Australian Conference of Economists 2021
"Wealth and Wellbeing" – 12 – 14 July 2021

Role of Energy in Welfare-Related TFP: Evidence From BRICS

By
Safdar Khan and Gulasekaran Rajaguru
Bond Business School
Bond University

Roadmap

- Reason
- literature
- Empirical model & methodology
- Results
- Concluding remarks

Reason

Economics of energy

I. Energy-growth conundrum (many papers)

- Growth hypothesis
- Conservation hypothesis
- Feedback hypothesis
- No causality

II. Renewable energy-growth (many papers)

There is great amount of literature on renewable energy consumption and growth analysis

III. Renewable/energy-welfare nexus (a few studies)

- Handful amount (discuss in the literature section)

IV. Renewable/energy-TFP nexus (a few studies)

V. Alternatively: Renewable energy and welfare-relevant TFP (no study)

Welfare-relevant TFP is constructed by using commodities and prices perceived by consumers not firms—factor share are used after tax wages and rental rates.

Literature

- Energy-growth nexus
  - Meta analysis - Sebri, M., 2015; Menegaki, A. N. (2020); Menegaki, A. N. (2014); Bouoiyour, J., Selmi, R., & Öztürk, İ. (2014); Kalimeris, P., Richardson, C., & Bithas, K. (2014); Chen, S., & Chen, B. (2017); Chen, P. Y., Chen, S. T., & Chen, C. C. (2012).
- Findings through the lens of history, development and challenges on energy-growth nexus—contradictory results (Hajko, V., Sebri, M., Al-Saidi, M., & Balsalobre-Lorente, D. (2018). Menegaki, A. N. (2020)

Literature …continued

Energy-welfare nexus

Table 1: Selected studies on energy-welfare nexus

Study	Time span	Country/ies	Methodology	Main findings
Menegaki and Tsagarakis (2015)	1990-2013	American economies including North America, South and Latin America	Multivariate panel co-integration technique	Energy does not affect either GDP or sustainability index, but sustainability index does affect energy
Zaman et al. (2016)	1975-2013	BRICS economies including Brazil, Russia, India, China, and South Africa	Multivariate panel co-integration technique	Energy increases economic growth
Menegaki and Tugcu (2016)	1985-2013	Sub-Saharan Africa (SSA)	Multivariate panel co-integration technique	Bi-directional causality between energy consumption and sustainability index
Menegaki and Tugcu (2017)	1995-2013	G-7 Economies	Multivariate panel co-integration technique	Energy negatively affect sustainability index of economic welfare
Menegaki and Tiwari (2017)	1990-2013	American economies including South America, North America and Central America	Multivariate panel cointegration and fixed effects models.	Energy does not affect GDP or sustainability index of welfare
Menegaki and Tugcu (2018)	1999-2017	Selected Asian Countries	Multivariate panel co-integration technique	Bi-directional causality exists between sustainability index of economic welfare and GDP with energy consumption in terms of both renewables and non-renewables.
Ahn, K., Chu, Z., & Lee, D. (2021)		USA	Caliberations	The results show that a 10% increase in the proportion of renewable energy in the energy mix decreases social welfare by 0.753% in the long run

Notes: Information extracted from relevant studies mentioned in the table.

What next!

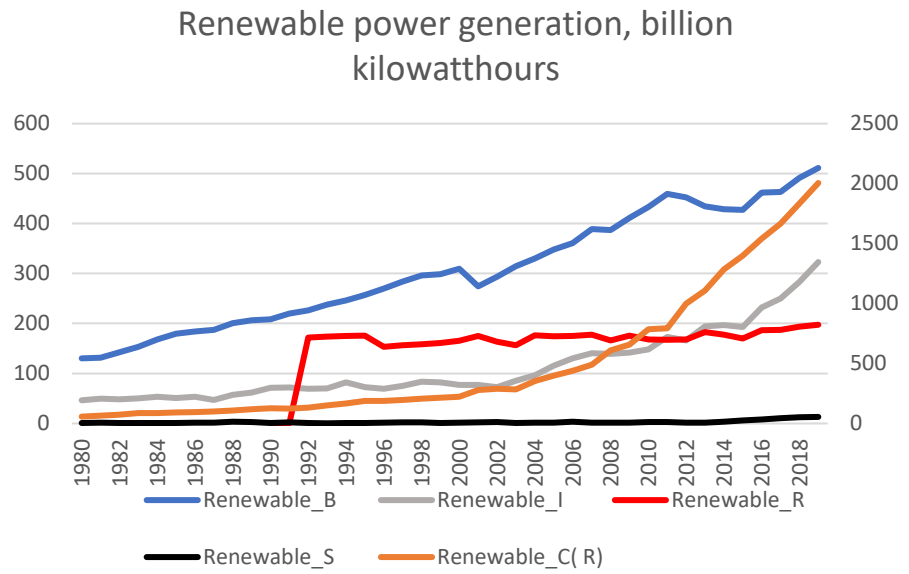
- Exploring interactions of renewable energy with welfare-relevant TFP, GDP growth, CO2 emissions
- Why BRICS
  - Economists believe—BRICS nations will become dominant suppliers of manufactured goods, services, and raw material by 2050 due to low labor and production costs.
  - Critics argue that the nations' raw materials are limitless and the growth models ignore the finite nature of fossil fuels, uranium, and other critical and heavily used resources.
- Renewable sources 45.2% – 3 times higher than the world average, 14%. The renewables comprises 31% of bio-energy, 12.6% of hydraulics, 1.4% of wind and 0.1% of solar.
- In non-renewable sources, oil 34.5%, natural gas 12.4%, mineral coal 5.8% and others 2%.

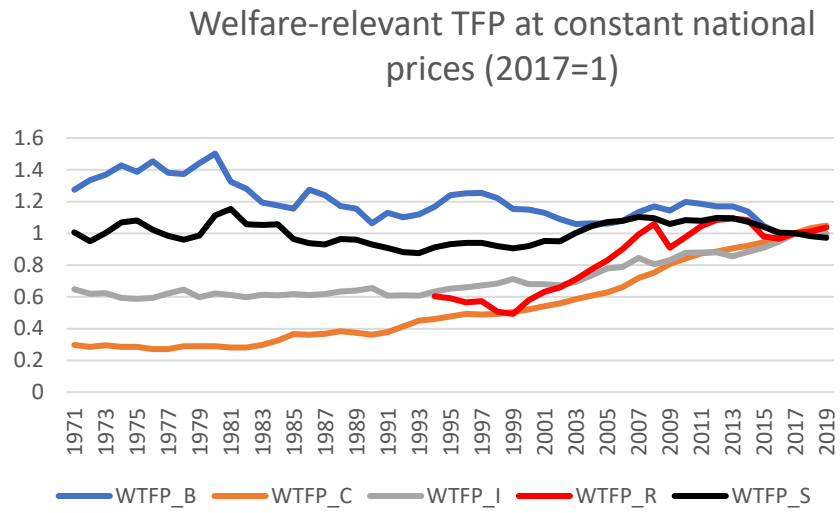
Empirical model & methodology

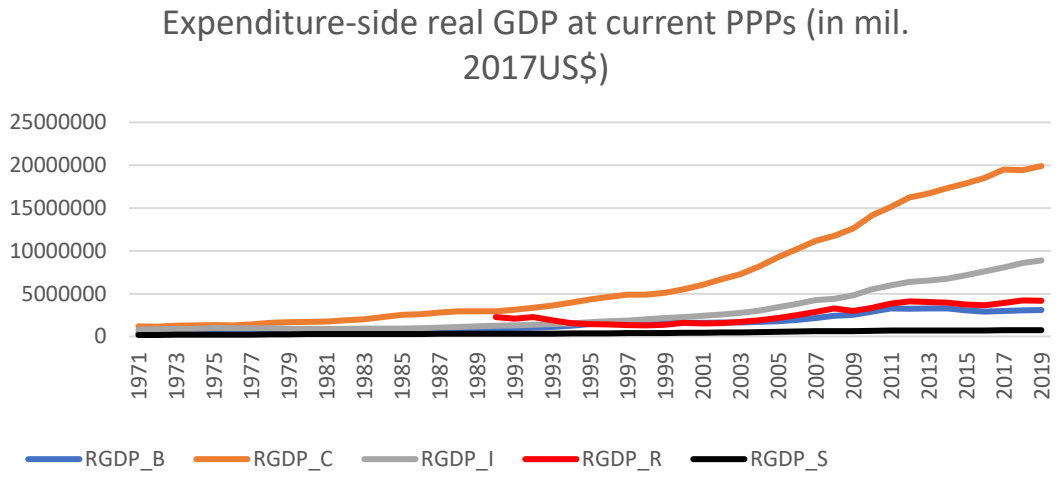
- Data
  - Welfare Related TFP
  - Real GDP
  - Energy Use and Renewable Energy Use
  - CO2 Emission per capita

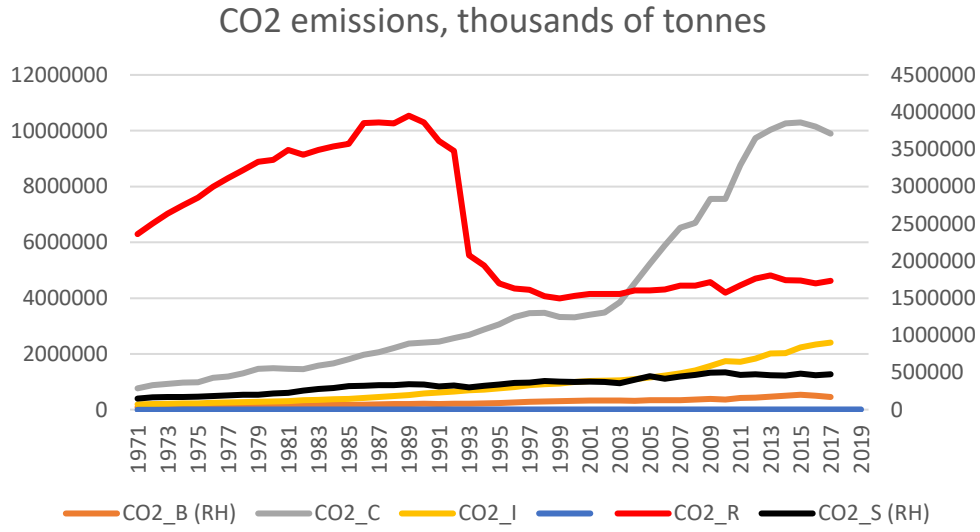
- Time Series Properties
  - ADF, PP, KPSS and Break Point Unit Root Tests – All series are I(1)

Data


Renewable power generation, billion kilowatthours
600
500
400
300
200
100
0
2500
2000
1500
1000
500
0
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018
Renewable_B
Renewable_I
Renewable_R
Renewable_S
Renewable_C(R)


Welfare-relevant TFP at constant national prices (2017=1)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015 2017 2019
WTFP_B
WTFP_C
WTFP_I
WTFP_R
WTFP_S


Expenditure-side real GDP at current PPPs (in mil. 2017US$)
25000000
20000000
15000000
10000000
5000000
0
1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015 2017 2019
RGDP_B
RGDP_C
RGDP_I
RGDP_R
RGDP_S

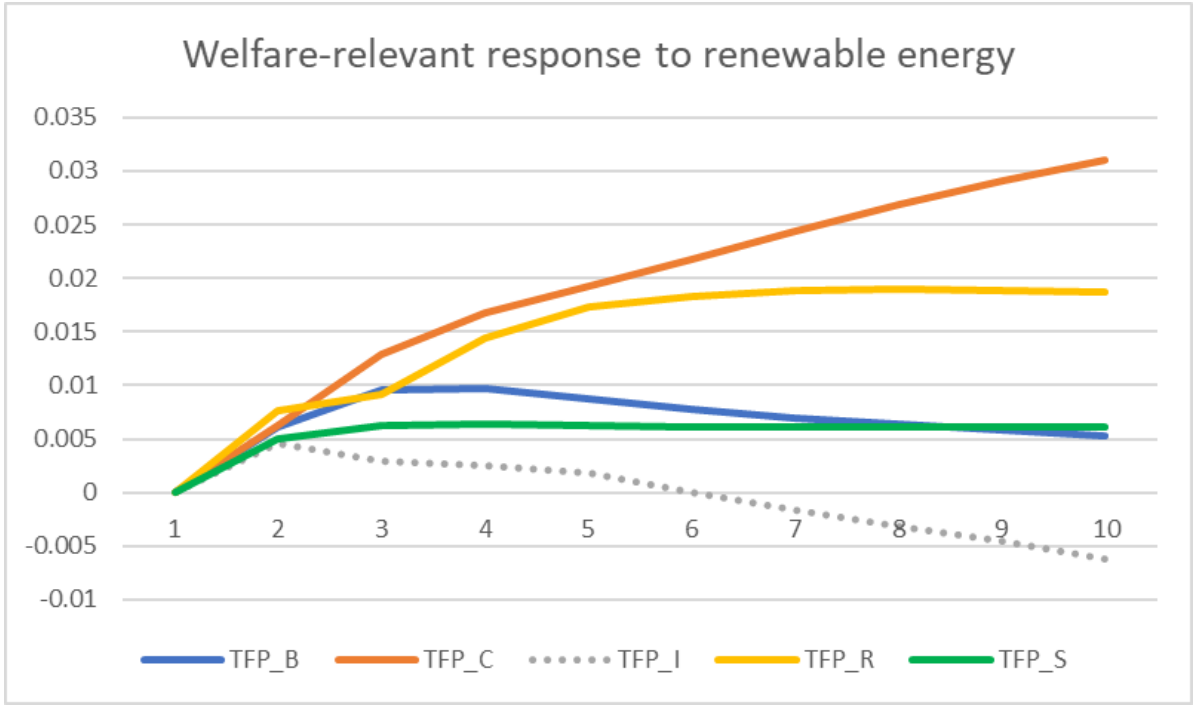

CO2 emissions, thousands of tonnes
12000000
10000000
8000000
6000000
4000000
2000000
0
4500000
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015 2017 2019
CO2_B (RH)
CO2_C
CO2_I
CO2_R
CO2_S (RH)

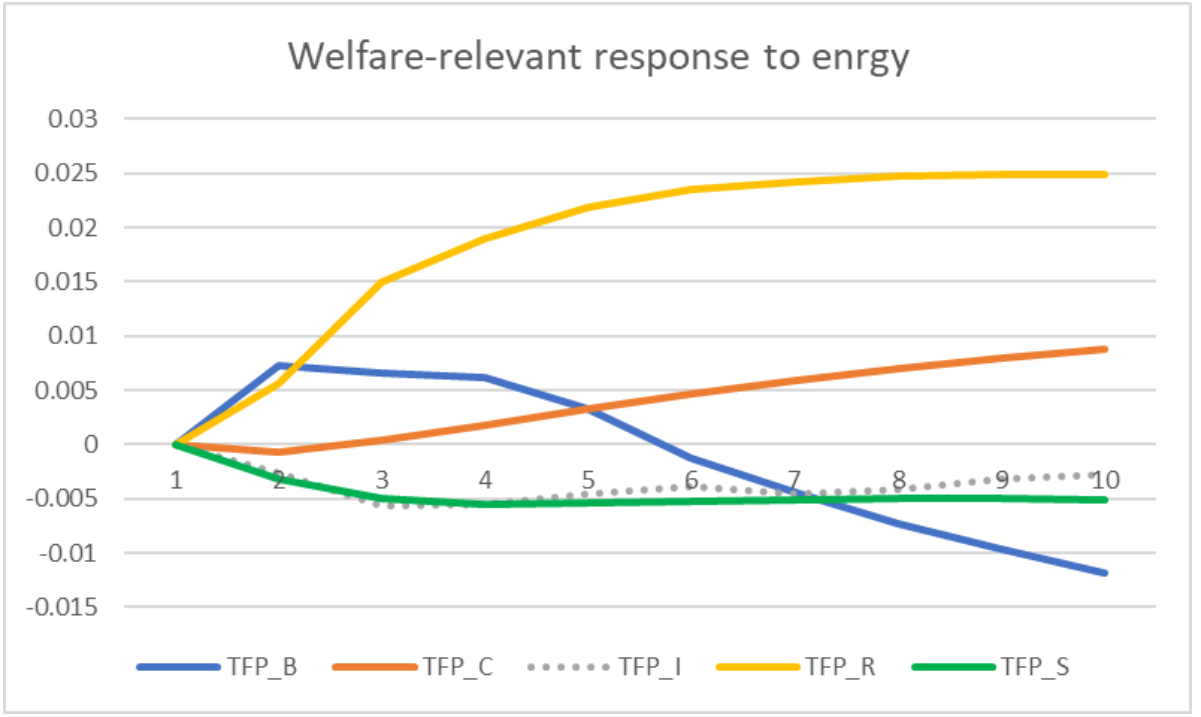
Empirical model & methodology

	Trace Test				Max EV test			
	r=0	r=1	r=2	r=3	r=0	r=1	r=2	r=3
Brazil	53.87*	26.43	12.23	4.28	26.44*	14.19	7.95	4.28
China	57.18**	29.04	13.81	4.28	28.14*	15.23	9.53	4.28
India	59.34**	28.22	14.63	6.14	31.11**	13.59	8.49	6.14
Russia	82.69***	39.16	17.33	5.81	43.54***	21.83	11.52	5.81
South Africa	50.09**	20.95	7.86	1.06	29.14**	13.09	6.80	1.06

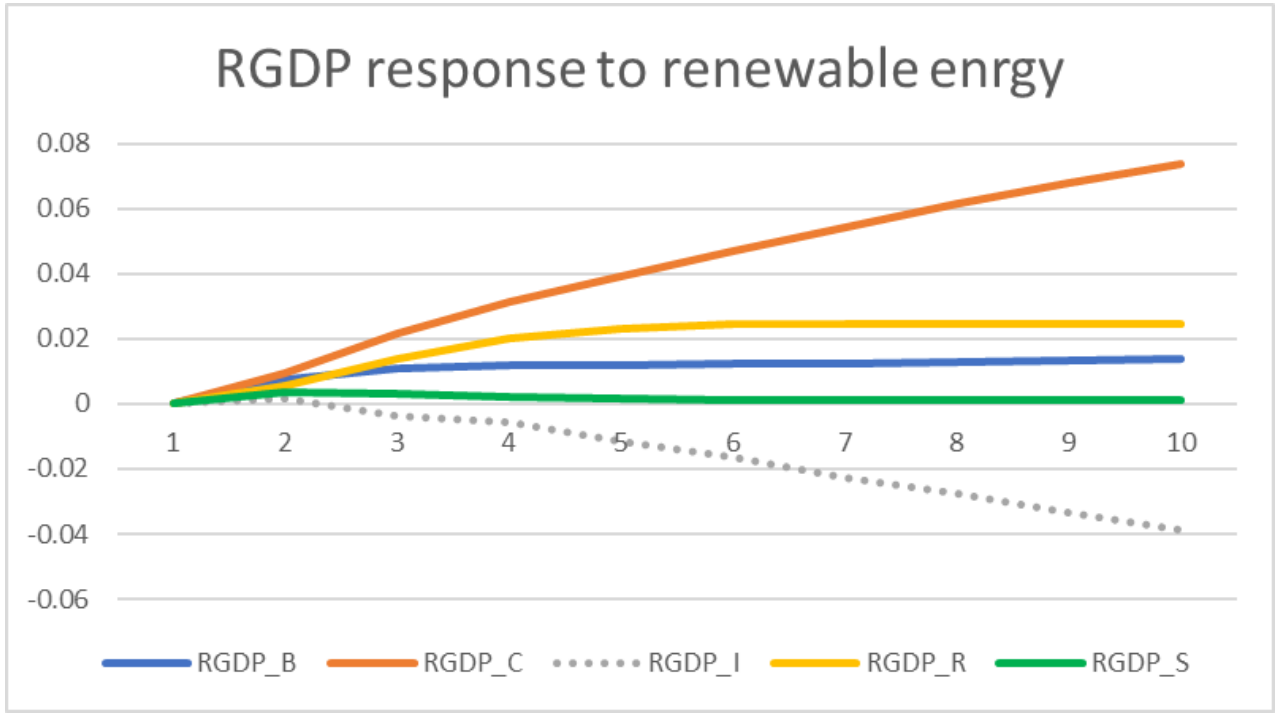
$$\begin{pmatrix} \Delta WTFP_t \\ \Delta EC_t \\ \Delta RGDP_t \\ \Delta Co2_t \end{pmatrix} = \mu + \Pi z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \begin{pmatrix} \Delta WTFP_t \\ \Delta EC_t \\ \Delta RGDP_t \\ \Delta Co2_t \end{pmatrix} + \Theta D_t + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{pmatrix}$$

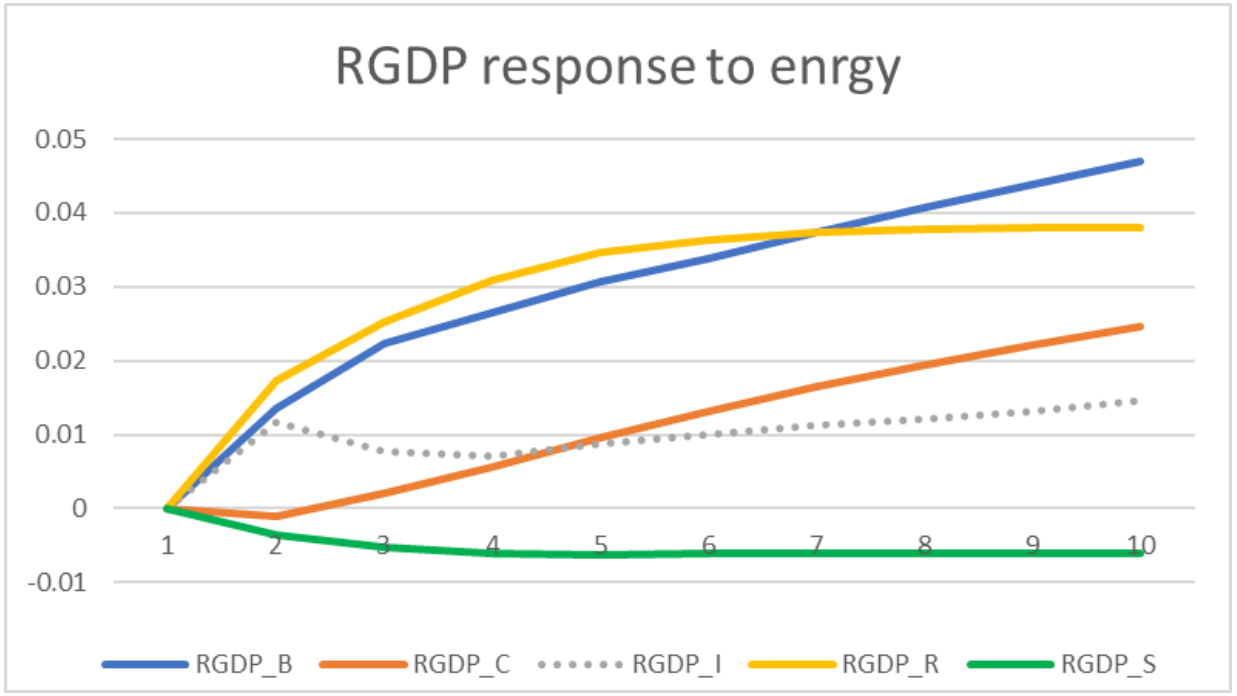
Results – Impulse Responses



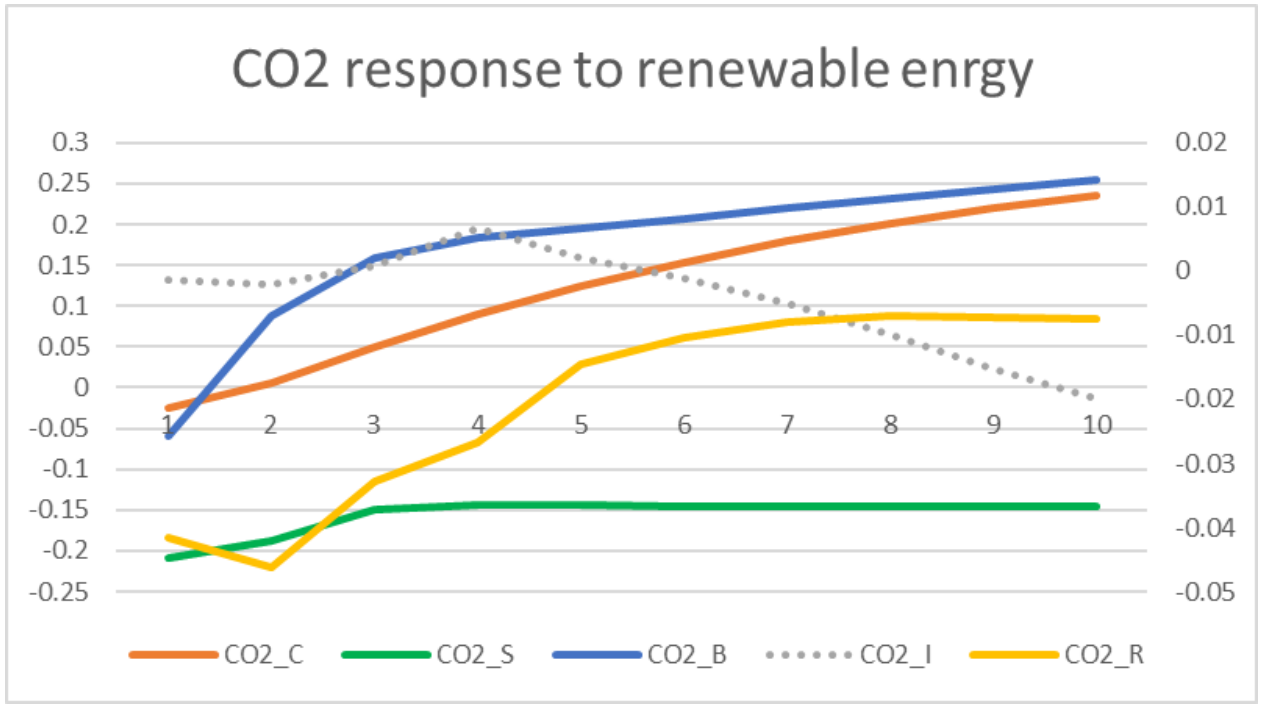


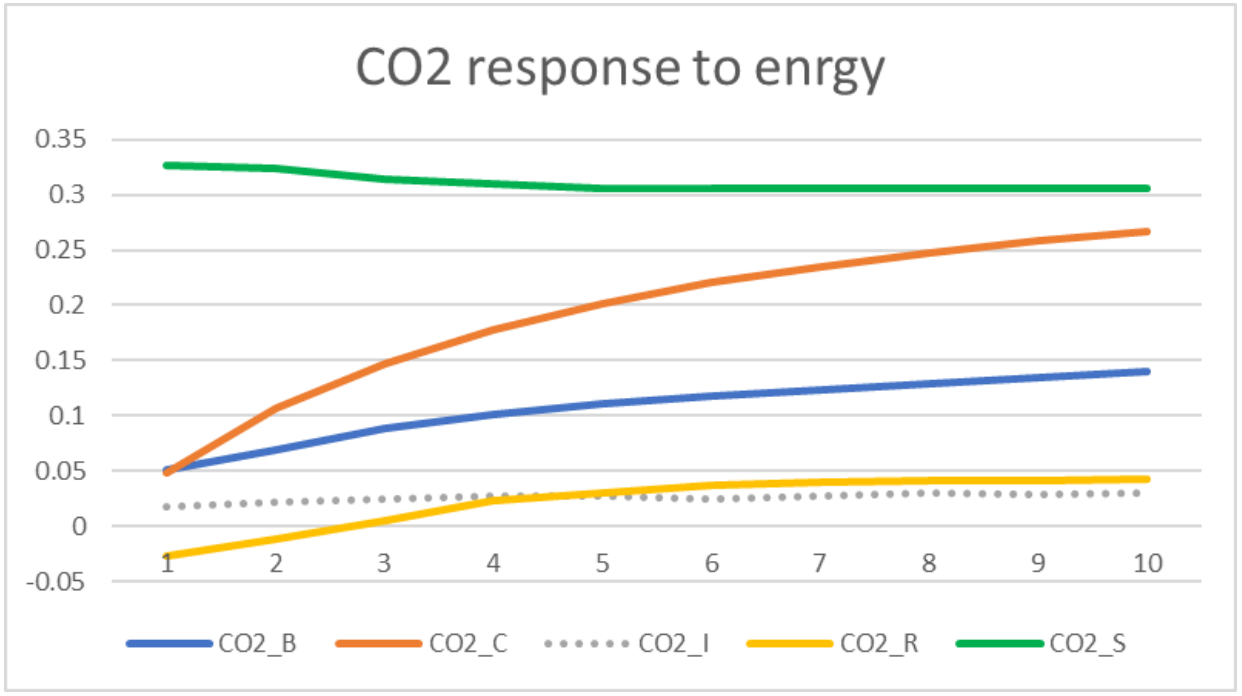
Results – Impulse Responses





Results – Impulse Responses





Concluding remarks

- Renewable energy and ‘primary energy use’ present different interactions with welfare-relevant TFP, RGDP and CO_2 emissions.
- Welfare relevant TFP responds well to renewable energy/energy
- Renewable energy initially increases the welfare-relevant productivity in all BRICS nations unlike to primary energy which affects W-TFP negatively in India China and South Africa
- In terms of RGDP, increasing renewable energy increases the RGDP in BRICS, contrarily increasing the primary energy use decreases RGDP in China and S. Africa
- Regardless of energy type, CO2 emissions are on rise except India where Co2 emissions drop on some stage in response to increasing renewable energy