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IMPACT OF ENVIRONMENTAL REGULATION AND FDI ON GREEN TOTAL FACTOR PRODUCTIVITY: EVIDENCE FROM CHINA

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Abstract

The energy constraints and environmental issues become more important in this green development era, in order to measure the quality of economic growth, this paper first introduces the definition of green total factor productivity, and then tries to find the relationship among environmental regulation, FDI and green total factor productivity. This paper also applies Luenberger productivity index and SBM directional distance function to measure provincial green total factor productivity of China from 2006 to 2017. The final results show that the environmental regulation influences green total factor productivity positively, and FDI has a negative relationship with green total factor productivity. Strict environmental regulation can improve the environmental threshold of FDI and play a role of "screening" for FDI. And the positive interaction between environmental regulation and FDI is an important factor affecting the promotion of green total factor productivity.

Key words: environmental regulation, FDI, green total factor productivity, interaction effect

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1. Introduction

Since 1979, China's industrial GDP, characterized by high investment and high emissions, has grown at almost 10% annually. The rapid growth of industry has made a great contribution to maintaining steady and rapid economic development. However, this extensive industrial growth mode leads to a large number of resource consumption and serious environmental pollution, and the pollutant discharge and resource consumption are close to the limit of environmental tolerance. In the study of Chen (2009), since 1979, industry only account for 40.1% of GDP, but it has consumed energy nearly 87%, and emitted carbon dioxide nearly 96%. In 2007, China became the largest carbon dioxide emitter in the world, and faced huge pressure of international carbon emission reduction. In recent years, the aggregation of air pollution further indicates the resources and environment will seriously restrict the further development the economy in China. The only way to realize the sustainable development is to transform China's industrial development mode and realize green development. GTFP, the green total factor productivity, is an important indicator to reduce emissions. So, the improvement of GTFP will play a very important role in the new industrialization by promoting environmental regulation.

As a large manufacturing country, it is particularly important to explore ways to enhance GTFP for Chinese manufacturing industry under this serious energy emissions and environmental pollution. FDI can affect total factor productivity to some extent. Some scholars believe that FDI can increase total factor productivity by technology innovation and production capacity improvement (Zhao and Yu,

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2012). However, some other scholars argue that FDI will weaken total factor productivity; the environmental spill over effect will make some countries absorb FDI by reducing environmental standards, which to some extent inhibits the total factor productivity growth (Liao and Xia, 2015). According to Porter hypothesis, environmental regulation will reduce the cost for complying with environmental constraints through innovation compensation effect (Porter, 1991), this can make GTFP increasing. Strict and reasonable environmental regulation is conducive to pollution reduction, and it can encourage firms to realize clean technology innovation, which provides support for the establishment of "Porter Hypothesis" in China (Yuan and Xie, 2015).

2. Reviews of literature

The environmental regulation affects production technology. The government should formulate reasonable environmental regulation policies, so that enterprises can not only achieve the improvement of pollution control technology, but also realize the progress of production technology. The relationship between total factor productivity and environmental protection under environmental regulation also can be found by using the panel data from 28 provinces in China (Ye and Peng, 2011). After considering environmental regulation, the average level of environmental technology efficiency in different regions of the country is improved, but the regional difference is large. (Yuan and Xie, 2015).

Domestic and foreign researchers have different views with the influences of FDI on GTFP. Some scholars believe that FDI has positive impact on total factor productivity. FDI, as the combination of capital and technology, not only brings advanced production technology and management experience to the host country, but also generates positive technology spill-over effect for host country enterprises by demonstration, imitation, training and competition effects, and then improves total factor productivity (Kinoshita, 2001). FDI, based on the data 2006-2011 of China, enhances the total factor productivity (Wu and Huang, 2016). Some scholar also believes that FDI has a restraining effect on TFP (Cheng, 2015). But, to some degree, other scholar proposes FDI does not affect TFP. By verifying the influence factors of TFP in service industry in China, it is showed that the influence of FDI is not obvious (Wang et al., 2016).

Since total factor productivity is determined by some factors, technological progress and efficiency are the most important ones. According to the promotion of workplace ratio of technique and innovation of science and technology, an idea was set up that FDI might release some indexes of both of them to explore the formation mechanism of FDI to total factor productivity, e.g. Xu et al. (2018), Zhang and Cui, (2019). FDI affects the technical efficiency and progress of TFP decomposition factor by influencing innovation input, and then influences total factor productivity.

Firstly, environmental regulation affects FDI inflows (Yuan and Xie, 2015). Environmental regulation could optimize FDI inflows and promote to introduce the FDI quality. The strict environmental regulation can resist the influx of heavily polluted FDI, thereby improving the introduction of energy-saving and environmentally friendly FDI, which is beneficial for environmental quality and people's welfare. Therefore, environmental regulation has a role in screening and improving on FDI.

Secondly, technical efficiency is the proportion between input and output under fixed production technology. If technical efficiency declines, the actual output is within the boundary of production possibility. FDI could influence technical efficiency through industrial agglomeration: in order to maximize profits, some enterprises would choose to gather in a certain area, and FDI could enable enterprises that are geographically clustered to achieve large-scale production. Thereby forming the advantage of increasing returns to scale, the technical efficiency of the region would be significantly higher than other regions (Zhang et al., 2013). The innovative investment brought by FDI would also make the labor force pay more attention to the specialized division of labor and cooperation, thus enhancing the competitiveness of enterprises. Enterprises with certain competitiveness use innovation investment to upgrade their production technology and management capabilities gradually, and produce more output at a fixed input level. In this way, they improve technical efficiency, and thus affect the total factor productivity of the industry (Xiao et al., 2013). And FDI could also influence technical efficiency by factor flow. The introduction of FDI brings talents, management, technology and other production elements into the host country, realizing the full flow of elements and increasing the input of advanced factors which brings innovation in talents and management. For the advanced technology and management training methods used by these enterprises to promote their own improvement at these levels, the host country optimizes its management methods and promotes technology to improve their technical efficiency (Liu et al., 2014).

Third, with the rapid development of science and technology, technological progress is particularly important for industrial development. FDI could have an important effect on the technological progress through technology transfer and technology spill overs (Xie et al., 2018), ultimately affecting the total factor productivity. FDI could influence technological progress through technology transfer. For traditional industries, especially traditional industries in developing countries, their industrial technology has a certain scale, but just meets the basic domestic consumption demand. And in practice, most of the traditional industries have obvious extensive production characteristics such as backward production equipment, low level of technology and insufficient production technology (Li and Peng, 2013). The introduction of the FDI could inject new vitality into the development of traditional industries through various means including technical assistance, licensing, technology sales or cooperative research and development. FDI could also increase the innovation investment of traditional enterprises and promote research in the field of traditional enterprise innovation. It is obvious that FDI optimizes resource allocation and improves the enterprises' technology, and thus improves the industry total factor productivity (Shao, 2017).

In terms of research methods and variable selection, some scholar selects the basic data o in China and used MAXDEA software to compute GTFP. A positive correlation exists between GFTP and environmental regulation (Gong and Li, 2019). Five control variables are selected, they are technology level, scale structure, scale structure, energy structure and industrial structure. Some scholar uses SBM directional distance function and index of Luenberger productivity calculating industrial GTFP and its source decomposition of 30 provinces in China, taking into account energy consumption and unintended output, and further empirically test on influencing of environmental regulation, FDI and their interaction on GTFP (Yuan and Xie, 2015). This paper selects four control variables, namely human capital, R & D investment, endowment characteristics and industrial structure. Firstly, we calculate GFTP in China; secondly, we compute the the impacts of FDI on GTFP. And also we demonstrate a series of proceedings that moderating elements produce some positive or negative actions and reactions from the perspective of environment on this impact. This study selects six control variables: industrial structure, energy structure, degree of nationalization, human capital, infrastructure construction level and trade openness.

3. Material and methods

3.1. Calculation of the green TFP

Total factor productivity (TFP) is different from the common factor productivity. Generally speaking, it refers to the comprehensive productivity of all factors input in specific period. The outcome of production is divided by total amount of factors on behalf of productivity. Based on it the green TFP adds energy consumption as input-output and environmental pollution as unexpected output. In general, the green TFP can be considered in terms of both technological efficiency and technological progress (Luo and Kan, 2012). Among them, technological efficiency of productivity can make an increase with the progress of management methods and the expansion of production scale. And technological progress of productivity can increase with the new technologies and the improvement of production processes. There are some ccommon methods of calculating green TFP, such as Solow's residual method, stochastic frontier analysis (SFA) and data envelopment analysis (DEA) method. The last one is a non-parametric method, it is unnecessary to consider the functional form, and further it can decompose TFP into the efficiency (GEC) and progress of technology (GTP). Green TFP value can be calculated by the Malmquist-Luenberger TFP Index with radial angular direction distance function and the slack variable SBM model. Based on the calculation method of the slack variable SBM model, the nonzero relaxation problem of the radial angle is overcome, which is more suitable for the production reality, and this calculation method reflects the essence of green development (Fu et al., 2018), and is fit for green TFP calculation. But this approach ignores the dynamic changes in technical efficiency and technological advancement. Thus, the following method is used to calculate green TFP. Initially, the static green TFP is recorded using the slack variable SBM model. Next, the Malmquist-Luenberger growth rate indicator of GTFP between period of t+1 and t is measured.

The Malmquist-Luenberger (ML) productivity index between t+1 and t, which is the total factor productivity (TFP) index, is measured in this paper based on the SBM direction distance function. The formula is shown in (Eq. 1):

$$MLT_t^{t+1} = \left\{ \frac{1+\overrightarrow{D_t}(x_{t+1}, y_{t+1}, d_{t+1}, g_{t+1})}{1+\overrightarrow{D_t}(x_t, y_t, d_t, g_t)} \times \frac{1+\overrightarrow{D_{t+1}}(x_{t+1}, y_{t+1}, d_{t+1}, g_{t+1})}{1+\overrightarrow{D_{t+1}}(x_t, y_t, d_t, g_t)} \right\}^{\frac{1}{2}} \quad (1)$$

In general, total factor productivity can be measured in terms of efficiency and progress of technology. Therefore, this paper further decomposes the ML productivity index into two parts of technology changes, one is efficiency change (MEC) and the other is progress change (MTP) as Eqs. (2-4):

$$ML_t^{t+1} = MEC_t^{t+1} \times MTP_t^{t+1} \quad (2)$$

$$MEC_t^{t+1} = \frac{1+\overrightarrow{D_{t+1}}(x_{t+1}, y_{t+1}, d_{t+1}, g_{t+1})}{1+\overrightarrow{D_t}(x_{t1}, y_{t+1}, d_{t+1}, g_{t+1})} \quad (3)$$

$$MTP_t^{t+1} = \left\{ \frac{1+\overrightarrow{D_t}(x_{t+1}, y_{t+1}, d_{t+1}, g_{t+1})}{1+\overrightarrow{D_{t+1}}(x_{t+1}, y_{t+1}, d_{t+1}, g_{t+1})} \times \frac{1+\overrightarrow{D_t}(x_t, y_t, d_t, g_t)}{1+\overrightarrow{D_{t+1}}(x_t, y_t, d_t, g_t)} \right\}^{\frac{1}{2}} \quad (4)$$

where: *D* represents the production unit, x represents the production input indicator, *y* represents the expectation stated indicator, *d* represents the unexpected output indicator, and *g* represents the direction vector. Using the MaxDEA software to calculate the ML-TFP index between the period of t and the period of t+1, that gets the value of green TFP. The variable of GEC refers to the green technology efficiency change index.

If GEC>1, it indicates that green technology efficiency has been better than before; otherwise, it indicates that green technology efficiency has deteriorated. The variable of GTP refers to the green technology progress change index. If GTP>1, it indicates that green technology has progressed. If GTP<1, it indicates that green technology has regressed.

3.2. Measuring green TFP in China's manufacturing industry and evaluations

The green TFP output includes both expected and unexpected outputs. Generally, the expected output refers to industrial added value. In order to decrease the price influence, here we take the year of 2000 as the base year and uses the GDP Deflator Index. Considering that sulphur dioxide is the main pollutant affecting green development, so the unexpected output is measured by the sulphur dioxide emission of manufacturing industry, it is calculated by industrial sulphur dioxide emissions. The factors of capital, labor and energy are input in green TFP. And the factor of capital can be estimated by capital stock evaluated by perpetual stock method. the factor of labor input can be evaluated annual average persons engaged in manufacturing industry. Energy input is calculated by the energy consumption in standard coal, including petroleum, coal, natural gas and so on. The description of the study variables are as follows (Table 1).

Manufacturing industry is an important industry that enhances China's technological level and increases China's economic income. According to China's National Economic Industry Classification Standard (GB/T 4754-2017), the manufacturing industry is divided into 31 categories. The production functions of the natural resources industry and the service industry are difficult to describe with a simple function. Therefore, the resources industries such as mining, petroleum and the water electricity and gas supply industry should be excluded in calculation.

We collect sample data from various yearbooks about industry, energy, eenvironment and provincial economy. The sample excludes Xinjiang, Tibet, Hong Kong SAR, Taiwan and Macao SAR, where Sichuan and Chongqing are unified in Sichuan, totally 28 provinces and cities. And we use MaxDEA software used to measure green TFP, GEC and GTP with China provincial data from 2006 to 2017.

4. Research design

On the Basis of the analysis of the impact mechanism and analysis model of Zhang and Cui (2019), here the model (Eq. 5) is introduced to verify the interaction among green TFP, environmental regulation and FDI in the manufacturing industry.

$$Y_{i,t} = \alpha + \beta_1 \times ER_{i,t} + \beta_2 \times FDI_{i,t} + \beta_3 \times ER_{i,t} \times FDI_{i,t} + \gamma \times X_{i,t} + + \mu_i + \varphi_t + \varepsilon_{i,t} \tag{5}$$

where: *Y* is the variable of green TFP (GTFP); *ER* is the environmental regulation variable; *FDI* refers to the variable of foreign direct investment; the product of ER and FDI is the interaction effect; X refers to a series of control variable. And the footnote of *i* represents the provinces, t refers to the year; μ is the regional fixed effect; φ is time fixed effect, and ε is the disturbance term, subject to the usual assumptions, α, β, γ are the coefficient to be estimated.

Y is an industrial GTFP, meanwhile GEC and GTP are used to measure the different path between FDI's effects and environmental regulation on green TFP. Because GTP, GEC, and green TFP increase on a chain growth, here we use the practice of Qiu et al. (2008), After setting the GTFP of 2006 to 1, the GTFP of 2007 is that multiplied by the GTFP of 2007, and then the other GTFP values of various provinces in China from 2008 to 2017 are calculated like that. Meanwhile GEC and GTP are adjusted by the same method. The explanatory variables in this model are ER and FDI. And a series of control variables are set to make the model more accuracy. The specific measurement methods are as follows:

Environmental Regulation (ER). This variable can be calculated by the value of industrial pollution control investment divided by regional GDP.

Foreign Direct Investment (FDI). It is estimated by the value of regional foreign investment volume divided by GDP after converting the annual average US dollar exchange rate into RMB.

Provincial Gross Domestic Product (PGDP). The per capita real GDP of the region is the most important indicator for measuring regional economic situation. In order to avoid the influence of the CPI factor, the PGDP growth rate is used for research.

Table 1. Description of study variables on green TFP in manufacturing industry

Variables	*Meaning*	*Measurement*	*Source*
expected outputs	Actual output added	The annual GDP deflator deflates the real added value of industry	China Industrial Statistics Yearbook
unexpected outputs	Sulfur dioxide emissions	Annual industrial sulphur dioxide emissions (unit is 10,000 tons)	China Environmental Statistics Yearbook
Capital input	Capital stock	Annual capital stock of manufacturing industry by the perpetual inventory method, and the depreciation rate is 9.6%	China Industrial Statistics Yearbook
Labor input	Annual average persons engaged	Annual average persons in manufacturing industry	China Industrial Statistics Yearbook
Energy input	Energy consumption	Annual Energy consumption	China Energy Statistics Yearbook

Human Resource (HR) is measured by average education years.

Research and Development (RD) refers to the different regional RD level and can be calculated by the value of internal expenditure in R&D divided by regional output.

Infrastructure Construction (IC) is measured by the value of road divided by regional area.

Financial Development (FD) variable can explain by banking development, in generally, it is calculated by the ratio of the sum of banking deposits and loans to regional GDP.

Trade Openness (TO) variable can be estimated by the value of the sum of import and export in the region divided by the regional GDP.

We continue use the sample of 28 provinces and cities in China in 2006-2017 (excluding Xinjiang, Tibet, Hong Kong SAR, Taiwan and Macao SAR, where Sichuan and Chongqing are unified for Sichuan). we research the sample data from various yearbooks of industry, foreign trade and economics published in the past and the provincial statistical yearbooks. The basic statistical characteristics are listed in Table 2.

Table 2. Descriptive statistics

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
GTFP	336	1.161	0.606	0.144	9.305
GEC	336	1.376	1.820	0.095	21.257
GTP	336	1.578	1.829	0.095	12.508
ER	336	15.548	13.607	0.674	99.185
FDI	336	14.468	17.503	0.039	108.741
PGDP	336	4.539	0.261	3.760	5.111
HR	336	8.849	0.999	6.594	12.502
RD	336	1.505	1.081	0.197	6.014
IC	336	0.864	0.454	0.066	2.101
FD	336	1.659	0.770	0.102	5.587
TO	336	0.315	0.385	0.017	1.721

The descriptive statistics in Table 2 shows that the green TFP is more affected by GTP than GEC in manufacturing industry.

5. Legal and empirical analysis

5.1. Legal analysis

The evolution of environmental regulation in China can be divided into three stages: creation, development and improvement. The first stage is the establishment stage (1971-1987). Due to the continuous growth of economy, the problem of environmental pollution in China is becoming increasingly serious. In this stage, China has established relevant laws and policies of environmental protection, and set up a special environmental protection agency to manage the environment. The second stage is the development stage (1988-1998). In 1988, the institutional reform of the State Council abolished the Ministry of urban and rural construction and environmental protection and established the Ministry of construction. So far, the State Environmental Protection Bureau was officially separated from the Ministry of urban and rural construction and environmental protection and became a ministerial unit directly under the State Council. The third stage is the improvement stage (1999 to present). In this stage, some laws and regulations are provided, such as conserving energy regulation in 2007, circular economy promotion law in 2008 and air pollution prevention law revised in 2018, in order to make the economy more sustainable by controlling air pollution and protecting living environment. The environmental regulation affecting FDI and GTFP is mainly reflected as follows: the strict ER restrains FDI inflow with high pollution density, and attracts clean investment with technical standards, which is conducive to attracting environmentally friendly investment with advanced technology and forming the effect of "good capital entering and bad capital outflow". Therefore, strict environmental regulation will inhibit negative effects on the environment, and thus affect green TFP positively.

5.2. Empirical verification

The correlation between both FDI and ER, and GFTP is measured by regression analysis of the panel data. Three regression models are constructed here, and their respective dependent variables are GTFP, GEC and GTP, which are used to measure the value of GFTP. Here the independent variables are FDI, ER and interaction item between them (ER×FDI). Table 3 report the regression results. From Table 3 we find 99% confidence interval passes the test, and the model 1 is overall effective. A positive relationship here exists between GTFP and ER. The variation coefficient is positive, so the environmental regulation with FDI can enhance the productivity of the green total factor.

Table 3. Estimation results

	(1)	*(2)*	*(3)*
Variables	GTFP	GEC	GTP
ER	0.042^{***} (14.977)	0.052^{***} (8.049)	0.057^{***} (8.618)
FDI	-0.038^{***} (-10.074)	-0.042^{***} (-4.868)	-0.057^{***} (-6.424)
ER*FDI	0.175^{***} (5.681)	0.204^{***} (2.852)	0.276^{***} (3.772)
Observations	336	336	336
R-squared	0.892	0.128	0.165
Number of Id	28	28	28

Model 2 and Model 3 get almost the same results: it passes the test of the 1% significance. ER shows positive effect on both GEC and GTP, while FDI has negative effect on them. Furthermore, the interaction effect of them is tested by the hypothesis of 1% significance level, and the interaction term's coefficient is significantly positive, showing that the enhancing of environmental regulation will improve FDI inflow, and then increasing the green technology efficiency change index. Strengthening environmental regulation will increase green TFP. For every 1% increase in environmental regulation, GTFP, GEC, and GTP will increase by 0.042%, 0.052%, and 0.057%, respectively.

The coefficient of FDI variable is negative remarkably. For every 1% increase in FDI, GTFP, GEC, and GTP will decrease by 0.038, 0.042%, and 0.057%, respectively. This is attributed to the fact that China's imported manufacturing FDI is mostly invested in polluting manufacturing industries. As a result, with the gradual increase of FDI, the investment of polluting enterprises in China is also gradually increasing, and the emission of pollution is bound to increase, which is not conducive to the promotion of green TFP. The control variables are added based on the three regression models constructed. According to Model 5, using fixed-effect regression, Table 4 reports the estimation results.

From the results of Table 4, the conclusions following can be known: the lagging item of the environmental regulation (ER) affects GTFP positively. For every 1% increase in environmental regulations, GTFP, GEC, and GTP will increase by 0.006%, 0.021%, and 0.026%, respectively. That is, by improving GTP, GTFP can be promoted by better environmental regulation (ER). However, there is a time lag effect in this influencing.

Furthermore, FDI has a a negative effect on green TFP. For every 1% increase in FDI, GTFP, GEC, and GTP will decrease by 0.006%, 0.048%, and 0.028%, respectively. This shows that the growth of FDI has hindered the increase of green TFP. For every 1% increase in the interaction effect, GTFP, GEC, and GTP will increase by 0.017%, 0.174%, and 0.210%, respectively. This shows that the strengthening of environmental regulations will improve the quality of FDI inflows, thereby increase the green TFP.

Another, there is also a positive effect of regional economic development on GTFP, and this effect is also in the impacts of human capital, innovation input and infrastructure construction on GTFP. However, the effects of financial development (FD) on GEC and GTFP are negative. Furthermore, there are negative effects of trade openness (TO) on GTFP and GEC, but surprisingly there is a positive relationship with GTP.

6. Conclusions

The environmental regulation affects GTFP significantly. Strict and reasonable environmental regulation is conducive to pollution reduction, and it also can motivate companies to innovate in clean technology. The influence of FDI on GTFP is negative, but interaction item (ER*FDI) affects green TFP positively.

Table 4. Regression results of GTFP

VARIABLES	*(1)*	*(2)*	*(3)*
	$GTFP_{i,t}$	$GEC_{i,t}$	$GTP_{i,t}$
$Y_{i,t-1}$	-0.134** (-2.20)	-0.240*** (-4.06)	-0.287*** (-4.85)
$ER_{i,t-1}$	0.006 (0.16)	0.021* (1.67)	0.026** (1.99)
$FDI_{i,t}$	-0.006 (-0.61)	-0.048* (-1.82)	-0.028 (-1.05)
$ER_{i,t-1}*FDI_{i,t}$	0.017 (0.48)	0.174* (1.67)	0.210** (1.99)
$PGDP_{i,t}$	-0.403 (-0.60)	4.805** (2.42)	0.532 (0.27)
$HR_{i,t}$	0.089 (0.40)	-0.659 (-1.01)	0.988 (1.51)
$RD_{i,t}$	0.179 (0.69)	0.202 (0.27)	1.683** (2.22)
$IC_{i,t}$	0.073 (0.08)	-0.471 (-0.18)	-3.326 (-1.25)
$FD_{i,t}$	-0.150 (-0.92)	-0.868* (-1.80)	-1.195** (-2.45)
$TO_{i,t}$	-0.320 (-0.63)	-0.361 (-0.24)	1.041 (0.70)
Constant	2.982* (1.82)	-12.607*** (-2.62)	-6.660 (-1.37)
Observations	336	336	336
R-squared	0.031	0.118	0.136
Number of Id	28	28	28
F	0.87	3.61	4.24

*Note:T-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1*

That is, with FDI flows, the government will strengthen the environmental regulation, and then the strict environmental regulation which can effectively raise the foreign investment's environmental threshold, so that the positive interaction effect between FDI and environmental regulation can positively affect the growth of GTFP.

Therefore, China should further optimize the combination of environmental policy tools, accelerate environmental regulation and innovation, and make full use of the "double dividend" of environmental regulation, that is, with improving environmental quality, enterprises are encouraged to carry out technological innovation to promote the improvement of GTFP and sustainable economic growth in China.

For manufacturing enterprises, they should increase scientific research investment through multiple channels, form independent innovation capability, provide a continuous source of power for the green total factor productivity growth. The manufacturing enterprises also should take the lead in realizing the transformation of economic development model. All provinces should strictly strengthen the level of environmental regulation and improve the efficiency of environmental governance. Because relatively strict environmental regulations can force enterprises to upgrade in production and management, which can stimulate enterprises' innovation. Therefore, when formulating environmental protection related policies, the government should clarify the space for enterprise upgrading and set reasonable environmental regulation requirements. And each province should also identify and control the quality of FDI introduction. At the same time, how to promote a positive interaction between environmental regulation and FDI will also be an important challenge in sustainable development.

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