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China's Pilot Free Trade Zones and Company's Sustainability Performance

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Abstract: This paper investigates the role of pilot free trade zones (FTZs) as a policy testing terrace for achieving the sustainable development goals in China. Using a sample of data from Chinese companies that were listed in Shanghai and Shenzhen A stocks, from 2009 to 2021, a difference-in-difference model is employed to assess the impact of FTZ establishment on sustainable development. The findings indicate that establishing FTZs significantly enhances a company's sustainability performance, particularly in terms of environmental and social responsibility performance. They also foster an innovation-friendly environment, facilitating sustainable development goals in both institutional and innovation domains. Furthermore, the policy effects of FTZs exhibit a mixed picture, involving both a curse effect of political resources and a reinforcement effect of environmental protection goals. Additionally, the Matthew effect and spillover effect are observed in FTZs. Finally, this paper explores the linkages between FTZ construction and China's "dual circulation" development pattern, revealing the effective role of FTZs in conjunction with new energy model cities for enhancing sustainable development. However, the linkage between FTZs and the Belt and Road Initiative is currently limited in terms of positively impacting a company's sustainability performance.

Keywords: pilot free trade zone; company's sustainability performance; ESG; institutional environment; innovation environment

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1. Introduction

China has established 21 pilot free trade zones (FTZs) and the Hainan Free Trade Port in China, forming a pilot pattern encompassing various regions across the country. First proposed by the United Nations in September 2015, sustainable development aims to address economic, social, and environmental issues that hinder global progress. In line with the global consensus on sustainable development, such as low-carbon and green growth, the FTZs have taken the lead in adopting environmentally friendly practices and promoting ecological protection [1]. The development objectives of the FTZs have a significant impact on enhancing the sustainable development capacity of enterprises. Therefore, this paper conducts a scientific assessment of the effectiveness of the FTZs in achieving sustainable development goals and explores the relationship between FTZ construction and major national strategies.

An FTZ is a significant means of adapting to globalization and establishing comparative advantages in global trade due to their low tariffs and reduced regulatory constraints [2]. There are numerous papers which focused on their policy effects as well as the relationship between FTZs and environmental benefits. Zhuo et al. (2021) [3] conducted a case study on the Guangdong FTZ and found that its establishment led to a "policy trap" in terms of environmental improvement and did not significantly enhance regional environmental welfare. Conversely, Jiang et al. (2021) [4] studied the Shanghai FTZ and reported that it contributed to an increase in green total factor productivity through the technology spillover effect, the competition effect, and the resource allocation effect. The majority of domestic scholars support the latter view, suggesting that the FTZs facilitate

regional green development [5–7]. Hsu et al. (2014) and Chen et al. (2018) [8,9] suggest that the policy effect of FTZs depends on the change in enterprise performance. Additionally, Song et al. (2019) and Li et al. (2021) [10,11] believe that enterprises are attracted by the policy dividend of FTZs, which affects their performance and management. However, few studies in the literature explore the impact of establishing an FTZ on a company's sustainability performance.

Additionally, several studies related to sustainable development are also worthy of attention in this paper. The current academic attitudes toward sustainable development are diverse, with some scholars arguing that it may restrict human behavior and hinder economic development [12,13]. However, most scholars believe that the benefits of sustainable development on the economy and society outweigh the disadvantages [14,15]. Moreover, Peng et al. (2006) [16] identified factors such as external environmental pollution, physical and human capital accumulation, and endogenous technological progress that positively contribute to sustainable economic development. In terms of firm performance, Luo et al. (2009,2013) [17,18] and Yu et al. (2008) [19] found that reduced political barriers and an improved institutional environment positively affect the performance of private firms, with regions characterized by developed financial markets, a high level of rule of law, and efficient administration, demonstrating better performance.

While these studies provide valuable insights into the sustainable development effects of FTZs, there are still a number of important drawbacks in the existing literature: First, few scholars have specifically examined the policy effects of FTZ establishment from the perspective of enterprises, despite the fact that enterprises are the actual beneficiaries of the institutional dividends of FTZs. Second, none of the previously mentioned studies have identified the transmission mechanisms through which the sustainable development effects of FTZs occur. Third, there has been a lack of examination of the performance of FTZ construction from a sustainable development perspective.

Therefore, we employ a multi-period difference-in-differences model to assess the impact of FTZ establishment on sustainable development using data from Chinese companies listed on the Shanghai and Shenzhen A stock markets from 2009 to 2021. This paper introduces several innovations from three aspects to address these research gaps. First, this study uses the enterprise micro data to measure sustainable development, which makes for a more scientific and accurate identification of the FTZ policy effects. Second, this research adopts an innovative research perspective by assessing the enhancement effect of FTZ construction on corporate sustainability performance. It further explores the impact on corporate environmental, social responsibility, and governance performance, considering variations in policy effects based on firms' political resources, environmental objectives, and industry characteristics. Third, this paper examines the synergies between the establishment of FTZs and the "dual circulation" development pattern. It specifically investigates the relationship among the FTZs, the New Energy City pilot policy, and the Belt and Road Initiative.

The remainder of this paper is organized as follows: Section 2 provides an overview of the institutional background and presents the theoretical hypotheses regarding the impact of FTZs on the sustainability of enterprises. Section 3 describes the methodology employed to verify these hypotheses, including the data used to generate our variables, and presents basic descriptive results. In Section 4, we present our main empirical findings. To further explore the relationship between FTZs and China's development, Section 5 offers additional insightful analyses and presents several limitations of this study. Section 6 concludes the study by providing policy recommendations based on our findings.

2. Institutional Background and Theoretical Hypotheses

2.1. Institutional Background

The FTZs in China represent a unique approach to reform and opening up, showcasing the country's progressive initiatives. These zones have implemented various institutional innovations aimed at improving trade efficiency, investment attractiveness, and establishing

a comprehensive framework for international engagement. Since the inception of the FTZ strategy in 2013, it has played a pivotal role in facilitating high-quality imports and exports, thereby providing a significant impetus for the sustainable development of the FTZs with a strong emphasis on ecological protection.

China's FTZs are guided by the principles of sustainable development and have successfully developed reproductive best practices in this regard. For instance, the Suzhou FTZ has introduced a "third-party assisted law enforcement" mechanism, which effectively monitors and manages pollution sources in enterprises through differentiated and graded approaches. This mechanism has proven to be successful in achieving environmental objectives and reducing compliance costs for businesses. Similarly, the Beijing FTZ has implemented a positive list for ecological and environmental supervision and enforcement, resulting in a mutually beneficial outcome by reducing government oversight costs and decreasing the regulatory burden on enterprises.

Furthermore, the Shanghai FTZ has pioneered innovative systems such as the "two assessments and one certificate" and the "one network for all" approaches. These initiatives have significantly streamlined the comprehensive approval process, leading to a reduction in the time and cost required for obtaining approvals by enterprises.

The continuous advancement of institutional innovation within the zone enables enterprises to further drive sustainable development in conjunction with the pilot liberalization of the financial sector in the FTZ. An illustrative example is the successful issuance of the country's inaugural green FTZ offshore bond, amounting to CNY 1.1 billion, by Air China International Finance & Leasing Company Limited. This bond is specifically designated for supporting environmentally friendly leasing projects in accordance with the sustainable financing framework. Such a milestone achievement showcases the extensive integration of green industries and financial services within the FTZ, serving as a significant catalyst for promoting sustainable development.

In conclusion, it is crucial to develop the FTZs in a coordinated manner to promote industrial restructuring, emission control, and collaboration with other zones in order to achieve low-carbon and environmentally friendly practices. These efforts contribute to national ecological protection and support green, low-carbon development objectives.

2.2. Hypothesis

The establishment of FTZs plays a crucial role in enhancing the sustainability of enterprises within the region, primarily through the level of local market, the intensity of local government environmental regulations, and the local innovation environment. FTZs have served as test beds for institutional reforms in China, with local governments initiating innovative institutional practices that, when approved by the central government, stimulate further institutional reform capacity. As a result, enterprises within FTZs tend to benefit from convenient, advanced, and innovative policy measures earlier than those outside the zones. The goal of China's FTZs is to develop a new institutional system aligned with international standards, creating a favorable business environment and a robust property rights protection system. As the level of market in the FTZs continues to rise, a spillover effect of the "institutional dividend" occurs, allowing for the replication and promotion of advanced experiences developed in each FTZ. This, in turn, enhances the sustainable development of enterprises and helps achieve China's sustainable development goals.

H1: *The establishment of an FTZ has a significant positive effect on the sustainability performance of the company*.

Regarding the institutional environment, this paper focuses on external institutional constraints faced by firms, including the business environment, property rights regime, and legal system. Firms operate in different markets based on the cost–benefit principle, where transaction costs often determine the interplay between firms and markets. Different institutional environments give rise to various forms of contracts that regulate firms' market behavior [20,21]. Since its establishment, the FTZ has worked on tariff prefer-

ences, investment liberalization, administrative simplification, optimization of the business environment, and financial market liberalization. The investment management system, trade regulation system, and ex-post supervision system in the FTZs are significantly more favorable compared to other regions, providing a stable institutional environment. These advanced and rational institutions tend to reduce the likelihood of irrational behavior by enterprises [22]; lower transaction costs related to innovation, production, and sales; improve environmental and social responsibility; corporate governance performance; and facilitate the achievement of sustainable development goals.

Regarding the innovation environment, this paper focuses on both the in-house and FTZ innovation environments. On one hand, preferential policies within the FTZ attract high-quality domestic and foreign enterprises, leading to increased competition and the necessity for manufacturers to innovate and enhance their core competitiveness [23–25]. Consequently, the establishment of the FTZ improves the innovation environment through industry competition, technological advancements, and increased knowledge capital. On the other hand, it is evident that domestic and foreign enterprises established in the FTZ face different situations, with the innovation environment within the enterprise being enhanced [26]. The improved innovation environment significantly strengthens the core competitiveness of enterprises, improves long-term profitability, allows for the development of environmental, social responsibility, and governance capabilities, and ultimately contributes to achieving China's sustainable development goals.

Based on the above analysis, the following hypotheses are formulated in this paper:

H2a: *By improving the institutional environment and reducing transaction costs for enterprises, the FTZ enables better environmental and social responsibility performance, enhances governance, and promotes sustainable development*.

H2b: *The FTZ enhances sustainable profitability and improves performance in environmental, social responsibility, and governance aspects for enterprises through an improved innovation environment*.

3. Methodology and Data

3.1. Data Sources and Sample Selection

This paper utilizes a research sample consisting of companies listed in Shanghai and Shenzhen A stocks from 2009 to 2021. To ensure data accuracy, certain exclusions were made, including the special financial and insurance industries, enterprises categorized as "special treatment" (ST), and years with limited observations. Specifically, our focus lies on the data of the company's sustainability performance located in cities with established FTZs, allowing us to discern the policy effects resulting from the FTZ establishments. As a result, a total of 21,949 enterprise–year observations were obtained. The data were sourced from the databases of *Wind* and *CSMAR*.

In addition, this paper incorporates a city-level database that matches the cities where the listed companies are located. Through city-level data, this paper provides a more detailed and specific understanding of the unique characteristics within each city. Furthermore, focusing on individual cities provides more details that can directly identify city-specific best policy practices. The relevant data for this matching process are derived from the *China City Statistical Yearbook.*

3.2. Difference-in-Difference Model

In order to examine the potential effect of free trade zones (FTZs) on sustainable development, it is essential to measure the policy effect on sustainability performance by comparing the difference before and after the establishment of FTZs. Ordinary least squares (OLS) regression may introduce issues like selective deviation into the analysis. Therefore, building on the methodology used by Zhuo et al. (2021) [3], this paper employs the multi-period difference-in-difference (DID) method. This approach offers a robust framework for estimating the net effect of multiple rounds of policy experiments, allowing for a more comprehensive and accurate assessment of the impact of FTZs on sustainability

performance. The cities that established FTZs between 2013 and 2019 are matched with the sample data of listed companies. The pilot batches of FTZs serve as the time nodes for analysis, considering the lag effect of policy trials. Control time nodes include 2013, 2015, 2017, 2018, and 2019. To ensure consistency, this paper excludes cities where matching with listed companies in Shanghai and Shenzhen A stock was not possible. The treatment group comprises enterprises located within the cities included in the pilot FTZs. The control group consists of non-control enterprises in other regions. The following model is constructed for analysis:

$$SDC_{it} = \alpha_0 + \beta_0 FTZ_{it} + \beta_1 X_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (1)$$

where SDC_{it} represents the sustainability of listed company i in year t, including its environmental performance (env_i), social responsibility performance (soc_i), and corporate governance performance (gov_i). FTZ_{it}, the core explanatory variable, indicates that firm i is located in the FTZ in year t. X denotes a set of control variables accounting for additional factors that may influence sustainable development performance. α_0, β_0, and β_1 are the parameters to be estimated, and the core estimated coefficients β_1 reflecting the impact of the establishment of the FTZ on the sustainable development performance of enterprises. μ_i, ν_t are firm and year fixed effects to control for time-invariant firm characteristics variables and economic cycle characteristics in each year, respectively. ε_{it} is the random disturbance terms.

3.3. Variable Description

3.3.1. Explanatory Variables

To assess the sustainable development capability (SDC) of enterprises, this paper employs the Sino-Securities Index (SNSI) ESG ratings methodology. The SNSI ESG rating system is built upon the latest ESG reporting guidelines as published by the Hong Kong Exchange, aligning with other international standards while considering China's unique national conditions. This comprehensive system assigns a nine-grade rating scale, encompassing the following categories: AAA, AA, A, BBB, BB, B, CCC, CC, and C. In line with the approach introduced by Lin et al. (2021) [27], this paper adopts a rating-based scoring system for companies. Under this system, each company's ESG rating is directly translated into a numerical score according to a predefined mapping. For example, a company rated as "AAA" is assigned a score of 9, whereas a company rated as "C" is assigned a score of 1. Corporate environmental performance (env), social responsibility performance (soc), and corporate governance performance (gov) provided by Bloomberg Consulting are also selected as secondary indicators to analyze the impact of FTZ establishment on various aspects of sustainable development.

3.3.2. Core Explanatory Variables

The implementation of the FTZ policy was determined by $FTZ_{it} = Treat_i \times Post_{it}$. $Treat_i$ is used to identify the city where the implementation zone is located. If enterprises i operate in the implementation zone, $Treat_i$ is assigned a value of 1; otherwise, it is assigned a value of 0. $Post_{it}$ is used to identify the time of FTZ construction. The year before establishment is assigned a value of 0, and the year after establishment is assigned a value of 1. Multiplying $Treat_i$ and $Post_{it}$ results in FTZ_{it}, indicating whether enterprise i is located in the FTZ in year.

3.3.3. Control Variables

In examining the impact of FTZ establishment on enterprise sustainability, this study controls for several factors which refer to the works of Zhuo et al. (2021) and Li et al. (2021) [3,28]. Enterprise-level controls include the gearing ratio, operating cash flow, enterprise size, shareholding ratio of the largest shareholder, and enterprise value. City-level controls include urban economic development, manufacturing level, urban population size, foreign investment level, and government control. The level of urban economic development is measured by actual regional GDP, manufacturing level is measured by value

added of the secondary industry, urban population size is measured by total population at year-end, foreign investment level is measured by the amount of actual foreign investment utilized in the year, and government control is measured by the general budget revenue of the local government. In order to avoid spurious regression and eliminate heteroscedasticity, city-level data is in the form of a logarithm.

The above variables are described in Table 1. The mean sustainability performance score of approximately 6.562 indicates that, on average, companies from the data exhibit reasonably good sustainability performance. However, the wide range from 1 to 9 implies significant variability, suggesting that some companies excel in sustainability while others lag behind. About 21.5% of companies are influenced by the pilot free trade zone policy. Financial metrics include gearing ratio (GR) and operating cash flow (CF). The mean GR of 0.37 suggests moderate financial leverage, while the low mean CF of 0.026 indicates limited cash generated from operations. Company characteristics include enterprise size (ES), shareholding ratio of the largest shareholder (SR), and enterprise value (EV). Larger companies (mean ES of 22.316) may have more resources to invest in sustainability initiatives. Shareholding ratios ranging from 9% to 75% could imply differences in corporate governance and decision-making, potentially affecting sustainability strategies. Enterprise value variation (mean EV of 2.033) may indicate varying levels of market recognition for sustainability efforts. Regional and economic factors include economic development (ED), manufacturing level (ML), population size (PS), foreign investment level (FI), and government control (GC), which vary across companies.

Table 1. Description of variables.

Symbols	Variables	N	Mean	Std.Dev	Min	Max
SDC	Companies sustainability performance	25,618	6.562	1.107	1	9
FTZ	Pilot free trade zone policy	25,618	0.215	0.41	0	1
GR	Gearing ratio	25,618	0.37	0.484	0	1
CF	Operating cash flow	25,618	0.026	0.16	0	1
ES	Enterprise size	25,618	22.316	1.323	20	26
SR	Shareholding ratio of the largest shareholder	25,618	34.785	15.042	9	75
EV	Enterprise value	25,618	2.033	1.345	1	8
ED	Economic development	25,618	17.103	0.968	12.792	18.469
ML	Manufacturing level	25,618	17.380	1.289	12.661	19.528
PS	Population size	25,618	11.184	0.422	9.232	12.128
FI	Foreign investment level	25,618	15.75	1.391	11.0713	18.087
GC	Government control	25,618	16.113	1.176	11.543	18.240

4. Results and Discussions

4.1. Baseline Regression

This paper examines the changes in the sustainability of enterprises before and after the establishment of the FTZ. The regression results are presented in Table 2. In column (1), which includes only the core explanatory variables, the coefficient of FTZ is 0.0535, indicating a statistically significant impact at the 1% level. This means that an FTZ can improve the sustainable performance of enterprises by 5.35%. Columns (2)–(4) include additional control variables based on column (1). When micro-level control variables are added separately, the coefficients of the FTZ are 0.0561 and 0.0587 in columns (2) and (3), respectively, both statistically significant at the 1% level. When all control variables are included in column (4), the coefficient of the FTZ is 0.0614, significant at the 1% level. Columns (5)–(7) analyze the impact of FTZs on environmental (env), social (soc), and governance (gov) aspects of sustainability. The coefficients of the FTZ are 0.9518, 1.4029, and 0.1452, respectively, which means that the FTZ has a positive relationship with the environmental, social, and governance performance of companies. Both the environmental and social coefficients are significant at the 1% level, indicating that the implementation of

FTZ policies has a stronger positive impact on corporate performance in terms of environmental and social responsibility. However, the coefficient for governance is not statistically significant, suggesting that the effect of FTZ policies on corporate governance performance is limited.

Table 2. Baseline regression.

	(1) SDC	(2) SDC	(3) SDC	(4) SDC	(5) env	(6) soc	(7) gov
FTZ	0.0535 ***	0.0561 ***	0.0587 ***	0.0614 ***	0.9518 ***	1.4029 ***	0.1452
	(2.7044)	(2.8465)	(2.9391)	(3.0820)	(2.9224)	(4.1280)	(0.3813)
GR		−0.1322 ***		−0.1303 ***	−0.3085	−0.6436 **	−0.3330
		(−8.1191)		(−8.0082)	(−1.1204)	(−2.2276)	(−1.0295)
CF		0.0741 **		0.0687 *	0.2891	0.3476	0.6409
		(2.0877)		(1.9375)	(0.3935)	(0.4845)	(0.8063)
ES		0.0895 ***		0.0907 ***	1.0447 ***	2.1058 ***	1.8228 ***
		(8.5279)		(8.6364)	(5.9087)	(11.5596)	(8.9233)
SR		0.0046 ***		0.0044 ***	0.0423 ***	0.0087	0.0610 ***
		(5.5638)		(5.3405)	(3.1158)	(0.6167)	(3.8338)
EV		0.0024		0.0017	0.3734 ***	0.2552 **	0.4324 ***
		(0.4196)		(0.3040)	(3.6672)	(2.4765)	(3.7287)
ED			−0.2017 ***	−0.1920 ***	−1.9411 **	−2.9126 ***	−3.5136 ***
			(−4.4390)	(−4.2344)	(−2.5354)	(−3.6104)	(−3.8737)
ML			0.3108 ***	0.2984 ***	−0.3245	1.4943 *	1.8354 *
			(5.9494)	(5.7244)	(−0.3795)	(1.6581)	(1.8236)
PS			0.1451 *	0.1556 **	0.7255	0.9774	0.7146
			(1.8494)	(1.9896)	(0.6227)	(0.7850)	(0.5097)
FI			0.0380	0.0325	0.8176	1.4525 *	0.5778
			(0.7435)	(0.6371)	(0.9706)	(1.6651)	(0.5927)
GC			−0.1548 ***	−0.1511 ***	−0.3879	−3.6280 ***	−2.2443 **
			(−2.8771)	(−2.8156)	(−0.4528)	(−4.0673)	(−2.2624)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Corporate FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	25,322	25,322	25,322	25,322	25,322	25,322	25,322
R^2	0.575	0.578	0.576	0.579	0.474	0.620	0.670

Note: *,**,*** indicate that the statistical value is significant at 10%, 5% and 1% respectively.

Overall, the results indicate that the establishment of FTZs significantly enhances the sustainability performance of enterprises compared to those outside the FTZ. The impact of FTZs on sustainability appears to be an external shock, improving the performance of enterprises in terms of environmental and social responsibility. Governance capacity is closely tied to internal aspects of enterprises, including management structure, employee relations, compensation policies, and more. External policy shocks often have a limited immediate impact on these internal governance factors.

4.2. Parallel Trend and Placebo Test

4.2.1. Parallel Trend Test

To assess the parallel trend assumption and ensure the validity of the findings regarding the impact of FTZ establishment on sustainable development capacity, a parallel trend test was conducted in this paper. The constructed model aims to examine whether there are significant differences in trends between the treatment group (enterprises within the FTZ) and the control group (enterprises outside the FTZ) before and after the establishment of the FTZ. The specific model for parallel trend testing is as follows:

$$SDC_{it} = \varphi_0 + \sum_{k=-4}^{6} FTZ_{it}^{k} + \varphi_c X_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (2)$$

where the FTZ_{it}^{k} is a set of dummy variables for the event of the establishment of the FTZ, assigned by s_i which denotes the time point of FTZ establishment. Specifically, if $t - s_i = k$, FTZ_{it}^{k} is assigned a value of 1; otherwise, it is assigned a value of 0.

To provide further context, considering the establishment of the FTZ in 2013, 2015, and 2017, respectively, and the limited data available for the four years preceding and six years following the policy implementation, k ranges from -4 to 6. The year immediately preceding the policy implementation is designated as the base period, while the year of the first batch of establishment serves as the 0th period.

The coefficients φ_k reflect the impact of the FTZ on the sustainability of the enterprises. If $k < 0$, when φ_k is not significantly different from 0, it is sufficient to indicate that it passes the parallel trend test. Figure 1 reports the regression coefficients φ_k over time, revealing that, prior to the establishment of the FTZ, the 95% confidence intervals for φ_k encompass the horizontal line at 0. This suggests that the parallel trends assumption is valid. Furthermore, the establishment of the FTZ has significantly enhanced enterprise sustainability, and the impact of FTZ policy implementation on sustainability has strengthened over time. This progression aligns with the pursuit of sustainability objectives.

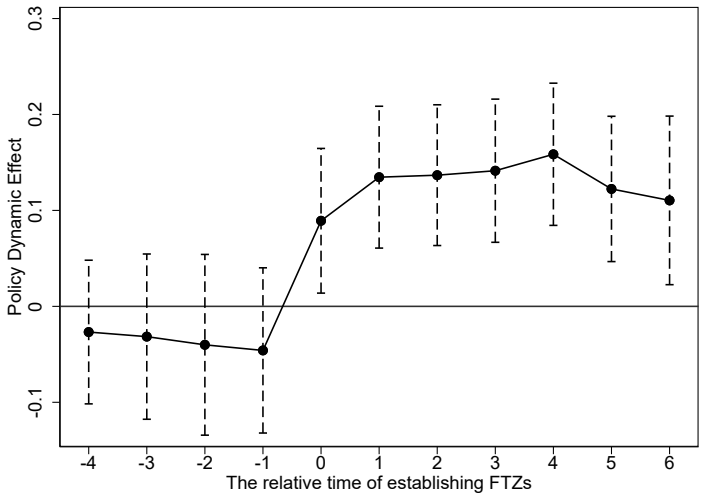

Figure 1. Parallel trend test.

4.2.2. Placebo Test

To further validate the robustness of the empirical findings mentioned above, a placebo test is conducted in this study. The placebo test involves randomly substituting the experimental group cities with a sample of 1000 different cities. This approach helps mitigate the influence of obscure omitted variables on the regression results. The coefficient estimates and p-values for the impact of free trade zone construction on the company's sustainability are obtained for 22 randomly selected cities within the sample, designated as the dummy experimental group cities, while the remaining cities serve as the dummy control group. The placebo test is repeated 1000 times, and the results are presented in Figure 2. The regression coefficients cluster around the value of 0 and exhibit a normal distribution, to the left of the FTZ coefficients of the baseline regression (the vertical dashed line), with p-values predominantly exceeding 0.1 (the horizontal dashed line). This indicates that the randomly generated dummy free trade zones have no discernible impact on the achievement of sustainability performance. Consequently, the results obtained from the baseline regression analysis in this paper can be considered reliable.

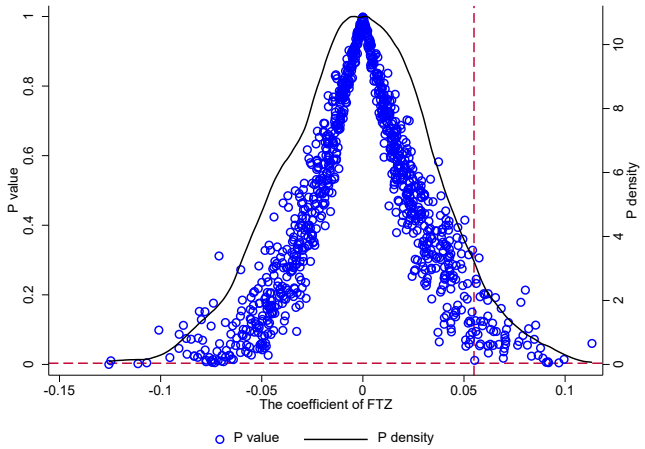

Figure 2. Placebo test.

4.3. Robustness Tests

4.3.1. Mitigating Outlier Effects

To address the potential issue of outlier effects on the core explanatory variable *SDC* in this study, the data were subjected to trimming at the 1st and 99th percentiles of the dependent variable, as shown in column (1) of Table 3. The results indicate that, even after the trimming process, the data still exhibit a strong level of significance, further affirming the robustness of the baseline regression findings.

Table 3. Robustness tests.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Mitigating Outlier Effects	**EC**	**EO**	**SO**	**Replace Samples**	**PSM-DID**	**Innovation City Pilot**	**Low Carbon Pilot City**	**Smart City Building**
FTZ	0.0592 ***	1.0460 *	0.1801 *	0.1762 *	0.1929 ***	0.0636 ***	0.0605 ***	0.0550 ***	0.0533 ***
	(3.1122)	(2.3670)	(1.9294)	(1.8412)	(3.3548)	(3.1157)	(3.0385)	(2.7452)	(2.5767)
Control variables	YES	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	YES	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Corporate FE	YES	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	24,322	22,470	22,470	22,903	4004	24,388	25,322	25,322	23,363
R^2	0.593	0.537	0.492	0.750	0.693	0.580	0.633	0.633	0.634

Note: * and *** indicate that the statistical value is significant at 10% and 1% respectively.

4.3.2. Substitution of Explanatory Variables

To assess the robustness of the empirical findings, this study refers to the work of Xu et al. (2023) [29], which regresses three indicators—economic sustainability (*EC*), environmental sustainability (*EN*), and social sustainability (*SO*)—on the core explanatory variable *FTZ*. The results, presented in columns (2)–(4) of Table 3, demonstrate that the coefficient of *FTZ* remains significantly positive, exerting the greatest impact on economic sustainability, followed by environmental sustainability, and the weakest impact on social responsibility sustainability. These results are consistent with the benchmark regression, indicating that the establishment of the FTZ significantly enhances sustainable development.

4.3.3. Replacement Sample

A panel of prefecture-level cities, identical to a similar study [7], is selected for analysis. The regression results, displayed in column (5) of Table 3, reveal a significant coefficient of the core explanatory variable *FTZ* at the 1% level. This further confirms the hypothesis H1 proposed in this paper.

4.3.4. Replacing Method

To eliminate issues such as sample selectivity bias, this paper uses the propensity score matching with difference-in-differences (PSM-DID) method [30,31] to examine the results of the baseline regression. The results are reported in Figure 3. Initially, there is a notable deviation between the two nuclear density curves before the matching process. However, after matching, these two curves converge, indicating a significant reduction in the disparity. This observation suggests that propensity score matching (PSM) has effectively mitigated sample selection bias, at least to some extent. This outcome underscores the utility of PSM as a means to enhance the comparability of the study groups, resulting in a more reliable and less biased analysis of the data.

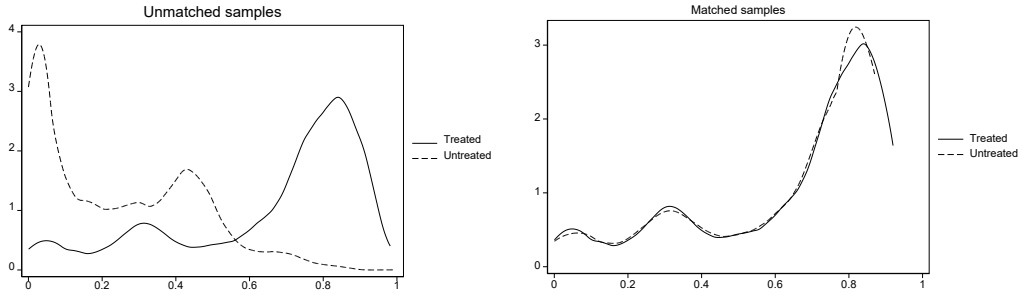

Figure 3. PSM-DID cross-section kernel density.

The empirical results are presented in column (6) of Table 3. The results indicate a statistically significant improvement in company sustainability performance following the establishment of FTZs, with an increase of 6.36%. This outcome underscores the robustness and reliability of the benchmark regression results, reinforcing the argument for the positive impact of FTZs on sustainable performance.

4.3.5. Excluding Related Policies

The establishment of the FTZ was accompanied by various national policies implemented through multiple regional pilots, such as the innovation city pilot, low-carbon city pilot, and smart city construction. These policies potentially affect the sustainable development of enterprises. To estimate the net effect of the FTZ pilot on sustainable development, an exclusion test is conducted to partially mitigate the exogenous shocks from other policies. Specifically, within cities featuring free trade zones, if there were policies in effect during the same period, we assigned a value of 0 to the $Treat_i$ variable. Conversely, if no such policies were in effect, $Treat_i$ remained at 0. The regression results, presented in columns (7)–(9) of Table 3, demonstrate that the core explanatory variables remain significant, consistent with the baseline regression results. This indicates the robustness of the results even after accounting for the impact of other relevant policies proposed during the same period. The lists of innovation city pilot, low-carbon city pilot, and smart city construction are sourced from the official website of the State Council departmental documents of the Central People's Government.

4.4. Heterogeneity Analysis

It is important to recognize that the role of the FTZ may vary due to substantial differences in the region, business backgrounds, and environmental objectives of the enterprises. Additionally, the effect of the FTZ on enhancing sustainable development objectives can also differ across industries, reflecting variations in environmental protection levels within each industry. To further explore the heterogeneity of the policy effects of the FTZ, this paper incorporates interaction terms for the core explanatory variables and control variables into the benchmark regression model.

4.4.1. Analysis of Regional Heterogeneity

This paper categorizes cities into coastal FTZs and inland FTZs to examine how region influences the policy outcomes of FTZs, with empirical results detailed in columns (1)–(8) of Table 4. The outcomes in columns (1) and (4) are particularly noteworthy, revealing that coastal FTZs have the potential to elevate sustainability performance by an impressive 8.35%, while inland FTZs, at present, do not exhibit a significant impact. This discrepancy can be attributed to fundamental disparities in the establishment times and functional objectives of coastal and inland FTZs. Coastal FTZs were primarily established in the early stages of China's institutional reform and innovation, positioning them at the forefront of sustainable development. In contrast, inland FTZs primarily focused on attracting investments to address regional disparities.

Table 4. Heterogeneity analysis: region level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	SDC	**env**	**soc**	**gov**	**SDC**	**env**	**soc**	**gov**
FTZ × costal	0.0835 ***	1.6624 ***	1.7161 ***	0.0465				
	(3.1225)	(3.9351)	(3.8725)	(0.0944)				
FTZ × inland					0.0158	1.9678 ***	1.5991 **	0.5619
					(0.3682)	(2.8387)	(2.2424)	(0.6987)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Corporate FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	25,322	10,382	11,507	11,704	25,322	10,382	11,507	11,704
R^2	0.579	0.474	0.620	0.670	0.578	0.474	0.619	0.670

Note: ** and *** indicate that the statistical value is significant at 5% and 1% respectively.

Columns (2)–(4) and (6)–(8) further illustrate that both coastal and inland FTZs have a positive impact on environmental and social responsibility performance, but the effect on corporate governance remains uncertain. This observation can be traced back to the differing foundations of sustainable development in these regions. Coastal FTZs embarked on their sustainable development journey earlier, resulting in advanced environmental protection measures. Meanwhile, enterprises in inland FTZs are still in the nascent stages of environmental governance, potentially explaining the comparatively weaker enhancement of social responsibility performance. Regarding corporate governance performance, it is important to note that internal structural changes within companies are inherently complex and less susceptible to external policy shocks, regardless of the establishment of FTZs.

4.4.2. Political Resource Curse Effect

The presence of political resources can significantly influence corporate development. Government-related political affiliation can hinder corporate innovation and disrupt market order, having a negative effect on both firm and regional sustainable development. Drawing on the work of Yuan et al. (2015) [32], the regression results presented in columns (1)–(4) of Table 5 confirm that having political resources does not improve the sustainability of enterprises. In fact, there is a curse effect wherein political resources negatively impact enterprise sustainability. This may be attributed to the fact that companies with extensive political resources tend to focus more on rent-seeking behavior rather than technological progress and innovation, thus weakening their sustainability. The empirical results in columns (2)–(4) further support the hypothesis that political resources have a negative impact on corporate environmental, social, and governance performance. Notably, the strongest negative impact is observed in corporate social responsibility performance, as companies with political connections tend to undermine market competition, leading to a decline in their social responsibility performance. In addition, our research reveals that the presence of political resources within an enterprise does not exert a statistically significant influence on its governance performance. This finding suggests that the immediate impact of corporate political resources on internal organizational structures and employee relations may be limited.

Table 5. Heterogeneity analysis: political resource curse effect and environmental goal reinforcement effect.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	SDC	**env**	**soc**	**gov**	**SDC**	**env**	**soc**	**gov**
FTZ × PR	0.0440	−0.8451 *	−1.1215 **	−0.6183				
	(1.2998)	(−1.7107)	(−2.0352)	(−1.3041)				
FTZ × EG					0.3162 ***	3.7869 ***	2.2497 ***	0.6120
					(8.9536)	(8.2858)	(4.5244)	(1.0897)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Corporate FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	23,405	9514	10,616	10,812	25,305	10,380	11,505	11,702
R^2	0.578	0.503	0.622	0.768	0.580	0.478	0.620	0.670

Note: *, ** and *** indicate that the statistical value is significant at 10%, 5% and 1% respectively.

4.4.3. Environmental Goal Reinforcement Effect

Since China's introduction of the concept of ecological civilization, listed companies have increasingly prioritized environmental protection initiatives. Companies that establish environmental goals demonstrate greater attention to environmental management performance and enhance their social responsibility performance as well. The regression results in columns (5)–(8) of Table 5 indicate that the establishment of the FTZ has a more significant contribution to the sustainability of firms with environmental goals. Additionally, in line with the benchmark regression, the contribution to environmental performance is the strongest, followed by social responsibility performance. However, the contribution to corporate governance performance is not significant. The establishment of environmental objectives tends to significantly influence companies' strategic direction and business objectives, encouraging green technological innovation and facilitating access to green credit. This, in turn, enhances sustainable profitability and creates a positive cycle that promotes corporate performance in environmental and social responsibility. It is important to note that the transformation of corporate internal governance is a long-term process and, given the relatively short period since the introduction of the FTZ and environmental objectives, the observed effects may not be significant. Furthermore, the result in column (8) indicates that the environmental protection targets do not have a statistically significant effect on their governance performance. This observation underscores the notion that corporate governance structures and strategic business decisions often represent long-term behaviors that may not be susceptible to short-term influence.

4.4.4. Differences in the Level of Green Development of Industries

Enterprises operating in industries with varying levels of green development often exhibit different performance in environmental, social, and governance aspects. Given the FTZ policy's emphasis on "bold experimentation" and "bold innovation," and the fact that different industries are subject to different industrial policies, the impact of the FTZ can vary across industries. To investigate this, this paper draws on the work of Zhang et al. (2015) [33], which divides the 80 industries into two groups: High Green Industry (HGI) and Low Green Industry (LGI). The regression results in columns (1) to (8) of Table 6 reveal interesting findings. Firstly, the empirical results in column (1) indicate that the implementation of the FTZ policy significantly enhances the sustainable development capabilities of enterprises operating in high green industries, with a coefficient of 0.0657, significant at the 5% level. Furthermore, the empirical results in columns (2) and (3) show that the establishment of the FTZ has a positive effect on the environmental and social performance of enterprises in high green industries.

Table 6. Heterogeneity analysis: Level of green development in the industry.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	SDC	**env**	**soc**	**gov**	**SDC**	**env**	**soc**	**gov**
FTZ × HGI	0.0657 **	1.4818 ***	1.4803 ***	0.0561				
	(2.2546)	(3.1668)	(3.1038)	(0.1332)				
FTZ × LGI					0.0042	0.0829	0.7501	0.3209
					(0.1002)	(0.1244)	(1.2169)	(0.5826)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Corporate FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	11,685	11,685	11,685	11,685	13,166	13,166	13,166	13,166
R^2	0.595	0.540	0.663	0.793	0.619	0.455	0.726	0.806

Note: ** and *** indicate that the statistical value is significant at 5% and 1% respectively.

However, the empirical results in column (5) suggest that the establishment of the FTZ does not enhance the sustainability of firms in low green industries. This may be attributed to the fact that the sustainability of low green industries is primarily constrained by their production methods, and policies have limited impact in improving their sustainability. Additionally, the FTZ's focus on the development of advanced manufacturing and production services aligns more closely with high green industries. In contrast, low green industries, which are often resource-intensive and labor-intensive, face challenges in benefiting from the institutional advantages offered by the FTZ.

5. Further Analysis

5.1. Mechanism Analysis

In this section, we aim to test the two potential mechanisms proposed earlier, namely the institutional environment and innovation environment, using an econometric model. We construct a mechanism validation model by utilizing these mechanisms as intermediate variables and by directly examining the impact of the FTZ establishment on these variables. It is widely argued in the existing literature and empirical studies that the institutional environment and innovation environment have a positive influence on the sustainability of enterprises [34–37].

To analyze the intermediate mechanisms for sustainable development, we establish a transmission chain that links the establishment of the FTZ to the promotion of these mechanisms and ultimately to sustainable development. The model can be represented as follows:

$$M_{\mathrm{it}} = \gamma_0 + \gamma_1 FTZ_{it} + \gamma_2 X_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (3)$$

where M_{it} is the mechanism variable. At the institutional level, this paper measures the institutional variables at the macro and micro levels using two proxies: the market-oriented index (MOI) and the dynamics of the external environment (EDI). In particular, MOI is based on the indicators constructed by Fan et al. (2003) [38], which serve as a proxy variable for the institutional environment at the city level. EDI, on the other hand, is measured by examining fluctuations in the sales revenue of listed companies, which reflect changes in their core business activities in response to external factors. At the innovation level, this paper draws on He et al.'s work (2017) [39], and employs two indicators to measure the innovation environment: innovation input persistence (IIP) and innovation output persistence (OIP). The innovation input persistence is calculated based on R&D intensity, while the innovation output persistence is measured by the number of granted patents [40]. The remaining variables have the same meaning as in Equation (1).

If the coefficients of the core explanatory variables in the regression of Equation (2) are significant, this indicates that the two mechanisms proposed in this study are reasonable.

The regression results are presented in Table 7. The findings in columns (1) to (2) show that the coefficients of the core explanatory variables, MOI and EDI, are significantly positive at the 1% level. This suggests that the establishment of the FTZ has effectively improved the institutional environment at both the macro and micro levels by 22.63% and 1.54%. The FTZ initiatives aim to enhance the institutional environment by establishing a

new system in line with international standards, fostering a robust legal framework, protecting property rights, and ensuring efficient governance. These efforts have contributed to an institutional environment characterized by efficient resource allocation and a stable business environment, thereby enhancing sustainable development and facilitating the achievement of sustainable development goals.

Table 7. Institutional, innovation-level mechanism analysis.

	(1)	(2)	(3)	(4)
	MOI	**EDI**	**IIP**	**OIP**
FTZ	0.2263 ***	0.0154 ***	0.0748 ***	0.1146 ***
	(22.2622)	(3.5921)	(3.3119)	(4.4492)
Control variables	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Corporate FE	Yes	Yes	Yes	Yes
N	25,322	14,661	25,322	18,520
R^2	0.953	0.362	0.749	0.737

Note: *** indicate that the statistical value is significant at 1%.

The empirical results in columns (3) and (4) of Table 6 reveal that the coefficients of the core explanatory variables, *IIP* and *OIP*, are significantly positive at the 1% level, with increases of 7.48% and 11.46%, respectively. This indicates that the establishment of the FTZ has had a positive impact on the firms' R&D investment and patent applications, thereby improving the innovation environment. The FTZs in Shanghai, Fujian, and Guangdong have implemented policies such as pre-entry national treatment and adjusted legal regulations on foreign investment. These measures have created a level-playing field, stimulated firms' R&D investment, increased their innovation success rate, and boosted their innovation output. Consequently, a positively reinforced innovation environment has been established, leading to improved sustainable development and effectively contributing to the achievement of sustainable development goals.

5.2. Matthew Effect Test

The Matthew effect illustrates a phenomenon wherein a pervasive pattern of self-reinforcing inequality emerges in relation to scarce or highly valued resources, including economic wealth and political power [41]. To examine this, the sample is divided into two groups based on the initial sustainability performance score at the city level: low and high initial sustainability values.

The empirical results in column (1) of Table 8 indicate that the establishment of the FTZ does not have a significant enhancement effect on regions with low initial sustainability scores. However, columns (2)–(4) reveal that the establishment of the FTZ has a significant enhancement effect on the environmental and governance performance of companies in regions with low initial sustainability scores. The effect on corporate social responsibility, however, is not as pronounced. On the other hand, the empirical results in column (5) of Table 8 demonstrate that the establishment of the FTZ has a significant enhancing effect on regions with high initial sustainability values, which has improved the company's sustainability performance by 6.19%. Columns (6)–(8) further reveal that the establishment of the FTZ has a positive impact on corporate environmental, social, and governance aspects in these regions, with all coefficients being significant at the 1% level. Moreover, the magnitude of these coefficients indicates a positive relationship between the presence of an FTZ and sustainability performance, encompassing environmental, social, and governance dimensions.

Table 8. Matthew effect test.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Areas with Low Sustainable Initial Values				Areas with High Sustainable Initial Values			
	SDC	env	soc	gov	SDC	env	soc	gov
FTZ	0.0343	1.3841 *	0.7517	2.0114 ***	0.0619 ***	1.4120 ***	1.6802 ***	1.7332 ***
	(1.5619)	(1.8098)	(1.4806)	(3.3264)	(3.4991)	(4.5706)	(3.9123)	(3.3565)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Corporate FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	13,849	13,849	13,849	13,849	10,849	10,849	10,849	10,849
R^2	0.243	0.418	0.753	0.840	0.604	0.639	0.589	0.483

Note: * and *** indicate that the statistical value is significant at 10% and 1% respectively.

According to the analysis of the empirical results, the enhancement effect of the establishment of the FTZ at the sustainable development level does not conform to the law of diminishing marginal effect. This deviation may be attributed to the relatively new concept of ESG disclosure among listed companies in the Chinese market, which could exhibit a Matthew effect at the initial stage. Regions with higher initial values are likely to absorb ESG information more efficiently, enabling them to benefit more from the policy dividends of the FTZ and further promote sustainable development. In contrast, regions with lower initial values may lack standardized ESG information disclosure or fail to take it seriously, resulting in an inefficient absorption of the policy dividends of the FTZ and a less noticeable enhancement effect on sustainable development.

5.3. Spillover Effect Test

The establishment of the FTZ not only aims to enhance the sustainable development of enterprises in the zone, but also focuses on promoting the policy experimentation process and releasing the policy spillover effects of sustainable development. This section will further investigate the spillover effects of the policy effects of the FTZ by setting up an econometric model as follows:

$$SDC_{it} = \delta_0 + \delta_1 CLS_{it} + \delta_2 X_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (4)$$

where CLS_{it} indicates whether firm i is near the FTZ in year t. The geographical boundary of the city is used to match whether the firm is near the FTZ; if it is, then this value takes 1, otherwise it takes 0. The coefficient δ_0 is measured to test the spillover effect of the implementation of the FTZ policy. The rest of the variables are consistent with the implications of the baseline regression model.

The results of the regression analysis in Table 9 support the presence of spillover effects from the FTZ policy on the sustainable development of enterprises in proximity. In column (1), the regression coefficient for the dummy variable indicating proximity to the FTZ is 0.2511 and is statistically significant at the 1% level. This suggests that the FTZ policy implementation has improved the sustainable development of enterprises in the nearby areas by 25.11%.

Columns (2)–(4) present the regression coefficients for the environmental, social, and governance aspects of firm performance in the nearby FTZs. The coefficients are 5.4225, 1.0855, and 1.5314, respectively. The coefficients for environmental and social performance are statistically significant at the 1% level, indicating that the FTZ policy implementation has a significant positive impact on these aspects of firm performance in the neighboring areas. However, the coefficient for governance performance does not pass the significance test, suggesting that the FTZ policy may not have a significant impact on corporate governance in the nearby regions.

Table 9. Test for spillover effects.

	(1) SDC	(2) env	(3) soc	(4) gov
CLS	0.2511 ***	5.4225 ***	1.0855 ***	1.5314
	(3.1362)	(4.6463)	(6.1356)	(1.0993)
Control variables	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Corporate FE	Yes	Yes	Yes	Yes
N	25,322	25,322	25,322	25,322
R^2	0.579	0.475	0.619	0.670

Note: *** indicate that the statistical value is significant at 1%.

These findings can be attributed to two main factors. The proximity to the FTZ allows neighboring areas to benefit from the enhanced sustainable development achieved within the FTZ. The positive effects demonstrated in the pilot areas can serve as effective examples and stimulate neighboring regions to emulate the policies and practices, further expanding the impact of the FTZ policy. Additionally, the implementation of the FTZ policy helps to improve the institutional and innovation environment, leading to positive effects on the sustainable development of enterprises in the neighboring FTZs. Reforms in investment management systems, technological progress, and innovation driven by the FTZ policy contribute to the sustainable development goals and positively influence the neighboring areas through various channels.

5.4. Synergy Effect Test

In the context of the new double-cycle development pattern, the establishment of free trade zones (FTZs) goes beyond its role as a platform for system integration, innovation, and expanding international openness.

5.4.1. The Synergy Effect between the FTZs and New Energy Demonstration Cities

The new energy policy system aims to facilitate the development of a resource-saving and environmentally friendly society. One notable aspect of this system is the establishment of new energy demonstration cities, which serve as exemplars for sustainable practices. These cities are designed to prioritize the restructuring of their energy mix, with a specific focus on the promotion of clean, low-carbon renewable energy sources. This institutional design aligns with the overarching objective of achieving sustainable development. The model can be represented as follows:

$$SDC_{it} = \alpha_1 + \beta_2 FTZ_{it} + \beta_3 NEC_c + \beta_4 FTZ_{it} \times NEC_c + \beta_5 X_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (5)$$

where NEC_c indicates whether city c represents a binary variable, in turn indicating whether city c is designated as a New Energy Demonstration City, taking the value of 1 if it is and 0 otherwise. The remaining variables retain their original meanings as described in the baseline regression. The interaction terms between FTZ_{it} and NEC_c are used to regress the explanatory variables. The coefficient of this interaction term is examined for significance to determine the presence of a synergistic effect between the two variables. A significant coefficient would provide evidence of an amplified impact resulting from the combined effect of being in the FTZ and being designated as a New Energy Demonstration City, surpassing the sum of their individual effects on the explanatory variables.

The empirical findings, presented in Table 10, reveal noteworthy results. In column (1), the regression coefficient of 0.1821 is highly significant at the 1% level, surpassing the coefficients of FTZ establishment (FTZ) and model city construction (NEC). This indicates that the construction of model cities can amplify the positive impact of the FTZ on the sustainable development of enterprises from 11.87% to 18.21%, resulting in a synergistic

effect. Moving on to columns (2) and (3), the regression coefficients of 0.1918 and 0.1439, respectively, are significant at the 1% and 5% levels. This signifies that the synergistic effect extends to the environmental and social responsibility dimensions of enterprises as well.

Table 10. Synergies effect: FTZ and New Energy Model Cities.

	(1) SDC	(2) env	(3) soc	(4) gov
FTZ	0.1187 ***	1.0452 ***	1.5496 ***	0.4558
	(3.7358)	(3.1401)	(3.0088)	(1.0882)
NEC	0.1317 ***	0.4337 ***	0.3725 **	0.1513
	(4.1989)	(3.0762)	(2.0281)	(0.2173)
FTZ × NEC	0.1821 ***	0.1918 ***	0.1439 **	0.9889
	(3.2767)	(2.6906)	(2.1619)	(1.0701)
Control variables	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Corporate FE	Yes	Yes	Yes	Yes
N	25,322	25,322	25,322	25,322
R^2	0.579	0.474	0.620	0.670

Note: ** and *** indicate that the statistical value is significant at 5% and 1% respectively.

However, in column (4) of Table 10, it is observed that this synergy does not yield improvements in corporate governance performance. This can be attributed to the fact that the policies of the FTZ, combined with the model city construction, are primarily geared toward objectives such as eliminating outdated and inefficient production capacities, enhancing production efficiency, reducing emissions, and actively fulfilling social responsibilities. On the other hand, the design of the model city system, in conjunction with the policies of the pilot free trade zone, implements targeted applications for energy conservation and pollution reduction to achieve sustainable development across enterprises in each jurisdiction. This concerted effort further enhances performance in terms of environmental and social responsibility, ultimately contributing to sustainable development objectives.

5.4.2. The Synergy Effect between the FTZs and the Belt and Road Initiative

The 20th Party Congress report emphasized the shared objective of the free trade zone (FTZ) and the construction of the Belt and Road initiative (BRI), which is to implement a more proactive opening strategy. This article aims to examine the role of the FTZ in the development of the BRI. The model can be represented as follows:

$$SDC_{it} = \alpha_2 + \beta_6 FTZ_{it} + \beta_7 EXP_i + \beta_8 FTZ_{it} \times EXP_i + \beta_9 X_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (6)$$

where EXP_i is a dummy variable that measures whether an enterprise has participated in the Belt and Road Initiative by verifying whether it has exported to countries across the Belt and Road; its value is 1 if it has exported to those countries, and 0 otherwise. The rest of the variables have the same meaning as in Equation (6). The interaction term between FTZ_{it} and EXP_i is examined to assess whether there is a synergistic effect between the two. If the coefficient of the interaction term on the explanatory variable is found to be significant, this indicates the presence of a synergistic effect between the FTZ and BRI.

The regression results can be found in Table 11. Columns (1)–(4) indicate that there is currently no established linkage mechanism between the construction of the free trade zone (FTZ) and the construction of the BRI. In fact, there seems to be a negative effect, with the most significant negative impact observed in terms of corporate governance. As can be seen from the results in column (1), the sustainability performance of enterprises participating in the FTZ and BRI has dropped significantly by 20.7%, with a particularly pronounced impact on corporate governance, with a coefficient of 0.99 and a significant 1% level. This decline can be attributed to their limited experience in international management practices,

which makes it challenging for them to maintain or enhance their corporate governance standards when operating in diverse international contexts.

Table 11. Synergies effect: FTZ and The Belt and Road Initiative.

	(1) SDC	(2) env	(3) soc	(4) gov
FTZ	0.2047 ***	0.2111	2.0766 *	0.3721 *
	(4.3389)	(0.1726)	(1.8877)	(1.8048)
EXP	−0.0085	−0.3942	0.1302 ***	−0.1353 *
	(−0.0480)	(−1.6046)	(5.0946)	(−1.9706)
FTZ × EXP	−0.2070 ***	0.9735	0.1737 *	−0.9941 ***
	(−3.0662)	(0.7148)	(1.7612)	(−2.9461)
Control variables	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Corporate FE	Yes	Yes	Yes	Yes
N	25,322	25,322	25,322	25,322
R^2	0.579	0.477	0.620	0.670

Note: * and *** indicate that the statistical value is significant at 10% and 1% respectively.

This negative effect could be attributed to two factors. Firstly, the concept of corporate sustainability is relatively new, and the alignment between developed countries/regions and lagging regions is significantly higher. Only when there is a "surplus" can companies develop more effective and scientifically driven sustainable development strategies to promote the achievement of sustainable development goals. Secondly, collaboration with less developed regions often slows down product iterations and fails to promote innovation. This can have a negative impact on the sustainability of both innovation inputs and outputs, ultimately affecting the sustainability of enterprises and impeding the achievement of sustainable development goals.

5.5. Limitations

There are several potential limitations in this paper. Although this paper utilizes a Chinese city-level database, offering valuable insights into local dynamic performance, it is constrained by the relatively limited time frame compared to national-level data. Future research may consider investigating policy effects from a broader perspective, encompassing coarser-grained dimensions. In addition, while this paper employs a cutting-edge causal inference method, future studies could explore the potential of machine learning techniques to enhance the identification of factors influencing corporate sustainability enhancement.

6. Conclusions and Policy Implications

This paper utilizes panel data from Chinese listed companies spanning the period 2009–2021 to assess the impact of FTZ establishment on a company's sustainability performance. The conclusions of this study are as follows:

(1) The establishment of FTZs can contribute to the achievement of sustainable development goals. By improving the institutional environment, the FTZ reduces transaction costs for enterprises and enhances their sustainable profitability through an improved innovation environment, thereby enabling the realization of sustainable development goals.

(2) The impact of FTZ establishment on sustainable development exhibits heterogeneity. This heterogeneity is evident at multiple levels, including regional, firm, and industry. In terms of regions, coastal FTZs exhibit a significant enhancement of company sustainability performance, whereas the policy effect of inland FTZs is not statistically significant. For firms, the possession of political resources tends to inhibit their sustainable development performance. Additionally, firms with a stronger environmental awareness can reinforce the policy effects of an FTZ establishment. For industries, high green industries are more

likely to absorb policy dividends compared to medium and low green industries, thereby facilitating the achievement of their sustainable development goals.

(3) The impact of the FTZ on sustainability includes a Matthew effect and a spillover effect. In terms of policy implementation, regions with higher initial levels tend to experience a more pronounced policy implementation effect, resulting in a "stronger the stronger" situation. Spatially, the establishment of the FTZ exhibits a policy spillover effect, positively influencing enterprises located in the vicinity of the FTZ.

(4) The synergy between FTZ construction and major national strategies demonstrates variation. The synergy between FTZ construction and the development of new energy model cities is more evident, while the synergy with the construction of the "Belt and Road" initiative is yet to be fully realized.

Based on the findings of this study, several policy recommendations are proposed to further reform and explore the construction of the FTZ to promote "carbon peaking" and "carbon neutrality" and achieve sustainable development:

(1) The government should prioritize the optimization of the regulatory system, investment regime, and administrative efficiency within the FTZ. It is crucial to design a system tailored to the specific attributes of different industries, with a focus on enhancing the sustainable development of low and medium green industries. Furthermore, strengthening the information exchange and mutual learning mechanism between high green industries and low and medium green industries, as well as improving the innovation environment within these industries, will facilitate the achievement of sustainable development goals.

(2) The government should play a vital role in optimizing the rational allocation of resources within the FTZ by further strengthening the institutional and innovation environment. This should involve emphasizing the structural adjustment of institutional innovation policies, providing a convenient business environment for enterprises, and optimizing the innovation environment. By doing so, the government can effectively contribute to the promotion of sustainable development within the FTZ.

(3) To achieve balanced and sustainable regional development, the government should leverage the Matthew effect and spillover effect. In developed regions, the government should capitalize on existing advantages, such as institutions and innovation, to further exploit the sustainable development potential of the eastern coastal FTZs. Meanwhile, in lagging regions, it is important to acknowledge the potential risk of "the weak getting weaker". However, by utilizing the spillover effect, these regions can improve by leveraging local advantageous industries and aligning them with the implementation of FTZ policies. This approach will ultimately contribute to sustainable development.

(4) It is crucial to enhance awareness of the FTZ's role in serving major national strategies. Future policy formulation should focus on promoting policy differentiation inwards by harnessing the FTZ's role in opening to the outside world and reforming the system. Moreover, each pilot trade zone should assess the effectiveness of its interface with the Belt and Road Initiative based on its comparative advantages. This assessment will facilitate the customization of cooperation mechanisms, directions, and areas of collaboration between each zone and the Belt and Road Initiative.

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