The Macroeconomic Uncertainty Premium in the Corporate Bond Market

Online Appendix

To save space in the paper, we present additional analyses (Sections A.1 to A.5) and robustness checks (Sections A.6 to A.10) in the Online Appendix.

A.1. Alphas on Value-Weighted β^{UNC} Portfolios

Table A.1 presents alphas for univariate portfolios of corporate bonds sorted by β^{UNC} based on the five-factor model of Fama and French (2015) and 4-factor model of Hou, Xue and Zhang (2015).

A.2. Investment-Grade (IG) Bonds

Table A.2 presents results from quintile portfolios of investment-grade (IG) bonds sorted by β^{UNC}. The results indicate that the return and alpha spreads are economically and statistically significant for investment-grade bonds.

A.3. Non-Investment-Grade (NIG) Bonds

Table A.3 presents results from quintile portfolios of non-investment-grade (NIG) bonds sorted by β^{UNC}. The results indicate that the return and alpha spreads are economically and statistically significant for non-investment-grade bonds.

A.4. Bivariate Portfolio-Level Analysis

This section examines the relation between uncertainty betas and future bond returns after controlling for well-known cross-sectional return predictors. As shown in Table 2, bonds with a low uncertainty beta have a higher market beta, a higher default beta, a higher term beta, and higher market volatility risk. Fama and French (1993) and Gebhardt, Hvidkjaer and Swaminathan (2005) show that default and term spreads are important factors in the corporate bond market. Ang et al. (2006) provide evidence of a significant link between the market volatility beta and future returns on equity portfolios.

To investigate the incremental predictive power of the uncertainty beta, we first perform "independent" bivariate portfolio sorts on the uncertainty beta (β^{UNC}) in combination with the bond market beta (β^{MKT}), the default beta (β^{DEF}), the term beta (β^{TERM}), and the market volatility beta (β^{VIX}). In addition, we control for the other bond characteristics, including bond-level illiquidity, credit rating, time-to-maturity, and size. Specifically, we independently sort all bonds into quintile portfolios based on an ascending sort of β^{UNC} and the control variables (β^{MKT}, β^{DEF}, β^{TERM}, β^{VIX}, ILLIQ, Rating, Maturity, and Size). The intersections of the five β^{UNC} and the five control groups generate a total of 25 portfolios.

Table A.4 shows that controlling for β^{MKT}, β^{DEF}, β^{TERM}, and β^{VIX} in 5×5 bivariate portfolios, the 9-factor alpha spreads between the lowest- and highest-β^{UNC} quintiles are in the range of −0.48% and −0.61% per month, and highly significant with t-statistics ranging from −2.61 to −2.72.[22] Table A.4 also shows that after we control for bond characteristics (illiquidity, credit rating, maturity, and size), the alpha differences between the low- and high-β^{UNC} quintiles are negative, in the range of −0.48% and −0.72% per month, and highly significant. Overall, the findings in Table A.4 indicate that the uncertainty premium in the corporate bond market survives well-known measures of systematic risk, liquidity and bond characteristics.

A.5. Bivariate Portfolios Based on the Equity Uncertainty Beta (β^{UNC}_{equity}) and Bond Uncertainty Beta (β^{UNC}_{bond})

Table A.5 presents results from independent bivariate portfolios of corporate bonds sorted by the equity uncertainty beta (β^{UNC}_{equity}) and β^{UNC}_{bond}.

[22]Starting with Table A.4, we report the risk-adjusted returns only from the 9-factor model (i.e., 9-factor alpha). The alpha estimates from alternative factor models are similar and available upon request.

Table 7 presents results from independent bivariate portfolios of corporate bonds sorted by institutional ownership and β^{UNC}.

A.6. Alternative Measures of the Uncertainty Beta

We have so far estimated the uncertainty beta controlling for the bond market portfolio based on equation (2). In this section, following Ang et al. (2006), we control for the exposure of individual bonds to changes in aggregate stock market volatility. We use the monthly VIX index from the CBOE as a proxy for expected future market volatility and estimate the uncertainty beta from the following time-series regression, controlling for innovations in the S&P500 index option implied volatility:

$$R_{i,t} = \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot \Delta UNC_t + \beta_{i,t}^{MKT} \cdot MKT_t + \beta_{i,t}^{VIX} \cdot \Delta VIX_t + \epsilon_{i,t}, \tag{A.1}$$

where ΔVIX_t is the monthly change in the VIX. The left panel in Table A.6 (denoted by Model 1) shows that the next-month value-weighted average excess return decreases from 1.35% to 0.43% per month, indicating a monthly average return difference of −0.92% between quintiles 5 and 1 with a significant t-statistic of −3.81. Similarly, the 9-factor alpha spread between the low- and high-β^{UNC} quintiles is negative, −0.59% per month, and highly significant.

Fama and French (1993) and Gebhardt, Hvidkjaer and Swaminathan (2005) show that the default and term factors are related to the cross-section of average bond returns. Thus, we use the regression specification in equation (A.2), estimated with a fixed 36-month rolling window, and test whether this alternative measure of the uncertainty beta, accounting for the default and term factors, predicts future bond returns:

$$R_{i,t} = \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot \Delta UNC_t + \beta_{i,t}^{MKT} \cdot MKT_t + \beta_{i,t}^{DEF} \cdot DEF_t + \beta_{i,t}^{TERM} \cdot TERM_t + \epsilon_{i,t}, \tag{A.2}$$

where DEF and TERM are the default and term factors, respectively. Once we estimate β^{UNC} from the above specification, we form the uncertainty beta portfolios similar to those in Table 2, where quintile 1 (quintile 5) is the portfolio with the lowest (highest) uncertainty beta. The middle panel in Table A.6 (denoted by Model 2) shows that the next-month value-weighted average excess return decreases from 1.30% to 0.47% per month, producing a monthly average return difference of −0.83% with a t-statistic of −3.44. The 9-factor alpha spread between the low- and high-β^{UNC} quintiles is also negative at −0.53% per month and highly significant.

Finally, we use a 9-factor model that combines all stock and bond market factors in the estimation of the uncertainty beta:

$$\begin{aligned} R_{i,t} \;=\; & \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot \Delta UNC_t + \gamma_{1,t} \cdot MKT_t^{Stock} + \gamma_{2,t} \cdot SMB_t + \gamma_{3,t} \cdot HML_t \\ & + \gamma_{4,t} \cdot MOM^{Stock} + \gamma_{5,t} \cdot LIQ^{Stock} + \gamma_{6,t} \cdot MKT_t^{Bond} + \gamma_{7,t} \cdot DEF_t \\ & + \gamma_{8,t} \cdot TERM_t + \gamma_{9,t} \cdot MOM^{Bond} + \gamma_{10,t} \cdot LIQ^{Bond} + \epsilon_{i,t}. \end{aligned} \tag{A.3}$$

The last two columns of Table A.6 (denoted by Model 3) show that the value-weighted return and 9-factor alpha spreads between the low- and high-β^{UNC} quintiles remain highly significant at −0.75% and −0.51% per month, respectively. The results in Table A.6, along with those reported in Table 2, indicate that the cross-sectional predictive power of economic uncertainty remains strong across alternative measures of the uncertainty beta.

A.7. Long-term Predictability

As discussed in the previous section, the pre- and post-ranking estimates of the uncertainty beta indicate that β^{UNC} is a stable measure of economic uncertainty risk. Hence, β^{UNC} is expected to predict corporate bond performance over horizons that are longer than a month. Our empirical analyses have thus far focused on one-month-ahead predictability. However, from a practical standpoint, it would make sense to investigate the predictive power of β^{UNC} for longer investment horizons, since some investors may prefer holding periods longer than a month.

In this section, we examine the longer-term predictive power of β^{UNC} based on the value-weighted univariate portfolios. The first six columns in Table A.7 report the 3-month-, 6-

month-, and 12-month-ahead average returns and the corresponding 9-factor alphas for β^{UNC}-sorted quintile portfolios. As shown in the last row of Table A.7, the average return spread between quintiles 5 and 1 is -0.63% per month (t-stat. $= -3.01$) for month $t+3$, -0.87% per month (t-stat. $= -3.08$) for month $t+6$, and -0.83% per month (t-stat. $= -2.35$) for month $t+12$. Similarly, the 9-factor alpha spreads between quintiles 5 and 1 are economically and statistically significant for the 3-, 6-, and 12-month-ahead predictability, with magnitudes ranging from -0.53% to -0.64%.

The last six columns in Table A.7 present the 3-month-, 6-month-, and 12-month-ahead *cumulative* returns and the corresponding 9-factor alphas for β^{UNC}-sorted quintile portfolios. The last row of Table A.7 shows that the average return spreads between quintiles 5 and 1 are -1.46% (t-stat. $= -2.43$), -3.97% (t-stat. $= -2.73$), and -10.04% (t-stat. $= -3.10$) for one-quarter, two-quarter, and one-year-ahead returns, respectively.[23] Similar results are obtained from the 9-factor alpha spreads, indicating that the negative cross-sectional relation between the uncertainty beta and future bond returns is not just a one-month affair. The predictive power of β^{UNC} lasts up to one year into the future.

A.8. Firm-Level Analysis

Throughout the paper, our empirical analyses are based on the bond-level data, since we test whether the uncertainty beta of *individual* bonds predict their future returns. However, firms often have multiple bonds outstanding at the same time. To control for bonds issued by the same firm in our cross-sectional regressions, for each month in our sample we pick one bond of median size as representative of the firm and re-run the Fama-MacBeth regressions

[23] Because of overlapping longer-horizon returns that are calculated by cumulating monthly returns, the standard errors of the 3-month, 6-month, and 12-month average return and alpha differences in Table A.7 are computed following Hodrick (1992). At an earlier stage of the study, we also compute Newey-West (1987) standard errors by setting the optimal lag length to equal the number of the monthly returns that are cumulated to calculate the longer-horizon returns. The Newey-West standard errors turn out to be similar to those reported in Table A.7.

using this firm-level dataset. As presented in Table A.8, our main findings from the firm-level regressions remain qualitatively similar to those obtained from the bond-level regressions reported in Table 6. Both the univariate and multivariate regression results present a negative and statistically significant relation between β^{UNC} and future firm-level bond returns.

A.9. Skipping a Month between the Portfolio Formation Month and the Holding Period

As discussed earlier, we find that the pre-ranking uncertainty betas capture bonds' differential exposures to economic uncertainty because the post-ranking uncertainty betas preserve the order of the pre-ranking betas for the quintile portfolios. Since the uncertainty beta estimates are stable, skipping a month between the portfolio formation month and the holding period should not affect our main findings. As a precaution, we replicate the univariate portfolio results to make sure that the cross-sectional relation between β^{UNC} and expected returns is not contaminated by any microstructure issues. Table A.9 of the online appendix shows that the return and alpha spreads between the low- and high-β^{UNC} quintiles are negative and highly significant, similar to those reported in Table 2, after skipping a month between portfolio formation month and holding period.

A.10. The Level of the Economic Uncertainty Index

The level of the economic uncertainty index proposed by Jurado, Ludvigson, and Ng (2015) is defined as the conditional variance of macroeconomic shocks. Campbell (1993, 1996) recommends using changes in VIX and changes in economic uncertainty when testing whether market volatility and/or economic uncertainty are priced. We should also note that Ang, Hodrick, Xing, and Zhang (2006) use the change in VIX to be consistent with the two-factor ICAPM of Campbell (1993, 1996). Thus, following Campbell (1993, 1996) and Ang et al. (2006), we use the change in economic uncertainty index in the main text.

In this section, we further test the robustness of our main findings and reestimate β^{UNC}

using the *level* of the economic uncertainty index (UNC) instead of the change (ΔUNC) based on the most comprehensive time-series specification:

$$\begin{aligned} R_{i,t} \;=\; & \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot UNC_t + \gamma_{1,t} \cdot MKT_t^{Stock} + \gamma_{2,t} \cdot SMB_t + \gamma_{3,t} \cdot HML_t \\ & + \gamma_{4,t} \cdot MOM^{Stock} + \gamma_{5,t} \cdot LIQ^{Stock} + \gamma_{6,t} \cdot MKT_t^{Bond} + \gamma_{7,t} \cdot DEF_t \\ & + \gamma_{8,t} \cdot TERM_t + \gamma_{9,t} \cdot MOM^{Bond} + \gamma_{10,t} \cdot LIQ^{Bond} + \epsilon_{i,t}. \end{aligned} \tag{A.4}$$

The results reported in Table A.10 of the online appendix show that the predictive of β^{UNC} remains strong when bond exposures to the level of UNC are used to predict the cross-sectional differences in future returns. The return and 9-factor alpha spreads between the low- and high-β^{UNC} quintiles are highly significant at -0.59% and -0.76% per month, respectively.

Table A.1: FF5 and Q-factor alphas on Value-Weighted β^{UNC} Portfolios

Quintile portfolios are formed every month by sorting corporate bonds based on the uncertainty beta (β^{UNC}) estimated from the following regression controlling for the bond market portfolio:

$$R_{i,t} = \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot \Delta UNC_t + \beta_{i,t}^{MKT} \cdot MKT_t + \epsilon_{i,t},$$

where β^{UNC} is the individual bond exposure to the change in the economic uncertainty index (ΔUNC). Quintile 1 is the portfolio with the lowest β^{UNC} and Quintile 5 is the portfolio with the highest β^{UNC}. The portfolios are value-weighted using amounts outstanding as weights. The table reports the average β^{UNC}, the next-month average excess return, 5-factor alpha from Fama and French (2015), and the 4-factor alpha from Hou, Xue, and Zhang (2015) for each quintile. The average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively. The sample period is from July 2004 to December 2017.

Quintiles	Average β^{UNC}	Average return	FF 5-factor alpha	Q-factor alpha
Low β^{UNC}	-1.34	1.34	1.25	1.27
		(5.61)	(4.96)	(4.34)
2	-0.36	0.50	0.44	0.46
		(3.82)	(3.40)	(3.33)
3	-0.11	0.33	0.26	0.25
		(3.08)	(2.24)	(2.09)
4	0.06	0.25	0.21	0.20
		(2.45)	(1.26)	(1.31)
High β^{UNC}	0.42	0.42	0.38	0.29
		(3.01)	(1.52)	(1.49)
High − Low	1.75	-0.92***	-0.87***	-0.98***
t-stat	(10.26)	(-4.04)	(-3.70)	(-3.94)

Table A.2: Univariate Portfolios of Investment-Grade Bonds Sorted by Uncertainty Beta

Quintile portfolios are formed every month by sorting investment-grade bonds based on the uncertainty beta (β^{UNC}) estimated from the following bivariate regression:

$$R_{i,t} = \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot \Delta UNC_t + \beta_{i,t}^{MKT} \cdot MKT_t + \epsilon_{i,t},$$

where β^{UNC} is the individual bond exposure to the change in the economic uncertainty index (ΔUNC). Quintile 1 is the portfolio with the lowest β^{UNC} and Quintile 5 is the portfolio with the highest β^{UNC}. The portfolios are value-weighted using amounts outstanding as weights. The table reports the average β^{UNC}, the next-month average excess return, the 5-factor alpha from stock market factors, the 4-factor alpha from bond market factors, and the 9-factor alpha for each quintile. The last row shows the differences in average β^{UNC}, monthly average returns, the differences in alphas with respect to the factor models. The average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively. The sample period is from July 2004 to December 2017.

Quintiles	Average	Average	5-factor stock	4-factor bond	9-factor	Average portfolio characteristics							
	β^{UNC}	return	alpha	alpha	alpha	β^{MKT}	β^{DEF}	β^{TERM}	β^{VIX}	ILLIQ	Rating	Maturity	Size
Low	-0.81	0.71	0.74	0.32	0.28	0.18	3.24	0.08	2.72	3.72	6.63	10.90	0.34
		(3.22)	(3.25)	(3.28)	(3.10)								
2	-0.26	0.35	0.35	0.27	0.12	0.14	2.83	0.08	3.45	1.53	6.29	8.27	0.48
		(2.72)	(2.46)	(2.38)	(2.19)								
3	-0.09	0.28	0.28	0.22	0.10	0.15	2.66	0.02	3.14	1.14	6.14	7.58	0.53
		(2.74)	(2.49)	(2.18)	(1.99)								
4	0.06	0.25	0.25	0.19	0.09	0.15	2.60	-0.19	2.72	1.11	6.13	8.56	0.48
		(1.35)	(1.21)	(1.44)	(1.21)								
High	0.38	0.18	0.25	-0.09	-0.12	0.18	3.54	-0.16	4.25	1.94	6.09	13.22	0.38
		(1.05)	(2.21)	(-0.34)	(-0.87)								
High − Low	1.19***	-0.53**	-0.49**	-0.41**	-0.40**								
t-stat	(10.86)	(-2.35)	(-2.43)	(-2.50)	(-2.38)								

Table A.3: Univariate Portfolios of Non-Investment-Grade Bonds Sorted by Uncertainty Beta

Quintile portfolios are formed every month by sorting non-investment-grade bonds based on the uncertainty beta (β^{UNC}) estimated from the following bivariate regression:

$$R_{i,t} = \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot \Delta UNC_t + \beta_{i,t}^{MKT} \cdot MKT_t + \epsilon_{i,t},$$

where β^{UNC} is the individual bond exposure to the change in the economic uncertainty index (ΔUNC). Quintile 1 is the portfolio with the lowest β^{UNC} and Quintile 5 is the portfolio with the highest β^{UNC}. The portfolios are value-weighted using amounts outstanding as weights. The table reports the average β^{UNC}, the next-month average excess return, the 5-factor alpha from stock market factors, the 4-factor alpha from bond market factors, and the 9-factor alpha for each quintile. The last row shows the differences in average β^{UNC}, monthly average returns, the differences in alphas with respect to the factor models. The average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively. The sample period is from July 2004 to December 2017.

Quintiles	Average	Average	5-factor stock	4-factor bond	9-factor	Average portfolio characteristics							
	β^{UNC}	return	alpha	alpha	alpha	β^{MKT}	β^{DEF}	β^{TERM}	β^{VIX}	ILLIQ	Rating	Maturity	Size
Low β^{UNC}	-2.34	2.05	2.03	1.28	0.92	0.99	6.78	4.43	-7.79	13.42	17.32	8.81	0.35
		(4.79)	(4.51)	(2.86)	(2.75)								
2	-1.14	0.90	0.74	0.62	0.57	1.08	9.83	3.00	-0.67	7.67	15.97	7.63	0.39
		(2.45)	(1.80)	(2.45)	(2.32)								
3	-0.56	0.61	0.48	0.42	0.39	0.69	6.36	1.90	-2.34	4.09	15.25	7.82	0.44
		(2.25)	(1.59)	(1.93)	(1.52)								
4	-0.15	0.46	0.40	0.20	0.14	0.51	5.53	1.19	-1.36	2.25	14.87	7.98	0.47
		(2.83)	(2.20)	(1.50)	(1.14)								
High β^{UNC}	0.41	0.75	0.70	0.11	0.11	0.54	8.19	2.17	-4.73	3.69	15.34	9.55	0.44
		(3.73)	(3.34)	(1.49)	(1.02)								
High − Low	2.68***	-1.30***	-1.33***	-1.17***	-0.81***								
t-stat	(13.02)	(-3.98)	(-3.64)	(-3.02)	(-3.50)								

Table A.4: Bivariate Portfolios of Corporate Bonds Sorted by Uncertainty Beta

Double-sorted quintile portfolios are formed by sorting corporate bonds based on the uncertainty beta (β^{UNC}) after controlling for the bond market beta (β^{MKT}), default beta (β^{DEF}), term beta (β^{TERM}), market volatility beta (β^{VIX}) and the bond characteristics including the bond-level illiquidity (ILLIQ), credit rating, time-to-maturity, and size. The uncertainty beta (β^{UNC}) is estimated using equation (2). The table reports the independent bivariate sort results. The portfolios are value-weighted using amounts outstanding as weights. The table presents average returns across the five control variable quintiles to produce quintile portfolios with dispersion in β^{UNC} but with similar levels of the control variable. "Return difference" is the difference in average monthly returns between the High β^{UNC} and Low β^{UNC} portfolios averaged across the quintiles of control variables. "Alpha difference" is the difference in alphas on the High β^{UNC} and Low β^{UNC} portfolios. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively. The sample period is from July 2004 to December 2017.

Control variable	β^{MKT}	β^{DEF}	β^{TERM}	β^{VIX}	ILLIQ	Rating	Maturity	Size
Low β^{UNC}	1.04	1.00	0.99	0.94	0.82	0.68	1.09	1.09
2	0.54	0.63	0.62	0.40	0.48	0.47	0.50	0.57
3	0.43	0.45	0.43	0.27	0.34	0.38	0.31	0.34
4	0.37	0.35	0.36	0.24	0.26	0.29	0.26	0.24
High β^{UNC}	0.49	0.44	0.47	0.32	0.35	0.29	0.37	0.38
Return diff.	-0.54***	-0.56***	-0.52***	-0.62**	-0.48**	-0.39**	-0.71***	-0.71***
t-stat	(-2.98)	(-2.78)	(-3.19)	(-2.54)	(-2.55)	(-2.52)	(-2.80)	(-3.23)
9-factor alpha diff.	-0.61**	-0.58**	-0.50**	-0.48**	-0.48**	-0.49**	-0.72**	-0.71**
t-stat	(-2.69)	(-2.68)	(-2.72)	(-2.61)	(-2.17)	(-2.15)	(-2.40)	(-2.75)

Table A.5: Independent Bivariate Portfolios of β^{UNC}_{equity} and β^{UNC}_{bond}

Independent bivariate portfolios are formed by sorting corporate bonds into quintile portfolios based on the equity uncertainty beta (β^{UNC}_{equity}) and β^{UNC}_{bond}. The portfolios are value-weighted using amounts outstanding as weights. The table reports the 5×5 next-month average returns and the 9-factor alphas for each of the 25 portfolios. Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Average return

	Low β^{UNC}_{bond}	2	3	4	High β^{UNC}_{bond}	High β^{UNC}_{bond} − Low β^{UNC}_{bond}
Low β^{UNC}_{stock}	0.60	0.48	0.36	0.29	0.36	-0.25
						(-1.06)
2	1.00	0.62	0.52	0.38	0.62	-0.38*
						(-1.96)
3	1.18	0.66	0.42	0.51	0.76	-0.42**
						(-2.06)
4	1.12	0.68	0.42	0.33	0.42	-0.71**
						(-2.67)
High β^{UNC}_{stock}	1.40	0.55	0.35	0.33	0.26	-1.16***
						(-2.98)

Panel B: 9-factor alpha

	Low β^{UNC}_{bond}	2	3	4	High β^{UNC}_{bond}	High β^{UNC}_{bond} − Low β^{UNC}_{bond}
Low β^{UNC}_{stock}	0.64	0.45	0.31	0.27	0.35	-0.29
						(-1.29)
2	0.95	0.59	0.45	0.30	0.54	-0.42
						(-1.62)
3	1.27	0.68	0.43	0.45	0.72	-0.56**
						(-2.09)
4	1.14	0.71	0.41	0.34	0.37	-0.78**
						(-2.26)
High β^{UNC}_{stock}	1.49	0.50	0.38	0.32	0.24	-1.26**
						(-2.47)

Table A.6: Univariate Portfolios of Corporate Bonds Sorted by Uncertainty Beta Estimated from Alternative Models

Quintile portfolios are formed every month by sorting corporate bonds based on the uncertainty beta (β^{UNC}) estimated from three alternative time-series regression models:

$$\text{Model 1}: R_{i,t} = \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot \Delta UNC_t + \beta_{i,t}^{MKT} \cdot MKT_t + \beta_{i,t}^{VIX} \cdot \Delta VIX_t + \epsilon_{i,t},$$

$$\text{Model 2}: R_{i,t} = \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot \Delta UNC_t + \beta_{i,t}^{MKT} \cdot MKT_t + \beta_{i,t}^{DEF} \cdot DEF_t + \beta_{i,t}^{TERM} \cdot TERM_t + \epsilon_{i,t},$$

$$\text{Model 3}: R_{i,t} = \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot \Delta UNC_t + \gamma_{1,t} \cdot MKT_t^{Stock} + \gamma_{2,t} \cdot SMB_t + \gamma_{3,t} \cdot HML_t + \gamma_{4,t} \cdot MOM^{Stock} + \gamma_{5,t} \cdot LIQ^{Stock}$$
$$+ \gamma_{6,t} \cdot MKT_t^{Bond} + \gamma_{7,t} \cdot DEF_t + \gamma_{8,t} \cdot TERM_t + \gamma_{9,t} \cdot MOM^{Bond} + \gamma_{10,t} \cdot LIQ^{Bond} + \epsilon_{i,t}.$$

Quintile 1 is the portfolio with the lowest β^{UNC} and Quintile 5 is the portfolio with the highest β^{UNC}. The portfolios are value-weighted using amounts outstanding as weights. The table reports the average β^{UNC}, the next-month average excess return, and the 9-factor alpha for each quintile. The last row shows the differences in average β^{UNC}, monthly average returns, the differences in alphas with respect to the factor models. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

	Model 1			Model 2			Model 3		
Quintiles	Average β^{UNC}	Average return	9-factor alpha	Average β^{UNC}	Average return	9-factor alpha	Average β^{UNC}	Average return	9-factor alpha
Low β^{UNC}	-1.34	1.35	0.58	-1.43	1.30	0.63	-1.45	1.27	0.59
		(5.46)	(3.50)		(5.30)	(3.36)		(5.24)	(3.59)
2	-0.36	0.55	0.25	-0.41	0.51	0.27	-0.42	0.53	0.32
		(4.11)	(2.83)		(3.76)	(2.62)		(3.98)	(2.83)
3	-0.12	0.37	0.18	-0.15	0.39	0.21	-0.14	0.37	0.24
		(3.33)	(1.90)		(3.43)	(1.92)		(3.34)	(1.90)
4	0.05	0.30	0.15	0.03	0.32	0.17	0.07	0.33	0.17
		(2.92)	(0.98)		(2.98)	(1.08)		(3.15)	(1.14)
High β^{UNC}	0.40	0.43	-0.01	0.41	0.47	0.11	0.55	0.52	0.08
		(3.21)	(-0.08)		(3.52)	(0.87)		(3.79)	(1.01)
High − Low	1.74***	-0.92***	-0.59**	1.84***	-0.83***	-0.53**	2.00***	-0.75***	-0.51**
t-stat	(11.20)	(-3.81)	(-2.69)	(11.38)	(-3.44)	(-2.37)	(12.24)	(-3.15)	(-2.60)

Table A.7: Long-term Predictability of Corporate Bonds Sorted by Uncertainty Beta

Quintile portfolios are formed every month by sorting corporate bonds based on the uncertainty beta (β^{UNC}) estimated with equation (2). The first six columns report the average 3-, 6-, and 12-month-ahead bond excess returns and the 9-factor alpha for each quintile. The last six columns present the average 3-, 6-, and 12-month-ahead cumulative bond excess returns and the corresponding 9-factor alpha for each quintile. For 3-, 6-, and 12-month-ahead cumulative returns and alphas, Hodrick (1992) t-statistics are given in parentheses to account for overlapping longer-horizon returns. The portfolios are value-weighted using amounts outstanding as weights. The last row shows the differences in average returns and the 9-factor alphas in percentage terms. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively. The sample period is from July 2004 to December 2017.

	3-month-ahead ($t+3$)		6-month-ahead ($t+6$)		12-month-ahead ($t+12$)		cumulative 3-month ($t+1:t+3$)		cumulative 6-month ($t+1:t+6$)		cumulative 12-month ($t+1:t+12$)	
Quintiles	Average return	9-factor alpha	Average return	9-factor alpha	Average return	9-factor alpha	Average return	9-factor alpha	Average return	9-factor alpha	Average return	9-factor alpha
Low	0.73	0.62	0.78	0.58	0.72	0.49	2.50	1.54	5.95	3.50	13.85	7.89
2	0.58	0.39	0.49	0.39	0.61	0.38	1.21	1.13	2.63	2.57	5.71	5.73
3	0.39	0.25	0.36	0.29	0.41	0.27	0.94	0.89	2.04	1.93	4.32	4.14
4	0.31	0.20	0.29	0.23	0.30	0.20	0.82	0.73	1.62	1.45	3.26	3.01
High	0.10	0.10	-0.09	-0.06	-0.11	-0.08	1.04	0.91	1.99	1.68	3.82	3.48
High − Low	-0.63***	-0.53***	-0.87***	-0.64**	-0.83**	-0.58***	-1.46**	-0.64**	-3.97***	-1.81**	-10.04***	-4.41***
t-stat	(-3.01)	(-2.86)	(-3.08)	(-2.92)	(-2.35)	(-2.93)	(-2.43)	(-2.48)	(-2.73)	(-2.82)	(-3.10)	(-2.92)

Table A.8: Firm-Level Fama-MacBeth Cross-Sectional Regressions

For each month in our sample, one bond is picked by the median size as the representative for the firm and the Fama-MacBeth regressions are replicated using this firm-level dataset. This table reports the average intercept and slope coefficients from the firm-level Fama and MacBeth (1973) cross-sectional regressions of one-month-ahead corporate bond excess returns on the uncertainty beta (β^{UNC}), bond market beta (β^{MKT}), default beta (β^{DEF}), term beta (β^{TERM}), and market volatility beta (β^{VIX}), with and without controls. Control variables include bond characteristics (ratings, maturity, size), bond-level illiquidity, and lagged returns. Ratings are in conventional numerical scores, where 1 refers to an AAA rating and 21 refers to a C rating. Higher numerical score means higher credit risk. Time-to-maturity is defined in terms of years and Size is defined in terms of $billion. ILLIQ is the bond-level illiquidity computed as the autocovariance of the daily price changes within each month. Newey-West (1987) t-statistics are reported in parentheses to determine the statistical significance of the average intercept and slope coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance at the 5% level or below.

Model	Intercept	β^{UNC}	β^{MKT}	β^{DEF}	β^{TERM}	β^{VIX}	ILLIQ	Rating	Maturity	Size	Lag Return	Adj. R^2
(1)	0.367	**-0.626**										0.031
	(2.75)	(-3.47)										
(2)	0.292	**-0.672**	**0.176**	**-0.024**	-0.006	-0.254						0.080
	(2.31)	(-3.41)	(2.10)	(-3.12)	(-0.32)	(-1.03)						
(3)	0.164	**-0.505**	0.094	**-0.019**	-0.005	-0.203	**0.101**					0.129
	(1.44)	(-2.48)	(1.23)	(-2.04)	(-0.27)	(-0.89)	(7.78)					
(4)	-0.273	**-0.558**	**0.136**	**-0.019**	-0.011	-0.116		**0.059**				0.108
	(-1.37)	(-3.22)	(1.90)	(-2.79)	(-0.54)	(-0.52)		(2.29)				
(5)	0.220	**-0.638**	**0.178**	**-0.022**	-0.007	-0.323			0.009			0.101
	(2.00)	(-3.24)	(2.10)	(-2.88)	(-0.34)	(-1.33)			(1.24)			
(6)	0.322	**-0.638**	**0.180**	**-0.022**	-0.009	-0.307				-0.078		0.083
	(2.51)	(-3.24)	(2.20)	(-2.95)	(-0.45)	(-1.21)				(-1.50)		
(7)	0.268	**-0.533**	**0.143**	**-0.022**	-0.003	-0.153					**-0.028**	0.096
	(2.30)	(-2.68)	(2.12)	(-2.49)	(-0.19)	(-0.77)					(-2.57)	
(8)	-0.281	**-0.289**	0.072	-0.013	-0.005	-0.157	**0.090**	**0.041**	0.008	0.135	**-0.057**	0.196
	(-1.72)	(-2.06)	(1.51)	(-1.64)	(-0.38)	(-0.97)	(7.35)	(1.91)	(1.02)	(1.09)	(-3.22)	

Table A.9: Skipping a Month between Portfolio Formation Month and Holding Period

Quintile portfolios are formed every month by sorting corporate bonds based on the uncertainty beta (β^{UNC}) estimated from the following multivariate regression controlling for the stock and bond market factors:

$$
\begin{aligned}
R_{i,t} \quad = \quad & \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot \Delta UNC_t + \gamma_{1,t} \cdot MKT_t^{Stock} + \gamma_{2,t} \cdot SMB_t + \gamma_{3,t} \cdot HML_t \\
& + \gamma_{4,t} \cdot MOM^{Stock} + \gamma_{5,t} \cdot LIQ^{Stock} + \gamma_{6,t} \cdot MKT_t^{Bond} + \gamma_{7,t} \cdot DEF_t \\
& + \gamma_{8,t} \cdot TERM_t + \gamma_{9,t} \cdot MOM^{Bond} + \gamma_{10,t} \cdot LIQ^{Bond} + \epsilon_{i,t}
\end{aligned}
$$

where β^{UNC} is the individual bond exposure to to the change in the economic uncertainty index (ΔUNC). Quintile 1 is the portfolio with the lowest β^{UNC} and Quintile 5 is the portfolio with the highest β^{UNC}. The portfolios are value-weighted using amounts outstanding as weights. The table reports the average β^{UNC}, the next-month average excess return (skipping month $t+1$) and the 9-factor alpha for each quintile. The last eight columns report average portfolio characteristics including the bond market beta (β^{MKT}), default beta (β^{DEF}), term beta (β^{TERM}), market volatility beta (β^{VIX}), illiquidity (ILLIQ), credit rating, time-to-maturity (years), and amount outstanding (size, in \$billion) for each quintile. The last row shows the differences in average β^{UNC}, monthly average returns, the differences in alphas with respect to the 9-factor model. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Quintiles	Average	Average	9-factor	Average portfolio characteristics							
	β^{UNC}	return	alpha	β^{MKT}	β^{DEF}	β^{TERM}	β^{VIX}	ILLIQ	Rating	Maturity	Size
Low	-1.60	1.29	0.72	0.77	0.65	0.31	-0.03	8.11	11.61	9.80	0.31
2	-0.49	0.57	0.30	0.28	0.31	0.13	0.01	2.47	8.59	9.00	0.44
3	-0.20	0.37	0.10	0.22	0.26	0.08	0.03	1.52	7.76	8.06	0.53
4	0.01	0.31	-0.12	0.20	0.24	0.07	0.03	1.30	7.79	8.74	0.50
High	0.48	0.43	-0.05	0.28	0.19	0.04	0.04	2.83	8.50	11.38	0.39
High − Low	2.10***	-0.86***	-0.77***								
t-stat	(13.01)	(-3.46)	(-3.50)								

Table A.10: Univariate Portfolios of Corporate Bonds Sorted by Bond Exposures to the *Level* of Uncertainty Index

Quintile portfolios are formed every month by sorting corporate bonds based on the uncertainty beta (β^{UNC}) estimated from the following multivariate regression controlling for the stock and bond market factors:

$$\begin{aligned} R_{i,t} \;=\; & \alpha_{i,t} + \beta_{i,t}^{UNC} \cdot UNC_t + \gamma_{1,t} \cdot MKT_t^{Stock} + \gamma_{2,t} \cdot SMB_t + \gamma_{3,t} \cdot HML_t \\ & + \gamma_{4,t} \cdot MOM^{Stock} + \gamma_{5,t} \cdot LIQ^{Stock} + \gamma_{6,t} \cdot MKT_t^{Bond} + \gamma_{7,t} \cdot DEF_t \\ & + \gamma_{8,t} \cdot TERM_t + \gamma_{9,t} \cdot MOM^{Bond} + \gamma_{10,t} \cdot LIQ^{Bond} + \epsilon_{i,t} \end{aligned}$$

where β^{UNC} is the individual bond exposure to the *level* of the economic uncertainty index (UNC). Quintile 1 is the portfolio with the lowest β^{UNC} and Quintile 5 is the portfolio with the highest β^{UNC}. The portfolios are value-weighted using amounts outstanding as weights. The table reports the average β^{UNC}, the next-month average excess return and the 9-factor alpha for each quintile. The last eight columns report average portfolio characteristics including the bond market beta (β^{MKT}), default beta (β^{DEF}), term beta (β^{TERM}), market volatility beta (β^{VIX}), illiquidity (ILLIQ), credit rating, time-to-maturity (years), and amount outstanding (size, in \$billion) for each quintile. The last row shows the differences in average β^{UNC}, monthly average returns, the differences in alphas with respect to the 9-factor model. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Quintiles	Average	Average	9-factor	Average portfolio characteristics							
	β^{UNC}	return	alpha	β^{MKT}	β^{DEF}	β^{TERM}	β^{VIX}	ILLIQ	Rating	Maturity	Size
Low	-0.25	1.34	0.74	0.48	1.35	0.68	-0.01	7.57	9.95	10.94	0.37
2	-0.05	0.51	0.32	0.24	0.80	0.40	0.02	2.25	8.01	8.79	0.49
3	0.01	0.37	0.20	0.21	0.68	0.31	0.02	1.44	7.73	7.56	0.52
4	0.06	0.38	0.12	0.27	0.64	0.30	0.02	1.55	8.20	8.75	0.45
High	0.26	0.75	-0.02	0.56	0.96	0.53	0.03	3.45	10.35	10.95	0.34
High − Low	0.51***	-0.59***	-0.76***								
t-stat	(18.05)	(-2.85)	(-3.22)								