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ANALYSIS

Determinants of CO_2 emissions in a small open economy

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Abstract

The aim of the paper is to explore the relationship between economic development and carbon dioxide (CO_2) emissions for a small open and industrialized country, Austria. We test whether an Environmental Kuznets Curve relationship also holds for a single country rather than concentrating on panel or cross-section data for a set of countries. A cubic (i.e. N-shaped) relationship between GDP and CO_2 emissions is found to fit the data most appropriately for the period 1960–1999, and a structural break is identified in the mid-seventies due to the oil price shock. Furthermore, two variables are additionally significant: import shares reflecting the well-known pollution haven hypothesis, and the share of the tertiary (service) sector of total production (GDP) accounting for structural changes in the economy. Emission projections derived from this single country specification support the widely held opinion that significant policy changes are asked for when implementing the Kyoto Protocol in order to bring about a downturn in future carbon emissions.

Keywords: CO_2 emissions and economic growth; Environmental Kuznets curve; Stationarity; Cointegration

JEL classification: Q2; O1; C2

1. Introduction

The Environmental Kuznets Curve (EKC hereafter) summarizes what has meanwhile become well known as the inverted U-shaped relationship between emissions (environmental pressure) and GDP per capita. The inverse relationship between pollution and per capita income has been explored for a variety of pollutants, such as nitrogen oxide, sulfur dioxide, suspended particulate matter, carbon monoxide, lead, and for deforestation, biological oxygen demand and others[1]. While the EKC hypothesis has been confirmed—albeit far from unanimously—for a set of air pollutants, water, and land use, the empirical evidence is very inconclusive in the case of greenhouse gas (GHG) emissions, in particular CO_2 emissions.

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[1] For critical surveys, see, for instance, Stern et al. (1996), Ekins (1997), and Panayotou (2000).

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Due to the release of enormous amounts of CO_2 in the combustion of fossil energy, CO_2 emissions are classified as one of the main driving forces behind global warming today. Worldwide, greenhouse gas emissions are increasing despite common efforts to implement internationally binding agreements such as the Kyoto Protocol, and a turning point in the positive relationship between CO_2 emissions and per capita income has not yet been identified, at least not on a global scale. The question arises as to whether the delinking of carbon emissions and income is possible at high levels of income. This is the main motivation for testing the EKC hypothesis for the case of CO_2 emissions in a single open and industrialized country.

From a theoretical point of view, the inverted-U relationship is less likely for CO_2 emissions than for 'traditional' air pollutants such as NO_x or SO_2. While these air pollutants have local effects, CO_2 emissions cause problems on a global scale, and the social costs of global warming accrue both across time and nations. Therefore, free-rider behavior might lead to a close relationship between carbon emissions and income at all levels of per capita income (Arrow et al., 1995). In line with this argument, a linear relationship for CO_2 emissions and GDP per capita was confirmed in early studies (Shafik and Bandyopadhyay, 1992; Shafik, 1994). A delinking of growth in carbon emissions from economic growth does, however, seem possible, if either carbon emissions fall as a by-product of other abatement activities (Holtz-Eakin and Selden, 1995) or institutions such as environmental regulations are improved with increasing per capita income. Thus, an inverted U-shaped function has also been identified (De Bruyn et al., 1998; Heil and Selden, 2001; Holtz-Eakin and Selden, 1995; Moomaw and Unruh, 1997), followed by N-shaped (cubic) specifications (e.g. Galeotti and Lanza, 1999). Neither the linear nor the cubic relationship allows for an optimistic interpretation of economic growth as being beneficial for the environment. Rather, at high levels of income, CO_2 emissions are found to increase with income.

One of the major qualifications regarding the existence of an EKC for all types of pollution is that economic growth is not sufficient for environmental recovery (see, for example, Stern et al., 1996). The fact that nations which formerly had or currently have low per capita income are experiencing increasing pollution while industrialized countries are successful in abating emissions does not imply that economic development will solve environmental problems quasi automatically. Rather, the EKC might be considered as a descriptive statistic on a par with literacy rates or health indicators relative to per capita income. The more promising approach, therefore, seems to be an investigation of the time-series data of a single country which may be able to account for historic experience such as environmental policy, development of trade relations, and exogenous shocks such as the oil crisis (Stern et al., 1996).

The vast majority of investigations regarding the existence of an EKC concentrate on cross-section and panel data. To the authors' knowledge, EKC studies for single countries most often address developing countries (e.g. Patel et al., 1995; Vincent, 1997). Rare exceptions addressing industrialized countries include De Bruyn et al. (1998) and Moomaw and Unruh (1997). Thus, the current study contributes to the discussion on the implementation of the Kyoto Protocol since the EKC relationship found for CO_2 could serve as a counterfactual scenario reflecting current developments of emissions in industrialized countries.

As far as Austria is concerned, Schandl et al. (1999, 2000) present an in-depth case study of Austrian materials flows. Other time-series investigations focusing particularly on Austrian CO_2 emissions in comparison to other countries have been carried out by Dijkgraaf and Vollebergh (1998), Liski and Toppinen (2001) and Panayotou et al. (2000).

The paper is structured as follows. Section 2 reviews previous efforts to test the EKC for carbon emissions in more detail. Different functional specifications are introduced and their economic implications are explained. Section 3 deals with the Austrian database and a description of the time path of CO_2 emissions, including environmental policy efforts to reduce CO_2 emissions. In addition, the empirical EKC model is described, stationarity and cointegration tests are reported, and structural breaks within the time series are