Economic Development and Environmental Sustainability: Evidence from Bahrain

Fatema Alaali [1] and Hanan Naser [2]

[1]College of Business and Finance - Ahlia University - Bahrain

[2]Faculty of Business Studies - Arab Open University - Bahrain

June 13, 2019

Background and Literature

- Bahrain population is about 1.5 million people
- about 1936 people per square kilometer of land area and a population growth of 4.6% in the year 2017
- Oil and gas sector contribution to Bahrain GDP is 19% in 2017 compared to 44% in year 2000
- Financial sector portion is 17% in 2017

Background and Literature

- Electric power consumption per capita increased by 3.2% over the period 2004 and 2014
- Higher local demand for electricity $\Rightarrow$ Higher electricity and heat production
- Electricity production is responsible for 80.5% of total fuel combustion of CO_2 emissions in 2014

Background and Literature

- CO_2 Emissions have a great impact on the global warming

$\Downarrow$

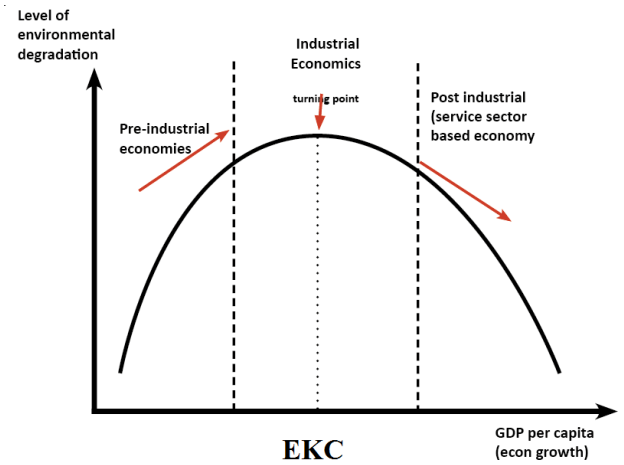
  - Warming oceans
  - Melting ice mass
  - Increasing evaporation

- **CO_2 emissions as a measure of environmental degradation**
  Chandran and Tang (2013); Onafowora and Owoye (2014); Shahbaz et al. (2014); Charfeddine and Khediri (2016); Lorente and Alvarez-Herranz (2016); Alshehry and Belloumi (2017); Bekhet et al. (2017); Ozokcu and Ozdemir (2017); Wang et al. (2017); Efiong and Iriabije (2018); Salahuddin et al. (2018), among others

- **Different air pollutants such as NO_2, SO_2, *CO*, *PM2.5* and CH_4**
  Day and Grafton (2003); Fodha and Zaghdoud (2010); Cho et al. (2014); Park and Lee (2011); Le et al. (2018), among others

EKC hypothesis argue that (Panayotou, 1993)

"at higher levels of development, structural change towards information-intensive industries and services, coupled with increased environmental awareness, enforcement of environmental regulations, better technology and higher environmental expenditures, result in leveling off and gradual decline of environmental degradation."



- Examples of studies which examined the EKC hypothesis
  Musolesi et al. (2010); Apergis (2016); Zambrano-Monserrate et al. (2018), among others

- EKC literature concerning GCC countries
  Al-Mulali and Tang (2013); Shahbaz et al. (2014); Charfeddine and Khediri (2016); Alshehry and Belloumi (2017); Bekhet et al. (2017); Salahuddin et al. (2018)

Objectives of the study

- Examine the **validity** of the **Environmental Kuznets Curve hypothesis (EKC)** in **Bahrain**
- Investigate the **short and long run impacts** of **economic growth, electric power consumption, foreign direct investment and financial development** on CO_2 **emissions** in **Bahrain** over the period 1980-2014

- CO_2 is carbon dioxide emissions (metric tons per capita)
- GDP is GDP per capita at constant 2010 US$
- Elec is electric power consumption (KWh per capita)
- FDI is foreign direct investment, net inflows (% of GDP)
- Fin is domestic credit provided by financial sector (% of GDP)
- Period 1980 to 2014 with 35 observations

CO_2 Emissions Model

$$ln(CO_2)_t = \beta_0 + \beta_1 lnGDP_t + \beta_2 (lnGDP_t)^2 + \beta_3 lnElec_t + \beta_4 Fin_t + \beta_5 FDI_t + \varepsilon_t \quad (1)$$

- $lnCO_2$ is the natural logarithm of carbon dioxide emissions
- $lnGDP_t$ is the natural logarithm of GDP per capita
- $(lnGDP_t)^2$ is the quadratic term of GDP per capita
- $lnElec_t$ is the natural logarithm of electricity consumption per capita
- Fin_t is the financial development measure
- FDI_t is the foreign direct investment

ARDL Estimation

$$\Delta ln(CO_2)_t = \delta 0 + \sum_{i=1}^{n} \delta_{1i} \Delta ln(CO_2)_{t-i} + \sum_{k=1}^{q} \delta_{2k} \Delta lnGDP_{t-k} + \sum_{j=1}^{d} \delta_{3d} \Delta (lnGDP_{t-k})^2 + \sum_{l=1}^{b} \delta_{4l} \Delta lnElec_{t-l} + \sum_{w=1}^{y} \delta_{5w} \Delta Fin_{t-w} + \sum_{m=1}^{r} \delta_{6m} \Delta FDI_{t-m} + \theta ECT_{t-1} + \varepsilon_t \quad (2)$$

Table 1: **Results of Unit Root Tests**

	ADF		KPSS		PP	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
$lnCO_2$	-3.286**	-3.340*	0.161	0.131	-3.332	-3.358*
lnGDP	-1.073	-2.327	0.309	0.108	-1.291	-2.548
lnElec	-3.225**	-2.545	0.372	0.152**	-3.654**	-2.565
Fin	-0.113	-3.043	0.460**	0.146**	0.222	-2.985
FDI	-5.507***	-5.480***	0.286	0.147**	-5.611***	-5.553***
$\Delta lnCO_2$	-7.401***	-7.300***	0.162	0.156**	-7.686***	-7.597***
$\Delta lnGDP$	-4.739***	-4.629***	0.138	0.114	-4.759***	-4.615***
$\Delta lnElec$	-5.241***	-5.697***	0.351	0.152**	-5.232***	-5.731***
ΔFin	-5.834***	-5.738***	0.288	0.134	-6.019***	-5.922***
ΔFDI	-8.051***	-7.939***	0.31	0.169**	-11.194***	-11.070***

Table 2: **Results of ARDL bound testing to cointegration**

Model	Optimal lag structure	F - value	t - statistics
$CO_2 = f(GDP, GDP^2, Elec, Fin, FDI)$	(1,0,1,0,3,1)	5.321	-4.171***

Table 3: **Estimated Coefficients from ARDL (1,0,1,0,3,1)**

$CO_2 = f(GDP, GDP^2, Elec, Fin, FDI)$		
Variable	Coefficients	t-statistics
Long run estimates: $lnCO_2$ as dependent variable		
GDP_t	1.237	3.12***
GDP_t^2	-0.103	-2.52**
$Elec_t$	0.09	2.57**
Fin_t	-0.04	-2.22**
FDI_t	0.034	3.46***
Short run estimates: $\Delta lnCO_2$ as dependent variable		
GDP_{t-1}	0.862	2.670**
GDP_{t-1}^2	-0.015	-2.460**
$Elec_{t-1}$	0.063	0.61
Fin_{t-1}	-0.006	-2.28**
FDI_{t-1}	0.002	0.63
FDI_{t-2}	-0.148	-3.11***
FDI_{t-3}	-0.007	-2.18**
ETC_{t-1}	-0.696	-4.17***

Table 4: **Diagnostic Tests**

Test	Coefficient
R^2	0.669
Adjusted R^2	0.496
F-statistics	2.600 (0.022)
Jarque-Bera normality test	1.200 (0.330)
Heteroscedasticity Test: ARCH	2.280 (0.545)
Breusch-Godfrey Serial Correlation LM Test	0.807 (0.415)
Ramsey RESET test	0.912 (0.317)

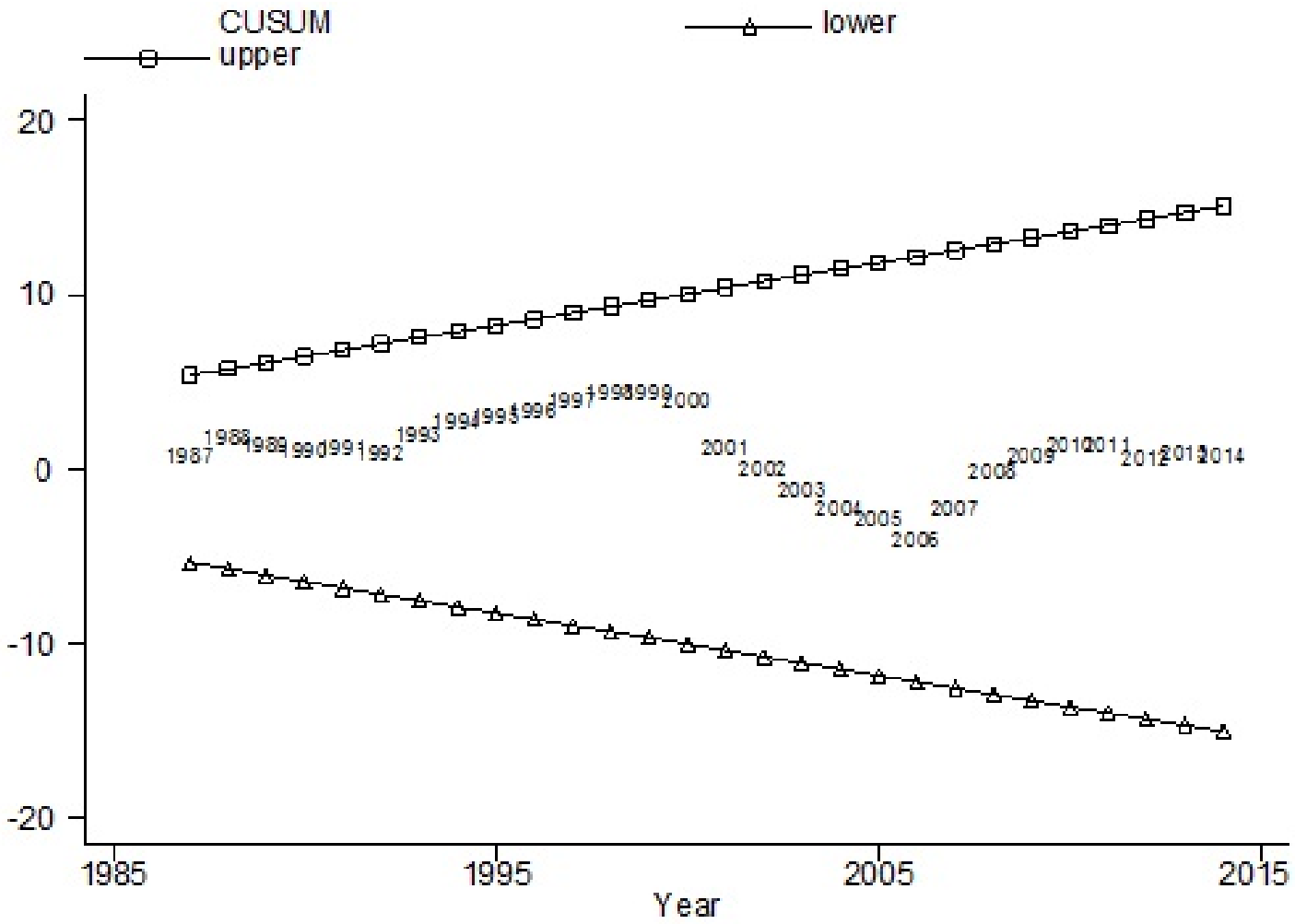


Figure 1: Plot of Cumulative Sum of Recursive Residuals

- Elasticity of GDP^2 term confirms that there is inverted U-shape long run relationship between CO_2 emissions and economic growth
- Electricity consumption and foreign direct investments have positive impact on CO_2 emissions
- Financial development has a negative impact on CO_2 emissions
- The estimated negative ECT_{t-1} indicates the adjustment speed after any shock will be corrected by almost 70% within a year

- Bahrain has to encourage the development of financial sector
- Follow the attempt of World Trade Center in using windmills to generate electrical energy in new malls and centers
- Assist individuals and institutions in installing solar cells
- Bahrain should expand the installation of Carbon Dioxide recovery plants that utilize the extracted CO_2 in producing ammonia and methanol

Thank you