Land Use Policy xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

How deep is China's environmental Kuznets curve? An analysis based on ecological restoration under the Grain for Green program

Junze Zhang[a,b], Mengting Luo[b], Shixiong Cao[a,*]

[a] School of Economics, Minzu University of China, No. 27 Zhongguancun South Street, Haidian District, Beijing, 100081, PR China
[b] Faculty of Geographical Science, Beijing Normal University, No. 19, Xinjiekouwai Street, Haidian District, Beijing, 100875, PR China

ARTICLE INFO

Keywords:
Environmental kuznets curve
Environmental attitudes
Environmental conservation
Public responses
Institutional innovation

ABSTRACT

Environmental Kuznets curve theory predicts that rapid economic development will initially and unavoidably create environmental problems until these problems are solved at higher development levels. However, because different economies face different impacts from economic growth, some may find ways to shorten the environmental Kuznets curve. To understand the characteristics of a "Kuznets curve" based on Chinese environmental attitudes and the factors that influence these attitudes, we interviewed 3000 randomly selected Chinese adults in 2014 using stratified random sampling in six areas (four provinces and two provincial-scale municipalities) that had been affected by the national Grain for Green program. Our goal was to determine their opinions on China's environmental policy. Based on their responses, we calculated that the minimum value of the environmental Kuznets curve (the income at which priorities change from income to environmental protection) occurred at a per capita income of between 20 200 and 27,000 RMB (an increase of 61.6% compared with results from a similar survey in 2004). We found significant impacts of income, education level, age, gender, employment, and region on Chinese environmental choices. To achieve sustainable socioeconomic development, China's government must account for how these factors affect public responses to its policy initiatives. China's government must also find ways to increase personal income faster to speed China's progress along the environmental Kuznets curve.

1. Introduction

Kuznets (1955) predicted that as per capita income increases, income inequality also increases at first and then starts declining after an inflection point, forming what is called a "Kuznets curve". This theory is interesting but controversial (Dinda, 2004; Stern, 2004). For example, it is unclear whether this is an inevitable path for economic development (Panayotou, 1993), or just a special case (Brajer et al., 2011) that occurs under specific conditions. If it occurs under specific conditions, what are those conditions and what causes this phenomenon? The Kuznets curve has also been extended to describe the initial increase in pollution or other impacts that is believed to occur during socioeconomic development, followed by a decrease after reaching some level of development; this curve is referred to as the "environmental Kuznets curve" (Panayotou, 1993). The abovementioned questions also apply in environmental Kuznets curve research.

Extensive research has been carried out on environmental Kuznets curves around the world. The results have been complex (Stern, 2004; Brajer et al., 2011; Liu, 2012), and some researchers consider the evidence unpersuasive (Dinda, 2004; Yang et al., 2015). Not only have researchers found inconsistent numerical values for the position of the inflection point, but they have also found inconsistencies in the shape and other characteristics of the curve (Fu, 2008). For instance, Grossman and Krueger (1991) and Panayotou (1993) supported Kuznets' hypothesis by finding an inverted-U-shaped curve for SO_2 pollution and economic growth, but Kaufmann et al. (1998) and Dinda et al. (2000) found the opposite results (i.e., an upright U-shaped curve). In their research on CO_2 pollution, Richmond and Kaufmann (2006) found no significant relationship between this pollution and economic growth. Based on data for seven pollutants in 29 Chinese provinces from 1995 to 2010, Yang et al. (2015) found no statistically significant environmental Kuznets curve for any of the seven pollutants.

Other recent studies have found that during socioeconomic development, the trends for carbon emission (Steinberger et al., 2012), N pollution (Zhang et al., 2015), and the human development footprint (Venter et al., 2016) all show an inverted-U shape. However, Liu (2012) found that a given region may include communities whose curves have different shapes. This suggests that some communities prosper at the

* Corresponding author.
E-mail address: shixiongcao@126.com (S. Cao).

http://dx.doi.org/10.1016/j.landusepol.2017.10.052
Received 6 September 2017; Received in revised form 26 October 2017; Accepted 27 October 2017

Table 1
Questionnaire used to obtain demographic data and determine the attitudes of Chinese citizens towards China's ecological problems. Values of responses to the questions in brackets represent the numerical value used to quantify the responses.

Question	Result (only one response per question is permitted)
Age	18–22, 23–27, 28–32, 33–37, 38–42, 43–47, 48–52, 53–58, > 58
Gender	Man, woman
Job	government employee, teacher, business manager, factory worker, farmer, student, self-employed, unemployed
Net annual income (RMB per person in the household)	< 5000, 5000-10 000, 10 000-15 000, 15 000-20 000, 20 000-25 000, 25 000-30 000, 30 000-35 000, 35 000-40 000, 40 000-45 000, 45 000-50 000, > 50 000
Educational level	Primary school (a total of 6 years), middle school (9 years), high school (12 years), and college (15 years) or university (16 years)
Location	rural, urban
Province or province-scale municipality	Beijing, Shanghai, Henan, Hubei, Hunan, Shaanxi
Q1: What do you think of the level of environmental degradation in China?	extremely serious (6), very serious (4), serious (2), not serious (-2), don't know (0)
Q2: How strongly does environmental degradation affect your health?	strongly (4), somewhat (2), not at all (-2), don't know (0)
Q3: Do you believe that the Grain for Green program has been worthwhile?	very worthwhile (4), worthwhile (2), not worthwhile (-2), don't know (0)
Q4: How much money would you be willing to pay to improve environmental conservation?	Quantity (RMB)

Notes: To ensure that respondents understood the context for our study and that variations in their understanding did not influence the responses, we designed a single sentence to explain the meaning of the term environmental degradation: "Sandstorms, air and water pollution, and other environmental problems that are threatening our way of life." For responses to question 3, we explained to the respondents that "worthwhile" referred to how well the program was able to reverse the environmental degradation that had already occurred. This explanation was provided by the interviewer to ensure that even illiterate citizens (many of whom participated in our survey) had the same understanding of the questions. This explanation was not included in the questionnaire itself.

expense of other communities, which may fall into poverty accompanied by environmental degradation, with the environmental degradation potentially becoming irreversible and leading to economic failure (Tallis et al., 2008). One problem with this previous research is that it has been based on panel data that mainly included pollutant emissions and local economic development indicators that could be collected from statistical yearbooks (Dinda, 2004; Stern, 2004; Brajer et al., 2008; Yang et al., 2015). As a result, the researchers only described an existing phenomenon, without identifying the underlying factors responsible for the shape of the curve or revealing what needs to be done to increase the sustainability of economic development (Dinda et al., 2000; Kotchen and Reiling, 2000; Liu, 2012). However, a few studies have used questionnaires designed to determine attitudes towards the environment, with the goal of revealing the underlying causes for the curve's characteristics (Cao et al., 2009; Lo, 2016).

In addition, the relationship between the environmental attitudes and the characteristics of the environmental Kuznets curve remained ambiguous (Xiao and Dunlap, 2007; Czap and Czap, 2010). One likely explanation for the contradictory results is that the underlying attitudes of residents of a study area shape the behaviors that lead to a given set of curve characteristics. Environmental attitudes can be divided into two general components: the environment itself (i.e., the conditions under which data for the curve is collected) and attitudes of residents of the study area towards the environment. Both components encompass many factors, and differences in these factors between studies or regions could produce dramatically different environmental Kuznets curves. Many scholars have found that environmental attitudes are strongly influenced by psychological predispositions, socioeconomic and demographic characteristics, and financial incentives provided by the government or another agent, and their research methods and results provide us with an important reference (Czap and Czap, 2010; Liu and Mu, 2016). To avoid ambiguity, we define environmental attitudes here as "the collection of individual beliefs, emotions, behaviors, and intentions related to the environment and to related activities and problems" (Schultz et al., 2004). These attitudes are closely related to the willingness of people to pay for environmental protection and to their behaviors that lead to environmental impacts such as pollution (Kotchen and Reiling, 2000).

One novel aspect of the present study is that we have changed the focus of the analysis. Traditional environmental Kuznets curves present the *results* of environmental attitudes (i.e., emission of pollution), and therefore provide no insights into the *causes* of those results. But as we noted earlier, differences in attitudes (the primary causes of environment-related behaviors) may create different environmental Kuznets curves. By examining environmental attitudes in the present study, we shift the focus towards the causes that underlie the shape of the curves. For example, the decision to purchase a fully electric vehicle that produces no greenhouse gas emissions rather than a vehicle powered by low-quality diesel fuel depends on the purchaser's attitudes towards the environment; the pollutant emission therefore depends on the results of that choice. We believe that adding these data to environmental Kuznets curve analysis provides insights that cannot be obtained only by focusing on the results of environmental attitudes (in the previous example, air pollution). Such data would contribute greatly to our understanding of how differences in environmental attitudes in different regions and at different development levels affect the characteristics of the environmental Kuznets curve. That is, understanding the underlying factors could explain why some studies produce contradictory results.

To provide more insights into these phenomena, we designed a study to answer two main questions: (1) Do key demographic indicators affect whether the current distribution of Chinese environmental attitudes affects the shape (an upright or inverted U) of the environmental Kuznets curve, and if so, what are the underlying attitudes responsible for these results? (2) If a statistically significant curve exists, where does its inflection point occur (i.e., when do priorities shift from increasing income to increasing environmental protection)? To answer these questions, we designed a questionnaire to explore Chinese attitudes towards environmental conservation and environmental policy based on the experience of respondents with a major national environmental restoration program: the Grain for Green program. This national program was designed to support ecological restoration by converting degraded land into forest or grassland in exchange for ecological compensation payments, including both a food supplement (the "grain" in the program's title) during initial stages of the program, followed by monetary payments. Cao et al. (2009) provide more details on the project. Applying the Kuznets method to a specific national-scale ecological restoration project, thereby revealing the income at which the project's effectiveness will begin to increase, is another novel aspect of the present study.