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Economic growth and carbon dioxide emissions: An analysis of Latin America and the Caribbean

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RESUMEN

En este trabajo se analiza la relación empírica entre las emisiones de dióxido de carbono (CO_2) per cápita y el crecimiento económico en un panel de 20 países de América Latina y el Caribe durante el periodo 1971-2011. Dicha relación empírica, conocida en la literatura económica como la hipótesis de la curva de Kuznets ambiental (CKA), sugiere que la relación entre ambas variables tiene en el largo plazo una relación funcional en forma de U-invertida, es decir, a partir de cierto nivel de renta per cápita, un mayor crecimiento económico iría acompañado de mejoras en la calidad ambiental. Si bien esta hipótesis ha sido estudiada desde la década de 1990, recientemente su validez empírica ha sido cuestionada, entre otras cosas, por la falta de análisis de estacionariedad de las variables, y en un contexto de datos panel, la presencia de dependencia cruzada. Tomando en cuenta ambas críticas, empleamos novedosas pruebas de raíces unitarias y técnicas de cointegración robustas para la presencia de dependencia en el panel. Encontramos resultados contradictorios dependiendo del supuesto de dependencia cruzada entre los países. Bajo el supuesto de independencia cruzada, se confirma la existencia de una CKA con puntos de quiebre realistas. Sin embargo, dicho supuesto es rechazado posteriormente, concluyendo así que en presencia de dependencia cruzada en el panel, no se puede establecer una relación de equilibrio a largo plazo entre las variables, i.e., se rechaza la existencia de una CKA.

ABSTRACT

This paper analyzes the empirical relationship between carbon dioxide (CO_2) emissions per-capita and economic growth in a panel of 20 Latin American and Caribbean countries over the period 1971-2011. This empirical relationship, known in the economic literature as the Environmental Kuznets Curve (EKC) hypothesis, suggests that the relationship between these variables, in the long run, follows an inverse U-shape, that is, from a certain level of per-capita income, an increased economic growth would be accompanied by improvements in environmental quality. Although this hypothesis has been studied since the 1990s, its empirical validity has recently been questioned on the basis of, among other things, the lack of diagnosis of the stationarity properties of the variables, and in a panel data context, the presence of cross-sectional dependence. Taking into account both criticisms, we use recent unit root tests and cointegration techniques that are robust to the presence of cross-sectional dependence. We find contradictory results depending on the assumption of cross-dependence. Under the assumption of cross-independence, the existence of an EKC with a realistic turning point is confirmed. However, this assumption is subsequently rejected, and because of the presence of cross-dependence in the panel, a long-run equilibrium relationship between the variables cannot be established, and we reject the existence of an EKC.

Keywords: Environmental Kuznets Curve, panel data, unit root, cointegration, cross-section dependency, Latin America and the Caribbean, carbon dioxide emissions.

1. Introduction

The relationship between economic growth and environmental pollution is considered one of the most important empirical relationships in environmental economics, having as one of its main assumptions that in a country´s development process, as per-capita income rises, environmental quality initially deteriorates to a certain point, after which environmental quality improves while income continues to rise. Graphically, this empirical relationship takes the form of an inverted U-shape, and is known in the economic literature as the Environmental Kuznets Curve (EKC). The intuition behind the EKC follows from three key effects that determine the relationship between economic growth and environmental quality during the process of development: i) the scale effect, states that an increase in production demands more inputs, which implies higher emissions of pollutants; therefore, it is said that economic growth has a negative impact on the environment; ii) composition effect, as the economy grows, its structure could change, consequently there may be greater participation of cleaner or dirtier activities, thus it is said that the composition effect has an ambiguous effect on environmental quality; iii) technique effect, suggests that changes in the level of per-capita income can induce changes in civil environmental preferences, for example, an increase can lead the preferences towards higher environmental quality, which may lead to changes in environmental policies, which in turn can have an effect on production methods, directing them towards the use of less polluting technologies (Grossman and Krueger, 1995; Panayotou, 1997).

From an optimistic point of view, the EKC hypothesis suggests that economic growth is, by itself, the solution to environmental problems in the sense that environmental improvement is almost an inevitable consequence of economic growth, and thus, when a country becomes richer, current environmental problems will be addressed by policy changes that not only protect the environment, but also promote economic development (Roca et al., 2001; Perman and Stern, 2003). However, this is a very simplistic conclusion, since environmental degradation is not explained solely by the current emissions rates or pollutant concentrations, but also depends on past environmental pressures, and as Arrow et al. (1995) conclude, "… economic growth is not a panacea for environmental quality; indeed is not even the main issue".

The empirical literature on the analysis of the EKC emerged during the early 1990s with the study by Grossman and Krueger (1991), who in the context of the North American Free Trade Agreement (NAFTA) found an inverted-U relationship between some pollutant emissions such as sulfur dioxide or smoke and per-capita income for the US previous to the NAFTA. Shafik and Bandyopadhyay (1992) estimated EKCs for ten indicators of environmental degradation for 149 countries over the period 1960-1990, and found an inverted-U relationship between income and ambient concentrations of air pollutants. In the Latin American context, Poudel et al. (2009) tested for EKC in the greenhouse gas carbon dioxide (CO_2) in 15 Latin American countries over the period 1980-2000. They do not find an inverted U-relationship, but instead, their results show an N-shaped curve for the region.

However, the empirical validity of the early EKC studies mentioned above has been questioned by some (for further discussion see Borghesi, 2001; Stern, 2004; Galeotti et al., 2006; Romero-Ávila, 2008) on the basis of the sensitivity of the results to variations in model-specification, the lack of diagnosis of the stationarity properties of the variables, and the assumption of cross-sectional independence, and the possible presence of structural breaks in the long-run relationship implied by the EKC hypothesis.

Regarding the first issue, the stationarity properties of the variables, let us remember that a time series is said to be stationary if all its statistical properties such as mean, variance, autocorrelation, and so on, remain constant over time; in contrast, in non-stationary processes, the statistical properties change over time. A non-stationary process that needs to be differenced d times before it becomes stationary is said to be integrated of order d or $I(d)$. A stationary process of order 0 or $I(0)$ is integrated, known as stationary level. The idea behind testing the stationarity properties of the variables is to avoid unreliable and spurious regressions, since by rule, non-stationary variables are unpredictable, the estimation results might indicate a relationship between variables where one does not exists (Phillips, 1986). The panel unit root tests (PURTs), which are used to test for stationarity, can be divided into two categories according to their cross-section dependence assumption: the so called *first generation* assume cross-section independence,