Internet appendix
"Who pays the greenium and why? A decomposition"

August 2, 2024

This appendix contains charts in color. Use color printer for best results.

Appendix A Additional Tables and Figures

A.1 Ownership dynamics

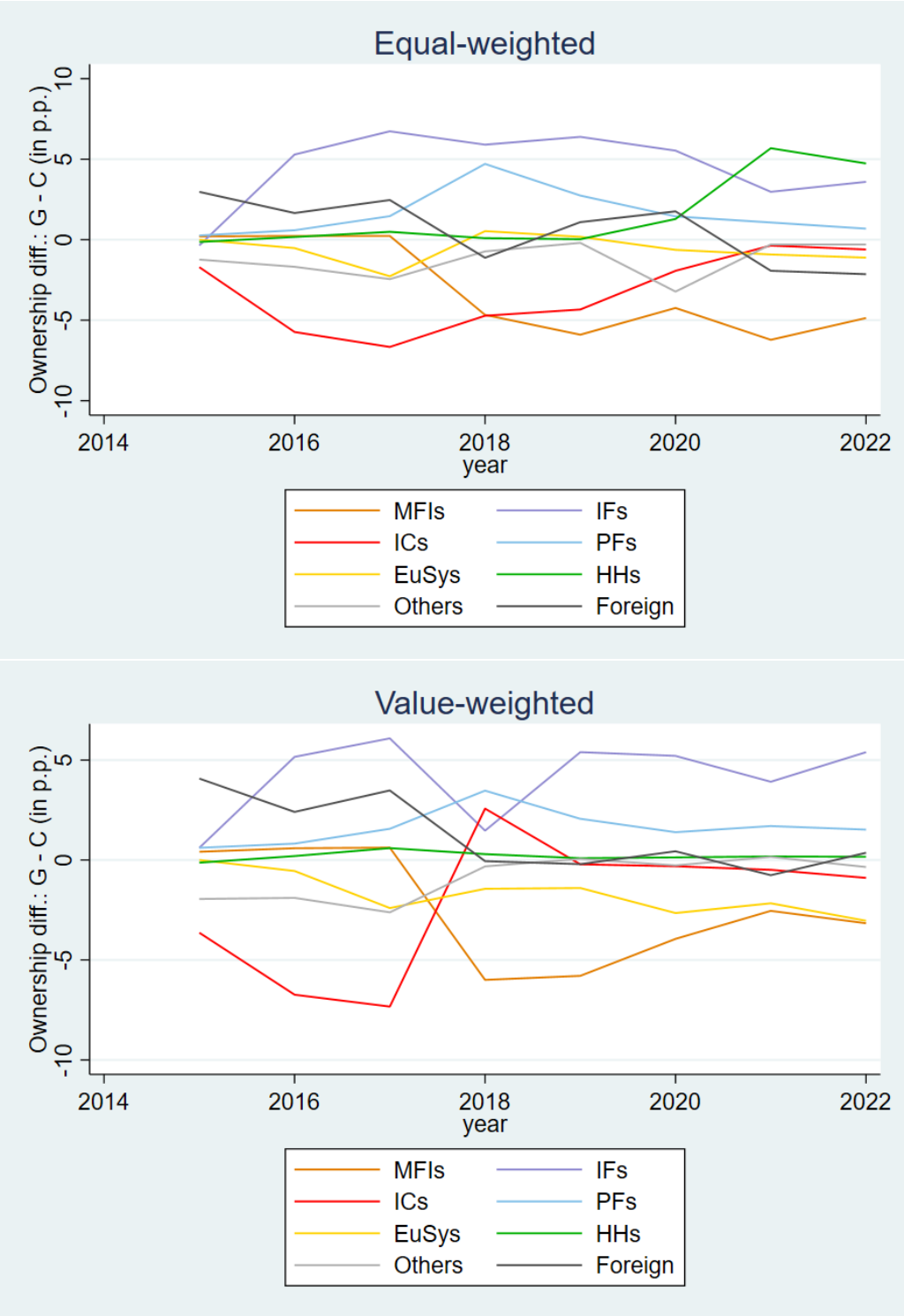

Figure A.1: Ownership Differential Over Time.

The figure displays the average equal-weighted (top) and value-weighted (bottom) ownership differential of green and conventional bonds by investor group over time. The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), and the Eurosystem (EuSys).

A.2 Ownership across various subsamples

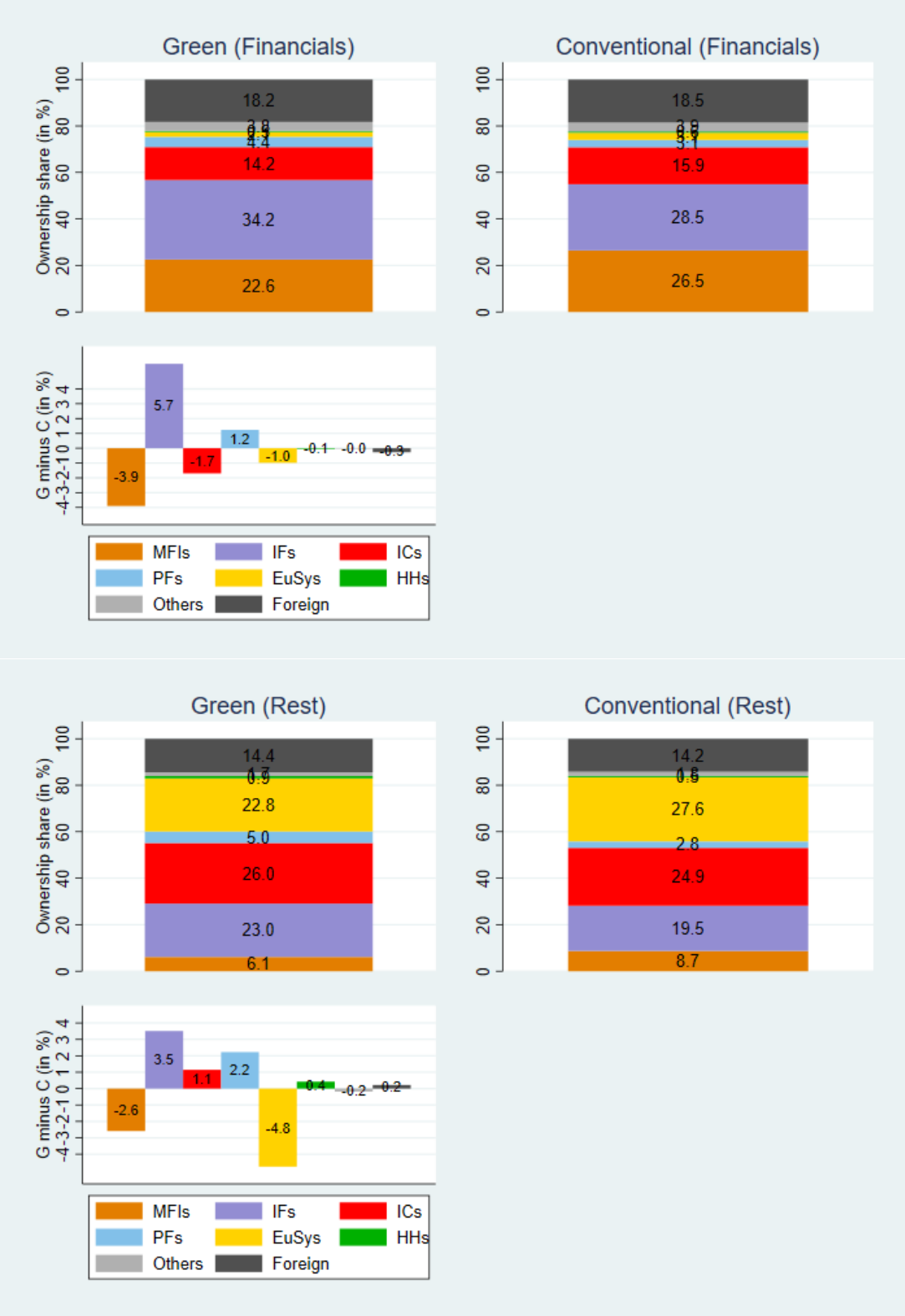

Figure A.2: Ownership - Financials vs. Rest (Value-weighted).

The graph displays the value-weighted average ownership structure of green and conventional bonds as in Figure 4,differentiating between bonds issued by financials (top) and all others (bottom) as in the sample split in Tables 4 and 5. The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), and the Eurosystem (EuSys).

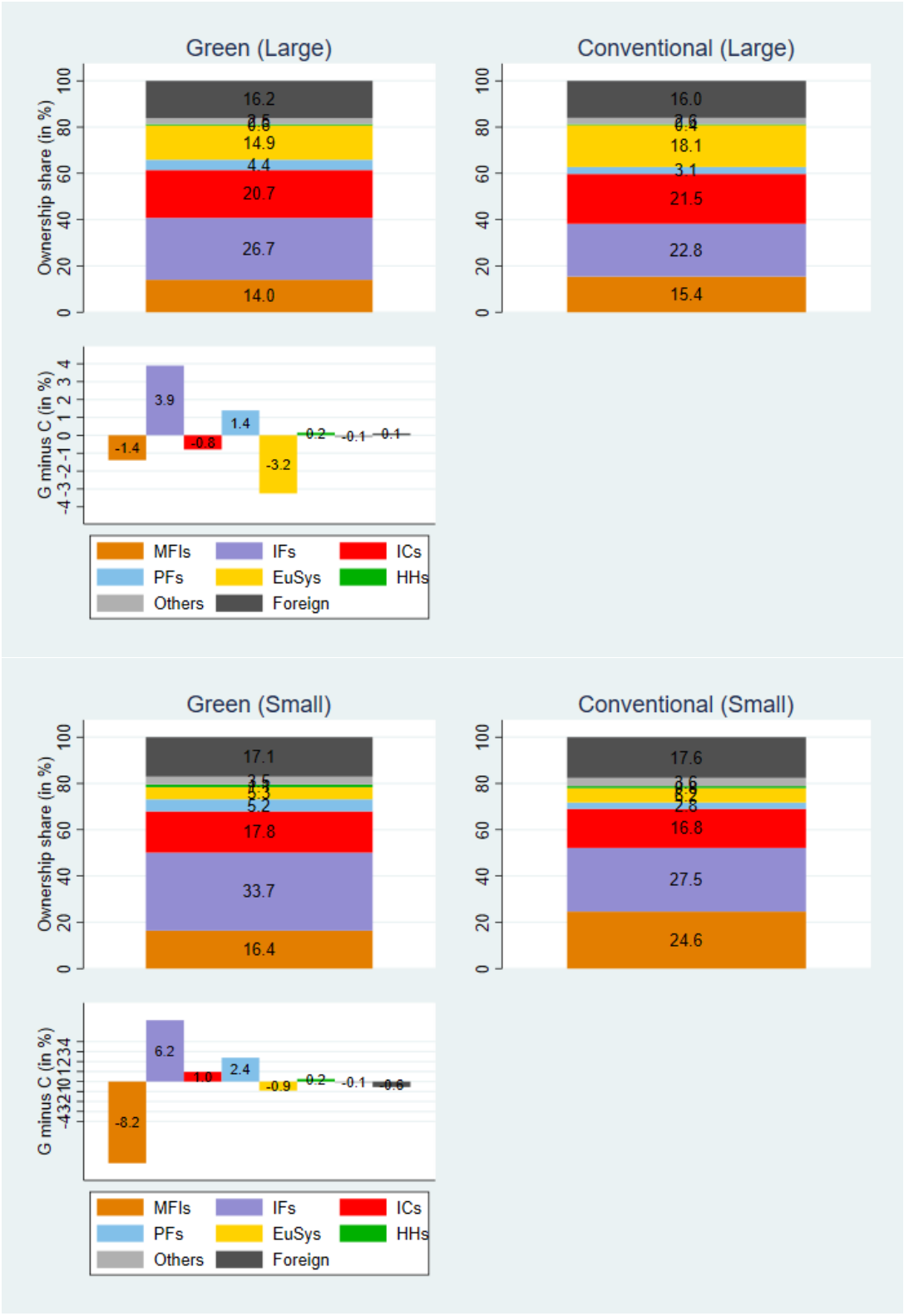

Figure A.3: Ownership - Large vs. Small (Value-weighted).

The graph displays the value-weighted average ownership structure of green and conventional bonds as in Figure 4, differentiating between large (top) and small bonds (bottom) as in the sample split in Tables 4 and 5. The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), and the Eurosystem (EuSys).

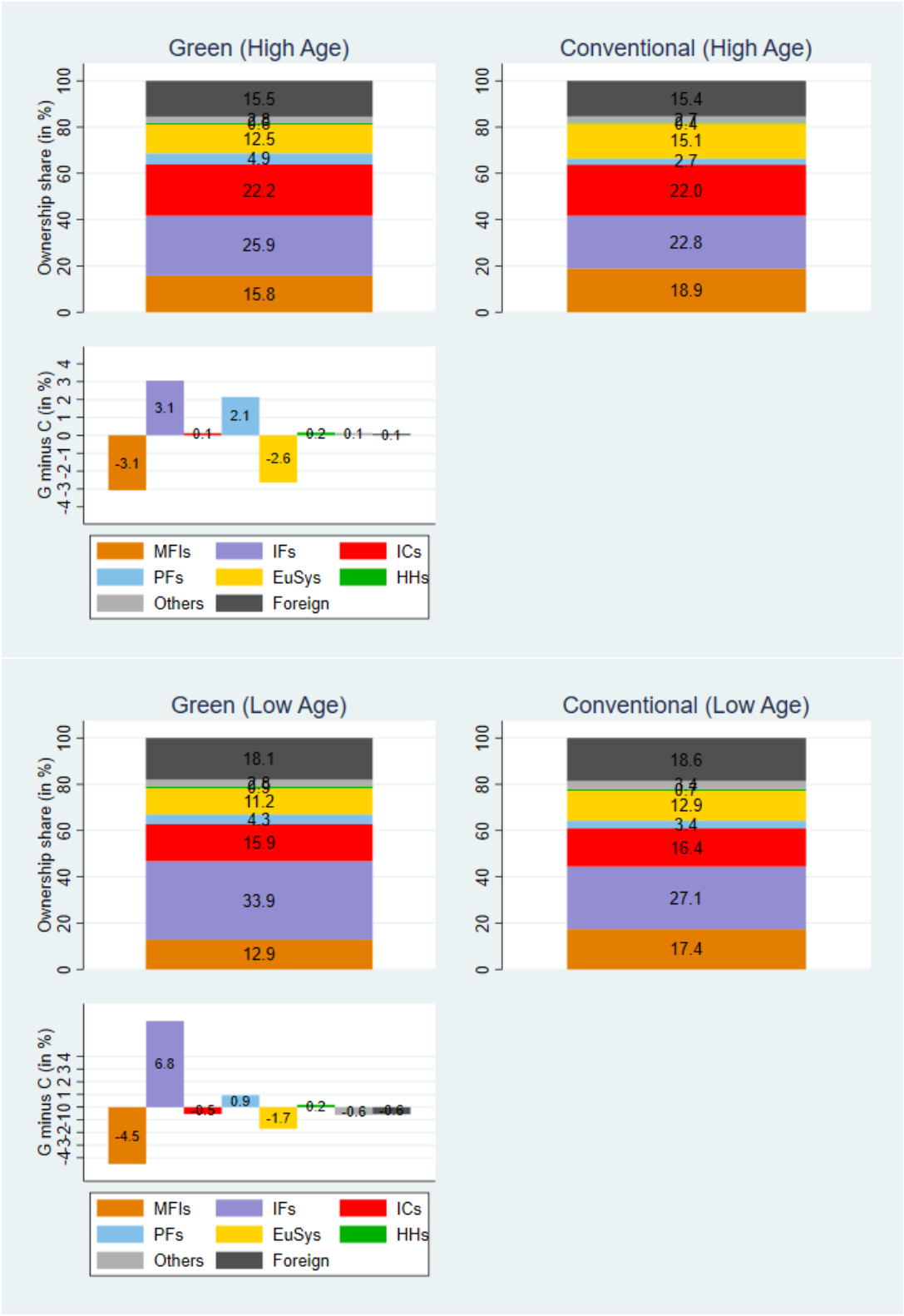

Figure A.4: Ownership - Old vs. Young (Value-weighted).

The graph displays the value-weighted average ownership structure of green and conventional bonds as in Figure 4, differentiating between old (top) and young bonds (bottom) as in the sample split in Tables 4 and 5. The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), and the Eurosystem (EuSys).

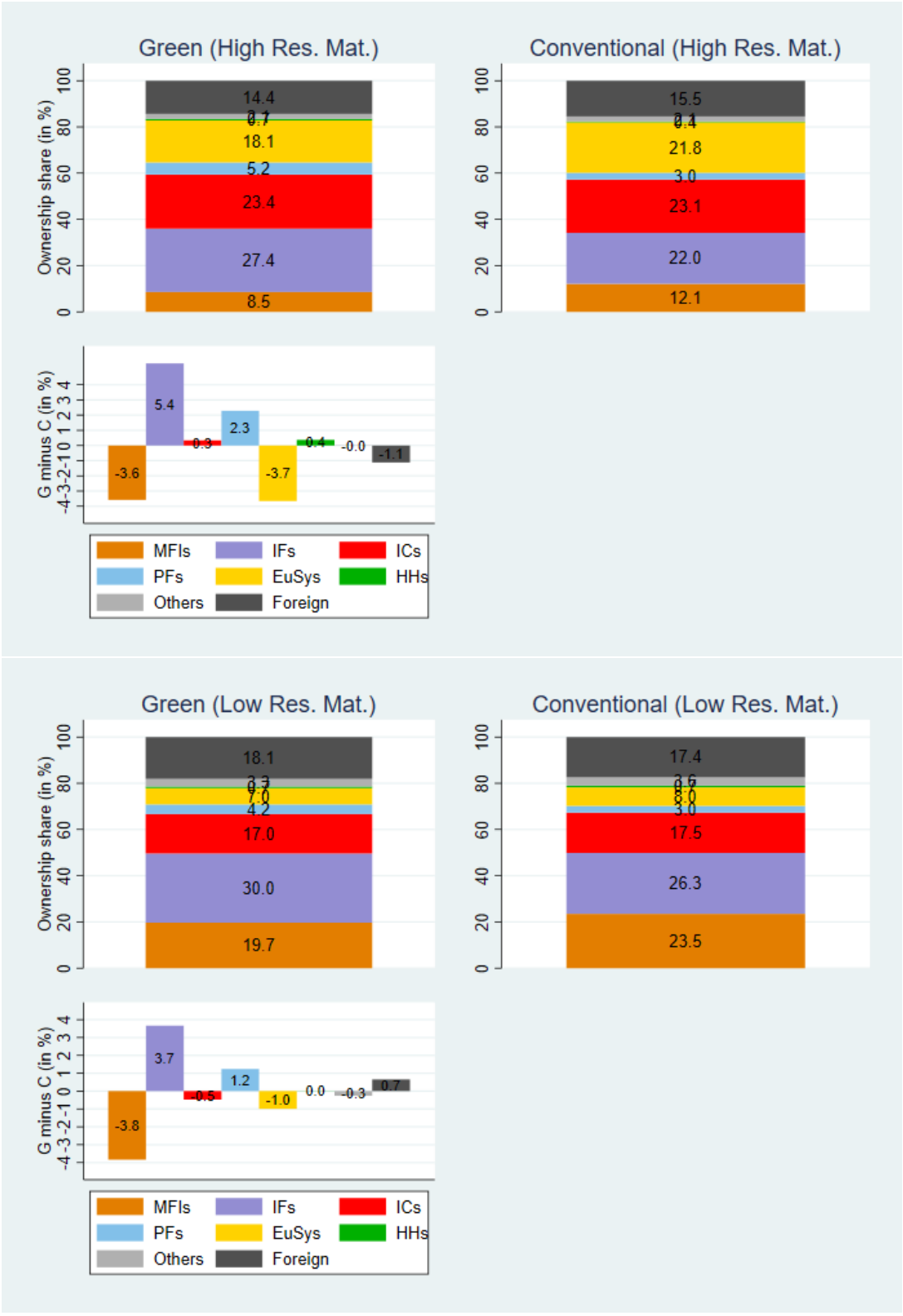

Figure A.5: Ownership - High vs. Low Residual Maturity (Value-weighted).

The graph displays the value-weighted average ownership structure of green and conventional bonds as in Figure 4, differentiating between bonds with high (top) and low residual maturity (bottom) as in the sample split in Tables 4 and 5. The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), and the Eurosystem (EuSys).

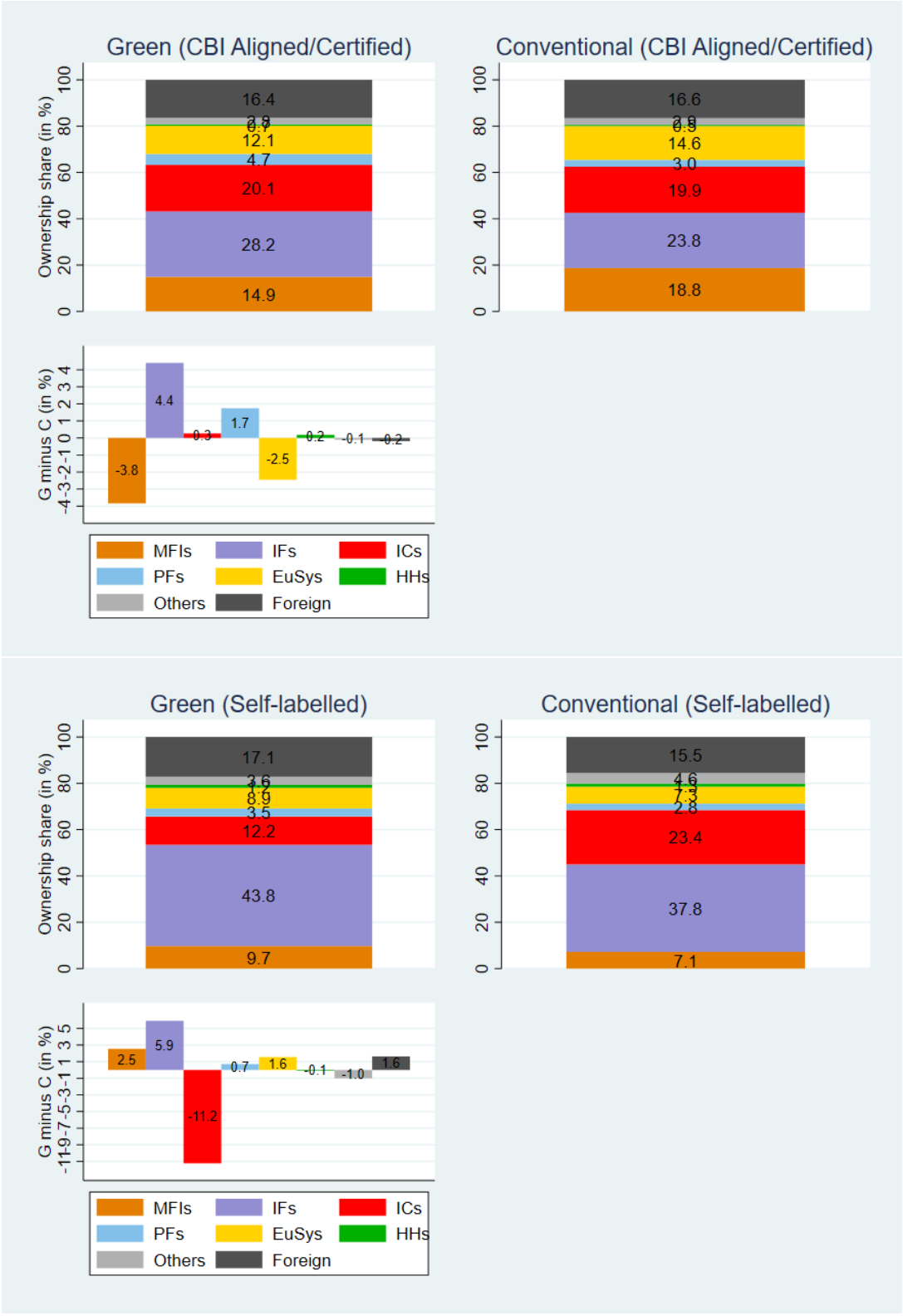

Figure A.6: Ownership - ESG Flag (Value-weighted).

The graph displays the value-weighted average ownership structure of green and conventional bonds as in Figure 4, differentiating between CBI-aligned/certified green bonds (top) and self-labeled green bonds (bottom) as in the sample split in Tables 4 and 5. The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), and the Eurosystem (EuSys).

A.3 Sample composition

		Before SHS-matching	After SHS-matching
Region			
	Euro area	198	138
	Japan	47	2
	Supranational	22	5
	Sweden	67	4
	US	45	1
	Rest	57	11
Currency			
	EUR	214	159
	NOK	11	0
	SEK	59	1
	USD	81	1
	JPY	40	0
	Rest	31	0
Bond size			
	Below 10 Million EUR	102	59
	Between 10 and 50 Million EUR	60	12
	Between 50 and 100 Million EUR	56	3
	Between 100 and 500 Million EUR	79	7
	Above 500 Million EUR	139	80
Issuer industry			
	Financials	220	122
	Non-financials	120	24
	Sovereigns	73	10
	Supranational	23	5
Issuer rating			
	IG (Above BBB)	331	132
	IG (BBB)	50	18
	Non-IG	4	2
	Unrated	51	9
ESG Flag (Eikon)			
	CBI Aligned Green bond	315	116
	CBI Certified Green Bond	36	13
	Self-Labeled Green Bond	85	32
Total number of bond pairs		436	161

Table A.1: Sample composition before and after the SHS coverage filter.

This table shows the number of bond pairs in our dataset before and after applying the SHS coverage filter, broken up across a number of bond/issuer characteristics.

in %	Financial		Non-Financial		Sovereign	
	=0	=1	=0	=1	=0	=1
Conventional issuers	55.98	44.02	44.09	55.91	99.94	0.06
Green issuers	55.81	44.19	46.62	53.38	97.57	2.43
# Issuers	8,382	6,594	6,621	8,835	14,949	27

in %	EU		US	
	=0	=1	=0	=1
Conventional issuers	70.20	29.80	56.95	43.05
Green issuers	55.68	44.32	86.49	13.51
# Issuers	10,405	4,571	8,747	6,229

Table A.2: Composition by Sector and Country.

The table reports descriptive statistics for two groups of corporate bond issuers in December 2021: (i) issuers which have only conventional and no green bonds outstanding (conventional issuers) and (ii) issuers which have at least one green bond outstanding (green issuers). The top panel decomposes these groups into financial, non-financial and sovereign issuers. The bottom panel decomposes them by the geographic location of the issuers. The percentages sum up to 100% for each split. The data is taken from the Eurosystem's CSDB. We restrict the sample to issuers in developed markets and standard non-money market debt instruments.

	(1) Rating Notch	(2) IG Rating	(3) Unrated
Green	-1.4326***	0.2724***	-0.2261***
	(-7.37)	(15.55)	(-13.87)
Country x Sector FEs	Yes	Yes	Yes
adj. R2	.1364	.2684	.3512
Obs.	6,589	14,976	14,976

Table A.3: Issuer ratings.

The table shows results from regressions of bond issuer ratings on a green issuer dummy variable. The sample is the same as in Table A.2, i.e. based on CSDB data for December 2021. The t-statistics in parentheses are based on robust standard errors. Column (1) uses the numerical rating scale for all issuers for which a credit rating is available, coded from 1 (AAA) to 29 (in default). Column (2) uses an indicator variable that equals 1 if the issuer has an investment grade credit rating (unrated issuers are set to 0 in this case). Column (3) uses an indicator that equals 1 if an issuer has no credit rating.

	(1) EUR	(2) USD	(3) Issuer Size	(4) Maturity	(5) Bond size
Green	1.5599	-2.5758*	6.1351***	-1.7110***	-0.0008
	(1.14)	(-1.74)	(3.93)	(-4.01)	(-0.05)
Country x Sector x Rating FEs	Yes	Yes	Yes	Yes	Yes
adj. R2	.7572	.7448	.9956	.3592	.5824
Obs.	6,589	6,589	6,589	6,589	6,589

Table A.4: Issuer-level bond characteristics.

The table shows results from regressions of several bond issuer characteristics on a green issuer dummy variable. The sample is the same as in Table A.2, i.e. based on CSDB data for December 2021. The t-statistics in parentheses are based on robust standard errors. Columns (1) and (2) use the share of bonds outstanding in EUR and USD, respectively. Column (3) uses the issuer's total bonds outstanding in billion EUR. Column (4) uses the issuer's value-weightedaverage bond maturity in years and column (5) the issuer's average bond size in billion EUR bn.

A.4 Further results for sample splits

I: Benchmark greenium Sample splits	MFIs	IFs	ICs	PFs	EuSys	HHs	Others	Foreign
Size (total amount outstanding)								
Small	0.602	-0.498	-2.263	-0.017	-0.033	0.073	0.307	-0.039
Large	-0.547	-1.606	-1.017	-0.156	-0.133	-0.024	-0.029	-0.957
(Diff)	1.15***	1.11***	-1.25***	0.14***	0.10*	0.10	0.34***	0.92***
	(5.42)	(6.13)	(-3.30)	(5.46)	(1.90)	(1.12)	(2.97)	(9.42)
Age (time since issuance)								
Young	0.616	-0.785	-0.552	-0.042	-0.011	0.035	0.184	-0.287
Old	-0.258	-1.017	-3.108	-0.094	-0.129	0.041	0.187	-0.459
(Diff)	0.87***	0.23	2.56***	0.05**	0.12**	-0.01	0.00	0.17*
	(3.38)	(1.33)	(5.64)	(2.49)	(2.37)	(-0.06)	(-0.02)	(1.87)
Residual maturity								
Low	-0.264	-1.172	-0.703	-0.113	0.004	-0.105	-0.078	-0.454
High	0.083	-0.997	-2.132	-0.076	-0.050	0.097	0.125	-0.444
(Diff)	-0.35***	-0.18***	1.43***	-0.04***	0.05***	-0.20***	-0.20***	-0.01*
	(-3.48)	(-3.15)	(4.96)	(-4.39)	(3.03)	(-2.60)	(-3.72)	(-1.81)
Issuer industry								
Non-Financials	-0.220	-0.819	-4.348	-0.083	-0.328	0.081	-0.002	-0.369
Financials	0.386	-0.939	-0.553	-0.060	0.059	0.017	0.278	-0.373
(Diff)	-0.61***	0.12	-3.79***	-0.02	-0.39***	0.06	-0.28***	0.00
	(-3.08)	(0.68)	(-5.74)	(-1.24)	(-5.97)	(0.72)	(-2.59)	(0.05)
ESG Flag								
CBI Aligned/Certified	0.083	-0.997	-2.132	-0.076	-0.050	0.097	0.125	-0.444
Self-labelled	0.720	-0.389	-0.129	-0.019	-0.169	-0.274	0.501	0.008
(Diff)	-0.64***	-0.61***	-2.00***	-0.06***	0.12**	0.37***	-0.38	-0.45***
	(-2.93)	(-3.67)	(-6.32)	(-3.43)	(2.51)	(3.52)	(-1.26)	(-5.86)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.5: Sample splits for benchmark greenium (component I in Eq. (8)).

This table reports Component I (benchmark greenium) from our main decomposition (as shown in Panel A of Table 3) for several sample splits. The rows labeled "Diff" report the differences between the two sub-samples and the t-statistic from a two-sample t-test of the null hypothesis that the two respective subsamples have the same means, allowing the variances to differ.The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), the Eurosystem (EuSys), and private households (HHs).

II: General green preference Sample splits	MFIs	IFs	ICs	PFs	EuSys	HHs	Others	Foreign
Size (total amount outstanding)								
Small	0.131	-0.070	0.009	-0.029	0.009	-0.101	0.025	0.027
Large	0.070	-0.217	0.149	-0.044	0.036	-0.005	0.024	-0.014
(Diff)	0.06***	0.15***	-0.14***	0.02***	-0.03**	-0.10***	0.00	0.04***
	(3.64)	(10.01)	(-9.32)	(3.08)	(-2.20)	(-6.98)	(0.05)	(2.85)
Age (time since issuance)								
Young	0.047	-0.032	0.007	-0.005	0.005	-0.055	0.018	0.014
Old	0.217	-0.222	0.105	-0.105	0.029	-0.016	-0.005	-0.004
(Diff)	-0.17***	0.19***	-0.10***	0.10***	-0.02***	-0.04*	0.02	0.02
	(-8.90)	(13.73)	(-6.76)	(15.06)	(-2.81)	(-1.78)	(0.94)	(1.14)
Residual maturity								
Low	0.137	-0.109	0.061	-0.030	0.022	-0.039	0.025	-0.067
High	0.163	-0.143	0.047	-0.053	0.025	-0.038	-0.025	0.024
(Diff)	-0.03	0.03	0.01***	0.02***	0.00	0.00***	0.05	-0.09***
	(-0.49)	(1.53)	(3.87)	(3.77)	(1.49)	(4.45)	(-0.33)	(-12.23)
Issuer industry								
Non-Financials	0.172	-0.252	0.138	-0.144	0.064	-0.019	0.064	-0.023
Financials	0.073	-0.050	0.013	-0.010	0.004	-0.061	0.012	0.017
(Diff)	0.10***	-0.20***	0.12***	-0.13***	0.06***	0.04***	0.05***	-0.04*
	(4.34)	(-10.90)	(5.35)	(-12.05)	(3.09)	(4.71)	(3.65)	(-1.91)
ESG Flag								
CBI Aligned/Certified	0.163	-0.143	0.047	-0.053	0.025	-0.038	-0.025	0.024
Self-labelled	-0.016	0.010	-0.005	0.001	0.000	0.041	-0.027	-0.003
(Diff)	0.18***	-0.15***	0.05***	-0.05***	0.02***	-0.08***	0.00	0.03***
	(15.15)	(-22.48)	(7.85)	(-17.56)	(5.10)	(-5.21)	(0.12)	(2.73)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.6: Sample splits for general green preference (component II in Eq. (8)).

This table reports Component II (general green preference) from our main decomposition (as shown in Panel A of Table 3) for several sample splits. The rows labeled "Diff" report the differences between the two sub-samples and the t-statistic from a two-sample t-test of the null hypothesis that the two respective subsamples have the same means, allowing the variances to differ. The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), the Eurosystem (EuSys), and private households (HHs).

Appendix B Robustness checks

B.1 Loosening the SHS data filter

Our main analyses includes a SHS coverage filter which ensures that euro area investors are economically important for our sample bonds. In particular, we only include bond pairs where euro area investors hold, on average, at least 50% of a green bond's total amount outstanding. We also experimented with alternative thresholds and, for the sake of completeness, Table B.1 shows the main decomposition results (corresponding to the equal-weighted case) for a lower threshold of 10%.

Equal-weighted	Total	MFIs	IFs	ICs	PFs	EuSys	HHs	Others	Foreign
Greenium (g_x)	-2.389*	-0.379*	-0.710**	-1.206	-0.069	-0.019	0.270*	0.278	-0.555*
	(-1.807)	(-1.921)	(-2.210)	(-1.322)	(-1.072)	(-0.288)	(1.770)	(1.610)	(-1.706)
I: Benchmark Greenium		0.188	-0.700**	-1.395	-0.056*	-0.024	0.018	0.141	-0.561
		(0.647)	(-2.471)	(-1.504)	(-1.756)	(-0.232)	(0.139)	(0.954)	(-1.601)
II: General green preference		0.096***	-0.120***	0.028*	-0.028***	0.016	-0.065*	0.020	0.053**
		(3.889)	(-6.142)	(1.729)	(-3.362)	(1.302)	(-1.930)	(0.531)	(2.280)
III: Bond-specific deviations		-0.663***	0.109	0.162	0.015	-0.012	0.317**	0.118	-0.047
		(-2.911)	(1.048)	(1.571)	(0.278)	(-0.179)	(2.379)	(0.665)	(-0.434)
Observations	4,069								

Value-weighted	Total	MFIs	IFs	ICs	PFs	EuSys	HHs	Others	Foreign
Greenium (g_x)	-3.666***	-0.521*	-1.116***	-0.408	-0.126	-0.071	-0.020*	-0.074	-1.330***
	(-2.849)	(-1.867)	(-2.721)	(-1.158)	(-1.593)	(-0.776)	(-1.881)	(-1.583)	(-3.132)
I: Benchmark Greenium		-0.218	-1.054***	-0.733*	-0.089	-0.077	-0.015*	-0.012	-1.468***
		(-0.804)	(-2.820)	(-1.679)	(-1.652)	(-0.617)	(-1.736)	(-0.297)	(-3.254)
II: General green preference		0.064***	-0.113***	0.039*	-0.031***	0.017	-0.002	0.003	0.023
		(2.691)	(-4.351)	(1.724)	(-3.440)	(0.999)	(-0.895)	(0.301)	(1.041)
III: Bond-specific deviations		-0.367**	0.052	0.285*	-0.006	-0.011	-0.004	-0.064	0.115
		(-2.144)	(0.378)	(1.678)	(-0.104)	(-0.145)	(-0.529)	(-1.628)	(1.010)
Observations	4,069								

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.1: Robustness. Greenium decomposition, SHS threshold at 10%.

The table reports our decomposition of the total greenium, exactly as in Table 3, but for a larger sample that is constructed with an SHS coverage filter of 10% instead of 50%. The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), the Eurosystem (EuSys), and private households (HHs).

B.2 Loosening the matching criteria

As another robustness check, Table B.2 shows our main decomposition results when loosening the bond-level matching criteria. In particular, we allow the issue date and the maturity date of green and conventional bonds to differ by up to 2 years (as opposed to 1 year in the baseline specification). Moreover, we allow the amount outstanding of green and conventional bonds to differ by a factor of 4 (as opposed to 2 in the baseline specification). The main patterns continue to hold in this larger sample. However, in line with the idea that loosening the matching criteria

should increase the noise level in the estimated greenium, we find that several point estimates do not necessarily remain statistically significant. This suggests a trade-off between the strictness of the matching criteria and the precision of the estimates, which is also affected by sample size.

Equal-weighted	Total	MFIs	IFs	ICs	PFs	EuSys	HHs	Others	Foreign
Greenium (g_x)	-1.550	-0.098	-0.388	-1.049	-0.051	-0.085	0.285	0.063	-0.225
	(-1.016)	(-0.307)	(-0.935)	(-1.223)	(-1.058)	(-0.316)	(1.635)	(0.659)	(-1.210)
I: Benchmark Greenium		0.236	-0.129	-1.358	0.039	-0.257	-0.029	0.177	-0.228
		(0.590)	(-0.400)	(-1.511)	(0.804)	(-0.905)	(-0.209)	(1.257)	(-1.141)
II: General green preference		0.067***	-0.109***	0.056**	-0.015***	0.026*	-0.057**	0.022	0.010
		(3.577)	(-7.115)	(2.273)	(-2.696)	(1.770)	(-2.393)	(0.951)	(0.677)
III: Bond-specific deviations		-0.401**	-0.150	0.253	-0.075*	0.145	0.370**	-0.136	-0.007
		(-2.201)	(-0.887)	(1.100)	(-1.806)	(1.083)	(2.616)	(-1.032)	(-0.059)
Observations	4,537								

Value-weighted	Total	MFIs	IFs	ICs	PFs	EuSys	HHs	Others	Foreign
Greenium (g_x)	-2.269	-0.474	-0.412	-0.263	-0.083	-0.568	-0.040	-0.046	-0.383
	(-1.261)	(-1.302)	(-0.829)	(-0.713)	(-1.032)	(-1.116)	(-1.069)	(-0.931)	(-1.320)
I: Benchmark Greenium		-0.294	-0.063	-0.587	0.059	-0.806	-0.060*	-0.008	-0.510
		(-0.697)	(-0.153)	(-1.200)	(0.788)	(-1.496)	(-1.730)	(-0.177)	(-1.388)
II: General green preference		0.031*	-0.110***	0.064**	-0.013**	0.032*	-0.003**	-0.003	0.002
		(1.890)	(-6.981)	(2.023)	(-2.230)	(1.947)	(-2.157)	(-0.519)	(0.101)
III: Bond-specific deviations		-0.211	-0.239	0.261	-0.129**	0.206	0.022	-0.035	0.125
		(-1.236)	(-1.375)	(0.942)	(-2.615)	(1.391)	(1.173)	(-0.906)	(0.698)
Observations	4,537								

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.2: Robustness. Greenium decomposition with looser matching criteria.

The table reports our decomposition of the total greenium, exactly as in Table 3, but for a larger sample that is constructed with loosened matching criteria: we allow the maturities of green and matched conventional bonds to differ by up to 2 years and the amount outstanding to differ by a factor of 4. The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), the Eurosystem (EuSys), and private households (HHs).

B.3 Alternative standard error clustering approaches

The statistical tests in the main text are based on standard errors clustered by bond and date. Below we provide results for alternative clustering approaches (by time, bonds, and/or issuers). The first row in both panels contains the numbers from the baseline case discussed in the main text. For brevity, we only present the sectoral greenium, not the decomposition.

Panel A: Equal-weighted Greenium (g_x)	Total	MFIs	IFs	ICs	PFs	EuSys	HHs	Others	Foreign
(Clustering s.e.)									
ISIN, time	-2.811*	-0.529**	-0.918**	-1.570	-0.090	-0.030	0.370*	0.380	-0.423**
	(-1.723)	(-2.109)	(-2.388)	(-1.329)	(-1.102)	(-0.353)	(1.869)	(1.528)	(-2.443)
ISIN	-2.811*	-0.529**	-0.918**	-1.570	-0.090	-0.030	0.370*	0.380	-0.423**
	(-1.709)	(-2.075)	(-2.350)	(-1.317)	(-1.095)	(-0.351)	(1.881)	(1.505)	(-2.400)
Time	-2.811***	-0.529***	-0.918***	-1.570***	-0.090***	-0.030*	0.370***	0.380***	-0.423***
	(-10.915)	(-9.319)	(-16.384)	(-11.903)	(-7.864)	(-1.953)	(5.497)	(4.331)	(-26.576)
Issuer, Time	-2.811	-0.529*	-0.918**	-1.570	-0.090	-0.030	0.370**	0.380	-0.423**
	(-1.498)	(-1.976)	(-2.142)	(-1.295)	(-1.090)	(-0.353)	(2.048)	(1.466)	(-2.301)
Issuer	-2.811	-0.529*	-0.918**	-1.570	-0.090	-0.030	0.370**	0.380	-0.423**
	(-1.472)	(-1.935)	(-2.095)	(-1.279)	(-1.079)	(-0.350)	(2.063)	(1.445)	(-2.245)
Observations	3,133								

Panel B: Value-weighted Greenium (g_x)	Total	MFIs	IFs	ICs	PFs	EuSys	HHs	Others	Foreign
(Clustering s.e.)									
ISIN, time	-3.712**	-0.755**	-1.342**	-0.562	-0.163	-0.105	-0.025*	-0.107*	-0.652***
	(-2.269)	(-1.995)	(-2.448)	(-1.164)	(-1.541)	(-0.847)	(-1.710)	(-1.767)	(-2.727)
ISIN	-3.712**	-0.755*	-1.342**	-0.562	-0.163	-0.105	-0.025*	-0.107*	-0.652***
	(-2.246)	(-1.971)	(-2.414)	(-1.157)	(-1.526)	(-0.843)	(-1.684)	(-1.752)	(-2.685)
Time	-3.712***	-0.755***	-1.342***	-0.562***	-0.163***	-0.105***	-0.025***	-0.107***	-0.652***
	(-15.914)	(-13.896)	(-16.377)	(-8.312)	(-12.487)	(-3.978)	(-15.158)	(-11.089)	(-22.000)
Issuer, Time	-3.712**	-0.755**	-1.342**	-0.562	-0.163	-0.105	-0.025**	-0.107*	-0.652***
	(-2.483)	(-2.095)	(-2.510)	(-1.507)	(-1.589)	(-0.788)	(-2.322)	(-1.812)	(-2.867)
Issuer	-3.712**	-0.755**	-1.342**	-0.562	-0.163	-0.105	-0.025**	-0.107*	-0.652***
	(-2.445)	(-2.062)	(-2.463)	(-1.490)	(-1.568)	(-0.783)	(-2.261)	(-1.790)	(-2.809)
Observations	3,133								

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.3: Robustness - g_x with alternative standard error clustering approaches.

The table shows the sector-specific average greenium g_x, as reported in the first rows in Panels A and B of Table 3, for different standard error specifications. Panel A shows results for the equal-weighted case, Panel B for the value-weighted case. The t-statistics in parentheses are based on standard errors that are clustered in different ways. The first specification in each panel corresponds to our baseline setup that is discussed in the main text and reported in Table 3. The labels refer to monetary financial institutions (MFIs), investment funds (IFs), insurance companies (ICs), pension funds (PFs), the Eurosystem (EuSys), and private households (HHs).