Does Climate Risk Affect Corporate Bond Yields Equally across Terms?

Jiemin Huang

Abstract—**This paper selects the data of corporate bond from 2005 to 2019, then divides them into long term bond and short term bond according to maturity of bond. Climate risk is found have significant impact on long term bond yield. Climate risk has no significant impact on short term bond yield. Callability has significant effect on both long term and short term bond yield, while callability has large effect on short term bond and relatively small effect on long term bond. The resale has significant effect on both long term and short term bond yield. The significant effect of the resale on short term bond yield explains large part of the short term bond yield. Issuance has significant impact on both long term and short term bond, with larger impact on short term bond yield. Maturity has significant effect on the yield of both long term and short term bond, and the effect is larger for short term bond. Bearish sentiment is negatively and significantly related to long term bond yield, but has no significant effect on short term bond yield. Credit ratings have large impact on long term bond yield and explain large part of this. However, credit ratings have no significant effect on short term bond yield.**

Index Terms—**climate risk, callability, issuance, credit rating**

I. Introduction

SCHOLARS at home and abroad have studied this problem.

Marcus Painter(2020) studied the impact of climate change on municipal bonds. Counties exposed to climate change will pay more in underwriting fees and initial yields when issuing long-term municipal bonds than counties not exposed to climate change. This difference disappears when comparing short-term municipal bonds, and the market price climate change risk is only available for long-term bonds.

There is little research on how changes in long-term climate risk are priced in financial markets. Hong et al.(2019) analyzed the drought caused by climate change and found that the market underreacted to the risk. However, Bansal et al.(2016) used temperature rise as the proxy variable of climate change and found that temperature rise had a negative impact on asset value, indicating that the market pricing climate change. In the real estate market, Bernstein et al.(2019) found that houses affected by sea level rise would sell at a lower price than those not affected by sea level rise.

Hong et al.(2019) proved that the production risk caused by long-term drought would have a negative impact on the stock return of companies in the food industry. Chava(2014) proved that investor of companies excluded by environmental screening need higher capital costs. These firms face either reputational risk of being flagged as a climate change indicator or regulatory risk, as current output is negatively affected by future climate change related to regulation. Bernstein et al.(2019) showed that the physical risk caused by sea level rise has a negative impact on the housing price exposed to the risk. They then find that this effect is very small when the housing market is highly liquid. Our study goes one step further and shows that in liquid markets investor take the physical risk of climate change to asset trading into account and price these risks in their holding.

Hallegatte et al.(2013) used altitude GIS for the first time to calculate population exposure per 50 cm "elevation" of current mean sea level. They convert the affected population into an affected asset using capital estimates for each resident. For the existing level of defence in coastal cities, we used the Linham, Green and Nichollas approaches.

Bond ratings affect municipal bond prices because investor rely on bond rating to evaluate credit risk (Cornaggia et al., 2017). In addition, credit ratings have an important impact on the local economy.

To sum up, scholars have studied the yields and prices of corporate and municipal bonds and found that credit risk, downside risk, liquidity and climate change are important influencing factors. This paper intends to analyze the impact of climate risk on corporate bond yield spreads based on the research of scholars.

II. Data

We collected the yield data of Shanghai corporate bonds and municipal bond from the GuoTaiAn database, excluding national bond, policy bank bond, central bank bill, financial bond, government-backed institution bond, ultra-short financing bond, medium-term note, short-term financing bond, perpetual medium-term note, SME collective note, convertible bond, etc. Finally, corporate bond and municipal bond with maturities of 2 to 15 years were selected. We chose corporate bond issued from 2005 to 2019, which are divided into three grades: AA, AA+ and AAA.

III. Variable setting

The variables selected in this paper include corporate bond yield, climate risk, bond issue size, maturity, bond rating, put, deem, sell. The climate risk in this paper is based on the measurement method in Hallegatte(2013), and the ratio between the possible loss caused by sea level rise and local GDP.

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IV. Descriptive Statistical Analysis

A. Bond yield

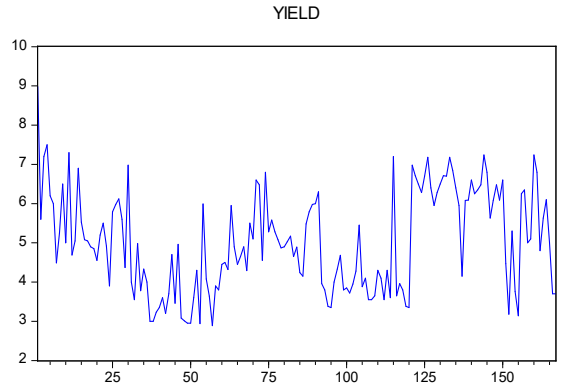

Figure 1. Short-term bond yield

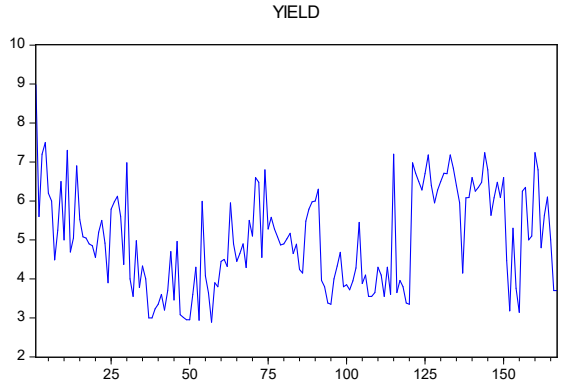

Figure 2. Long-term bond yields

In figure 1, horizontal axis represents time, vertical axis represents the rate of return, expressed in percentiles, short-term bond yields fluctuated greatly during the sample period, with yields ranging from 2.9% to 7.5%. Figure 2, horizontal axis represents time,vertical axis represents the rate of return, expressed in percentiles. Long-term bond yields fluctuate relatively little, with yields ranging from 2.9% to 9%.

B. Climate risk

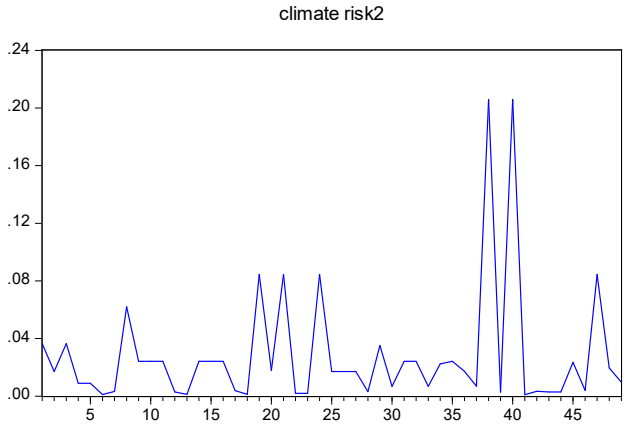

Figure 3. Short-term bond climate risk

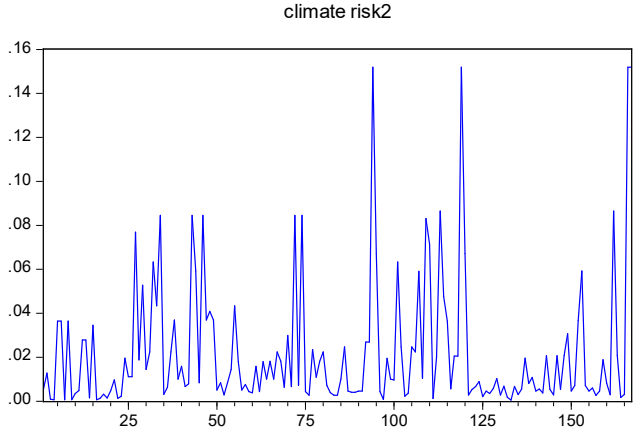

Figure 4. Long-term bond climate risk

In Figure 3, horizontal axis represents time, vertical axis represents the rate of return, expressed in percentiles, climate risk of short-term bonds ranges from 0 to 2.3%, with large fluctuations. Figure 4, horizontal axis represents time, vertical axis represents rate of return, expressed in percentiles, the climate risk of long-term bonds is between 0 and 1.5%, with large fluctuations.

C. Descriptive statistical analysis

Table 1 Descriptive statistical analysis of short-term bonds

	YIELD	RISK	DEEM	SELL	SIZE	MATURITY	PUT	RATING
Mean	5.02	0.03	0.06	0.43	10.46	3.10	0.37	1.49
Median	5.15	0.02	0.00	0.00	8.00	3.00	0.00	1.00
Maximum	7.50	0.21	1.00	1.00	30.0	4.00	1.00	3.00
Minimum	2.98	0.00	0.00	0.00	1.00	2.00	0.00	1.00
Std. Dev.	1.22	0.04	0.24	0.50	8.01	0.42	0.49	0.65
Skewness	0.13	2.98	3.66	0.29	0.94	0.66	0.55	0.96
Kurtosis	2.16	12.15	14.40	1.08	2.79	5.10	1.30	2.82
Jarque-Bera	1.58	243.7	374.7	8.18	7.31	12.63	8.35	7.60
Probability	0.45	0.00	0.00	0.02	0.03	0.00	0.02	0.02

Table 2 Descriptive statistical analysis of long-term bonds

	YIELD	RISK	DEEM	SELL	SIZE	MATURITY	PUT	RATING
Mean	5.03	0.02	0.05	0.78	13.19	5.51	0.67	1.80
Median	4.92	0.01	0.00	1.00	10.00	5.00	1.00	2.00
Maximum	8.98	0.15	1.00	11.00	60.00	10.00	1.00	3.00
Minimum	2.89	0.00	0.00	0.00	2.00	5.00	0.00	1.00
Std. Dev.	1.27	0.03	0.23	0.91	10.22	0.94	0.47	0.84
Skewness	0.26	2.47	3.95	8.31	2.22	2.05	-0.73	0.40
Kurtosis	2.22	9.75	16.61	95.32	8.92	7.85	1.53	1.54
Jarque-Bera	6.14	487.4	1723.9	61233.8	381.7	281.1	29.77	19.25
Probability	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00

In table 1, short term bond yield sequence is not significant, climate risk, maturity and callable, sequence are significant at 1% level, sellable, bearish and issuance sequence are significant at 5% level. Credit rating sequence is significant at 5% level.

In table 2, long term bond yield series is significant at 5% confidence level, climate risk series, callable series, sellable series, issuance series, expiration date series, credit rating sequence and bearish series are significant at 1% level.

V. MODEL BUILDING

To estimate the impact of climate risk change on corporate bond yield, we build the following model.

$$yield = \beta_1 * \text{climate risk} + \beta_2 * size + \beta_3 * maturity + \beta_4 * rating + \beta_5 * deem + \beta_6 * sell + \beta_7 * put + e_t \quad (1)$$

According to the relevant literature of corporate bonds, we include the following variables, such as climate risk, issuance, maturity date, credit rating, callability, sell, bearish and so on.

Since some independent variables are correlated, we adopt stepwise regression analysis to eliminate irrelevant variables.

VI. EMPIRICAL ANALYSIS

A. Climate risk impact analysis

TABLE 3 CLIMATE RISK ANALYSIS OF LONG-TERM BONDS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.3228***	0.1168	45.555	0.0000
CLIMATE_RISK	13.418***	3.1378	-4.2763	0.0000
R-squared	0.0998	Mean dependent var		5.0253
Adjusted R-squared	0.0943	S.D. dependent var		1.2747
S.E. of regression	1.2131	Akaike info criterion		3.2361
Sum squared resid	242.81	Schwarz criterion		3.2735
Log likelihood	-268.22	Hannan-Quinn criter.		3.2513
F-statistic	18.287***	Durbin-Watson stat		0.9816
Prob(F-statistic)	0.0000			

TABLE 4 CLIMATE RISK ANALYSIS OF SHORT-TERM BONDS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.1741***	0.2067	25.032	0.0000
CLIMATE_RISK	5.3361	4.0109	-1.3304	0.1898
R-squared	0.0363	Mean dependent var		5.0224
Adjusted R-squared	0.0158	S.D. dependent var		1.2166
S.E. of regression	1.2070	Akaike info criterion		3.2541
Sum squared resid	68.469	Schwarz criterion		3.3313
Log likelihood	-77.725	Hannan-Quinn criter.		3.2834
F-statistic	1.7699	Durbin-Watson stat		0.8214
Prob(F-statistic)	0.1898			

As shown in table 3, for long-term bond, climate risk and the constant term is significant at 1% confidence level. R^2 is 10%. Indicating that climate risk has an important impact on long-term bonds. The model was significant at 1% .

In table 4, constant term is significant at 1%, while the climate risk is not. The model is not significant.

Climate risk has greater impact on long term bond yield than on short term bond yield, and a negligible impact on short-term bond yields. This is mainly because short-term bonds have a short maturity and climate risk changes are long-term processes. Therefore, climate risk is not sensitive to short term bond yield but to long term bond yield.

B. The influence of callability on bond yield

TABLE 5 ANALYSIS OF THE IMPACT OF CALLABLE ON LONG-TERM BOND YIELD

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.3782	0.1191	45.142	0.0000
CLIMATE_RISK	13.923	3.1207	-4.4614	0.0000
DEEM	-0.8196	0.4135	-1.9823	0.0491
R-squared	0.1208	Mean dependent var		5.0253
Adjusted R-squared	0.1101	S.D. dependent var		1.2747
S.E. of regression	1.2025	Akaike info criterion		3.2244
Sum squared resid	237.13	Schwarz criterion		3.2804
Log likelihood	-266.24	Hannan-Quinn criter.		3.2472
F-statistic	11.271	Durbin-Watson stat		1.0084
Prob(F-statistic)	0.0000			

TABLE 6 ANALYSIS OF THE IMPACT OF CALLABLE ON SHORT-TERM BOND YIELD

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.9000	0.1663	29.467	0.0000
DEEM	-2.0000	0.6720	2.976	0.0046
R-squared	0.1586	Mean dependent var		5.0224
Adjusted R-squared	0.1407	S.D. dependent var		1.2166
S.E. of regression	1.1278	Akaike info criterion		3.1184
Sum squared resid	59.782	Schwarz criterion		3.1956
Log likelihood	-74.401	Hannan-Quinn criter.		3.1477
F-statistic	8.8566	Durbin-Watson stat		0.8554
Prob(F-statistic)	0.0046			

In table 5, constant terms, climate risk and redeemability are significant at 1% level. The model was significant at 1% level. R^2 increased from 10% to 12%. Callability has a significant effect on long-term bond yield.

In table 6, constant terms and redeemability are significant at 1% level. The model was significant at 1% level and R^2 was 16%. It shows that callability has an important effect on short term bond.

Compared with long term bond and short term bond, callability has more impact on short term bond, but less impact on long term bond.

C. The impact of sellable on bond yield

TABLE 7 ANALYSIS OF THE IMPACT OF RETURNABLE ON LONG-TERM BOND YIELD

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.6417***	0.1344	41.963	0.0000
CLIMATE_RISK	12.898***	3.0156	4.2769	0.0000
DEEM	-0.7239*	0.3987	-1.8156	0.0713
SELL	-0.3715***	0.0990	-3.7526	0.0002
R-squared	0.1908	Mean dependent var		5.0253
Adjusted R-squared	0.1759	S.D. dependent var		1.2747
S.E. of regression	1.1572	Akaike info criterion		3.1535
Sum squared resid	218.27	Schwarz criterion		3.2282
Log likelihood	-259.32	Hannan-Quinn criter.		3.1838
F-statistic	12.807	Durbin-Watson stat		1.2075
Prob(F-statistic)	0.0000			

In table 7, constant term and climate risk is significant at 1% level; callable term is significant at 10% level, and is negatively correlated with long term bond yield; sellable term is significant at 1% level, and is negatively correlated with long term bond yield. R^2 increased from 12% to 19%. The model was significant at 1% level.

TABLE 8 ANALYSIS OF THE IMPACT OF SELLABLE ON SHORT-TERM BOND YIELD

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.5436***	0.1984	22.9027	0.0000
DEEM	-1.4456**	0.6546	2.2082	0.0323
SELL	-0.9109***	0.3171	2.8721	0.0061
R-squared	0.2865	Mean dependent var		5.0224
Adjusted R-squared	0.2555	S.D. dependent var		1.2166
S.E. of regression	1.0498	Akaike info criterion		2.9943
Sum squared resid	50.692	Schwarz criterion		3.1101
Log likelihood	-70.36	Hannan-Quinn criter.		3.0382
F-statistic	9.2359	Durbin-Watson stat		0.6830
Prob(F-statistic)	0.0004			

As shown in table 8, constant term is significant at 1% level, callable term is significant at 5%, and is negatively correlated with short term bond yield; sellable term is significant at 1%, and is negatively correlated with short term bond yield. R^2 increased from 16% to 29%. The model was significant at 1%.

Compared with long term bond and short term bond, sellable bond have a significant impact on the yield of long-term bonds. If sellable bond, their yield decreases, while if not sellable bond, their yield increases. Retractable has a very important effect on short-term bond yield, which explains a lot of short-term bond yield.

D. Analysis of the impact of issuance on bond yield

TABLE 9 ANALYSIS OF THE IMPACT OF ISSUANCE ON LONG-TERM BOND YIELD

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.9659***	0.1617	36.895	0.0000
CLIMATE_RISK	10.550***	3.0043	-3.5116	0.0006
DEEM	-0.8167**	0.3875	-2.1079	0.0366
SELL	-0.3415***	0.0964	-3.5445	0.0005
ISSUE_SIZE	-0.0299***	0.0088	-3.3871	0.0009
R-squared	0.2443	Mean dependent var		5.0253
Adjusted R-squared	0.2256	S.D. dependent var		1.2747
S.E. of regression	1.1217	Akaike info criterion		3.0971
Sum squared resid	203.84	Schwarz criterion		3.1904
Log likelihood	-253.61	Hannan-Quinn criter.		3.1350
F-statistic	13.090	Durbin-Watson stat		1.2662
Prob(F-statistic)	0.0000			

TABLE 10 ANALYSIS OF THE IMPACT OF ISSUANCE ON SHORT-TERM BOND YIELDS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.1200***	0.3006	17.034	0.0000
DEEM	-1.2021*	0.6292	1.9104	0.0625
SELL	-0.7379**	0.3091	2.3869	0.0213
ISSUE_SIZE	-0.0466**	0.0189	-2.4604	0.0178
R-squared	0.3711	Mean dependent var		5.0224
Adjusted R-squared	0.3292	S.D. dependent var		1.2166
S.E. of regression	0.9965	Akaike info criterion		2.9089
Sum squared resid	44.681	Schwarz criterion		3.0633
Log likelihood	-67.268	Hannan-Quinn criter.		2.9675
F-statistic	8.8515	Durbin-Watson stat		0.8656
Prob(F-statistic)	0.0001			

In table 9, constant term is significant at 1% level, climate risk is significant at 1%, and is positively correlated with long term bond yield; callable term is significant at 5%, and is negatively correlated with long term bond yield; sellable term is significant at 1%, and is negatively correlated with long term bond yield; issuance term is significant at 1%, and is negatively correlated with long term bond yield. R^2 increased from 19% to 24%. The model was significant at 1%.

As shown in table 10, constant term is significant at the 1% level, callable term is significant at the 10% level, and is negatively correlated with short term bond yield; sellable term is significant at 5% level, and is negatively correlated with short term bond yield; issuance term is significant at 5% level, and is negatively correlated with short term bond yield. R^2 increased from 29% to 37%. The model was significant at 1% level.

Compared with impact of issuance on long term bond and short term bond, it is significant, and has greater impact on short term bond yield.

E. Analysis of the impact of maturity date on bond yield

As shown in table 11, constant term is significant at 1% level and climate risk is significant at 1% level, which is positively correlated with long term bond yield. When climate risk increases, long term bond yield increases; when climate risk becomes small, the long-term bond yield decreases. Callability is significant at 5% level and negatively correlated with long term bond yields. Sell is significant at 1% level and negatively correlated with long term bond yield. Issuance is significant at 1% level and negatively correlated with long term bond yields. Maturity is significant at 1% level and is positively correlated with long term bond yields. When maturity date is long, long term bonds face greater risks and higher yields; on the contrary, when maturity date is short, long term bond faces less risks and lower yields. R^2 increased from 24% to 29%. The model was significant at 1% level.

TABLE 11 ANALYSIS OF THE IMPACT OF MATURITY DATE ON LONG-TERM BOND YIELD

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.1643***	0.5564	7.4850	0.0000
CLIMATE_RISK	12.339***	2.9602	-4.1684	0.0000
DEEM	-0.8793**	0.3761	-2.3382	0.0206
SELL	-0.2884***	0.0947	-3.0441	0.0027
ISSUE_SIZE	-0.0247***	0.0087	-2.8428	0.0051
MATURITY	0.3145***	0.0939	3.3750	0.0009
R-squared	0.2942	Mean dependent var		5.0253
Adjusted R-squared	0.2723	S.D. dependent var		1.2747
S.E. of regression	1.0874	Akaike info criterion		3.0407
Sum squared resid	190.37	Schwarz criterion		3.1527
Log likelihood	-247.90	Hannan-Quinn criter.		3.0862
F-statistic	13.422	Durbin-Watson stat		1.3233
Prob(F-statistic)	0.0000			

As shown in table 12, the constant term is significant at 1% level, while callable has no significant effect on short term bond yield. Sellable is significant 1% level and negatively correlated with short term bond yield. Issuance is significant at 1% level and negatively correlated with short term bond yield. The confidence level of the maturity date is significant at 1%, which is positively correlated with the short term bond yield. When the maturity date is long, the risk is larger and the yield is higher; when maturity date is short, the risk is smaller and the yield is lower. R^2 increased from 37% to 59%. The model was significant at 1% level. Callable is not

significant, remove this variable.

Compared with the effect of maturity date on the yield of long term bond and short term bond, both of them are significant, but the effect of maturity date on short term bond is greater.

TABLE 12 ANALYSIS OF THE IMPACT OF MATURITY DATE ON SHORT-TERM BOND YIELD

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.7484***	0.9932	9.8148	0.0000
DEEM	-0.5908	0.5306	1.1134	0.2716
SELL	-1.4706***	0.2954	4.9783	0.0000
ISSUE_SIZE	-0.0457***	0.0155	-2.9451	0.0051
MATURITY	1.5844***	0.3294	-4.8099	0.0000
R-squared	0.5878	Mean dependent var		5.0224
Adjusted R-squared	0.5504	S.D. dependent var		1.2166
S.E. of regression	0.8158	Akaike info criterion		2.5272
Sum squared resid	29.284	Schwarz criterion		2.7202
Log likelihood	-56.9159	Hannan-Quinn criter.		2.6004
F-statistic	15.6878	Durbin-Watson stat		1.4710
Prob(F-statistic)	0.0000			

F. Bearish impact on bond yields

As shown in table 13, constant term is significant at 1% level, climate risk is significant at 1% level, and is positively correlated with long term bond yield. Callability is significant at 1% level and negatively correlated with long term bond yields. Sellable is not significant. Issuance is significant at 1% level and negatively correlated with long term bond yield. Maturity is significant at 5% level and is positively correlated with long term bond yield. Bearish is significant at 1% level and negatively correlated with long term bond yield. If bearish, long term bond yield will decrease; if bullish, long-term bond yields will rise. R^2 increased from 29% to 36%. The model was significant at the 1% level.

TABLE 13 BEARISH EFFECTS ON LONG-TERM BOND YIELDS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.1268***	0.5808	8.8276	0.0000
CLIMATE_RISK	8.9955***	2.9411	-3.0585	0.0026
DEEM	-1.5416***	0.3937	-3.9154	0.0001
SELL	-0.0733	0.1046	-0.7011	0.4843
ISSUE_SIZE	-0.0249***	0.0083	-3.0029	0.0031
MATURITY	0.2169**	0.0921	2.3552	0.0197
PUT	-0.9372***	0.2291	-4.0917	0.0001
R-squared	0.3611	Mean dependent var		5.0253
Adjusted R-squared	0.3371	S.D. dependent var		1.2747
S.E. of regression	1.0378	Akaike info criterion		2.9532
Sum squared resid	172.34	Schwarz criterion		3.0839
Log likelihood	-239.59	Hannan-Quinn criter.		3.0062
F-statistic	15.069	Durbin-Watson stat		1.3312
Prob(F-statistic)	0.0000			

As shown in table 14, the constant term is significant at 1% level, and resell is significant at 1%, which is negatively correlated with the short term bond yield. Issuance is significant at 1% and negatively correlated with short term bond yields. Maturity is significant at 1% level and is positively correlated with short term bond yields. Bearish is not significant, remove this variable. R^2 is 59%. The model was significant at 1% level.

TABLE 14 BEARISH EFFECTS ON SHORT-TERM BOND YIELDS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.7484***	0.9932	9.8148	0.0000
SELL	-2.0614***	0.5152	4.0009	0.0002
ISSUE_SIZE	-0.0457***	0.0155	-2.9451	0.0051
MATURITY	1.5844***	0.3294	-4.8099	0.0000
PUT	-0.5908	0.5306	-1.1134	0.2716
R-squared	0.5878	Mean dependent var		5.0224
Adjusted R-squared	0.5504	S.D. dependent var		1.2166
S.E. of regression	0.8158	Akaike info criterion		2.5272
Sum squared resid	29.284	Schwarz criterion		2.7202
Log likelihood	-56.916	Hannan-Quinn criter.		2.6004
F-statistic	15.688	Durbin-Watson stat		1.4710
Prob(F-statistic)	0.0000			

Comparing the impact of bearishness on long term bond yield and short term bond yield, bearishness has a significant negative correlation with long term bond yield, but has no significant impact on short term bond yield.

G. Analysis of the impact of credit rating on bond yield

As shown in table 15, constant term is significant at 1% level, while the climate risk is not. Callability is significant at 1% level and negatively correlated with long term bond yields. Issuance is significant at 1% level and negatively correlated with long term bond yield. Maturity date is not significant. Bearishness is significant at 1% level and negatively correlated with long term bond yield. The level of credit rating at 1% is significant, which is positively correlated with long term bond yield. When bond rating is low, bond yield rises; when bond rating is high, bond yield decreases. R^2 increased from 36% to 51%. The model was significant at 1% level.

TABLE 15 ANALYSIS OF THE INFLUENCE OF CREDIT RATING ON LONG-TERM BOND YIELD

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.6931***	0.5106	9.1914	0.0000
CLIMATE_RISK	1.5933	2.7591	-0.5775	0.5644
DEEM	-1.2978***	0.3342	-3.8837	0.0002
ISSUE_SIZE	-0.0213***	0.0073	-2.9329	0.0039
MATURITY	0.0080	0.0856	0.0930	0.9261
PUT	-0.8856***	0.1739	-5.0937	0.0000
RATING	0.7061***	0.0992	7.1146	0.0000
R-squared	0.5131	Mean dependent var		5.0253
Adjusted R-squared	0.4949	S.D. dependent var		1.2747
S.E. of regression	0.9060	Akaike info criterion		2.6814
Sum squared resid	131.32	Schwarz criterion		2.8121
Log likelihood	-216.89	Hannan-Quinn criter.		2.7344
F-statistic	28.104	Durbin-Watson stat		1.2905
Prob(F-statistic)	0.0000			

As shown in table 16, constant terms are significant at 1% level. Sellable is significant at 1% level and negatively correlated with short term bond yields. Issuance is significant at 5% level and negatively correlated with short term bond yield. Maturity is significant at 1% level and is positively correlated with short term bond yield. Credit rating has no

significant effect on short term bond yield. R^2 is 59%. The model was significant at 1% .

TABLE 16 ANALYSIS OF THE INFLUENCE OF CREDIT RATING ON SHORT-TERM BOND YIELD

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.4397***	1.1256	8.3865	0.0000
SELL	-1.5315***	0.2834	5.4042	0.0000
ISSUE_SIZE	-0.0414**	0.0168	-2.4711	0.0174
MATURITY	1.5971***	0.3289	-4.8563	0.0000
RATING	0.2107	0.2066	1.0198	0.3134
R-squared	0.5860	Mean dependent var		5.0224
Adjusted R-squared	0.5484	S.D. dependent var		1.2166
S.E. of regression	0.8176	Akaike info criterion		2.5316
Sum squared resid	29.414	Schwarz criterion		2.7246
Log likelihood	-57.024	Hannan-Quinn criter.		2.6048
F-statistic	15.570	Durbin-Watson stat		1.4440
Prob(F-statistic)	0.0000			

Comparing the effect of credit rating on yield of long term bonds and short term bonds, credit rating has a great impact on yield of long term bond and can explain a large part of the yield of long term bond. However, credit rating has no significant effect on short term bond yield.

VII. CONCLUSION

This paper mainly studies the impact of climate risk on the yield of long term bond and short term bond. The results are as follows.

First, climate risk has significant impact on long term bond yield. Climate risk has no significant impact on short term bond yield. Climate risk has greater impact on long term bond yield than on short term bond yield, and negligible impact on short term bond yield. This is mainly because short term bond have short maturity and climate risk changes are long term processes. Therefore, climate risk is not sensitive to short term bond yield but to long term bond yield.

Second, callability has significant impact on both long term and short term bond yield. However, callability has greater impact on short term bond and relatively small impact on long term bond.

Third, sellable bond have significant impact on yield of both long term bond and short term bond. When sellable bonds are available, their yield decreases, while when not sellable, their yield increases. Retractable has very important effect on short term bond yield, which explains a lot of short term bond yield.

Fourth, issuance has significant impact on both long term bond and short term bond, and greater impact on short term bond yield.

Fifth, by comparing impact of maturity date on yield of long term bond and short term bond, both of them are significant. When maturity date is long, the risk is larger and yield is higher; when maturity date is short, the risk is smaller and the yield is lower. But maturities matter more for short term bonds.

Sixth, by comparing the impact of bearishness on long term bond yield and short term bond yield, bearishness has a significant negative correlation with long term bond yield, but has no significant impact on short term bond yield.

In the end, by comparing the impact of credit rating on yield of long term bond and short term bond, credit rating has great impact on yield of long term bond and can explain large part of yield of long term bond. However, credit rating has no significant effect on short term bond yield.

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