The Relationship between Environmental Regulation, Economic Growth and Technological Innovation: Based on Panel Data in Beijing

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**Abstract.** Environmental problem has become an important constraint factors restricting the sustainable development of national economy, how to make environmental regulation and economic development level to reach a state of balance, has become a major problem faced in our country. This article Constructs Simultaneous Equations Model of Economic Growth and Environmental Regulation based on the building of economic growth and environmental regulation model, combined with Panel data of 16 districts and counties in Beijing from 2009 to 2014, makes the empirical analysis of the relationship between economic growth and environmental regulation. The results show that the present stage, the Beijing environmental regulation played a significant role in economic development. Economic growth inhibits the development of environmental regulation. The effect of technological innovation on economic growth is not significant, on environmental regulation directly effect is negative and the indirect effect is positive.

**Introduction**

How to solve the contradiction between environmental problems and regional economic growth, how to make the environmental regulation and economic level to a balanced state, has become a major problem facing China. Based on the model of economic growth and environmental regulation, this paper constructs a simultaneous equation model of economic growth and environmental regulation. Combining the panel data of 16 districts and counties in Beijing from 2009 to 2014, this paper analyzes the relationship between economic growth and environmental regulation relationship. The results show that Beijing's environmental regulation has promoted the economic development; the economic growth has restrained the development of environmental regulation; the effect of technological innovation on economic growth is not significant, the direct effect on environmental regulation is negative, and the indirect effect is positive. The results of the above-mentioned research indicate that the regional economic development should be combined with environmental regulation. While encouraging technological innovation, the government should promote the transformation of scientific and technological achievements. At the same time, the government should strive to break through the double threshold effect and eliminate bottlenecks. Economic development: the Government should increase the intensity of environmental regulation at the same time to give full consideration to the actual situation of enterprises, as much as possible to reduce production costs and pollution control costs, thereby enhancing the power of technological innovation. Enterprises have long-term strategic development vision, can not rigidly adhere to the current stage of economic decline, must take the initiative to innovate, increase R & D investment, so as to maintain long-term economic stability and growth.

**Ask Questions**

Environmental regulation is because the environment has external diseconomy, need the government formulates the corresponding policies and measures for adjustment, it is one of the important means to promote good coordination between environment and economy, its essence is to protect and improve the ecological environment. Nearly 30 years of reform and opening-up, our country economy has made remarkable achievements, GDP is growing at 9.8% on average. China
has become the world's second-largest economy steadily, and the comprehensive national strength has been significantly improved. People's living standards greatly improved, but at the expense of the ascension of China's GDP at the expense of resources from the annual 18% depend on resources and overdraw the ecological environment, and a variety of signs that China is the western developed country's "first pollution, then control". Recently, Yale University issued the Environmental Performance Index in 2016 Report pointed out that China's overall air quality in the second-to-last place only on the teacher elder sister. In order to link the environment pressure, adjust industrial structure, improve people's living conditions, in 1995, our country put forward in the ninth five-year plan, to China's economic growth mode change from extensive to intensive, this think-tank, points out that in the past decade, China's environmental pollution cost is close to 10% of gross domestic product (GDP) every year, today, however, the economic transformation is still not too big effect.

Literature Review

Environmental Regulation and the Relationship of Technology Innovation Research. At present, the research mainly focused on the relationship. First, "Porter hypothesis", Porter (1995,1996) thinks that reasonable environmental regulation tools can stimulate the enterprise innovation, enterprise research and development and production to reduce costs, improve enterprise productivity, and ultimately promote regional economic development level, Hamamoto (2006) study of Japanese manufacturing, that environmental regulation can stimulate enterprise's innovation activities, thus promoting effect on the economic growth. Lanjouw (1996) after the comparison of data from the United States, Germany and Japan found that environmental regulation positively related with the relationship between the technology innovation; Second it is "disadvantages", representatives Barbera and McConnell (1990) argue that environmental regulation will increase the constraints on enterprise production, the sale, to enterprise's costs, reduce the enterprise's profit level. Third, the "compromise". Part of people think that environmental regulation effect on economic growth is not obvious, the result uncertain, environmental regulation on technical progress or for positive, or negative or not significant, Zhang Cheng (2011), etc. to support this view. Each story will encounter with the rest of the two arguments against, also have the relevant data to support, at present there is no final conclusion.

Model Establishment and Variable Selection

Build a Model

According to general form of Cobb-Douglas production function and Solow neoclassical growth theory, a general formula for the economic growth:

\[ Y_{i,t} = A_{i,t} K^\alpha_{i,t} L^\beta_{i,t} \]  

(1)

\( Y \) is the regional economic level, \( i \) for the area, \( t \) for the year, said \( A \) technological innovation output, \( K \) represents capital input, \( L \) represents human input.

According to Jorgenson, such as environmental regulation to a certain extent affect the level of regional economy, so with ER said environmental regulation, bhagwati think that FDI has a higher efficiency, as part of the total domestic capital has an important effect on economic growth, and domestic scholars ZhangMingzhe in system combing to Europe in the 1990 s after the conclusion of economic growth, combined with the formula (1), are:

\[ Y_{i,t} = c \cdot ER_{i,t} K_{i,t} FDI_{i,t} L_{i,t} A_{i,t} \]  

(2)

Formula (2) on both sides of the exponential, get:

\[ \ln Y_{i,t} = \alpha_{0,t} + \lambda_1 \ln ER_{i,t} + \lambda_2 \ln K_{i,t} + \lambda_3 \ln FDI_{i,t} + \lambda_4 \ln L_{i,t} + \lambda_5 \ln A_{i,t} + \varepsilon_{i,t} \]  

(3)

Environmental regulation in addition to the affected by the economic growth, technological progress, technological innovation and to a certain extent, improve the environment, at the same
time to test technology progress through technology progress of the indirect effect of environmental regulation. Based on the above ideas, set the following equation:

\[
\ln ER = \beta_0 + \eta_1 \ln GDP + \eta_2 \ln R & D + \eta_3 \ln A + \eta_4 \ln GDP + \eta_5 FDI + v
\]

(4)

According to the equation (3), (4), we can see that environmental regulation and economic growth mutually dependent and causal relationship, so the simultaneous equation model is adopted to solve such problems.

**Variable Selection**

About environmental regulation measures, domestic and foreign scholars do a lot of research, at present there are several kinds of main measure: BaoQun (2006) proposed by the environmental regulation policies; Cole (2003), the per capita income as the intensity of environmental regulation indicators; Huang Jing (2011) to treat pollution investment of output value proportion; Xiang-li kong people choose such as per capita industrial pollution investment. Considering the availability of data, this paper USES the environmental investment to protect the forehead to measure environmental regulation level, environment protection investment amount is larger, the greater the intensity of environmental regulation.

This article selects the regional GDP to measure the quantity of regional economic output; FDI in each region to represent the actual foreign investment amount; Measured by the number of on-the-job number of human capital investment, with a degree of patent grant on behalf of the technical innovation, measured by regional science and technology R&D specific variable description as shown in Table 1.

<table>
<thead>
<tr>
<th>variable</th>
<th>explain</th>
<th>shorthand</th>
<th>unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>The gross regional product</td>
<td>Economic growth</td>
<td>GDP</td>
<td>Ten thousand yuan</td>
</tr>
<tr>
<td>Environmental protection investment measure</td>
<td>Environmental regulation intensity</td>
<td>ER</td>
<td>Ten thousand yuan</td>
</tr>
<tr>
<td>Patent grant</td>
<td>Technology innovation measure</td>
<td>A</td>
<td>a</td>
</tr>
<tr>
<td>Fixed investment in the whole society</td>
<td>Capital factors</td>
<td>K</td>
<td>One hundred million yuan</td>
</tr>
<tr>
<td>Number of on-the-job worker</td>
<td>Labor factors</td>
<td>L</td>
<td>people</td>
</tr>
<tr>
<td>The total amount of actual foreign investment</td>
<td>Actual foreign investment</td>
<td>FDI</td>
<td>Ten thousand yuan</td>
</tr>
<tr>
<td>Science and technology research and development investment</td>
<td>Technology innovation investment</td>
<td>R &amp; D</td>
<td>Ten thousand yuan</td>
</tr>
</tbody>
</table>

**Econometric Analysis**

**Statistical Description**

<table>
<thead>
<tr>
<th>variable</th>
<th>Max</th>
<th>Min</th>
<th>Mean</th>
<th>Std</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>43373000</td>
<td>615000</td>
<td>9066613.67</td>
<td>11288510.22</td>
</tr>
<tr>
<td>ER</td>
<td>156181</td>
<td>2918</td>
<td>36170.79</td>
<td>31498.40</td>
</tr>
<tr>
<td>R &amp; D</td>
<td>755411.2</td>
<td>4272.7</td>
<td>113850.67</td>
<td>169991.05</td>
</tr>
<tr>
<td>FDI</td>
<td>390011</td>
<td>100</td>
<td>46533.14</td>
<td>76524.32</td>
</tr>
<tr>
<td>L</td>
<td>1644145</td>
<td>56400</td>
<td>434101.32</td>
<td>428705.06</td>
</tr>
<tr>
<td>A</td>
<td>41352</td>
<td>32</td>
<td>3602.04</td>
<td>6512.01</td>
</tr>
<tr>
<td>K</td>
<td>12354413</td>
<td>48.2</td>
<td>368.74</td>
<td>292.58</td>
</tr>
</tbody>
</table>

The statistical description of each variable is shown in Table 2. The total amount of environmental investment varies greatly, with a maximum of 15.6 billion and a minimum of 0.29 billion. The gap
between the technological innovation level is also large, with a maximum of 40,000 patent grants and a minimum of only 32, economic growth is also a big difference, but whether the economic growth caused by environmental regulation and technological innovation, whether the environmental regulation with economic growth and technological innovation changes and how to change, and still need further study.

**The Identification of Simultaneous Equations**

\[
\begin{align*}
\text{When } K - k > m - 1, \text{ equation is excessive identification;} \\
\text{When } K - k = m - 1, \text{ equation is cut good recognition;} \\
\text{When } K - k < m - 1, \text{ the equation is not to be identified.}
\end{align*}
\]

Among them, the \( M \) as the endogenous variable in the model number, \( m \) as the number of endogenous variables in the equation, \( K \) as front variable sum Numbers, the number of \( k \) for front variable in the equation

In this paper, the relationship between economic growth and environmental regulation in simultaneous equation model, the rules can be identified by the above equation (1) and equation (2) are excessive recognition, accord with the premise of parameter estimation.

**Estimated Simultaneous Equation**

The system estimation method takes into account the relationship information between the equations. Based on the three-stage least-squares method, firstly, the 2SLS estimation of each equation is carried out. According to the former method, the system estimation method is adopted. The estimation of the covariance matrix of the perturbation term of the whole system is obtained by the two-step estimation, so the generalized least squares (GLS) estimation of the whole simultaneous equation is carried out. This method is a combination of 2SLS and SUR, which takes into account the simultaneous bias problem in the equation and the correlation of the cross-equation. The first step is to estimate the simplified equation by OLS method, find the endogenous variable. In the second stage, the estimated value of the endogenous variable is substituted into the structural equation, and the 2SLS estimator of the parameter is obtained by OLS. In the third stage, the estimator of the structural parameter is obtained by the generalized least squares method.

Simultaneous regression model regression results show that environmental regulation has a significant impact on economic growth, which proves that Beijing's districts and counties are in line with the theory of "compensation for innovation". The input of material capital and human capital has passed the 1%. This proves that human capital and physical capital play a very important role in the development of Beijing's regional economic growth, and this investment is continuous, consistent with the above-mentioned literature; the direct investment of foreign capital on economic growth In the process of FDI, foreign direct investment (FDI) may bring in technology, knowledge, organization and product innovation, accelerate the acquisition of China's technological backwardness, and thus affect economic growth through technological progress; technological progress has an impact on economic growth But the impact of technological progress on economic growth also has a "double-threshold effect", the effect that, only when the economic development of the economy to the economic growth of the economic growth. A certain level, technological progress will have a positive impact on economic growth, and technological progress at this time on the role of economic growth can be demonstrated, it may be due to the low transformation rate of scientific and technological achievements lead to patent licensing can’t be very good conversion and applied society.

**Conclusion**

In today's high-speed economic development, solve the problem of environmental pollution is imminent, how can you keep in good economic growth while protecting the natural environment more and more get the attention of the government, scholars and experts. In this paper, on the basis of theoretical analysis, and through the 16 districts and counties of Beijing in 2007-2014 panel data to empirically, economic growth and environmental regulation simultaneous equation analysis
indicates that overall, economic growth and environmental regulation simultaneous relationship exists between the two variables, have significant impact on each other, the difference is that economic growth regulation plays an inhibitory effect to the environment, and played a significant role in environmental regulation on economic growth, from the economic growth and the relationship of the intensity of environmental regulation, economic growth does not increase the environmental protection in Beijing, although the original depends on the consumption of resources to promote the development of the economic growth pattern has been shifting, but at present, enterprises in the process of reducing pollution and improving technology, would increase the cost of production and research and development, is not conducive to the short-term development of the enterprise and economic progress.

This study also found that with the progress of science and technology can directly lead to the environmental protection investment in reducing the intensity of environmental regulation in the weak, but the progress of science and technology for environmental regulation indirect effects can promote the increase of the environmental protection investment, due to the double threshold effect, scientific and technological progress to the role in economic development is a process of first after Yang suppression, only when at a certain stage of economic development, scientific and technological progress to promote role on economic growth and economic growth on environmental regulation intensity at the same time had the opposite effect.

In the process of analysis, this paper there are some deficiencies: environmental regulation intensity measure is not perfect, only to a certain extent, on behalf of environmental regulation; Not considering the hysteresis of environmental regulation; Selected data structure of a single, not effective to the distinction between industry in Beijing, such as transformation of governance after the industry and the transformation of governance before the scale of industrial structure is not consistent, the next step will discuss these issues for further research.

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References