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# The Influence of Enterprises' Bargaining Power on the Green Total Factor Productivity Effect of Environmental Regulation—Evidence from China

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**Abstract:** In response to the ecological and environmental problems caused by high energy consumption and pollution, Chinese governments have raised their concerns and tighten the regulations. Even though local governments have achieved certain degree of success during policy implementation, it is still far from realizing the ultimate goal. Our study fills the gap in the existing literature by exploring the dynamic effects of environmental regulations on enterprises' green total factor productivity (GTFP) from the perspective of enterprise bargaining power. With data obtained from the industrial pollution database and the Chinese industrial enterprise database, we calculated the GTFP at enterprise level using the Luenberger productivity index. The results from balanced panel data models show that environmental regulations would have negative impacts on enterprise's GTFP in the short run. However, in the long run, the implementation of environmental policies would achieve the win-win goal in terms of enterprises competitiveness and environmental protection. In addition, indicated by industrial output, tax revenue and number of employees, enterprise bargaining power could weaken the dynamic effects of environmental regulations. Moreover, state ownership, local official changes and weak political constraints would enhance enterprise's bargaining power and thus reduce the dynamic effects. By focusing on the enterprise's bargaining power and its heterogeneous factors during policy implementation, our study provides implications for mitigating distortions and improving GTFP.

**Keywords:** environmental regulations; enterprise's bargaining power; green total factor productivity; Luenberger productivity index

## 1. Introduction

As the largest developing country in the world, China has achieved remarkable economic growth over the past four decades. In the meantime, there have been increasing concerns among academics and policy makers about the ecological and environmental problems caused by high energy consumption and pollution. Chinese government has implemented a series of policies to shift the economy to a more sustainable and green mode [1]. However, to date, China's energy consumption per unit of GDP and the cost of environmental degradation still need improvements. The current situation in Chinese economy indicates that the poor effects of the policy implementation are more likely due to local authorities' weak enforcement of environmental law [2,3] and many enterprises have a "chip" while negotiating with local governments. As a result, our study provides new insights to existing studies by investigating the effects of environmental regulations on green total factor productivity (GTFP) from the perspective of enterprise's bargaining power.

The China Environmental Protection Supervision Committee was established in January 2016 with the aim to carry out environmental protection supervision in all provinces on behalf of the

Central Committee and the State Council. However, during the inspections, a large number of local governments were found to be weak in environmental protection and policy implementation. Problems such as "surface rectification," "pretend rectification" and "perfunctory rectification" also appeared during "retrospective" inspections. These inefficient behaviors of local governments make it harder for China to achieve the win-win goal in terms of both the economy and the environment.

China's environmental policies are generally made by the central government and local governments are responsible for the implementation in accordance with the law. However, under the mechanism of territorial management, local governments have greater discretions during the implementation process, which opens up a window for enterprise negotiation [4,5]. Scholars have carried out empirical studies from different perspectives to examine this issue. Using the provincial level data and a spatial panel econometric model, Renard and Xiong [6] verify that when the central government evaluates local performance based on economic growth, environmental policies would be used as a tool to attract liquidity investments. The local governments would compete to relax the enforcement of environmental regulations, leading to strategic interactions which are particularly strong among provinces with similar industrial structures. The evidence of Van der Kamp et al. [7] shows that although China's fiscal decentralization system has effectively promoted economic growth, such a decentralization of power can also slow down or prevent central government's environmental governance reform. This is because the fiscal system, together with the system of promoting officials in China, have produced incompatible incentives which encourage local governments with insufficient funds to relax the implementation of the central government's environmental policies.

The above studies discuss the incomplete implementation of environmental policies from the perspective of the principal-agent relationship between the central and local governments. In reality, the industrial output, tax revenue and the number of employment created by enterprises will also have significant impacts on the performance of local governments. This means that enterprises with different characteristics would have a "chip" to negotiate with local government for relaxing environmental regulations. To the best of our knowledge, this is the first study analyzing the impacts of environmental regulations from the perspective of the enterprise's bargaining power.

The lagged value of GTFP at enterprise level has been chosen to evaluate the firm competitiveness and ecological wellbeing for the following two reasons [8,9]. First, previous researches generally measure GTFP in China at the province [10,11] and industry [12,13] level. As the most direct target of environmental regulations, the heterogeneous responses of enterprises have consistently been a "black box," which has remained unopened. Using aggregated information to analyze the effects of environmental regulations on enterprise's GTFP may erase the heterogeneous impacts, leading to partial or even biased conclusions. Second, most studies mainly focus on the magnitude of environmental regulation impacts on enterprise's GTFP from a static point of view, concluding that it is not a simple linear relationship [10,14]. However, these studies ignore the time lag effects of environmental policy implementation. Since the implementation effects on enterprise's innovation usually take a certain amount of time to be reflected, it is possible that the bright side of environmental regulations could be underestimated [15].

Based on above discussions, our study first calculates the GTFP at enterprise level using data from industrial pollution database under China's "environmental statistical reporting system." On this basis, we examine the impacts of environmental policy implementation on the current and lagged period GTFP and test whether China's environmental regulations can truly realize the win-win goal of enterprises competitiveness and ecological wellbeing in the dimension of time. Next, from the perspective of enterprises' bargaining power with local governments, this paper reveals the heterogeneous impacts of incomplete implementation of environmental policies on enterprises' GTFP. We find that in the short term, environmental regulations would reduce enterprises' GTFP, however, such regulations would increase their GTFP in the long term. Moreover, the bargaining power of polluting enterprises would weaken the dynamic effects of environmental regulations. In addition, the bargaining power would be

amplified for enterprises with state ownership, weak political constraints and enterprises located in the city which has undergone official changes. This would further weaken the dynamic effects.

Our research mainly contributes to the existing literature in the following three aspects. First, we bridge a gap in the current literature by calculating the GTFP at the enterprise level using energy inputs and pollution emission data. This enable us to provide micro-evidence for the win-win effect of environmental regulations. Second, by examining the bargaining power of enterprises with different characteristics, we enrich the literature on the heterogeneous impacts of incomplete implementation of environmental policies from the perspective of the relationship between enterprises and local governments. Third, the micro-empirical results of this paper provide implications for weakening the bargaining power of enterprises and mitigate distortion in the process of environmental regulations. We also provide new directions for further improving and standardizing the environmental policies.

The remainder of this paper is organized as follows. Section 2 provides an overview of related literature. Section 3 proposes theoretical hypotheses. Sections 4 and 5 describe the data selection and empirical methodology. Sections 6 and 7 present and analyze the estimation results and robustness test. Section 8 concludes and discusses the policy implications.

## 2. Literature Review

In the model of green and sustainable development, resources and environment are not only the endogenous variables but also the rigid constraints to the scale and speed of economic growth. In China, the contradiction between environment and economic development has become an increasingly prominent problem. Economists have proposed GTFP index as a suitable analytical framework since it simultaneously incorporates the resources and environmental constraints. Besides, evidence from empirical studies have shown that using traditional total factor productivity (TFP) may lead to misleading conclusions and inappropriate recommendations since GTFP values are generally lower than TFP with consideration of resource consumptions and pollutant emissions [11,16]. Thus far, GTFP has been proved to be an ideal measurement to evaluate whether environmental regulations could achieve the win-win situation. And it would be more effective in guiding local governments to realize resource conservation and sustainable development objectives.

Our study is related to the researches investigating GFTP from different perspectives in China. Based on provincial-level panel data, Zhou et al. [17] analyze the direction and intensity of financial influences on GTFP using threshold model. Their results indicate that there exists an optimum interval in which financial development would enhance GTFP. The excessive financial growth would reduce the enhancement effects while the low financial development would reduce GTFP. Moreover, Yue et al. [18] document that foreign direct investments (FDI) would increase urban green growth using data from 104 cities in China. Besides, with consideration of different industries, they conclude that this improvement is mainly caused by the flow of FDI from industries with high pollution and emission to more environmentally friendly industries. Nevertheless, the influences of FDI on clean technology transfer and environmental technology spillover are not obvious. Besides, Song et al. [5] explore the impacts of fiscal decentralization on GTFP by constructing a panel quantile regression model. The results show that fiscal decentralization could stimulate GTFP growth. However, with the increase of the quantile value, this effect would be weakened gradually. That is, the proper fiscal decentralization could improve GTFP while excessive fiscal decentralization may hinder GTFP growth. Furthermore, Lin and Chen [19] point out that factor market distortion would have negative impacts on GTFP and the threshold effects of factor markets on export and FDI would further reduce GTFP. In addition, many scholars have discussed GTFP and its driving factors at city, province and industry levels respectively [20–22].

Based on China's current situation, the exploration of existing literature on the mechanism and influencing factors of GTFP provides a theoretical and empirical basis for policy makers to improve GTFP. At present, environmental policies are still the most important means for Chinese central government to solve the ecological and environmental problems and realize the green transformation

of industries. By investigating the heterogeneous impacts of enterprise's bargaining power on the implementation of environmental policies and the resulting GTFP changes, our study provides a new perspective to improve the environmental regulation efficiency.

Our paper is also related to the studies in terms of environmental regulations and policy implementation on different levels. The degree of regulation enhancement would have significant influences on enterprise's GTFP. Moreover, the relaxation of policy implementation would lead to misleading evaluations of environmental law on the assumption of fully compliance [23]. First, on the international level, Rohling [24] argues that unified environmental policies among regulated countries would result in incomplete implementation. In this case, the quantity-based environmental policies (e.g., tradable pollution permits) would be implemented more strictly than the price-based environmental policies (e.g., emission taxes). This is mainly because regulated actors are sovereign states, not the corporations or other private entities. The national sovereignty means that governments can decide their fiscal and tax policies independently of the supranational environmental regulators to offset international tax rules. On the contrary, governments cannot directly undermine quantitative-based regulatory mechanisms, which would reduce the possibility of non-cooperation of the country. Second, on the national level, Coria et al. [25] show that under the tradable pollution permit system, regardless of the probability of government regulations, the proportion of enterprises violating regulations and the total degree of violation are lower than those under the tax system. It further points out that for many developing countries, although the implementation of environmental policies is weak, the tradable pollution permits would be a more viable policy option. Third, on the enterprise project level, MacKenzie and Ohndorf [26] extend the general framework of incomplete policy implementation in order to examine the special characteristics of credit-based emission trading mechanism (e.g., clean development mechanism). According to the emission reduction cost and penalty scheme, the optimal supervision of credit-based systems is usually discontinuous, which is significantly different from that of cap-and-trade scheme and environmental tax system.

In the real world, project acceptance should be ultimately based on criteria which could be verified. Learning from the experiences from different levels, our paper provides another feasible solution to this problem from the perspective of bargaining power between polluting enterprises and local governments in China.

## 3. Theoretical Hypothesis

### 3.1. Environmental Regulation Effects on Enterprise's GTFP

The purpose of environment regulations is to internalize the environmental externalities caused by the production activities into enterprise's costs, thus forcing them to improve technological innovations [27]. The increased GTFP would enable enterprises to realize the win-win goal of competitiveness and ecological wellbeing. At present, few studies has analyzed the dynamic effects of environmental regulation mechanism on GTFP. In reality, enterprises response to environmental regulations via different paths with various durations. It is only over a long time span that we can fully evaluate the regulation impacts.

In the initial stage, in order to meet the regulatory requirements, enterprises need to pay compliance costs for energy consumption and pollutant emissions [10]. In addition, these compliance costs would exert a crowding-out effect on enterprises' productive and profitable investments [28]. As a result, in the short term, environmental regulations would be more likely to increase enterprises' operating costs and reduce their potential output and efficiency. These would result in negative impacts on the GTFP.

From a dynamic perspective, the Porter Hypothesis points out that the proper design of environmental regulations could stimulate enterprises to improve technological innovations which would compensate their compliance costs caused by regulations and generate competitive advantages [29,30]. However, after the implementation of environmental policies, enterprises need a

period of time to optimize the resource allocation and upgrade green technology in order to achieve the "innovation compensation" effects [31,32]. Thus, the GTFP improvement would be only achieved in the long run. Therefore, we propose the following hypotheses:

**Hypothesis 1.** *In the short run, environmental regulations will have negative impacts on enterprise's GTFP, while, in the long run, environmental regulations will have positive impacts on enterprise's GTFP.*

For the convenience of expression, Hypothesis 1 would be referred as "the dynamic effects of environmental regulations on enterprise's GTFP" throughout the paper.

*3.2. The Moderating Effects of Enterprise Bargaining Power*

Over the past few decades, China's central government has promulgated a number of environmental laws and administrative policies in order to protect the environment and achieve sustainable economic growth. However, the phenomena such as weak enforcements of environmental laws and "softening" policy implementation during environmental regulations also exist [2]. Even though the central government has launched the national environmental supervision campaign since 2016, many local authorities still have sufficient ability and incentives to weaken the policy implementation.

Under China's current regulation mechanism, local governments are responsible for the environmental protection under their unified jurisdiction. Meanwhile, to a large extent, they could also determine the appointment, dismissal and fund allocation of the local environmental protection departments. Therefore, local governments are fully capable to influence the enforcement of environmental regulations [33]. The excessive influence of local governments on the environmental protection sectors provides bargaining opportunities to polluting enterprises.

Moreover, incentives for local governments to weaken the implementation of environmental policies come from different sources. On one hand, such incentives arise from the current promotion mechanisms, in which economic performance has long been the core evaluation criterion in China [34]. Environmental regulations generally require long-term efforts while the local officials' tenure is limited. Thus, many politicians believe the Chinese proverb that, "the predecessors plant the trees and the descendants enjoy the shade" and wish to benefit from the previous achievements. On the contrary, with the efforts of proactive governments, the local economy could achieve rapid growth in the short run. Therefore, when facing the trade-off between economy growth and environment protection, a large number of officials would choose to prioritize economic development. On the other hand, these are caused by the inefficient administrative system. Environmental regulations usually incorporate with serious information asymmetry and externality problems. Unlike the economic growth, the assessment of environmental performance is highly professional and technical, making it harder for central government to quantify the enforcement results [35].

To be more specific, when the high-polluting enterprises have great contributions to local economic growth, the resulted environment costs may be tacitly accepted by local governments. Even though under strict environmental regulations, these enterprises could also use their importance to local economic as a bargaining "chip" with local governments to obtain exemptions or relaxed implementation of environmental policies. Meanwhile, attracted by economic contributions, local government also try to avoid the "unfavorable" policies regarding to the enterprises under their jurisdiction [7].

Combined with Hypothesis 1, we expect that the bargaining power of polluting enterprises is positively related to their economic contribution. Furthermore, polluting enterprises with a high degree of bargaining power could obtain exemptions from policy implementation to a larger extent. In light of this, we propose the second hypothesis:

**Hypothesis 2.** *The bargaining power of polluting enterprises with local governments will weaken the dynamic effects of environmental regulations on enterprise's GTFP.*

*3.3. Heterogeneous Factors of Enterprises' Bargaining Power and Their Influences*

In the context of China, state-owned enterprises have close relationships with local governments due to historical reasons. As the ultimate investor, local governments could exert great influences on the appointment, dismissal and business decisions of state-owned enterprises. Moreover, many executives of state-owned enterprises could also be elected as local officials [36,37]. As a result, state-owned enterprises are more likely to be sheltered by the government when they encounter difficulties. Some governments even exhibit the tendency of "paternalism" towards state-owned enterprises [38].

Besides the important contributions to regional output and tax revenue, state-owned enterprises play a significant role in alleviating public expenditures and they also bear certain social responsibilities [39,40]. Therefore, under same circumstances, state-owned enterprises can obtain a great extent of government exemption from complying with environmental regulations.

Although private enterprises do not have the "congenital advantages" as state-owned enterprises, they are also familiar with local political and business culture and the corresponding methods. Many private enterprises have attempted to build political relationships with local governments for regulation exemptions [41,42]. Foreign-owned enterprises usually have disadvantages compared with the above two types of enterprises, meaning that their bargaining power with local governments in terms of environmental policy implementation is weak. Therefore, we propose the following hypothesis:

**Hypothesis 3A.** *The dynamic effects of environmental regulations on the GTFP of state-owned enterprises and private enterprises are weaker than that of foreign-owned enterprises.*

Due to the significant and extensive influences of local governments on the economy, the change of government officials may affect the bargaining power of local enterprises during environmental policy implementation, therefore exerting heterogeneous impacts on the GTFP. Lazear [43] argues that when agents face same risks and the degree of their efforts is not easy to observe, relative performance could be a better choice since it can filter out the common factors affecting agents' performances and thus principal can evaluate them more accurately. Using data pertaining to the promotion of provincial and municipal officials in China, many scholars confirm that former officials play a benchmarking role in the performance evaluation of current officials.

In reality, most new officials attempt to achieve outstanding economic growth than their predecessors in order to increase the probability of promotion [44,45]. With official changes in local governments, the bargaining power of polluting enterprises would be increased indirectly since new officials would pay more attention to their economic contributions. This would in turn weaken the dynamic effects of environmental regulations on the GFTP. As such, we come up with the following hypothesis:

**Hypothesis 3B.** *The change of government officials will increase the bargaining power of polluting enterprises and reduce the dynamic effects of environmental regulations on enterprise's GTFP.*

In China's current urban system, there are two types of cities facing stricter political constrains of environmental regulations—the municipalities under the direct control of central government and the provincial capital cities. The municipalities are under direct jurisdiction and supervision of the central government. Furthermore, the secretary of the municipal party committee is usually a member of the political bureau of the central committee. In order to create a better urban environment and play an exemplary role in the whole country, environmental policies are implemented more strictly in these cities, with polluting industries even being relocated [46].

The provincial capitals generally receive more attention from the central government and urban residents in these regions would express their environmental concerns more directly. Compared with non-provincial cities, the development goals of provincial capitals are more diversified and their environmental preferences would be stronger [47]. As a result, the bargaining power of polluting enterprises in these two types of cities would be reduced. Therefore, we propose that:

**Hypothesis 3C.** *In cities with stricter political constraints, the bargaining power of polluting enterprises will be weakened and the dynamic effects of environmental regulations on enterprise's GTFP will be enhanced.*

## 4. Sample Selection and Key Indicators

### 4.1. Sample Selection

The reasons for using industrial pollution database under China's "environmental statistical reporting system" to calculate an enterprise's GTFP are as follows. (The reporting system of environmental statistics is in accordance with the Statistics Law of The People's Republic of China and Measures for the Administration of Environmental Statistics.) First, the major pollutants of polluting enterprises from the above database account for more than 85% of the total amount of pollution in the region for the whole year. Thus, these enterprises are the main body of pollution emission in the area and their heterogeneous responses to environmental regulations are more realistic and representative than that of normal enterprises. Second, it is the most detailed and comprehensive database in China in terms of enterprises' energy consumption and pollutant types. Besides, this database records the amount of energy such as coal, oil, natural gas and water consumed by polluting enterprises, as well as the discharge amount of industrial wastewater, ammonia nitrogen, chemical oxygen, nitrogen oxides, sulfur dioxide, smoke, dust and other contaminants. These would enable us to calculate an enterprise's GTFP more precisely. Third, the industrial pollution database perfectly suits our study in terms of analyzing the impacts of environmental regulations. In the short run, polluting enterprises need to pay more compliance costs and the crowding-out effects are larger. Moreover, they also need to spend a large amount of efforts on technological innovations in the long run. Therefore, the dynamic effects of environmental regulations could be examined more directly and accurately using this database.

We first used the keywords "enterprise name + year" to match the enterprises in the industrial pollution database and the China's industrial enterprise database and then we delete the key variables with recording errors (such as the negative values of industrial output, total assets, fixed assets, interest expenditures and management expenses). After further excluding enterprises with missing key indicators and whose average annual employment number was less than eight, we deflated the price related variables with the fixed asset investment price index. Meanwhile, the industrial output and sales revenue were deflated by the product ex-factory price index. Our final sample consisted of 84844 observations from 2007 to 2010.

### 4.2. Estimation for Enterprise's GTFP

As a superior method of Data Envelopment Analysis (DEA), we used the Luenberger productivity index to calculate an enterprise's GFTP. The Luenberger productivity index is based on the relaxed directional distance function which does not require a distribution hypothesis. Meanwhile, it can solve the "radial" and "angle" problems and consider the "good" and "bad" outputs at the same time. With the Luenberger productivity index, we could incorporate energy inputs and pollutant emissions into the analysis framework simultaneously. The Luenberger productivity has been regarded as the most generalized method for GTFP calculation [9,48] and it has been widely used in recent years [49]. A detailed discussion can be found in relevant literature [8,9,20,50].

According to the principle of the Luenberger productivity index, each enterprise could be regarded as an independent decision-making unit of production. Therefore, we could construct the optimal

annual production boundary of Chinese enterprises. In our study, energy inputs such as capital and labor in the production process were included in the boundary construction. The capital inputs were measured by the total fixed assets and labor inputs were indicated with the number of employees of the enterprise. We defined the enterprise's production as "good" output (measured by the total industrial output) while the pollutants discharged were regarded as "bad" output.

Due to the heterogeneity of inputs, technology, production and pollutant emission among enterprises, we performed the following two standardizations in order to realize the uniformity and comparability of our measurements.

*Energy inputs*—China currently adopts standard coal as the unit measurement for energy conversions. According to the General Principles for Computing Comprehensive Energy Consumption (GB/T 2589-2008), different energy (The energy inputs calculated in our study included total coal consumption, total fuel oil consumption, total clean gas consumption and total industrial water consumption.) is converted into a unified standard coal consumption, which would be used as an energy input parallel to capital input and labor input for GTFP calculation.

*Pollutant measurements*—After the implementation of The Regulations on Collection and Use of Pollution Discharge Fees in 2003, China has transformed its fee system from the previous "single-factor charging according to excessive sewage and exhaust gas" mode into the current "multi-factor charging for total discharge per unit of pollution equivalent" mode, meaning that enterprises are charged by a unified fee for each "pollution equivalent" (The pollution equivalent refers to a comprehensive index or unit of measurement to indicate the environmental pollution of different pollutants according to the degree of harmfulness to the environment.). Therefore, different pollutants (The discharge of various pollutants mainly includes: (1). chemical oxygen and ammonia nitrogen in industrial wastewater; (2). sulfur dioxide, nitrogen oxides, smoke and dust in industrial waste gas.) were converted into a unified pollution equivalent number as a measurement of "bad" output, which is included in the GTFP calculation. In addition, the levy standard for sewage discharge fees is 0.7 yuan per pollution equivalent and it is 6 yuan per pollution equivalent for waste gas. Therefore, when we added these two up, the weight of each pollution equivalent was adjusted according to the ratio of the levy fees.

Finally, we use Max DEA software to measure the enterprise's GFTP in 286 cities (some cities were deleted due to the lack of data or the lack of successful matching of polluting enterprises during the database matching process, such as Sanya, Lhasa and so on.) from 2007 to 2010. In order to reduce the number of infeasible solutions in the calculation [51], we chose the sequential DEA method, in which the reference technology of each year was determined by the available inputs and outputs in all periods.

Table 1 reports the descriptive statistics of GTFP classifications. In terms of enterprise ownerships, the average growth of the GTFP of state-owned enterprises is the lowest, indicating that state-owned enterprises do have natural advantages in bargaining with the local governments. Meanwhile, in line with our expectations, private enterprises have stronger bargaining power than foreign-owned enterprises. However, the GTFP growth rate of private enterprises is the highest, which means they have improved their resource consumption and pollution emission significantly in recent years. This may be due to the fact that most state-owned enterprises are located in industries with a high degree of monopoly, thus making it easier for them to obtain competitive advantages while private enterprises can only rely on technological innovations. Table 1 also shows the GTFP growth decreases with official changes and increases with strong political constraints, implying that the turnover of government officials and strong political constraints and can amplify and inhibit the enterprise's bargaining power respectively.

**Table 1.** Descriptive statistics of green total factor productivity (GTFP) classification.

| Grouping Type | | Mean | Standard Deviation | Median | Observations |
|---|---|---|---|---|---|
| Grouping by enterprise | state-owned | 0.3753 | 6.6470 | 0.1100 | 2402 |
| | privately-owned | 0.6176 | 7.3179 | 0.2300 | 41,600 |
| | foreign-owned | 0.4788 | 6.9104 | 0.1700 | 13,243 |
| Grouping by city | officials changed | 0.6335 | 7.2888 | 0.2000 | 38,521 |
| | officials unchanged | 0.4558 | 7.0080 | 0.2200 | 18,724 |
| | weak political constraints | 0.5299 | 6.9333 | 0.2000 | 45,963 |
| | strong political constraints | 0.7607 | 8.1889 | 0.2200 | 11,282 |
| full sample | | 0.5754 | 7.1986 | 0.2000 | 57,245 |

## 5. Empirical Methodology

### 5.1. Dynamic Effects of Environmental Regulations on Enterprise's GTFP

Following the Gaus Markov assumptions, estimations based on the balanced panel data models were adopted for our analysis in terms of 5 hypotheses tests. We estimate the following equation to test Hypothesis 1:

$$GTFP_{it} = \theta + \alpha ERI_{mt} + \beta ERI_{mT} + \chi X_{it} + \delta Y + \gamma Z + \varepsilon_{it} \tag{1}$$

where $GTFP_{it}$ denotes the GTFP growth rate of enterprise $i$ in year $t$, $\theta$ is the constant term to be estimated and $ERT_{mt}$ denotes the intensity of environmental regulations in city $m$ in year $t$. In order to examine the time lag effects of environmental regulations, vector $ERT_{mT}$ represents the environmental regulation intensities of city $m$ lagging behind one to five years respectively. Vectors $X_{it}$, $Y$, $Z$ indicate the control variables at the enterprise, industry and city levels and $\varepsilon_{it}$ is the iid error term. The detailed estimations of above variables are described below.

At present, there is no standard measurement of environmental regulation intensity (*ERI*). We adopted the widely used comprehensive index approach [52] to calculate ERI. This approach includes a target layer and multiple evaluation index layers. In order to obtain regional environmental regulation intensity, we first calculated the intensity of each single pollutant and then sum them up by assigning different weights. Moreover, we constructed the comprehensive measurement system using three indicators of standard rates—industrial wastewater discharge rate, industrial sulfur dioxide removal rate and industrial dust removal rate.

The control variables at the enterprise level include enterprise scale (*ES*), measured by total fixed assets; enterprise age (*EA*); profitability level (*PL*), indicated by the ratio of operating profits to total assets; asset flow ratio (*AFR*), calculated by the ratio of total current assets to total current assets and total fixed assets; asset-liability ratio (*ALR*), which is the ratio of total liabilities to total assets; financing constraints (*FC*), measured by the ratio of interest expenditure to fixed assets; and management level (*ML*), which is the ratio of management expenses to the main business.

The control variables at the industry level include the total output scale of the industry (*TOC*), which is the sum of the industrial sales output value of all enterprises in the industries with 4-digit code; and the degree of industry competition (*HHI*), calculated by the industrial sales value of enterprises in the industries with 4-digit code.

The control variables at the city level include Research and Development intensity (*RDI*), which is the proportion of science and technology expenditures to GDP; and the urban development level (*UDL*), measured by per capita GDP.

### 5.2. The Moderating Analysis of Enterprise Bargaining Power

Based on Equation (1), we would test Hypothesis 2 using the following estimation:

$$
\begin{aligned}
GTFP_{it} = \quad & \theta + \alpha ERI_{mt} + \beta ERI_{mT} + \alpha' Bar * ERI_{mt} + \beta' Bar * ERI_{mT} + \chi X_{it} \\
& + \delta Y + \gamma Z + \varepsilon_{it}
\end{aligned}
\tag{2}
$$

where *Bar* is the bargaining power of the enterprise, expressed by industrial output (*Output*), total taxation (*Tax*) and the number of employees (*Worker*). As we have mentioned, enterprises' bargaining power with local governments during the implementation of environmental policies comes from their contribution to local economy and the assessment of officials' performance. Since the early 1980s, the focus of the Chinese government has shifted from class conflicts to economic development. The criteria for the promotion and appointment of local officials have also shifted from political indicators to economic performance indicators, with GDP growth as the core [34].

In addition to fiscal revenue, the responsibility of local governments on social security, basic education, health care and public safety has also increased following the reform of the central and local financial systems [5]. Moreover, stability has consistently remained a prerequisite for development and it is a major part of the performance appraisal of local officials. The central government has emphasized that "stability overrides everything" is the first principle of the administrative system at all levels [53]. Maintaining and increasing the rate of urban employment is important for regional stability.

Therefore, GDP, fiscal revenue and employment rate have become the key performance indicators of local officials and the local economy [3,54]. In order to avoid the heterogeneous influences of economic developments on enterprises' bargaining power, we divide the industrial output of a single enterprise by the average industrial output of all enterprises in the city. Tax and total staff are also expressed in the relative terms.

### 5.3. The Heterogeneous Factors of Enterprise Bargaining Power

We investigated the heterogeneous factors of enterprise's bargaining power and test Hypotheses 3A, 3B and 3C by adding moderating variables, on the basis of the interaction terms of *Bar * ERI*.

$$
\begin{aligned}
GTFP_{it} = \quad & \theta + \alpha ERI_{mt} + \beta ERI_{mT} + \alpha' Bar * ERI_{mt} + \beta' Bar * ERI_{mT} \\
& + \alpha'' Hete * Bar * ERI_{mt} + \beta'' Hete * Bar * ERI_{mT} + \chi X_{it} + \delta Y + \gamma Z + \varepsilon_{it}
\end{aligned}
\tag{3}
$$

where *Hete* is the heterogeneous factor of enterprise's bargaining power, expressed by the enterprise ownership, change of government officials and political constraints respectively. Other variables are the same as Formulas (1) and (2).

The descriptive statistics of each variable are shown in Table 2.

**Table 2.** Descriptive statistics of major variables.

| Variable | Mean | Standard Deviation | Median | Observations |
|----------|------|--------------------|--------|--------------|
| *GTFP* | 0.5754 | 7.1986 | 0.2000 | 57,245 |
| *ERI* | 0.7091 | 1.3814 | 0.4960 | 858 |
| *ERI_t-1* | 0.7360 | 1.5304 | 0.5000 | 858 |
| *ERI_t-2* | 0.7301 | 1.3597 | 0.5003 | 858 |
| *ERI_t-3* | 0.7055 | 1.0884 | 0.4941 | 858 |
| *ERI_t-4* | 0.6663 | 0.7185 | 0.4794 | 858 |
| *ERI_t-5* | 0.6623 | 0.7176 | 0.4644 | 858 |
| *ES* | 1.2742 | 11.9468 | 0.1530 | 57,245 |
| *EA* | 12.8083 | 13.9098 | 9.0000 | 57,245 |
| *PL* | 0.2181 | 1.0767 | 0.0537 | 57,245 |
| *AFR* | 0.4174 | 0.2922 | 0.4322 | 57,245 |
| *ALR* | 1.2646 | 2.5228 | 0.6699 | 57,245 |
| *FC* | 0.0197 | 0.0482 | 0.0067 | 57,245 |

**Table 2.** *Cont.*

| | | | | |
|---|---|---|---|---|
| *ML* | 0.0614 | 3.2987 | 0.0266 | 57,245 |
| *TOC* | 2.9508 | 5.0677 | 1.5360 | 57,245 |
| *HHI* | 0.0140 | 0.0214 | 0.0077 | 57,245 |
| *RDI* | 0.2445 | 0.1993 | 0.1995 | 57,245 |
| *UDL* | 3.9991 | 2.4148 | 3.4140 | 57,245 |
| *Output* | 2.9251 | 16.8284 | 0.6373 | 57,245 |
| *Tax* | 2.9159 | 20.5847 | 0.4586 | 57,245 |
| *Worker* | 2.3160 | 8.1509 | 0.8961 | 57,245 |

## 6. Results

In terms of Hypothesis 1, the results of Column (1) in Table 3 indicate that the impacts of environmental regulations on enterprise's GTFP have time heterogeneity. The coefficients of environmental regulations have gradually shifted from significant negative (−0.7501) to significant positive (0.5609) from the current year to the four lagging periods. The results of Columns (2) to (4) further confirm the dynamic effects of Hypothesis 1.

In the current period, the compliance costs of environmental regulations and the crowding-out effect of productive and profitable investments play a major role, while the innovation compensation effect is the weakest or even zero, resulting in negative impacts on enterprises' GTFP. As time goes by, these two effects change their positions until cancel out, making the environmental regulation effects statistically insignificant. Finally, the compensation effect would override the crowding out effect and enterprise's GTFP would be increased. As a result, we conclude that in the short run, environmental regulations would have negative impacts on enterprise's GTFP, while, in the long run, environmental regulations would have positive impacts on enterprise's GTFP. Besides, since environmental regulations only have significant impacts on enterprise's GTFP from now to the four lagging periods, we would exclude the fifth year in the following estimations.

Our results in Column (2) confirm our Hypothesis 2 that the bargaining power of polluting enterprises with local governments would weaken the dynamic effects of environmental regulations. The coefficients of environmental regulations are consistent with Hypothesis 1. Moreover, enterprise's bargaining power is indicated by annual output, tax revenue and total number of employees. Therefore, we would analyze our results in these three aspects.

The coefficient of the interaction item between annual output and environmental regulation in current year is significantly positive (0.1388), while it is significantly negative in the fourth period (−0.1073). This means that in the short run, enterprises' bargaining power could slow down the decline of GTFP. However, it is not beneficial for enterprise's growth in the long run. In the context of resource and environmental deterioration, the state has increased the intensity of environmental protection supervision. With low GTFP, enterprises could easily become the rectification object of "shutdown and merger," which is harmful for their long-term developments. Similarly, the regression results in terms of enterprises' total tax revenue in Column (3) are consistent with enterprise annual output.

Nevertheless, although the bargaining power represented by the total number of employees does not have an obvious impact on enterprise's GTFP in current year, it is significantly negative in the long run (−0.1502). Most labor contracts are based on a three-year cycle, therefore the current bargaining "chip" of losing employment due to environmental punishments between enterprises and governments is less effective. However, in the long run, enterprises would be more capable to adjust their number of employees and the bargaining power obtained from it would be stronger.

Regarding to Hypotheses 3A, 3B and 3C, we try to test the effects of the enterprise ownership, change of government officials and political constraints on enterprises' bargaining power and the resulting GTFP differences due to government regulations. Columns (1) to (3), (4) to (6) and (7) to (9) in Table 4 report the three sets of test results respectively.

**Table 3.** Regression results.

| | (1) | | (2) | (3) | (4) |
|---|---|---|---|---|---|
| ERI | −0.7501 ** (−2.3819) | ERI | −0.9797 *** (−5.0153) | −0.9354 *** (−4.7922) | −0.7252 *** (−3.6984) |
| ERI_t-1 | −0.2881 (−0.9234) | ERI_t-4 | 0.7212 *** (4.0821) | 0.6867 *** (3.9021) | 0.5389 *** (3.0504) |
| ERI_t-2 | 0.0453 (0.3187) | Output*ERI | 0.1388 *** (6.6985) | | |
| ERI_t-3 | −0.0701 (−0.4471) | Output*ERI_t-4 | −0.1073 *** (−5.0423) | | |
| ERI_t-4 | 0.5609 *** (3.0510) | Tax*ERI | | 0.0659 *** (4.8017) | |
| ERI_t-5 | 0.3201 (1.4218) | Tax*ERI_t-4 | | −0.0809 *** (−5.9220) | |
| | | Worker*ERI | | | 0.0004 (0.0167) |
| | | Worker*ERI_t-4 | | | −0.1502 *** (−5.2738) |
| ES | −0.0160 *** (−18.9182) | ES | −0.0172 *** (−19.0968) | −0.0155 *** (−17.7342) | −0.0129 *** (−14.2113) |
| EA | −0.0197 *** (−3.9856) | EA | −0.0197 *** (−4.0032) | −0.0196 *** (−3.9621) | −0.0187 *** (−3.7958) |
| PL | 0.1978 *** (4.6649) | PL | 0.1969 *** (4.6490) | 0.2002 *** (4.7007) | 0.1936 *** (4.5735) |
| AFR | 0.8808 *** (5.3526) | AFR | 0.9102 *** (5.5385) | 0.8141 *** (4.8623) | 0.8742 *** (5.3250) |
| ALR | −0.0437 ** (−2.4136) | ALR | −0.0440 ** (−2.4569) | −0.0404 ** (−2.2464) | −0.0423 ** (−2.3637) |
| FC | −2.5032 ** (−2.2502) | FC | −2.3846 ** (−2.1457) | −2.4506 ** (−2.1837) | −2.7273 ** (−2.4557) |
| ML | −0.004 (−0.3072) | ML | −0.004 (−0.3050) | −0.0041 (−0.3134) | −0.0041 (−0.3124) |
| TOC | 0.0767 *** (3.7525) | TOC | 0.0761 *** (3.7239) | 0.0746 *** (3.6238) | 0.0805 *** (3.9397) |
| HHI | −1.4134 (−0.3809) | HHI | −1.4735 (−0.3973) | −1.2851 (−0.3445) | −1.1214 (−0.3025) |
| RDI | 1.4334 ** (2.3089) | RDI | 1.4567 ** (2.3494) | 1.5296 ** (2.4447) | 1.3872 ** (2.2384) |
| UDL | 0.1382 ** (2.0897) | UDL | 0.1364 ** (2.0700) | 0.0978 (1.4630) | 0.0988 (1.4997) |
| _cons | −0.1344 (−0.3528) | _cons | −0.1560 (−0.4239) | 0.1162 (0.3128) | 0.2875 (0.7801) |
| N | 57,245 | N | 57,245 | 57,245 | 57,245 |
| $R^2$ | 0.2345 | $R^2$ | 0.2464 | 0.2438 | 0.2568 |
| F | 30.1471 | F | 37.1471 | 35.7500 | 39.7343 |

Note: (1) Numbers in parentheses are t-statistics; ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively. The following tables are the same.

**Table 4.** Regression results.

| Bargain | (1) Output | (2) Tax | (3) Worker | (4) Output | (5) Tax | (6) Worker | (7) Output | (8) Tax | (9) Worker |
|---|---|---|---|---|---|---|---|---|---|
| ERI | −0.9056 *** (−4.6307) | −0.8981 *** (−4.5999) | −0.7071 *** (−3.5968) | −0.9677 *** (−4.9517) | −0.9210 *** (−4.7194) | −0.7040 *** (−3.5889) | −1.0052 *** (−5.1476) | −0.9568 *** (−4.9010) | −0.8027 *** (−4.0855) |
| ERI_t-4 | 0.5931 *** (3.3362) | 0.6335 *** (3.5947) | 0.5268 *** (2.9631) | 0.7306 *** (4.1330) | 0.6945 *** (3.9475) | 0.5365 *** (3.0368) | 0.7598 *** (4.3013) | 0.7128 *** (4.0489) | 0.6303 *** (3.5535) |
| Bar*ERI | 0.1943 *** (4.5903) | 0.1995 *** (4.6863) | 0.1926 *** (4.5488) | 0.1387 *** (6.3023) | 0.0658 *** (4.6704) | −0.0139 (−0.5692) | 0.1530 *** (7.2902) | 0.0790 *** (5.3846) | 0.0927 (0.6332) |
| Bar*ERI_t-4 | −0.0453 ** (−2.5310) | −0.0407 ** (−2.2608) | −0.0425 ** (−2.3723) | −0.1215 *** (−5.2363) | −0.0847 *** (−5.8707) | −0.1412 *** (−4.8927) | −0.1402 *** (−6.4072) | −0.1054 *** (−7.0309) | −0.0819 *** (−2.9429) |
| State*Bar*ERI | 0.1398 * (1.7481) | 0.1086 ** (2.2657) | 0.2179 (1.5769) | | | | | | |
| Priv*Bar*ERI | 0.0106 (0.1401) | 0.0528 (1.1626) | 0.1375 (1.0067) | | | | | | |
| State*Bar*ERI_t-4 | −0.3042 *** (−3.6714) | −0.1750 *** (−3.4504) | −0.1014 (−0.6768) | | | | | | |
| Priv*Bar*ERI_t-4 | −0.0700 (−0.8760) | −0.0672 (−1.3498) | −0.0943 (−0.6369) | | | | | | |
| Offic*Bar*ERI | | | | 0.0054 (0.4298) | 0.0341 *** (2.6391) | 0.0024 (0.1365) | | | |
| Offic*Bar*ERI_t-4 | | | | 0.0102 (0.7366) | −0.0284 ** (−2.2179) | 0.0212 (1.1165) | | | |
| Plict*Bar*ERI | | | | | | | −0.3125 *** (−2.7200) | −0.3542 *** (−2.8051) | −0.3638 *** (−3.5452) |
| Plict*Bar*ERI_t-4 | | | | | | | 0.4895 *** (4.6341) | 0.1079 *** (2.8186) | 0.3401 *** (5.0878) |
| N | 57,245 | 57,245 | 57,245 | 57,245 | 57,245 | 57,245 | 57,245 | 57,245 | 57,245 |
| $R^2$ | 0.2633 | 0.2545 | 0.2592 | 0.2496 | 0.2565 | 0.2598 | 0.2583 | 0.2587 | 0.2644 |
| F | 32.8691 | 30.302 | 32.0896 | 33.5597 | 32.9408 | 35.8823 | 35.6209 | 32.9685 | 37.0055 |

Note: *Bar* stands for *Output*, *Tax* and *Worker*, respectively. The following tables are the same.

The general results in Table 4 further verify the Hypothesis 1 that the current environmental regulations will have negative impacts on enterprise's GTFP, while the regulations would have positive influences on enterprise's GTFP in the fourth lagging period. In addition, they are also consistent with our Hypothesis 2 that the bargaining power of polluting enterprises with local governments will weaken the dynamic effects of environmental regulations on enterprise's GTFP.

The coefficients of *State*Bar*ERI* and *Priv*Bar*ERI* indicate the bargaining power of state-owned enterprises and private enterprises respectively. Reflected by industrial output in Column (1), the coefficient of state-owned enterprises in the current year is significantly positive (0.1398), while the coefficient of *State*Bar*ERI_t-4* of state-owned enterprises is significantly negative (−0.3042). This means that compared with foreign-owned enterprises, state-owned enterprises do have stronger bargaining power with local governments in the process of environmental policy implementation. The same conclusion can be drawn from the regression results reflecting enterprises' bargaining power by the total amount of tax payable in Column (2). However, the coefficients corresponding to number of employees in Column (3) are not significant. Therefore, compared with foreign-owned enterprises, state-owned enterprises with larger amount of industrial output and total tax payments can obtain stronger bargaining power, thereby weakening the dynamic effects of environmental regulations on enterprise's GTFP.

In the meantime, the coefficients of *Priv*Bar*ERI* are all insignificantly positive while the *Priv*Bar*ERI_t-4* coefficients are all insignificantly negative. This shows that in reality, only few private enterprises could obtain certain degree of exemptions from environmental regulations via specific political and business relationships. Most private enterprises would face the same intensity of environmental regulations as foreign-owned enterprises. According to the descriptive statistics in Table 1, the average GTFP of private enterprises in China is the highest, which indirectly indicates that private enterprises do not benefit from higher bargaining power than foreign enterprises. To sum up, we only partially verified Hypothesis 3A in that the dynamic effects of environmental regulations on the GTFP of state-owned enterprises are weaker than that of foreign-owned enterprises. However, no significant differences were found between private enterprises and foreign-funded enterprises in this aspect.

Following above analytical logic, only the coefficients of official turnovers listed in Column (5) are significant when the enterprises bargaining power is reflected by total tax payments. The coefficient of *Offic*Bar*ERI* is 0.0341 while the coefficient of *Offic*Bar*ERI_t-4* is −0.0284. These findings indicate that compared with enterprises in cities without changes of officials, enterprises in cities with official turnovers would have stronger bargaining power, which is consistent with our Hypothesis 3B. However, we cannot find the same conclusion for enterprises with a high degree of industrial output and a large number of employment.

This may be because most official changes generally do not occur at the beginning of the year. New officials are more likely to blame their predecessors for poor GDP growth and employment performance. Therefore, enterprises with an advantage in terms of industrial output and total workforce may not necessarily be able to obtain exemptions from environmental regulations. However, no matter what time of year the new officials take their positions, the amount of fiscal expenditure in their jurisdiction remains fixed. The tax revenue obtained by local governments could be used to upgrade public facilities, improve service and people's living standards. Therefore, local officials would be able to gain public recognition and promotion. As a result, enterprises contributing a large amount of tax revenues would be more likely to obtain a higher degree of bargaining power.

In the context of political constraints intensity, the coefficients of *Plict*Bar*ERI* are consistently negative at the 1% significance level and the coefficients of *Plict*Bar*ERI_t-4* are all significantly positive. This shows that strong political constraints will reduce enterprises' bargaining power in all three aspects and thus enhance the dynamic effects of environmental regulations on enterprise's GTFP. This finding is consistent with Hypothesis 3C.

## 7. Robustness Test

The Chinese government has long been aware of the importance of environmental protection to the sustainable development of national economy. In 1998, the State Council's Approval on the Issues Concerning Acid Rain Control Zones and Sulfur Dioxide Pollution Control Zones (referred as the "two control zones policy" in following analyses) was published. In our study, we use this policy as an identification variable of environmental regulations to further test the robustness of our results. Given that the two control zones policy was implemented long time ago, its immediate impacts on enterprise's GTFP cannot be tested empirically due to data limitation. Therefore, we mainly focus on win-win effect of environmental regulations with regard to ecological environment and enterprise competitiveness in the long run. We investigate the lagging impacts of the two control zones policy by constructing the following equation:

$$GTFP_{it} = \theta + \alpha TCZ_{mt} + \chi X_{it} + \delta Y + \gamma Z + \varepsilon_{it} \tag{4}$$

where *TCZ* is the dummy variable of environmental regulations which equals to 1 if the enterprise is located in the two control zones and 0 otherwise; other variables remain the same as in Formula (1).

The regression results of Column (1) in Table 5 indicate that since the coefficient of *TCZ* is significantly positive (2.0054), enterprise's GTFP in the two control zones has a higher growth rate than that of enterprises in the non-control zones in the long run. As a result, we confirm the robustness of Hypothesis 1.

$$GTFP_{it} = \theta + \alpha TCZ_{mT} + \alpha' Bar * TCZ_{mT} + \chi X_{it} + \delta Y + \gamma Z + \varepsilon_{it} \tag{5}$$

Based on Equation (2), interaction term *Bar*TCZ* has been added in Equation (5) (*Bar* denotes *Output*, *Tax* and *Worker*, respectively), indicating the enterprise bargaining power in the two control policy regions. The results from Columns (2) to (4) in Table 5 show that the coefficients of *Output*TCZ*, *Tax*TCZ* and *Worker*TCZ* are all significantly negative at the 1% level. Thus, enterprise output, tax revenue and number of employees are positively correlated with enterprise bargaining power, which would lead to weaker regulation effects of environmental policies on enterprise's GTFP. This conclusion is consistent with Hypothesis 2.

**Table 5.** Robustness test regression results.

|  | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *TCZ* | 2.0054 *** (3.5554) | 1.8907 *** (3.3548) | 1.8572 *** (3.2642) | 2.1198 *** (3.7563) |
| *Output*TCZ* |  | −0.0588 *** | −0.0588 *** |  |
| *Tax*TCZ* |  |  | −0.0663 *** (−3.3013) |  |
| *Worker*TCZ* |  |  |  | −0.0735 *** (−5.0154) |
| N | 57,245 | 57,245 | 57,245 | 57,245 |
| $R^2$ | 0.2324 | 0.2538 | 0.2316 | 0.2385 |
| F | 41.8275 | 44.8698 | 37.6856 | 40.5697 |

Similarly, in order to perform the robustness test of Hypothesis 3, *Hete*Bar*TCZ* has been added in Equation (6) (*Hete* stands for *State*, *Priv*, *Offic*, *Plict*, respectively). The regression results are shown in Table 6.

$$GTFP_{it} = \theta + \alpha TCZ_{mT} + \alpha' Bar * TCZ_{mT} + \alpha'' Hete * Bar * TCZ_{mT} \\ + \chi X_{it} + \delta Y + \gamma Z + \varepsilon_{it} \tag{6}$$

**Table 6.** Regression results.

| Bargain | (1) Output | (2) Tax | (3) Worker | (4) Output | (5) Tax | (6) Worker | (7) Output | (8) Tax | (9) Worker |
|---|---|---|---|---|---|---|---|---|---|
| TCZ | 1.8895 *** (3.3527) | 1.8538 *** (3.2591) | 2.2938 *** (4.0603) | 1.8887 *** (3.3530) | 1.8512 *** (3.2550) | 2.1123 *** (3.7449) | 1.8833 *** (3.3420) | 1.8792 *** (3.3035) | 2.1191 *** (3.7551) |
| Bar*TCZ | −0.0377 *** (−3.3238) | −0.0549 *** (−6.8404) | −0.0201 *** (−4.0802) | −0.0444 *** (−2.4961) | −0.0473 ** (−2.6590) | −0.0426 *** (−2.1456) | −0.0145 *** (−4.6636) | −0.0133 ** (−2.3893) | −0.0748 *** (−4.6010) |
| State*Bar*TCZ | −0.0309 *** (−2.8874) | −0.0538 *** (−4.8053) | −0.0448** (−2.5173) | | | | | | |
| Priv*Bar*TCZ | −0.0129 (−0.8830) | −0.0202 ** (−2.1760) | 0.0173 (0.7100) | | | | | | |
| Offic*Bar*TCZ | | | | −0.0199 *** (−4.0320) | −0.0202 *** (−4.0742) | −0.0204 *** (−4.1347) | | | |
| Plict*Bar*TCZ | | | | | | | 0.0616 *** (3.2780) | 0.0379 *** (4.5693) | 0.0405 *** (5.1688) |
| N | 57,245 | 57,245 | 57,245 | 57,245 | 57,245 | 57,245 | 57,245 | 57,245 | 57,245 |
| $R^2$ | 0.2563 | 0.2137 | 0.2537 | 0.2645 | 0.2394 | 0.2489 | 0.2556 | 0.2374 | 0.2387 |
| F | 39.7292 | 34.227 | 38.3357 | 44.7824 | 37.2364 | 40.4654 | 42.4431 | 36.504 | 37.6734 |

In Columns (1) to (3), the coefficients of *State\*Bar\*TCZ* are significantly negative (−0.0309, −0.0538 and −0.0448), indicating that compared with foreign-owned enterprises, state-owned enterprises could obtain higher bargaining power. Conversely, the coefficient of *Priv\*Bar\*TCZ* is only significantly negative (−0.0202) in Column (2), showing that after the implementation of environmental policies in the two control zones, private enterprises with higher value of tax payments could also obtain stronger bargaining power than foreign-owned enterprises, thus weakening the dynamic effects of environmental regulations on GTFP.

In Columns (4) to (6), the coefficients of *Offic\*Bar\*TCZ* are all significantly negative (−0.0199, −0.0202 and −0.0204), demonstrating that the change of government officials in the two control zones will increase enterprises' bargaining power and weaken the enforcement of environmental regulations. At the same time, the coefficients of *Plict\*Bar\*TCZ* in Columns (7) to (9) are all significantly positive (0.0616, 0.0379 and 0.0405). This shows that in the two control zones, cities with strong political constraints would reduce the bargaining power of enterprises and enhance the implementation of environmental policies, which would increase the dynamic effects. To sum up, the results in Table 6 validate the robustness of Hypotheses 3A, 3B and 3C.

## 8. Conclusions and Policy Suggestions

Our study investigates the impacts of environmental regulations on enterprise's GTFP with data obtained from the industrial pollution database under China's "environmental statistical reporting system" and the Chinese industrial enterprise database during 2007–2010. Based on the relaxed directional distance function, we calculate the GTFP at enterprise level using the Luenberger productivity index. This would enable us to evaluate whether the win-win goal of enterprise competitiveness and sustainable ecological environment could be realized via implementation of environmental policies. In our study, we find that enterprise bargaining power with local governments plays a significant role in mediating the impacts of environmental regulations. Besides, the enterprise bargaining power itself is influenced by various factors.

The empirical results of our study find that an enterprise's GTFP would be reduced by environmental regulations in the short run, while it would be increased in the long run. Moreover, using industrial output, tax revenue and number of employees as indicators, enterprise bargaining power would weaken the dynamic effects of environmental regulations. It is because the contribution of enterprises to local economic would be beneficial to local official's performance assessments. Local governments thus would provide certain degree of exemptions in terms of policy implementation. In addition, when the enterprises in our research are state-owned, locating in cities with official changes and weak political constraints, their bargaining power would be enhanced and the dynamic effects of environmental regulations would be further reduced. With above conclusions, out paper proposes following policy recommendations.

First, maintain the consistency of the environmental policies and avoid the "campaign" type law enforcement ("Campaign" type law enforcement refers to the short-term organized, purpose-oriented and large-scale law enforcement activities conducted by law agencies by utilizing labor forces and resources to solve the prominent problems.). In order to cope with severe ecological problems, the central government has already promulgated different kinds of environmental policies. However, due to idle government practices, inaction and slow action in terms of environmental supervision have appeared in some local governments. When the central environmental tightens the environmental policies, local officials tend to conduct the "campaign" to meet the requirements. In line with our conclusions, the dynamic impacts of environmental regulations on enterprises' GTFP is a long-term process. And only in the long run, these policies could have positive impacts on the GTFP. Without effective supervision, environmental externalities could not be internalized into production costs. Thus enterprises would not have sufficient incentives to improve their technology innovations and achieve higher GTFP. However, when the local governments implement environmental policies, polluting enterprises could not conduct green technology innovation in a short period of time. Usually, they can only opt for a temporary

production reduction or shutdown to cope with the environmental law enforcement and thus reduce their GFTP. Therefore, local governments should place greater emphasis on environmental regulations and form an institutionalized and normalized long-term environmental supervision mechanism, so as to avoid the sudden start and abrupt stop of "campaign" type environmental law enforcement.

Secondly, increase the weight of environmental performance appraisals and solve the incompatible problems between central objectives and local incentives. Our results indicate that polluting enterprises could obtain exemptions or relaxations of environmental regulations by applying bargaining power based on their contribution to industrial output, total tax payment and the number of employees. The ultimate reason for this is the incompatibility between the central objectives and local incentives. With the increasingly severity of pollution problems, the protection of the ecological environment has gradually become an equally important objective with economic growth and social stability. Therefore, in order to weaken the bargaining power of polluting enterprises and strengthen the enforcement of environmental regulations, the performance of environmental governance should be included in the evaluation system. Besides, the weight of environmental performance should be raised, so that local governments would change their attitude from passive to active in strict environmental policy implementation. In addition, the top-level design of the country's green development strategy should also be strengthened in order to pass on the environmental objectives at all levels of governments. With the efficient performance evaluation mechanisms introduced across the country, the bargaining power of polluting enterprises would be reduced.

Third, the reforms of environmental regulation mechanism and the central environmental protection supervision system should be continued and it is important to weaken the intervention of local governments during the implementation of environmental policies. For a long time, China's environmental regulation mechanism has adopted the territorial management model. Local governments have sufficient capacities to intervene the policy implementation. Our results show that these interventions would be more serious when the enterprises are state-owned and locating in the city with official changes or weak political constraints. As a result, cities with above characteristics have an urgent need to promote the reform of the environmental management system. On one hand, the vertical management system of environmental protection organizations should be enhanced to ensure independence, authority and effectiveness of environmental law enforcement in local areas. On the other hand, the central environmental protection supervision system should be further legalized and standardized, which would impose regular restrictions on provincial party committees, governments and related departments. Therefore, local governments would be forced to take initiatives to promote the full implementation of environmental policies.

## References

1. Ren, S.; Li, X.; Yuan, B.; Li, D.; Chen, X. The effects of three types of environmental regulation on eco-efficiency: A cross-region analysis in China. *J. Clean. Prod.* **2018**, *173*, 245–255. [CrossRef]

2. Wang, H.; Mamingi, N.; Laplante, B.; Dasgupta, S. Incomplete enforcement of pollution regulation: Bargaining power of Chinese factories. *Environ. Resour. Econ.* **2003**, *24*, 245–262. [CrossRef]

3. Jiang, L.; Lin, C.; Lin, P. The determinants of pollution levels: Firm-level evidence from Chinese manufacturing. *J. Comp. Econ.* **2014**, *42*, 118–142. [CrossRef]

4. Van Rooij, B. Implementation of Chinese environmental law: Regular enforcement and political campaigns. *Dev. Chang.* **2006**, *37*, 57–74. [CrossRef]

5. Song, M.; Du, J.; Tan, K.H. Impact of fiscal decentralization on green total factor productivity. *Int. J. Prod. Econ.* **2018**, *205*, 359–367. [CrossRef]

6. Renard, M.; Xiong, H. *Strategic Interactions in Environmental Regulation Enforcement: Evidence from Chinese Provinces*; CERDI: Clermont-Ferrand, France, 2012.

7. Van der Kamp, D.; Lorentzen, P.; Mattingly, D. Racing to the bottom or to the top? Decentralization, revenue pressures and governance reform in China. *World Dev.* **2017**, *95*, 164–176. [CrossRef]

8. Mahlberg, B.; Sahoo, B.K. Radial and non-radial decompositions of Luenberger productivity indicator with an illustrative application. *Int. J. Prod. Econ.* **2011**, *131*, 721–726. [CrossRef]

9. Bing, W.; Yanrui, W.; Pengfei, Y. Environmental Efficiency and Environmental Total Factor Productivity Growth in China's Regional Economies. *Econ. Res. J.* **2010**, *5*, 95–109.

10. Xie, R.; Yuan, Y.; Huang, J. Different Types of Environmental Regulations and Heterogeneous Influence on "Green" Productivity: Evidence from China. *Ecol. Econ.* **2017**, *132*, 104–112. [CrossRef]

11. Zhang, C.; Liu, H.; Bressers, H.T.A.; Buchanan, K.S. Productivity growth and environmental regulations—Accounting for undesirable outputs: Analysis of China's thirty provincial regions using the Malmquist–Luenberger index. *Ecol. Econ.* **2011**, *70*, 2369–2379. [CrossRef]

12. Shao, Y.; Wang, S. Productivity growth and environmental efficiency of the nonferrous metals industry: An empirical study of China. *J. Clean. Prod.* **2016**, *137*, 1663–1671. [CrossRef]

13. Shen, N.; Liao, H.; Deng, R.; Wang, Q. Different types of environmental regulations and the heterogeneous influence on the environmental total factor productivity: Empirical analysis of China's industry. *J. Clean. Prod.* **2019**, *211*, 171–184. [CrossRef]

14. Wang, Y.; Shen, N. Environmental regulation and environmental productivity: The case of China. *Renew. Sustain. Energy Rev.* **2016**, *62*, 758–766. [CrossRef]

15. Lanoie, P.; Patry, M.; Lajeunesse, R. Environmental regulation and productivity: Testing the porter hypothesis. *J. Prod. Anal.* **2008**, *30*, 121–128. [CrossRef]

16. Hailu, A.; Veeman, T.S. Environmentally sensitive productivity analysis of the Canadian pulp and paper industry, 1959–1994: An input distance function approach. *J. Environ. Econ. Manag.* **2000**, *40*, 251–274. [CrossRef]

17. Zhou, Y.; Xu, Y.; Liu, C.; Fang, Z.; Fu, X.; He, M. The Threshold Effect of China's Financial Development on Green Total Factor Productivity. *Sustainability* **2019**, *11*, 3776. [CrossRef]

18. Yue, S.; Yang, Y.; Hu, Y. Does foreign direct investment affect green growth? Evidence from China's experience. *Sustainability* **2016**, *8*, 158. [CrossRef]

19. Lin, B.; Chen, Z. Does factor market distortion inhibit the green total factor productivity in China? *J. Clean. Prod.* **2018**, *197*, 25–33. [CrossRef]

20. Liu, G.; Wang, B.; Zhang, N. A coin has two sides: Which one is driving China's green TFP growth? *Econ. Syst.* **2016**, *40*, 481–498. [CrossRef]

21. Zhang, J.; Tan, W. Study on the green total factor productivity in main cities of China. *Zb. Rad. Ekon. Fak. Rijeci/Proc. Rij. Fac. Econ.* **2016**, *34*, 215–234.

22. Cui, H.; Wang, H.; Zhao, Q. Which factors stimulate industrial green total factor productivity growth rate in China? An industrial aspect. *Greenh. Gases Sci. Technol.* **2019**, *9*, 505–518. [CrossRef]

23. Heyes, A. Implementing environmental regulation: Enforcement and compliance. *J. Regul. Econ.* **2000**, *17*, 107–129. [CrossRef]

24. Rohling, M. Prices vs. Quantities with Incomplete Enforcement and Different Enforcement Probabilities. In Proceedings of the Sixth Annual Conference of the Verein für Socialpolitik, Research Committee Development Economics, Hannover, Germany, 18–19 June 2010.

25. Coria, J.; Villegas-Palacio, C.; Cárdenas, J.C. *Should We Tax or Let Firms Trade Emissions? An Experimental Analysis with Policy Implications for Developing Countries*; Department of Economics, University of Gothenburg: Gothenburg, Sweden, 2011.

26. MacKenzie, I.A.; Ohndorf, M. Optimal monitoring of credit-based emissions trading under asymmetric information. *J. Regul. Econ.* **2012**, *42*, 180–203. [CrossRef]

27. Jaffe, A.B.; Palmer, K. Environmental Regulation and Innovation: A Panel Data Study. *Rev. Econ. Stat.* **1997**, *79*, 610–619. [CrossRef]

28. Gray, W.B.; Shadbegian, R.J. Plant vintage, technology and environmental regulation. *J. Environ. Econ. Manag.* **2003**, *46*, 384–402. [CrossRef]

29. Porter, M.E.; Claas, V.D.L. Toward a New Conception of the Environment-Competitiveness Relationship. *J. Econ. Perspect.* **1995**, *9*, 97–118. [CrossRef]

30. Porter, M.E. Towards a dynamic theory of strategy. *Strateg. Manag. J.* **1991**, *12*, 95–117. [CrossRef]

31. Peuckert, J. What shapes the impact of environmental regulation on competitiveness? Evidence from Executive Opinion Surveys. *Environ. Innov. Soc. Transit.* **2014**, *10*, 77–94. [CrossRef]

32. Yang, C.; Tseng, Y.; Chen, C. Environmental regulations, induced R&D and productivity: Evidence from Taiwan's manufacturing industries. *Resour. Energy Econ.* **2012**, *34*, 514–532.

33. Kaneko, S.; Managi, S. Environmental productivity in China. *Econ. Bull.* **2004**, *17*, 1–10.

34. Li, H.; Zhou, L. Political turnover and economic performance: The incentive role of personnel control in China. *J. Public Econ.* **2005**, *89*, 1743–1762. [CrossRef]

35. Yu, J.; Gao, X. Behavioral Logic and Institutional Basis of Local Developmental States. *Soc. Sci. China* **2012**, *5*, 95–112.

36. Fan, J.P.; Wong, T.J.; Zhang, T. Politically connected CEOs, corporate governance and Post-IPO performance of China's newly partially privatized firms. *J. Financ. Econ.* **2007**, *84*, 330–357. [CrossRef]

37. Ding, S.; Jia, C.; Wu, Z.; Zhang, X. Executive political connections and firm performance: Comparative evidence from privately-controlled and state-owned enterprises. *Int. Rev. Financ. Anal.* **2014**, *36*, 153–167. [CrossRef]

38. Kornai, J. Resource-Constrained versus Demand-Constrained Systems. *Econometrica* **1979**, *47*, 801–819. [CrossRef]

39. Shleifer, A.; Vishny, R.W. Politicians and Firms. *Q. J. Econ.* **1994**, *109*, 995–1025. [CrossRef]

40. Maung, M.; Wilson, C.; Tang, X. Political connections and industrial pollution: Evidence based on state ownership and environmental levies in China. *J. Bus. Ethics* **2016**, *138*, 649–659. [CrossRef]

41. Li, H.; Meng, L.; Zhang, J. Why Do Entrepreneurs Enter Politics? Evidence from China. *Econ. Inq.* **2006**, *44*, 559–578. [CrossRef]

42. Chen, C.J.P.; Li, Z. Rent Seeking Incentives, Political Connections and Organizational Structure: Empirical Evidence from Listed Family Firms in China. *City Univ. Hong Kong Work. Pap.* **2005**, *1*, 22–29.

43. Lazear, E. Rank-Order Tournaments as Optimal Labor Contracts. *J. Political Econ.* **1981**, *89*, 841–864. [CrossRef]

44. Luo, D.L.; She, G.M.; Chen, J. A New Re-Examination of the Relationship between Economic Performance and Local Leader'Promotion: New Theory and New Evidence from City-Level Data. *China Econ. Q.* **2015**, *3*, 1145–1171.

45. Chen, Y.; Li, H.; Zhou, L. Relative performance evaluation and the turnover of provincial leaders in China. *Econ. Lett.* **2005**, *88*, 421–425. [CrossRef]

46. Li, B.; Wu, S. Effects of local and civil environmental regulation on green total factor productivity in China: A spatial Durbin econometric analysis. *J. Clean. Prod.* **2017**, *153*, 342–353. [CrossRef]

47. Zheng, S.; Kahn, M.E.; Sun, W.; Luo, D. Incentives for China's urban mayors to mitigate pollution externalities: The role of the central government and public environmentalism. *Reg. Sci. Urban Econ.* **2014**, *47*, 61–71. [CrossRef]

48. Zhang, N.; Choi, Y. A note on the evolution of directional distance function and its development in energy and environmental studies 1997–2013. *Renew. Sustain. Energy Rev.* **2014**, *33*, 50–59. [CrossRef]

49. Song, M.; An, Q.; Zhang, W.; Wang, Z.; Wu, J. Environmental efficiency evaluation based on data envelopment analysis: A review. *Renew. Sustain. Energy Rev.* **2012**, *16*, 4465–4469. [CrossRef]

50. Charnes, A.; Cooper, W.W.; Lewin, A.Y.; Seiford, L.M. *Data Envelopment Analysis: Theory, Methodology and Applications*; Springer Science & Business Media: Berlin/Heidelberg, Germany, 2013.

51. Oh, D.; Heshmati, A. A sequential Malmquist–Luenberger productivity index: Environmentally sensitive productivity growth considering the progressive nature of technology. *Energy Econ.* **2010**, *32*, 1345–1355. [CrossRef]

52. Zhao, X.; Sun, B. The influence of Chinese environmental regulation on corporation innovation and competitiveness. *J. Clean. Prod.* **2016**, *112*, 1528–1536. [CrossRef]

53. Wu, W. Commencement of Bankruptcy Proceedings in China: Key Issues in the Proposed New Enterprise Bankruptcy and Reorganisation Law. *Vic. Univ. Wellingt. Law Rev.* **2004**, *3fi5*, 239.

54. Bai, C.; Du, Y.; Tao, Z.; Tong, S.Y. Local protectionism and regional specialization: Evidence from China's industries. *J. Int. Econ.* **2004**, *63*, 397–417. [CrossRef]