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Research on the Impact of Environmental Regulation on Economic Growth in China

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Abstract

Environmental regulation can effectively improve the quality of economic growth by promoting technological innovation of enterprises. Based on this background, this paper selects the data of China's inter provincial panel from 2002 to 2018, and uses System GMM to explore the impact of environmental regulation on high-quality economy. The results show that the relationship between environmental regulation and TFP is inverted U-shaped, and the intensity of environmental regulation is on the left side of the inflection point. Increasing environmental regulation properly will help to improve the quality of economic growth in China. In addition, human capital and industrial structure are also the key to achieve high-quality economic growth in China. Finally, according to the conclusion, we put forward the policy suggestions to promote the technological innovation and industrial structure upgrading of enterprises through environmental regulation so as to realize the economic quality growth.

Keywords

Environmental regulation, High quality economic growth, System GMM.

1. Introduction

Since the reform and opening up, China's economic growth has made remarkable achievements. From 1979 to 2018, the annual average growth rate of China's GDP was 9.4%, far higher than the annual average growth rate of the world economy of about 2.9% in the same period. Behind the continuous high growth of China's economy, there are huge hidden dangers of environmental pollution and loss of human welfare. In the report of the 19th National Congress of the Communist Party of China, it is put forward that China's economy has changed from a stage of rapid growth to a stage of high-quality development, and the quality of ecological environment is repeatedly mentioned; the 13th Five-Year Plan also takes overall improvement of ecological environment quality as the core goal of building a moderately prosperous society in an all-round way, and requires that the current development pattern of high pollution, high energy consumption and high cost be reversed, and the five development concepts be adhered to as the basis. We should take a practical and high-quality development road. Therefore, how to realize the high-quality development of China's economy by environmental regulation is the main task facing China. In 2015, China put forward detailed requirements for environmental regulations for the first time, and made clear restrictions on emissions of carbon dioxide, sulfur dioxide, nitrogen oxides, etc. At the same time of strengthening environmental regulation, the cost of environmental governance is rising, and so is the environmental loss.

As for the research on environmental regulation and economic development, foreign scholars mainly study from the following cost theory, innovation compensation theory and the existence of environmental Kuznets curve, which have launched heated debates one after another. Domestic scholars tend to think that environmental regulation can prevent environmental deterioration and promote economic development. The impact of environmental regulation on economic growth is mainly focused on the speed of economic growth, rather than the quality The connotation of high-quality economic development includes both speed and quality. If they can go hand in hand, economic growth can enter a high-quality development situation, otherwise, economic growth will fall into a "recession circle" of apparent prosperity. Whether from the perspective of cost theory or from the perspective of the innovation compensation theory, the relationship between environmental regulation and economic growth cannot be concluded.

2. Model Setting, Index Selection and Data Description

2.1. Model Setting

Referring to the form of improved Cobb Douglas production function, it is set that environmental regulation is the influencing factor of high-quality economic development. The expression is as follows:

$$TFP = EV^{\alpha} \times Contr^{\omega} \tag{1}$$

In formula (1), TFP stands for total factor productivity, EV stands for environmental regulation, and Contr stands for other factors. The relationship between the three factors shows that TFP is influenced by environmental regulation and other factors. Other factors mainly include the degree of opening to the outside world, industrial structure, the degree of marketization, the quality of human capital and the level of urbanization. Considering the endogeneity of the model, the lag period of TFP is taken as the explanatory variable, and the multiple power term of environmental regulation is taken as the explanatory variable to verify the Environmental Kuznets inverted U curve. Therefore, in this paper, the logarithmic equation is adopted for (1), and the specific expression is as follows:

$$\begin{aligned} \ln TFP_{it} = \beta_0 + \beta_1 \ln TFP_{it} + \beta_2 \ln EV_{it} + \beta_3 \ln EV_{it}^2 + \beta_4 \ln Open_{it} + \beta_5 \ln Market_{it} \\ + \beta_6 \ln H_{it} + \beta_7 \ln Urban_{it} + \beta_8 \ln Indus_{it} + \varepsilon_{it} \end{aligned} \tag{2}$$

2.2. Index Selection

2.2.1. Interpreted Variables

The explained variable is TFP. For the measurement of economic growth quality indicators, there are still disputes in the existing literature research. According to Wu Jinglian (2015) and Liu Shijin (2017), the core of economic growth quality is efficiency, and the most effective indicator to measure efficiency is economic total factor productivity [1] [2]. At the same time, the world bank, OECD and other relevant international authorities also give a strong interpretation of TFP as an agent variable of economic growth quality. Therefore, this paper also uses economic total factor productivity as the proxy variable of economic growth quality, and the specific calculation process refers to Lin Chun (2017) [3].

2.2.2. Explanatory Variables

The explanatory variable is environmental regulation. Experts and scholars have their own opinions on the measurement of environmental regulation indicators. It mainly includes the subsequent aspects. Wang Wenpu (2011) measures environmental regulation by logarithm and absolute number of some indicators, such as environmental pollution investment, emission fee, SO2, industrial COD emission, etc. [4]; Zhong Maochu et al. (2015), Huang Qinghuang and Gao Ming (2016) use comprehensive index method to build environmental

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regulation indicators [5] [6]; Liao Han and Xie Jing (2017) used the proportion of pollution control investment in GDP as an indicator of environmental regulation. [7]. In view of the difference of regional development and the comparative advantage of regional entropy index method to measure environmental regulation, and referring to Li Shanshan's (2015) calculation method of environmental regulation [8], we will use the method of regional entropy to build environmental regulation indicators, the calculation method is as follows:

$$EV_{it} = \frac{ER_{it}/DGP_{it}}{ER_t/DGP_t} \quad (3)$$

Among them, EVit is the location entropy index of the period t of the province i, which is the ratio of the proportion of environmental treatment cost in the period t of the province i to the proportion of environmental pollution investment and pollution discharge cost in the period T of the whole country. If EV > 1, the level of environmental regulation in the province is high; if EV < 1, the level of environmental regulation in the province is low.

2.2.3. Control Variables

Degree of opening to the outside world (open): Sun Jin et al. (2014) believed that opening to the outside world not only promoted but also inhibited economic growth [9]. Obviously, opening up plays an important role in economic development, so the impact of the degree of opening up on the quality of China's economic growth can not be avoided. This paper uses the ratio of foreign direct investment (converted at the exchange rate of the current year) to GDP to measure. This paper uses the ratio of foreign direct investment (converted at the exchange rate of the year) to GDP to measure the degree of opening up.

Marketization degree (Market): the goal of economic development is to realize the full, reasonable and effective allocation of resources, which requires the market to be demand-oriented and competitive. Under the background of marketization, the government deregulates the economy, which to some extent affects the quality of China's economic growth. In this paper, the market-oriented index calculated by Fan Gang is used to express the development degree of each regional market.

Human capital quality (H): human capital is the basis of high-quality economic growth cycle. The quality of human capital directly affects the quality of economic growth. The "homogenization" of human capital can promote economic growth. This paper uses the number of R & D personnel in the whole year as an indicator to measure the quality of human capital.

Urbanization level (Urban): Peng Yuwen et al. (2017) believed that there was a causal relationship between the urbanization level and the quality of economic growth, and the functional relationship between different regions was also different [10]. Therefore, urbanization can be regarded as one of the factors that affect the quality of economic growth. This paper uses the ratio of urban population to total population to measure the level of urbanization.

Industrial structure (Indus): the change of regional industrial structure has absolute and relative contributions to the quality of economic growth. Optimizing industrial structure is conducive to the improvement of the quality of regional economic growth. It can be seen that the industrial structure is an important factor that affects the quality of economic growth. This paper uses the ratio of the added value of the tertiary industry and the added value of the secondary industry to measure the industrial structure.

2.3. Data Description

Considering the availability of data, in this paper, 30 provinces, autonomous regions and municipalities directly under the central government in mainland China, excluding Tibet, are selected, with the time range of 2002-2018. The data come from China Statistical Yearbook,

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China Science and Technology Statistical Yearbook, China Environment Statistical Yearbook and Statistical Yearbook of Each Province. The total factor productivity referred in this paper includes labor and capital input, of which the labor input is measured with the number of employed persons, while capital input is calculated according to the perpetual inventory method. Investment is calculated by dividing the fixed capital formation amount by the fixed base investment price index. The investment price index is the fixed asset investment price index of each province, and the initial capital stock is the fixed asset in the base period of production investment divided by depreciation rate and growth rate of fixed asset investment near the base period. The output referred in this paper is the GDP of each province measured by constant price, and the consumer price index of each province is selected as the conversion index, and the data are adjusted based on the year 2000. The descriptive statistics of each variable are shown in Table 1.

Table 1:descriptive statistics of each variable

Variable	Observation value	Average value	Standard deviation	Minimum value	Maximum value
TFP	510	-0.04	0.36	-1.42	1.47
EV	510	-1.2	0.74	-4.8	2.1
Open	510	-0.09	-0.64	-3.05	1.95
Market	510	1.41	0.53	-0.14	2.3
H	510	2.12	0.11	1.8	2.49
Urban	510	-0.75	0.29	-1.6	-0.1
Indus	510	0.11	0.33	-0.69	1.39

3. Empirical Analysis

3.1. Analysis of TFP Decomposition Results

There are two kinds of methods to measure TFP, including nonparametric method and parametric method, among which DEA method and Malmquist index method are the main methods. The nonparametric method can not test the applicability of the front and does not consider the influence of random factors on the measurement results, while the parametric method can overcome the above shortcomings. Therefore, in this paper, parameter method is used to estimate TFP. Parameter method can be sorted into Solow residual method, implicit variable method and stochastic frontier production function method (SFA). SFA sets the form of production function as the transcendental logarithmic production function, which is more flexible than the C-D function. At the same time, it relaxes the assumption of constant returns to scale and technology neutrality, allows the situation of underutilization of labor and capital, and describes the gap between the actual production state and the frontier with technical efficiency. Therefore, TFP can be decomposed into technical efficiency Rate and technological progress. In this paper, SFA method is used to analyze TFP in China. On the basis of Battese and Coelli model, the TFP growth rate is further sorted into technological progress, change rate of technological efficiency, scale efficiency and allocation efficiency by using the method proposed by Kumbhakar.

According to the estimation results of SFA model, technological progress, change rate of technological efficiency, scale efficiency and allocation efficiency of each province in China are calculated, and the sum of these four items is taken as the calculation results of TFP growth rate of each province. On this basis, the calculation results of each province are summed up and averaged, so as to obtain the changes and decomposition of TFP growth rate in China in 2002-2018. The contribution rate of TFP to GDP growth rate is 22.25%, and the contribution rate of factor input to GDP growth rate is more than 72.5%, which shows that China's economic growth still depends on the growth of factor input, rather than largely driven by TFP, and that the quality of economic growth brought by factor drive is not high. Calculation and Decomposition Results of TFP in 2002-2018 are not shown in table 2.

Table 2: Calculation and Decomposition Results of TFP in 2002-2018

Particular year	GDP growth rate	Technical progress	Change rate of technical efficiency	Scale efficiency	Allocative efficiency	TFP growth rate	TFP contribution rate	Factor contribution rate
2002	7.3	0.75	-0.39	0.77	0.83	1.96	26.84	73.16
2003	8	0.64	-0.25	0.79	0.79	1.97	24.62	75.38
2004	9.1	0.58	-0.17	0.84	0.83	2.08	22.85	77.15
2005	9.5	0.50	-0.05	0.89	0.75	2.09	22	78
2006	9.9	0.48	-0.01	0.90	0.83	2.2	22.22	77.78
2007	10.7	0.47	0.02	0.90	0.82	2.21	20.65	79.35
2008	11.4	0.44	0.03	0.91	0.75	2.13	18.68	81.32
2009	9	0.37	0.05	0.88	0.70	2.00	22.22	77.78
2010	8.7	0.36	-0.05	0.97	0.75	2.03	23.33	76.67
2011	10.3	0.35	0.20	0.95	0.79	2.29	22.23	77.77
2012	9.2	0.27	0.19	0.94	0.64	2.04	22.17	77.83
2013	7.8	0.19	0.04	0.89	0.65	1.77	22.69	77.31
2014	7.7	0.05	0.02	0.86	0.56	1.49	19.35	80.65
2015	7.4	0.047	0.02	0.89	0.67	1.63	20.23	77.22
2016	6.9	0.5	-0.13	0.93	0.65	1.95	21.56	73.76
2017	6.7	0.41	0.07	0.93	0.70	2.11	22.38	77.87
2018	6.9	0.057	0.1	0.87	0.81	1.84	21.97	72.5

3.2. Regression Analysis of Environmental Regulation and TFP

In model 1, the impact of environmental regulation (investment perspective) on TFP is significantly positive at the level of 10%, with a coefficient of 0.3432; the secondary term is significantly negative at the level of 5%, with a coefficient of - 0.15. It shows that when the intensity of environmental regulation is weak, the enhancement of environmental regulation is conducive to the improvement of the quality of economic growth; when environmental regulation exceeds the inflection point, environmental factors will restrict the improvement of the quality of economic growth. At the same time, it shows that environmental regulation promotes the quality of economic growth. By adding control variables one by one, the quality of industrial structure and human capital can promote the quality of economic growth, and the quality of industrial structure and human capital is more significant; while both marketization and urbanization can inhibit it, the degree of marketization is more significant. Estimated Results of Environmental Regulation and Factor Productivity are not shown in table 3.

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From table 3, it is very necessary to strengthen environmental regulation to promote the high-quality transformation of China's current economic growth. At the same time, it also verifies the fact that the "Porter Hypothesis" effect has been established in China. Environmental regulation effectively stimulates the technological change of enterprises, plays the core driving role of enterprises, and realizes the effective upgrading of business model, so as to promote the high-quality development of regional economic growth.

Table 3: Estimated Results of Environmental Regulation and Factor Productivity

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
lnTEP(-1)	0.6438 (5.22)***	0.6214 (5.01)***	0.6378 (5.45)***	0.675 (6.01)***	0.6556 (5.79)***	0.6756 (6.00)***
lnEV	0.3432 (1.91)*	0.3317(1.95)*	0.346(2.08)*	0.3812 (2.34)*	0.3712 (2.3)*	0.3791 (2.22)*
(lnEV)2	-0.15 (-2.09)**	-0.147 (2.00)**	-0.151 (-2.09)**	-0.161 (-2.67)**	-0.161 (-2.21)**	-0.161 (-2.21)**
lnOpen		0.0078(0.02)	0.081(0.031)	0.0081(0.34)	0.0081(0.34)	0.0083(0.35)
lnMarket			-0.1224(-1.87)*	-0.1245(-1.89)*	-0.131 (-1.98)*	-0.134 (-2.01)*
lnH				1.1395(2.52)*	1.143 (2.65)*	1.154 (2.76)*
lnUrban					-0.0676(-0.41)	-0.0686(-0.43)
lnIndus						0.3531 (2.77)***
C	-2.0475 (-2.02)**	7.631(2.98)**	-8.0973 (-8.02)**	-0.828 (-1.27)*	2.98 (1.02)**	7.76 (2.32)**
AR(1)	0.000	0.003	0.003	0.001	0.0036	0.0021
AR(2)	0.336	0.67	0.78	0.66	0.71	0.32
Hansentest	0.999	0.995	0.998	0.998	0.992	0.998

4. Suggestions on Promoting High Quality Economic Growth through Environmental Regulation

The above research results show that the contribution of TFP growth rate to GDP growth rate is still low, that TFP growth is more dependent on the growth of scale efficiency and allocation efficiency, that the role of technological progress in promoting economic growth is limited, and that the mode of economic growth is the extensive growth mainly based on factor investment at the cost of environment. Under the new normal of economy, China must upgrade its industrial structure by promoting technological innovation of enterprises through environmental regulation, which will play an important role in helping the13th Five-Year Plan to steadily achieve the goal of medium and high-speed economic growth.

First, the state should change the previous performance evaluation standard of "GDP only heroes" for local governments, realize the green evaluation mechanism of linking environmental protection and performance, avoid the opportunity of "competition times" for local governments in environmental regulation, make environmental incentive policies truly integrate into the innovation and development of local enterprises, and stimulate new momentum of local economic development, so as to realize the win-win of environmental protection and economic development.

Second, the transformation of mode and structure is the power source of economic development. The transformation of production is to develop from an extensive mode to an intensive mode. The transformation of structure is reflected in the continuous upgrading of industrial structure. Both of them follow the development of Kuznets type, that is, the transfer of resources from low productivity sectors to high productivity sectors, so as to achieve economic growth.

Third, it is necessary to actively implement the innovation driven development strategy and strengthen the accumulation of human capital. The adjustment of production mode and industrial structure can not be separated from the promotion of innovation. However, the ability of independent innovation in China is relatively poor, and the promotion of economic growth has not been fully exerted. Therefore, it is necessary to strength the technological research on the frontier fields, build an innovation system combining production, learning and research, strengthen the protection of intellectual property rights, improve the incentive policies for independent innovation, and increase the science and technology. In order to improve the environment of independent innovation, we need to change the standard of evaluating achievements of cadres from GDP growth to technology progress.

Fourth, it is necessary to comprehensively deepen reform and release market power. At present, monopoly still exists in some industries in our country. Monopoly will not only restrict the free flow of resources among departments, but also cause price distortion and resource mismatch. And it also increases the cost of social production and reduces the efficiency of social production. In recent years, the role of allocation efficiency in promoting economy gradually becomes insignificant, which also shows that resource allocation is under a certain process degree of obstruction. Therefore, it is necessary to comprehensively deepen the reform of monopoly industry, break the barriers of entry and exit of enterprises, give full play to the regulatory role of the market, improve the investment and financing environment of enterprises, so as to realize the optimal allocation of resources among departments.

5. Conclusion

This paper studies the impact of China's environmental regulation on high-quality economy by using system GMM, and draws the following conclusions: first, the relationship between environmental regulation and TFP is inverted U-shaped, and the current intensity of environmental regulation is on the left side of the inflection point. Properly enhancing environmental regulation will help to improve the quality of China's economic growth. Second, human capital and industrial structure are also the key to achieve high-quality economic growth in China. Third, policy suggestions should be put forward to promote the technological innovation and industrial structure upgrading of enterprises through environmental regulation so as to realize the economic quality growth.

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