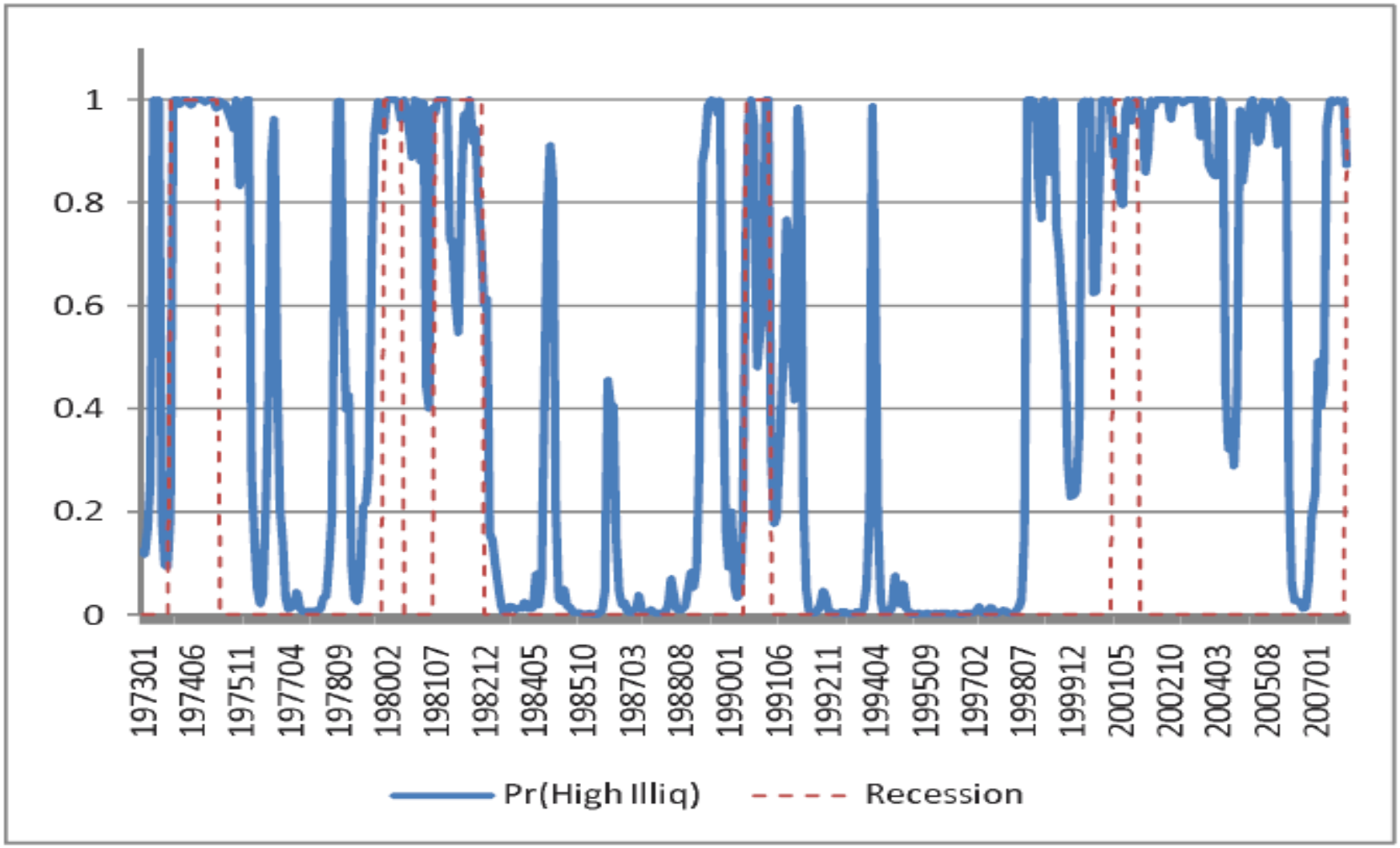
Wald tests for differences in coefficients between Regime 1 and Regime 2

	Investment Grade		Junk Grade	
	Chi-Sq	p-value	Chi-Sq	p-value
Term and Def	50.92	0.00	1.22	0.54
Term	0.01	0.94	0.95	0.33
Def	13.01	0.00	1.20	0.27
Liquidity (Stock and Bond)	1.34	0.51	15.32	0.00
Illiqinnov	0.11	0.74	11.61	0.00
Bondilliqinnov	1.26	0.26	2.97	0.08

Wald tests for differences in coefficients between IG and Junk

	Regime 1		Regime 2	
	Chi-Sq	p-value	Chi-Sq	p-value
Term and Def	36.72	0.00	15.34	0.00
Term	0.07	0.79	1.36	0.24
Def	4.26	0.04	3.92	0.05
Liquidity (Stock and Bond)	12.69	0.00	31.32	0.00
Illiqinnov	10.87	0.00	22.41	0.00
Bondilliqinnov	1.99	0.16	8.28	0.00
Log Likelihood	-4701.09			
Sample Period	1973:01 - 2007:12			

Regimes linked to recession



High liquidity risk ("stress") regime

- ***Striking characteristics:***
  - ✓ IG and Junk bond returns ***more variable***
  - ✓ Stock-market illiquidity shocks ***more skewed***
  - ✓ Treasury illiquidity ***more variable***
  - ✓ Stock and treasury illiquidity (somewhat) ***more correlated***
- ***Relationship to macroeconomic factors:***
  - ✓ Positively linked to
    - ***Recession:*** NBER, Stock and Watson, Hamilton
    - ***Decline in stock markets and corporate earnings***
    - ***Widening of commercial paper to Tbill spread***
- ***73% likelihood of switching out in a year***

Economic magnitude *large*

- ***Is higher volatility driving higher betas?***
  - ✓ Correlations with liquidity factors increase too
- ***Effect of liquidity risk magnifies three-four times***
  - ✓ Little shift in effect of *Term* and *Def*

Normal - Regime 1	Coeff	σ	$Coeff * \frac{\sigma_{factor}}{\sigma_{return}}$
IG Return		97.50	
IG * Term	-0.05	290.97	14%
IG * Default	0.45	238.15	110%
IG * Illiqinnov	16.85	0.18	3%
IG * Bondilliqinnov	-10.96	0.38	4%
Junk Return		95.85	
Junk * Term	-0.03	290.97	10%
Junk * Default	0.31	238.15	76%
Junk * Illiqinnov	-68.19	0.18	13%
Junk * Bondilliqinnov	-30.04	0.38	12%

15-20 bps

Stress - Regime 2	Coeff	σ	$Coeff * \frac{\sigma_{factor}}{\sigma_{return}}$
IG Return		160.58	
IG * Term	-0.05	356.28	11%
IG * Default	0.57	284.68	101%
IG * Illiqinnov	9.78	0.20	1%
IG * Bondilliqinnov	0.50	0.50	0.2%
Junk Return		251.98	
Junk * Term	-0.12	356.28	17%
Junk * Default	0.43	284.68	48%
Junk * Illiqinnov	-309.92	0.20	24%
Junk * Bondilliqinnov	-86.47	0.50	17%

50-60 bps

Robustness checks

- ***Controlling for changes in expected cash flows***
  - ✓ Default likelihood: MKMV's aggregate EDF
  - ✓ LGD: Altman et al's aggregate recovery fn (agg EDF)
  - ✓ *Little effect*
- ***Controlling for changes in (equity-mkt) volatility***
  - ✓ *Little effect*
- ***Schaefer-Strebulaev (2006) model***
  - ✓ Average firm-level equity return as *Def*
  - ✓ *Liquidity betas remain strong in stress regime*
  - ✓ *Term and Def betas even less significant than before*

Relationship to liquidity risk of stocks

- ***Acharya and Pedersen (2005)***
  - ✓ Illiquid stocks are also more liquidity risky
  - ✓ This paper: Junk bonds are more illiquid and liquidity risky than IG bonds (also de Jong, Driessen 2005)
  - ✓ *Additional:* Liquidity risk is time-varying and economically substantial primarily in stress periods

- ***Watanabe and Watanabe (2007)***
  - ✓ Stock betas on *ILLIQ* innovations also show regimes
  - ✓ Regimes correspond to high and low *ILLIQ*
  - ✓ This paper: Provides a similar result for junk bonds
  - ✓ Liquidity risk is priced more in cross-section in stress

Interpretation

- Beta = Cash flow beta + Expected return beta
- For corporate bonds, cash flow beta should be small (controlled)

- ***Higher liquidity beta in stress (high volatility) regime***

-> Higher beta of expected return on liquidity risks,
But not so for interest rate and default risks

- ***"Flight to quality/liquidity"***
  - ✓ Effect of market liquidity on (junk bond) risk premium

- ***How does this relate to the risk-premium being apparently common across equities and bonds?***
  - ✓ Chen, Collin-Dufresne, Goldstein (2005):
    - BBB-AAA: ***credit*** spread, AAA-Tsy: ***liquidity*** spread

Conclusion

- ***Much has been accomplished over the past few years***
  - ✓ Measuring corporate bond market liquidity
  - ✓ Quantifying the liquidity risk of corporate bonds
  - ✓ Relating liquidity and liquidity risk to spreads
- ***Our paper:***
  - ✓ Focused on ***time-varying liquidity risk*** of corporate bonds
  - ✓ Evidence for time-varying liquidity betas for junk bonds
  - ✓ Consistent with "flight to quality/liquidity" in volatile/stress periods
  - ✓ Conditional liquidity risk effects large, unconditional effects small
- ***Much remains to be done…***
  - ✓ Relating these effects to time-series of spread changes
  - ✓ Differentiating fully liquidity risk premium from the usual one
  - ✓ Identifying "stress" periods in corporate bond market liquidity

Corporate bond liquidity measures

One-way or round-trip cost (bid-ask spread)	Chen, Lesmond and Wei (2005), Goldstein, Hotchkiss and Sirri (2005)
Price impact based on Stulz (2001) approach, TRACE	Bessembinder, Maxwell and Venkataraman (2005), Edwards, Harris and Piwowar (2005), Goldstein, Hotchkiss and Sirri (2005)
Price impact based on daily data using Amihud (2002)	Downing, Underwood and Xing (2005)
Frequency of zero returns and its variants	Lesmond, Ogden and Trzcinka (1999), Chen, Lesmond and Wei (2005)
Accessibility: Turnover of portfolios holding the bond	Chacko (2005), Chacko, Mahanti, Mallik and Subrahmanyam (2005)