Internet Appendix for "Equity Trading Activity and Treasury Bond Risk Premia"

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This document includes supplementary material to the paper. Section 1 provides tables on the robustness of some of our empirical results. Section 2 provides tables for the sample without stock exclusions. Section 3 provides tables for the VVR constructed with average median weighting.

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Contents

1 Additional Figures and Tables

In this Appendix, we provide additional tables related to the robustness of some of our empirical results.

FIGURE IA.1
Volatility, Volume, and VVR Levels

The figure presents the monthly levels of absolute returns (volatility), trading volume (volume, in $ billions), and volatility-to-volume ratio (VVR) for the January 1964 to December 2018 sample period. All variables are averaged at the monthly level for each stock and then the market value weighted average across stocks is calculated.

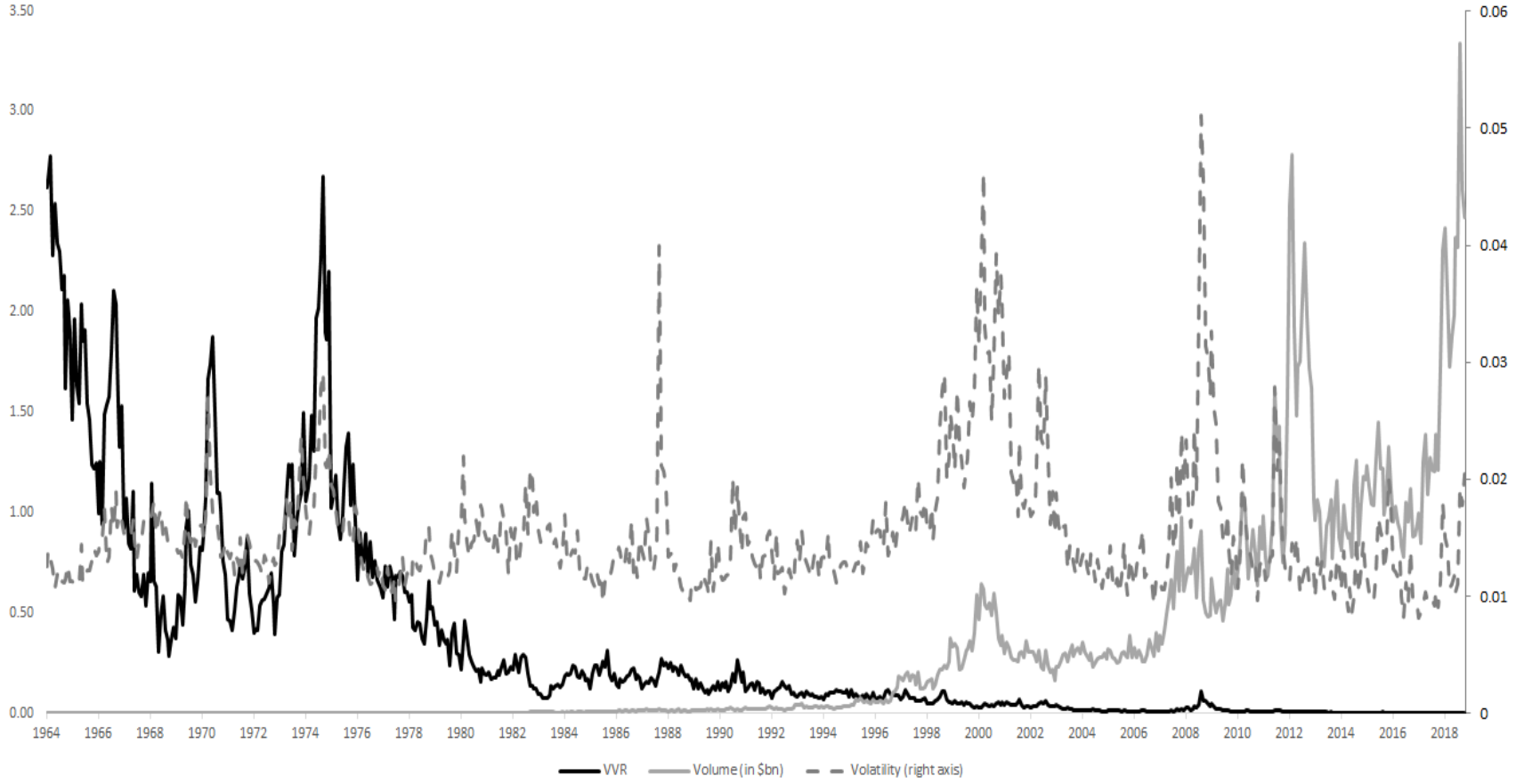

FIGURE IA.2
Stability of the VVR Coefficient

The figure presents the recursive, expanding window, estimate of the volatility-to-volume ratio coefficient in the in-sample forecasting regression in column (2) of Table 3. The dashed lines show the 95% confidence intervals.

TABLE IA.1
Factor Characteristics

The table presents preliminary statistics for the CP and LN factors. $\overline{rr}^{e}_{t+12}$ is the equally-weighted excess bond return one-year-ahead ($r^{e,(n)}_{t+12} = p^{(n-12)}_{t+12} - p^{(n)}_{t} - y^{(1)}_{t}$, as described in Section III), LNF_1 to LNF_9 are the Ludvigson and Ng factors, $f^{(1)}$-$f^{(5)}$ are the one- to five-year forward rates. Panel A presents a data summary for the level of the (equity) volatility-to-volume ratio (VVR$_l$, VVR MDW$_l$) as described in Section III.A, excess bond returns, and CP and LN variables. Panel B presents correlations for the yearly change in the log volatility-to-volume ratio *VVR* and *VVR MDW* (the regression independent variables), excess bond returns, and CP and LN variables. VVR MDW is the equally weighted average of the market value weighting of firms split into large and small stocks by median market capitalization. The sample period is January 1964 to December 2018.

Panel A. Sample Characteristics

	$\overline{rr}^{e}_{t+12}$	LNF_1	LNF_2	LNF_3	LNF_4	LNF_5	LNF_6	LNF_7	LNF_8	LNF_9	$f^{(1)}$	$f^{(2)}$	$f^{(3)}$	$f^{(4)}$	$f^{(5)}$	VVR$_l$	VVR MDW$_l$
Mean	0.009	0.002	-0.007	-0.002	0.001	-0.003	0.003	-0.004	-0.005	0.081	0.052	0.056	0.060	0.063	0.064	0.352	2.183
Median	0.007	-0.040	0.007	0.002	0.010	0.011	-0.023	-0.010	-0.004	0.000	0.054	0.057	0.060	0.061	0.062	0.120	1.198
Maximum	0.114	1.885	1.191	1.353	1.048	0.671	1.000	1.279	0.628	6.695	0.158	0.158	0.154	0.167	0.148	2.781	16.281
Minimum	-0.111	-0.970	-1.396	-1.297	-1.056	-0.898	-0.657	-0.510	-0.472	-0.914	0.001	0.003	0.004	0.008	0.012	0.002	0.034
Std. Dev.	0.036	0.402	0.271	0.265	0.240	0.209	0.196	0.173	0.156	0.588	0.033	0.033	0.031	0.029	0.028	0.526	2.769

Panel B. Correlations

LNF_1	0.27															
LNF_2	0.24	0.02														
LNF_3	0.10	0.01	0.00													
LNF_4	-0.08	0.00	0.01	0.00												
LNF_5	0.05	-0.03	0.00	0.00	-0.01											
LNF_6	0.00	0.01	-0.01	-0.02	-0.01	0.00										
LNF_7	0.15	-0.01	-0.01	0.00	0.01	0.00	-0.01									
LNF_8	0.00	0.00	0.02	-0.01	-0.02	-0.01	0.02	0.01								
LNF_9	0.01	0.70	-0.06	0.04	0.05	0.00	-0.04	0.02	0.03							
$f^{(1)}$	0.02	-0.09	-0.51	-0.28	0.07	0.09	0.37	-0.03	0.08	-0.02						
$f^{(2)}$	0.11	-0.08	-0.41	-0.22	0.12	0.14	0.36	0.00	0.07	-0.01	0.98					
$f^{(3)}$	0.16	-0.05	-0.36	-0.20	0.16	0.17	0.35	0.02	0.07	0.00	0.95	0.99				
$f^{(4)}$	0.19	-0.04	-0.33	-0.18	0.14	0.15	0.34	0.02	0.04	-0.02	0.93	0.98	0.99			
$f^{(5)}$	0.16	-0.02	-0.29	-0.16	0.13	0.15	0.35	0.02	0.04	0.03	0.91	0.96	0.97	0.97		
VVR	0.23	0.20	-0.25	-0.21	-0.08	-0.06	-0.10	0.21	0.01	0.16	0.14	0.13	0.12	0.12	0.10	
VVR MDW	0.24	0.19	-0.23	-0.20	-0.02	-0.06	-0.08	0.17	0.02	0.12	0.15	0.13	0.13	0.12	0.10	0.94

TABLE IA.2
Bond Premia and CP/LN Factors

The table presents the monthly in-sample forecasting regression results for excess bond returns: $\overline{rx}_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \bar{\varepsilon}_{t+12}$. $\overline{rx}$ is the equally-weighted yearly excess bond return, LNF_1-LNF_9 are the Ludvigson and Ng factors, $f^{(1)}$-$f^{(5)}$ are the one- to five-year forward rates. *CP* is the Cochrane-Piazzesi factor, a linear combination of the forward rates, *LN* is the linear combination of the Ludvigson and Ng factors. The sample period is January 1964 to December 2018. *p-val* is the *p*-value calculated using the Newey-West correction for heteroscedasticity and autocorrelation with 18 lags. The *p*-values based on the parametric VAR block-bootstrap analysis, as described in Appendix B, are presented in round brackets. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Coef.	*p*-val.	Coef.	*p*-val.
Constant	-0.015**	0.03	-0.005**	0.05
LNF_1	0.041***	<0.001		
LNF_2	0.027***	<0.001		
LNF_3	0.012***	0.01		
LNF_4	-0.035***	<0.001		
LNF_5	-0.014**	0.02		
LNF_6	-0.014*	0.07		
LNF_7	0.021***	<0.001		
LNF_8	-0.006	0.14		
LNF_9	-0.017***	<0.001		
$f^{(1)}$	-1.335***	<0.001		
$f^{(2)}$	0.344	0.14		
$f^{(3)}$	1.990***	<0.001		
$f^{(4)}$	0.655**	0.04		
$f^{(5)}$	-1.327***	<0.001		
CP			0.753***	<0.001
				(0.00)
LN			0.745***	<0.001
				(0.00)
R^2	0.42		0.35	
Adj. R^2	0.40		0.34	

TABLE IA.3
VVR and Bond Premia Within Subsamples

The table presents monthly forecasting regressions for excess bond returns: $\overline{r^e}_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \overline{\varepsilon}_{t+12}$ for four subsamples. $\overline{r^e}$ is the equally-weighted yearly excess bond return, and VVR is the yearly change in log volatility-to-volume ratio as described in Section III.A. The VVR coefficient is presented in % points. Column (1) presents the full sample results in Table 5, column (2) covers the great moderation period 1964 to 2008, column (3) covers the period of high inflation and high interest rates 1964 to 1984, column (4) covers the post-Volcker period 1985 to 2018, and column (5) covers the period during and post the great recession 2009 to 2018. The p-value calculated using the Newey-West correction for heteroscedasticity and autocorrelation with 18 lags is presented in square brackets. The p-values based on the parametric VAR block-bootstrap analysis, as described in Appendix B, are presented in round brackets. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
	1964-2018	1964-2008	1964-1984	1985-2018	2009-2018
VVR	1.695***	2.107***	1.750***	0.915***	0.669***
	[<0.001]	[<0.001]	[<0.001]	[0.01]	[<0.001]
	(<0.001)	(<0.001)	(<0.001)	(0.06)	(<0.001)
CP	0.757***	0.665***	0.655***	0.927***	0.870***
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
LN	0.735***	0.715***	0.712***	0.813***	0.408***
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[0.01]
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
R^2	0.40	0.45	0.51	0.32	0.81
Adj. R^2	0.40	0.45	0.50	0.32	0.80

TABLE IA.4
Stock Market Liquidity, VVR Volatility, and Bond Premia

The table presents the monthly in-sample forecasting regression for excess bond returns $\overline{rx}_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \varepsilon_{t+12}$ controlling for stock market liquidity. $\overline{rx}$ is the equally-weighted yearly excess bond return, VVR is the yearly change in log volatility-to-volume ratio as described in Section III.A, Spread is the value weight spread of the market, and volatility is the yearly standard deviation in VVR. The VVR and Spread coefficients are presented in % points. The sample period is January 1964 to December 2018. The p-value calculated using the Newey-West correction for heteroskedasticity and autocorrelation with 18 lags is presented in square brackets. The p-values based on the parametric VAR block-bootstrap analysis, as described in Appendix B, are presented in round brackets. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
Constant	-0.002	-0.002
	[0.13]	[0.16]
CP	0.755***	0.759***
	[<0.001]	[<0.001]
	(<0.001)	(<0.001)
LN	0.736***	0.732***
	[<0.001]	[<0.001]
	(<0.001)	(<0.001)
VVR	1.720***	1.697***
	[<0.001]	[<0.001]
	(0.01)	(<0.001)
Spread	-0.037**	
	[0.05]	
	(0.81)	
Volatility		-0.009
		[0.21]
		(0.54)
R^2	0.40	0.40
Adj. R^2	0.40	0.39

TABLE IA.5
Other Robustness

We adopt various controls that could potentially account for the relation between VVR and bond returns. Panel A shows in-sample forecasting regressions for excess bond returns, using VVR and NBER recession years. *NBER Rec* is a dummy variable for NBER recession months as provided by the FRED database of St. Louis Federal Reserve. Panel B shows in-sample forecasting regressions for excess bond returns VVR and the investor sentiment index of Baker and Wurgler (2006). *Sent.* and *Sent*2 are the investor sentiment measures as provided by Jeff Wurgler for 1965-2018. *CP* is the Cochrane Piazzesi factor, *LN* is the linear combination of the Ludvigson and Ng factors, VVR is the yearly change in log volatility-to-volume ratio as described in Section III.A. The VVR coefficient is presented in % points. *p-val* is the p-value calculated using the Newey-West correction for heteroscedasticity and autocorrelation with 18 lags. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A. NBER Recession

	Coef.	p-val.	Coef.	p-val.	Coef.	p-val.	Coef.	p-val.
Constant	0.008**	0.04	-0.004*	0.06	-0.002	0.12	-0.003	0.11
CP			0.774***	< 0.001	0.742***	< 0.001	0.752***	< 0.001
LN			0.757***	< 0.001	0.726***	< 0.001	0.741***	< 0.001
VVR					1.774***	< 0.001	1.776***	< 0.001
NBER Rec	0.013**	0.03	-0.005	0.13	0.004	0.25	-0.003	0.17
VVR* NBER							1.193***	0.01
R^2	0.01		0.35		0.40		0.41	
Adj. R^2	0.01		0.35		0.40		0.40	

Panel B. Sentiment

	Coef.	p-val.	Coef.	p-val.	Coef.	p-val.	Coef.	p-val.
Constant	-0.002	0.12	-0.003	0.10	-0.002	0.12	-0.003*	0.09
CP	0.731***	< 0.001	0.711***	< 0.001	0.697***	< 0.001	0.686***	< 0.001
LN	0.702***	< 0.001	0.699***	< 0.001	0.723***	< 0.001	0.713***	< 0.001
VVR	1.430***	< 0.001	1.462***	< 0.001	1.394***	< 0.001	1.426***	< 0.001
Sentiment	0.006***	0.01	0.005***	0.01				
VVR*Sent			0.774***	0.01				
Sentiment2					0.006***	0.01	0.005**	0.02
VVR*Sent2							0.891***	0.01
R^2	0.42		0.43		0.42		0.43	
Adj. R^2	0.41		0.43		0.41		0.43	

2 Sample Without Exclusion of Stocks

This section presents results for a larger sample of stocks. In this sample, we do not exclude stocks that change exchange, ticker, and CUSIP to construct VVR. Thus, this sample includes the complete CRSP common stock universe with price over $1 and with 15 or more trading days in a month.

TABLE IA.6
Volatility-to-Volume Ratio and Bond Premia

The table presents the monthly in-sample forecasting regression for excess bond returns: ${r^e}_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \varepsilon_{t+12}$. r^e is yearly excess bond return, and VVR is the yearly change in log volatility-to-volume ratio as described in Section III.A. Average is the equally-weighted yearly excess bond return and 2- to 5-year are individual maturities yearly excess bond return. *VVR AVG*, *VVR VW*, and *VVR MDW* are the equally weighted, market capitalization value weighted, and equally weighted average of the market value weighting of firms split by median market capitalization of individual stocks' *VVR*, respectively. The VVR coefficient is presented in % points. The sample period is January 1964 to December 2018. The p-value calculated using the Newey-West correction for heteroskedasticity and autocorrelation with 18 lags is presented in square brackets. The p-values based on the parametric VAR block-bootstrap analysis, as described in Appendix B, are presented in round brackets. ***, **, * denote significance at the 1%, 5%, and 10% levels using the Newey-West p-values, respectively.

	Average	2-year	3-year	4-year	5-year
Constant	0.010***	0.005***	0.009***	0.012***	0.014***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
VVR AVG	1.333***	0.743***	1.265***	1.568***	1.756**
	[0.01]	[<0.001]	[0.01]	[0.01]	[0.02]
Bootstrap p-value	(0.02)	(0.01)	(0.01)	(0.03)	(0.03)
R^2	0.04	0.05	0.05	0.04	0.03
Adj. R^2	0.04	0.05	0.04	0.04	0.03

	Average	2-year	3-year	4-year	5-year
Constant	0.010***	0.005***	0.009***	0.013***	0.014***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
VVR VW	1.108**	0.636***	1.054**	1.305**	1.436**
	[0.03]	[0.01]	[0.02]	[0.03]	[0.05]
Bootstrap p-value	(0.04)	(0.02)	(0.03)	(0.04)	(0.06)
R^2	0.02	0.03	0.03	0.02	0.02
Adj. R^2	0.02	0.03	0.03	0.02	0.02

	Average	2-year	3-year	4-year	5-year
Constant	0.010***	0.005***	0.009***	0.013***	0.014***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
VVR MDW	1.256**	0.701***	1.185***	1.487**	1.652**
	[0.02]	[0.01]	[0.01]	[0.02]	[0.03]
Bootstrap p-value	(0.02)	(0.01)	(0.02)	(0.03)	(0.04)
R^2	0.04	0.05	0.04	0.04	0.03
Adj. R^2	0.04	0.05	0.04	0.03	0.03

TABLE IA.7
Volatility-to-Volume Ratio and Spanning Hypothesis Tests

The table presents the monthly in-sample forecasting regression for excess bond returns, VVR, and yields: $r^e_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \varepsilon_{t+12}$. Returns are from Le and Singleton (2013). r^e are yearly excess bond returns: average (equally weighted) and individual maturities (2- to 5-years), $PC1$-$PC5$ are the five principal components of the term structure, and VVR is the yearly change in log volatility-to-volume ratio as described in Section III.A. *VVR AVG*, *VVR VW*, and *VVR MDW* are the equally weighted, market capitalization value weighted, and equally weighted average of the market value weighting of firms split by median market capitalization of individual stocks' *VVR*, respectively. All coefficients are presented in % points. The sample period is January 1964 to December 2017. *p-val* is the p-value calculated using the Newey-West correction for heteroskedasticity and autocorrelation with 18 lags. The p-values based on the bias-corrected bootstrap analysis (Bauer and Hamilton, 2017) are presented in round brackets. Adj. R^2 is the adjusted R^2 of the relevant regression and ΔR^2 represents the increase from a model with only principal components. ***, **, * denote significance at the 1%, 5%, and 10% levels using the Newey-West p-values, respectively.

	Average				2-year		3-year		4-year		5-year	
	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val
PC1	0.003	0.92	0.006	0.83	0.028***	<0.001	0.031**	0.03	0.023	0.22	0.016	0.50
PC2	2.036***	<0.001	2.031***	<0.001	0.424***	<0.001	0.803***	<0.001	1.257***	<0.001	1.680***	<0.001
PC3	0.008	0.98	0.010	0.98	0.026	0.86	-0.078	0.76	-0.122	0.72	-0.173	0.68
PC4			-1.096	0.30	-1.115***	<0.001	-1.647	<0.001	-2.065***	0.01	-2.172**	0.02
PC5			9.359***	<0.001	1.921***	<0.001	4.488***	<0.001	7.176***	<0.001	8.035***	<0.001
VVR AVG	2.243***	<0.001	2.159***	<0.001	0.772***	<0.001	1.282***	<0.001	1.640***	<0.001	1.893***	<0.001
BC bootstrap p-value		(0.04)		(0.05)		(0.01)		(0.02)		(0.03)		(0.04)
R^2	0.23		0.26		0.19		0.22		0.25		0.25	
ΔR^2	0.03		0.03		0.01		0.04		0.04		0.03	

	Average				2-year		3-year		4-year		5-year	
	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val
PC1	0.000	0.99	0.004	0.87	0.027***	<0.001	0.030**	0.03	0.022	0.24	0.015	0.54
PC2	2.017***	<0.001	2.011***	<0.001	0.417***	<0.001	0.791***	<0.001	1.241***	<0.001	1.660***	<0.001
PC3	-0.030	0.95	-0.031	0.95	0.012	0.93	-0.103	0.68	-0.156	0.64	-0.214	0.61
PC4			-1.330	0.21	-1.222***	<0.001	-1.813***	<0.001	-2.262***	<0.001	-2.387***	0.01
PC5			9.227***	<0.001	1.844***	<0.001	4.381***	<0.001	7.064***	<0.001	7.927***	<0.001
VVR VW	2.194***	<0.001	1.815***	<0.001	0.747***	<0.001	1.215***	<0.001	1.519***	<0.001	1.726***	<0.001
BC bootstrap p-value		(0.08)		(0.14)		(0.02)		(0.04)		(0.08)		(0.12)
R^2	0.22		0.25		0.21		0.21		0.23		0.24	
ΔR^2	0.03		0.02		0.04		0.03		0.02		0.02	

	Average				2-year		3-year		4-year		5-year	
	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val
PC1	-0.002	0.95	0.002	0.95	0.026***	<0.001	0.029**	0.04	0.020	0.28	0.013	0.60
PC2	2.023***	<0.001	2.019***	<0.001	0.419***	<0.001	0.794***	<0.001	1.246***	<0.001	1.667***	<0.001
PC3	0.044	0.93	0.039	0.93	0.035	0.81	-0.063	0.80	-0.103	0.76	-0.150	0.72
PC4			-1.258	0.23	-1.169***	<0.001	-1.737***	<0.001	-2.182***	<0.001	-2.305***	0.01
PC5			9.208***	<0.001	1.880***	<0.001	4.42***	<0.001	7.085***	<0.001	7.933***	<0.001
VVR MDW	2.144***	<0.001	1.861***	<0.001	0.708***	<0.001	1.176***	<0.001	1.509***	<0.001	1.737***	<0.001
BC bootstrap p-value		(0.05)		(0.07)		(0.01)		(0.03)		(0.04)		(0.05)
R^2	0.23		0.26		0.22		0.22		0.24		0.25	
ΔR^2	0.03		0.02		0.05		0.04		0.03		0.03	

TABLE IA.8
Volatility-to-Volume Ratio, Bond Premia, CP, and LN Factors

The table presents monthly in-sample forecasting regression results of bond premia, VVR, and the Cochrane-Piazessi and Ludvigson and Ng factors. We estimate the regression $r^e_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \varepsilon_{t+12}$, where r^e is the excess bond risk return: average (equally weighted) and individual maturities (2- to 5-years). CP denotes the Cochrane-Piazzesi factor. LN is the linear combination of the nine macro factors of Ludvigson and Ng. VVR is the yearly change in log volatility-to-volume ratio as described in Section III.A. *VVR AVG*, *VVR VW*, and *VVR MDW* are the equally weighted, market capitalization value weighted, and equally weighted average of the market value weighting of firms split by median market capitalization of individual stocks' VVR, respectively. The VVR coefficient is presented in % points. The sample period is January 1964 to December 2018. The p-values calculated using the Newey-West correction for autocorrelation and heteroskedasticity with 18 lags are presented in square brackets. The p-values based on the parametric VAR block-bootstrap analysis, as described in the Appendix B, are presented in round brackets. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Average		2-year		3-year		4-year		5-year	
Constant	-0.005**	-0.004*	-0.002*	-0.001	-0.003*	-0.003	-0.005**	-0.004*	-0.008**	-0.007**
	[0.05]	[0.07]	[0.09]	[0.13]	[0.07]	[0.10]	[0.05]	[0.07]	[0.03]	[0.04]
CP	0.753***	0.736***	0.321***	0.333***	0.621***	0.642***	0.955***	0.982***	1.116***	1.145***
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
LN	0.745***	0.710***	0.340***	0.321***	0.645***	0.611***	0.886***	0.845***	1.108***	1.062***
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
VVR AVG		1.242***		0.700***		1.184***		1.465***		1.618***
		[<0.001]		[<0.001]		[<0.001]		[<0.001]		[<0.001]
		(<0.001)		(<0.001)		(<0.001)		(0.01)		(0.01)
R^2	0.35	0.38	0.30	0.35	0.33	0.37	0.36	0.39	0.34	0.37
Adj. R^2	0.34	0.38	0.30	0.35	0.33	0.37	0.36	0.39	0.34	0.37

	Average		2-year		3-year		4-year		5-year	
Constant	-0.005**	-0.004*	-0.002*	-0.001	-0.003*	-0.002	-0.005**	-0.004*	-0.008**	-0.007**
	[0.05]	[0.08]	[0.09]	[0.14]	[0.07]	[0.11]	[0.05]	[0.07]	[0.03]	[0.05]
CP	0.753***	0.772***	0.321***	0.331***	0.621***	0.639***	0.955***	0.977***	1.116***	1.140***
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
LN	0.745***	0.726***	0.340***	0.330***	0.645***	0.627***	0.886***	0.864***	1.108***	1.083***
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
VVR VW		1.121***		0.639***		1.061***		1.330***		1.454**
		[<0.001]		[<0.001]		[0.01]		[0.01]		[0.02]
		(0.01)		(<0.001)		(0.01)		(0.01)		(0.02)
R^2	0.35	0.37	0.30	0.34	0.33	0.36	0.36	0.38	0.34	0.36
Adj. R^2	0.34	0.37	0.30	0.33	0.33	0.36	0.36	0.38	0.34	0.36

	Average		2-year		3-year		4-year		5-year	
Constant	-0.005**	-0.004*	-0.002*	-0.001	-0.003*	-0.002	-0.005**	-0.004*	-0.008**	-0.007**
	[0.05]	[0.07]	[0.09]	[0.14]	[0.07]	[0.10]	[0.05]	[0.07]	[0.03]	[0.04]
CP	0.753***	0.764***	0.321***	0.327***	0.621***	0.642***	0.955***	0.967***	1.116***	1.129***
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
LN	0.745***	0.724***	0.340***	0.329***	0.645***	0.611***	0.886***	0.861***	1.108***	1.080***
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
VVR MDW		1.177***		0.664***		1.116***		1.394***		1.533***
		[<0.001]		[<0.001]		[<0.001]		[<0.001]		[0.01]
		(0.01)		(<0.001)		(<0.001)		(0.01)		(0.01)
R^2	0.35	0.38	0.30	0.35	0.33	0.37	0.36	0.39	0.34	0.37
Adj. R^2	0.34	0.38	0.30	0.35	0.33	0.37	0.36	0.39	0.34	0.37

3 VVR using Average Median Weighting

This section presents results for a different construction of VVR. We separate stocks into two groups, large and small stocks, according to the median market capitalization. We value weight each individual stock's VVR within its group. We then equally-weight the VVR of the two groups to create VVR MDW.

TABLE IA.9
Data Characteristics

The table presents preliminary statistics for *VVR* and excess bond returns. $\overline{r^e}_{t+12}$ is the equally-weighted excess bond return one-year-ahead ($r^{e,(n)}_{t+12} = p^{(n-12)}_{t+12} - p^{(n)}_t - y^{(1)}_t$) and $r^{e,(2)}_{t+12} - r^{e,(5)}_{t+12}$ are the 2- to 5-year maturity excess bond returns, as described in Section III. Panel A presents a data summary for the level of the (equity) volatility-to-volume ratio (VVR MDW$_l$) as described in Section III.A and excess bond returns. Panel B presents correlations for the yearly change in log volatility-to-volume ratio *VVR MDW* (the regression independent variable) and excess bond returns. The sample period is January 1964 to December 2018.

Panel A. Sample Characteristics

	VVR MDW$_l$	$\overline{r^e}_{t+12}$	$r^{e,(2)}_{t+12}$	$r^{e,(3)}_{t+12}$	$r^{e,(4)}_{t+12}$	$r^{e,(5)}_{t+12}$
Mean	2.183	0.009	0.005	0.008	0.011	0.013
Median	1.198	0.007	0.003	0.006	0.009	0.010
Maximum	16.281	0.114	0.059	0.102	0.144	0.169
Minimum	0.034	-0.111	-0.056	-0.104	-0.135	-0.175
Std. Dev.	2.769	0.036	0.017	0.031	0.044	0.054

Panel B. Correlations

	VVR MDW	$\overline{r^e}_{t+12}$	$r^{e,(2)}_{t+12}$	$r^{e,(3)}_{t+12}$	$r^{e,(4)}_{t+12}$	$r^{e,(5)}_{t+12}$
$\overline{r^e}_{t+12}$	0.245					
$r^{e,(2)}_{t+12}$	0.272	0.968				
$r^{e,(3)}_{t+12}$	0.257	0.993	0.981			
$r^{e,(4)}_{t+12}$	0.241	0.998	0.959	0.989		
$r^{e,(5)}_{t+12}$	0.227	0.993	0.935	0.975	0.992	

TABLE IA.10
Volatility-to-Volume Ratio and Bond Premia

The table presents the monthly in-sample forecasting regression for excess bond returns: ${r^e}_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \varepsilon_{t+12}$. r^e is yearly excess bond return, and *VVR MDW* is the yearly change in log volatility-to-volume ratio constructed as the equally weighted average of the market value weighting of firms split by median market capitalization of individual stocks' *VVR*. Average is the equally-weighted yearly excess bond return and 2- to 5-year are individual maturities yearly excess bond return. The VVR coefficient is presented in % points. The sample period is January 1964 to December 2018. The p-value calculated using the Newey-West correction for heteroskedasticity and autocorrelation with 18 lags is presented in square brackets. The p-values based on the parametric VAR block-bootstrap analysis, as described in Appendix B, are presented in round brackets. ***, **, * denote significance at the 1%, 5%, and 10% levels using the Newey-West p-values, respectively.

	Average	2-year	3-year	4-year	5-year
Constant	0.011***	0.005***	0.010***	0.013***	0.015***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
VVR MDW	1.583***	0.828***	1.439***	1.877***	2.190***
	[<0.001]	[<0.001]	[<0.001]	[0.01]	[0.01]
Bootstrap p-value	(<0.001)	(<0.001)	(<0.001)	(0.01)	(0.01)
R^2	0.06	0.07	0.07	0.06	0.05
Adj. R^2	0.06	0.07	0.06	0.06	0.05

TABLE IA.11
Volatility-to-Volume Ratio and Spanning Hypothesis Tests

The table presents the monthly in-sample forecasting regression for excess bond returns, VVR, and yields: $r^e_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \varepsilon_{t+12}$. Returns are from Le and Singleton (2013). r^e are yearly excess bond returns: average (equally weighted) and individual maturities (2- to 5-years), $PC1$-$PC5$ are the five principal components of the term structure, and *VVR MDW* is the yearly change in log volatility-to-volume ratio constructed as the equally weighted average of the market value weighting of firms split by median market capitalization of individual stocks' *VVR*. All coefficients are presented in % points. The sample period is January 1964 to December 2017. *p-val* is the p-value calculated using the Newey-West correction for heteroskedasticity and autocorrelation with 18 lags. The p-values based on the bias-corrected bootstrap analysis (Bauer and Hamilton, 2017) are presented in round brackets. Adj. R^2 is the adjusted R^2 of the relevant regression and ΔR^2 represents the increase from a model with only principal components. ***, **, * denote significance at the 1%, 5%, and 10% levels using the Newey-West p-values, respectively.

	Average				2-year		3-year		4-year		5-year	
	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val	Coef.	p-val
PC1	-0.006	0.83	-0.003	0.91	0.025***	<0.001	0.027**	0.05	0.017	0.35	0.009	0.72
PC2	2.034***	<0.001	2.030***	<0.001	0.421***	<0.001	0.797***	<0.001	1.252***	<0.001	1.676***	<0.001
PC3	0.116	0.81	0.102	0.82	0.050	0.72	-0.036	0.89	-0.060	0.86	-0.095	0.82
PC4			-1.381	0.19	-1.176***	<0.001	-1.763***	<0.001	-2.239***	<0.001	-2.405***	0.01
PC5			8.584***	<0.001	1.736***	<0.001	4.149***	<0.001	6.681***	<0.001	7.386***	<0.001
VVR MDW	2.741***	<0.001	2.466***	<0.001	0.825***	<0.001	1.409***	<0.001	1.878***	<0.001	2.258***	<0.001
BC bootstrap p-value		(0.01)		(0.02)		(0.01)		(0.01)		(0.01)		(0.02)
R^2	0.25		0.28		0.24		0.24		0.26		0.27	
ΔR^2	0.06		0.05		0.07		0.06		0.05		0.05	

TABLE IA.12
Volatility-to-Volume Ratio, Bond Premia, CP, and LN Factors

The table presents monthly in-sample forecasting regression results of bond premia, VVR, and the Cochrane-Piazessi and Ludvigson and Ng factors. We estimate the regression $r^e_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \varepsilon_{t+12}$, where r^e is the excess bond risk return: average (equally weighted) and individual maturities (2- to 5-years). CP denotes the Cochrane-Piazzesi factor. LN is the linear combination of the nine macro factors of Ludvigson and Ng. $VVR\ MDW$ is the yearly change in log volatility-to-volume ratio constructed as the equally weighted average of the market value weighting of firms split by median market capitalization of individual stocks' VVR. The VVR coefficient is presented in % points. The sample period is January 1964 to December 2018. The p-values calculated using the Newey-West correction for autocorrelation and heteroskedasticity with 18 lags are presented in square brackets. The p-values based on the parametric VAR block-bootstrap analysis, as described in the Appendix B, are presented in round brackets. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Average		2-year		3-year		4-year		5-year	
Constant	-0.005**	-0.003*	-0.002*	-0.001	-0.003*	-0.002	-0.005**	-0.003*	-0.008**	-0.006*
	[0.05]	[0.09]	[0.09]	[0.17]	[0.07]	[0.13]	[0.05]	[0.09]	[0.03]	[0.06]
CP	0.753***	0.756***	0.321***	0.322***	0.621***	0.623***	0.955***	0.958***	1.116***	1.119***
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
LN	0.745***	0.734***	0.340***	0.335***	0.645***	0.635***	0.886***	0.873***	1.108***	1.093***
	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
VVR MDW		1.534***		0.805***		1.397***		1.818***		2.117***
		[<0.001]		[<0.001]		[<0.001]		[<0.001]		[<0.001]
		(0.01)		(<0.001)		(<0.001)		(<0.001)		(<0.001)
R^2	0.35	0.40	0.30	0.37	0.33	0.39	0.36	0.41	0.34	0.39
Adj. R^2	0.34	0.40	0.30	0.37	0.33	0.39	0.36	0.41	0.34	0.39

TABLE IA.13
Out-of-Sample Forecasting of Bond Risk Premia

The table presents the monthly out-of-sample forecasting results for excess bond returns. Forecasts are generated using a moving window of 15 years (180 monthly observations). *RMSE Ratio* is the ratio of the root mean squared error (RMSE) of a model with VVR over the benchmark model that includes only the CP and LN factors. CW is the Clark and West (2007) test for equal predictive ability, with corresponding approximate *p-value* based on the standard normal distribution. GW is the Giacomini and White (2006) test for predictive ability, with corresponding asymptotic *p-value*. *p*-values are presented in round brackets. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Average	2-year	3-year	4-year	5year
RMSE Ratio	1.010	0.978	0.989	0.990	0.990
CW	-0.144	1.981**	2.146**	1.994**	2.049**
p-val.	(0.56)	(0.02)	(0.02)	(0.02)	(0.02)
GW	-0.520	1.586*	1.493*	1.353*	1.367*
p-val.	(0.70)	(0.06)	(0.07)	(0.09)	(0.09)

TABLE IA.14
VVR and Liquidity Premia

The table presents monthly forecasting regression results for excess bond returns of the form $\overline{r^e}_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \bar{\varepsilon}_{t+12}$ and liquidity premia. $\overline{r^e}$ is the equally-weighted yearly excess bond return, and *VVR MDW* is the yearly change in log volatility-to-volume ratio constructed as the equally weighted average of the market value weighting of firms split by median market capitalization of individual stocks' *VVR*. Panel A presents the relation with equity market liquidity risk. LIQ_V is the traded liquidity factor measured as the value-weighted return on the 10-1 portfolio from a sort on historical liquidity betas (Pastor and Stambaugh, 2003). The sample period is January 1968 to December 2017 as per data availability in `http://finance.wharton.upenn.edu/~stambaug/liq_data_1962_2020.txt`. Panel B presents the relation with funding liquidity premia. L_t is the funding liquidity measure from Fontaine and Garcia (2012) based on mispricing of bonds with similar characteristics but different ages. The sample period is January 1987 to December 2016 as per data availability in `http://jean-sebastienfontaine.com/wp-content`. Panel C presents the relation with funding constraints. *TED* is the Ted spread, and *HPW* is the Hu, Pan, and Wang (2013) funding risk measure constructed using yield errors or differences between observed market yields and model-implied yields based on Svensson (1994). The sample period January 1987 to December 2016 as per data availability. The *VVR* and L_t coefficients are presented in % points. *p-val* is the *p*-value calculated using the Newey-West correction for heteroscedasticity and autocorrelation with 18 lags. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Stock Market Liquidity Risk

Constant	0.011***	0.01	-0.006**	0.03	-0.005**	0.03
CP			0.751***	<0.001	0.762***	<0.001
LN			0.773***	<0.001	0.771***	<0.001
VVR MDW					1.484***	<0.001
PS	0.119***	0.01	0.120***	<0.001	0.101***	<0.001
R^2	0.01		0.35		0.40	
Adj. R^2	0.01		0.35		0.40	

Panel B. Funding Liquidity

	Coef.	*p*-val.	Coef.	*p*-val.	Coef.	*p*-val.
Constant	0.016***	0.00	-0.008**	0.04	-0.007*	0.06
CP			0.712***	0.00	0.697***	0.00
LN			0.824***	0.00	0.801***	0.00
VVR MDW					0.568**	0.04
L_t	-0.686***	0.01	-0.194	0.13	-0.284*	0.08
R^2	0.07		0.26		0.28	
Adj. R^2	0.06		0.26		0.27	

Panel C. Other Funding Liquidity Measures

	Coef.	*p*-val.	Coef.	*p*-val.		*p*-val.	MDW	*p*-val.
Constant	0.014***	0.01	-0.009**	0.03	0.009*	0.07	-0.008**	0.04
CP			0.816***	0.00			0.840***	0.00
LN			0.871***	0.00			0.856***	0.00
VVR MDW			0.450*	0.07			0.507**	0.03
TED	0.003	0.18	-0.001	0.21				
HPW					0.002**	0.03	-0.001*	0.09
R^2	0.00		0.25		0.03		0.27	
Adj. R^2	0.00		0.25		0.02		0.26	

TABLE IA.15
Bond Risk Premia, VVR, and Bond Illiquidity

The table presents in-sample forecasting regressions for excess bond returns, using equity and bond market VVRs. The table presents yearly excess bond return regressions: $\overline{r^e}_{t+12} = \beta_0 + \boldsymbol{\beta}_1' \boldsymbol{X}_t + \bar{\varepsilon}_{t+12}$. $\overline{r^e}$ is the equally-weighted yearly excess bond return. *Bond VVR* is the treasury market illiquidity measured as the yearly change in the average log volatility-to-volume ratio for treasury bonds of 2-, 5-, and 10-year maturity, *CP* is the Cochrane Piazzesi factor, *LN* is the linear combination of the Ludvigson and Ng factors, *VVR MDW* is the yearly change in log volatility-to-volume ratio constructed as the equally weighted average of the market value weighting of firms split by median market capitalization of individual stocks' *VVR*. The VVR coefficients are presented in % points. The sample period is June 1991 to December 2017. *p-val* is the p-value calculated using the Newey-West correction for heteroskedasticity and autocorrelation with 18 lags. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Coef.	p-val.	Coef.	p-val.	Coef.	p-val.		p-val.		p-val.
Constant	0.015***	<0.001	-0.013***	0.01	-0.013***	0.01	-0.013***	0.01	-0.013***	0.01
CP			0.936***	<0.001	0.957***	<0.001	0.962***	<0.001	0.977***	<0.001
LN			0.959***	<0.001	0.952***	<0.001	0.940***	<0.001	0.937***	<0.001
VVR MDW							0.460*	0.08	0.402*	0.09
Bond VVR	0.166*	0.09			0.188*	0.06			0.162*	0.08
R^2	0.01		0.21		0.21		0.22		0.22	
Adj. R^2	0.00		0.20		0.21		0.21		0.21	

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