Carbon emission, energy consumption, trade openness and financial development in Pakistan: A revisit

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ARTICLE INFO

ABSTRACT

The paper empirically examines the cointegrating relationship between carbon emissions, energy consumption, trade openness and financial development in Pakistan using ARDL bounds test for cointegration procedure. Annual time series data is used for the period 1971–2011. The results reveal an inverted U-shaped relationship between carbon emission and energy consumption with a maximum threshold value of energy consumption per capita 640 kg of oil equivalent. Currently, the economy is operating below this level and therefore it is expected that carbon emission will continue to rise gradually over some time until the threshold level is reached. The lower than threshold level of energy consumption implies that scale and composition effects dominate the technology effect in terms of energy use. Further, the long-run results indicate that one percent increase in trade openness and financial development will increase carbon emission by 0.247% and 0.165%, respectively. The short-run elasticities are 0.122% and 0.087% for trade openness and financial development, respectively. The Granger causality results indicate a unidirectional causality from energy consumption, trade openness and financial development to carbon emission; and a bi-directional causality between energy consumption and financial development. In line with the results and given the growing focus on climate change effects in Pakistan, the paper discusses some policy issues for consideration and highlights the need to interpret elasticities with caution.

1. Introduction

Among greenhouse gas emissions carbon dioxide is the most important as it contributes to 58% of the total greenhouse emissions of the world. Globally carbon emission is increasing at a higher rate since 1970s [9] and Pakistan is no exception. Pakistan has gradually shifted from agriculture driven growth economy to industry-led growth. This industry-led growth has increased energy demand which in turn is increasing pollution in the country. Alongside this, carbon emission is increasing and the country is experiencing adverse effects of climate change. As noted by Cheema [12], the 2015 summer's heatwave was the worst in more than 30 years, which caused more than 1,200 deaths in Karachi alone. In another part of the country, hundreds

of people were killed and thousands were left homeless by the floods. According to the Global Climate Risk Index (2015) Pakistan is among the top ten countries which is adversely affected by climate change. Amidst these, the energy crisis in Pakistan is a serious issue, which has adversely affected the economic growth [25]. However, financial sector of Pakistan is showing promising signs of supporting growth and the country's small equity market is ranked among the top performing markets of the world by the Bloomberg.

The weak environmental protection laws have called for government action [13]. In 2005, Pakistan implemented controls on environmental degradation through National Environmental Policy (NEP). The rising carbon dioxide emission in Pakistan is primarily due to the heavy use of petroleum in transportation and industrial sector. Globally,

although Pakistan contributes a marginal 0.4% of the world's total carbon emissions, this is gradually increasing. Furthermore, during the period 2005–2011, income per capita at 2005 constant dollars has increased from US$693.18 (PKR 48,984.39) to US$755.41 (53,381.94). As a result, the demand for industrial goods and hence energy consumption has increased. The latter has direct association with carbon emission which has increased from 0.86 metric tons to 0.92 metric tons over the same periods.

Against these backdrops, in this paper we examine the relationship between energy consumption and carbon emission. The relationship may be obvious; however, what is interesting and important is to examine the threshold level of energy consumption to examine the tipping point. We examine the non-linear relationship and hence estimate the threshold level of energy consumption in Pakistan. Relying on the vast literature on energy-growth and environmental Kuznet curve (EKC), we draw on some notable and relevant macro-economic factors besides energy consumption that has a plausible influence on carbon emission in the country. Based on literature we have included trade openness and financial development in our analysis.

It is noted that energy consumption (and hence economic growth) and carbon emission are inextricably linked. Energy consumption releases combustion products, especially carbon emissions, which are polluting the atmosphere. Thus a positive impact of energy consumption is contemplated on carbon emission. Financial development is another source of carbon emission [55,63]. Financial development gives more access to the financial capital to both business firms and households. This increases the demand for machinery, automobiles, etc., which increases manufacturing and transport activities. The increasing consumption of energy, in turn, elevates carbon emissions into the air and of organic pollutants into water [47]. In turn, developed financial markets provide capital for renewable energy sector and offer credits for environmental friendly projects at low financing costs, which can help to reduce energy use and carbon emissions by stimulating technological progress in the energy sector [59]. Financial development also promotes research and development activities and hence improves environmental quality. Thus, the overall effect of financial development on energy consumption is equivocal.

Trade openness is also an important variable which affects carbon emission and environment. Trade openness has three types of effects on environment i.e. technology effect, scale effect and composition effect [8]. In technology effect, when trade increases it helps to improve technology which in turn decreases carbon emission. In scale effect, free trade increases trade volume and output, which subsequently results in deleterious effect on the environment. Finally, in composition effect, developing countries attract pollution intensive industries which subsequently contribute to the deterioration of the environment. It indicates that technology effect has positive effect while scale and composition effects have negative effects on carbon emission and environment. The net effect of trade openness on environment is ambiguous as it depends on which effect is dominant of the three. Generally, scale and composition effects are dominant and both of which have adverse impact on the environment. For developing country like Pakistan, we argue that both trade openness and financial development will have a positive impact on carbon emission because greater focus is on increasing investment and creating employment than ensuring green production.

Copeland and Taylor [14] stipulate two types of hypotheses to explain nexus between trade openness and environment: pollution haven hypothesis and factor endowment hypothesis. According to the pollution haven hypothesis, low income countries with weak environmental regulation will specialize in the production of the polluting goods and multinational companies will take advantage of this by reallocating their polluting industries into these countries. As a result, low income countries will become havens for polluters so trade openness will deteriorate environment in these countries, while rich

countries will benefit from free trade. Factor endowment hypothesis stipulates that capital rich countries will specialize in the production of the capital-intensive goods without any consideration given to the environmental policy. Consequently, rich countries by exporting goods will become dirtier and countries that are relatively abundant in resources that are used in the production of the clean goods will become cleaner with free trade. It again indicates that the relationship between free trade and environment is ambiguous as it depends on the distribution of the comparative advantages among countries. In a recent study, Mavragani et al. [30] examine the extent to which the openness and the quality of the institution affect environmental performance using a large dataset of 75 countries and environmental performance index (EPI). The study shows a significant positive correlation between a country's economic growth, the openness of an economy, high levels of effective governance, and its EPI.

The purpose of this study is to empirically evaluate the nexus between carbon emission and macroeconomic variables in Pakistan. Our paper differs from other similar studies [34,54,57] in the sense that the focus of the paper is not on establishing the environmental Kuznet curve (EKC) but to estimate the threshold effect of energy consumption and the magnitude effects of trade openness and financial development on carbon emission. More specifically, we formulate carbon emission as a function of energy consumption, trade openness and financial development. Unlike previous studies, we exclude per capita income, since the latter is directly related to energy consumption, as noted from the huge literature on energy-growth nexus. In estimating the model in this manner, we derive, based on the threshold level of energy consumption, the dominating effects between technology, scale, and composition, where the former is considered to enhance the environment. Moreover, by showing the basic mathematical derivations, we highlight that the coefficients of non-linear estimation for variable which is associated with the squared-term should not be interpreted as elasticity coefficients (as in [57]) and should only be used for computing threshold values.

The rest of the paper is set out as follows. Section 2 provides literature review. Section 3 presents econometric methodology. Section 4 presents the estimated results. The final section concludes the paper.

2. Literature survey

The economic studies relating to cointegrating and causality in relation to carbon emission and macroeconomic factors are growing, see e.g. [39,40,56,3,19,49,28]. There are also studies which have focussed Pakistan [34,54]. However, the findings are at odds. The differences in the studies are due to differences in sample size, model specification, estimation technique, among other things. While the goal of most of these studies is to establish EKC hypothesis, only few studies quantify the threshold effects. Moreover, these studies consider energy consumption and income as independent variable in the model specification ignoring their 'obvious' multicollinearity. Tables 1–3 provide a list of studies that have examined the causality nexus. Literature review reveals that the research related to the effect of financial development on carbon emission and environmental degradation is still new and has been encouraged for further policy [47,58]. We use these studies as a guide to specify the relationship between carbon emission and energy consumption.

3. Econometric methodology

3.1. Model

Our model for estimation is as follows:

$$\ln CO2_t = \alpha_0 + \alpha_1 \ln ENG_t + \alpha_2 (\ln ENG_t)^2 + \alpha_3 \ln TRD_t + \alpha_4 \ln FIN_t + \alpha_5 T + \varepsilon_t$$

(1)

where $T \in \{TB_x, Trend\}$, such that TB_x is structural break in series x