Research article

Green bond market boom: did environmental, social and governance criteria play a role in reducing health-related uncertainty?

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Supplementary Appendix

Appendix A

Table A1. Results with the application of a two-step machine learning procedure: RIDGE (first stage) and dynamic spatial Durbin model (second stage).

Covariates	$\lambda_{\text{LOPT}}^{*}$ [λ_{LSE}^{*}]	Marginal effects of the DSDM						
	RIDGE	Post-estimation OLS	Short run Direct	Indirect	Total	Long run Direct	Indirect	Total
VI1BusinInten	0.1316	0.1259	0.0384	0.0140	0.0524	0.0612	0.0545	0.1157
	[0.2171]	[0.1259]	(0.0464)	(0.1093)	(0.1278)	(0.0744)	(0.2437)	(0.2816)
VI2ATourismFlow	−0.1264	−0.1280	−0.0235	0.1064	0.0829	−0.0316	0.2086	0.1770
	[−0.0809]	[−0.1280]	(0.0521)	(0.0998)	(0.0874)	(0.0795)	(0.2022)	(0.1942)
VI4ForeignOpen	0.0082	0.0089	0.0208*	0.0433	0.0641	0.0351*	0.1054	0.1405
	[−0.0066]	[0.0089]	(0.0111)	(0.0537)	(0.0585)	(0.0188)	(0.1223)	(0.1333)
VI5IntConsump	0.4548	0.4610	0.4662***	−0.1495	0.3166	0.7244***	−0.0483	0.6761
	[0.3327]	[0.4610]	(0.1437)	(0.2519)	(0.2872)	(0.2266)	(0.5437)	(0.6310)
VI3Mob	0.1521	0.1505	−0.0296	0.1029	0.0733	−0.0408	0.2055	0.1647
	[0.1827]	[0.1505]	(0.0672)	(0.2095)	(0.2313)	(0.1079)	(0.4536)	(0.5021)
VI6EldIPSS	0.0656	0.0661	−2.4050	−15.0124	−17. 4174	−4.5189	−32.5838	−37.1057
	[0.0497]	[0.0661]	(5.2987)	(13.3379)	(12.4784)	(8.0918)	(27.9652)	(27.7303)

Mean of FE	3.3062
Time-lagged χ	0.3459*** (0.0397)
Spatial and time-lagged φ	−0.0785 (0.0525)
Spatial ρ	0.4870*** (0.0673)
σ_{ε}^{2}	0.0135***(0.0013)
R^2	0.0109
Log Pseudo-likelihood	1244.3117
AIC	−2587.8640
BIC	−2501.1540
Obs.	1668
Stability (Identification) [Endogeneity]	Satisfied (Satisfied) [Satisfied]

Notes. Considering k-fold cross-validation (with 10 folds) as the decision criterion, results determine that the value of α that minimizes the mean squared prediction error (MSPE) is α* = 0 such that RIDGE regression is the optimal choice. This implies that all 6 explanatory variables significantly affect the dependent variable such that none is excluded. Consequently, second-stage outcomes resulting from the application of DSDM coincide with those obtained in the benchmark exercise. The value of lambda (i.e. penalty level) that minimises the MSPE is given by $\lambda_{\text{LOPT}}^{*}$= 17.8375, where the value of MSPE corresponds to 0.03818. In turn, the largest lambda for which the MSPE is within one standard error of the minimal MSPE is given by λ_{LSE}^{*}= 671.5690. Estimated coefficients associated with λ_{LSE}^{*} are provided within brackets immediately below the estimated coefficients associated with λ_{LOPT}. Symbol *** (**) [*] represents 1% (5%) [10%] of significance level, respectively. The regression includes robust standard errors, which accurately take into account the cluster-correlated data by adjusting for within-cluster correlation, and the constant term was omitted.

Table A2. Use of time-variant models for stochastic frontier analysis.

Covariates	Tfe SFA	Tre SFA	MLrei SFA	ILSfe SFA	MLred SFA	LSDVfe SFA
VI1BusinInten	0.1170***	–0.0494	0.0268	–0.0616	–0.0100	–0.0025
	(0.0000)	(0.0498)	(0.1603)	(0.0503)	(0.0491)	(0.0757)
VI2ATourismFlow	–0.0869***	–0.0878**	–0.0342	0.0437	–0.0880*	–0.1832*
	(0.0000)	(0.0384)	(0.1148)	(0.0579)	(0.0485)	(0.1078)
VI4ForeignOpen	0.0077***	0.0156	0.0184	–0.0403	0.0136	0.0228
	(0.0000)	(0.0155)	(0.0286)	(0.1065)	(0.0084)	(0.0161)
VI5IntConsump	0.8140***	0.8350***	–0.6793***	–0.0021	0.5203***	–0.3018
	(0.0000)	(0.0621)	(0.2147)	(0.0089)	(0.0485)	(0.2231)
VI3Mob	0.3526***	0.1090	1.2412	–0.0478	0.1224	–0.0219
	(0.0000)	(0.0771)	(1.3045)	(0.1030)	(0.1003)	(0.1372)
VI6EldIPSS	0.1040***	0.2266***	0.0274	–0.1229*	0.0596**	–18.1665*
	(0.0000)	(0.0667)	(0.0462)	(0.0711)	(0.0279)	(10.9022)

Notes: Estimated coefficients through panel data time-varying SFA models should be interpreted as direct (i.e. own-municipality) effects since they correspond to representative coefficients of the β vector. Tfe SFA stands for true fixed effects SFA model (Greene, 2005). Tre SFA stands for true random effects SFA model (Greene, 2005) MLrei SFA stands for maximum likelihood (ML) random effects time-varying inefficiency effects model (Battese & Coelli, 1995). ILSfe SFA stands for iterative least squares time-varying fixed effects model (Lee & Schmidt, 1993). MLred SFA stands for ML random effects time-varying efficiency decay model (Battese & Coelli, 1992). LSDVfe SFA stands for modified LSDV time-varying fixed effects model (Cornwell et al., 1990). Symbol *** (**) [*] represents 1% (5%) [10%] of significance level, respectively. The regression includes robust standard errors, which accurately take into account the cluster-correlated data by adjusting for within-cluster correlation. Constant terms were deliberately omitted.

Table A3. Benchmark results with the adoption of different estimators.

Coefficients	GMM	IV applied to DSDM with GS2SLS			
		Absence of lags in covariates	With lag in VI5IntConsump	With lag in VI1BusinInten	With lag in VI2ATourismFlow
VD2dInfCov_L1		0.0163 (0.0190) [0.86]	0.0323 (0.0173) [1.87]	0.0399 (0.0163) [2.44]	0.0167 (0.0188) [0.89]
VI1BusinInten	0.1252*** (0.0392)	–0.0225 (0.0308) [–0.73]	–0.0104 (0.0299) [–0.35]	–0.0161 (0.0293) [–0.55]	–0.0303 (0.0311) [–0.97]
VI2ATourismFlow	–0.1285*** (0.0371)	–0.0709 (0.0264) [–2.68]	–0.0701 (0.0255) [–2.75]	–0.0571 (0.0251) [–2.28]	–0.0925 (0.0292) [–3.17]
VI4ForeignOpen	0.0080 (0.0206)	0.0140 (0.0198) [0.71]	0.0140 (0.0191) [0.73]	0.0142 (0.0188) [0.75]	0.0137 (0.0198) [0.69]
VI5IntConsump	0.4616*** (0.0283)	0.4950*** (0.0474) [10.44]	0.4129*** (0.0445) [9.28]	0.4132*** (0.0423) [9.77]	0.4956*** (0.0472) [10.50]
VI3Mob	0.1514*** (0.0357)	0.1069 (0.0529) [2.02]	0.0919 (0.0512) [1.80]	0.0807 (0.0504) [1.60]	0.1054 (0.0530) [1.99]
VI6EldIPSS	0.0672*** (0.0151)	0.0498 (0.0312) [1.59]	0.0429 (0.0301) [1.43]	0.0396 (0.0295) [1.34]	0.0486 (0.0313) [1.55]
VI5IntConsump_L1			0.0715*** (0.0192) [3.73]		
VI1BusinInten_L1				0.1027*** (0.0223) [4.61]	
VI2AtourismFlow_L1					0.0497 (0.0280) [1.78]
F-test	229.9419***	51.0870***	50.6117***	54.4015***	44.8917***
σ_ε^2 (MSE)	0.0441	0.0427	0.0408	0.0399	0.0427
R^2	0.4528	0.4707	0.4938	0.5057	0.4711
Log Likelihood	429.3723	461.5681	505.0072	528.2470	462.2972
Obs.	1946	1946	1946	1946	1946

Notes: GMM stands for generalised method of moments, IV stands for instrumental variable and GS2SLS stands for generalised spatial two-stage least squares. Estimated coefficients through different spatial panel data estimators should be interpreted as direct (i.e. own-municipality) effects since these correspond to coefficients of the β vector. Symbol *** (**) [*] represents 1% (5%) [10%] of significance level, respectively. Constant terms were deliberately omitted. The IV approach assumes that the one period lagged dependent variable is influenced by all covariates according to which, by construction, the ones representative of the economic dimension are already lagged by one period in time. Consequently, the setting faces the danger that the one period lagged dependent variable is endogenous. The model consists of 6 exogenous variables and contains 12 possible instruments (i.e. all covariates and respective one period lagged covariates). We opt to use VI5IntConsump as IV of VD2dInfCov_L1. Finally, t-ratios are presented within brackets and already take into account the rule clarified in Lee et al. (2022) according to which the criterion for trusting in t-ratio inferences is to have F-test ≥ 104.7 in the IV first-stage or, in case of considering 10 ≤ F-test < 104.7, the critical value 1.96 must be replaced by the critical value 3.43 to ensure the persistence of the symbol *** representative of 0.01 significance level.

Table A4. Re-estimation of coefficients considering:
(1) health-related uncertainty index computed through principal component analysis
(2) accumulated number of new confirmed COVID-19 cases divided by the 2019 population density.

	DSDM spatial and time-period fixed effects		Short run Direct	Indirect	Total	Long run Direct	Indirect	Total
	β vector	θ vector	Direct	Indirect	Total	Direct	Indirect	Total
(1)								
Time-lagged χ	0.6166***							
	(0.0458)							
Spatial and time-lagged φ	−0.2535***							
	(0.0459)							
VI1BusinInten	−0.0116	−0.0119	−0.0125	−0.0236	−0.0361	−0.0319	−0.0558	−0.0877
	(0.0181)	(0.0270)	(0.0179)	(0.0416)	(0.0511)	(0.0463)	(0.1066)	(0.1299)
VI2ATourismFlow	−0.0132	−0.0240	−0.0165	−0.0443	−0.0608	−0.0423	−0.1122	−0.1545
	(0.0212)	(0.0353)	(0.0209)	(0.0505)	(0.0527)	(0.0555)	(0.1338)	(0.1424)
VI4ForeignOpen	0.0068**	−0.0083	0.0063*	−0.0088	−0.0025	0.0166*	−0.2259	−0.0059
	(0.0034)	(0.0098)	(0.0035)	(0.0145)	(0.0156)	(0.0090)	(0.0375)	(0.0402)
VI5IntConsump	0.3527***	−0.0199**	0.3661***	−0.1760	0.5421***	0.9525***	−0.4165	1.3690***
	(0.0683)	(0.1023)	(0.0666)	(0.1509)	(0.1595)	(0.1790)	(0.4678)	(0.5145)
VI3Mob	−0.0321	0.0335	−0.0290	0.0343	0.0052	−0.0755	−0.0957	0.0202
	(0.0260)	(0.0541)	(0.0267)	(0.0818)	(0.0910)	(0.0694)	(0.2093)	(0.2312)
VI6EldIPSS	4.8252	−12.2076***	3.8460	−16.4116***	−12. 5656**	10.2608	−42.1551**	−31.894**
	(3.1199)	(4.4236)	(2.9826)	(5.8505)	(5.3615)	(7.7818)	(16.8048)	(15.7239)
Mean of FE (Obs.)	2.6770 (1668)							
Spatial ρ	0.3838*** (0.047)							
σ_ε^2	0.0019*** (0.0002)							
R² (Log Pseudo-likelihood)			0.0430 (2925.3837)					
AIC (BIC)	−5916.3910 (−5829.6810)							
Stability (Identification) [Endogeneity]			Satisfied (Satisfied) [Satisfied]					
(2)								
Time-lagged χ	1.1431***							
	(0.0679)							
Spatial and time-lagged φ	0.6333***							
	(0.0835)							

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	DSDM	Short run	Long run

	spatial and time-period fixed effects		**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**
	β vector	**θ vector**						
VI1BusinInten	−0.0072*	−0.0118	−0.0071*	−0.0143	−0.214*	0.2432	−0.2231	0.0201*
	(0.0043)	(0.0121)	(0.0041)	(0.0127)	(0.0120)	(4.5798)	(4.5808)	(0.0117)
VI2ATourismFlow	0.0060	0.0269***	0.0068	0.0319***	0.0388***	0.0096	−0.0452	−0.036***
	(0.0052)	(0.0092)	(0.0049)	(0.0104)	(0.0080)	(0.9263)	(0.9266)	(0.0068)
VI4ForeignOpen	0.0033	−0.0090	0.0034	−0.0084	−0.0051	−0.1191	0.1243	0.0052
	(0.0055)	(0.0107)	(0.0053)	(0.0123)	(0.0133)	(2.5849)	(2.5846)	(0.0124)
VI5IntConsump	0.0161	−0.1060***	0.0128	−0.1189***	−0.1061***	−0.1028	0.2011	0.0982***
	(0.0132)	(0.0287)	(0.0130)	(0.0318)	(0.0311)	(9.6211)	(9.6222)	(0.0299)
VI3Mob	−0.0057	−0.0435**	−0.0069	−0.0514**	−0.0583**	0.0992	−0.0457	0.0535**
	(0.0049)	(0.0202)	(0.0046)	(0.0232)	(0.0238)	(0.6538)	(0.6536)	(0.0210)
VI6EldIPSS	2.3192**	2.7086	2.3709**	3.6882*	6.0591***	−7.3984	1.8832	−5.515***
	(1.0106)	(1.7431)	(0.9430)	(2.0325)	(1.5420)	(237.9190)	(237.9250)	(1.0957)
Mean of FE (Obs.)				−2.0239 (1668)				
Spatial ρ	0.1456*** (0.0456)							
σ_ε^2	0.0006*** (0.0001)							
R^2 (Log Pseudo-likelihood)				0.0013 (3106.9334)				
AIC (BIC)				−7937.5200 (−7850.8100)				
Stability (Identification) [Endogeneity]				Satisfied (Satisfied) [Satisfied]				

Notes: t-statistics in parenthesis and degrees of freedom in brackets. Symbols ***, ** and * represent one, five, and ten percent significance levels. The regression includes robust standard errors estimations and robust variance estimations, which accurately take into account the cluster-correlated data by adjusting for within-cluster correlation.

Table A5. Re-estimation of coefficients considering:
(1) only 35 municipalities of the MAL and MAP
(2) remaining 243 municipalities of mainland Portugal.

	DSDM spatial and time-period fixed effects		Short run Direct	Indirect	Total	Long run Direct	Indirect	Total
	β vector	θ vector						
(1)								
Time-lagged χ	0.3559*** (0.0439)							
Spatial and time-lagged φ	–0.0593 (0.0821)							
VI1BusinInten	0.0816 (0.0955)	0.1082 (0.1329)	0.1150 (0.0970)	0.3221 (0.2527)	0.4371 (0.3014)	0.2207 (0.1784)	1.2067 (1.7636)	1.4275 (1.8652)
VI2ATourismFlow	0.0013 (0.0604)	–0.0758 (0.1206)	–0.0136 (0.0568)	–0.1593 (0.2272)	–0.1728 (0.2406)	–0.0378 (0.1016)	–0.5344 (1.1908)	–0.5722 (1.2394)
VI4ForeignOpen	0.8009 (0.6286)	1.7880** (0.8714)	1.1485* (0.6714)	4.6524** (2.0456)	5.8010** (2.4328)	2.3479* (1.3304)	16.4215 (25.9453)	18.7694 (26.7261)
VI5IntConsump	0.7825** (0.3312)	–0.7806** (0.3441)	0.7116* (0.3748)	–0.8146 (0.8436)	–0.1030 (1.1280)	1.0917 (0.6941)	–1.7358 (6.0178)	–0.6441 (6.4364)
VI3Mob	0.0489 (0.1006)	0.4444* (0.2497)	0.1227 (0.1071)	0.9349* (0.5187)	1.0576* (0.5686)	0.2985 (0.2321)	3.1758 (3.5302)	3.4743 (3.5302)
VI6EldIPSS	–17.2881 (16.1604)	19.1495 (30.2050)	–15.4969 (16.1129)	24.6530 (61.4301)	9.1561 (68.8571)	–23.0898 (30.7006)	62.6167 (318.9860)	39.5269 (338.3546)
Mean of FE (Obs.)	–0.0418 (1668)							
Spatial ρ	0.5291*** (0.0621)							
σ_ε^2	0.0047*** (0.0008)							
R^2 (Log Pseudo-likelihood)			0.0126 (2138.2706)					
AIC (BIC)	–4321.8550 (–4235.1450)							
Stability (Identification) [Endogeneity]			Satisfied (Satisfied) [Satisfied]					
(2)								
Time-lagged χ	0.3868*** (0.0570)							
Spatial and time-lagged φ	–0.0813 (0.0524)							
VI1BusinInten	0.0308 (0.0629)	0.0193 (0.0595)	0.0399 (0.0616)	0.0528 (0.0876)	0.0928 (0.1224)	0.0672 (0.1023)	0.1078 (0.1710)	0.1750 (0.2336)
VI2ATourismFlow	0.0273 (0.0753)	0.0604 (0.0843)	0.0331 (0.0722)	0.1112 (0.0992)	0.1443 (0.0956)	0.0576 (0.1177)	0.2144 (0.1859)	0.2720 (0.1885)

VI4ForeignOpen	0.0162	0.0053	0.0179*	0.0182	0.0361	0.0301*	0.0402	0.0703
	(0.0100)	(0.0292)	(0.0103)	(0.0438)	(0.0471)	(0.0174)	(0.0858)	(0.0932)
VI5IntConsump	0.3782**	−0.2760	0.3555**	−0.2474	0.1081	0.5776*	−0.3831	0.1944
	(0.1814)	(0.1852)	(0.1795)	(0.2453)	(0.2982)	(0.2954)	(0.4624)	(0.5684)
VI3Mob	−0.1005	−0.1564	−0.1143	−0.2714*	−0.3857**	−0.1952	−0.5279*	−0.7231**
	(0.0827)	(0.1006)	(0.0826)	(0.1403)	(0.1763)	(0.1372)	(0.2789)	(0.3463)
VI6EldIPSS	−3.4172	−10.9738	−4.5378	−17.1021*	−21.6399**	−7.9295	−32.6562*	−40.5857**
	(4.7666)	(7.4312)	(4.5806)	(10.0649)	(9.7628)	(7.4518)	(19.0078)	(18.9745)
Mean of FE (Obs.)				4.7089 (1668)				
Spatial ρ	0.3345*** (0.0573)							
σ_ε^2	0.0103*** (0.0013)							
R^2 (Log Pseudo-likelihood)				0.0096 (1487.7924)				
AIC (BIC)				−3090.2850 (−3003.5740)				
Stability (Identification) [Endogeneity]				Satisfied (Satisfied) [Satisfied]				

Notes: t-statistics in parenthesis and degrees of freedom in brackets. Symbols ***, ** and * represent one, five, and ten percent significance levels. By definition, dynamic spatial panel data models only consider fixed effects. The regression includes robust standard errors estimations and robust variance estimations, which accurately take into account the cluster-correlated data by adjusting for within-cluster correlation.