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# Relationship between Industrial Water Consumption and Economic Growth in China Based on Environmental Kuznets Curve

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**Abstract**

China faces a critical situation because its water resources account for merely a quarter of the global average. Balancing the relationship between economic development and industrial water consumption is an important issue for China. In this study, a reduction model is established. The model adopts the per capita industrial water consumption and GDP of the eight economic zones from 2002–2014. Unit root and co-integration tests are employed to analyze the stationarity of data, and the triple reduction model is used for the fitting of variables. Results show that the eastern coastal and middle Yangtze River regions pass the turning point of their Environmental Kuznets Curve (EKC) during the period of statistics. By contrast, the northern coastal region is declining, which may be attributed to the short period of statistics. At the turning point of the EKC for per capita industrial water consumption in China, the per capita GDP ranges from 18,000–30,000 Yuan (at constant prices of 2000) and that of industrial water consumption is approximately 100–240 m3. The increasing industrial water consumption in China is consistent with the characteristics of the EKC; the relationship between per capita industrial water consumption and GDP exhibits an inverted U-shape. The varying economic development of each region cause different turning points for their per capita industrial water consumption that are attributable to factors such as technical innovation and industrial structure upgrading. This research on the EKC for industrial water consumption is crucial for studies on collaborative economic development and industrial water consumption. To reach the turning point of the EKC at the soonest possible time, industrial water consumption should be addressed by adjusting industrial structure, raising water use efficiency, and developing cutting-edge technology.

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*Keywords:* Environmental Kuznets Curve; industrial water consumption; economic growth; reduction model; panel data

## 1 Introduction

The insufficient and imbalanced water resources across the globe is an important problem facing the 21st century. The World Water Council[1] estimated that approximately 40% of the world population

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experiences water shortage, and the ratio is likely to reach 50% by 2025. As the most populous country, China accounts for 21% of the world population but possesses a measly 6% of global water resources, and its per capita water resources amount to merely 2048 $m^3$ or 29% of the global average. The situation is severe. In the water consumption structure of China, agriculture accounts for the largest share, but the proportion is declining. By contrast, that of industrial water consumption continues to grow. The National Bureau of Statistics[2] stated that the proportion of agricultural water consumption in China fell from 69% to 63% from 2000 to 2014, whereas that of industrial water consumption rose from 21% to 22%. The World Bank[3] estimated that before 2050, the agricultural water consumption rate will drop to roughly 50%, but the industrial water consumption rate will increase steadily. In this study, per capita industrial water consumption and GDP are used as indicators to investigate the EKC of northeastern, northern coastal, eastern coastal, southern coastal, middle Yellow River, middle Yangtze River, southwestern, and northwestern regions. Regional panel data from 2002–2014 are utilized for verifying and analyzing the EKC for industrial water consumption and economic development to provide a scientific reference for the concerted development of industrial water consumption and economic growth.

## 2 Model Selection and Methodology

### *2.1 Method and model*

The reduction model proposed by Katz et al.[4] is employed in this study. This model can reflect the relevance between independent and dependent variables rather than the direct influence of the former on the latter. The method adopted is consistent with that of initial EKC research. The logarithm to the per capita GDP of China and each of the eight economic zones from 2002–2014 is derived as the independent variable, and the per capita industrial water consumption is obtained as the dependent variable. Logarithms of the independent and dependent variables are used because they can mitigate data fluctuation, remove the heteroscedasticity of the time series, and reduce the extremum, abnormal distribution, and heteroscedasticity of variables. This method is identical to that in the EKC research of Stern[5]. Consistent with the research of Katz[4], per capita data are employed because they can reflect the living standard directly, whereas nationwide industrial water consumption data is affected by population.

The reduction model is adopted, including the first power, square, and cube of the independent variable. The cubic model is used because per capita industrial water consumption does not decline after a turning point, and the model can display two turning points. The failed reflection of the original data trend and the reduced accuracy in the quadratic model can be avoided. List et al.[6] also adopted the cubic model.

The adopted reduction model is defined as follows:

$$\log water_{it} = \beta_0 + a_i + \beta_1 \cdot \log GDP_{it} + \beta_2 \cdot (\log GDP_{it})^2 + \beta_3 \cdot (\log GDP_{it})^3 + e_{it} \quad (1)$$

where $log\ water_{it}$ represents the logarithm of per capita industrial water consumption in region *i* in year *t*; $log\ GDP_{it}$ is the logarithm of per capita GDP in region *i* in year *t*; $\beta_1, \beta_2, \beta_3$ represent the parameters to be identified in the model; $a_i$ is the correction factor of region *i*; and $e_{it}$ is the error term.

### *2.2 Samples and data*

The Development Research Center of the State Council[7] reported that the original division of China into eastern, central, and western regions cannot reasonably reflect regional characteristics because they cover a large area and population. The regional development strategy now focus on the concerted

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