

# Carbon dioxide emissions and economic growth in the U.S.

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## Abstract

The objective of this paper is to analyze the relationship of the carbon Kuznets curve. We discuss two potential flaws in past carbon Kuznets curve studies: one, the potential misspecification of energy consumption as a control variable; and, two, the use of vector error correction models as an empirical specification. Given these potential flaws we estimate a dynamic ordinary least squares model of monthly carbon dioxide emissions, personal income, and energy production in the U.S. from 1981 to 2003. Our results suggest that economic growth drives emissions intensities, not absolute emissions as is often implied in past studies.

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## 1. Introduction

The objective of this paper is to integrate the approaches of the environmental Kuznets curve (EKC), decomposition analysis, and energy-growth based on three relatively independent streams

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of literature into one cohesive discussion on the nexus among energy, the environment, and the economy. Developing a discussion will aid in our understanding of energy resources as one of the major factors affecting both the economy and the environment. With current discussions surrounding global climate change, greenhouse gas emissions (GHGs), and economic development, the results within this study imply that economic development (including energy infrastructure development) can be beneficial to the environment (and arguably is necessary for environmental quality improvements). The environmental benefits of economic development as suggested by the EKC hypothesis are not to discredit those that advocate for sustainable growth, but rather to further the energy-pollution-income debate so that the public is aware of policies alternative to the limits-to-growth argument. More importantly, energy policy could play a significant role in stimulating economic development while at the same time ameliorating harmful pollution emissions.

This study offers a unique contribution to the literature in four ways. The first contribution involves an empirical example in which we synthesize the three separate literatures outlined below. The second contribution is noting the potential flaw in many past studies that have empirically estimated the effects of energy use and economic growth on carbon dioxide emissions. Namely, carbon dioxide emissions in many past studies are estimated based upon energy consumption within a particular jurisdiction. Several studies then proceed to specify a covariate of energy consumption on the right-hand side (RHS) of the model, which may lead to spurious empirical results due to simultaneity bias. The third contribution is to point out the potential flaw in specifying a dynamic econometric model, such as a vector autoregressive (VAR) model or vector error correction model (VECM), which are popular in many recent studies. Subject to these potential flaws we estimate a dynamic ordinary least squares (DOLS) model among monthly time series of U.S. personal income, CO<sub>2</sub> emissions (based upon U.S. monthly energy consumption), and energy production from 1981 to 2003. Our fourth contribution constitutes the use of high frequency, monthly data from 1981 to 2003. Many past studies use annual data that miss potential inter-annual variation in the time series variables. Further, the higher frequency data provide better asymptotic qualities for dynamic regression analysis. Using this uniquely high frequency of data we find a long-run relationship between the variables that suggests the inverted-U shaped relationship between CO<sub>2</sub> emissions and personal income as espoused by the EKC. However, based upon our estimated data for CO<sub>2</sub> emissions, our results may suggest that this relationship is instead between CO<sub>2</sub> emissions *intensities* and income.

## 2. Background

### 2.1. The environmental Kuznets curve

The EKC hypothesis came to prominence in the 1990s after the early works of [Grossman and Krueger \(1991, 1995\)](#), [Shafik and Bandyopadhyay \(1992\)](#), and [Selden and Song \(1994\)](#). The first EKC papers were advanced by trade/developmental economists in the context of international trade agreements. Since these three initial papers the EKC literature has developed into a rich examination of both the empirical and theoretical aspects of the relationship between the environment and the economy. According to [Carson \(2010\)](#), “[the] lasting contribution of the EKC literature has been to shift the conventional wisdom of rank-and-file economists and many policy makers toward a belief that economic growth is good for the environment.” Yet, despite this robust literature there has been until recently a paucity of EKC

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