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Can Regional Integration Policies Enhance the Win–Win Situation of Economic Growth and Environmental Protection? New Evidence for Achieving Carbon Neutrality Goals

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Abstract: In the pursuit of carbon neutrality goals, local governments usually face the dilemma of whether to focus on economic development or environmental protection. Regional integration is a beneficial policy solution to address the challenges inherent to this dilemma. This research considers the expansion of the Urban Economic Coordination Committee in the Yangtze River Delta as a quasi-natural experiment in regional integration. It employs the difference-in-differences model to assess its potential for fostering a win–win situation in terms of economic growth and environmental protection, with the results showing that regional integration has a significantly positive impact on attaining this win–win situation. Inhibiting pollution transfer and promoting green transformation are crucial mechanisms by which regional integration can help strike a balance between economic growth and environmental protection. However, the effects of both regional integration and win–win mechanisms are heterogeneous across cities. The conclusion suggests that the government should accelerate the implementation of regional integration policies across a wider range, recognize and maximize the important role of intermediate mechanisms, and encourage cities to adopt different strategies according to their heterogeneous characteristics, forming a high-level collaborative development pattern.

Keywords: carbon neutrality goals; regional integration; win–win situation; difference-in-differences method; Yangtze River Delta

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1. Introduction

Many regions around the world face increasingly serious challenges related to environmental pollution and economic contraction. Promoting carbon neutrality is an inherent requirement for overcoming environmental constraints and ensuring the sustainability of economic growth, and it is a global concern that is gaining attention worldwide. The introduction of the concepts of "carbon peaking" and "carbon neutrality" in the 2015 Paris Agreement marked a significant milestone in the global transition towards sustainable economies [1]. Decoupling economic growth from increasing carbon emissions is undeniably a tough but pressing task [2]. Currently, several scholars have examined various approaches to enhancing emission reduction from the perspectives of green innovation [3], green policies [4], and green behaviors [5]; however, limited research has been conducted on how to achieve emission reductions without compromising economic growth. To align with China's dual carbon goal, achieving a win–win situation that harmonizes both economic growth and environmental protection is imperative.

Many countries have introduced a range of policies aiming to achieve this win–win situation. However, the ecological environment, as a public good with a large number of externalities, makes it challenging to obtain compensation for local pollution control costs [6].

Some scholars have proposed that advanced emission reduction technologies should be provided by developed countries to developing countries [7] and that an international carbon market should be established to reduce pollution externalities [8]. However, the lack of a coordinated system for international emission reduction hinders joint responsibility implementation for emission reduction in reality [9]. In this case, regional integration policies have emerged, aiming to promote cross-border economic and environmental cooperation. An illustrative example is the North American Agreement on Environmental Cooperation [10].

In addition, China has made some favorable efforts in this regard. As the most highly integrated and economically developed region in China, the Yangtze River Delta is a pilot area for promoting balanced economic growth and green transformation [11,12]. Since its establishment in 1997, the Urban Economic Coordination Committee (UECC) has accelerated regional integration within the Yangtze River Delta by promoting cooperation between cities. Specifically, the UECC aims to establish a cross-border ecological governance system to prevent pollution transfer resulting from industrial relocation while also facilitating collaborative technological breakthroughs to drive the green transformation of polluting enterprises. In this regard, coordinated pollution prevention and control is set as the UECC's development objective. A regional office for air pollution prevention and control cooperation has been established in the Yangtze River Delta, gradually implementing harmonization of regional pollutant emission standards. These environmental regulation measures increase enterprise costs associated with transferring pollution and effectively constrain their motivation to seek out havens.

The objective of this research is to explore the possibility of regional integration in enhancing the win–win situation of economic growth and environmental protection. Drawing on the specific strategic approach of the UECC, this paper investigates the efficacy of two win–win mechanisms: inhibiting pollution transfer and promoting green transformation. This research paper offers three noteworthy contributions.

Firstly, the current research primarily focuses on the economic and environmental consequences of integration in economically developed regions such as Europe and the United States [13–16]. However, developing countries face unique challenges in balancing economic growth and environmental protection. In particular, developing countries are unwilling to compromise economic growth for the sake of promoting environmental protection due to non-compliance with the "fair but differentiated principle" [17]. This study takes China, the largest developing country, as its research subject and reveals that regional integration is advantageous for achieving a win–win situation of economic growth and environmental protection; it also reveals that inhibiting pollution transfer and promoting green transformation are internal mechanisms. Therefore, the research findings provide valuable insights for developing countries aiming to achieve the dual carbon goal, thereby offering a significant contribution to the existing body of literature.

Secondly, the current research focuses on the potential of regional integration to stimulate economic growth [18,19] and mitigate environmental pollution [20]. Some scholars have realized that regional integration is conducive to improving carbon emission performance [21], linking carbon markets [22] and reducing carbon intensity [23]. However, there has been a lack of investigation into the determinants of a win–win situation concerning economic growth and environmental protection. The government aims to maintain economic growth while alleviating environmental pollution. This study demonstrates that regional integration can achieve a win–win situation, providing policy implications for governmental authorities. The present study thus addresses the limitations of previous research by integrating regional integration, economic growth, and environmental protection within a comprehensive analytical framework.

Finally, some scholars contend that enhancing environmental regulations is pivotal in augmenting the efficacy of environmental protection [24,25]. However, environmental regulations may only mitigate local environmental pollution and fail to restrict the spatial diffusion of pollution. Moreover, compliance costs associated with environmental regulations could impede economic growth [26]. This paper posits that regional integration could make up for the deficiency of environmental regulation and help strike a balance between economic growth and environmental protection by inhibiting pollution transfer and promoting green transformation. Therefore, this paper reveals the mechanism black box of regional integration and further clarifies the pathways to achieve a win–win situation concerning economic growth and environmental protection.

The rest of this manuscript is organized as follows: Section 2 offers an extensive examination of the relevant literature, Section 3 delineates the research methodology employed in this study, Section 4 presents and analyzes the primary findings, and Section 5 provides key conclusions and related recommendations.

2. Literature Review

2.1. The Win–Win Situation

The win–win situation referred to throughout this paper means one in which economic growth and environmental protection are in a state of coordination, which is a necessary condition for achieving carbon peaking and carbon neutrality goals. Therefore, scientific estimation of the levels required within this coordination state is a fundamental step towards formulating economic development targets, emission reduction targets, and policies to improve environmental quality more comprehensively. Coordination state levels could be measured using either "quality" or "efficiency" approaches. Quality indicators usually adopt a comprehensive index consisting of growth quality level, environmental ecological level, resource utilization efficiency, and environmental governance, which are linearly weighted and coupled with many single indicators. Examples include the environmental performance index (EPI), green economy performance index system [27,28], ecosystem service management indicators [29], and human green development index (HGDI) [30]. Although the comprehensive index method has strong practicability, these indicators have limitations in objectively considering the multi-dimensional characteristics of sustainable development and the complex effects of environmental and social factors. On the contrary, the efficiency index is measured from the perspective of input–output, comprehensively considering factors related to economic activities such as capital investment, labor scale, energy consumption, and so on, as well as desirable and undesirable outputs. The methods applied to study efficiency include the data envelopment analysis (DEA) method as well as stochastic frontier analysis (SFA) approaches [31–34] and their various extended models, such as the DDF-DEA and SBM-GML models. The efficiency measure indicator calculated using those methods is usually called green total factor productivity (GTFP); it comprehensively and objectively measures the relationship between desirable outputs such as GDP and undesirable outputs such as carbon dioxide, sulfur dioxide, and air pollutants, avoiding the influence of subjective factors to obtain more accurate assessments, representing, to a certain extent, the win–win situation of striking a balance between economic growth and environmental protection. Therefore, this study adopts the green total factor productivity (GTFP) to characterize the win–win situation concerning economic growth and environmental protection based on the Super-SBM model.

In addition to measuring and analyzing the characteristics of and relationship between the economy and environment, scholars also pay attention to the effects and influencing mechanisms of a wide range of factors using panel models and spatial econometric methods. Factors that have been extensively studied include technological innovation [35,36], industrial structure and clusters [37], urbanization level [38], foreign direct investment (FDI) [39], financial support and subsidies [40,41], environmental regulations [42], human capital [43], etc. Theoretical and empirical research has pointed out that there are complex and diverse driving factors between economic growth and environmental protection. Ma et al. [44] concluded that the Chinese digital economy could directly promote high-quality green development, with a positive nonlinear effect, but the marginal effect is decreasing, and industrial structure adjustment and green technology innovation are significant intermediary mechanisms. Chen [45] elucidated that the intensity of R&D investment in the central and eastern regions has a significant positive and heterogeneous impact on the efficiency of industrial green development in China. In summary, existing studies have found that many market and government factors affect the process of regional economic green development. However, few scholars have paid attention to whether regional integration can coordinate economic growth and environmental protection.

2.2. Regional Integration

Regional integration originated from economic and trade exchanges between countries; through the establishment of a customs union and free trade area, trade barriers have been weakened or eliminated, production factors have tended to flow freely [46,47], and the innovation activities of enterprises have been strengthened, thus enhancing the ability of member states to jointly cope with external risks. The development and prosperity of the European Union (EU) is a canonical example of regional integration. However, regional integration has intensified market competition. Due to the consideration of the cost–benefit ratio and trade deficit, new member countries' enterprises and industries will inevitably undergo local migration. There is a risk of trade and industry transfer, and market activity and economic resilience will decline for new members. Schemenets et al. [48] pointed out that after Ukraine joined the free trade zone, the number of new technology processes implemented by enterprises and the proportion of innovative products in the sales of industrial products decreased.

International academic research on regional integration focuses on three aspects. The first is the formation, historical evolution, and practical path of regional integration. Pang [49] interpreted the internal relationship and changes between regionalization, group development practice, and regional integration. Liebman et al. [50] found that the historical heritage of the Soviet Union has a direct impact on the evolution of Eurasian regional organization itself through the inertial effect of implicit environmental factors and path dependence. The second aspect is influencing factors and internal mechanism of regional integration. Scholars have carried out extensive discussions on the impact of regional integration on economic infrastructure, urban resilience and sprawl, green innovation, and income gap [51–54]. For example, by building a multidimensional infrastructure index, Saima [51] confirmed that the complementarity of infrastructure with institutions and regional integration are factors that play a stimulating role in improving the spillover effects of infrastructure. An empirical study by Jiang [54] showed that RIPs have a significant influence, improving urban resilience by 8.6%; RIPs could thus enhance economic resilience remarkably without any obvious effect on society and infrastructure. The third aspect is the evaluation of regional integration. Many researchers replace regional integration with factor flow, industrial agglomeration, market integration, and opening, and construct a composite index to characterize the degree of regional integration [55–57]. Some researchers use dummy variables to observe these policy changes. Based on the panel data for 241 cities, the empirical results from Feng et al. [58] explored the effect of regional integration on economic resilience. In short, while there are numerous studies on regional integration, there remains a gap in the exploration of its relationship with the economy and environment.

2.3. The Mechanism of Regional Integration to Attain the Win–Win Situation

Regional integration and the win–win situation of economic growth and environmental protection are closely related. Firstly, in the initial stage of regional integration, the policy objective was to increase the market size and promote economic growth by strengthening cooperation among local governments. However, the blind pursuit of economic development has brought about environmental pollution problems. Moreover, the externality of environmental pollution intensifies the contradiction between local governments, which is not conducive to the in-depth development of regional integration. Therefore, another goal of regional integration is to alleviate environmental pollution within the region by formulating a series of cooperative governance policies. Especially driven by the carbon neutrality target, environmental protection has become as important as economic growth, and both have become important goals of regional integration.

Secondly, inhibiting pollution transfer is considered to be an important mechanism linking regional integration and the achievement of the win–win situation. Based on the extensive negative externality of environmental pollution, the spatial spillover of environmental pollution is going from bad to worse. The pollution haven hypothesis [59] is a concentrated portrayal of environmental problems that profoundly reveals the dilemma of local sustainable development. Research indicates that regional disparities in the stringency of environmental regulations serve as the primary impetus for firms to seek out pollution havens [60–62], so cross-border governance has become a necessary means of solving the transfer of environmental pollution [63]. In this case, the implementation of regional integration policies promotes the spatial agglomeration of production factors, as well as the sharing of industries, transport networks, and pollution control systems, inhibiting environmental pollution due to the pollution haven effect. At the same time, regional integration can also enhance environmental cooperation among participating areas [64], reduce carbon dioxide marginal abatement costs [65], and promote technology spillover to mitigate environmental pollution [66] to achieve a win–win situation concerning economic growth and environmental protection.

Third, the promotion of green transformation has played a key role in regional integration and the win–win situation, remarkably advancing the upgrading of industrial structure and the improvement of green output efficiency. On the one hand, regional integration reduces productive factors such as circulation costs and transaction costs, and based on the difference in factor prices, productive factors will flow to industries with high rates of return to facilitate efficient allocation and optimal utilization of resources. Enterprises with high pollution, high energy consumption, high emissions, and low capacity will be eliminated, and enterprises with high industrial homogeneity in the region will be merged to rationalize and advance the industrial structure. On the other hand, based on the high infrastructure accessibility, regional integration can provide opportunities for local governments to cooperate in international trade [19], foreign investment introduction [67], and income inequality [68,69]. By establishing common markets and supply chains, countries could share and complement resources, improve the efficiency of energy resource utilization, and accelerate the innovation and diffusion of new technologies, improving local energy use efficiency and green output efficiency, ultimately boosting economic growth and environmental protection [70,71].

The attention of scholars has been captured by the mutually beneficial mechanisms that promote both economic growth and environmental protection. Wang et al. [72] argued that cities equipped with advanced technologies can enhance environmental efficiency, thereby enhancing the win–win effect of economic growth and environmental protection. Yang et al. [25] suggested that by upgrading the industrial structure, increasing the construction of drainage infrastructure, and encouraging centralized wastewater treatment, a win–win situation balancing water resource management and economic development can be achieved. Tian et al. [73] discovered that regional trade agreements not only increase the economic output of member countries but also exacerbate global CO_2 emissions. However, the technological spillover effects of deeper trade liberalization can help alleviate this burden to a certain degree.

In summary, local governments place significant emphasis on balancing economic growth and environmental preservation during the process of regional integration, which has attracted substantial scholarly interest. However, further research is imperative to ascertain whether regional integration can effectively achieve a mutually beneficial outcome for both economic growth and environmental protection. Additionally, it is important to acknowledge that regional integration may give rise to the pollution haven effect as well as technology spillover effects. Therefore, it is crucial to conduct further investigations into whether inhibiting pollution transfer and promoting green transformation can serve as viable win–win mechanisms. The influencing mechanisms framework of the study is illustrated in Figure 1.

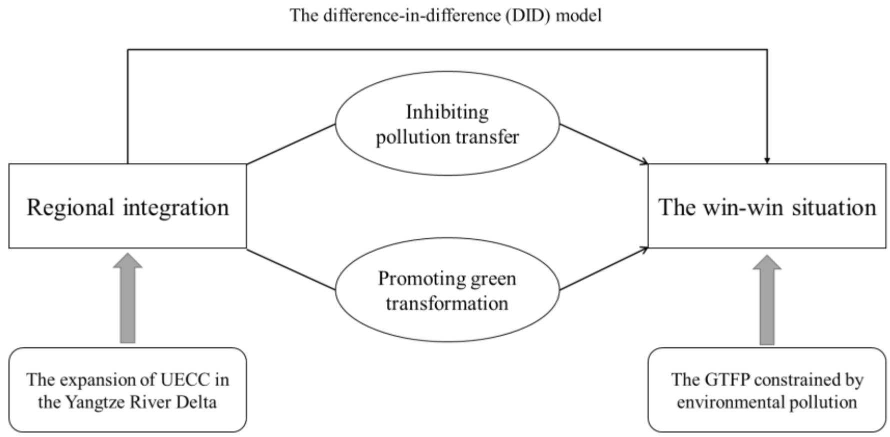

Figure 1. Influencing mechanism framework of the study.

3. Materials and Methods

3.1. Identifying Regional Integration and the Win–Win Situation of Economic Growth and Environmental Protection

3.1.1. Identifying Regional Integration

The establishment of the UECC in the Yangtze River Delta is a pivotal policy in implementing the regional integration strategy of China. In 1997, the UECC was established by 15 cities including Shanghai, Nanjing, Hangzhou, Suzhou, Ningbo, Wuxi, Changzhou, Nantong, Jiaxing, Yangzhou, Huzhou, Shaoxing, Zhoushan, Zhenjiang and Taizhou. Subsequently, in 2003, Taizhou joined the UECC, thus forming a coalition of 16 core cities. In 2010, Yancheng, Huai'an, Jinhua, Quzhou, Hefei, and Ma'anshan were incorporated into the UECC. In 2013, Xuzhou, Wuhu, Huainan, Chuzhou, Lishui, Wenzhou, Suqian, and Lianyungang were assimilated by the UECC. The expansion continued in 2018, with Tongling, Chizhou, Anqing, and Xuancheng joining the UECC. In 2019, Bengbu, Lu'an, Huangshan, Huaibei, Suzhou, Fuyang, and Bozhou became members of the UECC. After five rounds of expansion, a total of 41 cities from Shanghai, Jiangsu, Zhejiang, and Anhui have all become members of the UECC. The distribution of cities is shown in Figure 2.

Figure 2. Distribution of cities in the Yangtze River Delta.

The UECC has implemented a range of measures to promote economic growth and enhance environmental protection, including the establishment of the Yangtze River Delta Pilot Free Trade Zone to expand the domestic demand market and the signing of China's first declaration about regional environmental cooperation aiming to address cross-border pollution issues: the Declaration on Regional Environmental Cooperation in the Yangtze River Delta. The expansion of the UECC provides a quasi-natural experiment for identifying regional integration between new cities and core cities. Drawing on the ideas of Huan et al. [74], we can regard the expansion of the UECC in the Yangtze River Delta after 2010 as an example of regional integration.

3.1.2. Identifying the Win–Win Situation for Economic Growth and Environmental Protection

The green total factor productivity (GTFP) constrained by environmental pollution is a widely used indicator for evaluating win–win situations regarding economic growth and environmental protection [19,72,75]. GTFP is influenced by the connections between inputs and outputs, where inputs encompass capital, labor, and technology, while outputs comprise GDP and pollutants. Among these outputs, GDP is considered desirable, while pollutants are deemed undesirable. The primary objective of regional integration is to promote GDP growth while limiting pollutant emissions. Therefore, the increase in GTFP signifies a simultaneous reduction in undesirable outputs and an augmentation of desirable outputs, thereby exemplifying a mutually beneficial scenario for both economic growth and environmental protection.

Data envelopment analysis (DEA) is a robust technique used to assess decision-making entities (DMUs), which have numerous inputs and outputs, without the need for predetermining functional relationships. The proposed efficiency measure method solves the measurement problem of input/output slack and undesirable output by directly incorporating slack variables into the objective function. However, empirical research on efficiency evaluation has often resulted in multiple DMUs being classified as efficient at 100%, creating sorting and comparison challenges. To overcome this issue, Tone [76,77] introduced the super SBM model; this approach effectively addresses the comparability issue encountered in frontier samples. In this paper, the super SBM model considering undesirable output is used to measure GTFP [75,78].

$$
\begin{aligned}
&\varphi^* = \min\left[\frac{(1/m)\sum_{i=1}^{m}\overline{x}/x_{io}}{1/(s_1+s_2)(\sum_{r=1}^{s_1} y^g/y^g_{ro}+\sum_{u=1}^{s_2} y^b/y^b_{uo})}\right]\\
&(s.t.)\overline{x} \geq \textstyle\sum_{.j=1,j\neq o}^{n} \lambda_j x_{ij}, i = 1,\ldots,m\\
&\qquad \overline{y}^g \leq \textstyle\sum_{j=1,j\neq o}^{n} \lambda_j y^g_{rj}, r = 1,\ldots,s_1\\
&\qquad \overline{y}^b \geq \textstyle\sum_{j=1,j\neq o}^{n} \lambda_j y^b_{uj}, u = 1,\ldots,s_2\\
&\qquad \lambda_j > 0, j = 1,\ldots,n, j \neq o\\
&\qquad \overline{x} \geq x_0, i = 1,\ldots,m\\
&\qquad \overline{y}^g \leq y^g_o, r = 1,\ldots,s_1\\
&\qquad \overline{y}^b \geq y^b_o, u = 1,\ldots,s_2
\end{aligned}
\tag{1}
$$

where φ^*, whose range could be >1, stands for the super-efficiency value of the DMU. Suppose a production system has n DMUs, each of which has three vectors: inputs ($x \in R_m$), desirable outputs ($y^g \in R_{S1}$), and undesirable outputs ($y^b \in R_{s2}$). m, s_1, and s_2 are the numbers of those vectors, respectively. $\overline{x}, \overline{y}^g, \overline{y}^b$ are the average values of those vectors, respectively. λ denotes the non-negative intensity vector.

The Input variables selected for this study include labor, capital, and technology. Specifically, the labor input is measured by the number of urban employed population members. To determine the capital stock, we have utilized the perpetual inventory approach [79]. Technology is represented by R&D investment. The GDP is selected as the desirable output. Given its high mobility and impact on local environments, air pollution has become a focal point for joint prevention and control efforts undertaken by local governments. Therefore, we consider emissions of CO_2, SO_2, and PM2.5 undesirable outputs [80].

3.2. Models

3.2.1. Identifying Whether Regional Integration Can Achieve a Win–Win Situation for Economic Growth and Environmental Protection

The establishment of the UECC in the Yangtze River Delta is a pivotal policy in the implementation of China's regional integration strategy, while the difference-in-differences (DID) model serves as a prevalent approach in the field of policy impact evaluation [25,81]. Therefore, to investigate the potential for regional integration in achieving a win–win situation for economic growth and environmental protection, we employed a DID model to assess the impact of the expansion of the UECC on GTFP:

$$GTFP_{it} = \alpha_0 + \alpha_1 INT_{it} + \alpha_2 X_{it} + \mu_i + \eta_t + \varepsilon_{it} \tag{2}$$

where GTFP is the variable used to measure the win–win situation for economic growth and environmental protection of a city i in year t. INT_{it} is regional integration, which is represented by a dummy variable of whether city i has joined the UECC in year t. The treatment group comprises 16 core cities and 25 new cities that have successively joined the UECC since 2010, while the control group consists of cities outside the Yangtze River Delta. X_{it} represents the control variables considered in this paper. u_i and η_t are the fixed effects for cities and years, respectively. ε_{it} denotes a random error term. α is the parameter to be estimated. α_1 is the coefficient of concern in this research. If $\alpha_1 > 0$, it indicates that the regional integration has had a significantly positive effect on the win–win situation for economic growth and environmental protection.

3.2.2. Identifying How Regional Integration Enhances the Win–Win Situation concerning Economic Growth and Environmental Protection

To examine whether inhibiting pollution transfer is a win–win mechanism, this paper constructs the following model:

$$GTFP_{it} = \gamma_0 + \gamma_1 POL_{it} + \gamma_2 X_{it} + \mu_i + \eta_t + \varepsilon_{it} \tag{3}$$

$$POL_{it} = \beta_0 + \beta_1 INT_{it} + \beta_2 X_{it} + \mu_i + \eta_t + \varepsilon_{it} \tag{4}$$

where *POL* represents environmental pollution. The meanings of GTFP and INT are consistent with those above. In Equation (3), if $\gamma_1 < 0$, it is significantly negative, indicating that environmental pollution hinders the achievement of a win–win situation for economic growth and environmental protection. In Equation (4), *INT* is still regional integration represented by dummy variables, but the treatment group is divided into three cases. First, the treatment group includes core cities and new cities. Second, there are only core cities in the treatment group. Third, the treatment group has only new cities. The coefficient β_1 in the first scenario can vary, either being negative or positive, contingent upon the extent to which regional integration manifests evident impacts on environmental collaborative governance. If the coefficient β_1 exhibits a significant negative value in the second scenario and a significantly positive value in the third scenario, it can be inferred indirectly that regional integration has resulted in the relocation of environmental pollution from core cities to new cities. Conversely, if this coefficient does not demonstrate such trends, it can be concluded that there is no evidence of pollution transfer.

To examine whether promoting green transformation is a win–win mechanism, this paper constructs the following model:

$$GRE_{it} = \delta_0 + \delta_1 INT_{it} + \delta_2 X_{it} + \mu_i + \eta_t + \varepsilon_{it} \tag{5}$$

$$GTFP_{it} = \rho_0 + \rho_1 INT_{it} + \rho_2 GRE_{it} + \rho_3 X_{it} + \mu_i + \eta_t + \varepsilon_{it} \tag{6}$$

where *GRE* represents green transformation. The meanings of GTFP and *INT* are consistent with those above. δ *and* ρ are the parameters to be estimated. If $\delta_1 > 0$ and $\rho_2 > 0$, it is indicated that the regional integration has improved green transformation and the green transformation has promoted the achievement of our research objectives.

3.3. Variables

3.3.1. Independent Variable: Regional Integration (INT)

As mentioned in Section 3.1.1, the expansion of the UECC in the Yangtze River Delta after 2010 is regarded as an example of regional integration (*INT*). *INT* is a dummy variable that is assigned 1 if city i has already joined the UECC in year t and is assigned 0 otherwise.

3.3.2. Dependent Variable: The Win–Win Situation for Economic Growth and Environmental Protection (GTFP)

The DEA method, introduced in Section 3.1.2, is utilized to calculate GTFP, which includes inputs, desired outputs, and undesirable outputs at the city level.

3.3.3. The Win–Win Mechanism Variables

(1) Environmental pollution (*POL*).

The transfer of pollution between cities is primarily facilitated through industrial relocation, particularly the movement of highly polluting industrial enterprises. To examine the influence of regional integration on pollution transfer, this study employs the emission intensity of pollutants as a measure of environmental pollution, specifically focusing on the ratios of CO_2, SO_2, and PM2.5 to GDP.

(2) Green transformation (*GRE*).

The rise in the proportion of environmentally friendly industries is indicative of urban green transformation, which can be quantified using the location entropy method as follows:

$$GRE_{it} = \frac{CLE_{ijt}/GDP_{it}}{CLE_{jt}/GDP_{t}} \tag{7}$$

where GRE_{it} represents the green transformation of the city i in year t. CLE_{ijt} denotes the output value of industry j in city i in year t, which is represented by the main business income of listed companies. GDP_{it} represents the gross domestic product of city i in year t. CLE_{jt} represents the total output value of national industry j in year t. GDP_t refers to China's gross domestic product in year t. The larger the GRE_{it} is, the stronger the green transformation ability of city i in year t is compared with that of the whole country. According to the Guidelines on Environmental Information Disclosure of Listed Companies published by the Ministry of Environmental Protection of China, heavily polluting industries encompass 16 categories, including thermal power, coal, steel, cement, electrolytic aluminum, chemical, paper making, petrochemical, metallurgy, building materials, brewing, pharmaceuticals, textiles, fermentation, tanning, and mining. Industry j refers to other industries that are not included in these heavily polluting categories.

3.3.4. Control Variables

To alleviate the issue of missing variables, this paper incorporates the following control variables. (1) Openness level (*OPE*), which is determined by the ratio of foreign direct investment (FDI) to GDP. The inflow of FDI may facilitate technology diffusion, thereby mitigating environmental pollution. However, it can also exacerbate environmental pollution through the pollution haven effect [82]; (2) Financial development (*FIN*), which is calculated as the ratio of financial institutional loans to GDP. Enhanced financial development can alleviate the financing constraints associated with both economic growth and pollution control [83]; (3) Environmental regulation (*REG*), which is reflected by the government's environmental attention and quantified by the proportion of frequency of the term "environmental protection" in the government work report [84]. Environmental regulations can either stimulate economic growth through the innovation compensation effect or impede it due to the compliance cost effect [85]; (4) Population density (*POP*), which is determined by dividing the urban population by the area of the administrative district. Although an increase in population density can lead to an expansion of market demand and subsequently stimulate economic growth, it also poses a threat to the local environmental carrying capacity [86]; (5) Government intervention (*GOV*), which is measured by the ratio of fiscal expenditures to GDP. Government intervention not only plays a crucial role in macroeconomic control to promote growth but also serves as a catalyst for investment in environmental governance [87].

3.4. Descriptive Statistics of Variables

This study covers the period from 2007 to 2021 and incorporates data from 285 cities across China. The expanded information of the UECC in the Yangtze River Delta was manually collected through Baidu Baike (https://baike.baidu.com/) (accessed on 10 September 2023). The basic data for measuring GTFP and POL were obtained from various sources, including the China City Statistical Yearbook, Corrected NPP-VIIRS nighttime light data, and NASA Socioeconomic Data and Applications Center [88,89]. Meanwhile, CSMAR provided necessary data for calculating GRE (https://www.gtarsc.com/) (accessed on 15 September 2023). Control variables were measured using data sourced from China City Statistical Yearbooks as well as statistical yearbooks of various provinces and cities. To minimize the influence of price fluctuation, all price-specific data were adjusted to reflect their values at a constant level of 2005 based on the consumer price index.

Table 1 provides an overview of the descriptive statistics for these variables. From the statistics of various variables, the average GTFP is 1.2195; the maximum value is 3.7476, and the minimum value is 0.1438, indicating the large gap between cities and years. The average levels of CO_2, SO_2, and PM2.5 belonging to POL are 0.8723, 2.0402, and 0.1298, respectively; the highest levels are 14.8640, 62.2074, and 9.3229, respectively, the lowest level is 0.001, and the gap is particularly large. The average level of GRE is 0.3672; the highest level is 14.3148, and the lowest is 0.000. From the statistics of control variables, the average level of OPE development is 1.8602; the highest level is 19.8940, and the lowest is 0.0011. The average level of FIN is 0.8722; the highest level is 9.6221, and the lowest is 0.0753. The average level of REG is 0.0114; the highest level is 0.2445, and the lowest level is 0.0045. The average level of POP is 0.0456; the highest level is 0.6626, and the lowest level is 0.0005. The average level of GOV is 0.1761; the highest level is 1.4852, and the lowest level is 0.0426. It can be seen that the gap is large and the imbalance between regional cities is serious.

Table 1. Descriptive statistics of the variables.

Variables		Obs	Mean	Std. Dev.	Min	Max
INT		4275	0.0681	0.2519	0.0000	1.0000
GTFP		4275	1.2195	0.1438	0.1652	3.7476
POL	CO_2	4275	0.8723	1.3984	0.0001	14.8640
	SO_2	4275	2.0402	3.3353	0.0001	62.2074
	PM2.5	4275	0.1298	0.0822	0.0001	9.3229
GRE		4275	0.3672	1.1123	0.0000	14.3184
OPE		4275	1.8602	1.9779	0.0011	19.8940
FIN		4275	0.8722	0.5502	0.0753	9.6221
REG		4275	0.0114	0.0170	0.0045	0.2445
POP		4275	0.0456	0.0501	0.0005	0.6626
GOV		4275	0.1761	0.1000	0.0426	1.4852

Figure 3 visually demonstrates the changing trend of GTFP in the Yangtze River Delta region from 2007 to 2021. The three curves correspond to 16 core cities that joined the UECC before 2010, 25 new cities that joined the UECC after 2010, and all 41 cities in the Yangtze River Delta region, respectively. It can be seen that all of the GTFP curves have increased over time, but the rates of increase are different. In terms of average size, the GTFP of 41 cities has gradually increased from 1.0588 to 1.2173. Meanwhile, the GTFP of 16 cities has gradually increased from 1.0588 to 1.1812. However, compared with the other two curves, the GTFP of 25 cities has increased from 1.0588 to 1.2403, with the largest growth rate, which translates to an average annual growth rate of 1.14%. The data indicate that with the expansion of the UECC in the Yangtze River Delta, regional integration policies have promoted the development and transition of cities, especially benefiting the cities that have joined after the implementation of the policy. Since 2010, the growth rate of GTFP has increased compared with previous years (the slope of the graph has become steep), which indicates that China attaches increasing importance to regional policy implementation and practical efficiency under carbon neutrality goals and green transition.

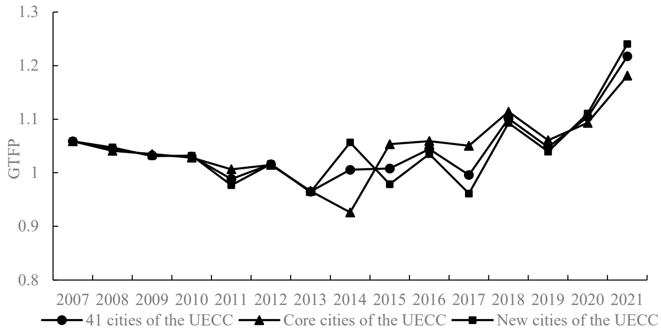

Figure 3. GTFP in the Yangtze River Delta region from 2007 to 2021.

Figure 4 presents a visualization of GTFP in 285 cities in some specific years to observe data characteristics on a larger scale and more vividly; for this purpose, ArcGIS 10.8 was employed to illustrate its spatial distribution. Through a comparison of the spatial distribution and evolution of 285 cities' GTFP in 2007, 2010, 2015 and 2021, it is evident that there was a gradual increase in GTFP over the study period; however, the spatial agglomeration characteristics appear to be unstable. In the first two research nodes, the GTFP does not show an obvious and long-term stable spatial agglomeration pattern. However, values in 2015 and 2021 show improvement, demonstrating a relatively obvious growth pattern as a whole, as indicated by the increasing number of dark blue areas and the decreasing number of green areas. Among them, the Pearl River Delta, Yangtze River Delta, and Bohai Rim have obvious high-value agglomeration areas, indicating that these areas have good momentum in terms of green and low-carbon development.

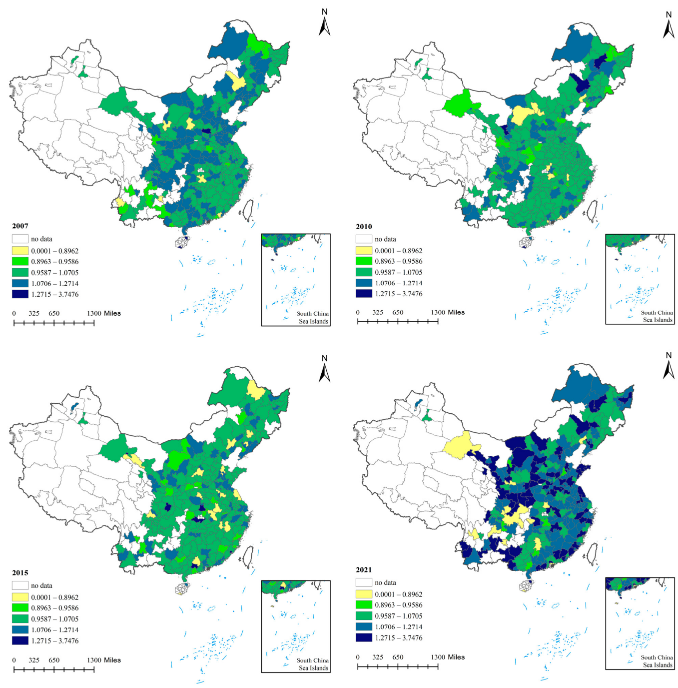

Figure 4. Spatial distribution of GTFP in 2007, 2010, 2015, and 2021.

4. Empirical Results and Discussions

4.1. Whether Regional Integration Can Enhance the Win–Win Effect of Economic Growth and Environmental Protection

Table 2 displays the outcomes of the regression analysis conducted for Equation (2). Notably, as control variables are gradually introduced into the model, the coefficient of INT consistently demonstrates a robust and highly significant positive association, reaching a 1% level of statistical significance. This suggests that the participation of cities in the UECC led to an increase in their GTFP. Regional integration policies have promoted the win–win situation concerning economic growth and environmental protection for all cities in the UECC.

Table 2. The win–win effects of regional integration.

Variables	GTFP (1)	GTFP (2)	GTFP (3)	GTFP (4)	GTFP (5)
INT	0.0025 *** (3.45)	0.0028 *** (3.23)	0.0022 *** (3.56)	0.0019 *** (3.24)	0.0015 *** (3.16)
OPE	0.0016 ** (2.12)	0.0015 ** (2.09)	0.0016 ** (2.02)	0.0014 ** (2.03)	0.0016 ** (1.97)
FIN		0.0093 ** (2.18)	0.0087 ** (2.11)	0.0089 ** (2.03)	0.0083 ** (2.06)
REG			0.1458 ** (1.98)	0.1659 ** (2.08)	0.0986 *** (3.11)
POP				−0.1337 ** (−2.23)	−0.1543 ** (−2.11)
GOV					0.0916 ** (2.16)
City Fixed	Yes	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes	Yes
R^2	0.2976	0.2934	0.2982	0.2916	0.2933
Obs.	4275	4275	4275	4275	4275

Notes: *** and ** indicate statistical significance at the 1%, 5% levels, respectively.

By specifically observing the coefficient of INT in Column (5), it can be found that the effect of INT on GTFP is 0.0015. The average GTFP of cities that have not joined the UECC was 1.0214 during the period 2010–2021. The estimated coefficient of 0.0015 suggests that participation in the UECC led to an approximate 0.15% (0.0015/1.0214) increase in the cities' GTFP. From 2010 to 2021, the GTFP of the cities that joined the UECC increased by 1.24%. The figures above indicate that the INT contributed 12.10% (0.15%/1.24%) of the total increase in GTFP.

4.2. How Regional Integration Enhances the Win–Win Situation of Economic Growth and Environmental Protection

4.2.1. Inhibiting Pollution Transfer

Table 3 presents the regression results of Equations (3) and (4). Column (1) reports the effect of POL on GTFP, and Columns (2), (3), and (4) report the effect of INT on POL. To be specific, in Column (2), the treatment group in INT comprises both core cities and new cities, whereas in Column (3), it only includes core cities, and in Column (4), it only encompasses new cities.

The first step is to observe Panel 1, which represents the scenario wherein the pollutant being analyzed is CO_2. Upon examining Column (1), it is evident that POL exerts a significantly adverse impact on GTFP, indicating that environmental pollution forms a barrier between economic growth and environmental protection. Upon examining Columns (2), (3), and (4), it is evident that INT exerts a significantly negative impact on POL, implying that regional integration can mitigate environmental pollution in both core and new cities without causing pollution transfer.

Table 3. The win–win mechanism: pollution transfer.

Variables	**GTFP (1)**	**POL (2)**	**POL (3)**	**POL (4)**
	Panel 1: POL = CO_2			
POL	−0.0035 *** (−3.21)			
INT		−0.0254 *** (−2.98)	−0.0568 ** (−2.14)	−0.0643 *** (−2.83)
Control Variables	Yes	Yes	Yes	Yes
City Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes
R^2	0.2439	0.5478	0.6436	0.5898
Obs.	4275	4275	3900	4035
	Panel 2: POL = SO_2			
POL	−0.0158 ** (−2.16)			
INT		−0.0069 * (−1.86)	−0.0051 (−0.37)	−0.0081 ** (−2.03)
Control Variables	Yes	Yes	Yes	Yes
City Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes
R^2	0.2176	0.1021	0.1732	0.3364
Obs.	4275	4275	3900	4035
	Panel 3: POL = PM2.5			
POL	−0.0028 ** (−2.11)			
INT		−0.0677 *** (−2.96)	−0.0551 ** (−1.98)	−0.0781 (−0.62)
Control Variables	Yes	Yes	Yes	Yes
City Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes
R^2	0.2094	0.2966	0.2498	0.1298
Obs.	4275	4275	3900	4035

Notes: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Then, based on the findings outlined in Panel 2, it is evident that even when SO_2 is considered as the primary pollutant, the inhibitory impact of POL on GTFP remains conspicuous. However, while INT does not significantly mitigate the pollution in core cities, it does exhibit a significant reduction in pollution within new cities. This observation further substantiates that regional integration does not trigger pollution transfer but rather alleviates environmental pollution in new cities.

Finally, in Panel 3, PM2.5 is identified as a pollutant, and POL continues to have a significant negative impact on GTFP. While INT effectively reduces POL in the core cities, it does not demonstrate a significant reduction in the new cities. Therefore, the relocation of environmental pollution from core cities to new cities cannot be confirmed. These empirical results indirectly prove that inhibiting pollution transfer is a crucial mechanism for regional integration to achieve a win–win situation concerning economic growth and environmental protection.

4.2.2. Promoting Green Transformation

Table 4 presents the regression results of Equations (5) and (6). Upon examining Column (1), it is evident that INT has a remarkable positive impact on GRE. Moreover, as evidenced by Column (2), GRE also has a significant positive effect on GTFP. This suggests that GRE serves as a mediating variable in the relationship between INT and GTFP. Thus, it can be proved that promoting green transformation is also a crucial mechanism for regional integration to enhance win–win economic growth and environmental protection.

Table 4. The win–win mechanism: green transformation.

Variables	GRE (1)	GTFP (2)
INT	0.0365 *** (3.32)	0.0126 *** (3.53)
GRE		0.0043 ** (2.12)
Control Variables	Yes	Yes
City Fixed	Yes	Yes
Year Fixed	Yes	Yes
R^2	0.2870	0.2943
Obs.	4275	4275

Notes: *** and ** indicate statistical significance at the 1%, 5% levels, respectively.

4.3. Robustness Test

4.3.1. Parallel Trend Test

Prior to employing the DID method for policy evaluation, it is imperative to satisfy the assumption of a common trend between the treatment and control groups, ensuring consistent changes in both groups before policy implementation. In this study, we adopt the event study approach to conduct a parallel trend analysis, verifying the dynamic impact of GTFP during the observed sample period [25,81]. Figure 5 demonstrates the GTFP pattern before and after introducing the expansion of the UECC. Before 2010, there was no significant divergence in GTFP between the treatment and control groups at a 95% confidence interval; however, a substantial discrepancy emerged between these two groups after 2010. This indicates that the parallel trend assumption was satisfied and the impact of INT on GTFP was indeed significant.

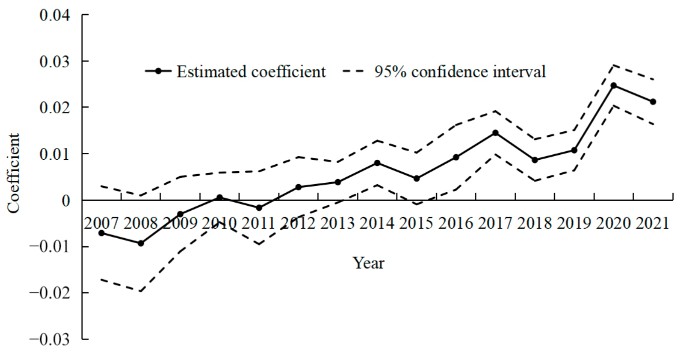

Figure 5. Results of the parallel trend test.

4.3.2. Placebo Test

Referring to Chetty et al. [90] and Ferrara et al. [91], a group of cities were randomly selected as the treatment group for the expansion of the UECC in the Yangtze River Delta, while other cities served as the control group. This produced a new variable INT to estimate Equation (2). The test was conducted 1000 times to eliminate potential confounding factors. Figure 6 illustrates that the kernel density distribution of t values approached zero and followed a normal distribution, indicating robustness in our estimation results and significant promotion of GTFP by INT.

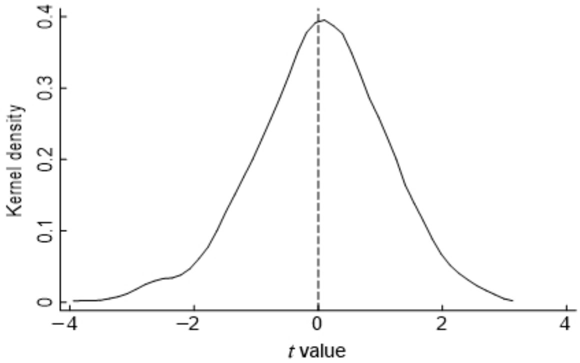

Figure 6. Placebo test results.

4.3.3. Replacing the Dependent Variable

The GTFP is a comprehensive index used to characterize the win–win situation regarding economic growth and environmental protection, signifying the attainment of pollution emission control alongside economic growth. Thus, the rate of economic growth (EG) and the rate of pollution growth (PR) can be considered as viable substitutes for GTFP. The GDP growth rate is employed as a proxy for EG in this study, while the growth rates of CO_2, SO_2, and PM2.5 are utilized to represent PR.

Upon examining Table 5, it is evident that INT exerts a significant positive impact on EG, while simultaneously exerting a significant negative impact on PR. This implies that regional integration enhances the rate of economic growth and diminishes the rate of pollution growth, thereby achieving a win–win situation concerning economic growth and environmental protection. The above conclusions are robust.

Table 5. The impact of regional integration on economic growth and pollution reduction.

	GDP Growth Rate	**CO_2 Growth Rates**	**SO_2 Growth Rates**	**PM2.5 Growth Rates**
Variables	EG (1)	PR (2)	PR (3)	PR (4)
INT	0.0478 *** (3.89)	−0.0240 ** (−2.03)	−0.0740 *** (−3.63)	−0.0157 ** (−1.98)
Control Variables	Yes	Yes	Yes	Yes
City Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes
R^2	0.4701	0.2251	0.3417	0.2642
Obs.	4275	4275	4275	4275

Notes: *** and ** indicate statistical significance at the 1%, 5% levels, respectively.

4.3.4. Other Robustness Tests

In this study, additional tests were conducted to enhance robustness, including the following: (1) Excluding municipalities under the direct jurisdiction of the Central Government. The local governments of Beijing, Tianjin, Shanghai, and Chongqing have high administrative levels and may not ensure equal cooperation with other cities during the process of regional integration; thus, they were removed from the sample; (2) Adding urban characteristic variables. The expansion of the UECC in the Yangtze River Delta is carried out within the regions of Jiangsu, Zhejiang, Anhui, and Shanghai, where pre-existing urban characteristics may affect GTFP. To control for these urban characteristics, this paper added three control variables—whether the city holds provincial capital status, is located along the coast, or is designated as a special economic zone—to form interaction terms with the time linear trend, respectively; (3) Reassigning the control group through the application of the propensity score matching–difference-in-differences (PSM-DID) technique. Table 6 demonstrates the strong and positive influence of INT on GTFP, thereby affirming the reliability and consistency of our empirical findings.

Table 6. Other robustness tests.

Variables	**Excluding Municipalities Directly under the Central Government GTFP (1)**	**Adding Urban Characteristic Variables GTFP (2)**	**Using the PSM-DID Method GTFP (3)**
INT	0.0032 *** (3.43)	0.0021 ** (2.02)	0.0029 *** (3.24)
Control Variables	Yes	Yes	Yes
City Fixed	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes
R^2	0.2439	0.3023	0.2430
Obs.	4215	4275	3983

Notes: *** and ** indicate statistical significance at the 1%, 5% levels, respectively.

4.4. Heterogeneity Discussion

As demonstrated earlier, the implementation of regional integration not only effectively increases economic efficiency but also improves the effectiveness of environmental protection and promotes urban green development. Two key win–win mechanisms include inhibiting pollution transfer and promoting green transformation. Subsequently, this paper analyzes the heterogeneous effects of regional integration and these win–win mechanisms.

4.4.1. Heterogeneous Effects of Regional Integration

Transport accessibility plays a crucial role in regional integration, as cities with better transport accessibility are more likely to engage in the industrial division system of the UECC, thereby influencing local economic growth and environmental protection. To assess urban transport accessibility (TRA), this study examines the daily frequency of train services between cities and introduces an interaction term with regional integration into Equation (2) to examine the heterogeneous effect of regional integration under the influence of transport accessibility. In Column (1) of Table 7, it is suggested that the interaction between transport accessibility and regional integration (*TRA* × *INT*) significantly enhances GTFP, indicating that enhancing transportation accessibility can reinforce the impact of regional integration. Therefore, cities with stronger transportation accessibility are better positioned to benefit from regional integration and achieve a win–win situation concerning economic growth and environmental protection.

Table 7. Heterogeneous effects of regional integration and win–win mechanisms.

Variables	**GTFP (1)**	**POL**			**GTFP (5)**
		CO_2 (2)	**SO_2 (3)**	**PM2.5 (4)**	
INT	0.0023 *** (3.42)	−0.0145 ** (−1.89)	−0.0068 *** (−3.36)	−0.0219 ** (−1.89)	0.0018 *** (3.21)
TRA	0.0216 *** (3.08)				
TRA × INT	0.0032 ** (2.12)				
RES		0.0216 ** (2.13)	0.0674 ** (2.08)	0.0096 (0.78)	

Table 7. *Cont.*

Variables	GTFP (1)	POL			GTFP (5)
		CO_2 (2)	SO_2 (3)	PM2.5 (4)	
RES×INT		0.0021 ** (1.87)	0.0009 ** (2.04)	0.0083 ** (1.97)	
GRE					0.0039 ** (1.98)
INN					0.0072 *** (2.86)
INN × GRE					0.0009 ** (2.03)
Control Variables	Yes	Yes	Yes	Yes	Yes
City Fixed	Yes	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes	Yes
R^2	0.2879	0.4573	0.2374	0.3257	0.2587
Obs.	4215	4035	4035	4035	4275

Notes: *** and ** indicate statistical significance at the 1%, 5% levels, respectively.

4.4.2. Heterogeneous Effects of Win–Win Mechanisms

On the one hand, polluting enterprises are more attracted to resource-based cities [92]. Therefore, during the process of regional integration, resource-based cities tend to become the preferred destination for pollution transfer. This paper constructs a dummy variable of whether the new city is a resource-based city (*RES*) (among the new cities that joined the UECC after 2010, the resource-based cities are Ma'anshan, Xuzhou, Chuzhou, Huainan, Suqian, Tong Ling, Chizhou, Xuancheng, Huaibei, Suzhou and Bozhou), and forms an interaction term with *INT* to test Equation (4). The findings shown in Columns (2), (3) and (4) of Table 7 reveal that the coefficients of *INT* exhibit significant negative effects, while the coefficients of $RES \times INT$ demonstrate significant positive effects. This indicates that the mitigation effect of regional integration on environmental pollution is weak in resource-based cities. Consequently, it can be observed that resource-based cities face challenges in improving economic growth quality and preserving the ecological environment by inhibiting pollution transfer in the context of regional integration.

On the other hand, enhancing urban innovation capacity is crucial for achieving industrial green transformation [93]. Therefore, differences in innovation capacity among cities affect the effectiveness of the green transformation mechanism. Following Yang et al. [94], this research employs a dummy variable indicating whether a city is designated an innovative city to measure its innovation capability (*INN*) and constructs an interaction term with *GRE* to test Equation (6). The results presented in Column (3) of Table 7 show that coefficients for *GRE*, *INN*, and $INN \times GRE$ are significantly positive. This demonstrates that urban innovation capacity strengthens the positive impact of *GRE* on *GTFP*. It can be inferred that cities with stronger innovation capabilities are more likely to achieve a win–win situation regarding economic growth and environmental protection by promoting green transformation in the context of regional integration.

5. Conclusions and Policy Implication

5.1. Conclusions

China has implemented regional integration policies, with the Yangtze River Delta serving as a crucial pilot area. This study examined the expansion of the UECC in the Yangtze River Delta as a quasi-natural experiment in regional integration and employed the DID model to assess its potential for achieving a win–win situation concerning economic growth and environmental protection, providing new evidence for achieving carbon neutrality goals.

The empirical results demonstrate that regional integration can effectively strike a balance between economic growth and environmental protection. The results were found to be robust following rigorous verification tests. Crucial mechanisms involved in achieving equilibrium between economic growth and environmental protection include inhibiting pollution transfer and promoting green transformation. However, the effects of both regional integration and win–win mechanisms are heterogeneous across cities. Specifically, cities with stronger transportation accessibility are better positioned to benefit from regional integration. For resource-based cities, achieving this win–win situation through the mechanism of inhibiting pollution transfer is challenging. Meanwhile, innovative cities can achieve this win–win situation by promoting green transformation.

5.2. Policy Implications

This study provides useful implications for governments to achieve both economic growth and environmental protection through the formulation of regional integration policies.

Firstly, to accelerate the implementation of regional integration policies in a wider range, it is imperative to strengthen planning guidance and institutional innovation. Initiatives such as implementing institutional reform and opening up policies could facilitate collaboration between cross-border government cooperation agencies such as the UECC. On the other hand, the formation of a unified domestic market is urgent, which is the basis of regional integration. It is necessary to reduce market barriers and promote the construction of a unified market.

Secondly, it is crucial to recognize the important role of intermediate mechanisms. Local governments share a common vision and demand for curbing pollution transfer and promoting green transformation, and regional integration policies have deepened cooperation in achieving the goal of carbon neutrality between them. Therefore, strengthening cooperation in research, technology, and capital investment will help adjust and optimize the industrial and energy structure, promote green transformation, and protect the ecological environment.

Thirdly, it is necessary to utilize the heterogeneous characteristics of cities to promote coordinated development between them. This involves improving transportation infrastructure networks to advance the accessibility of urban transportation, increasing the energy transformation of resource-based cities, and strengthening the construction of innovative cities. Cities are also encouraged to adopt different strategies according to their heterogeneous characteristics, forming a high-level collaborative development pattern.

5.3. Limitations and Future Research

This research has limitations that need to be addressed. Firstly, regional integration is a collaborative process involving multiple stakeholders such as governments, enterprises, and individuals. This paper specifically focuses on the impact of the expansion of the UECC in the Yangtze River Delta, a government-led regional integration project. The behavior of enterprises and individuals in the process of regional integration is equally worth studying. Secondly, due to data limitations, this study employs city-level data to assess win–win situations concerning economic growth and environmental protection. However, more profound conclusions may be obtained from studies at the enterprise level. Thirdly, the evaluation of the economic and environmental benefits of regional integration using the DID model is subject to certain measurement errors. In order to enhance the robustness of empirical results, it is imperative to employ more scientifically rigorous approaches for quantifying regional integration in future studies. Finally, drawing from policy practice experience, inhibiting pollution diversion and promoting green innovation are important mechanisms for achieving a win–win situation. Nevertheless, there may be other unexplored mechanisms. These limitations need to be addressed in further research.

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References

1. Massaro, L.; Calvimontes, J.; Ferreira, L.C.; De Theije, M. Balancing economic development and environmental responsibility: Perceptions from communities of garimpeiros in the Brazilian Amazon. *Resour. Policy* **2022**, *79*, 103063. [CrossRef]
2. Wu, Y.; Tam, V.W.; Shuai, C.; Shen, L.; Zhang, Y.; Liao, S. Decoupling China's economic growth from carbon emissions: Empirical studies from 30 Chinese provinces (2001–2015). *Sci. Total Environ.* **2019**, *656*, 576–588. [CrossRef]
3. Ramzan, M.; Abbasi, K.R.; Salman, A.; Dagar, V.; Alvarado, R.; Kagzi, M. Towards the dream of go green: An empirical importance of green innovation and financial depth for environmental neutrality in world's top 10 greenest economies. *Technol. Forecast. Soc. Chang.* **2023**, *189*, 122370. [CrossRef]
4. Green, F.; Healy, N. How inequality fuels climate change: The climate case for a Green New Deal. *One Earth* **2022**, *5*, 635–649. [CrossRef]
5. Wu, C.; Ge, M.; Huang, Z.; Wang, L.; Liu, T. An extended STIRPAT model and forecast of carbon emission based on green consumption behaviors: Evidence from China. *Environ. Dev. Sustain.* **2023**. [CrossRef]
6. Sheldon, I. Trade and environmental policy: A race to the bottom? *J. Agric. Econ.* **2006**, *57*, 365–392. [CrossRef]
7. Brewer, T.L. Climate change technology transfer: A new paradigm and policy agenda. *Clim. Policy* **2008**, *8*, 516–526. [CrossRef]
8. Fan, Y.; Wu, J.; Xia, Y.; Liu, J.Y. How will a nationwide carbon market affect regional economies and efficiency of CO_2 emission reduction in China? *China Econ. Rev.* **2016**, *38*, 151–166. [CrossRef]
9. Nordhaus, W. Climate clubs: Overcoming free-riding in international climate policy. *Am. Econ. Rev.* **2015**, *105*, 1339–1340. [CrossRef]
10. Gladstone, F.; Liverman, D.; Rodríguez, R.A.S.; Santos, A.E.M. NAFTA and environment after 25 years: A retrospective analysis of the US-Mexico border. *Environ. Sci. Policy* **2021**, *119*, 18–33. [CrossRef]
11. Li, Y.; Wu, F. Understanding city-regionalism in China: Regional cooperation in the Yangtze River delta. *Reg. Stud.* **2018**, *52*, 313–324. [CrossRef]
12. She, Q.; Cao, S.; Zhang, S.; Zhang, J.; Zhu, H.; Bao, J.; Meng, X.; Liu, M.; Liu, Y. The impacts of comprehensive urbanization on PM2.5 concentrations in the Yangtze River delta, China. *Ecol. Indic.* **2021**, *132*, 108337. [CrossRef]
13. Phillips, K.; Caas, J. Regional business cycle integration along the US-Mexico border. *Ann. Reg. Sci.* **2008**, *42*, 153–168. [CrossRef]
14. Ehrlich, M.V.; Seidel, T. The persistent effects of place-based policy: Evidence from the West-German zone randgebiet. *Am. Econ. J. Econ. Policy* **2018**, *10*, 344–374. [CrossRef]
15. Brown, W.M.; Dar-Brodeur, A.; Tweedle, J. Firm networks, borders, and regional economic integration. *J. Reg. Sci.* **2020**, *60*, 374–395. [CrossRef]
16. Shen, Y.F.; Yuan, Y. Regional integration and inequality comovement: Evidence from Europe. *Appl. Econ. Lett.* **2020**, *27*, 539–543. [CrossRef]
17. Hamdi-Cherif, M.; Waisman, H. Global carbon pricing and the "Common but Differentiated Responsibilities": The case of China. *Int. Environ. Agreem. Politics Law Econ.* **2016**, *16*, 671–689. [CrossRef]
18. Velde, D.W.T. Regional integration, growth and convergence. *J. Econ. Integr.* **2011**, *26*, 1–28. [CrossRef]
19. Geldi, H.K. Trade effects of regional integration: A panel cointegration analysis. *Econ. Model.* **2012**, *29*, 1566–1570. [CrossRef]
20. Li, H.; Lu, J. Can regional integration control transboundary water pollution? A test from the Yangtze River economic belt. *Environ. Sci. Pollut. Res.* **2020**, *27*, 28288–28305. [CrossRef]
21. Ai, K.P.; Xu, N. Does Regional Integration Improve Carbon Emission Performance?—A Quasi-Natural Experiment on Regional Integration in the Yangtze River Economic Belt. *Sustainability* **2023**, *15*, 15154. [CrossRef]
22. He, P.; An, C.J.; Chen, Z.K.; Tian, X.L.; Sun, Y. Promoting Cross-Regional Integration of Maritime Emission Management: A Euro-American Linkage of Carbon Markets. *Environ. Sci. Technol.* **2023**, *57*, 12180–12190.
23. Feng, Y.; Peng, D.Y.; Li, Y.F.; Liu, S. Can regional integration reduce carbon intensity? Evidence from city cluster in China. *Environ. Dev. Sustain.* **2024**, *26*, 5249–5274. [CrossRef]
24. Murty, M.N.; Kumar, S. Win–win opportunities and environmental regulation: Testing of porter hypothesis for Indian manufacturing industries. *J. Environ. Manag.* **2003**, *67*, 139–144. [CrossRef]

25. Yang, T.B.; Zhu, Y.M.; Li, Y.; Zhou, B. Achieving win-win policy outcomes for water resource management and economic development: The experience of Chinese cities. *Sustain. Prod. Consum.* **2021**, *27*, 873–888. [CrossRef]
26. Porter, M.E.; Van Der Linde, C. Toward a new conception of the environment-competitiveness relationship. *J. Econ. Perspect.* **1995**, *9*, 97–118. [CrossRef]
27. Nahman, A.; Mahumani, B.K.; De Lange, W.J. Beyond GDP: Towards a green economy index. *Dev. South. Afr.* **2016**, *33*, 215–233. [CrossRef]
28. Kasztelan, A. The use of the Hellwig's pattern model for the evaluation of green growth in OECD countries. In Proceedings of the 29th International Business Information Management Association Conference, Vienna, Austria, 3–4 May 2017; pp. 3–4.
29. Zinia, N.J.; McShane, P. Ecosystem services management: An evaluation of green adaptations for urban development in Dhaka, Bangladesh. *Landsc. Urban Plan.* **2018**, *173*, 23–32. [CrossRef]
30. Li, X.X.; Liu, Y.M.; Song, T. Measurement of human green development Index. *Soc. Sci. China* **2014**, *6*, 69–95+207–208.
31. Wang, B.; Liu, G.T. Energy conservation and emission reduction and China's green economy growth: Based on the perspective of total factor productivity. *China Ind. Econ.* **2015**, *5*, 57–69.
32. Tu, Z.G.; Wang, K.; Chen, R.J. Economic growth and pollution reduction: An integrated analysis framework. *Econ. Res.* **2022**, *57*, 154–171.
33. Kumbhakar, S.C.; Lovell, C.K. *Stochastic Frontier Analysis*; Cambridge University Press: Cambridge, UK, 2000; pp. 136–142.
34. Anser, M.K.; Iqbal, W.; Ahmad, U.S.; Fatima, A.; Chaudhry, I.S. Environmental efficiency and the role of energy innovation in emissions reduction. *Environ. Sci. Pollut. Res.* **2020**, *27*, 29451–29463. [CrossRef]
35. Walz, R.; Pfaff, M.; Marscheider-Weidemann, F.; Glöser-Chahoud, S. Innovations for reaching the green sustainable development goals: Where will they come from? *Int. Econ. Econ. Policy* **2017**, *14*, 449–480. [CrossRef]
36. Abid, N.; Ceci, F.; Ahmad, F.; Aftab, J. Financial development and green innovation, the ultimate solutions to an environmentally sustainable society: Evidence from leading economies. *J. Clean. Prod.* **2022**, *369*, 133223. [CrossRef]
37. Lis, A.M.; Mackiewicz, M. The implementation of green transformation through clusters. *Ecol. Econ.* **2023**, *209*, 107842. [CrossRef]
38. Sun, H.Y.; Liu, Z.J. Urban sprawl, producer services agglomeration and green total factor productivity: A study of the underlying logic based on the concept of green development. *Macroecon. Res.* **2023**, *2*, 85–101.
39. Huang, L.; Wu, C.Q. Foreign investment, environmental regulation and urban green development efficiency in the Yangtze River Economic Belt. *Reform* **2021**, *3*, 94–110.
40. Naqvi, B.; Rizvi SK, A.; Mirza, N.; Umar, M. Financial market development: A potentiating policy choice for the green transition in G7 economies. *Int. Rev. Financ. Anal.* **2023**, *87*, 102577. [CrossRef]
41. Wang, R.; Tan, J.L. Exploring the coupling and forecasting of financial development, technological innovation, and economic growth. *Technol. Forecast. Soc. Chang.* **2020**, *43*, 120466. [CrossRef]
42. Du, L.Z.; Zhao, Y.H.; Tao, K.T.; Lin, W.F. The compound effect of environmental regulation and governance transformation on the improvement of green competitiveness: Based on the empirical evidence of Chinese industry. *Econ. Res.* **2019**, *54*, 106–120.
43. Zhang, W.; Hu, Y. The impact of innovative human capital on green total factor productivity in the Yangtze River Delta region: An empirical analysis based on the spatial Durbin model. China Population. *Resour. Environ.* **2020**, *30*, 106–120.
44. Ma, D.; Zhu, Q. Innovation in emerging economies: Research on the digital economy driving high-quality green development. *J. Bus. Res.* **2022**, *145*, 801–813. [CrossRef]
45. Chen, Y. Evaluation of regional industrial green development efficiency in China: From the perspective of R&D investment. *Econ. Issues* **2018**, *12*, 77–83.
46. Cutrini, E. Specialization and concentration from a twofold geographical perspective: Evidence from Europe. *Reg. Stud.* **2010**, *44*, 315–336. [CrossRef]
47. Duranton, G.; Puga, D. From sectoral to functional urban specialisation. *J. Urban Econ.* **2005**, *57*, 343–370. [CrossRef]
48. Semenets, A.; Tiurina, D.; Kuzkin, Y.; Yarmak, O. An analysis of the European integration processes in Ukraine. *Financ. Credit. Act. Probl. Theory Pract.* **2020**, *4*, 495–506.
49. Pang, X.M. The theoretical concept and development of regional integration. *Adv. Geogr. Sci.* **1997**, *2*, 39–47.
50. Liebman, A.; Obtenkova, A.; Zhang, H. Historical Heritage and Eurasian Regional Integration. *Russ. Stud.* **2017**, *6*, 40–56.
51. Nawaz, S.; Mangla, I.U. The economic geography of infrastructure in Asia: The role of institutions and regional integration. *Res. Transp. Econ.* **2021**, *88*, 101061. [CrossRef]
52. Santos-Paulino, A.U.; DiCaprio, A.; Sokolova, M.V. The development trinity: How regional integration impacts growth, inequality and poverty. *World Econ.* **2019**, *42*, 1961–1993. [CrossRef]
53. Tian, Y.S.; Mao, Q.H. The effect of regional integration on urban sprawl in urban agglomeration areas: A case study of the Yangtze River Delta, China. *Habitat Int.* **2022**, *130*, 102695. [CrossRef]
54. Jiang, N.N.; Jiang, W. How does regional integration policy affect urban resilience? Evidence from urban agglomeration in China. *Environ. Impact Assess. Rev.* **2024**, *104*, 107298. [CrossRef]
55. Qi, F.M.; Wu, W.F.; Xu, Q.; Xiao, P. The impact of digital economy and regional integration on common prosperity-an empirical study based on the data of the Yangtze River Delta. *Stat. Decis.* **2023**, *39*, 70–74.
56. Yang, Q.K.; Duan, X.J.; Wang, L.; Wang, S. synergy Measurement and Interactive Response of Regional Integration and Urban Land Use Efficiency in Yangtze River Delta. *Resour. Sci.* **2021**, *43*, 2091–2104.

57. Luan, Q.L.; Jin, Q.Q. Government subsidies, regional integration and high-quality economic development in the western region: A new economic geography theory based on enterprise heterogeneity. *J. Hebei Univ. Econ. Bus.* **2023**, *44*, 99–109.
58. Feng, Y.; Lee, C.C.; Peng, D.D. Does regional integration improve economic resilience? Evidence from urban agglomerations in China. *Sustain. Cities Soc.* **2023**, *88*, 104273. [CrossRef]
59. Copeland, B.R.; Taylor, M.S. Trade, growth and the environment. *Econ. Lit.* **2004**, *42*, 7–71. [CrossRef]
60. Derek, K. An empirical investigation of the pollution haven effect with strategic environment and trade policy. *J. Int. Econ.* **2009**, *78*, 242–255.
61. Jaffe, B.; Peterson, R. Environmental regulation and the competitiveness of US manufacturing: What does the evidence tell us? *J. Econ. Lit.* **1995**, *33*, 132–163.
62. Peter, G.P.; Hertwich, E.G. Pollution embodied in trade: The Norwegian case. *Glob. Environ. Chang.* **2006**, *16*, 379–387. [CrossRef]
63. Fan, W.; Yan, L.; Chen, B.; Ding, W.; Wang, P. Environmental governance effects of local environmental protection expenditure in China. *Resour. Policy* **2022**, *77*, 102760. [CrossRef]
64. Yoo, I.T.; Kim, I. Free trade agreements for the environment? Regional economic integration and environmental cooperation in East Asia. *Int. Environ. Agreem.* **2016**, *16*, 721–738. [CrossRef]
65. He, W.; Wang, B.; Danish; Wang, Z. Will regional economic integration influence carbon dioxide marginal abatement costs? Evidence from Chinese panel data. *Energy Econ.* **2018**, *74*, 263–274. [CrossRef]
66. Baghdadi, L.; Martinez-Zarzoso, I.; Suarez-Burguet, C. *Is the Road to Regional Integration Paved with Pollution Convergence?* Working Papers 2012/03; Economics Department, Universitat Jaume I: Castellón, Spain, 2012.
67. Nwosu, E.O.; Orji, A.; Urama, N. Regional integration and foreign investment: The case of ASEAN countries. *Asian Econ. Financ. Rev.* **2013**, *3*, 1670–1680.
68. Peluffo, A. Regional integration and technology diffusion: The case of Uruguay. *J. Int. Trade Econ. Dev.* **2013**, *22*, 786–816. [CrossRef]
69. Florence, B. Regional integration and income inequality: A synthetic counterfactual analysis of the European monetary union. *Oxf. Rev. Econ. Policy* **2021**, *37*, 172–200.
70. Muhammad, I.S. Investigating the role of regional economic integration on growth: Fresh insights from South Asia. *Glob. J. Emerg. Mark. Econ.* **2021**, *13*, 35–57.
71. Campos, N.F.; Coricelli, F.; Franceschi, E. Institutional integration and productivity growth: Evidence from the 1995 enlargement of the European Union. *Eur. Econ. Rev.* **2022**, *142*, 104014. [CrossRef]
72. Wang, Q.; Zhao, Z.; Shen, N.; Liu, T. Have Chinese cities achieved the win-win between environmental protection and economic development? From the perspective of environmental efficiency. *Ecol. Indic.* **2015**, *51*, 151–158. [CrossRef]
73. Tian, K.; Zhang, Y.; Li, Y.; Ming, X.; Jiang, S.; Duan, H.; Yang, C.; Wang, S. Regional trade agreement burdens global carbon emissions mitigation. *Nat. Commun.* **2022**, *13*, 408. [CrossRef]
74. Huan, H.; Zhu, Y.; Liu, J. A quasi-natural experiment research regarding the impact of regional integration expansion in the Yangtze River Delta on foreign direct investment. *Growth Change* **2022**, *53*, 1854–1876. [CrossRef]
75. Lyu, Y.; Zhang, J.; Wang, L.; Yang, F.; Hao, Y. Towards a win-win situation for innovation and sustainable development: The role of environmental regulation. *Sustain. Dev.* **2022**, *30*, 1703–1717. [CrossRef]
76. Tone, K. A slacks-based measure of efficiency in data envelopment analysis. *Eur. J. Oper. Res.* **2001**, *130*, 498–509. [CrossRef]
77. Tone, K. A slacks-based measure of super-efficiency in data envelopment analysis. *Eur. J. Oper. Res.* **2002**, *143*, 32–41. [CrossRef]
78. Ananda, J. Explaining the environmental efficiency of drinking water and waste water utilities. *Sustain. Prod. Consum.* **2019**, *17*, 188–195. [CrossRef]
79. Barnhart, S.; Miller, E. Problems in the estimation of equations containing perpetual inventory measured capital. *J. Macroecon.* **1990**, *12*, 637–651. [CrossRef]
80. Chen, J.; Gao, M.; Cheng, S.; Hou, W.; Song, M.; Liu, X.; Liu, Y.; Shan, Y. County-level CO_2 emissions and sequestration in China during 1997–2017. *Sci. Data* **2020**, *7*, 391. [CrossRef] [PubMed]
81. Yan, D.; Li, P. Can regional integration reduce urban carbon emission? An empirical study based on the Yangtze River Delta, China. *Int. J. Environ. Res. Public Health* **2023**, *20*, 1395. [CrossRef] [PubMed]
82. Balsalobre-Lorente, D.; Driha, O.M.; Halkos, G.; Mishra, S. Influence of growth and urbanization on CO_2 emissions: The moderating effect of foreign direct investment on energy use in BRICS. *Sustain. Dev.* **2022**, *30*, 227–240. [CrossRef]
83. Bertone, E.; Sahin, O.; Stewart, R.A.; Zou, P.X.; Alam, M.; Hampson, K.; Blair, E. Role of financial mechanisms for accelerating the rate of water and energy efficiency retrofits in Australian public buildings: Hybrid Bayesian network and system dynamics modelling approach. *Appl. Energy* **2017**, *210*, 409–419. [CrossRef]
84. Pei, Y.; Zhu, Y.; Liu, S.; Wang, X.; Cao, J. Environmental regulation and carbon emission: The mediation effect of technical efficiency. *J. Clean. Prod.* **2019**, *236*, 117599. [CrossRef]
85. Hao, F.; Wu, H.; Liu, J.; Zhu, M.; Xu, W. Environmental regulation, trade openness and polluting emissions: City-level empirical evidence from China. *J. Int. Trade Econ. Dev.* **2023**, *32*, 494–507. [CrossRef]
86. Liu, C.; Ni, T. Further exploring the driving mechanism of ecological carrying capacity changes at the urban agglomeration level. *Ecol. Indic.* **2023**, *150*, 110231. [CrossRef]
87. Shao, S.; Yang, L.L.; Yu, M.B.; Yu, M.L. Estimation, characteristics, and determinants of energy-related industrial CO_2 emissions in Shanghai (China), 1994–2009. *Energy Policy* **2011**, *39*, 6476–6494. [CrossRef]

88. Chen, H.X.; Zhang, X.L.; Wu, R.W.; Cai, T.Y. Revisiting the environmental Kuznets curve for city-level CO_2 emissions: Based on corrected NPP-VIIRS nighttime light data in China. *J. Clean. Prod.* **2020**, *268*, 121575. [CrossRef]
89. Su, W.J.; Xie, C.X. High-speed rail, technological improvement, and PM2.5: Evidence from China. *Econ. Anal. Policy* **2023**, *80*, 1349–1362. [CrossRef]
90. Chetty, R.; Looney, A.; Kroft, K. Salience and taxation: Theory and evidence. *Am. Econ. Rev.* **2009**, *99*, 1145–1177. [CrossRef]
91. Ferrara, E.; Chong, A.; Duryea, S. Soap operas and fertility: Evidence from Brazil. *Am. Econ. J. Appl. Econ.* **2012**, *4*, 1–31. [CrossRef]
92. Sun, Y.; Li, Y.; Yu, T.; Zhang, X.; Liu, L.; Zhang, P. Resource extraction, environmental pollution and economic development: Evidence from prefecture-level cities in China. *Resour. Policy* **2021**, *74*, 102330. [CrossRef]
93. Liu, W.; Wang, Z. The effects of climate policy on corporate technological upgrading in energy intensive industries: Evidence from China. *J. Clean. Prod.* **2016**, *142*, 3748–3758. [CrossRef]
94. Yang, S.; Jahanger, A.; Mohammad, R.H. Enhancing export product quality through innovative cities: A firm-level quasi-natural experiment in China? *Econ. Anal. Policy* **2022**, *79*, 462–478. [CrossRef]