



Empirical investigation of environmental Kuznets curve for carbon emission in Morocco



Ihtisham ul Haq^{a,*}, Shujin Zhu^a, Muhammad Shafiq^b

^a College of Economics and Trade, Hunan University, Changsha, Hunan 410082, China

^b Institute of Statistics and Mathematical Methods in Economics Vienna University of Technology, Austria

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ABSTRACT

This study explored the relationship among income, carbon emissions, energy consumption, and trade openness for Morocco from 1971 to 2011. The Johansen cointegration technique confirmed the long run relationship among the variables. The energy consumption deteriorated the environment quality and found to be true for both short run and long run. Foreign trade is beneficial for environment quality as foreign trade openness has negative impact on carbon emissions. This study did not confirm the environmental Kuznets curve hypothesis in long run. Furthermore, there is a strong one way causation from income to carbon emissions. Thus, Morocco can improve environment quality by reducing the carbon emissions and it will not disturb economic pace of the economy. Therefore, energy and trade policies should be made growth oriented. In the same way energy production and consumption has to be made environmental friendly.

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1. Introduction

The environmental Kuznets curve (EKC) hypothesis in literature has received significant attention from the researchers since the pioneer work of Grossman and Krueger (1991). According to EKC hypothesis, environmental degradation increases at the early stage of development and reduces after a certain threshold income level. A significant number of studies have been conducted to examine the EKC hypothesis. Ang (2007), Apergis and Payne (2009), Jalil and Mahmud (2009), Pao and Tsai (2010), Nasir and Rehman (2011), Kanjilal and Ghosh (2013), and Shahbaz et al. (2014) found support for the EKC hypothesis. On the other hand studies like, Soytaş et al. (2007), Akbostanci et al. (2009), Seetanah and Vinesh (2010), Arouri et al. (2012), Hossain (2012), Kareem et al. (2012), and Ozturk and Al-Mulali (2015) did not find support for EKC.

Ozturk and Acaravci (2013) tested the EKC hypothesis for Turkey by utilizing data on carbon emissions, income, energy, trade openness and financial development. This study covered time period from 1960 to 2007. They applied Granger causality based on error correction model for long run and short run causality. They found significant evidence for long run causality running from income, trade openness, energy consumption, and financial development to

carbon emissions and not vice versa. Based on long run relationship between variables and their results verified that EKC hypothesis holds in Turkey.

Similarly, Shahbaz et al. (2013) studied the relationship among carbon emissions, economic growth, financial development and energy consumption over period 1971–2011 for Malaysia. They applied bounds testing approach to determine long run relationship among variables. The study revealed that financial development has negative impact on carbon emission whereas energy consumption and economic growth have positive effect on carbon emissions. They applied vector error correction model for short run and long run causal relationship. The results showed that there is bidirectional causality between financial development and carbon emissions, economic growth and carbon emissions, and between energy consumption and carbon emissions. They argued that financial development helps Malaysia to improve environment quality, however, reduction in activities responsible for worsening environment quality will effect economic growth.

Wang et al. (2015) carried out empirical study to determine relationship between environment quality and income for Gansu province, China. They constructed environment quality index, and income levels were taken at current prices in local currency. This study covered the period from 1980 to 2012. They applied Bayesian VAR with Minnesota prior, which is considered as an optimal model for EKC. The results confirmed the existence of EKC and determined

* Corresponding author. Tel.: +86 15111465103.

E-mail address: ihtishamin.99@yahoo.com (I.u. Haq).

that the turning point for Gansu province is 2273 local currency (RMB). Thus, they concluded and suggested that Gansu province can improve environment quality without disturbing their economic development.

Ahmed (2014) examined the effect of economic growth, energy consumption and trade openness on environmental degradation in Mongolia. They used time series data from 1980 to 2012. The long run estimates based on cointegration determined the presence of EKC hypothesis in Mongolia. The results of vector error correction model (VECM) revealed that there is unidirectional causality running from carbon emission to growth and from trade to growth in long run. They suggested that Mongolia can devise environmental policies to improve environment quality however; it will not affect Mongolia growth.

Ozturk and Al-Mulali (2015) tested the EKC hypothesis for Cambodia over period from 1996 to 2012. The time period was short so they applied generalized method of movements and two-stage least squares. Their variables were carbon emissions, GDP as indicator for income, electricity consumption as indicator for total energy consumption, urbanization, governance, and control of corruption. Results of the study indicated that governance and control of corruption has negative effect on carbon emissions whereas the rest of variables are responsible for increase of carbon emissions. They did not find evidence for the existence of EKC in Cambodia.

The impact of trade on environment may be positive or negative and can be explained through, scale, technique, and composition effects (Antweiler et al., 2001). Energy is considered as an engine for economic growth. However, energy has bad effects on environment quality as it leads to pollutant emissions like CO₂, SO₂, etc. The positive impact on economic growth and negative effects on environment ask for investigation of the emission-energy-economic growth nexus Nasir and Rehman (2011).

Aroui et al. (2012) pointed out that mostly empirical studies regarding pollutant emissions (CO₂ and SO₂) are carried out either for developed countries or for major emerging economies of Asia and Latin America. The emerging economies of the Middle East and North African region (MENA) got less attention from researchers. No single study has been conducted to examine the effect of trade on environmental degradation in Morocco. Thus, this study fills this gap in the existed literature related to environmental degradation by adding trade openness to the emission-energy-income relation in Morocco. Besides this, short run dynamics and causality analysis are also carried out.

The Moroccan economy performed well in last two decades. The size of the economy became more than double and infant mortality rate (per 1000 live births) has been reduced by more than half. Furthermore, a substantial reduction in poverty and increase in life expectancy are also witnessed. The energy use has been more than double what it was in 1990. The increase in CO₂ emissions is more than 75% over 1990–2012 and remains high on average than lower middle income countries (World Bank, 2014). The continuous increase in CO₂ and the average CO₂ emissions are high than lower middle income country makes strong case to examine the EKC hypothesis in Morocco.

2. Data, empirical model, and research methodology

This study covers the period from 1971 to 2011. The time period has been chosen due to availability of the data on carbon emissions and electricity consumption. The data has been taken from World Development Indicators (World Bank, 2014). The income is indicated by GDP per capita (PC) and is calculated by dividing the GDP of the respective year by total population series. The GDP is measured in current US dollars. The trade openness index (TR) is calculated by the ratio of exports plus imports to GDP. It is used as a proxy for

foreign trade. The carbon dioxide (CO) is carbon emissions in metric tons per capita, which represents environmental degradation.

Electricity consumption increased by 5.6 times as compare to total energy consumption which increased by 2.6 times in Morocco during study period. Population access to electricity is 100% in Morocco as compared to other developing countries in the region like Kenya 23%, Mauritania 21%, Senegal 55.56% and Sudan 35.56% (World Bank, 2015). The consumption of electricity for residential purposes is increased by more than 200% compared to industry. The overall consumption of electricity is increased by 50% since 2000. Similarly, consumption of gas and diesel by industry is decreased around 60% and for residential purposes decreased more than 83%. The reason may be that Morocco depends on energy imports and not like other countries in the region (Saudi Arabia, Algeria and UAE) who are oil exporters. Moroccan government is interested to reduce its energy imports and on the other hand, has deep concern about environment quality. Government has initiated several projects and projected that the share of renewable resources in electricity production will increase up to 42% of total electricity production by 2020, and it will reduce carbon emissions by 5.6 metric tons per year (ONEE, 2013). Considering the importance of electricity in consumption and production, the government concerns about its production from renewable resources, and about environment quality, the authors decided to use electricity consumption as a proxy for energy consumption. Electricity consumption per capita (EC) is measured in kilowatt-hours. Ozturk and Al-Mulali (2015) also considered electricity consumption as indicator of energy consumption. Table 1 reports the summary statistics of the data.

Following Jalil and Mahmud (2009), Nasir and Rehman (2011), Kanjilal and Ghosh (2013), and Farhani et al. (2014) the study model in log-linear form is presented in Eq. (1) as follows:

$$\log CO_t = \beta + \beta_1 \log PC_t + \beta_2 \log PCS_t + \beta_3 \log EC_t + \beta_4 \log TR_t + \varepsilon_t \quad (1)$$

where ε_t is the regression residual term and log is natural log of respective variable. The log-linear model will help to interpret the coefficients as elasticity of the respective variable and to deal with heteroskedasticity at initial stage.

Time series data is usually non-stationary and leads to spurious regression. This study applied augmented Dickey–Fuller (ADF) Dickey and Fuller (1979) and Phillips and Perron (PP) (1988) to detect this problem. If two time series variables x_t and y_t are integrated of same order, then there exists at most one cointegration vector. This idea was generalized by Johansen and Juselius (1990) that for n variables there will exist at most $n - 1$ cointegration vectors. The Johansen cointegration test will be applied to test long run relationship between variables. The long run and short run causality are obtained through vector error correction mechanism (VECM). There are as many equations in VECM as many variables are there in model. Each variable is treated as endogenous in each equation of VECM and these equations for study are given as follows:

$$\begin{aligned} \Delta \log CO_t = & \lambda + \sum_{i=1}^{q1} \beta_1 \Delta \log CO_{t-i} + \sum_{i=0}^{q2} \beta_2 \Delta \log PC_{t-i} \\ & + \sum_{i=0}^{q3} \beta_3 \Delta \log PCS_{t-i} + \sum_{i=0}^{q4} \beta_4 \Delta \log EC_{t-i} \\ & + \sum_{i=0}^{q5} \beta_5 \Delta \log TR_{t-i} + \phi_1 z_{t-1} + \varepsilon_t \end{aligned} \quad (2)$$

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