

# DEVELOPING STATES AND THE GREEN CHALLENGE. A DYNAMIC APPROACH - APPENDIX

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Table A1

**List of countries**

Geographic Region		
East Asia and Pacific (10)	Europe and Central Asia (6)	Latin America and Caribbean (5)
Indonesia	Armenia	Bolivia
Kiribati	Georgia	El Salvador
Lao PDR	Kyrgyz Republic	Guatemala
Mongolia	Tajikistan	Honduras
Myanmar	Ukraine	Nicaragua
Papua New Guinea	Uzbekistan	
Philippines		
Solomon Islands		
Vanuatu		
Vietnam		
Middle East and North Africa (5)	South Asia (6)	Sub-Saharan Africa (36)
Egypt, Arab Rep.	Bangladesh	Angola
Jordan	Bhutan	Benin <sup>‡</sup>
Morocco	India	Burkina Faso <sup>‡</sup>
Tunisia	Nepal <sup>‡</sup>	Burundi <sup>‡</sup>
Yemen, Rep.	Pakistan	Cabo Verde
	Sri Lanka	Cameroon
		Central African Republic <sup>‡</sup>
		Chad <sup>‡</sup>
		Comoros <sup>‡</sup>
		Congo, Dem. Rep. <sup>‡</sup>
		Congo, Rep.

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Geographic Region		
East Asia and Pacific (10)	Europe and Central Asia (6)	Latin America and Caribbean (5)
		Côte d'Ivoire Ethiopia <sup>‡</sup> Gambia <sup>‡</sup> Ghana Guinea <sup>‡</sup> Guinea-Bissau <sup>‡</sup> Kenya Lesotho Liberia <sup>‡</sup> Madagascar <sup>‡</sup> Malawi <sup>‡</sup> Mali <sup>‡</sup> Mauritania Mozambique <sup>‡</sup> Nigeria Rwanda <sup>‡</sup> Senegal <sup>‡</sup> Sierra Leone <sup>‡</sup> Sudan Swaziland Tanzania <sup>‡</sup> Togo <sup>‡</sup> Uganda <sup>‡</sup> Zambia Zimbabwe <sup>‡</sup>

Notes: <sup>‡</sup> denotes that the respective country belongs to the low income group.

Table A2

Variables Definition

Variable	Defintion	Source	
CO2	CO2 emissions totals of fossil fuel use and industrial processes (ktonnes)	The European Commission, Joint Research Centre (EC-JRC)/Netherlands Environmental Assessment Agency (PBL). Emissions Database for Global Atmospheric Research (EDGAR), release EDGARv4.3.2_FT2016 (1970 - 2016). Janssens-Maenhout, G., Crippa, M., Guizzardi, D., Muntean, M., Schaaf, E., Olivier, J.G.J., Peters, J.A.H.W., Schure, K.M., Fossil CO2 and GHG emissions of all world countries, EUR 28766 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-73207-2, doi:10.2760/709792, JRC107877 ( <a href="http://edgar.jrc.ec.europa.eu/overview.php?v=booklet2017&amp;dst=CO2emi">http://edgar.jrc.ec.europa.eu/overview.php?v=booklet2017&amp;dst=CO2emi</a> )	
CO2_T	CO2 emission from transport		
CO2_B	CO2 emission from buildings		
CO2_OIC	CO2 emission from other industrial combustion		
CO2_NC	CO2 emission from non-combustion		
CO2_PI	CO2 emission from power industry		
GDP	GDP based on purchasing power parity (PPP) (constant 2011 international \$)		The World Bank, World Bank Indicators ( <a href="https://databank.worldbank.org/data/home.aspx">https://databank.worldbank.org/data/home.aspx</a> )
URB	Urban population (% of total population)		
RENG	Renewable energy consumption (% of total final energy consumption)		
EINT	Energy intensity level of primary energy computed as total primary energy supply over GDP measured in constant 2011 US dollars at PPP (MJ/\$2011 PPP GDP)		
POP	Total midyear population		
AGRI	Agriculture, value added (% of GDP)		
IND	Industry, value added (% of GDP)		
SERV	Services, value added (% of GDP)		
TRADE	Trade (% of GDP)		
FRENTS	Forest rents (% of GDP)		
CREDIT	Domestic credit to private sector (% of GDP)		
GDPc	GDP per capita based on purchasing power parity (PPP) (constant 2011 international \$)		
REM	Migrant remittance inflows (nominal US\$ million)	The World Bank staff calculation based on data from IMF Balance of Payments Statistics database and data releases from central banks, national statistical agencies, and World Bank country desks ( <a href="https://www.worldbank.org/en/topic/labormarkets/brief/migration-and-remittances">https://www.worldbank.org/en/topic/labormarkets/brief/migration-and-remittances</a> )	
CO2c	CO2 per capita emissions totals of fossil fuel use and industrial processes (ktonnes)	Authors' computation based on The European Commission, Joint Research Centre (EC-JRC)/Netherlands Environmental Assessment Agency (PBL) (CO2 emissions: <a href="http://edgar.jrc.ec.europa.eu/overview.php?v=booklet2017&amp;dst=CO2emi">http://edgar.jrc.ec.europa.eu/overview.php?v=booklet2017&amp;dst=CO2emi</a> ) and World Bank Indicators	

Variable	Defintion	Source
		data (population: <a href="https://databank.worldbank.org/data/home.aspx">https://databank.worldbank.org/data/home.aspx</a> )
EINTc	Energy intensity level of primary energy per capita computed as total primary energy supply over GDP measured in constant 2011 US dollars at PPP (MJ/\$2011 PPP GDP)	Authors' computation based on the World Bank Indicators data (energy intensity level of primary energy and population: <a href="https://databank.worldbank.org/data/home.aspx">https://databank.worldbank.org/data/home.aspx</a> )

**Table A3**

**Descriptive statistics (full-sample)**

Variable/Statistic	Mean	Std. dev	Median	Min	Max	Observations
Baseline Analysis						
GDP	1.54e+11	5.49e+11	2.52e+10	1.43e+08	7.54e+12	1632
URB	36.97067	15.85659	35.3225	6.288	83.679	1632
EINT	8.732009	6.978321	6.149098	1.91032	57.98816	1632
RENG	59.00502	29.2848	63.37218	0.600592	98.34261	1632
CO2	45506.02	185879.9	4161.842	20.6217	2419637	1632
Robustness Analysis						
GDPc	2815.427	2185.772	2085.198	180.4062	12152.17	1632
CO2c	0.0008181	0.0012382	0.0003974	0.0000311	0.012404	1632
EINTc	3.02e-06	7.44e-06	6.84e-07	3.61e-09	0.000069	1632
POP	4.17e+07	1.38e+08	1.03e+07	74769	1.31e+09	1632
AGRI	23.93044	12.40996	22.88478	2.706677	79.04237	1559
IND	24.93198	10.76102	24.15961	2.073173	77.41367	1540
SERVI	45.03406	9.706143	45.77348	12.43525	77.02007	1485
TRADE	72.59632	32.94223	67.26805	0.1674176	311.3553	1565
FRENTS	4.593966	6.052195	2.429323	0.0000	40.42677	1616
REM	2072.407	6065.007	204.5626	0.0095628	70388.64	1340
CREDIT	21.92812	18.57499	15.66249	0.4103563	114.7235	1521
CO2 Sector-specific Analysis						
CO2_T	7117.286	20936.74	1244.581	15.26836	257301.2	1632
CO2_B	5187.247	17222.53	561.6689	0.407881	180733.1	1632
CO2_NC	5724.411	18873.11	476.8578	0.046156	206595.6	1632
CO2_OIC	10202.23	42005.12	636.099	0.0000	529105.3	1608
CO2_PI	17424.87	91486.77	608.0745	0.0000	1245902	1632

Table A4

**Descriptive Statistics (sub-samples)**

Variable/Statistic	Mean	Std. dev	Median	Min	Max	Observations
Low Income Economies						
GDP	1.97e+10	2.16e+10	1.36e+10	5.13e+08	1.53e+11	576
URB	29.17297	11.52414	30.2355	6.288	59.632	576
EINT	11.83926	8.449231	9.401523	1.91032	57.98816	576
RENG	81.83385	14.57414	86.66449	40.46676	98.34261	576
CO2	2391.314	2914.064	1306.94	45.36593	18988.19	576
Lower-middle Income Economies						
GDP	2.27e+11	6.71e+11	4.27e+10	1.43e+08	7.54e+12	1056
URB	41.22395	16.2794	40.0925	12.977	83.679	1056
EINT	7.037145	5.31305	5.425794	1.992982	38.33533	1056
RENG	46.55294	27.75466	51.01571	0.600592	95.85808	1056
CO2	69023.13	227689	8254.396	20.6217	2419637	1056
Kyoto Protocol Status Group A						
GDP	1.90e+11	6.53e+11	2.88e+10	1.43e+08	7.54e+12	1104
URB	38.34527	17.04287	36.327	6.288	83.679	1104
EINT	8.284522	6.528194	5.964056	1.91032	57.98816	1104
RENG	53.47162	30.03119	57.21445	0.600592	97.29142	1104
CO2	59523.13	222856.2	5533.39	20.6217	2419637	1104
Kyoto Protocol Status Group B						
GDP	7.91e+10	1.77e+11	2.00e+10	6.37e+08	9.47e+11	528
URB	34.09649	12.56938	33.7425	9.585	65.526	528
EINT	9.667664	7.759983	6.990818	2.056564	50.13474	528
RENG	70.57486	23.83922	78.07493	5.554171	98.34261	528
CO2	16197.52	41380.69	2583.84	43.01915	227542	528

Table A5

## Cross-sectional Dependence Tests

Test/Variable	CO2	GDP	EINT	RENG	URB
Breusch-Pagan LM	34483.67*** (0.000)	44405.60*** (0.000)	19907.45*** (0.000)	18059.67*** (0.000)	43539.82*** (0.000)
Pesaran scaled LM	477.134*** (0.000)	624.129*** (0.000)	261.184*** (0.000)	233.808*** (0.000)	611.303*** (0.000)
Pesaran CD	141.464*** (0.000)	202.439*** (0.000)	55.523*** (0.000)	59.380*** (0.000)	110.153*** (0.000)
BC scaled LM	475.655*** (0.000)	622.651*** (0.000)	259.705*** (0.000)	232.330*** (0.000)	609.824*** (0.000)

Notes: The Breusch-Pagan (1980) LM, Pesaran (2004) scaled LM, Pesaran (2004) CD, and Baltagi et al. (2012) Bias-Corrected (BC) scaled LM test.  $H_0$  is "no cross-section dependence (correlation)". P-values in brackets. \*\*\*, \*\*, \*, denotes significance at the 1%, 5% and 10% level, respectively.

Table A6

## Stationarity Analysis I

Test/ Variable	Harris-Tzavalis test			
	Level (cons & trend)		$\Delta$ (cons)	
	rho	p-value	rho	p-value
GDP	0.748	(0.983)	0.235***	(0.000)
URB	0.853	(1.000)	0.839**	(0.033)
EINT	0.685	(0.258)	-0.007***	(0.000)
RENG	0.675	(0.145)	-0.056***	(0.000)
CO2	0.686	(0.271)	0.004***	(0.000)

Notes: We remove cross-sectional means and apply small-sample adjustment to  $T$ .  $H_0$  is "panels contain unit roots". P-values in brackets. \*\*\*, \*\*, \*, denotes significance at the 1%, 5% and 10% level, respectively.

Table A7

## Stationarity Analysis II

Test/ Variable	Pesaran's CADF test							
	Level (cons & trend)		$\Delta$ (cons)		Level (cons & trend)		$\Delta$ (cons)	
	Augmented by one lag (average)				Augmented by two lags (average)			
	t-bar	p-value	t-bar	p-value	t-bar	p-value	t-bar	p-value
GDP	-2.263	(0.663)	-2.819***	(0.000)	-1.969	(0.999)	-2.139***	(0.000)
URB	-2.620***	(0.003)	-1.674	(0.740)	-2.325	(0.446)	-1.965**	(0.034)
EINT	-2.185	(0.865)	-2.962***	(0.000)	-1.866	(1.000)	-2.114***	(0.001)
RENG	-1.884	(1.000)	-3.017***	(0.000)	-1.740	(1.000)	-2.036***	(0.008)
CO2	-2.597***	(0.005)	-3.234***	(0.000)	-2.166	(0.899)	-2.630***	(0.000)

Notes:  $H_0$  is "all series are non-stationary". P-values in brackets. \*\*\*, \*\*, \* denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table A8

Panel Cointegration Tests

Westerlund (2007)				
Statistic	Z-value	Robust p-value	Z-value	Robust p-value
bootstrap with 100 replications			bootstrap with 800 replications	
Gt	0.669	0.271	0.669	0.271
Ga	13.271	1.000	13.271	1.000
Pt	10.714	0.591	10.714	0.591
Pa	9.670	0.684	9.670	0.684

Notes:  $H_0$  is "no cointegration". The equation includes the constant term, one lag, and one lead. The width of the Bartlett kernel window is set to three. \*\*\*, \*\*, \*, denotes significance at the 1%, 5% and 10% level, respectively.

Table A9

## Panel SVAR-Granger Causality Wald Test

[Equation] \ Excluded variable	chi2	df	prob > chi2
[GDP]			
URB	1.083	1	(0.298)
EINT	1.531	1	(0.216)
RENG	2.812*	1	(0.094)
CO2	0.469	1	(0.493)
ALL	5.921	4	(0.205)
[URB]			
GDP	10.608***	1	(0.001)
EINT	0.167	1	(0.683)
RENG	2.247	1	(0.134)
CO2	1.989	1	(0.158)
ALL	16.152***	4	(0.003)
[EINT]			
GDP	22.044***	1	(0.000)
URB	0.149	1	(0.699)
RENG	0.563	1	(0.453)
CO2	0.805	1	(0.370)
ALL	23.092***	4	(0.000)
[RENG]			
GDP	11.287***	1	(0.001)
URB	5.934**	1	(0.015)
EINT	2.131	1	(0.144)
CO2	1.273	1	(0.259)
ALL	23.727***	4	(0.000)
[CO2]			
GDP	4.828**	1	(0.028)
URB	15.787***	1	(0.000)
EINT	6.179**	1	(0.013)
RENG	1.313	1	(0.252)
ALL	22.787***	4	(0.000)

Notes:  $H_0$  is "Excluded variable does not Granger-cause equation variable", while according to  $H_1$  "Excluded variable Granger-causes equation variable. \*\*\*, \*\*, \*, denotes significance at the 1%, 5% and 10% level, respectively.



Table A10

Panel SVAR selection Order Criteria

Lag	CD	J	J p-value	MBIC	MAIC	MQIC
1	0.988	70.449	0.019	-270.824	-25.550	-117.853
2	0.988	48.099	0.033	-179.417	-15.900	-77.435
3	0.988	17.601	0.345	-96.156	-14.398	-45.166
Observations	1224					
Panels	68					

Notes: Model and moment selection criteria are computed using the first four lags of variables.

Table A11

First-order panel SVAR-GMM Estimates

Response of	Response to				
	GDPT-1	URBt-1	EINTt-1	RENGt-1	CO2t-1
GDP	0.3746*** (0.0436)	-0.2343 (0.2251)	0.0190 (0.0154)	-0.0292* (0.0174)	0.0083 (0.0122)
URB	0.0066*** (0.0020)	0.9398*** (0.0241)	0.0002 (0.0007)	0.0010 (0.0007)	0.0011 (0.0007)
EINT	-0.2868*** (0.0610)	0.1219 (0.3158)	-0.0517 (0.0427)	0.0271 (0.0362)	0.0246 (0.0274)
RENG	-0.1375*** (0.0409)	0.4409** (0.1810)	-0.0481 (0.0329)	-0.0618 (0.0497)	-0.0263 (0.0233)
CO2	0.1628** (0.0741)	1.9181*** (0.4827)	0.1078** (0.0433)	0.0536 (0.0468)	0.0072 (0.0367)
Observations (N x T)	1428				
Countries	68				

Notes: The five-variable one lag panel SVAR is estimated by GMM, using first four lags of the variables as instruments. The country-specific fixed effects are removed during estimation via the Helmert transformation. Reported numbers display the coefficients of regressing the row variables on first lag of the column variables. Standard errors robust to heteroskedasticity and serial correlation in brackets. \*\*\*, \*\*, \*, denotes significance at the 1%, 5% and 10% level, respectively.

**Table A12**

**Model stability condition**

Eigenvalue		
Real	Imaginary	Modulus
0.940	0	0.940
0.372	0	0.372
-0.081	0	0.081
-0.045	0	0.045
0.022	0	0.022

*Notes: All the eigenvalues lie inside the unit circle. The GMM panel SVAR model satisfies stability condition.*

**Figure A1**

**Inverted Roots of AR Characteristics Polynomial (GMM-SVAR)**

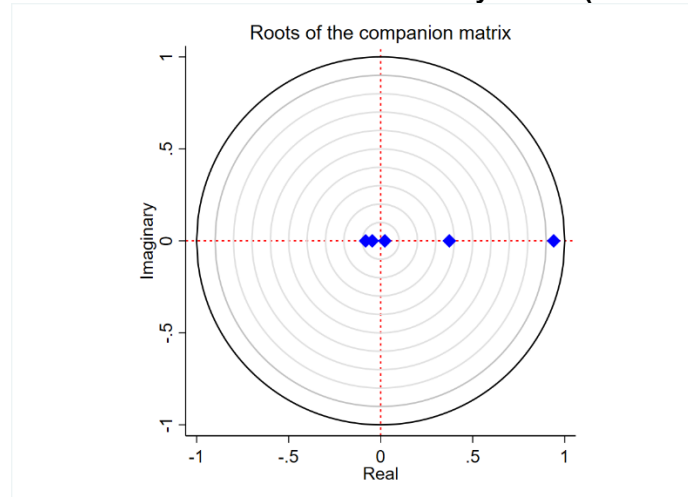
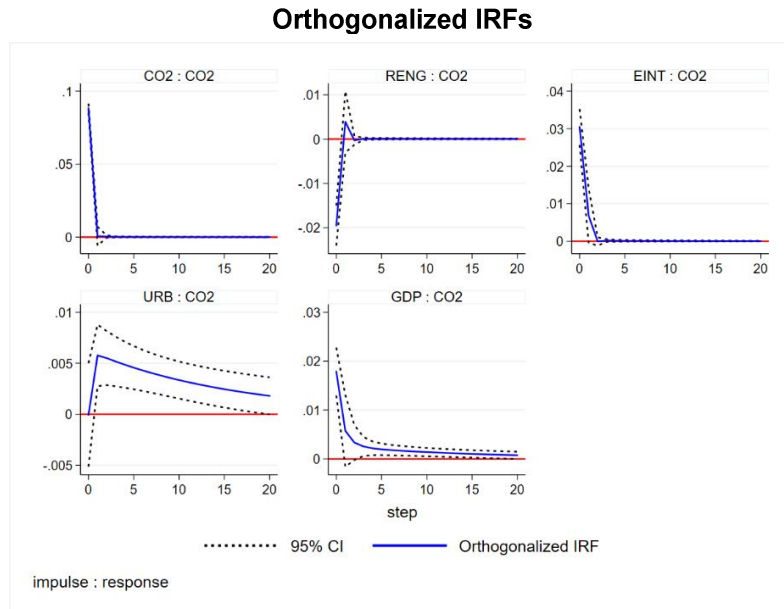


Figure A2



Observations: 1428 • Groups: 68

Notes: The continuous line denotes the impulse response functions. The dashed lines stand for the associated 95% confidence interval computed based on 1000 Monte Carlo simulations.

**Figure A3**

**Cumulative Orthogonalized IRFs: Robustness (alternative ordering)**

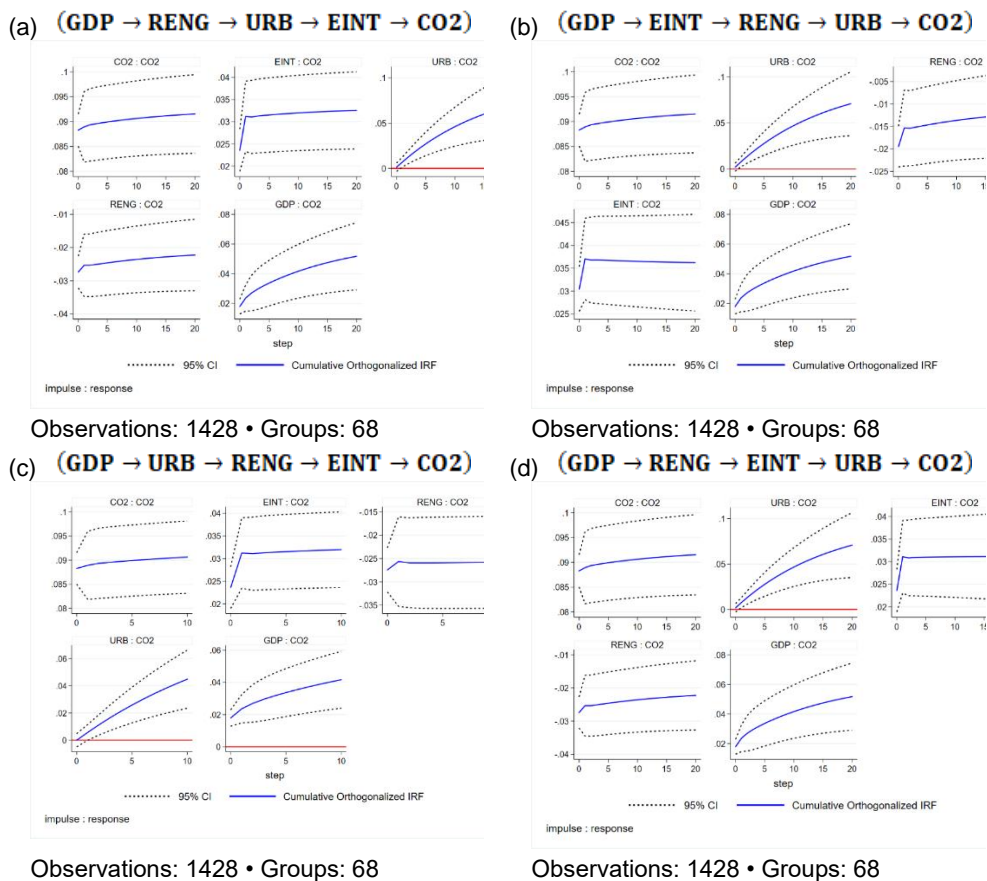
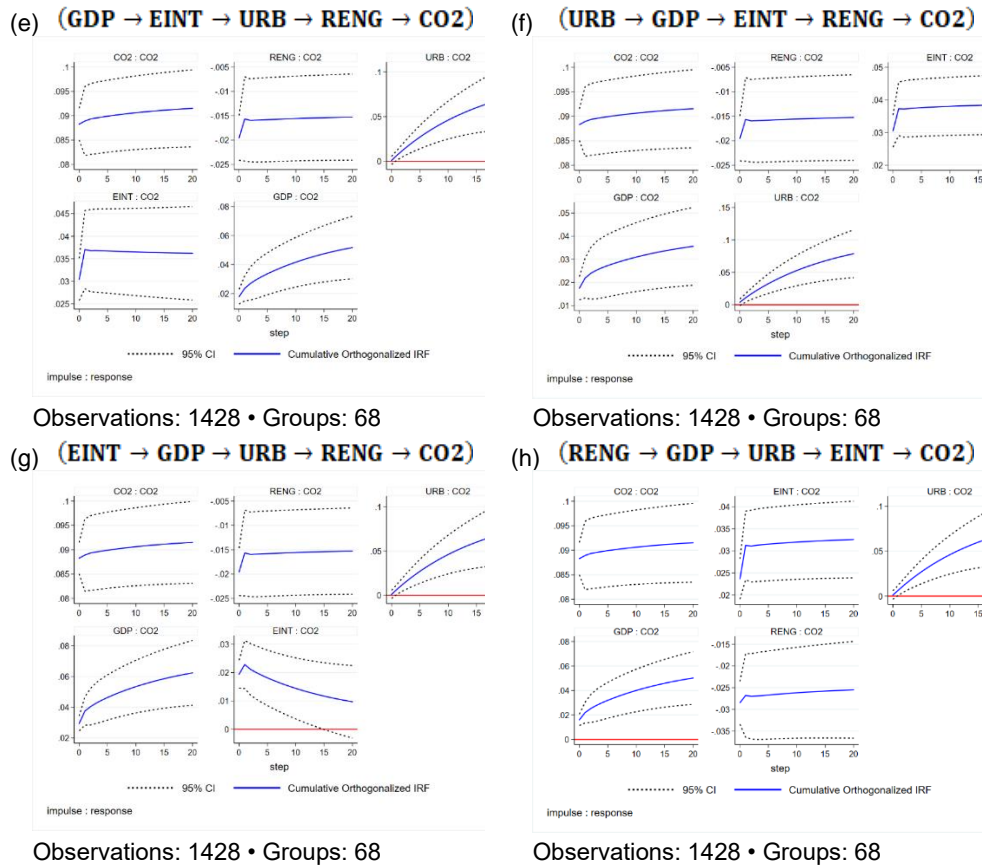


Figure A3

(Continued)

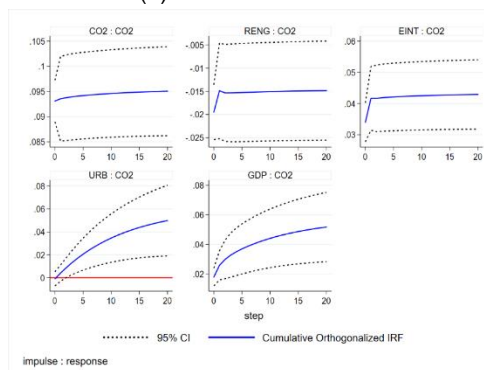


Notes: The continuous line denotes the impulse response functions. The dashed lines stand for the associated 95% confidence interval computed based on 1000 Monte Carlo simulations.

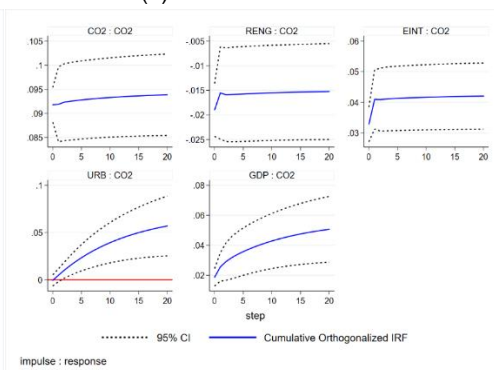
**Figure A4**

**Cumulative Orthogonalized IRFs: Altering the Sample & Variables in per Capita Terms**

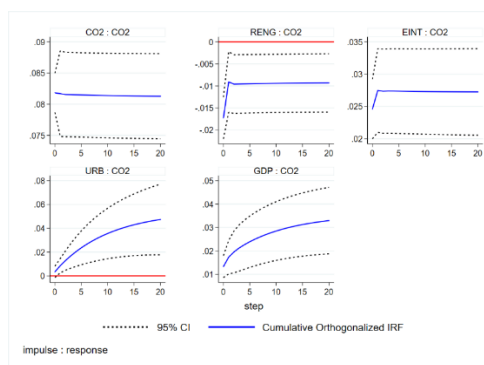
(a) Period: 1992-2008



(b) Period: 1992-2010



(c) Period: 1996-2015



(d) Without: Egypt, Jordan, Mauritania, Morocco, Sudan, Tunisia, Yemen

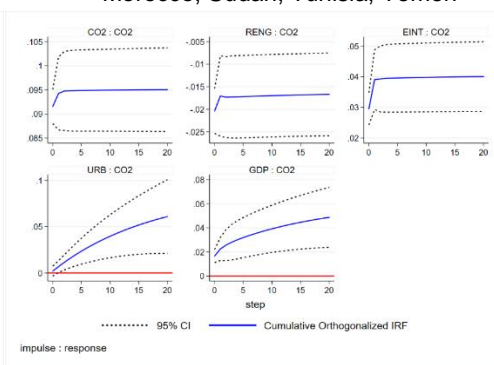
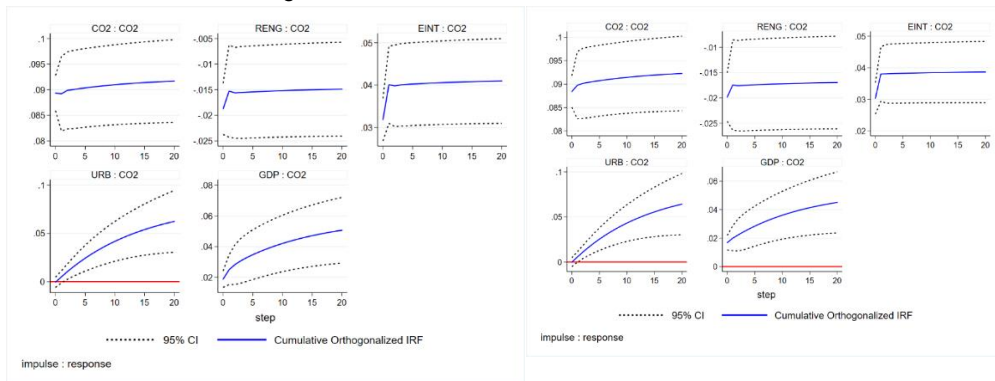


Figure A4

(Continued)

(e) Without: Angola, Congo Rep., Egypt, Indonesia, Nigeria, Vietnam

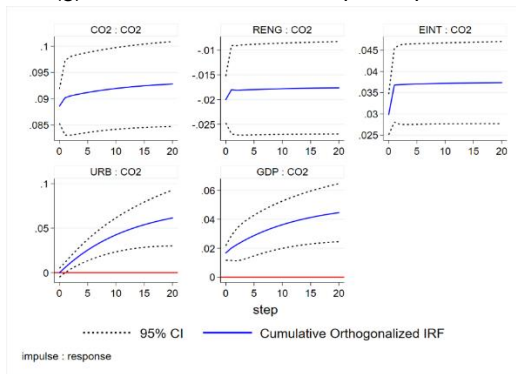
(f) GDP and CO2 in per Capita Terms



Observations: 1302 • Groups: 62

Observations: 1428 • Groups: 68

(g) GDP, EINT, and CO2 in per Capita Terms

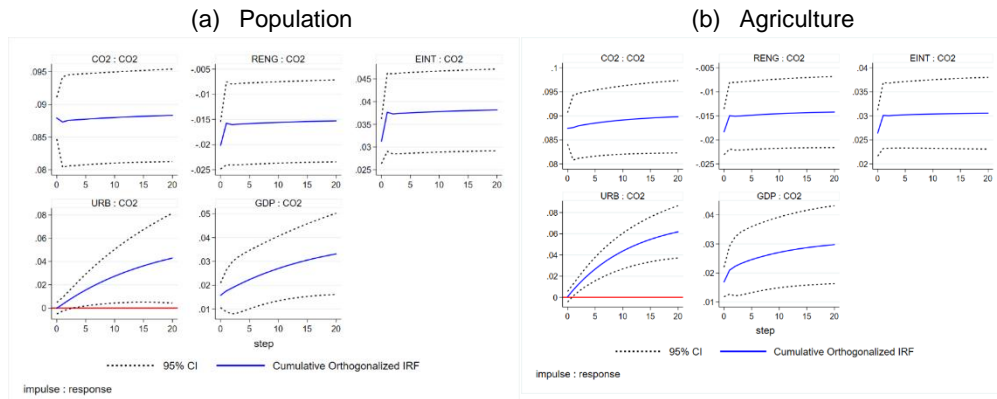


Observations: 1428 • Groups: 68

Notes: The continuous line denotes the impulse response functions. The dashed lines stand for the associated 95% confidence interval computed based on 1000 Monte Carlo simulations.

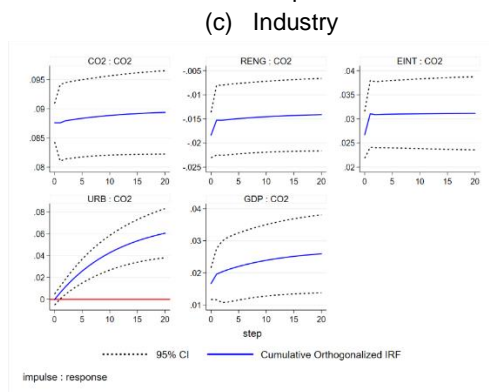
**Figure A5**

**Cumulative Orthogonalized IRFs: Exogenous Additional Controls**

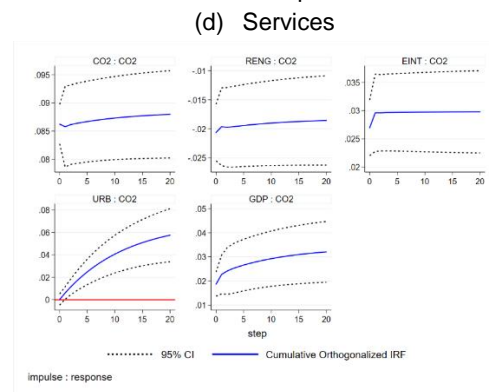


Observations: 1428 • Groups: 68

Observations: 1361 • Groups: 68



Observations: 1344 • Groups: 68

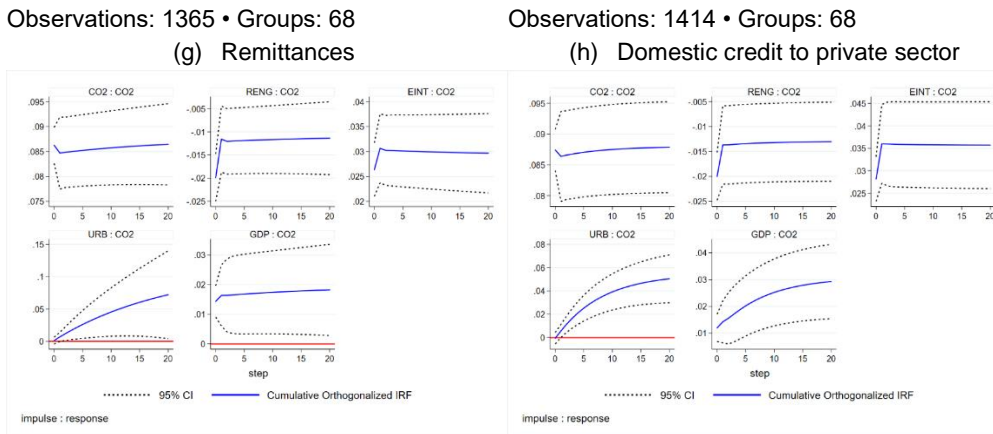
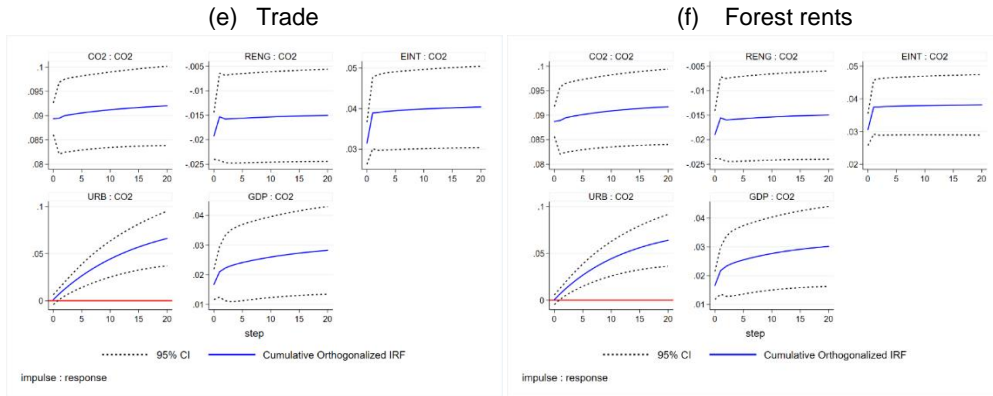


Observations: 1269 • Groups: 68



Figure A5

(Continued)



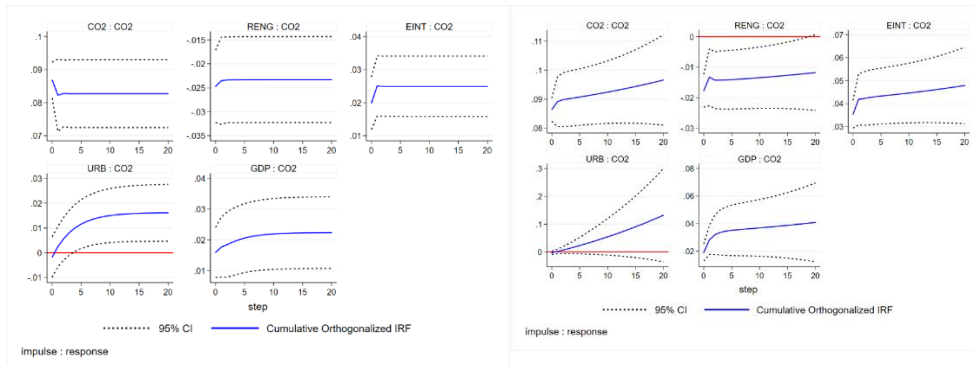
Notes: The continuous line denotes the impulse response functions. The dashed lines stand for the associated 95% confidence interval computed based on 1000 Monte Carlo simulations.

**Figure A6**

**Cumulative Orthogonalized IRFs: Level of Income and the Kyoto Protocol Status**

(a) Low Income Economies

(b) Lower-middle Income Economies

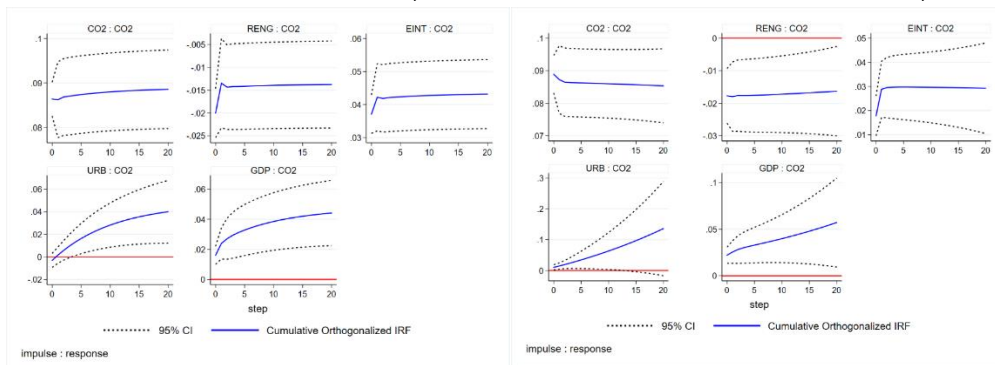


Observations: 504 • Groups: 24

Observations: 924 • Groups: 44

(c) Kyoto Protocol Group A (ratification or ascension date < 2005)

(d) Kyoto Protocol Group B (ratification or ascension date ≥ 2005)



Observations: 966 • Groups: 46

Observations: 462 • Groups: 22

*Notes: The continuous line denotes the impulse response functions. The dashed lines stand for the associated 95% confidence interval computed based on 1000 Monte Carlo simulations.*

Table A13

**Cross-sectional Dependence Tests**

Test/Variable	CO2_T	CO2_B	CO2_NC	CO2_OIC	CO2_PI
BC scaled LM	508.921*** (0.000)	172.403*** (0.000)	259.421*** (0.000)	188.111*** (0.000)	456.459*** (0.000)
Pesaran CD	168.292*** (0.000)	22.035*** (0.000)	77.171*** (0.000)	46.489*** (0.000)	93.698*** (0.000)
Pesaran scaled LM	510.399*** (0.000)	173.882*** (0.000)	260.899*** (0.000)	189.568*** (0.000)	457.938*** (0.000)
Breusch-Pagan LM	36729.01*** (0.000)	14014.72 *** (0.000)	19888.26*** (0.000)	14816.93*** (0.000)	33187.98*** (0.000)

Notes: The Breusch-Pagan (1980) LM, Pesaran (2004) scaled LM, Pesaran (2004) CD, and Baltagi et al. (2012) Bias-Corrected (BC) scaled LM test.  $H_0$  is "no cross-section dependence (correlation)". P-values in brackets. \*\*\*, \*\*, \*, denotes significance at the 1%, 5% and 10% level, respectively.

Table A14

**Stationarity Analysis I**

Test/Variable	Harris-Tzavalis test			
	Level (cons & trend)		$\Delta$ (cons)	
	rho	p_value	rho	p_value
CO2_T	0.629	(0.001)***	-0.028	(0.000)***
CO2_B	0.667	(0.075)*	-0.150	(0.000)**
CO2_NC	0.643	(0.006)***	-0.083	(0.000)***
CO2_OIC	0.512	(0.000)***	-0.225	(0.000)***
CO2_PI	0.618	(0.000)***	-0.010	(0.000)***

Notes: We remove cross-sectional means and apply small-sample adjustment to  $T$ .  $H_0$  is "Panels contain unit roots". Tajikistan and Togo (for CO2\_OIC), and Congo Rep. And Ghana (for CO2\_PI) are excluded from the sample due to missing values. P-values in brackets. \*\*\*, \*\*, \* denote statistical significance at the 1%, 5%, and 10% level, respectively.

**Table A15**

**Stationarity Analysis II**

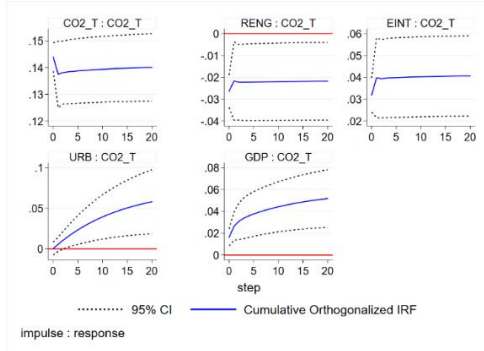
Test/Variable	Pesaran's CADF test							
	Level (cons & trend)		$\Delta$ (cons)		Level (cons & trend)		$\Delta$ (cons)	
	Augmented by one lag (average)				Augmented by two lags (average)			
	t-bar	p-value	t-bar	p-value	t-bar	p-value	t-bar	p-value
CO2_T	-2.533**	(0.024)	-3.359***	(0.000)	-2.697***	(0.000)	-2.803***	(0.000)
CO2_B	-2.105	(0.966)	-3.287***	(0.000)	-1.964	(0.999)	-2.486***	(0.000)
CO2_NC	-2.255	(0.686)	-3.433***	(0.000)	-2.123	(0.951)	-2.475***	(0.000)
CO2_OIC	-8.874***	(0.000)	-20.063***	(0.000)	2.369	(0.991)	-6.841***	(0.000)
CO2_PI	-4.375***	(0.000)	-14.658***	(0.000)	-1.947**	(0.026)	-10.466***	(0.000)

*Notes: Pesaran (2003) H0 is "all series are non-stationary". For the unbalanced panels, namely for CO2\_OIC and CO2\_PI, we report the standardized t-bar statistic. P-values in brackets. \*\*\*, \*\*, \* denote statistical significance at the 1%, 5%, and 10% level, respectively.*

Figure A7

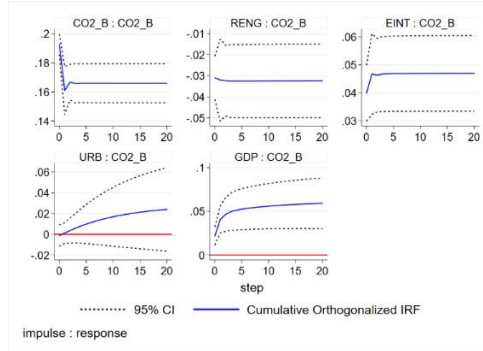
Cumulative Orthogonalized IRFs: Sectoral CO2 Emissions

(a) CO2 from Transport



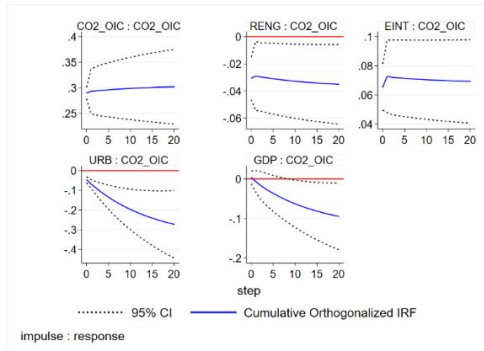
Observations: 1428 • Groups: 68

(b) CO2 from Buildings



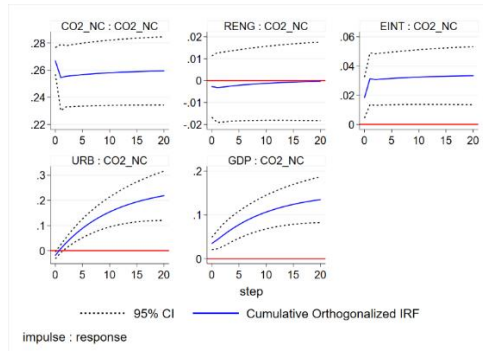
Observations: 1428 • Groups: 67

(c) CO2 from Other Industrial Combustion



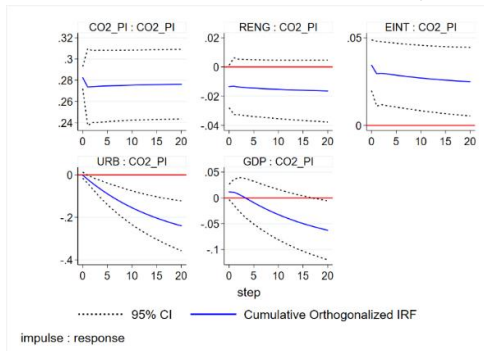
Observations: 1405 • Groups: 67

(d) CO2 from Non-combustion



Observations: 1428 • Groups: 68

(e) CO2 from Power Industry



Observations: 1422 • Groups: 68

Notes: The continuous line denotes the impulse response functions. The dashed lines stand for the associated 95% confidence interval computed based on 1000 Monte Carlo simulations.

## **Additional Reference for the Appendix**

Janssens-Maenhout, G., Crippa, M., Guizzardi, D., Muntean, M., Schaaf, E., Olivier, J.G.J., Peters, J.A.H.W. and Schure, K.M., 2017. Fossil CO<sub>2</sub> and GHG emissions of all world countries. EUR 28766 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-73207-2, doi:10.2760/709792.