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# A Literature Survey on Environmental Kuznets Curve

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## Abstract

The relationship between environmental protection and economic development has long been a controversial issue. This paper presents a literature survey on Environmental Kuznets Curve (EKC), which includes genesis, explanations and empirical evidence of EKC. The conclusion of this paper are, on the one hand, some factors are key reasons to EKC, including income elasticity of environmental quality demand, scale, technological and composition effects, international trade, FDI and history accidents, etc., on the other hand, from the empirical literature of EKC, the environmental quality indicators improved with public health. Moreover, Different data type will lead to different empirical result, so it is important to choose suitable indicators and data.

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*Key words:* Environmental Kuznets Curve; Literature Survey ;Economic Growth; Environmental Pollution

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## 1. Introduction

The relationship between environmental protection and economic development has long been a controversial issue. In the early 1970's, the perspective of "growth limit" was put forward by "Rome Club"[1], which argued that economic growth is not sustainable subjected to natural resources condition and we should lower the economic growth rate for environmental protection. Dasgupta and Heal [2] saw the complementary relation between economic growth and environment improvement in the late 1970's. So there exists two opinions about the relation between economic growth and environment improvement. In 1990's, the literature in the field turned to Environmental Kuznets Curve, or EKC. In this paper, we will survey the origin, the evolvement and the empirical research of EKC and then obtain some enlightenment, as a reference for further researches of economic and environment issues in China.

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## 2. The raise of EKC

Kuznets once raised a hypothesis about the relation between economic growth and income inequality in 1950's, which claimed that the income inequality tends to increase with income at low levels of income and then to decrease with income at higher levels of income, namely an inverted U-shaped relation between income inequality and GDP *per capita* in Kuznets Curve.

Grossman and Krueger [3] found the inverted U-shaped relation first time between income and environmental involvement when analyzing the environmental effect of NAFTA, and verified it as well. Shafik and Bandyopadhyay [4], Panayotou [5] and others also found this inverted U-shaped relation between income and environmental pollution. By the way of Kuznets Curve, Panayotou named the inverted U-shaped relation as environmental Kuznets curve (EKC). In "World Development Report 1992", the definition of EKC is given by "The view more economic activities mean more environmental pollution bases on the assumption that technology, preference and environmental investment are constant", "but people will pay more attention to environment issues and resolve it with increasing income, consequently, environmental pollution level will decrease". Briefly, environmental quality will get worse first and then improve with economic development.

## 3. The origin of EKC

The first reason is income elasticity of environment demand. People pay more attention to life quality with increasing income, wish to enjoy better environmental welfare, and be willing to consume healthy products. As a result, the government will make stricter rule of environmental protection, which improve environment level eventually. Many researches [6][7][8] on EKC emphasize the role of income elasticity of environment demand, as a key decreasing factor of environmental pollution level.

The second reason is the effect of economic scale, technology and structure. Grossman and Krueger [9][3] depart the affects economic growth exert to environment to three aspects. The first is scale effect. Growth in output means more consumption in resource and energy, and more pollution emission, which degrades environmental quality. The second effect lies in structural aspect, that is to say the structural changes influence on environment with economic development. The third one is technical effect. With income increasing and technique advance, the old and pollution-caused technique will be replaced by new and clean technique, and this will help improve environmental quality.

Therefore, EKC can be interpreted to a curve that, in the early stage the negative scale effect plays a leading role, then the positive structural and technical effect, and structural and technical effect will exceed scale effect. In this way, environmental pollution deteriorates early, but improves afterwards with the income increasing.

The third aspect comes from international trade, or international trade is an important generated factor of EKC. The influences of free trade to environment give dual aspects, one is environmental improvement via technical effect, the other one is aggravation of environmental pollution with the expansion of economic scale. Antweiler et al [10] built a model on the affects free trade to environment, which depart the affects international trade to environment to economic scale, technique and structure effect. Using the data of SO<sub>2</sub> collected by Global Environmental Supervising System, they had some empirical verification to this model, which demonstrated the structural effect of international trade to environment is relatively small, but the net effect of technique plus economic scale is negative, and the conclusion is free trade brings benefit to environment. But Chai's empirical analysis [11], a research on the effects free trade to environment using the data of Chinese manufacturing industry, showed that the economic scale effect of enormous export increasing in China exceeded economic scale effect and technique effect, which told us

free trade is no good for environmental improvement. In this way, free trade deteriorates environment in the short run, but benefit to environment in the long run.

The fourth cause is FDI, which has dual influences on environment. On the one hand, the developing countries will be asylum of pollution if they want to attract FDI by lowering environmental admittance, which aggravates environmental pollution, on the other hand, most of developing countries get technology by FDI from developed countries, which help improve environment[12][13].

Besides the reasons above mentioned, Unruh and Moomaw [14] examined the track of environment changes by nonlinear dynamic system approach, which concluded that EKC resulted by exogenous history accidents. But they completely agree the opinions in some researches before (especially raised by World Bank [4]), which attribute the environment change to policy choice and price of resources.

#### 4. Empirical examinations to EKC

From 1990's, the data of various pollutant can be obtained via GEMS and OECD, and scholars did some empirical examinations to EKC hypothesis. Differences in the choice of environment indicators in these researches can lead to different empirical results, so most of analysis chose waste gas, waste water, solid waste and traffic flow as indicator. Using the gas indicators harmful to people's health like SO<sub>2</sub>, SPM, CO, nitrogen oxide and etc., scholars testified the inverted U-shaped relation between income and these indicators[3][15][16][17][18][19]. In the indicators of waste water, some appeared inverted U-shaped relation between both, but others appeared N-shaped relation between income and other indicators [4]. Indicators of other aspects including solid waste, use of energy and traffic flow didn't support EKC hypothesis.

To every indicator about pollution, the income level in inflexion of EKC is different. Grossman and Krueger's estimate [3] is under 8000\$ *per-head* in inflexion to indicators of gas pollutant, Selden and Song's estimate [15] is under 10000\$ *per-head*, and Kahn's estimate [18] is about 35000\$ *per-head* in inflexion to the indicator hydrocarbon. So the estimated range of inflexion change is about 3000-10000\$ *per-head* (based on the price index 1985).

One point to be mentioned is that these empirical verifications to EKC model mostly use transversality data or panel data in national level, based on the coincidence of individuals in development level and environmental evolvement path. And if not, the result of estimate will be uncertain. Using panel data in state level, List [16] examined the compatibility of simplified model in empirical literature of EKC, which showed that it is not suitable to ignore the differences of development path existed in different districts. This reminds us that it is comparatively reliable to use the data of regions which have same environmental evolvement path when examining EKC model.

#### 5. Conclusion

Firstly, just as the empirical examinations proved, environmental quality indicators which directly relate to humanity's health usually improve with income increasing, but these indicators do not decrease even if at higher income level if environmental problems are externalized. So it is important to choose suitable indicators when considering the relation between economic development and environment change.

Secondly, at present most of domestic researches use simplified models about income and environment to study EKC, but deeper investigation to the evolution mechanism between income and environment needs building environmental theoretic model, and introduce comprehensive methods into our research.

Finally, since using panel data to empirically verify EKC model needs the similar evolution path among individuals, so it is more reliable to use the time-series data or panel data involving similar environmental evolution path.

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