The liquidity impact on Chinese green bonds spreads

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RESEARCH BACKGROUND FOR REALITY

- **Green bonds:** The use of proceeds are limited to funding the green projects that meet the prescribed conditions.
- As a new financing channel for green projects, green bonds have been keenly promoted. Since 2016, China's green bond market has been developing rapidly and has achieved *"From Zero To Hero"*. Nowadays, China is the second largest green bonds issuance nation.
- China has set a goal to peak carbon emissions by 2030 and achieve **carbon neutrality** by 2060. The realization of this goal will inevitably require the applications of financial instruments. Actually, promoting the development of green bonds has sufficient practical significance for the green economy and the realization of carbon neutrality
- Such contexts provide considerable demands to investigate the green bonds from operation mechanisms, financial characteristics, and investment strategies, especially for China

RESEARCH BACKGROUND FOR LITERATURE

- The research on green bonds mainly includes three aspects:
  (1) the issuers' financial reaction to green bonds issuance;
  (2) the premium between green and conventional bonds;
  (3) how to introduce the green bonds into portfolio.

- Little attention has been paid from the perspective of liquidity preference: *People are more willing to hold the risk assets with better liquidity, otherwise, they acquire premium profits.* The bond market's liquidity is directly related to the financing ability and financing of the issuers, and it is also associated with investors' vital interests.

Aim **Identify the notion of liquidity impact with a special focus on the green bonds.**

Research setting *China* (due to the realistic demand and typicality for developing nations.)

Market concentration *Secondary market* (This is still an unknown area)

Liquidity proxies *Indirect measures* (Direct measures like LOT or Bid-Ask are not be consistently reliable and difficult to obtain; for most investors, indirect measures based on bond traits and/or related market information are effective to guide the them conveniently judging the liquidity).

Summarized as two key questions

- Which potential proxies based on bond characteristics can effectively indicate the liquidity of the green bond?
- How much the liquidity impact is embedded in green bond spreads?

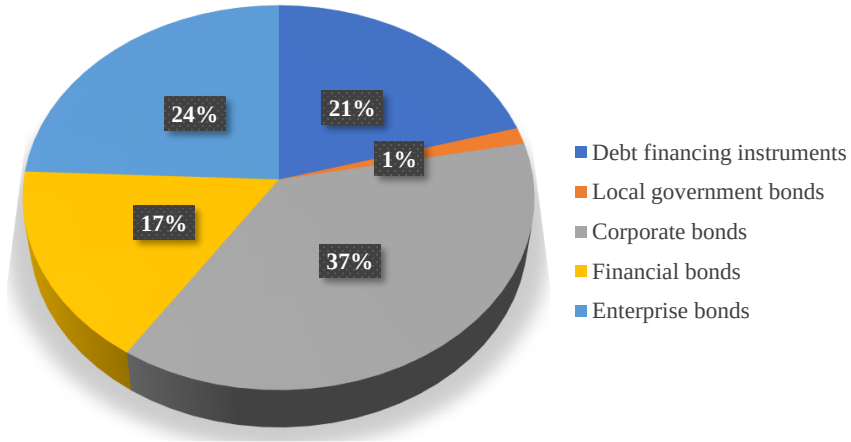


Figure: The stylized facts for Chinese green bond markets

This study focuses on green corporate and enterprise bonds to address liquidity impact issues

Do research as the following steps

Figure: Three main steps for the study

Data collection

We collect the data from the CSMAR, including the sample period from June 5, 2016, to December 31, 2020.

Data framework

After filtering the samples with missing fields, 124 labeled green bonds were tracked and 2778 secondary market observations were obtained

Selecting proxies based on related researches

Table: Description of nine potential liquidity proxies

Potential liquidity proxy	Description	Type	Expected sign
Issued amount	CNY billion	Quantitative	-
Maturity	Maturity period in years	Quantitative	+
Yield volatility	The standard deviation of yield spreads of a green bond	Quantitative	+
Yield dispersion	The standard deviation of secondary market green bond yield spreads relative to the spreads at issuance	Quantitative	+
Time to maturity	The remaining trading time to the maturity date (years)	Quantitative	+
The listed issuer or not	Whether the green bond is issued by the listing issuer, if so, the value is 1 and 0 otherwise	Qualitative	-
The specific target of proceeds	Does the green bond specifically describe the utilization target of the proceeds (For instance, a green bond declares their proceeds would be used in a specific wind power project), 1 if specific green projects are pointed, 0 otherwise	Qualitative	+
On the run	Whether a green bond is the latest bond released by the same issuer, if so 1, 0 otherwise (Note: if an issuer has issued only one bond, we define this bond as an on-the-run bond)	Qualitative	-
Reputation of underwriter	The reputation of a lead underwriter of a green bond, measured by the classic MW method (Megginson and Weiss, 1991)	Quantitative	-

Specific description for some proxies

The specific target of proceeds

Since the main difference between the green and conventional bonds are the limitation of the use for proceeds, in other words, the greenness distinguishes them. Assuming that this difference causes the two bonds to be affected by different liquidity (exactly it has been supported by Febi et al., 2018), it is rational to infer the degree of greenness might display similar effects inside the green bonds.

The reputation of underwriters

A more reputable underwriter can bring more attention to the bond; thus, we consider the reputation of the underwriter might negatively affect the liquidity premiums of green bonds(Andres et al.,2014).

Selecting control variables based on related researches

Bond-related variables

1. bond rating
2. bond issuer rating
3. bond specific type

Macro-related variables

1. SHCI stock return
2. Shanghai Energy Industry Index changes
3. Corporate Bond Index

Panel A: Cross-sectional statistics over the sample for Chinese green bonds										
	N	Mean	SD	variance	Min	25th percentiles	75th percentiles	Max	Kurtosis	Skewness
Yield spread (bps)	2778	191.401	113.525	12887.810	0.538	109.425	258.469	648.476	3.536	0.914
Issued amount	2778	1.449	1.068	1.140	0.030	0.600	2.000	5.000	4.765	1.364
Maturity	2778	6.385	2.448	5.993	3.000	5.000	7.000	20.000	8.826	1.625
Volatility	2778	0.078	0.095	0.009	0.009	0.035	0.091	1.609	64.743	6.264
Dispersion	2778	2.801	3.601	12.965	0.035	0.047	29.675	35.485	19.364	3.371
Time to maturity	2778	4.869	2.591	6.712	0.172	3.008	6.325	19.820	8.226	1.476
Listed issuer or not	2778	0.444	0.497	0.247	0.000	0.000	1.000	1.000	1.050	0.225
Specific target of proceeds	2778	0.517	0.500	0.250	0.000	0.000	1.000	1.000	1.004	-0.066
On the run	2778	0.435	0.496	0.246	0.000	0.000	1.000	1.000	1.068	0.261
Reputation of underwriter	2778	2.498	2.206	4.867	0.000	0.452	4.046	8.898	2.921	0.706

Panel B: Average cross-sectional correlations										
	Yield spread (bps)	Issued amount	Maturity	~~Volatility~~	Dispersion	Time to maturity	The listed issuer or not	The specific target of proceeds	~~On the run~~	Reputation of underwriter
Yield spread (bps)	1.000	**-0.301**	**0.137**	**-0.091**	**0.005**	**0.135**	**-0.221**	**0.268**	**0.089**	**-0.303**
Issued amount		1.000	-0.032	0.065	0.098	-0.069	0.036	-0.005	-0.151	0.473
Maturity			1.000	-0.157	-0.029	0.913	-0.207	-0.027	-0.100	-0.011
Volatility				1.000	0.144	-0.202	0.079	-0.073	-0.004	0.017
Dispersion					1.000	-0.193	0.321	-0.287	-0.149	0.183
Time to maturity						1.000	-0.299	-0.059	-0.061	-0.097
The listed issuer or not							1.000	-0.092	-0.054	0.171
The specific target of proceeds								1.000	-0.075	-0.102
On the run									1.000	0.072
Reputation of underwriter										1.000

Average values of yield spread across portfolios

Sorting the green bonds based on each proxy to construct corresponding five portfolios with the same numbers of observations, the sort order is the supposed bond liquid decreasing; thereby Portfolio 5 would have the largest liquidity premiums

Panel A: Mean values of yield spread

Liquidity Proxies	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5
Issued amount	119.8902	163.8515	200.2369	227.0084	245.9011
Maturity	152.8105	165.3481	180.8417	261.2634	197.0390
Volatility	200.7133	189.4313	190.2418	195.7943	180.8296
Dispersion	157.2984	184.0134	193.8501	207.2464	214.6129
Time to maturity	177.7596	184.0564	188.1414	212.3769	194.6961
Listed sponsor or not	188.2612	197.1076			
Specific target of proceeds	180.9942	201.1410			
On the run	207.6126	178.9094			
Reputation of underwriter	147.5637	170.9639	200.1313	210.1462	228.1978

Portfolio-based regression analysis

$$ln(YiledSpread_{it}^{kj}) = \alpha_0^{kj} + \beta_1^{kj} Rating_i + \beta_2^{kj} Irating_i + \beta_3^{kj} Type_i + \beta_4^{kj} Stateownedissuer_i + \beta_5^{kj} SHCI_i + \beta_6^{kj} Energy_i + \beta_7^{kj} BondIdex_i + \beta_8^{kj} Year_i + \varepsilon_{it}^{kj}$$

Where j =1,2...9 representing different proxies and k =1,2...5 indicating the portfolios. Note that Rating and Irating are assigned values according to the regime that 1 for AA, 2 for AA+, and 3 for AAA.

	Amount		Maturity		Volatility	
Portfolio	Intercept	R-squared	Intercept	R-squared	Intercept	R-squared
1	2.314**	0.782	-0.329	0.3134	-0.329	0.313
	(1.686)		(2.726)		(2.726)	
2	5.159	0.646	1.253	0.2588	1.253	0.259
	(2.501)		(2.382)		(2.382)	
3	-1.065	0.569	4.599**	0.5131	4.599**	0.5133
	(1.975)		(1.840)		(1.840)	
4	1.312**	0.334	3.269*	0.6497	3.269*	0.650
	(1.750)		(1.950)		(1.950)	
5	4.201	0.223	3.741**	0.6110	3.741**	0.611
	(1.792)		(1.512)		(1.511)	
	Dispersion		Time to maturity		Listed sponsor or not	
Portfolio	Intercept	R-squared	Intercept	R-squared	Intercept	R-squared
1	1.131	0.683	-1.114	0.234		
	(1.411)		(3.044)			
2	-0.853	0.619	-2.172	0.307	2.509	0.286
	(1.484)		(2.244)		(1.681)	
3	3.365*	0.512	5.730***	0.441		
	(1.864)		(1.908)			
4	6.214**	0.484	4.440**	0.618	1.963*	0.533
	(2.921)		(1.785)		(1.034)	
5	2.435	0.237	3.971***	0.650		
	(2.735)		(1.374)			
	The specific target of proceeds		On the run		Reputation of main underwriter	
Portfolio	Intercept	R-squared	Intercept	R-squared	Intercept	R-squared
1					-0.394	0.624
					(1.960)	
2	3.613***	0.410	1.665	0.414	-0.240	0.559
	(1.157)		(1.320)		(2.645)	
3					1.719	0.553
					(2.136)	
4	3.405**	0.408	2.637**	0.451	5.257***	0.308
	(1.568)		(1.309)		(1.693)	
5					5.723***	0.208
					(2.154)	

Pooled regression method

$$ln(YiledSpread_{it}^{kj}) = \alpha_0^{kj} + \beta_1^{kj} Rating_i + \beta_2^{kj} Irating_i + \beta_3^{kj} Type_i + \beta_4^{kj} Stateownedissuer_i + \beta_5^{kj} SHCI_i + \beta_6^{kj} Energy_i + \beta_7^{kj} BondIdex_i + \beta_8^{kj} Year_i + \gamma^j proxy_{it}^j + \varepsilon_{it}^{kj}$$

Where the abbreviations and subscript denote the same meaning as the Eq. (1). γ^j is the coefficients of liquidity proxies

	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Constant	2.376** (0.955)	2.303** (0.941)	2.278** (0.960)	2.504*** (0.955)	2.189** (0.944)	2.285** (0.962)	2.349** (0.956)	2.569*** (0.948)	2.367** (0.958)	2.365** (0.950)
Amount		-0.130*** (0.012)								
Maturity			0.013** (0.005)							
~~Yield volatility~~				-0.139 (0.161)						
Yield dispersion					0.031*** (0.003)					
Time to maturity						0.009* (0.005)				
~~The listed issuer or not~~							0.027 (0.025)			
The specific target of proceeds								0.194*** (0.024)		
~~On the run~~									0.008 (0.024)	
Reputation of underwriter										-0.033*** (0.006)
Controlling other risks	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observation	2,778	2,778	2,778	2,778	2,778	2,778	2,778	2,778	2,778	2,778
R-squared	0.4216	0.4542	0.4232	0.4219	0.4413	0.4224	0.4218	0.4354	0.4216	0.4288

Pooled regression method

$$ln(YiledSpread_{it}^{kj}) = \alpha_0^{kj} + \beta_1^{kj} Rating_i + \beta_2^{kj} Irating_i + \beta_3^{kj} Type_i + \beta_4^{kj} Stateownedissuer_i +$$
$$\beta_5^{kj} SHCI_i + \beta_6^{kj} Energy_i + \beta_7^{kj} BondIdex_i + \beta_8^{kj} Year_i + \gamma^j proxy_{it}^j + \gamma^k proxy_{it}^k + \varepsilon_{it}^{kj}$$

if γ^k a significant coefficient with the expected sign, it is supported to have the additional interpretative capacity to $proxy^j$

	Model 0	Model 1-2	Model 1-4	Model 1-5	Model 1-7	Model 1-9	Model 2-4	Model 2-5	Model 2-7
Constant	2.376** (0.955)	2.241** (0.946)	2.097** (0.925)	2.281** (0.947)	2.492*** (0.936)	2.304** (0.940)	2.120** (0.948)	2.333** (0.965)	2.452*** (0.953)
Amount		-0.128*** (0.012)	-0.137*** (0.012)	-0.129*** (0.012)	-0.128*** (0.012)	-0.121*** (0.012)			
Maturity		0.008 (0.005)					0.010* (0.005)	0.030** (0.013)	0.016*** (0.005)
Yield dispersion			0.034*** (0.003)				0.031*** (0.003)		
Time to maturity				0.002 (0.005)				-0.017 (0.012)	
The specific target of proceeds					0.190*** (0.024)				0.201*** (0.024)
Reputation of underwriter						-0.013** (0.006)			
Controlling other risks	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observation	2,778	2,778	2,778	2,778	2,778	2,778	2,778	2,778	2,778
R-squared	0.423	0.450	0.472	0.449	0.462	0.450	0.442	0.424	0.438

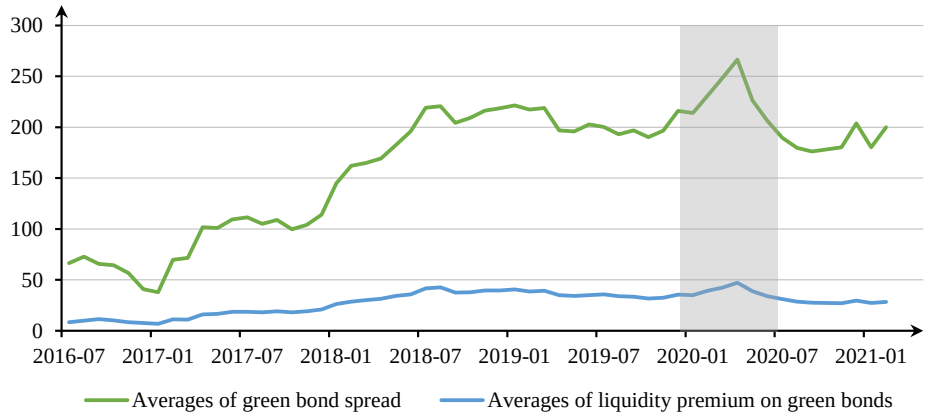
	Model 2-9	Model 4-5	Model 4-7	Model 4-9	Model 5-7	Model 5-9	Model 7-9	Model 1-2-4-5-7-9	Model 1-4-5-7-9
Constant	2.266** (0.956)	2.054** (0.951)	2.407*** (0.924)	2.1616** (0.9376)	2.430** (0.954)	2.294** (0.957)	2.554*** (0.944)	2.044** (0.907)	2.159** (0.910)
Amount								-0.120*** (0.012)	-0.121*** (0.012)
Maturity	0.013** (0.005)							-0.053*** (0.015)	
Yield dispersion		0.032*** (0.003)	0.043*** (0.003)	0.0338*** (0.0027)				0.055*** (0.004)	0.048*** (0.003)
Time to maturity		0.013*** (0.005)			0.014*** (0.024)	0.007 (0.005)		0.065*** (0.014	0.015*** (0.005)
The specific target of proceeds			0.288*** (0.026)		0.205*** (0.005)		0.189*** (0.024)	0.332*** (0.028)	0.303*** (0.025)
Reputation of underwriter	-0.033*** (0.006)			-0.036*** (0.006)		-0.033*** (0.006)	-0.032*** (0.006)	-0.014*** (0.005)	-0.017*** (0.005)
Controlling other risks	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observation	2,778	2,778	2,778	2,778	2,778	2,778	2,778	2,778	2,778
R-squared	0.430	0.443	0.4691	0.451	0.438	0.429	0.442	0.507	0.504

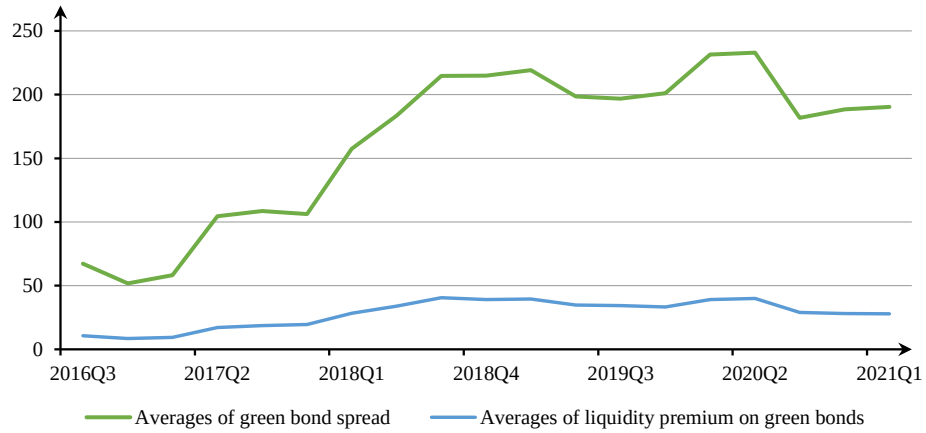
Three steps for estimating liquidity premium based on Nielson et al. (2012)

1. Based on the previous regression of Model 1-4-5-7-9, we obtain the coefficients for liquidity proxies while controlling for credit and macro risk.
2. Defining the liquidity fraction as $\gamma^j(proxy^j_{it} - proxy^j_5)$, where $proxy^j_5$ is the 0.05 quantile of the liquidity proxy j distribution or 0.95 quantile for negative indicators of liquidity impact (The most liquid case). Thus this complete fraction could be interpreted as the amount of the spread due to illiquidity
3. Multiplying the median value of the estimated fraction by the median yield spread of green bonds, which could represents the liquidity impact.

The average liquidity premium calculated based on this approach is 28.14 bps, it accounts for 16.92% of the total green bond spreads

The liquidity premium trends for Chinese green bonds

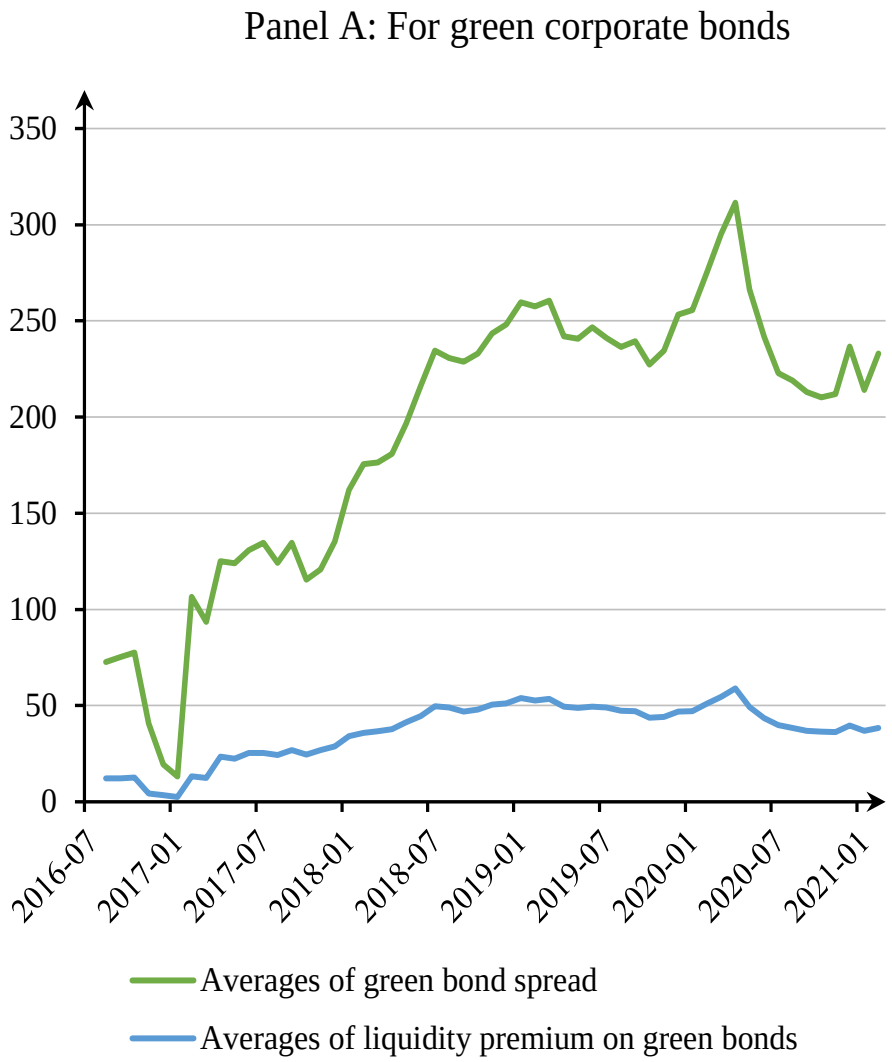




The average yield spreads and liquidity premiums are overall increasing before 2019, which attributes to the interest rate changes and also illustrates the vast development of this emerging asset, the value of Chinese green bonds is gradually recognized by investors. Almost at the same time, the gap between the spreads and premiums is enlarging from a small difference, namely, the weight of liquidity impact in Chinese green bonds has declined. The short-lived peak shape might due to COVID-19.

1. Testing the potential model bias by changing our pooled regression with the fixed effects and random-effects models
2. Regressing two sub-samples of green corporate bonds and green enterprise bonds

	Panel A		Panel B	
	Fixed effects modeling	Random effects modeling	Green corporate bond subsample	Green enterprise bond subsample
Constant	2.760***	1.632**	1.103	3.063***
	(0.926)	(0.745)	(1.538)	(0.965)
Amount	-0.121***	-0.124***	-0.084***	-0.160***
	(0.011)	(0.012)	(0.021)	(0.016)
Yield dispersion	0.048***	0.056***	0.055***	0.034***
	(0.003)	(0.003)	(0.004)	(0.007)
Time to maturity	0.015***	0.014***	0.056***	-0.0124**
	(0.004)	(0.004)	(0.008)	(0.005)
Specific target of proceeds	0.303***	0.338***	0.414***	0.151***
	(0.024)	(0.023)	(0.040)	(0.036)
Reputation of underwriter	-0.017***	-0.019***	-0.014	-0.033***
	(0.006)	(0.006)	(0.014)	(0.006)
Controlling other risks	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Observation	2778	2778	1322	1456
R-squared	0.425	0.424	0.398	0.5737



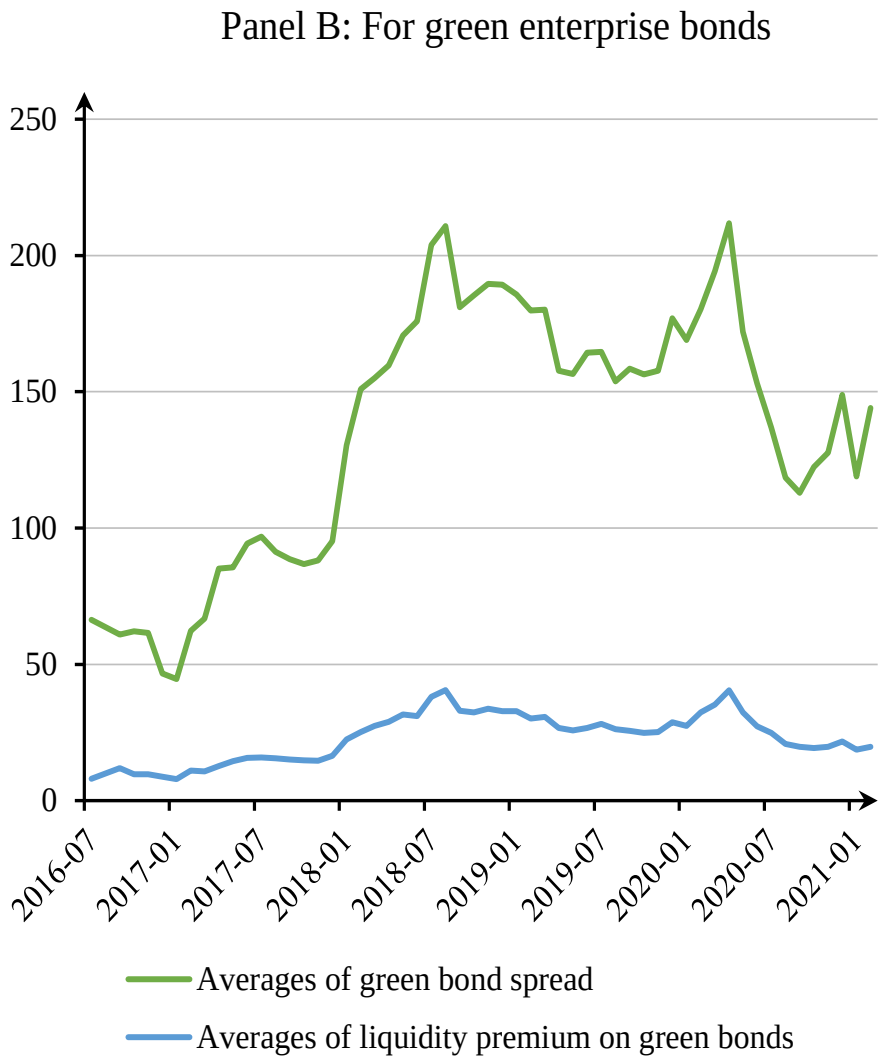


FIGURE: Check for time-varying liquidity premiums of Chinese green bonds

Whether some liquidity differences do exist in green and conventional bonds?

With the employment of mathcing process as Zerbib (2019)

Panel A: The results for green bonds (Excerpted from Table X.)		Panel B: The results for corresponding conventional bonds	
Constant	2.159**	Constant	4.788***
	(0.910)		(0.985)
Amount	-0.121***	Amount	-0.009***
	(0.012)		(0.002)
Yield dispersion	0.048***	Yield volatility	0.609***
	(0.003)		(0.2618)
Time to maturity	0.015***	Time to maturity	0.063***
	(0.005)		(0.012)
Specific target of proceeds	0.303***	Reputation of underwriter	-0.025***
	(0.025)		(0.012)
Reputation of underwriter	-0.017***		
	(0.005)		
Controlling other risks	Y	Controlling other risks	Y
Year fixed effects	Y	Year fixed effects	Y
Observation	2778	Observation	2,106
R-squared	0.504	R-squared	0.455

The differences of liquidity impacts

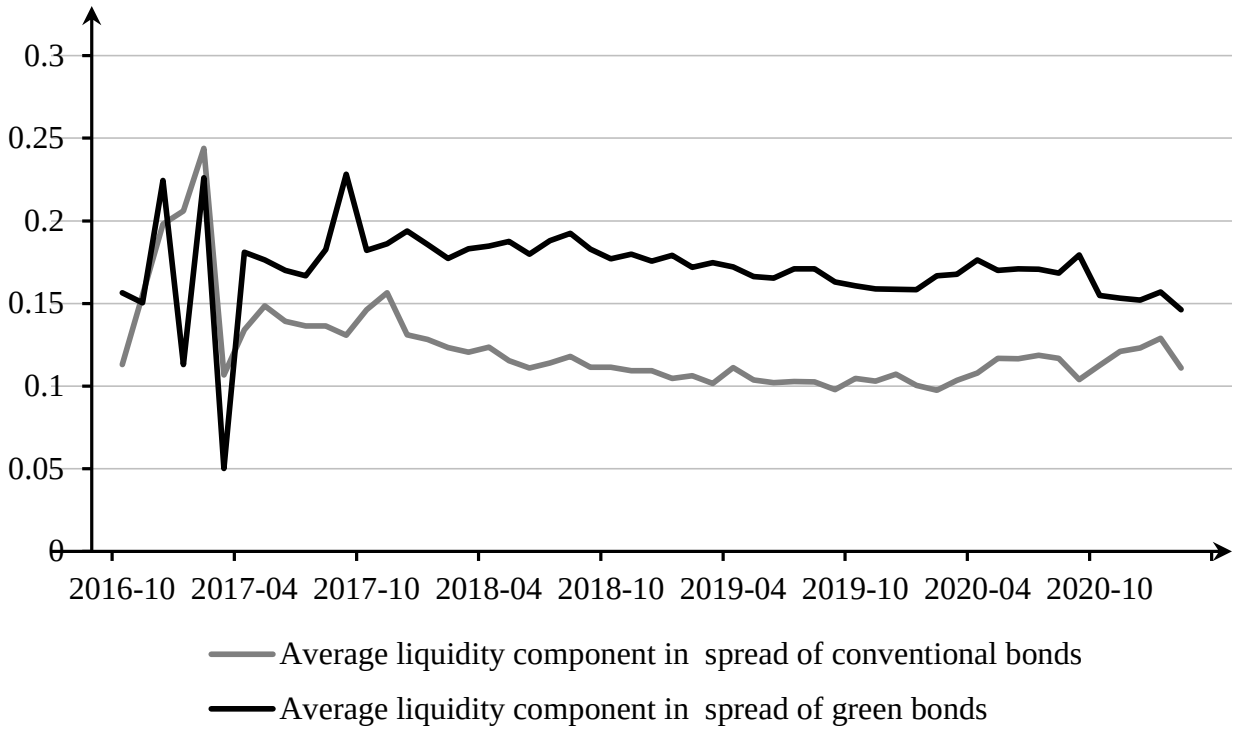


Figure: The liquidity components for green and conventional bonds

- The average liquidity premiums of the matching conventional bonds is around 19.4 bps, significantly lower than green bonds
- The average liquidity component in spread indicates the conventional bonds are more liquid while green bonds are getting more liquid.

1. There are five efficient liquidity proxies out of nine potential measures, they are *issued amount, yield dispersion, time to maturity, the specific target of proceeds, and the reputation of underwriter*;

2. The liquidity impact on Chinese green bonds is the average premium as 28.14 bps, while matching conventional bonds is only 19.4bps on average, green bonds are more illiquid;

3. The overall liquidity of Chinese green bonds is getting better, thus displaying a rising gap between spread and premium, and the liquidity premiums are sensitive to considerable external shocks such as COVID-19.

For Further Reading I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