

Green Official Development Aid and carbon emissions: do institutions matter?

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ONLINE APPENDIX

Appendix A. Definition, source, and summary statistics of variables

Table A1 provides definitions, data sources, and summary statistics for all variables.

Table A1. Variables, data sources, and descriptive statistics

Variable (notation)	Data source	Obs.	Mean	Min	Max
CO ₂ per capita emissions (metric kilos) (CO2)	World Bank Indicators (2017) http://data.worldbank.org/	1026	3303.5	19.19	36092.9
GDP per capita (constant 2010 US\$) (GDP)	World Bank Indicators (2017) http://data.worldbank.org/	1029	4601.1	193.87	21183.5
Energy intensity (kilos of oil equivalent per constant 2011 international \$ PPP)	World Bank Indicators (2017) http://data.worldbank.org/	1021	163.19	47.6	789.49
Green ODA per capita (constant 2015 US\$) (GODA)	OECD Rio Marker Creditor Reporting System (2017) http://stats.oecd.org/Index.aspx?DataSetCode=CRS1	1032	7.768	0	190.07
Economic Freedom Index (EF)	Heritage Media Contacts (2017) https://www.heritage.org/index/explore?view=by-region-country-year	987	0.5713	0.214	0.79
Control of Corruption (CC)	Worldwide Governance Indicators (2017) http://databank.worldbank.org/data/reports.aspx?source=worldwide-governance-indicators	1032	0.3935	0.1556	0.8164
Rule of Law Index (RL)	Worldwide Governance Indicators (2017) http://databank.worldbank.org/data/reports.aspx?source=worldwide-governance-indicators	1032	39.28	0.1167	0.7866
Total ODA per capita (constant 2015 US\$) (TODA)	OECD Rio Marker Creditor Reporting System (2017) http://stats.oecd.org/Index.aspx?DataSetCode=CRS1	1032	54.09	0	430.97

Appendix B. OLS estimation with fixed effects

As was mentioned, the system GMM does not allow the inclusion of a square term of per capita GDP. Thus, in order to show that the CO₂ emissions increase with per capita GDP for our country set, we estimated the similar models utilizing the fixed effects model. As shown in the models in tables B1-B4, the results show the linear relationship between per capita CO₂ emissions and per capita GDP. Although models *FE_EF_L(2)*, *FE_CC_L(2)* and *FE_RL_L(2)* suggest an inverse U-shaped relationship between these variables, all estimated turning points (27,773, 33,461 and 30,913 constant US\$ respectively) are above the maximum per capita GDP level of analyzed countries (21,183 constant US\$). Parameters of energy intensity in all models are positive and statistically significant. In models without interaction terms (see table B1), the impact of green ODA and institutional quality indices are negative but insignificant.

Table B1. Fixed effects parameter estimates: direct effects of institutional quality on CO₂ emissions

CO ₂ emissions	FE_FREE	FE_CORR	FE_RL
GDP	0.467*** (0.076)	0.462*** (0.072)	0.470*** (0.072)
GDP square	4.76E-06 (3.79E-06)	4.93E-06 (3.64E-06)	4.58E-06 (3.65E-06)
Energy intensity	3.847*** (0.703)	3.886*** (0.685)	3.811*** (0.685)
Green ODA	-2.173 (3.904)	-2.138 (3.774)	-2.137 (3.769)
Economic freedom	-351.444 (788.285)		
Control of corruption		-875.330 (733.984)	
Rule of law			-1 319.989 (805.220)
Constant	561.740 (488.319)	686.661* (388.891)	848.002** (405.933)
R-square	0.5787	0.5927	0.5902
Within R-square	0.2841	0.2838	0.2847

Notes: * Denotes statistical significance within 10%, ** within 5% and *** within 1%. Standard deviations of parameter estimates in brackets. L1 is the lag operator and represents the first lag.

Tables B2, B3 and B4 show that the estimation results of the fixed effects model with the interaction term between green ODA and different institutional quality indices are similar to

tables 3-5 in the main text. As indicated, the current and lags of direct and indirect effect (GODA*EF, GODA*CC and GODA*RL) of green ODA are significant and have opposite signs. Comparing the estimation results of the system GMM and fixed effects model, we can observe that some coefficients are statistically significant in fixed effects regression, but not significant in system GMM estimation. This difference might have occurred due to spurious regression; when nonstationary variables are used in a regression model it may result in significant relationships from unrelated variables.

Table B2. Indirect effects of institutional quality on CO₂ emissions: Economic Freedom Index and green ODA (fixed effect model)

CO ₂ emissions	FE_EF	FE_EF_L(1)	FE_EF_L(2)
GDP	0.471*** (0.076)	0.599*** (0.081)	0.761*** (0.084)
GDP square	4.87E-06 (3.78E-06)	-2.55E-06 (4.01E-06)	-1.37E-05*** (4.16E-06)
Energy intensity	3.943*** (0.702)	4.673*** (0.772)	5.156*** (0.843)
Green ODA	78.028** (35.374)	57.303* (33.320)	67.462** (31.011)
GODA*EF	-122.437** (53.674)	-90.240* (50.563)	-104.114** (47.153)
Economic Freedom	-124.078 (792.719)	-1 531.557* (832.553)	-1 815.012** (863.411)
L1(GODA)		62.150* (36.552)	57.739* (33.495)
L2(GODA)			45.672 (37.727)
L1(GODA*EF)		-92.726* (55.108)	-85.576* (50.439)
L2(GODA*EF)			-68.453 (57.328)
Constant	387.390 (493.128)	773.380 (514.425)	546.052 (538.800)
R-square	0.5812	0.5782	0.5521
Within R-square	0.2883	0.2726	0.2557

Notes: * Denotes statistical significance within 10%, ** within 5% and *** within 1%. Standard deviations of parameter estimates in brackets. Standard deviations of parameter estimates are shown in brackets. L1 and L2 are lag operators and represent the first and second lag respectively.

Table B3: Indirect effects of institutional quality on CO₂ emissions: Control of Corruption index and green ODA (fixed effect model)

CO ₂ emissions	FE_CC	FE_CC_L(1)	FE_CC_L(2)
GDP	0.467*** (0.071)	0.550*** (0.076)	0.696*** (0.080)
GDP square	5.55E-06 (3.63E-06)	1.02E-07 (3.86E-06)	-1.04E-05*** (4.01E-06)
Energy intensity	4.012*** (0.683)	4.673*** (0.750)	5.118*** (0.817)
Green ODA	52.526*** (17.486)	43.732*** (16.377)	39.650*** (15.027)
GODA*CC	-114.424*** (35.748)	-94.248*** (33.651)	-84.910*** (30.938)
Control of Corruption	-598.781 (735.440)	59.848 (744.880)	843.288 (742.706)
L1(GODA)		45.528** (18.243)	41.895** (16.672)
L2(GODA)			36.596** (18.173)
L1(GODA*CC)		-93.806** (38.203)	-85.592** (34.826)
L2(GODA*CC)			-76.876** (38.586)
Constant	500.999 (391.287)	-34.151 (403.332)	-670.593 (412.475)
R-square	0.5947	0.5884	0.5580
Within R-square	0.2916	0.2728	0.2526

Notes: **Denotes statistical significance within 5% and *** within 1%. Standard deviations of parameter estimates in brackets. L1 and L2 are lag operators and represent the first and second lag respectively.

Table B4. Indirect effects of institutional quality on CO₂ emissions: Rule of Law index and green ODA (fixed effect model)

CO ₂ emissions	FE_RL	FE_RL_L(1)	FE_RL_L(2)
GDP	0.477*** (0.072)	0.561*** (0.077)	0.711*** (0.081)
GDP square	4.78E-06 (3.64E-06)	-8.35E-07 (3.87E-06)	-1.15E-05*** (4.03E-06)
Energy intensity	3.928*** (0.684)	4.592*** (0.752)	5.084*** (0.819)
Green ODA	45.598*** (17.566)	39.588** (16.533)	41.370*** (15.403)
GODA*RL	-93.115*** (33.473)	-79.262** (31.692)	-81.993*** (29.672)
Rule of Law	-1 269.885 (802.509)	-819.881 (832.132)	-383.500 (842.780)
L1(GODA)		37.156** (17.611)	35.434** (16.165)
L2(GODA)			27.865 (17.676)
L1(GODA*RL)		-70.182** (33.903)	-65.792** (31.023)
L2(GODA*RL)			-54.735 (35.019)
Constant	763.309* (405.608)	311.545 (422.551)	-211.918 (431.616)
R-square	0.5936	0.5913	0.5667
Within R-square	0.2907	0.2703	0.2492

Notes: * Denotes statistical significance within 10%, ** within 5% and *** within 1%. Standard deviations of parameter estimates in brackets. L1 and L2 are lag operators and represent the first and second lag respectively.

Appendix C. The impact of total aid and institutions on CO₂ emissions

Since the empirical studies on aid effectiveness mostly use aid in general, we also use the total ODA, which covers all sectors, to test whether it helps to mitigate CO₂ emissions directly and whether higher institutional quality in recipient countries matters for the effectiveness of total ODA. Tables C1, C2 and C3 show the estimation results with total ODA and interaction effects of economic freedom, corruption and rule of law indices respectively. All models were constructed in the same manner as models with green ODA by substitution of green ODA with total ODA. According to the estimation results, the coefficients of lagged CO₂ emissions variable, GDP and energy intensity are also statistically

significant and have expected signs, as in models with green ODA. However, lagged total ODA and interaction terms are found to be statistically insignificant in all models.

Table C1. Indirect effects of institutional quality on CO₂ emissions: Economic Freedom Indices and total ODA

CO ₂ emissions	TODA_EF	TODA_EF_L(1)	TODA_EF_L(2)
L1(CO ₂)	0.624*** (0.072)	0.623*** (0.072)	0.607*** (0.072)
GDP	0.496*** (0.110)	0.507*** (0.115)	0.521*** (0.116)
Energy intensity	15.716*** (3.807)	15.321*** (3.884)	15.922*** (3.823)
Total ODA	-0.653 (3.441)		
Economic freedom	3 140.148 (2 684.541)	3 213.922 (2 672.216)	4 189.799 (3 143.660)
TODA*EF	0.003 (5.569)		
L1(TODA)		2.086 (3.016)	2.016 (2.915)
L2(TODA)			0.863 (2.115)
L1(TODA*EF)		-2.858 (4.936)	-2.759 (4.614)
L2(TODA*EF)			-1.315 (3.518)
Constant	-5 318.730*** (1 935.568)	-5 417.454*** (1 949.410)	-6 083.003*** (2 164.672)
Arellano-Bond test for zero autocorrelation	AR(1)	-1.84*	-1.81*
	AR(2)	0.55	0.60
Joint test	1.73	0.93	0.91

Notes: * Denotes statistical significance within 10% and *** within 1%. Standard deviations of parameter estimates in brackets. L1 and L2 are lag operators and represent the first and second lag respectively.

Table C2. Indirect effects of institutional quality on CO₂ emissions: Corruption Indices and total ODA

CO ₂ emissions		TODA_CC	TODA_CC_L(1)	TODA_CC_L(2)
L1(CO ₂)		0.636*** (0.069)	0.634*** (0.070)	0.614*** (0.068)
GDP		0.484*** (0.111)	0.489*** (0.114)	0.500*** (0.110)
Energy intensity		15.345*** (3.855)	15.496*** (3.833)	16.974*** (4.053)
Total ODA		0.853 (1.193)		
Control of corruption		1 661.040 (1 924.702)	1 651.864 (1 875.038)	2 173.952 (1 858.368)
TODA*CC		-3.546 (3.089)		
L1(TODA)			1.959 (1.875)	1.796 (1.761)
L2(TODA)				1.166 (2.692)
L1(TODA*CC)			-4.244 (3.812)	-4.007 (3.639)
L2(TODA*CC)				-2.986 (6.296)
Constant		-4 080.022*** (1 202.053)	-4 169.829*** (1 180.154)	-4 591.408*** (1 160.276)
Arellano-Bond test for zero autocorrelation	AR(1) AR(2)	-1.93* 0.60	-1.91* 0.61	-1.97** 0.61
Joint test		2.06	1.26	1.25

Notes: * Denotes statistical significance within 10% and *** within 1%. Standard deviations of parameter estimates in brackets. L1 and L2 are lag operators and represent the first and second lag respectively.

Table C3. Indirect effects of institutional quality on CO₂ emissions: Rule of Law Indices and total ODA

CO ₂ emissions	TODA_RL	TODA_RL_L(1)	TODA_RL_L(2)
L1(CO ₂)	0.634*** (0.070)	0.632*** (0.072)	0.611*** (0.069)
GDP	0.485*** (0.108)	0.490*** (0.111)	0.499*** (0.105)
Energy intensity	15.473*** (3.954)	15.607*** (3.934)	17.029*** (4.093)
Total ODA	1.578 (1.192)		
Rule of law	1 235.465 (2 176.260)	983.378 (2 068.353)	1 784.676 (1 843.717)
TODA*RL	-5.377 (3.516)		
L1(TODA)		0.402 (1.021)	0.429 (1.148)
L2(TODA)			0.087 (1.059)
L1(TODA*RL)		-0.583 (2.495)	-0.832 (2.889)
L2(TODA*RL)			-0.562 (3.308)
Constant	-3 901.868*** (1 208.987)	-3 891.513*** (1 188.199)	-4 394.718*** (1 146.550)
Arellano-Bond test for zero autocorrelation	AR(1) AR(2)	-1.87* 0.45	-1.86* 0.41
Joint test	1.18	1.90	0.17

Notes: * Denotes statistical significance within 10%, ** within 5% and *** within 1%. Standard deviations of parameter estimates in brackets. L1 and L2 are lag operators and represent the first and second lag respectively.

Appendix D. Green ODA recipient Country lists

Table D1. Green ODA recipient country list

Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Bangladesh, Belarus, Benin, Bolivia, Botswana, Brazil, Cambodia, Cameroon, Chile, China, Colombia, Congo, Republic, Costa Rica, Croatia, Côte d'Ivoire, Ecuador, El Salvador, Ethiopia, Gabon, Georgia, Ghana, Guatemala, Haiti, Honduras, India, Indonesia, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyz Republic, Lebanon, Libya, Macedonia, FYR, Malaysia, Mauritius, Mexico, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Nigeria, Oman, Pakistan, Panama, Peru, Philippines, Saudi Arabia, Senegal, Serbia, South Africa, Sri Lanka, Sudan, Suriname, Tajikistan, Tanzania, Thailand, Togo, Tunisia, Turkey, Turkmenistan, Ukraine, Uruguay, Uzbekistan, Venezuela, RB, Vietnam, Yemen, Republic, Zambia, Zimbabwe, Bosnia and Herzegovina, Congo, Democratic Republic, Dominican Republic, Egypt, Arab Republic, Trinidad and Tobago, Iran, Islamic Republic
