

Web Appendix

Notes on Bonds: Illiquidity Feedback During the Financial Crisis

This web appendix contains results for the manuscript, “Notes on Bonds: Illiquidity Feedback During the Financial Crisis,” in addition to those reported in the paper itself. The results are summarized as follows:

Table A1. This table reports estimation results for equation (2), applied only to the sub-sample of matched-maturity bond/note pairs, as a robustness check for the results in Table 3 in the paper.

Table A2. This table reports estimation results for equation (6), including interactions of fixed effects for cusip i , insurer j , and month t . These regression specifications expand on those in Table 5 in the paper.

Table A1. Fitting Errors and Treasury Security Liquidity for Maturity-Matched Bond/Note Pairs

Dependent Variable: Fitting Error _{it}										
Panel A: Characteristics that Differ by Security										
Bid-Ask _{it}	-3.99***								-4.29***	-4.12***
	(0.51)							(0.56)	(0.53)	
ShrStrip _{it}		39.72						41.02	136.07	
		(88.53)						(47.49)	(89.79)	
Volume _{it}			9.98					-16.60	-11.21	
			(13.62)					(14.78)	(11.24)	
ln(Age) _{it}				-29.72**				-4.29***	-39.14**	-37.03**
				(15.04)				(0.56)	(16.17)	(14.65)
ln(Out) _i					35.21***			41.02	-14.64	
					(7.34)			(47.49)	(22.47)	
Coupon _i						-11.48***		-16.60	-16.62**	
						(1.64)		(14.78)	(8.19)	
Pair _i							32.54***	-39.14**	-4.53	
							(3.51)	(16.17)	(3.84)	
Day Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
CUSIP Fixed Effects	YES	YES	YES	YES	NO	NO	NO	NO	NO	YES
R-Squared, % (total)	48.85	41.77	41.75	43.87	20.11	29.95	34.90	47.97	47.97	51.67***
R-Squared, % (within)	12.20	0.03	0.01	3.65	16.14	26.46	31.67	45.39	45.39	17.03
Observations	20,446	20,446	20,446	20,446	20,446	20,446	20,446	20,446	20,446	20,446
Dependent Variable: Fitting Error _{it}										
Panel B: Security Characteristics Interacted with Aggregate Liquidity										
AggLiq _{it} ×Bid-Ask _{it}	-1.42***								-0.67***	-0.64***
	(0.43)							(0.17)	(0.18)	
AggLiq _{it} ×ShrStrip _{it}		-157.97***						70.91***	25.59*	
		(28.88)						(21.00)	(13.14)	
AggLiq _{it} ×Volume _{it}			38.02**					-4.90	-0.47	
			(15.90)					(5.33)	(6.81)	
AggLiq _{it} ×ln(Age) _{it}				-16.95***				-0.67***	-29.03***	-18.66***
				(0.91)				(0.17)	(4.65)	(3.06)
AggLiq _{it} ×ln(Out) _i					2.55***			70.91***	-42.20**	-0.42
					(0.67)			(21.00)	(16.87)	(6.47)
AggLiq _{it} ×Coupon _i						-5.96***		-4.90	-7.12**	1.63
						(0.69)		(5.33)	(3.25)	(1.72)
AggLiq _{it} ×Pair _i							19.48***	-29.03***	-4.20***	1.52**
							(1.68)	(4.65)	(1.61)	(0.70)
Bid-Ask _{it}	6.96**							-9.34	8.90*	
	(2.99)							(6.95)	(4.76)	
ShrStrip _{it}		312.74***						7.79***	7.67***	
		(74.70)						(1.61)	(1.69)	
Volume _{it}			-120.49***					-147.39***	-84.65*	
			(44.72)					(39.65)	(48.33)	
ln(Age) _{it}				9.95*				-42.20**	10.28	-1.88
				(5.60)				(16.87)	(15.83)	(19.30)
ln(Out) _i								33.55***		
								(10.92)		
Coupon _i								79.43*		
								(41.59)		
Pair _i								5.08		
								(5.46)		
Day Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
CUSIP Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES
R-Squared, % (total)	51.45	55.47	41.93	73.01	43.25	61.25	67.70	76.79	76.79	78.38
R-Squared, % (within)	16.66	23.56	0.30	53.66	2.58	33.48	44.56	75.64	75.64	62.89
Observations	20,446	20,446	20,446	20,446	20,446	20,446	20,446	20,446	20,446	20,446

Table A1. This table presents a panel regression of fitting errors on security characteristics, for the same specifications as in Panels A and B of Table 3 in the manuscript, but applied only to the sub-sample of matched-pair data. The *Fitting Error*, the dependent variable, is defined as the difference between the actual price of the security and the fitted price based on a smoothed yield curve, measured in basis points of par value. *Volume* is trading volume of U.S. insurance companies; *Volume* for each security on each day is the ratio of the trading volume for that security relative to the sum of volume for all securities on that day. *Coupon* is measured in percentage points per year. *Pair* is a dummy equal to 1 for a note and -1 for a bond in cases where both the note and bond have the same maturity date, and 0 for all other securities. Panel A shows univariate and multivariate results for characteristics that differ by security. Panel B shows results for specifications that include interaction effects between security characteristics and *AggLiq_t*, which is a time series proxy for market-wide liquidity. The variable *AggLiq_t* is the average bid-ask spread over all securities in our sample on day *t*. Calendar day fixed effects are included in each regression, and security CUSIP fixed effects are included in the regressions as indicated. R-squared values show the total variation explained (total) and the within variation explained (within) by the fixed effects specification. Standard errors (in parentheses) account for clustering within security *i* and within day *t*; *** indicates significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table A2. Who Engages in the Arbitrage?

Dependent Variable: Net Purchases _{ijt}																					
Panel A: Insurer Characteristics Interacted with Fitting Error																					
Capital/Assets _{ijt} * FE _{it}	-0.11***																				
	(0.03)																				
RBC _{ijt} * FE _{it}		-1.88*																			
		(1.13)																			
Net Income _{ijt} * FE _{it}			1.30																		
			(1.25)																		
Annuity _{ijt} * FE _{it}				16.82**																	
				(7.47)																	
Churn _{ijt} * FE _{it}					0.94***																
					(0.20)																
Hold Horizon _{ijt} * FE _{it}						-5.52***															
						(1.10)															
FE _{it} (Fitting Error)	10.26***	6.04***	4.30***	4.02***	0.87	8.99***	6.64***	9.83***	5.64***	3.97***	-414.53*	-4.20	15.06	6.16***	8.36***	4.14***	2.66***	2.45***	-0.70	7.42***	4.93***
	(1.91)	(1.15)	(1.09)	(0.69)	(0.58)	(1.56)	(1.77)	(1.83)	(1.07)	(1.03)	(232.44)	(8.90)	(44.45)	(1.73)	(1.71)	(0.88)	(0.96)	(0.42)	(0.50)	(1.31)	(1.69)
CUSIP Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO
Insurer Fixed Effects	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES
Month Fixed Effects	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
R-Squared, % (total)	0.092	0.091	0.091	0.092	0.092	0.092	0.093	0.024	0.002	0.023	0.002	0.024	0.002	0.025	0.055	0.054	0.054	0.055	0.055	0.055	0.056
R-Squared, % (within)	0.002	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.002	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.002

Observations = 31,895,540

Dependent Variable: Net Purchases_{ijt}																					
Panel B: Insurer Characteristics Interacted with Single Interactions of Fixed Effects																					
Capital/Assets _{ijt} * FE _{it}	-0.18***						-0.09***	-0.13***						-0.09***	-0.11***						-0.08***
	(0.04)						(0.03)	(0.03)						(0.03)	(0.03)						(0.03)
RBC _{ijt} * FE _{it}		-3.74**					-0.46		-2.13*					0.71		-1.90*					0.78
		(1.53)					(1.73)		(1.23)					(1.56)		(1.14)					(1.47)
Net Income _{ijt} * FE _{it}			1.27				3.93**			1.16				3.05**			0.07				1.70
			(1.44)				(1.66)			(1.32)				(1.54)			(1.17)				(1.32)
Annuity _{ijt} * FE _{it}				36.36***			31.92***			19.49**				15.80*			16.80**				13.27*
				(11.63)			(11.74)			(8.14)				(8.29)			(7.47)				(7.60)
Churn _{ijt} * FE _{it}					1.61***		0.81***				1.06***			0.49**				0.93***			0.42**
					(0.29)		(0.27)				(0.22)			(0.20)				(0.20)			(0.18)
Hold Horizon _{ijt} * FE _{it}						-8.38***	-3.91***							-6.03***	-3.33***						-5.61***
						(1.58)	(1.41)							(1.18)	(1.04)						(1.10)
FE _{it} (Fitting Error)	13.22***	7.04***	4.38***	3.50***	-1.54**	11.55***	5.25**	10.76***	6.13***	4.32***	4.21***	0.67	9.69***	6.38***							
	(2.41)	(1.37)	(1.23)	(0.56)	(0.69)	(1.95)	(2.19)	(2.02)	(1.21)	(1.13)	(0.68)	(0.59)	(1.64)	(1.87)							
CUSIP×Insurer Fixed Effects	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Insurer×Month Fixed Effects	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO
CUSIP×Month Fixed Effects	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES
CUSIP Fixed Effects	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	YES	YES	YES	YES	YES	YES
Insurer Fixed Effects	N/A	N/A	N/A	N/A	N/A	N/A	N/A	YES	YES	YES	YES	YES	YES	YES	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Month Fixed Effects	YES	YES	YES	YES	YES	YES	YES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
R-Squared, % (total)	18.00	18.00	18.00	18.00	18.00	18.00	18.00	6.08	6.08	6.08	6.08	6.08	6.08	6.08	1.33	1.33	1.33	1.33	1.33	1.33	1.33
R-Squared, % (within)	0.002	0.001	0.001	0.003	0.002	0.002	0.004	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.001	0.000	0.000	0.001	0.001	0.001	0.002
Observations =	31,895,540																				

Dependent Variable: Net Purchases _{ijt}																					
Panel B: Insurer Characteristics Interacted with Single Interactions of Fixed Effects																					
Capital/Assets _{ijt} * FE _{it}	-0.18*** (0.04)																				
RBC _{ijt} * FE _{it}		-3.74** (1.53)																			
Net Income _{ijt} * FE _{it}			1.27 (1.44)																		
Annuity _{ijt} * FE _{it}			36.36*** (11.63)																		
Churn _{ijt} * FE _{it}				16.77*** (3.05)																	
Hold Horizon _{ijt} * FE _{it}					-8.38*** (1.58)																
FE _{it} (Fitting Error)	13.22*** (2.41)	7.04*** (1.37)	4.38*** (1.23)	3.50*** (0.56)	-2.07*** (0.74)	11.55*** (1.95)	3.70* (2.05)	10.76*** (2.02)	6.13*** (1.21)	4.32*** (1.13)	4.21*** (0.68)	0.30 (0.61)	9.69*** (1.64)	5.24*** (1.77)							
CUSIP×Insurer Fixed Effects	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Insurer×Month Fixed Effects	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO
CUSIP×Month Fixed Effects	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES
CUSIP Fixed Effects	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	YES	YES	YES	YES	YES	YES	YES
Insurer Fixed Effects	N/A	N/A	N/A	N/A	N/A	N/A	N/A	YES	YES	YES	YES	YES	YES	YES	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Month Fixed Effects	YES	YES	YES	YES	YES	YES	YES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
R-Squared, % (total)	18.00	18.00	18.00	18.00	18.00	18.00	18.00	6.08	6.08	6.08	6.08	6.08	6.08	6.08	1.33	1.33	1.33	1.33	1.33	1.33	1.33
R-Squared, % (within)	0.002	0.001	0.001	0.003	0.002	0.002	0.004	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.001	0.000	0.000	0.001	0.001	0.001	0.002
Observations = 31,895,540																					

Dependent Variable: Net Purchases _{ijt}																					
Panel C: Insurer Characteristics Interacted with Two Interactions of Fixed Effects																					
Capital/Assets _{ijt} * FE _{it}	-0.20*** (0.04)																				
RBC _{ijt} * FE _{it}		-4.19** (1.73)																			
Net Income _{ijt} * FE _{it}			1.01 (1.53)																		
Annuity _{ijt} * FE _{it}			42.31*** (13.51)																		
Churn _{ijt} * FE _{it}				1.83*** (0.34)																	
FE _{it} (Fitting Error)	14.19*** (2.66)	7.22*** (1.50)	4.50*** (1.30)	3.26*** (0.57)	-2.42*** (0.82)	12.13*** (2.10)	4.49* (2.38)														
CUSIP×Insurer Fixed Effects	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES
Insurer×Month Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO
CUSIP×Month Fixed Effects	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-Squared, % (total)	23.80	23.80	23.80	23.80	23.80	23.80	23.80	7.30	7.30	7.30	7.30	7.30	7.30	7.30	19.19	19.19	19.19	19.20	19.20	19.19	19.20
R-Squared, % (within)	0.002	0.001	0.001	0.003	0.002	0.002	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.000	0.000	0.000	0.002	0.001	0.000
Observations = 31,895,540																					

Dependent Variable: Net Purchases _{ijt}							
Panel D: Insurer Characteristics Interacted with Three Interactions of Fixed Effects							
Capital/Assets _{jt} * FE _{it}	-0.06***						-0.10***
	(0.01)						(0.03)
RBC _{jt} * FE _{it}		-2.59**					-0.36
		(1.03)					(1.92)
Net Income _{jt} * FE _{it}			-0.27				2.50*
			(0.62)				(1.52)
Annuity _j * FE _{it}				40.85***			36.66***
				(13.08)			(13.53)
Churn _j * FE _{it}					0.09***		0.99***
					(0.02)		(0.25)
Hold Horizon _j * FE _{it}						-4.13***	-3.76***
						(0.78)	(1.09)
CUSIP×Insurer Fixed Effects	YES	YES	YES	YES	YES	YES	YES
Insurer×Month Fixed Effects	YES	YES	YES	YES	YES	YES	YES
CUSIP×Month Fixed Effects	YES	YES	YES	YES	YES	YES	YES
R-Squared, % (total)	24.98	24.98	24.98	24.99	24.98	24.98	24.99
R-Squared, % (within)	0.000	0.000	0.000	0.002	0.001	0.000	0.004
Observations = 31,895,540							

Table A2: This table presents results from a pooled regression of an insurance company’s monthly average net purchases of Treasury security i for insurer j in month t on the fitting error for each security i at time t , interacted with various characteristics of the insurance company, similar to Table 5 in the manuscript. The fitting error is defined as the difference between the actual price of the security minus the fitted price based on a smoothed yield curve, measured in basis points of par value. Panel A shows fixed effects for security i , insurer j , and month t entering independently. Panel B shows single interactions of fixed effects for security i , insurer j , and month t , as indicated in the table. Those marked N/A are redundant because of the two-way fixed effects that are included. Panels C and D shows multiple interactions of fixed effects for security i , insurer j , and month t , as indicated in the table. Those marked N/A are redundant because of the two-way fixed effects that are included. Insurer characteristics that vary over time, not interacted with the fitting error, are also included in the regressions. R-squared values show the *total* and *within* variation explained by the fixed effects specification. The sample period is January 1, 2006 through September 30, 2011. Standard errors are clustered at the insurer level, and are shown in brackets beneath the coefficient estimates; *** indicates significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.