Financing Renewable Energy: Exploring Green Bonds

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Contents

1 Introduction

Green Bond (GB)

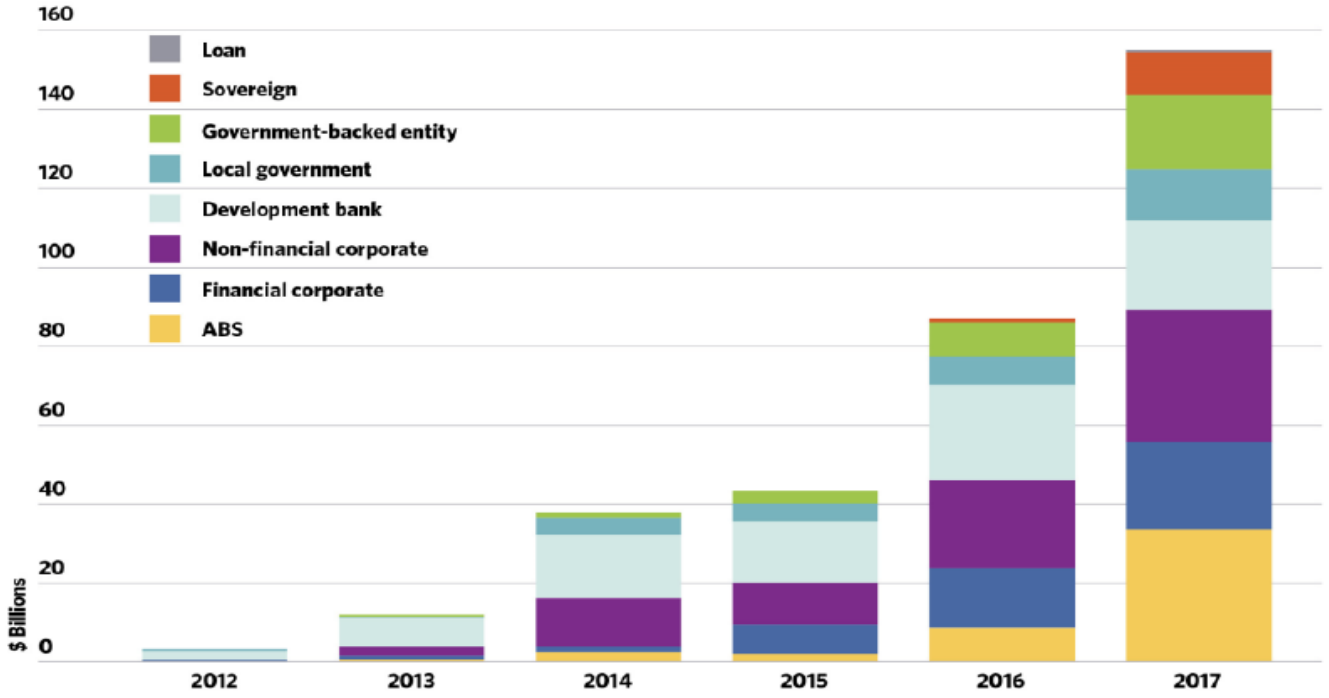
- Financing green investments:
  - Green bonds are fixed income securities which fund exclusively green projects with environmental impacts.
  - They combine both financial and environmental risk into a financial product.
  - Green bonds have been gaining more attention as an innovative way of reducing the negative impacts caused by human economic activities on climate change.
- The green bonds market has grown rapidly over the past decade since the first green bond, "Climate Awareness Bond" was issued by European Investment Bank in 2007.
- More ethical investors emerge and demand for green bond

Green Bond Principles (GBP)

- A key catalyst for the green bond market development was the introduction of the Green Bond Principles (GBP) in January 2014 by the International Capital Market Association (ICMA).
  - The ICMA's GBPs are voluntary process guidelines that outline general criteria that most certification schemes follow. They describe criteria and requirements that underpin the concept of green bonds.
  - The GBPs provide prospective issuers with guidance on the four key elements of green bond issuance:
    - use of proceeds
    - process for project evaluation and selection
    - management of proceeds
    - reporting.

Fast growth of green bond market in recent years

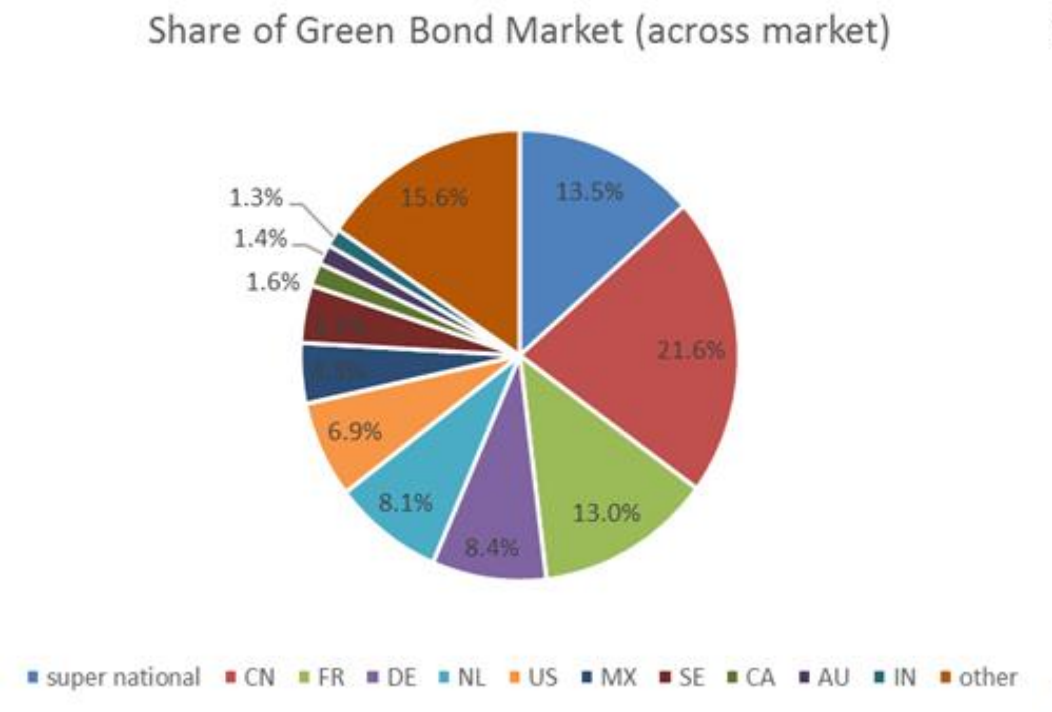
- The GBPs introduced in 2014 contributed to the boom of green bond market during the past 5 years.
- According to Climate Bonds Initiative, green bond issuance worldwide in 2017 reached 155.5 billion USD, amongst which 33% (51 billion) was used for renewable energy projects.

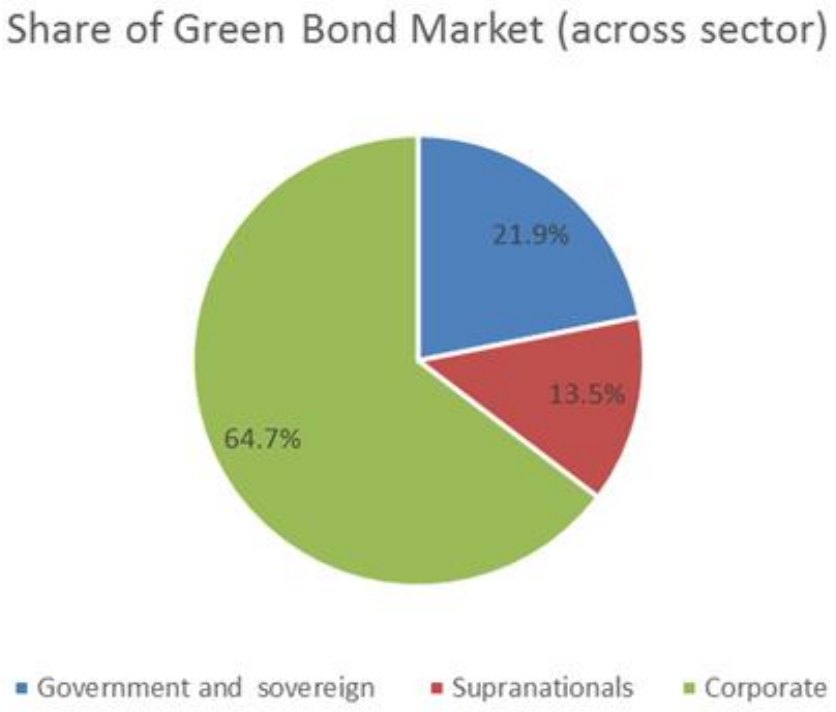


Source: Climate Bonds Initiative

Further breakdown of green bond market

- US, EU and China are leading markets utilizing green bonds to finance for green projects
- Commercial banks are major private issuers





Source: calculated based on Bloomberg data.

Why issuers issue green bond

- Issuers:
  - Boost reputation and claim sustainability
  - Attract ethical investors
- Investors: meet investment mandate
- Governments: achieve sustainable growth

2 Green Bond Market

Players of GB Markets

Issuers

- Cash flow benefit: when an issuer issue both green bonds and conventional bonds, while the risk profiles of the issuers remain unchanged, the proceeds from the green bond form extra cash flows for the green projects and mitigate cash flow pressure of the entire operations of the issuer

Investors

- Investment mandate: green bonds enjoy an extra portion of investors that have green investment mandate. These investors will check indexes and reports provided by the issuers to make their green investment. Usually, investors for green bonds are institutional investors such as investment funds (with green mandate), pension funds and insurance companies.

Players of GB Markets

Underwriters

- Financial institutions that deal with public issuance & distribution of the bond. The terms, definitions, obligations of the bond shall be specified by the under writers.

External Reviewer

- Green claim: The role of the external reviewers is to verify the greenness of th e underlying projects before issuance.

Index Provider

- Enhancer: The index providers are not directly involved in the underwriting of the bond. The inclusion of a green bond to a widely-recognized index may add an extra inch of reliability for investors

Motivation of this study

- Although the green bonds market has expanded substantially, Ehlers and Packer (2017) show that the market for green bonds is nevertheless **still very small** compared to the wider global bond market, representing less than 1.6% of the global debt issuance in 2016.

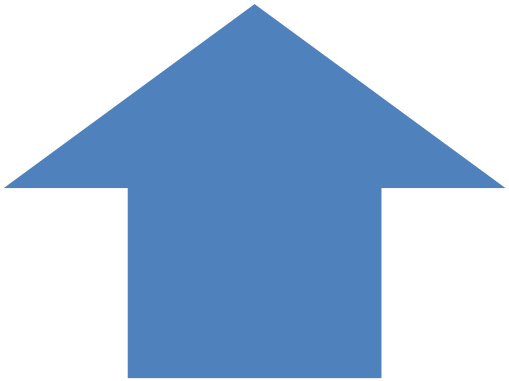
- Several challenges faced by this nascent market
  - while the GBP and Climate Bonds Standard (CBS) serve as the general guidelines to distinguish between green bonds and conventional bonds, a universally accepted definition, standards, enforcement mechanisms and regulations for green bonds still lacks. What constitutes greenness still needs further clarification.
  - The pricing mechanism of green bonds still remains unclear. So called "green bond premium" is not associated directly with the impact green bonds exert on the environment but with sizeable excess demand from ethical investors such as pension fund and insurer
  - This study aims to: 1) uncover the differences between green bonds and conventional bonds pricing ; and 2) to discuss possible measures and building blocks to further develop green bonds markets.

Green Bond Pricing is a key issue in green bond market

Matter to Issuers and Investors

Excess demand from ethical investors

Small market and less liquidity



Existing evidence about green bond pricing

	Major findings
Zerbib (2017)	- Using a matching method (compare 135 eligible green bond to similar conventional bonds) and show that the **average green bond premium was -8bps against conventional bonds** within the whole sample of Investment Grade bonds, -5bs in the USD bonds, and -2bps in the EUR. - He calls attention to the presence of **excess demand** for green bonds in the market.
Ehlers and Packer (2017)	- Compare the credit spreads at issuance of a cross-section of 21 green bonds issued between 2014 and 2017 and show that green bond issuers on average have borrowed at **lower** spreads than they have through conventional bonds. - Their findings confirm the results from other recent studies such as Zerbib (2017), Barclays (2015)

Existing evidence about green bond pricing

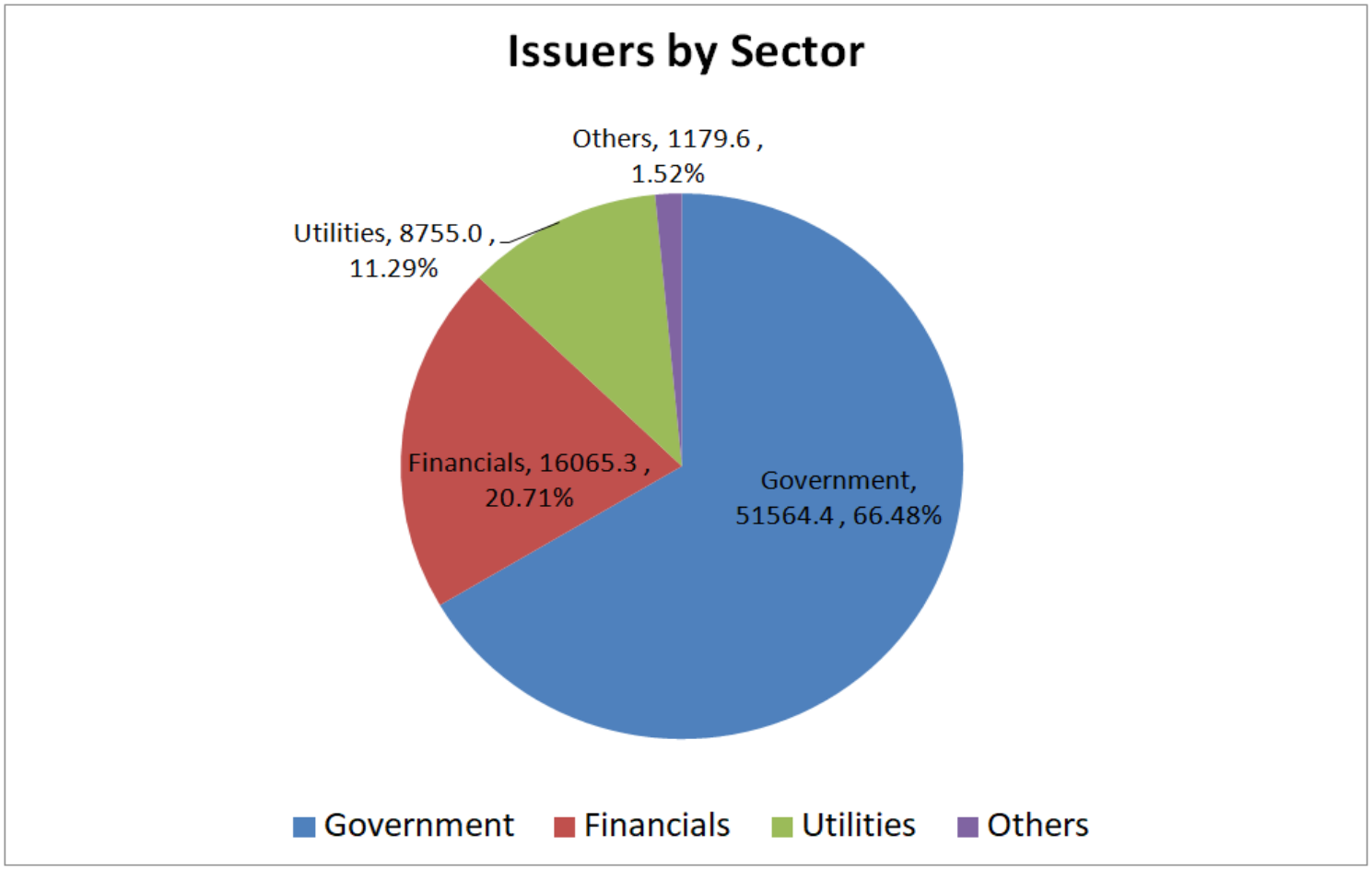
	Major findings
Wulandari et al (2017)	Investigate the relationship between liquidity risk and yield spread for both green and conventional bonds. The evidence shows that liquidity is positively related to the yield spread. However, for green bonds, the impact of **liquidity risk on yield spread has become negligible** over time.
Barclays (2015)	The cross-sectional analysis indicates that **-17 bps premium** as of mid-2015. However, historical returns of green bonds show similar results with conventional bonds.
Petrova (2016)	He finds **no evidence for the difference** between green bonds and conventional bonds during 2008-2016 by using time-series and panel-data analysis in a multi-index model framework.
Östlund (2015)	- Using 28 matching pairs of green bonds and conventional bonds and test a statistical hypothesis that the yield of green bond is equal to that of conventional bond. The results show that there is **no evidence of green bond discount** in the overall dataset.

3 Empirical Analysis

Sample Construction

- Starting from a sample of 990 green bonds complying with the GBPs on November 10, 2017.
- Matching sample: build the equivalent conventional bond, for each green bond, with the closest maturity, currency, rating, bond structure, seniority, collateral and coupon type from the same issuer, i.e. having exactly the same characteristics
  - Using the same selection process in line with Zerbib (2017), 123 green bonds with investment grade senior bullet fixed-coupon are considered while the 123 equivalent conventional bonds by the same issuers are selected.
- Their issuers are mainly among the most active bond issuers in the market.

Sample description
Issuers by Sector



Average Issue Amount by Currency

Currency	Average issued amounts (in USD)	
	Green Bond	Conventional Bond
AUD	402,150,000	631,950,000
CAD	1,222,175,000	3,942,500,000
CHF	351,400,000	306,220,000
EUR	937,467,683	1,589,211,490
GBP	1,846,600,000	4,468,112,500
INR	191,250,000	260,100,000
MXN	109,830,000	277,190,000
SEK	168,178,500	216,943,239
TRY	71,170,000	284,680,000
USD	624,444,444	1,266,000,000
Mean	592,466,563	1,324,290,723
Median	376,775,000	469,085,000

Rating and Yield by Currency

Currency	Average Ask Yield to Convention (%)							
	Green Bond				Conventional Bond			
	AAA	AA	A	BBB	AAA	AA	A	BBB
AUD	2.01	2.69			1.95	2.72		
CAD			2.13				2.04	
CHF	-0.25				-0.14			
EUR	-0.14	0.21	0.11	0.69	-0.10	0.30	0.20	0.72
GBP	0.66				0.72			
INR	5.69			6.71	5.84			6.72
MXN	6.76				7.33			
SEK	0.01	0.20	0.47	0.94	0.06	-0.02	0.41	0.42
TRY	12.60				12.19			
USD	2.04	2.12	2.61	2.44	2.05	2.13	2.63	2.51
Mean	3.26	1.30	1.33	2.69	3.32	1.28	1.32	2.59
Median	2.01	1.16	1.30	1.69	1.95	1.21	1.23	1.62

Descriptive Statistics

Variables	N	Mean	Median	Std. Dev.	Min	Max	Mean Difference (P-value)
AskYLD (%)	123	1.30	0.85	1.72	-1.22	12.60	0.9422
AskYLD_M (%)	123	1.32	0.89	1.72	-0.71	12.19	
BidYLD (%)	123	1.37	0.90	1.74	-0.56	13.07	0.9757
BidYLD_M (%)	123	1.38	0.94	1.73	-0.50	12.42	
BidAskSP (%)	123	-0.07	-0.05	0.11	-1.14	0.00	0.3974
BidAskSP_M (%)	123	-0.06	-0.05	0.04	-0.24	0.00	
TimeToMat (days)	123	1,535	1,328	926	18	4,944	0.8115
TimeToMat_M (days)	123	1,506	1,299	965	75	5,176	
CPN (%)	123	1.72	1.63	1.40	0.00	8.50	0.9798
CPN_M (%)	123	1.73	1.50	1.30	0.00	8.00	
AmtIssued ($)	123	639,410,207	500,000,000	529,038,534	27,531,000	3,499,500,000	<.0001
AmtIssued_M ($)	123	1,180,293,338	816,550,000	1,331,281,622	23,940,000	7,353,425,000	

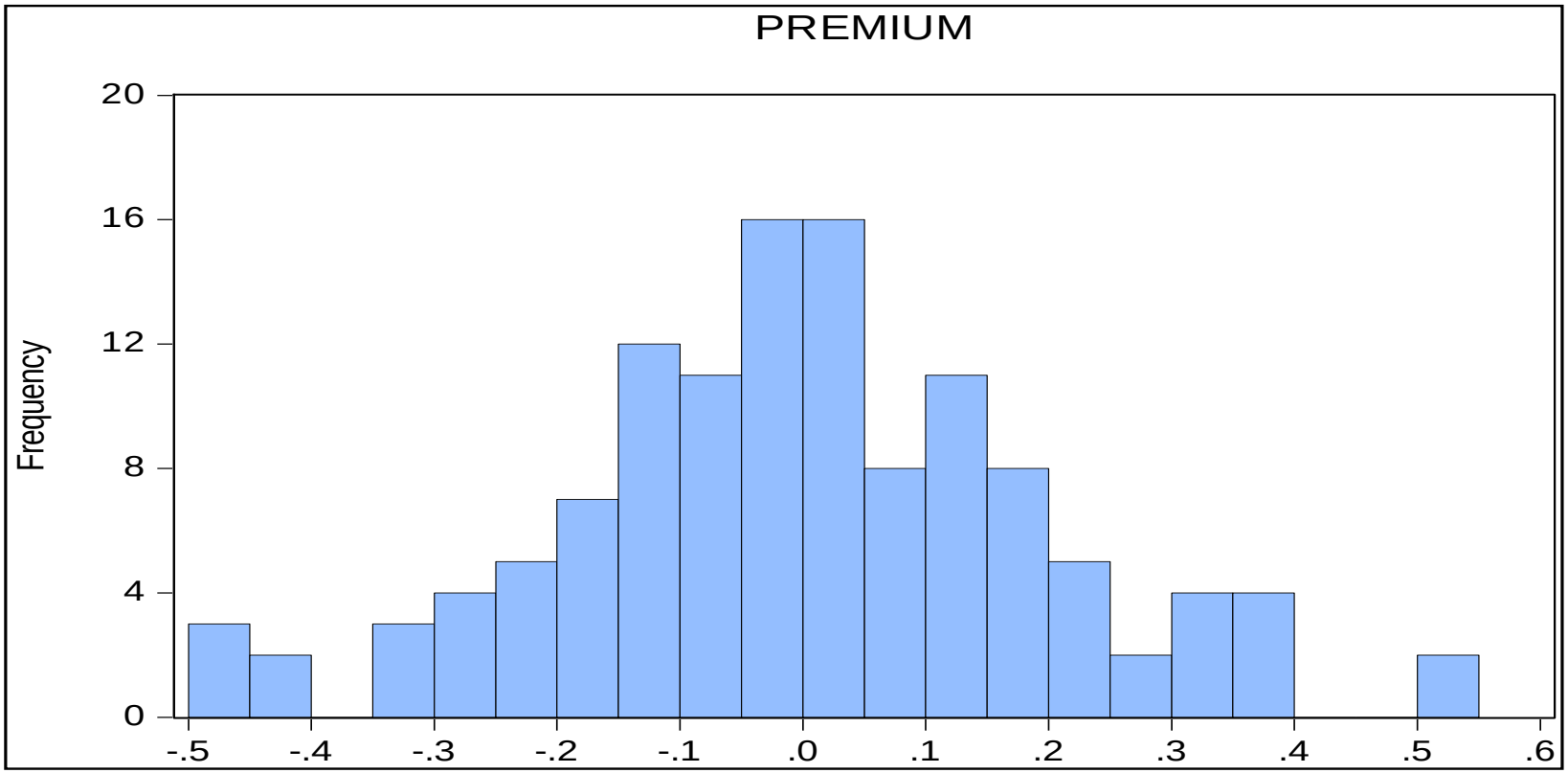
Empirical Result (I): Green Bond Premium

Green bond premium is defined as the difference in yield between these two bonds after removing effects of liquidity (bid-ask spread), i.e. the residual of this regression.

Dependent variable: Diff_AskYLD	
Liquidity	0.496**
	(2.432)
Intercept	-0.011
	(-0.631)
N	123
Adjusted R^2	0.0387

Distribution of Green Bond Premium

- The distribution of the green bond premia ranges from -0.49% to +0.54% with a mean and a median value of near zero and -73.17 bps respectively, and 51% of the premia in our sample are negative



Empirical Results (II) Determinants of GB Premium

- We consider determinants of the green bond premium.
  - The structural part: the yield curve
  - The specific bond characteristics: rating, maturity, issued amount, and Bloomberg classification level 1 for sector group

Estimation for Determinants in Green Bond Premium

$$\hat{p}_i = \overbrace{\alpha_0 + \alpha_1 Yield_i}^{Structural\ part} + \overbrace{\alpha_{2,1} Issued\ Amount_i + \alpha_{2,2} Issued\ Amount_i^2 + \alpha_{3,1} Maturity_i + \alpha_{3,2} Maturity_i^2 + \sum_{j=1}^{p} \alpha_{4,rating_j} 1_{rating_j} + \sum_{j=1}^{r} \alpha_{5,group_j} 1_{group_j} + \eta_i}^{Variable\ part}$$

Empirical Results (II) Determinants of GB Premium

	Dependent variable: Green Bond Premium (residual terms of step 1 regression)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
AskYLD	0.010									0.009
	(0.927)									(0.860)
TimeToMaturity (years)		0.032								0.046**
		(1.404)								(2.061)
TimeToMaturity_Square		-0.003								-0.004**
(years)		(-1.393)								(-2.042)
AmtIssued (billion USD)			-0.203**				-0.188**	-0.188**	-0.170**	-0.170*
			(-2.477)				(-2.212)	(-2.228)	(-2.000)	(-1.954)
AmtIssued_Square			0.055*				0.052*	0.047	0.047	0.050
			(1.793)				(1.665)	(1.504)	(1.509)	(1.583)
Rating_AA				0.075		0.111**	0.050		0.087*	0.104**
				(1.634)		(2.357)	(1.063)		(1.811)	(2.090)
Rating_A				-0.011		0.123*	-0.011		0.119*	0.119*
				(-0.241)		(1.776)	(-0.226)		(1.720)	(1.719)
Rating_BBB				0.026		0.142*	0.034		0.129*	0.134*
				(0.452)		(1.931)	(0.595)		(1.751)	(1.830)
Group_Utilities					-0.089	-0.184**		-0.045	-0.142	-0.146
					(-1.284)	(-2.089)		(-0.637)	(-1.585)	(-1.638)
Group_Financials					-0.069*	-0.149**		-0.072*	-0.147**	-0.155**
					(-1.680)	(-2.462)		(-1.755)	(-2.450)	(-2.580)
Intercept	-0.013	-0.066	0.092**	-0.018	0.024	-0.018	0.071	0.109***	0.063	-0.048
	(-0.561)	(-1.215)	(2.398)	(-0.676)	(1.112)	(-0.692)	(1.537)	(2.737)	(1.362)	(-0.697)
N	123	123	123	123	123	123	123	123	123	123
R^2	0.0071	0.0164	0.0589	0.0279	0.0312	0.0876	0.0727	0.0838	0.1227	0.1595

4 Summary and Conclusion

Summary

- The preliminary results obtained on the whole sample show that the yield level is not a statistically significant driver of green premium

- The **issued amount** negatively relates to lowers green bond premium. The larger the issued amount is, the lower the green bond premium becomes.

- **Financial bonds** show a 6.9 to 15.5 bps premium below the reference level (government group).

Discussion (I)

- The urgent needs to finance the transfer to a low carbon economy make green bonds more attractive and essential based on non-economic criteria like social, environmental and governance (ESG).

- Like conventional bonds, green bonds are also not standardized instruments. Certain factors like “greenness” affect issuers and investors' needs. These factors might have impact on the price, liquidity and volatility of green bonds.

- Current negative green bond premium benefits expansion of funding capacity for green projects with issuers enjoy with lower yields attract ethical investors who would like to participate in environmentally friendly projects.

Discussion (II)

- Going green does not mean sacrificing yield. The current premium has been driven by excessive demand but not by environmental impacts.

- However, in essence, to make green bonds more attractive and desirable than conventional bonds, externalities like environmental benefits generated from green projects should be monetized to fan of green bonds.

- Yoshino et al (2015) insist that spill-over effects can be measured from tax increment generated from the infrastructure projects by using difference-in-difference method, which can be internalized to be additional return for investors not by increasing issuer's burden.

Thank You!