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Energy Procedia 5 (2011) 1689–1696

Energy Procedia

IACEED2010

Income Distribution, Human Capital and Environmental Quality: Empirical Study in China

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Abstract

This paper has structured the simultaneous equations including the environmental quality determined equation and the income distribution determined equation, which are then applied Chinese provincial panel data to from 1996 to 2008. From the econometrical result, it is concluded that there is a significantly negative relationship between environmental quality and the imbalance of income distribution in China at the present; the improvement of human capital can reduce the detrimental effects from the differences in income distribution and better the environmental quality in China.

Selection and peer-review under responsibility of RIUDS

Key Words: Income Distribution, Human Capital, Environmental Quality, EKC (Environment Kuznets Curve);

1. Introduction

Since the reformation of 1978, the economy has been growing rapidly with the annual GDP growth rate reaching a peak level of 9.8% in China. However, this impressive economic performance has also placed traumatic levels of stress on environment and natural resources. What is more, China's environmental problems are currently exploding in size and complexity. An investigation of World Bank revealed that about eight to twelve percent of Chinese GDP is consumed with paying huge costs of environmental crisis and that thirty of the most polluted cities in the world were located in China. Not surprisingly, the GINI coefficient has reached 0.48 in China, which is far above the international red line (0.4).

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doi:10.1016/j.egypro.2011.03.288

The current studies suggest that income distribution is one of the key factors which can significantly affect environmental quality. Therefore, in order to understand and solve the emerging environmental problems in the fast-growing economy in China, it is important to study the relationship between income distribution and environment quality, specifically the individual characteristics in China. At the same time, this paper has also provided a representative case for developing countries regarding the study of the relationship between income distribution and environmental quality.

2. Literature Review

The study of the relationship between economic development and environmental problems was proposed during the negotiation of NATFA (North American Free Trade Area) and the early study was made by Grossman and Krueger (1991) [1]. Grossman and Krueger (1991) concluded that the pollution level would increase as GDP Per Capita rises in less developed regions, but decrease in the highly-developed regions. Later, Panayotou (1993) [2] proposed the Environmental Kunzites Curve (EKC) to illustrate how environmental quality would be deteriorated in accordance with an increase in GDP Per Capita, and improved when income level rises to a certain degree. At present, there is a consensus in academia that EKC exists in the current economy, but the relative inflexion point, which is the bottom of the curve of EKC, will not appear spontaneously. Therefore, it is valuable to discuss factors which can accelerate or slow the coming of the inflexion point of EKC, and income distribution is one of the most important factors which can affect the inflexion significantly.

Firstly, this paper reviews such literatures which consider that an imbalance in income distribution is detrimental to the improvement of environmental quality. Boyce (1994) [3] publishes the pioneering study in this scope and concludes that the rich would have always had more social power and prefer to consume more high-polluting goods but bear less responsibility for the corresponding pollution cost, since the imbalanced distribution of social power has always resulted from an unequal income distribution, therefore, the greater the income distribution differential, the worse the environmental quality. Martinez-Alier （1995） [4] has classified environmental goods into two categories: the environment-luxury which is low in demand income elasticity and the environment-necessary which is higher, He concludes that as the income distribution gap rise, the following would likely occur: 1) the demand of the environment-luxury goods would increase, 2) the supply would also increase because the poor tend to sell cheap, and 3) the imbalance of income distribution is detrimental to the improvement of environmental quality. From the perspective of the go-between theory in democratic voting, Magnani (2000) [5] proposes that, since the demand of the environment-goods is more flexible, therefore, as the income per capita rises, the structure of goods shall be changed to be environment-friendly, and environmental quality shall be improved. However, if the income distribution gap continues to increase, the relative income of the go-between shall be decreased and they would pay less to environment-friendly goods and the inflexion of EKC shall be delayed. Marsiliani and Thomas (2002) [6] adopt both the static and inter-temporal models to find that a larger income distribution gap reduces the ability of the go-between and the equilibrium of the political economy shall pay less attention to environmental protection. Torras and Boyce (1998) [7], Boyce et al. (1999) [8], Maganani (2000) [5], Gawande et al. (2001) [9], and Bimonte (2002) [10] adopt the GINI index coefficient to measure the gap in income distribution and confirm that a greater gap in income distribution would deteriorate environmental quality. Bimonte (2002) [10] also finds that the balance of income distribution would accelerate the coming of the inflexion of EKC.

Next, we consider the literature which maintains that the effect of a bigger gap in income distribution upon environmental quality is uncertain. Scruggs (1998) [11] questions the assertions of Boyce (1994) [3] firstly, he considers that income distribution has nothing to do with environmental policy upon real democratic politics, but he also considers that based on the social paradigm proposed by Hofrichter and

Reif (1990) the relation between income distribution and environment quality should be reversed when the income per capita reaches a certain level. Therefore, he concludes that there is an uncertain relationship between income distribution and environment quality which would be affected by factors such as different preferences regarding environmental quality, relative policy and so on. From the discussion on the relation between pollutant emissions and income distribution, Ravallion et al. (2000) [12] believes that there is a reciprocal relationship between income distribution and environmental quality and the relation would be weaken over the long-term. Heerink et al. (2001) [13] makes an empirical study about the relation between individual income level and environmental quality and his conclusions contradict the arguments of Boyce (1994), and the study suggests that the imbalance of income distribution would be inclined to improve the regional environmental quality. Scruggs (1998) [11] applies the data of GEMS (Global environmental monitoring system) and seventeen OECD countries' data to the econometrical model and found that there would be an uncertain relation between GINI coefficient and environmental quality. Mattieu and Andre (2008) [14] reach the similar conclusions by the panel data of developing countries from 1988 to 2003. However, Heerink et al. (2001) [13] concludes that the imbalance in income distribution may help improve environmental quality.

In summary, the consensus regarding the relationship between income distribution and environmental quality has not been reached among academia, and many factors such as income distribution and human capital can significantly affect the relationship. Brasington and Hite (2005) [15] and Jalan (2007) [16] consider that the public would pay increasing attention to environmental protection in conjunction with the rise of human capital; on the other hand, Costantini and Monni (2008) [17], Serkan Gurluk (2009) [18] reach the conclusions that environmental quality would be improved by the technology advancement brought about by the increasing of human capital. According to the above literature review, there are few studies on the relation between income distribution and environmental quality from the perspective of human capital. Therefore, this paper structures the model containing income distribution, environmental quality and human capital, and discusses whether human capital can affect the relation between environmental quality and income distribution significantly, and then applies Chinese panel data to the model in order to provide the empirical evidence for the real cause of the current pollution and the appropriate solution in China.

3. Model, Data and Method

3.1. Structure

It is known that there are many factors which can affect environmental quality significantly, such as: human capital, technology advancement, industry structure, urbanization and so on. Therefore, based on the classical econometrical model proposed by Grossman and Krueger (1995) [19], this paper incorporates income distribution, human capital, technology advancement, industry structure and urbanization into the model to describe how income distribution exactly affects environmental quality. The environmental quality determined equation is as follows:

$$EQ_{it} = C_i + \alpha_1 I_{it} + \alpha_2 I_{it}^{\ 2} + \alpha_3 I_{it}^{\ 3} + \beta ID_{it} + \theta_1 HC_{it} + \theta_2 RD_{it} + \theta_3 Str_{it} + \theta_4 UB_{it} + \varepsilon_{it} \quad (1)$$

The existing studies suggest that there is a nonlinear relation between income distribution and economic growth, and education expense is one of the important factors which can affect income distribution remarkably. Therefore, this paper structures the model to describe the income distribution determined equation as follows:

$$ID_{it} = B_i + \gamma_1 I_{it} + \gamma_2 I^2{}_{it} + \lambda_1 HC_{it} + \lambda_2 Edu_{it} + \xi_{it} \quad (2)$$

In the equation *(1)* and *(2),* i stand for the i province, t for the year, EQ for the environmental quality, ID describes income distribution, HC is the human capital, RD is the technology advancement, Str is the industry structure, UB is the rate of urbanization and Edu is variable of education expense, C and B are special sectional effects respectively.

According to equation *(1)* and *(2)*, this paper has structured the simultaneous equations which can precisely reflect the relation between income distribution and environmental quality, and then incorporate the variable of human capital to find a potential way to improve EKC.

3.2. Data

Serial data is always applied to the existing literature on the relationship between income distribution and environmental quality in China. However, there exist not only serial features but also sectional features in the form of EKC; therefore the sole serial or sectional data cannot provide an accurate result. Accordingly, this paper adopts panel data which contains Chinese provincial data from 1996 to 2008 to make an empirical study. Due to the change of administrative districts, this paper removes the data of Chongqing in 1996, and the final data includes 31 sections and 13 series and 402 samples. All the data are from < Chinese Statistical Yearbook >, < Chinese Statistical Yearbook on Environment >, < China Population and Employment Statistics Yearbook >, < China Yearbook of Rural Household Survey > and the website of National Bureau of Statistics of People's Republic of China.

As for income distribution, it is popular to adopt GINI coefficients to measure the gap of income distribution. Based on the non-equal calculation method proposed by Thomaset al (2003) [20], this paper adopts the formulation as equation (4) to calculate both urban and rural GINI coefficients.

$$G = \frac{1}{\mu} \sum_{i=2}^{N} \sum_{j=1}^{i-1} P_i \left| y_i - y_j \right| p_j \quad (3)$$

$$G = \sum_{i=1}^{N} W_i y_i + 2 \sum_{i=1}^{N-1} W_i (1 - V_i) - 1 \quad (4)$$

In equation *(3)* and *(4)*, G is for the GINI coefficient, μ stands for the expected value of the total income, N for the total population of the group divided, y_i for the average income and p_i for the proportion of the population of the i group in the whole, W_i for the proportion of the whole population grouped in the whole and V_i is the accumulation of y_i from 1 to i.

As for the GINI coefficient of the total number of residents, we cannot get the very value from the existing investigation. Therefore, this paper adopts the method proposed by Sundrum (1999) [21] to calculate GINI coefficient for the total number of residents as equation *(5)*

$$G = p_1 \frac{\mu_1}{\mu} G_1 + p_2 \frac{\mu_2}{\mu} G_2 + p_1 p_2 \left| \frac{\mu_2 - \mu_1}{\mu} \right| \quad (5)$$

In equation *(5)*, G_1 and G_2 are for urban and rural GINI coefficients respectively, P_1 and P_2 are for the proportion of urban population and rural population in the whole, μ and μ_1 and μ_2 are for the value of the income per capita of the whole, urban and rural residents. Population proportion and income per capita use the year-end statistics in order to keep the consistence of statistic time.

As for environmental quality, there are many pollutants which are measured differently. Therefore, it is difficult to find a comprehensive index to describe environmental quality. According to the existing research, this paper adopts industry wastewater and industry waste gas to reflect regional environmental quality, and structures the index of environmental quality (EQ) by the natural logarithm of the value of industry wastewater and industry waste gas.

As for human capital, this paper adopts the index of education-year per capita proposed by Barro and Lee (2000) [22], and calculates the index by the method of adding all the relative education-year by the weights which are that primary education is charged for six years, junior education for nine year, high school for twelve years and university education for sixteen years.

Since the absolute indexes of the output and input are always restricted by regional development, this paper takes the natural logarithm of the values of the relative indexes such as GDP per capita. As for the index of technology advancement, this paper takes the value of the proportion of the R & D fees in GDP to make the measurement, and the index of industry structure (Str) is measured by the proportion of the second industry's output-value in GDP, and the index of the rate of urbanization by the value of the proportion of agricultural population in the whole, and the index of education input by the proportion of education expense in the overall financial expenditures.

3.3. Method

Since there are endogeneity among variables in the model specifications and heteroscedasticity among different provincial estimating equations, this paper adopts the three-stage least square method to estimate the simultaneous equations which can accommodate the relation among equations into the estimation and generate the most accurate result. It is discovered that only the variables of EQ and ID are endogenous, and in accordance with order and rank conditions of the model reorganization, we can conclude that the model is over-identified and the coefficients are estimable.

4. Econometrical Result

4.1. The Discussion on the Result of Environmental quality Determined Equation

Firstly, this paper analyses the relationship between environmental quality and income per capita. The empirical study suggests that the cubic term of the income per capita cannot pass the significance test which denies that there is the "N" curve of the relationship between environmental quality and income per capita, according to Chinese provincial data. After removing the variable of the cubic term of income per capita, we find that the coefficients are 6.7967(2.76) for I and -0.3706(-2.81) for I^2 in the regression equation (Ⅰ), and 3.2475(1.61) for I and -0.2007(-1.86) for I^2 in regression equation (Ⅱ), which all pass the significance test at the 10% level. We observe that the variable of income per capita displays inverted "U" relationships with the emissions of industrial wastewater and industrial waste gas which remarkably confirms the theory of Environment Kuznets Curve. As for the income distribution, the coefficients estimated are -17.2927(-5.77) in regression equation (Ⅰ) and -9.7857(-3.98) in regression equation (Ⅱ) which all pass the significance test at the 1% level, which reveals that the larger gap of income distribution has restricted the emissions of pollutants, which provides the evidence for the relative academia subject.

Regarding the effects of human capital on environmental quality, the econometric result suggests that the coefficients are -0.1142(-1.06) and -0.4451(-5.06), which confirm that human capital is negative correlative with environmental quality. Therefore, it is concluded that increasing human capital can reduce the emissions of pollutants and improve environmental quality.

Table 1. The Econometrical Result of the Simultaneous Equations

Environmental quality Determined Equation	Industrial Wastewater Emission (EQ_{wit})	Industrial Waste Gas Emission (EQ_{ait})
	Regression Equation Ⅰ	Regression Equation Ⅱ
I_{it}	6.7967***（2.76）	3.2475*（1.61）
I_{it}^2	-0.3706***（-2.81）	-0.2007*（-1.86）
ID_{it}	-17.2927***（-5.77）	-9.7857***（-3.98）
HC_{it}	-0.1142（-1.06）	-0.4451***（-5.06）
RD_{it}	-2.3399*（-1.75）	-2.5298*（-1.74）
Str_{it}	5.5698***（7.84）	8.7550***（14.58）
Ub_{it}	0.4331*（1.91）	0.4721***（2.46）
Constant	-15.1228（-1.38）	1.2731（0.14）
Chi^2	200.14	559.09
R^2	0.43	0.47
Income Distribution Determined Equation	ID_{it}	ID_{it}
I_{it}	0.2272**（2.04）	0.2273**（2.04）
I_{it}^2	-0.0125**（-2.08）	-0.0125**（-2.08）
HC_{it}	-0.0234***（-5.97）	-0.0234***（-5.97）
Edu_{it}	-0.7711***（-7.10）	-0.7711***（-7.10）
Constant	-0.3488（-0.68）	-0.3488（-0.68）
Chi^2	125.28	125.28
R^2	0.29	0.29
Obs	402	402

The model is significant at 1% level; the value in the bracket is the value of the Z test; ***, **, * denote significance at 1%, 5% and 10% levels.

As for other variables, the econometric results are consistent with the expectation and all coefficients have passed the significance test at the 10% level. The coefficients of RD are -2.3399(-1.75) in regression equation (Ⅰ) and -2.5298(-1.74) in regression equation (Ⅱ) which confirm the assertion of Grossman and Krueger (1995) [19] that technology advancement can improve environmental quality. The coefficients of the variable of Str are 5.5698(7.84) in regression equation (Ⅰ) and 8.7550(14.58) in regression equation

(Ⅱ) which all pass the significance test at the 1% level, confirming that industrialization can worsen the environment, as proposed by Heerink et al (2001) [13]. At last, the coefficients of urbanization are 0.4331(1.91) in regression equation (Ⅰ) and 0.4721(2.46) in regression equation (Ⅱ), which reveals that the urbanization is also one of the important factors which can worsen environmental quality in China.

4.2. The Discussion on Income Distribution Determined Equation

In the econometric model, the coefficients are 0.2772(2.04) for "I" and -0.0123(-2.08) for "I^2" in regression equation (Ⅰ), and 0.2773(2.04) and -0.0123(-2.08) in regression equation (Ⅱ) which all passes the significance test at 5% level. Therefore, this empirical study confirms the primary claim that there is the inverted "U" relation between income distribution and economic growth.

As for the variable of human capital and education input, the coefficients are -0.0234(-5.79) for HC and -0.7711(-7.10) in equation (Ⅰ) and (Ⅱ) which all pass the significance test at the 1% level, and since the coincidence of the econometric result exists in both regression equations, there are robust effects on income distribution derived from the human capital and education inputs. Therefore, the results reveal that increasing the human capital and education inputs can improve environment remarkably.

5. Conclusions

This paper structures the econometric model including income distribution determined equation and environmental quality determined equation, and applies provincial data from 1996 to 2008 to do the relative empirical study in China. At last, it is concluded that: 1) there is a negative relationship between income distribution and environmental quality, 2) the increase of human capital can improve environmental quality and reduce the gap of income distribution, and 3) the change of industrial structure and the enhancement of scientific research and the urbanization are also the important factors which can remarkably affect environmental quality.

From the econometric result, we also find that the provinces where there is the greater gap of income distribution are always in western China, which typically has a lower level of economic development. In order to reduce the gap of income distribution and accelerate economic growth, a policy of local industrialization is always being promoted in China, which has the effect to worsening the regional environment. However, unlike the view point proposed by Scruggs (1998) [11] which considers that the rich pay more attention to environmental quality; this paper considers it to be an inappropriate development paradigm which has worsen the regional environmental quality.

The empirical study also reveals that the accumulation of human capital and increasing of education input are the most important factors which can reduce the gap of income distribution and improve environmental quality. Based on the endogenous economic growth theory, it is agreed that the accumulation of human capital is among the most powerful resources for economic growth. Therefore, this paper suggests the proposal that more investment in human capital is the key to solving the dilemma between the fast growing economy and worsening environmental quality as well as the ever widening gap of income distribution.

Acknowledgements

This paper is supported by the Fundamental Research Funds for the Central Universities (Grant No. CDJSK10 02 10).

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