Ecological Indicators 67 (2016) 474–483

Contents lists available at ScienceDirect

Ecological Indicators

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

Analysis of relationship between Beijing's environment and development based on Environmental Kuznets Curve

Zhihua Wang [a], Yuhan Bao [a], Zongguo Wen [a,*], Qilu Tan [b]

[a] State Key Joint Laboratory of Environment Simulation and Pollution Control (SKLESPC), School of Environment, Tsinghua University, Beijing 10084, China
[b] Energy Research Institute, National Development and Reform Commission, Beijing 100038, China

ARTICLE INFO

Article history:
Received 18 October 2015
Received in revised form 16 February 2016
Accepted 17 February 2016
Available online 25 April 2016

Keywords:
Environmental Kuznets Curve
Intensity EKC
Beijing

ABSTRACT

Urbanization nowadays is a very important driving force for China's social and economic development, but the resource shortage and pollution accompanied have troubled China especially in the urban areas. As the capital of China, Beijing is a mega-city and densely populated. Its development and prosperity is supported by a large amount of material consumption, rendering a severe shortage of natural resources and serious pollution. Underlying the premise of maintaining its development and prosperity, Beijing is facing an enormous challenge in dealing with heavy pollution load. Therefore, it is a very important step to decouple the relationship between economic development and environmental pollution. This paper makes a study on the relationship between the economic growth and pollution load for Beijing based on the analysis of Environmental Kuznets Curves (EKC) which builds an econometric model using data over the period 1990–2014. We found the intensity of most pollutants have arrived at the turning point around 2006 while the total amount of most emissions remain at a high level, this is a favorable initiation for the transforming the development patterns as it has begun to decouple the pollution intensity and economy. Based on the statistics, this paper further analyzes the driving factors behind the active change. We found that the adjustment of industrial structure, a reasonable city planning, powerful measures in pollutants control and technology advance, contribute a lot to the transformation. Especially in the recent years, Beijing and correlative regions took joint measures to prevent and reduce air pollution, which have an apparent functions. Finally, this paper proposes several suggestions for Beijing to decouple the economic growth and environmental pollution load, based on these important conclusions.

1. Introduction

A rapid development of urbanization process with almost 1% increase per year has become commonplace in China in recent times. It has become a primary driving force of China's economic and social development after meeting most peoples basic quality standard of life. The enormous demands requires the enlargement of the heavy industries for construction and transportation, however the expansion of these heavy industries has always accompanied excess consumption and serious pollutants emissions. Therefore the urbanization process is bound to accompany a substantial resource consumption and severe pollutant emissions, and these environmental problems of mega cities such as Beijing are more serious. Beijing is a typical example of these cities as it is still growing with more than 20 million people requiring considerable amounts for water, energy, life supplies and building materials. All of these consumption consumes too much energy and resources causing significant damage to the ecosystem and environment. Beijing is also troubled by "mega city disease" which means a crowd and city health crisis given its large scale and large amount of cars and populations.

Aiming to discuss the relationship between economic growth and pollution load, and the influencing factors which can result in the environment improvement, this paper takes Beijing as a case study over the period of 1990–2014. Obviously, Beijing is a unique city in China due to its large scale and its ongoing crisis from the air pollution. During the period selected, many measures have been undertaken including environment protection and the reform for its economic development. This period is a special period with a lot of special points such as proposition of scientific development concept in 2004, Olympic Games in 2008 and etc., which has made environmental issues more pressing, hastening the need to decouple environmental pressures from economic growth through integrated decisions. The municipal government has taken many

* Corresponding author. Tel.: +86 10 62792921.
E-mail address: wenzg@tsinghua.edu.cn (Z. Wen).

http://dx.doi.org/10.1016/j.ecolind.2016.02.045
1470-160X/

measures to deal with the problem which can be retrospectively assessed and judged in its effect. In this new period, Beijing is burdened with greater pressure as the government attaches more importance to the ecological civilization after the 18th Congress of China's Communist Party in 2012. On July 31st this year Beijing was awarded the host for 2022 Winter Olympic Games and it has made a promise that Beijing will provide cleaner air and quicker transportation system which provides a challenge to the municipal government. Beijing and its near provinces are implementing the Integration in Jing-Jin-Ji Area development plan into action which can shift the population and traffic pressure, providing for Beijing's transformation.

The decoupling of economy and ecology is not only important for Beijing, but also a key point for China current "new normal" economy and new-type urbanization. The new urbanization is a kind of healthy urbanization, this means a fundamental difference with traditional urbanization with environmental and society problem. It is thought to be the only way for the realization of modernization in China which require an environmental-friendly ways of urbanization and development. The decoupling of economy and ecology can satisfy the requirement precisely. So a deep discussion on this topic has practical significance.

Section 2 applies the EKC model based on the statistics from 1990 to 2014 in order to describe the process of decoupling and changing of Beijing's environment while Section 3 provides a more detailed analysis. In Section 4, economic structure change and policy factors are used to explain the change in the environment and the initial decouple success before we concluded this paper.

2. The approach to urban Environmental Kuznets Curves

2.1. The EKC hypothesis

In studying the long-term changes of 14 air and water pollutants in 66 countries and areas, Grossman and Krueger (1997) found that the levels of most pollutants followed an inverted U-shape relationship with the change of per capita GDP, and from which they proposed the Environmental Kuznets Curves (EKC) hypothesis. The EKC hypothesis illustrates that environmental pollution and degradation would become worse as economy grows during the early stage of development. As economy continues to grow, however, the trend of environmental degradation would slow down, and over a certain level of economic development, environmental quality would start to improve (Selden and Song, 1995).

Presently, EKC studies are mainly in three aspects. The first investigated whether the EKC hypothesis are widely applicable. It is found that four kinds of relationships are present between environmental quality and economic growth, i.e., inverted U-shape, in-phase, U-shape and N-shape. Most environmental indicators on this kind of studies are taken from production activities and few are drawn from consumption activities (Rothman, 1998). Some scholars (Jha and Bhanu, 2003) then exploit the complex induces of economic growth and environmental deterioration to study the global EKC. The second looked into the conditions under which the EKC hypothesis would hold true, with particular focus on the causes leading to environmental improvement (John and Pecchenino, 1994; Suri and Chapman, 1998; Magnani, 2000). Different cases may have different forces to drive the trends inverted, yet increased investment in pollution control and the implementation of rigors environmental policies as well as the change in income allocation are the major factors (Magnani, 2000; Shafik, 1994; Dinda, 2004). The third is to link EKC with different policy designs, including for instance the control of international trade (Suri and Chapman, 1998; Hettige et al., 1996) and international environmental aids to developing countries (John and Pecchenino, 1994; Johnes and Manuelli, 1995).

Due to the lack of historical data as well as unreliable data sets, most studies have so far used cross-sectional data of different countries in a given year to verify the EKC hypothesis, and then further to predict environmental changes in the concerned developing country (Yu, 2006). It has been questionable that conclusions from such an analysis could be close to those when time series data were employed. Consequently, there has been an increasing number of studies to apply long time series panel data in a selected country or area to examine the statistical relationship between pollutant concentration (or emission) and per capita income (or per capita GDP) (Fan, 2002; Marzio and Alessandro, 2005).

EKC is also widely applied in China at different geographic levels. For instance, a national EKC of the disposal of municipal and industrial wastes were developed in the eastern, central and western regions of China (Li and Bao, 2002), and it was found that their turning points were not yet available. Bao et al. (2005) verified the EKC hypothesis using panel data of six pollutant emissions from 30 provinces between 1996 and 2002. The findings of this empirical study verified the relationship between economic growth and most pollution indicators to be an inverted U-shaped EKC. At municipal level, the relationship between waste disposal and per capita GDP was also found uncertain, for instance, a clear inverted U-shape was observed in Shanghai city (Yang et al., 2003a,b), yet not in Qingdao city (Xing et al., 2005).

2.2. Beijing's EKC model

To reflect the environment change with the economic development, per capita GDP and per capita industrial output was selected as the economic variable to reflect urban economic growth in the EKC Curves (per capita GDP is corresponding to total pollutants emissions, per capita industrial output is corresponding to industrial pollution), while environmental quality was reflected by 16 variables, i.e., discharged amounts of waste gases, waste water and solid wastes from all the city, as well as the annual average concentrations of SO_2, NO_x, $PM_{2.5}$, PM10 and TSP as given in Table 1. Note that the emission loads of pollutants from industry reflect environmental pressures caused by the industrial production. Data from 1990 to 2014 were used herein (BEPB, 1991–2014; SEPA(a), 1991–2014; SEPA (b), 1991–2014; SEPA (c), 1991–2014; CSB, 1991–2014; BEPB, 1991–2014; see Table 1), during which per capita GDP varied between US $1000 and 16,000.

Industry pollution is an important contributor to the total pollution, in order to describe the change of its pollution, we relate the per capita industrial output to 6 industry pollutants variables as a variation of EKC as an EKC model of industry. The data used were from 1990 to 2014, we select 6 industry pollutants emissions to represent the industry main pollutants.

2.3. Beijing's intensity EKC(IEKC) model

To eliminate the impact of urban economic and population sizes, an *Intensity EKC(IEKC)* is also proposed in this study by replacing pollution emissions with their per unit of GDP. The IEKC reflects the impact of economic size, industrial structure, technology level and management ability on the environmental state at the different development stages of a city (Yang, 2006). Note that in order to discuss the promotion and advance of technology in industry which contribute a lot to the pollution, in this model industry pollutants emissions are replaced by per unit of industrial GDP and it is corresponding to the industrial GDP while the total pollutants emissions per unit of GDP are corresponding to total GDP.