

Economic development and CO₂ emissions: A nonparametric panel approach

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Abstract

We examine the empirical relation between CO₂ emissions per capita and GDP per capita during the period 1960–1996, using a panel of 100 countries. Relying on the nonparametric poolability test of Baltagi et al. [Baltagi, B.H., Hidalgo, J., Li, Q., 1996. A nonparametric test for poolability using panel data, *Journal of Econometrics* 75, 345–367], we find evidence of structural stability of the relationship. We then specify a nonparametric panel data model with country-specific effects. Estimation results show that this relationship is upward sloping. Nonparametric specification tests do not reject monotonicity but do reject the polynomial functional form which leads to the environmental Kuznets curve in several studies.

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1. Introduction

The relationship between economic development and environmental quality has been extensively explored in recent years. The shape of this relationship has implications for the definition of an appropriate joint economic and environmental policy: depending on whether there is a negative or a positive influence of economic development on environmental quality, policy recommendations will differ. In the literature, this animated debate revolves around the

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existence of an *Environmental Kuznets Curve* (or inverted-U shaped curve, EKC), which implies that, starting from low levels of income per capita, environmental degradation increases, but after a certain level of income (turning point) it diminishes. Despite some exceptions, empirical studies are generally based on ad hoc parametric specifications with little attention paid to model robustness; yet different parametric specifications can lead to significantly different conclusions, and a functional misspecification problem is likely to occur. Popular parametric functional forms are linear, quadratic, and cubic polynomials in GDP per capita.

This study investigates the question of the existence of an EKC using a nonparametric approach. In this framework, no a priori parametric functional form is assumed for modelling the relationship between carbon dioxide (CO₂) emissions and GDP per capita. While there exist many panel studies on the existence of an EKC for CO₂, with various conclusions as we will see in detail in the next section, we offer the first nonparametric panel study on that topic that is able to point out an important source of these divergencies.¹

We follow the bulk of the literature on this relationship by not controlling for possible determinants for CO₂ emissions, like technological change, energy prices, etc. Of course, it is not our intention to deny the role of these factors. However, a number of points can be made in support of our choice. The first, obvious one, concerns data limitations. In this respect, it is important to note that using panel methods that sweep country effects away lets us control implicitly for any time invariant determinant. The second obvious point concerns comparability with existing studies. A more technical point concerns the curse of dimensionality in nonparametric studies: adding discrete regressors to a nonparametric regression does not alter the speed of convergence of the estimator, but adding continuous regressors does — although admittedly additional regressors could be included in a parametric way (as illustrated by Bertinelli and Strobl, 2005, although they include only country and year effects as supplementary regressors). More importantly, we are not concerned here with obtaining best predictions for CO₂ emissions next year, say, but with the *shape* of the relationship with GDP. In this respect, determinants of CO₂ emissions which are not correlated with GDP become irrelevant. Moreover the impact of determinants which *are* correlated with GDP will be captured in the effect of GDP. Depending on the question asked, this can be seen as a drawback or as an advantage. It is a drawback if we purport to determine the ceteris paribus impact of GDP on CO₂ emissions — but what list of regressors would guarantee this? It is an advantage if we are interested in the global effect of GDP, including indirect effects linked with omitted variables. This is indeed the stance we take here. While the results of our study will not enable us to make precise policy prescriptions, we will be in a position to intervene convincingly in the long debate on the existence of EKCs. Finding an increasing profile would default the hope for sustained economic growth without excessive increase in CO₂ emissions in the absence of active policies designed to modify the shape of the relationship revealed on the basis of the current and past policies.

The main reason for studying CO₂ emissions is that they play a focal role in the current debate on environment protection and sustainable development. CO₂ has been recognized by most scientists as a major source of global warming through its greenhouse effects. Pollutants like sulphur oxides or oxides of nitrogen, have a more local impact on the environment. Another

¹ The only other nonparametric panel study available, as far as we know, is the study of Bertinelli and Strobl (2005), but their paper is much more modest in scope — although it addresses broadly the same issue, and reaches a qualitatively similar conclusion of absence of an EKC. Moreover the first version of this paper dates back to 2001.

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