

Climate risk, responsible banking and securitization

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Introduction

- **Climate change** is the **most pressing challenge** for the sustainable economic development (WHO, 2014).
- **Banks are expected to play a significant role** in tackling climate change.
- **Because banks allocate financial resources economy-wide** (Brunnermeier and Landau, 2021; Aracil et al., 2021).

Introduction

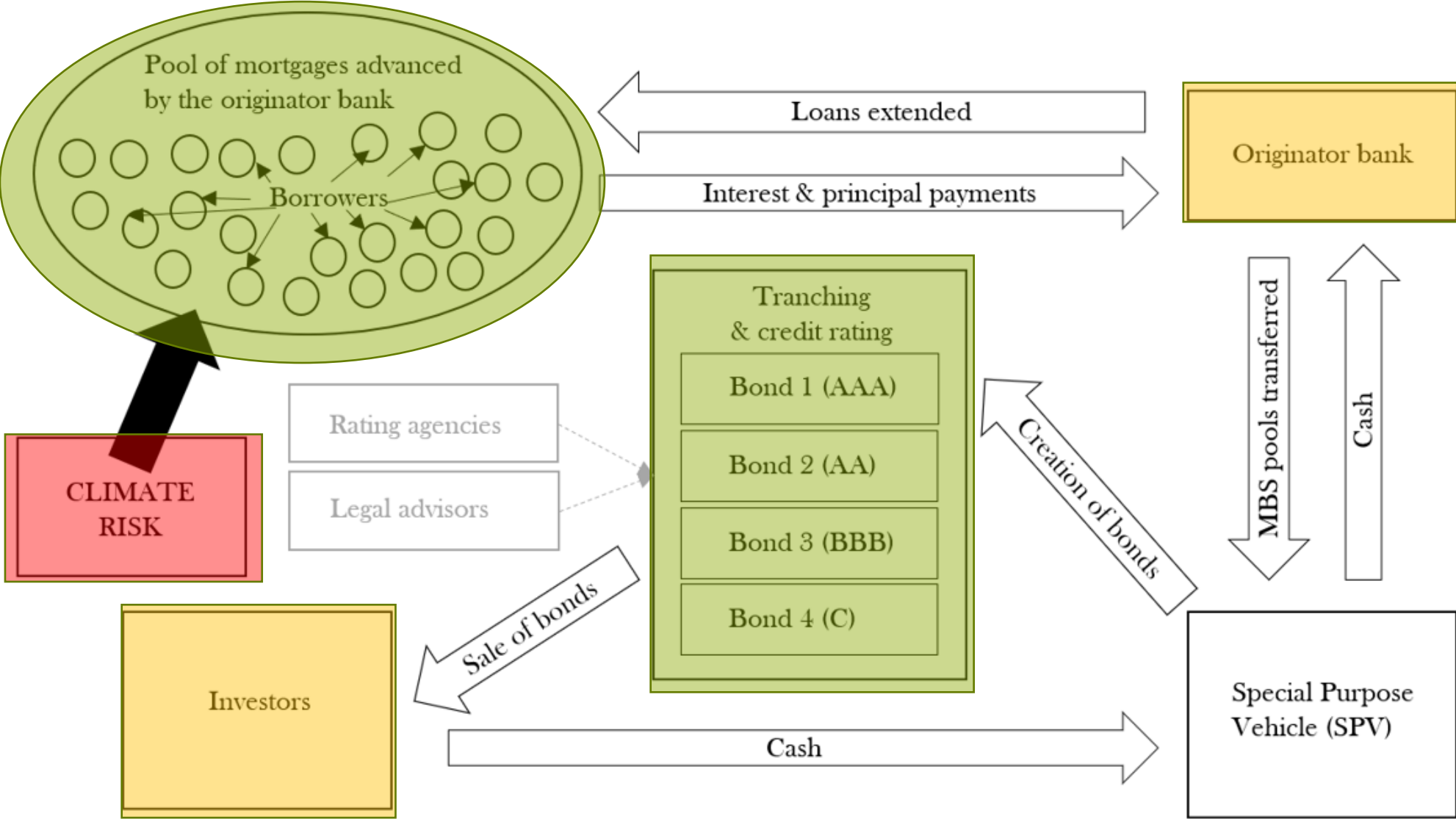
- Investors' pay much more attention to climate risk mitigation strategies.
- Investors consider climate risks when pricing assets (Huynh and Xia, 2021; Huynh et al., 2020; Baldauf et al., 2020).
- Especially for securities with longer term horizons (Painter, 2020).

Motivation 1

- Are **banks exposed** to climate risk when **issuing long-term and complex to evaluate financial instruments**?
- Focus: **Mortgage-backed securities (MBS)**



Securitization process



Climate risk and MBS

- MBS are **long-term instruments** supported by pools of **mortgages that have very long maturities**.
- Average **maturity** for MBS is over **30** years.
- Adverse effects of climate change are **more likely to materialize in the long-term** (Javadi and Masum, 2021).
- MBS are exposed to the climate change due to **underlying collateral (properties) exposure** in countries where the mortgages are given.

Climate risk and MBS

- Both **physical** and **transition risks** are relevant in the context of real-estate collateral.
- **Physical risk:**
 - **Sea level rise (SLR)** as a result of climate change.
 - SLR leads to **price discounts** due to concerns about climate change (Baldauf et al., 2020; Keys and Mulder, 2021).
 - Banks charge higher interest rates for mortgages on **properties exposed** to greater SLR risk (Nguyen et al., 2022).

Climate risk and MBS

- Transitional risk:

- Real-estate may be also be impacted as a result of **rising costs** due to:
 - Changing **stringent building codes and regulation**,
 - **Tax increases**,
 - **Lower demand for less efficient buildings** (UNEP FI, 2022; Wein et al., 2022).

Motivation 2

- Does **responsible banking** mitigate exposure to climate risk?
- Following a set of voluntary sustainability measures
 - Principles of Responsible Banking (PRB)
 - Principles of Responsible Investment (PRI)
- Signatories **may be perceived by investors** as engaging in measures mitigating climate risk.

Hypotheses

- H_1 : MBS which are more exposed to climate risk have higher spreads at issuance
- H_2 : Being a signatory bank of responsibility charters mitigates the negative impact of climate change on MBS spreads at issuance

Contribution

- Provide evidence on the **link between climate risk and securitization** as well as **MBS valuation**.
 - The integration of climate risk into pricing of **long-term and complex to value** financial assets is **understudied**.
 - Incorporation of sustainability issues into securitized assets **lags behind others markets** (Nuzzo, 2021).
- Expanding evidence on the effect of **banks' voluntary adoption of responsible banking** on climate risk mitigation.

Dataset

- 13,045 MBS issued in 28 countries between 2000–2019
- Climate risk proxy: Notre Dame Global Adaptive Initiative Index (ND-GAIN) vulnerability index
- ND-GAIN combines 74 variables to form 45 core indicators of environmental vulnerability in collaboration with its readiness to improve resilience.



ND-GAIN

Notre Dame Global Adaptation Initiative

UNIVERSITY of NOTRE DAME

VULNERABILITY

Measures a country's exposure, sensitivity and capacity to adapt to the negative effects of climate change. ND-GAIN measures overall vulnerability by considering six life-supporting sectors – [food](#), [water](#), [health](#), [ecosystem service](#), [human habitat](#), and [infrastructure](#).

EXPOSURE: Degree to which a system is exposed to significant climate change from a biophysical perspective. It is a component of vulnerability independent of socio economic context. Exposure indicators are projected impacts for the coming decades and are therefore invariant overtime in ND-GAIN.

SENSITIVITY: Extent to which a country is dependent upon a sector negatively affected by climate hazard, or the proportion of the population particularly susceptible to a climate change hazard. A country's sensitivity can vary over time.

ADAPTIVE CAPACITY: Availability of social resources for sector-specific adaptation. In some cases, these capacities reflect sustainable adaptation solutions. In other cases, they reflect capacities to put newer, more sustainable adaptations into place. Adaptive capacity also varies over time.

Methodology

$$\textit{Spread} = \beta_0 + \beta_1 \textit{Climate risk} + \gamma' X + \varepsilon$$

- *Spread*: Initial yield spread of MBS at issuance set in basis points over the relevant benchmark interest rate.
- *Climate risk*: ND-GAIN vulnerability index - *GDP adjusted*
- *X*: Tranche-specific and macro characteristics
- Control for *country fixed effects* in all estimations

Table 1. Definitions of the variables

Variable	Definition	Source
Spread	Natural logarithm of fixed premium, set in basis points, over the relevant benchmark.	Refinitiv
Climate risk	Measure of a country's exposure, sensitivity, and adaptability to the negative impact of climate change adjusted by GDP.	Notre Dame Global Adaptation Initiative
UNPRB	Measure of sustainability that takes the value of 1 if as bank is signatory to the responsibility charters, 0 otherwise.	United Nations
Rating	Categorical variable reflecting a bond's underlying credit rating.	Refinitiv
Insured	Dummy variable that takes the value of 1 if a bond is insured, 0 otherwise.	Refinitiv
Listed	Dummy variable that takes the value of 1 if bond is listed on a stock exchange, 0 otherwise.	Refinitiv
Gross proceeds	Natural logarithm of tranche size in (US \$) of each security in a structured deal.	Refinitiv
Maturity	Tranche's maturity conditional upon prepayment expectations.	Refinitiv
Global market	Dummy variable that takes the value of 1 if tranche is traded in the global market, 0 otherwise.	Refinitiv
Private	Dummy variable showing whether sale deals are placed in a private or public offering, 1 private 0 public.	Refinitiv
CMBS	Dummy variable taking the value of 1 if the security is a commercial MBS and 0 if residential MBS.	Refinitiv
Use of funds	Categorical variable for the issuer's primary use of funding.	Refinitiv
Country fixed	The country of origination for the assets underlying the security.	Refinitiv
GDP capita	Natural logarithm of GDP per capita.	World Bank
GDP growth	Annual growth rate of GDP.	World Bank
Population density	Number of people per unit of area.	World Bank

This table presents the definitions of the variables used in the study.

Table 2. Descriptive statistics

	Mean	Median	STD	Minimum	Maximum
Spread (original)	129.067	95.000	130.274	0.010	4971.000
Spread (log)	4.450	4.564	0.988	0.010	8.512
Climate risk	-0.024	-0.017	0.054	-0.124	0.234
UNPRB	0.333	0.000	0.471	0.000	1.000
Insured	0.002	0.000	0.043	0.000	1.000
Listed	0.437	0.000	0.496	0.000	1.000
Gross proceeds (original)	237.491	53.05	672.410	0.070	21153.250
Gross proceeds (log)	4.234	3.989	1.495	0.068	9.960
Maturity (years)	31.688	30.44	18.655	0.750	100.440
Global market	0.018	0.000	0.132	0.000	1.000
Private	0.327	0.000	0.469	0.000	1.000
CMBS	0.473	0.000	0.499	0.000	1.000
Rating	4.443	3.000	4.008	1.000	20.000
GDP capita	10.741	10.764	0.188	9.172	11.284
GDP growth (%)	1.397	1.687	1.509	-6.428	23.999
Population density	141.588	35.766	135.956	2.558	511.458

This table presents the descriptive statistics of the variables used in the study. Definitions of the variables are provided in Table 1.

Table 3. The impact of climate risk on MBS spread

	(1)	(2)	(3)
Climate risk	7.451*** (0.625)	5.917*** (1.031)	11.551*** (3.902)
CMBS		0.016 (0.057)	0.093 (0.108)
Insured		-0.248* (0.138)	0.244* (0.120)
Listed		-0.146 (0.123)	0.019* (0.009)
Gross proceeds		-0.252*** (0.062)	-0.082** (0.035)
Maturity		0.001 (0.001)	-0.000 (0.001)
Global market		-0.211*** (0.029)	0.124** (0.045)
Private		-0.023 (0.074)	0.014 (0.033)
GDP capita		0.362 (0.403)	-2.473** (1.066)
GDP growth		-0.097*** (0.028)	0.006 (0.014)
Constant	4.657*** (0.056)	1.967 (4.350)	33.080*** (11.619)
Rating	No	No	Yes
Year	No	No	Yes
Country fixed	No	No	Yes
Use of funds	No	No	Yes
N	14,695	14,695	13,045
R squared	0.161	0.319	0.666

Table 4. Subsample analysis

	US sample (1)	Non-US sample (2)	CMBS (3)	RMBS (4)
Climate risk	4.651*** (0.628)	11.772** (5.651)	4.784** (2.031)	15.432*** (2.814)
CMBS	-0.031 (0.022)	0.318*** (0.060)		
Insured		0.272** (0.123)	-0.321*** (0.056)	0.311** (0.124)
Listed	-0.018 (0.016)	0.051*** (0.014)	0.037*** (0.010)	0.060*** (0.021)
Gross proceeds	0.023*** (0.008)	-0.103*** (0.019)	0.057 (0.042)	-0.147*** (0.023)
Maturity	0.001 (0.001)	0.001* (0.001)	-0.001 (0.001)	0.002** (0.001)
Global market	0.114** (0.047)	-0.194*** (0.039)	0.097*** (0.023)	0.087 (0.153)
Private	0.070*** (0.021)	0.062* (0.035)	0.001 (0.023)	0.083* (0.048)
GDP capita		-3.107** (1.424)	-0.627 (0.563)	-4.479*** (1.344)
GDP growth		0.013 (0.016)	-0.019** (0.008)	0.029 (0.021)
Constant	4.260*** (0.060)	39.626** (15.721)	11.874* (6.122)	55.089*** (14.424)
Rating	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Country fixed	No	Yes	Yes	Yes
Use of funds	Yes	Yes	Yes	Yes
N	6522	6523	6176	6869
R squared	0.485	0.764	0.635	0.712

Table 5. The role of sustainability on the relationship between climate risk and MBS pricing

	Whole sample		US sample		Non-US sample	
	(1)	(2)	(3)	(4)	(5)	(6)
Climate risk	11.576*** (3.898)	11.992*** (3.756)	4.657*** (0.628)	5.279*** (0.710)	11.838** (5.679)	13.690** (6.025)
UNPRB	-0.018 (0.012)	-0.039 (0.036)	0.004 (0.015)	0.030 (0.022)	-0.017 (0.026)	-0.144** (0.062)
Climate risk x UNPRB		-1.141*** (0.184)		-1.544** (0.645)		-1.974** (0.800)
CMBS	0.097 (0.108)	0.110 (0.111)	-0.033 (0.023)	-0.029 (0.023)	0.319*** (0.059)	0.325*** (0.057)
Insured	0.246* (0.125)	0.260* (0.126)	0.000 (.)	0.000 (.)	0.274** (0.129)	0.304* (0.149)
Listed	0.020** (0.009)	0.029** (0.012)	-0.019 (0.016)	-0.014 (0.016)	0.050*** (0.013)	0.057*** (0.016)
Gross proceeds	-0.082** (0.035)	-0.083** (0.035)	0.023*** (0.008)	0.023*** (0.008)	-0.102*** (0.019)	-0.101*** (0.019)
Maturity	-0.000 (0.001)	-0.000 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001* (0.001)	0.001* (0.001)
Global market	0.126*** (0.045)	0.130*** (0.041)	0.114** (0.047)	0.112** (0.046)	-0.196*** (0.040)	-0.186*** (0.036)
Private	0.014 (0.032)	0.019 (0.035)	0.070*** (0.021)	0.065*** (0.021)	0.060 (0.036)	0.067* (0.035)
GDP capita	-2.476** (1.059)	-2.371** (1.046)			-3.124** (1.418)	-3.297** (1.431)
GDP growth	0.006 (0.014)	0.004 (0.013)			0.013 (0.016)	0.013 (0.015)
Constant	33.116*** (11.542)	32.014*** (11.392)	4.259*** (0.060)	4.248*** (0.061)	39.807** (15.657)	41.839** (15.812)
Rating	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed	Yes	Yes	Yes	Yes	Yes	Yes
Use of funds	Yes	Yes	Yes	Yes	Yes	Yes
N	13045	13045	6522	6522	6523	6523
R squared	0.666	0.667	0.485	0.485	0.764	0.765

Table 6. Instrumental variable regressions

	First stage (1)	Whole sample (2) (3)		US sample (4) (5)		Non-US sample (6) (7)	
Climate risk		15.765*** (4.680)	15.636*** (4.725)	152.140** (72.209)	148.572** (73.037)	11.379*** (3.899)	11.540*** (3.710)
UNPRB		-0.008 (0.011)	-0.042 (0.035)	-0.000 (0.017)	0.029 (0.022)	0.003 (0.027)	-0.129* (0.070)
Climate risk x UNPRB			-1.353*** (0.234)		-2.477*** (0.715)		-1.924** (0.914)
Population density	-0.001*** (0.000)						
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Use of funds	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<u>Kleibergen-Paap LM (p value)</u>		0.000	0.000	0.000	0.000	0.000	0.000
N	11476	11406	11406	5340	5340	6066	6066
R squared	0.782	0.659	0.660	0.484	0.485	0.752	0.752

This table presents the results for 2SLS IV regression analysis. Population density is used as an instrument for Climate risk (Column 1). Dependent variable is Climate risk in Column 1. Dependent variable in all second stage regressions is Spread (Columns 2-7). Definitions of the variables are presented in Table 1. Kleibergen-Paap LM statistic tests whether the equation is identified. A rejection of null hypothesis suggests that equation is identified. Country-level clustered robust standard errors are in parentheses.***, ** and * denote significance at 1%, 5% and 10% levels.

Table 8. Regressions after entropy balancing

	(1)	(2)	(3)
Climate risk	13.570*** (3.158)	13.771*** (3.099)	13.996*** (2.963)
UNPRB		-0.049** (0.023)	-0.061 (0.040)
Climate risk x UNPRB			-0.563** (0.238)
Constant	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Rating	Yes	Yes	Yes
Year	Yes	Yes	Yes
Country fixed	Yes	Yes	Yes
Use of funds	Yes	Yes	Yes
N	13045	13045	13045
R squared	0.697	0.697	0.698

This table presents the weighted-least square regression results after entropy balancing. Dependent variable in all regressions is Spread. Definitions of the variables are presented in Table 1. Country-level clustered robust standard errors are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% levels.

Table 9. Controlling for issuer fixed effects

	(1)	(2)	(3)
Climate risk	4.728 ^{***} (0.673)	8.298 ^{***} (1.566)	5.404 ^{**} (2.535)
Constant	Yes	Yes	Yes
Controls	No	Yes	Yes
Rating	No	No	Yes
Year fixed	No	No	Yes
Country fixed	No	No	Yes
Use of funds	No	No	Yes
N	13045	13045	13045
R squared	0.431	0.706	0.776

This table presents the regression results controlling for issuer fixed effects. Dependent variable in all regressions is Spread. Definitions of the variables are presented in Table 1. Country-level clustered robust standard errors are in parentheses. ^{***}, ^{**} and ^{*} denote significance at 1%, 5% and 10% levels.

Table 10. The role of maturity

	(1)	(2)
Climate risk	11.575*** (3.898)	10.617*** (3.453)
Maturity	-0.001 (0.001)	0.001 (0.001)
Climate risk x Maturity		0.027* (0.013)
Constant	Yes	Yes
Controls	Yes	Yes
Rating	Yes	Yes
Year fixed	Yes	Yes
Country fixed	Yes	Yes
Use of funds	Yes	Yes
N	13045	13045
R squared	0.665	0.666

This table presents the role of maturity of the security (Maturity) on the relationship between Climate risk and MBS Spread. Dependent variable in all regressions is Spread. Definitions of the variables are presented in Table 1. Country-level clustered robust standard errors are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% levels.

Table 11. Target market

	Target market: Non-US		Target market: US	
	(1)	(2)	(3)	(4)
Climate risk	12.634*** (3.697)	13.634*** (3.424)	6.151*** (0.846)	6.453*** (0.985)
UNPRB	-0.037 (0.029)	-0.089*** (0.022)	0.049** (0.021)	0.055** (0.026)
Climate risk x UNPRB		-1.589*** (0.244)		-0.588 (0.762)
Constant	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Rating	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Country fixed	Yes	Yes	Yes	Yes
Use of funds	Yes	Yes	Yes	Yes
N	9358	9358	3687	3687
R squared	0.738	0.739	0.456	0.456

This table presents the regression results of subsample analysis based on target market. Dependent variable in all regressions is Spread. Definitions of the variables are presented in Table 1. Country-level clustered robust standard errors are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% levels.

Table 12. The impact of the Paris Agreement

	Whole sample (1)	US sample (2)	Non-US sample (3)
Climate risk	9.784** (1.044)	11.009*** (0.942)	14.341*** (1.949)
UNPRB	-0.016 (0.012)	0.004 (0.014)	-0.020 (0.018)
Paris	-0.107 (0.091)	-0.735*** (0.084)	-0.075 (0.200)
Climate risk x Paris	-4.254*** (0.401)	3.637 (2.249)	-5.600*** (0.673)
Constant	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Rating	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes
Country fixed	Yes	Yes	Yes
Use of funds	Yes	Yes	Yes
N	13045	6522	6523
R squared	0.668	0.485	0.767

This table presents the regression results of the role of the Paris Agreement on the impact of Climate risk and UNPRB on Spread. Dependent variable in all regressions is Spread. Definitions of the variables are presented in Table 1. Country-level clustered robust standard errors are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% levels.

Main Conclusions

- Investors demand higher returns for MBS from countries with greater exposure to climate risk.
- Negative impact of climate risk on MBS returns is lower for responsible banks.
 - Commitment to responsible banking is viewed as a mitigating factor.
 - Banks efforts in sustainability and tackling climate change is valued
- Paris Agreement significantly changed the risk perception of investors.

Climate risk, responsible banking and securitization

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