



Effects of public and private expenditures on environmental pollution: A dynamic heterogeneous panel data analysis[☆]



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ABSTRACT

This paper examined the impact of expenditures of household, firm and government on aggregate and sectoral carbon emissions in the world economies during 1990–2015. The modified heterogeneous panel data technique was used to estimate both carbon emission and income models from which both the direct and indirect effects of expenditure categories were estimated along with long-run and short-run analyses.

Empirical results indicate that, in the long-run, the negative direct effect of government expenditure was reduced by the positive indirect effects, leading to positive total effect on aggregate carbon emission. However, in the short-run, the negative direct effect was enhanced by the negative indirect effect, culminating into negative total effect. Further, in the long-run, the positive direct effect of investment expenditure was reduced by the negative indirect effects, resulting into negative total effect on aggregate carbon emissions. However, the negative short-run direct effect was reduced by the positive indirect effect leading to marginal positive total effect. The total direct effect of household consumption spending was negative in the long-run and could be relatively large in the short-run. The effect of the household expenditure on sectoral carbon emissions was negative, while that of private investment was positive, and that of public spending was diverse.

The policy lessons include the need to conduct value chain environmental pollution implications of any expenditure policy.

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1. Introduction

1.1. Research issues and motivation for the study

The quest for sustainable development has generated renewed interest in the study of the relationship between growth of economic activities and environmental quality (Sharma, [1]; Al-mulali, [2]; and Khan, et al. [3]). This reawakening of interest is due to the observed growth of economic activities all over the World and the associated rise in carbon emission. In 2010, top 10 countries of the World (China, United States, European Union –27), India, Russian, Japan, Germany, Iran, South Korea and Canada) with high gross domestic product (GDP) accounted for 84.4 per cent of World carbon emission.¹ However, there are wide variations in per-capita emission levels across the World, which is a reflection of the diverse ways in which nations and regions consume energy (OECD/IEA, [4]). For instance, the share of World Co2 emissions varied among the highest emitters in 2010, ranging from lowest share recorded by Canada (1.6%) to middle level by European Union (13.3%) and highest share by the China (26.4%) followed by United States (17.3%). On the average, industrial nations discharged far higher quantities of CO2 emission per capita compared to developing nations, while Africa recorded the lowest level (OECD/IEA, [4]).

The starting point of the exploration of the link between economic activities and environmental quality is the Environmental Kuznets Curve (EKC) or hypothesis developed by Kuznets [5] and extended by Grossman and Krueger [6]. The EKC hypothesis states that environmental quality deteriorates initially when a country's per capita income is at low level but after a while, as the economy grows and per capita income rises, environmental quality improves. This relationship between income level and pollution is portrayed in an inverted U-shaped curve (EKC). Subsequently, environmental quality has been linked with a number of factors such as governance, trade, foreign direct investment and other socio-political/economic issues apart from income. However, there is the need to further develop the EKC to make it more amenable to empirical and policy analysis than it is now. The contributions of this study to the existing body of knowledge in this area are articulated in the following dimensions. First, as an alternative to the usual income/output approach to the analysis of EKC, this study attempts an expenditure approach. In particular, little or no attention has been given to the role of expenditure of various economic agents (households, firms and governments) in the generation of carbon emissions, which is the focus of this paper.

In essence, there is dearth of studies on the effects of expenditure on various economic activities undertaken by different economics agents (government spending, private investment expenditure and household consumption spending) on carbon emissions. To my knowledge, only few (eight) studies have made significant contributions in this area (Halkos and Paizanos, [7,8]; Lopez, et al. [9]; Lopez and Palacios, [10,11]; Bernauer and Koubi, [12,13]; and Galinato and Galinato, [14]) as noticed in the course of survey of literature in the Section 1.3 and mentioned earlier by

Halkos and Paizanos [7]. However, little or no such studies analysed the link between carbon emissions and expenditure of the various economic agents at both aggregate and sectoral levels as done in this present study. This approach is important so as to trace economic agents' spending to CO2 emission associated with specific sectoral activities they undertake. Thus, the comprehensiveness of this paper is reflected in the aggregate and sectoral analyses. Second, instead of drawing country sample based on data availability criteria alone (as done in the previous studies), this present study generated a sample consists of a panel of 40 top emitters (top 10 emitters per region) so as to have a representative sample that would permit generalization of empirical findings of this research. Analysis of the direct and indirect effects (as well as total effect) of spending of each economic agent on carbon emissions could inform different fiscal and industrial policies such as environmental regulations, and policies that could change the composition of consumption and investment. For instance, for the purpose of environmental sustainability, fiscal or industrial policy could be used to induce producers to purchase (import) less polluting technology; and consumers to direct their spending pattern toward purchasing energy efficient and less polluting automobiles and electrical equipment. Third, the need for further development of the theoretical basis of empirical research in this area mentioned in earlier studies was addressed in this paper. The earlier framework on the effect of the composition of government expenditure on environmental quality provided by Lopez et al [9] was expanded to cover the effects of spending of firms and households. The theoretical expositions were also developed to include the direct and indirect effects of the expenditure categories on environmental pollution. Therefore, a pollution production function integrated with the standard augmented growth model was articulated for empirical analysis.² Fourth, econometric modeling issues inherent in macroeconomic economic and time series panel data and modeling such as cross-section dependence, endogeneity problem, stationarity and consistency of estimates when number of cross section and time period³ are relatively large (Sharma, [1]; Pesaran, [15,16]⁴; and Eherhardt, [17]) were addressed in this research. Wrong choice of estimation techniques with the existence of cross-section dependence and endogeneity problem can lead to imprecise estimates and identification problem (Pesaran, [15,16] and Eherhardt, [17]).

This study examines the direct, indirect and total effects of public and private spending (households and firms) on carbon emission. The rest of this paper is organized as follows; sub-Sections 1.2 and 1.3 contain stylized facts about the subject of this paper and summary of literature review respectively. Section II describes methodology of the study, while Section III presents and

² According to Sardosky (2011), some existing energy and pollution economic related studies adopted ad hoc approaches for empirical analysis. Thus, we have developed a logical theoretical perspective upon which empirical analysis is rooted.

Sadorsky P. Trade and energy consumption in the Middle East. *Energy Econ* 2011;33:739–49.

³ In this paper, we have 40 countries and about 26 years 1990–2015.

⁴ The potential endogeneity problem was initially investigated by conducting correlation analysis between the error terms generated from the estimated regression models and the explanatory variables.

¹ See <http://Wikipedia.org/wiki/list> of countries by carbon emission.

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