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Procedia Economics and Finance 38 (2016) 318 – 339

Procedia Economics and Finance

www.elsevier.com/locate/procedia

Istanbul Conference of Economics and Finance, ICEF 2015, 22-23 October 2015, Istanbul, Turkey

The Nonlinear Relationship of Environmental Degradation and Income for the 1870-2011 Period in Selected Developed Countries: The Dynamic Panel-STAR Approach

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Abstract

The study aims at analyzing the nonlinear effects of GDP on CO2 emissions for a long span of data, covering the period of 1870-2011 for a panel of 13 developed countries with nonlinear heterogeneous dynamic Panel-STAR framework. The group analyzed consists of Australia, Belgium, Canada, France, Germany, Sweden, Switzerland, UK, USA, Italy, Netherlands, Norway and Spain. The Panel-STAR model evaluated in the study allows modeling and testing heterogeneity and nonlinearity simultaneously within the nonlinear STAR methodology. The difference of the Panel-STAR models analyzed in the study from the Panel-STR models is, they allow dynamic effects. The motive behind proposing dynamic modelling of heterogeneous Panel-STAR models is related to the fact that CO2 emissions are an accumulated process which possess path-dependence to the history of the emissions and economic growth. Both variables are integrated of order 1 due to serial panel unit root tests. For the data, Panel-STAR type nonlinearity cannot be rejected. The empirical findings suggest that various thresholds could be obtained and the rejection of linearity is strongest for the Panel-STAR model with the transition variable taken as the emissions growth rate. A second-best model is also estimated by taking the transition variable as the rate of economic growth. The empirical findings suggest that i. the effects of economic growth on emissions growth cannot be rejected in both regimes, ii. in both regimes, the effect is positive in contrast to EKC type theoretical expectations, iii. the positive effects of economic growth are lower in the second regime suggesting asymmetry, iv. after achieving a threshold of emissions' growth, though the political commitment against environmental degradation exists, the growth of CO2 emissions is partially slowed and the relation is not reversed.

Peer-review under responsibility of the Organizing Committee of ICEF 2015.

Keywords: CO2 emissions; economic growth; environmental Kuznets curve; panel-smooth transition autoregression

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Peer-review under responsibility of the Organizing Committee of ICEF 2015.
doi:10.1016/S2212-5671(16)30205-2

1. Introduction

One point that cannot be overlooked is the fact that the public interest and awareness on climate change in the 21th century is continuingly increasing which also brings about an increasing interest in the empirical studies focusing on modelling the relationship between production, economic growth and hazardous emissions such as carbon dioxide CO_2 and Sulphur dioxide SO_2. Nevertheless, the continuing acceleration in the concentration of carbon dioxide in the atmosphere is predicted to result in significant changes in the climate Cox et.al. [1]. Among the six dominant greenhouse gases, the CO_2 emissions make the largest contribution to the accumulated greenhouse gases representing more than 62% of the total and starting from early 1990's to 2015. Hence, the total global accumulation of CO2 emissions increased by around 40% and reached 33.1 billion tons in the year 2009[2]. In a recent study, Grunewald and Martinez-Zarzoso [2] discuss the success of the Kyoto Protocol and questions if it failed. They show that though the treaty is often deemed a 'failure', the protocol may in fact be producing some non-negligible effects for the countries who signed it. UNFCCC[3] notes that developed countries are principally responsible for the current levels of greenhouse gas (GHS) emissions as a result of more than 150 years of industrial activity and as a result, the UNFCC underlines the fact that the Kyoto Protocol places heavier burden on the developed nations [3]. Further, the preliminary analysis of UNFCC in August, 2015 demonstrates that countries with targets under the Kyoto Protocol collectively exceeded their original ambitions by a large margin – a powerful demonstration that climate change agreements not only work but can drive even higher ambition over time [4]. In addition to the Kyoto Protocol, important steps are taken with the 1997 Montreal Protocol with which many governments agreed to eliminate the usage of chemicals that harm the stratospheric ozone [5]. It should be noted that though UNFCCC calls up the developed countries (DC) for political action, the largest share of CO2 emission cannot be fully attributed to the DC's in the year 2014. If the regional intensity of CO2 emissions is to be analyzed, as of 2009, the 53% of the total CO2 emissions resulted from the activities in developing countries compared to 44% share of the industrialized countries. China, EU-28 and India account for almost 60% of all emissions. Further, China accounted for almost half of the 61% of the non-OECD countries in the year 2014. However, it should be noted that industrialization and FDI flows in the last two decays to China resulted largely from DC's. As Lei [6] points out, FDI flows have strong impact on the pollutant emissions in different regions of China. Another important factor is that, there is an ongoing shift from the primary fossil based primary energy consumption towards renewable energy sources which accounted for the two thirds of the total increase in energy production between 2004-2014[4].

If an historical perspective is followed instead of covering only the last two decays, the large share of the emissions could be attributed to the structural transformation of the economic development of DC's. This transformation from industrialization towards high-mass consumption period is expected to have various impacts on the path followed by CO2 emissions. In addition to the political efforts such as the Kyoto Protocol, a continuing interest also prospers in the economics and econometrics literature focusing on understanding the relationship between economic activity and environmental emissions.

One of the important finding in the literature is the environmental Kuznets curve (EKC) and the empirical studies investigating the possibility of such relation deserves special attention for the study. The EKC hypothesis is an adaptation of the original work of [8]. The seminal paper of Grossman & Krueger notes that the inverted Kuznets curve thesis postulates an inverted U shaped relation between income inequality and economic growth. The EKC adaptation of the curve assumes an inverted U-shape relation between environmental degradation and income per capita, where, growth reduces the environmental impact of economic activity as economic development fosters [9]. Nevertheless, there is a consensus in the economics literature on three factors that lead the relationship between income and pollution to become negative once a certain level of economic development is reached. The factors that would result in such relation in the literature could be summarized as supply and demand-side factors. Further, in the

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[2] Though the emissions showed an almost 7% decline in 2009, this decrease is also criticized as not being largely due to the Kyoto Protocol, but being largely due to the decline in economic activity during the 2009 Global Recession [2]

[3] UNFCC stands for Kyoto Protocol to the United Nations Framework Convention on Climate Change adopted in New York on 9 May 1992.

[4] According to [7], the six largest emitting countries in 2014 were China, US and European Union (EU-28), Russian Federation, India and Japan with 30%, 15%, 9.6%, 6.6%, 5.0% and 3.6%, respectively. Among these countries, the top three accounted for 54% of total global emissions.