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Original Research

Do Environmental Information Disclosure Discourage Foreign Direct Investment? Empirical from China

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Abstract

As a cutting-edge topic within the realm of international investment, deciphering the influence of informational factors on Foreign Direct Investment (FDI) is of paramount importance. Due to the difficulty of capturing, identifying, and endogenizing, the "information" factor makes it particularly difficult to draw causal inferences between them. However, the environmental information disclosure policy enacted by China in 2007 has presented a unique opportunity and a natural exogenous variable for examining the influence of local environmental information announcements on the inflow of FDI. This study selects the panel data of prefecture-level cities in China from 2004 to 2021 and, constructs a quasi-natural experiment with the environmental information disclosure approach introduced in 2007. Those cities that disclose environmental information are referred to as the treatment group, while those that do not disclose such information are referred to as the control group. Using propensity score matching (PSM) to match the sample cities and exclude those with large differences, and then choosing difference-in-differences (DID) analysis to explore the net effect of environmental information disclosure on regional FDI. The findings indicate that environmental information disclosure significantly decreases regional FDI inflows, and the policy is not effective until a significant amount of time has passed. The estimation results of the balance trend test, replace the matching method test and, the counterfactual test, and the exclusion of similar policy shocks and verifies the robustness of the empirical findings. In further analysis, it is revealed that environmental information disclosure impacts FDI differently depending on city geographic location, city tiers, and environmental regulation intensity.

Keywords: environmental information disclosure, FDI, PSM-DID, Quasi-natural experiment

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Introduction

With the acceleration of the globalization process, the scale of foreign investment has been expanding globally, and FDI has become an important force driving global economic development. Following its economic reforms and opening-up policies, China has experienced a significant enlargement of its capital attraction endeavors, emerging as the leading recipient of FDI among developing nations globally, as shown in Fig. 1. In 2022, the world FDI flow is 1.3 trillion US dollars, and China has garnered an actual inflow of FDI amounting to 189.13 billion US dollars, accounting for 14.55% of the world FDI flow. FDI not only makes up for the shortage of physical capital in China, but also brings the spillover effect of advanced knowledge, technology, management experience, human capital, and other factors. It holds a significant role in the economic development narrative of China, and it is an important carrier and tool to promote China's economic growth and realize international capital flow and technology transfer [1]. According to the 19th CPC National Congress report, China's economy has shifted from high-speed growth to high-quality development, and it is at a critical stage where the development model needs to be transformed, the economy needs to be optimized, and the growth engines need to be converted. However, the environmental pollution and ecological damage caused by rapid economic development are also becoming increasingly serious, and sustainable development has become a key issue of concern to the world [2, 3]. China's Ecological Environment Situation Bulletin pointed out that the proportion of 339 cities in China whose atmospheres did not meet the standards was as high as 37.2% in 2022. According to the World Air Quality Report 2022, 16 of the world's 100 most polluted cities are in China. In the face of such serious environmental problems, there is an urgent need to strengthen China's environmental regulations to protect the ecological environment. For a long time, in order to cope with global threats such as climate change, the elimination of carbon dioxide, and the adoption of renewable energy sources, governments around the world have been implementing regulations and policies to mitigate climate change, with a view to improving the quality of the environment and promoting sustainable development [4, 5]. Since the beginning of the 21st century, the Chinese administration has persistently intensified environmental governance, devising and implementing an array of environmental statutes and guidelines. These measures are aimed at mitigating the adverse effects of corporate manufacturing practices on the ecosystem. However, the strengthening of environmental regulations will inevitably have an impact on economic development. As Walter and Ugelow explain in their pollution paradise hypothesis, strict environmental regulations affect local enterprises' production behavior, as well as foreign investment's location preference and production mode, which in turn affects the amount of local foreign direct investment [6]. So, is the pollution paradise hypothesis also valid in China? Will the successive introduction of environmental regulatory policies inhibit the inflow of FDI? Therefore, examine the impact of environmental regulatory policies on FDI inflows comprehensively and find a balance between them, which has far-reaching practical significance for China's economic transformation and upgrading.

As China is one of the world's important FDI attractors, the study of clarifying the factors affecting FDI inflows and location choice is an important guide for socio-economic development. In the established literature, scholars have looked at economic growth [7], foreign exchange level [8], tax environment [9], urban competition [10], institutional factors [11], geographical environment [12], market capacity [13], firm entry [14], and environmental quality improvement [15], to explore the influencing factors and logical mechanisms of FDI inflow volatility, location choice, and structural adjustment. Researchers have focused a lot of attention on the relationship between environmental regulations

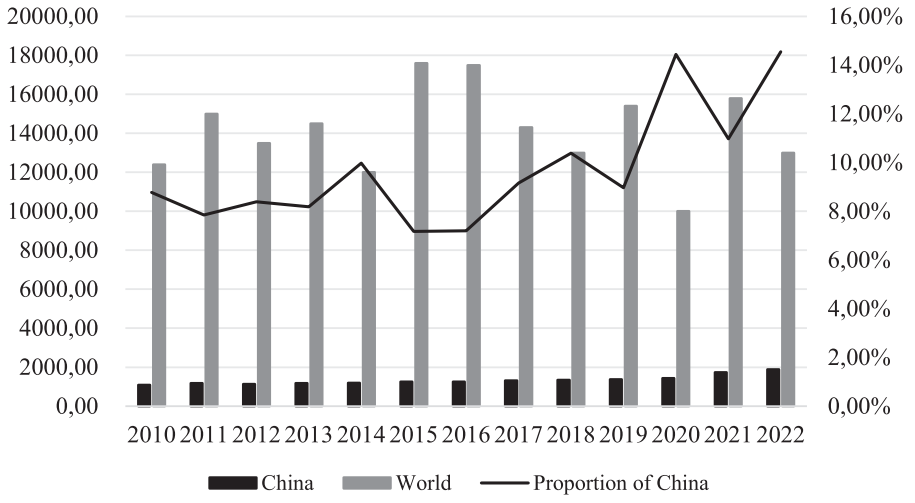

Fig. 1. FDI inflows in China and the world from 2010 to 2022.

and FDI since the pollution paradise hypothesis was proposed, and the relationship between them has become one of the most controversial issues [16]. Currently, there are two completely opposite views on this issue: One view supports the pollution haven hypothesis [17], asserting that environmental regulations will increase the production costs of foreign enterprises, thereby hindering FDI inflows. Becker et al. selected the United States as the object of study, and the pollution haven theory is supported by their results [18]. The study of Mulatu shows that strict environmental regulations will force enterprises to move to pollution shelters with a lower intensity of government regulation, which is not conducive to the inflow of FDI [19]. Yang and Wang et al. found that environmental regulation inhibits the flow of regional FDI significantly [20, 21]. In general, the influence of environmental regulation intensity on FDI in China is mainly manifested as the pollution paradise effect. Another view is the Porter's hypothesis [22], arguing that moderate environmental regulation is conducive to attracting foreign direct investment. Kheder, Zugravu, and Rezza studied in France and Norway, respectively, found that the pollution haven effect was not significant, and there is even the pollution halo effect in some areas [23, 24]. Kim and Rhee conducted an empirical study using a panel of 120 developing countries from 2000 to 2014 and found that, contrary to the pollution paradise hypothesis, strict environmental regulations would change firms' existing production technologies and environments, improve their production efficiency, and significantly attract FDI inflows [25]. Some scholars regard that China does not provide strong evidence for the pollution haven hypothesis [26], the implementation of environmental regulation policy is not a stumbling block to foreign direct investment, and will significantly promote foreign direct investment [27, 28].

Although there are numerous studies regarding the nexus between environmental regulatory measures and FDI [29-34], the relationship between FDI and environmental information disclosure is rarely studied. Environmental disclosure in host countries can have a significant impact on the attractiveness of foreign investment. According to Shroff et al., it concluded that the total amount of FDI is positively correlated with the number of ISO quality certifications, and the more the number of quality certifications, the more the total amount of FDI in the country [35]. Earnhart et al. argues that information disclosure is one of the important factors examined by FDI firms when making cross-border investment decisions, and that information regulation in the host country will be conducive to favoring their FDI inflows [36]. Although environmental information disclosure has a significant impact on FDI, its net effect on FDI is difficult to be accurately estimated and measured by empirical tests due to the difficulty of quantifying environmental information disclosure and the strong endogeneity between them. Based on this, to address this, the study devises a quasi-natural experimental framework leveraging the exogenous policy shock of environmental information disclosure legislation enacted in 2007, taking cities with environmental information disclosure as the treatment group and cities without information disclosure as the control group. Utilizing the PSM-DID analytical approach, this paper aims to empirically assess the net efficacy of the environmental information disclosure policy on FDI.

The distinctive contributions of this study are articulated in several dimensions: Firstly, the research capitalizes on the exogenous nature of the environmental information disclosure policy shock to construct a quasi-natural experimental setup. This approach enables the precise delineation and assessment of the net effects of environmental regulatory policies on FDI in China, thereby circumventing the quantification challenges and endogeneity inherent in such analyses. Secondly, the study presents an innovative viewpoint regarding the impact of environmental information disclosure on FDI, thereby augmenting the existing literature on the subject of environmental regulation's impact on FDI. Thirdly, while the majority of extant research has focused on the macroeconomic national or provincial level and the micro-economic industry or firm level, this study employs data from prefecture-level cities in China. This choice of data provides a more nuanced and accurate reflection of the influence that information disclosure exerts on FDI.

The subsequent structure of this paper is organized as follows: the initial segment presents the policy backdrop and theoretical framework. This is followed by an exposition of the data and methodologies employed in the study. The penultimate section delineates the empirical findings, accompanied by a discussion. An analysis of heterogeneity is then conducted. The paper culminates with concluding remarks and policy implications. A visual representation of the research concept is depicted in Fig. 2.

Policy Context and Theoretical Model

Policy Context

In 2007, the State Environmental Protection Administration adopted the "Measures for Environmental Information Disclosure (for Trial Implementation)" at its first bureau meeting, which mainly regulates the disclosure of governmental and corporate environmental information, and was formally implemented on May 1st, 2008. Post the enactment of the Measures, a collaborative effort between China's Public Environmental Research Center and the Natural Resources Defense Council culminated in the development of the Pollution Information Disclosure Index (PITI). This index serves to evaluate the extent of pollution information disclosure among cities designated as key focal points in the national

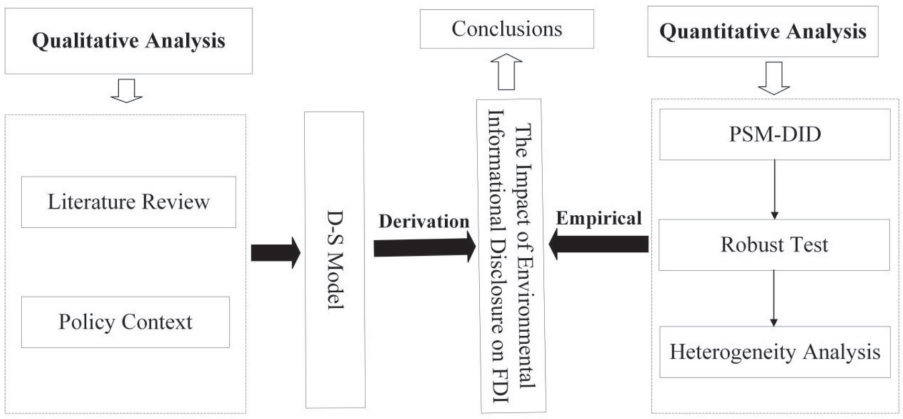

Fig. 2. Idea diagram of the study.

environmental protection strategy. Among the cities with environmental information disclosure between 2008 and 2012, 110 were national environmental key cities and three were non-national environmental key cities. Its PITI evaluation indicators include eight items, namely, the daily supervision information of pollution sources, centralized remediation information, cleaner production audit information, enterprise environmental behavior evaluation information, complaint case information, Environmental Impact Assessment documents acceptance information, pollution charge information, and application disclosure information. After 2013, the number of cities with environmental information disclosure increased to 120, and the PITI was refined to include four key evaluation indicators, with the addition of online monitoring details and annual emission disclosures from enterprises.

Theoretical Model

Drawing upon the scholarly work of D'Aspremont et al. (1996) [37], this study expands the D-S model, introduces environmental regulation into the model, and constructs a dynamic model of FDI enterprise investment choices, focusing on the strategies adopted by FDI enterprises in the face of environmental regulation policies implemented by the host country. In the model, it is assumed that in a small open economy, FDI enterprises can freely enter or exit the host country's market. Supposing that there are X production sectors in the economic system, each sector has m enterprises, and the enterprises can only produce one product, so the demand utility Equation is:

$$U = \prod^{X} C_x^{c_x}; C_x = \left(\int_{m \in \Phi} c_m^{\theta/\theta-1} \right)^{\theta/\theta-1} \tag{1}$$

In Equation (1), c_x is the consumption of product x, c_m is the consumption of product m, Φ is the product consumption set, θ is the alternative elasticity between the two products, and θ>1. In the cross-sectoral Cobb-Douglas (C-D) production function, ω and r represent the marginal return of labor and capital respectively, and the supply of capital and labor is fixed. Assuming that the unit variable cost of the enterprise is φ and the wage level is ω, the marginal cost of the enterprise m is $\varphi_m \omega$. If the country has trade transactions with S countries, then the production function that maximizes consumer utility for enterprise i in sector x can be expressed as follows:

$$C_{xi} = \frac{p_{xi}^{-\theta} c_x E}{p_x^{1-\theta}}; P_x \equiv \left(\int_{x \in \Phi} p_{xm}^{1-\theta} dm + \sum_{s=1}^{S} \Psi \int_{l_s \in \Psi} p_{xl}^{1-\theta} dl_s \right)^{1/1-\theta} \tag{2}$$

In Equation (2), E is the total consumer spending, P is the price index, l_s is the number of products imported from country s, Ψ is the trade openness, $\Psi = \tau^{1-\theta}$, τ is the iceberg cost. If $\tau = 1$, $\Psi = 1$, the country is in an opened economy; if $\tau \to \infty$, $\Psi = 0$, the country is in a completely closed economy. Similarly, it is easy to obtain the consumption function of the enterprises in country s:

$$C_{xi}^{s} = \frac{(\tau p_{xi}^{-\theta}) c_x E^s}{(p_x^s)^{1-\theta}}; P_x^s \equiv \left(\int_{m \in \Phi} p_{xm}^{1-\theta} dm + \sum_{s=1}^{S-1} \Psi \int_{l \in \Phi} p_{xl}^{1-\theta} dl + \int_{l \in \Phi} p_{xl_s}^{1-\theta} dl_s \right)^{1/1-\theta} \tag{3}$$

In Equation (3), E^s is the consumer spending on purchasing products in country s, and P^s is the price index in country s. Assuming that the FDI enterprise will produce products and pollution emissions during the production process, in the face of the environmental regulation policies adopted by the host government, FDI enterprises can choose to invest and conserve energy, or divest and carry out international industry transfer. If the enterprise chooses energy conservation and emission reduction, assuming that the marginal cost of pollution control is A, so its total control cost function can be expressed as: $TC = \omega A_x q_{xi}$, q_{xi} is the total output level of the sector x enterprise i, then the average cost of governance of the enterprise is $AC = \omega A_x$. However, there are many fixed and variable

costs in the production, so we can get the total cost function of the enterprise as follows:

$$TC_{xi} = F_i + \omega\phi_i q_{xi} + \omega A_x q_{xi} \tag{4}$$

According to the D-S model, the consumer price index of domestic product *i* and the price index of imported product *i* from country *s* can be obtained as follows:

$$p_{xi} = \frac{(\varphi_i + A_x)\omega}{1-1/\theta}; p_{xi}^s = \frac{\tau(\varphi_i + A_x)\omega}{1-1/\theta} \tag{5}$$

Its profit Equation can be obtained through Equations (2), (3), and (5) as follows:

$$\begin{aligned}\pi_x^{domestic} &= \left(\frac{E}{P_x^{1-\theta}} + \sum_{s=1}^{S}\Psi\frac{E^s}{(P_x^s)^{1-\theta}}\right)\frac{c_x}{\theta}(1-1/\theta)^{\theta-1}(\varphi_i\omega + A_x\omega)^{1-\theta} \\ &= N(\varphi_i\omega + A_x\omega)^{1-\theta}\end{aligned} \tag{6}$$

In Equation (6)

$$N = \left(\frac{E}{P_x^{1-\theta}} + \sum_{s=1}^{S}\Psi\frac{E^s}{(P_x^s)^{1-\theta}}\right)\frac{c_x}{\theta}(1-1/\theta)^{\theta-1}$$

If the enterprise chooses to divest, its pollution control cost $A = 0$. However, the enterprise will incur an import cost $\tau_x\omega^*$ when carrying out industrial transfer, ω^* is the labor price of the transferred country, and $\omega^*<\omega$. Therefore, when FDI enterprises choose to transfer theirits industries, the marginal cost is $\tau_x\omega^*+\varphi_i\omega$, and foreign enterprises' profit function of the enterprise can be expressed as:

$$\begin{aligned}\pi_x^{foreign} &= \left(\frac{E}{P_x^{1-\theta}} + \sum_{s=1}^{S}\Psi\frac{E^s}{(P_x^s)^{1-\theta}}\right)\frac{c_x}{\theta}(1-1/\theta)^{\theta-1}(\tau_x\omega^* + \varphi_i\omega)^{1-\theta} \\ &= N(\tau_x\omega^* + \varphi_i\omega)^{1-\theta}\end{aligned} \tag{7}$$

Finally, compare the profit difference between the enterprise in choosing these two strategies; it can be expressed as:

$$\lambda = \pi_x^{foreign} - \pi_x^{domestic} = N\left((\tau_x\omega^* + \varphi_i\omega)^{1-\theta} - (\varphi_i\omega + A_x\omega)^{1-\theta}\right) \tag{8}$$

If $\lambda>0$, it means that FDI enterprises will choose to divest for international industrial transfer, which will reduce the FDI of the host country. If $\lambda<0$, it means that the enterprise will choose the resident capital for energy conservation and emission reduction, and at this time, the FDI of the host country will increase. Experience has shown that international industrial transfer will improve its production efficiency, that is, $\tau_x\omega^*+\varphi_i\omega<\varphi_i\omega+A_x\omega$, thereby making $\lambda>0$. Based on this, this paper proposes that:

Hypothesis 1: In general, the implementation of environmental information disclosure measures will hinder FDI inflows to the disclosure cities.

Hypothesis 2: The implementation of the environmental information disclosure measure has a heterogeneous impact on FDI in cities with different regions, levels, and environmental regulation intensity.

Material and Methods

Model Specification

In this paper, we first use the PSM method to solve the endogenous problem that may exist at the city level caused by sample selection bias [38, 39], then used the matched samples for DID estimation to attenuate the systematic errors and estimation bias among cities. This paper uses 113 cities that disclosed environmental information in 2007 as the treatment group and other cities as the control group to investigate the impact of environmental information disclosure methods on FDI. The model is specified as follows:

$$\begin{aligned}env_i = \alpha_0 + \alpha_1 growth + \alpha_2 \ln density + \alpha_3 government \\ + \alpha_4 \ln wage + \alpha_5 \ln hum + \varepsilon_i\end{aligned} \tag{9}$$

$$fdi_{it} = \beta_0 + \beta_1 treat_{it} \times year_{it} + \beta_2 Z_{it} + D_{it} + D_{it} + \nu_{it} \tag{10}$$

Model (9) is the Logit regression model used for PSM matching. The explained variable (*env*) is a dummy variable of whether to disclose environmental information. If the city *i* discloses environmental information, the value is 1, otherwise, the value is 0. In addition, this study identifies individual urban characteristics that potentially influence the choice of areas for environmental information disclosure as the variables for matching, which include economic development level (*growth*), population concentration (*lndensity*), government size (*government*), labor costs (*lnwage*), and human capital level (*lnhum*).

Model (10) is a DID model with a two-way fixed effect. The explained variable is fdi_{it}, which indicates the actual utilization of FDI in each city. The core explanatory variable is the interaction terms ($treat_{it}\times year_{it}$) of the grouping dummy variable of the environmental information disclosure cities ($treat_{it}$) and the time dummy variable ($year_{it}$). Z_{it} is a set of a series of control variables, including economic development level, population concentration, government size, labor costs, and human capital level, respectively. The coefficient β_1 denotes the net effect of the policy.

Variables Selection

Explained variable (*fdi*): The total amount and per capita of FDI actually utilized by the city are used to express the FDI attraction of the city, respectively [40].

Core explanatory variable: *treat×year*. *Treat* is a grouping dummy variable that assumes the value of 1 to designate a city that is part of the environmental information disclosure. Conversely, for cities not participating in such disclosure, *treat* is assigned a value of 0; otherwise, the value is 0. *Year* is a time dummy variable for the policy shock that takes a value of 0 before 2008, and it takes a value of 0 after 2008 (including 2008). *treat×year* is assigned the value of 1 solely under the condition that the city is identified as a participant in environmental information disclosure and the year in question is subsequent to 2008. If not, this term is given the value of 0 and takes the value of 1 only if the city is an information disclosure city and the time period is after 2008; otherwise, it takes the value of 0.

Control Variables: The study identifies a set of control variables, which are delineated as follows: (1) *growth* quantified by the annual economic growth rate of each city [28]. (2) *lndensity* represented by the natural logarithm of the population density. (3) *Government* is represented by the ratio of governmental budgetary expenditures to the region's Gross Domestic Product. (4) *lnwage* denoted by the natural logarithm of the average wage of urban employees. (5) *lnhum* expressed as the natural logarithm of the enrollment figures in tertiary educational institutions.

Data Description

In order to ensure the continuous availability of sample data, this paper retained 265 prefecture-level cities in China, including 110 cities with disclosure information and 155 cities with undisclosed information. The sample interval was selected from 2004 to 2021. In order to calculate the actual utilization of FDI, we use the average annual exchange rate between USD and RMB, and all the prices involved in this paper are calculated according to the GDP deflator over the years as the actual price in 2004. The indices utilized in this study are sourced from authoritative publications, including the China Urban Statistical Yearbook, the China Regional Economic Statistical Yearbook, the Statistical Yearbook of each province, and the National Economic and Social Development Statistical Bulletin' issued by each prefecture-level city. Descriptive statistics for the variables are presented in Table 1.

Results and Discussion

PSM Matching Result

The sample cities were first tested for balance, and the results are shown in Table 2. After matching between the two groups of the sample cities, not only the absolute values of the standard deviation were less than 10% in each characteristic variable but also the major variable decreased significantly. Moreover, the t-test showed that there was no significant difference in the mean of each characteristic variable. In terms of other test indicators, the B's value is 17.1 after matching, less than 25%, and the R^2 value is 1.15, falling down [0.5, 2], which suggests that the chosen selection of matching variables is, on the whole, more justifiable, and that the subsequent matching process yields estimation outcomes that are enhanced in terms of efficacy and reliability.

According to Fig. 3, it can be intuitively found that there is a large difference between the covariates of the treatment group and the control group before matching, and the standardized deviation of the covariates of the treatment group and the control group is almost close to 0 after PSM treatment, which is consistent. Therefore, it can be argued that the two sets of samples after matching satisfy the parallel trend assumption, which screens out more ideal sample data for the DID estimation below, which is conducive to obtaining the net effect of the environmental information disclosure method on the FDI of the information disclosure city.

Table 1. Descriptive statistics of main Variables.

Variables	Observations	Mean	Std. Deviation	Maximum Value	Minimum Value
lnfdi	4770	11.684	1.870	16.873	3.008
lnperfdi	4770	5.761	1.728	9.884	-1.683
growth	4770	11.645	4.145	37.690	-6.780
lndensity	4770	5.796	0.885	7.882	1.548
government	4770	15.942	7.987	148.516	4.049
lnwage	4770	10.396	0.566	11.914	8.734
lnhum	4770	10.438	1.324	13.898	5.485

Table 2. Matching the results of the Balance Test.

Variables	Samples	Mean		Std. Deviation (%)	Reduction in Standard Deviation (%)	T-test	
		Treatment Group	Control Group			t	P>|t|
growth	Before	11.560	11.294	-5.3	52.5	1.34	0.180
	After	11.513	11.494	-3.5		-1.07	0.284
lndensity	Before	6.073	5.609	55.6	93.9	16.81	0.000
	After	5.991	6.019	-3.4		-0.91	0.365
government	Before	12.992	17.940	-68.1	96.8	-20.12	0.000
	After	13.373	13.530	-2.2		-0.68	0.499
lnwage	Before	10.516	10.315	36.4	73.1	11.19	0.000
	After	10.441	10.518	-9.8		-3.50	0.254
lnhum	Before	11.398	9.788	148.6	99.8	46.89	0.000
	After	10.809	10.807	0.3		0.08	0.993
B	Before	161.6		R	Before	1.19	
	After	17.1			After	1.15	

Note: The matching ratio is 1:5, and the null hypothesis of the t-test is "the sample means of the treatment and control groups are equal".

Baseline Model Test

Based on the PSM matching results, DID estimation was carried out after excluding the sample cities with large differences. The findings are detailed in Table 3, which reveals that the coefficients of *treat×year* are significantly negative at the 10% confidence level. This statistical significance implies a detrimental impact of environmental information disclosure on the inflow of FDI into urban areas. Consequently, it can be inferred that environmental information disclosure tends to suppress the influx of urban FDI [41], confirming hypothesis H1.

Lag Effect Test

To examines the delayed impacts of environmental information disclosure policies on urban FDI, this study incorporates three temporal dummy variables. Specifically, $year_0$, $year_1$, and $year_2$ correspond to the year of the policy's enactment (2008), the first year after implementation (2009), and the second year after implementation (2010), respectively. The regression analysis outcomes are depicted in Table 4. The data indicate that the coefficients for the interaction terms do not achieve statistical significance; the results were observed not solely in the year of environmental

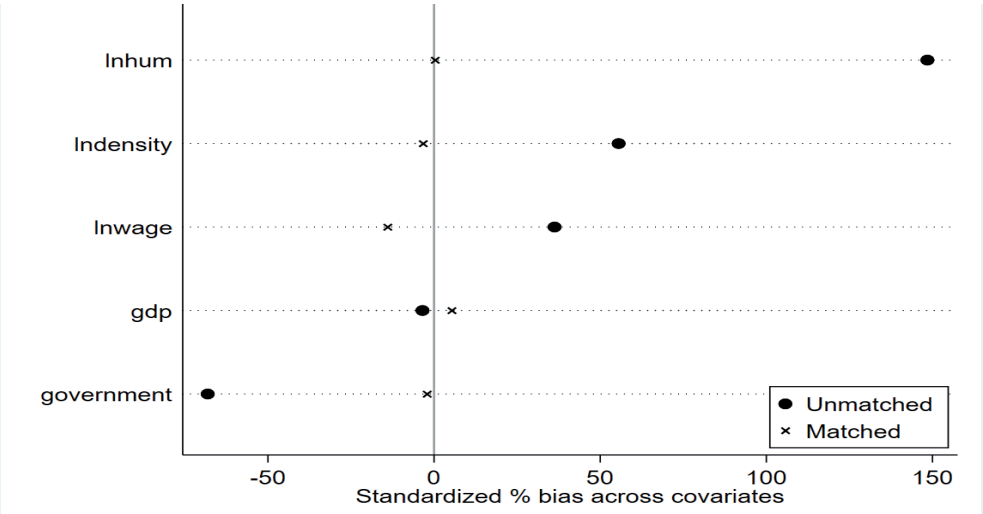

Fig. 3. Standardized deviation of each characteristic variable.

information disclosure but also persisting into the initial year post-implementation. Nevertheless, the coefficients for the interaction terms are notably negative in the second year post-disclosure, suggesting that the influence of environmental information disclosure on urban FDI is subject to a temporal lag. The adverse effect of the policy on FDI inflows is not evident until the second year following the implementation of the disclosure measures.

Robustness Tests

Balance Trend Test

Firstly, $treat^{\pm m}$ series dummy variables are constructed. $treat^{-m}$ takes the value of 1 when the treatment group is in the m years before environmental information disclosure, $treat^{+m}$ takes the value of 1 when it is in the m years after environmental information disclosure, and $treat^{\pm m}$ takes the value of 0 in other cases. Then examine whether FDI levels have changed

Table 3. Baseline regression results.

Variables	*lnfdi*		*lnperfdi*	
	(1)	(2)	(3)	(4)
treat×year	-0.154** (-2.322)	-0.116* (-1.699)	-0.170** (-2.558)	-0.129* (-1.895)
Control Variables	NO	YES	NO	YES
Controls for Time	YES	YES	YES	YES
Controls for Urban	YES	YES	YES	YES
Constant Term	10.508*** (195.541)	11.329*** (5.468)	4.696*** (87.493)	8.107*** (3.919)
N	4194	4194	4194	4194
r2_a	0.193	0.198	0.171	0.177
F	73.181	59.390	65.454	53.381

Note: The symbols ***, **, and * correspond to levels of statistical significance at the 1%, 5%, and 10% confidence levels, respectively. The corresponding t-values, which are indicative of the statistical reliability of the estimates, are presented in parentheses.

Table 4. Lag effect test results.

Variables	*lnfdi*		*lnperfdi*	
	(1)	(2)	(3)	(4)
$treat \times year_0$	0.127 (1.229)	0.100 (0.964)	0.138 (1.333)	0.107 (1.033)
$treat \times year_1$	0.054 (0.609)	0.028 (0.317)	0.063 (0.714)	0.036 (0.409)
$treat \times year_2$	-0.178** (-2.019)	-0.192** (-2.223)	-0.164** (-1.866)	-0.180** (-2.085)
Control Variables	NO	YES	NO	YES
Controls for Time	YES	YES	YES	YES
Controls for Urban	YES	YES	YES	YES
Constant Term	10.510*** (157.995)	0.602 (0.124)	4.697*** (70.414)	-2.942 (-0.660)
N	4194	4194	4194	4194
r2_a	0.250	0.268	0.229	0.249
F	20.561	18.735	18.584	17.652

Note: The symbols ***, **, and * correspond to levels of statistical significance at the 1%, 5%, and 10% confidence levels, respectively. The corresponding t-values, which are indicative of the statistical reliability of the estimates, are presented in parentheses.

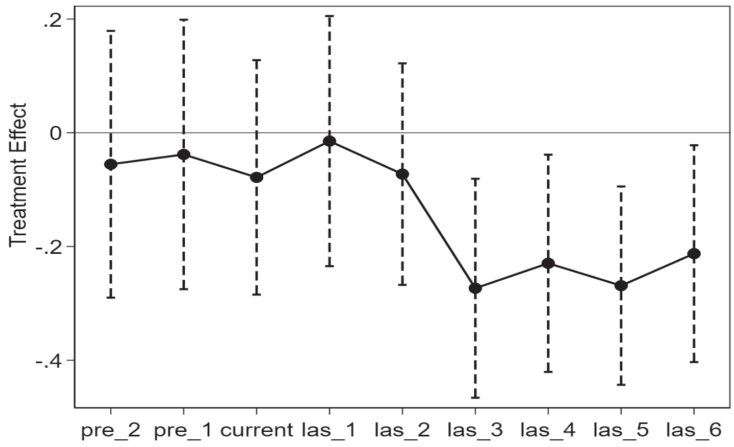

Fig. 4. Balance Trend Test results.

significantly between before and after environmental information disclosure in the m years. In order to avoid multi-collinearity, the first year was excluded with reference to the study of Deng et al. (2022) [42], and the regression analysis outcomes are depicted in Fig. 4. The data shows that before 2008, the impact of environmental information disclosure on *lnfdi* and *lnperfdi* was not significant, and the difference in FDI between the two groups has not changed significantly. Its hindrance effect on FDI was significant until 2010, and eventually leveled off, indicating that disclosure of environmental information has a lag effect on FDI.

Replace the Matching Method Test

This study chooses radius matching and kernel matching to re-match the initial sample, and the outcomes are delineated within Table 5. Analysis reveals that the coefficients *treat×year* are significantly negative at the 10% significance level, under the influence of the environmental information disclosure approach. This finding indicates that the disclosure of environmental information exerts a substantial impeding effect on the inflow of urban FDI.

Counterfactual Analysis

In this study, we have shifted the temporal reference for environmental information disclosure forward by 1 to 3 years and subsequently applied the DID method to conduct the estimation. If the coefficient of the interaction term is significant, it indicates that the change in FDI is not entirely caused by environmental information disclosure; there are other factors that can affect it as well. Conversely, if the coefficient is not significant, it means that the change in FDI is completely caused by environmental information disclosure; besides, nothing else can affect it. This suggests that the

Table 5. Counterfactual analysis and counterfactual analysis results.

Variables	Radius Matching		Kernel Matching		Counterfactual Analysis		
	lnfdi	*lnperfdi*	*lnfdi*	*lnperfdi*	2005	2006	2007
treat×year	-0.126* (-1.845)	-0.139** (-2.049)	-0.150** (-2.338)	-0.164** (-2.556)	-0.026 (-0.224)	-0.012 (-0.137)	-0.031 (-0.415)
Control Variables	YES	YES	YES	YES	YES	YES	YES
Controls for Time	YES	YES	YES	YES	YES	YES	YES
Controls for Urban	YES	YES	YES	YES	YES	YES	YES
Constant Term	11.234*** (5.572)	8.244*** (4.096)	10.514*** (5.381)	7.505*** (3.848)	0.632 (0.254)	0.635 (0.255)	0.710 (0.284)
N	4230	4230	4230	4230	4194	4194	4194
r2_a	0.196	0.175	0.197	0.176	0.211	0.211	0.211
F	59.226	53.373	62.987	56.559	60.119	60.117	60.127

Note: The symbols ***, **, and * correspond to levels of statistical significance at the 1%, 5%, and 10% confidence levels, respectively. The corresponding t-values, which are indicative of the statistical reliability of the estimates, are presented in parentheses.

empirical findings are robust, with the corresponding regression analyses detailed in Table 5. The regression analysis indicates that the coefficients of *treat×year* do not meet the criteria for statistical significance when presupposing the premature implementation of environmental information disclosure measures. This implies the presence of a shared trend between the treatment and control groups, and it also proves that the change in FDI is indeed caused by environmental information disclosure, rather than other factors.

Cities Environmental Information Disclosure Re-examination

Given the expansion to 120 cities implementing environmental information disclosure in 2013, this study incorporates the seven additional cities from that year into the treatment group, with the remaining cities serving as the control group. The environmental information disclosure for these new cities is set to 2013 for the purpose of conducting a DID estimation, the regression outcomes as presented in Table 6. The results demonstrate that the coefficients of *treat×year* are significantly negative in both *lnfdi* and *lnperfdi*. These findings support the conclusion that environmental information disclosure has a substantial inhibitory effect on Foreign Direct Investment (FDI), the conclusion remains valid.

Excluding the Impact of Similar Policy Shocks

Controlling for the implementation of similar policies, including specifically: (1) The carbon pilot policy implemented by the state in five provinces and eight cities in 2010. (2) In 2011, a carbon exchange policy was enacted in Beijing, Shanghai, Chongqing, Tianjin, Shenzhen, Guangdong, and Hubei. In the subsequent regression analysis, as detailed in Table 6, the findings shown that the coefficient of the interaction term continues to exhibit significantly negative behavior. This persistently negative coefficient suggests that the adverse impact of environmental information disclosure on FDI remains largely unaffected even after accounting for a series of policies that potentially affect FDI.

Heterogeneity Analysis

The Heterogeneity Impact of Different Regions

Given the unbalanced economic progress across China's eastern, central, and western regions, the influence of environmental information disclosure policies on urban FDI might vary by region. With this consideration, the study categorizes the sampled cities into these three distinct regional groupings: east, central, and west. Subsequently, it investigates the differential effects of environmental information disclosure on urban FDI across these regions. The regression analysis presented in Fig. 5, indicates that environmental information disclosure has a markedly suppressive effect on FDI inflows to the cities in the eastern region. In contrast, it has no substantial effect on FDI in the western region's cities and is observed to enhance FDI within the central region's sample cities [43]. This divergence in outcomes can be attributed to the higher influx and saturation of foreign capital in the eastern cities, where the imposition of environmental regulatory policies tends to have a more pronounced deterrent effect on FDI. Cities in the western region have lower levels of human capital, closed transportation, imperfect infrastructure, and weaker attraction to foreign capital. The implementation of environmental regulation policies does not have a significant impact on the cities in the western region, where FDI inflow is

Table 6. Re-examination results and similar policy shock test results.

Variables	Re-examination		Excluding Low-Carbon Cities		Excluding Carbon Exchange Cities	
	lnfdi	*lnperfdi*	*lnfdi*	*lnperfdi*	*lnfdi*	*lnperfdi*
treat×year	-0.110* (-1.673)	-0.115* (-1.754)	-0.151** (-2.178)	-0.165** (-2.391)	-0.1412* (-1.835)	-0.148* (-1.918)
Control Variables	YES	YES	YES	YES	YES	YES
Controls for Time	YES	YES	YES	YES	YES	YES
Controls for Urban	YES	YES	YES	YES	YES	YES
Constant Term	1.141 (0.455)	-2.393 (-0.957)	-0.337 (-0.129)	-4.941* (-1.891)	5.739** (2.239)	1.245 (0.487)
N	3492	3492	3474	3474	3582	3582
r2_a	0.212	0.192	0.275	0.253	0.227	0.207
F	60.308	54.725	65.511	59.480	58.069	52.874

Note: The symbols ***, **, and * correspond to levels of statistical significance at the 1%, 5%, and 10% confidence levels, respectively. The corresponding t-values, which are indicative of the statistical reliability of the estimates, are presented in parentheses.

originally low. The central region boasts a higher caliber of human capital compared to the western region, while its labor force is compensated at a significantly lower wage rate than that of the eastern region. The implementation of environmental information disclosure is posited to engender improvements in environmental and technological conditions, thereby fostering an optimized industrial structure, which will be conducive to the attraction of foreign capital and increase foreign direct investment, confirming hypothesis H2.

The Heterogeneity Impact of Different City Tiers

In China, the capacity of cities to influence economic progress and attract foreign investment can differ according to the city's tier. Consequently, the repercussions of environmental information disclosure on FDI might also vary across cities of differing tiers. From the perspective of urban comprehensive strength, the sampled cities are stratified into three categories: first-tier (*tier-1*), second-tier (*tier-2*), and other cities (*tier-3*). This stratification is utilized to examine the effects of environmental information disclosure on the FDI of these cities. As depicted in Fig. 5, the regression analysis reveals that the impact coefficients for first-tier and second-tier cities are negative and have met the criteria for statistical significance. This suggests that the disclosure of environmental information tends to deter FDI inflows in cities with strong comprehensive strength [32]. Examination of the interaction term's coefficient absolute value indicates that the impact on first-tier cities significantly exceeds that on second-tier cities, suggesting that environmental information disclosure poses a more substantial barrier to FDI in the former compared to the latter. This variation can be ascribed to the fact that first-tier cities, being more attractive destinations for foreign investment with higher inflows, experience a more pronounced inhibitory impact from the enforcement of environmental regulations on FDI. Conversely, for other cities, environmental regulatory policies may serve to enhance their investment climate, refine their industrial composition, and establish a more conducive environment for attracting foreign capital. As a result, the disclosure of environmental information could significantly foster FDI in these cities, confirming hypothesis H2.

The Heterogeneity Impact of Different Environmental Regulation Intensity City Level

Environmental regulation intensity will also impact on foreign investment activities. Based on the average score of PITI in previous years, the cities in the treatment group are divided into three categories: high environmental regulation (high), medium environmental regulation (medium), and weak environmental regulation (low), so as to investigate the heterogeneous effect of environmental information disclosure on urban FDI under the intensity of environmental regulation, and the regression outcomes are presented in Fig. 5. The findings indicate that environmental information disclosure will impede the FDI in cities with strong and medium environmental regulations, and with a more pronounced deterrent effect observed in cities with higher environmental regulation intensity. However, in cities with weak environmental regulations can

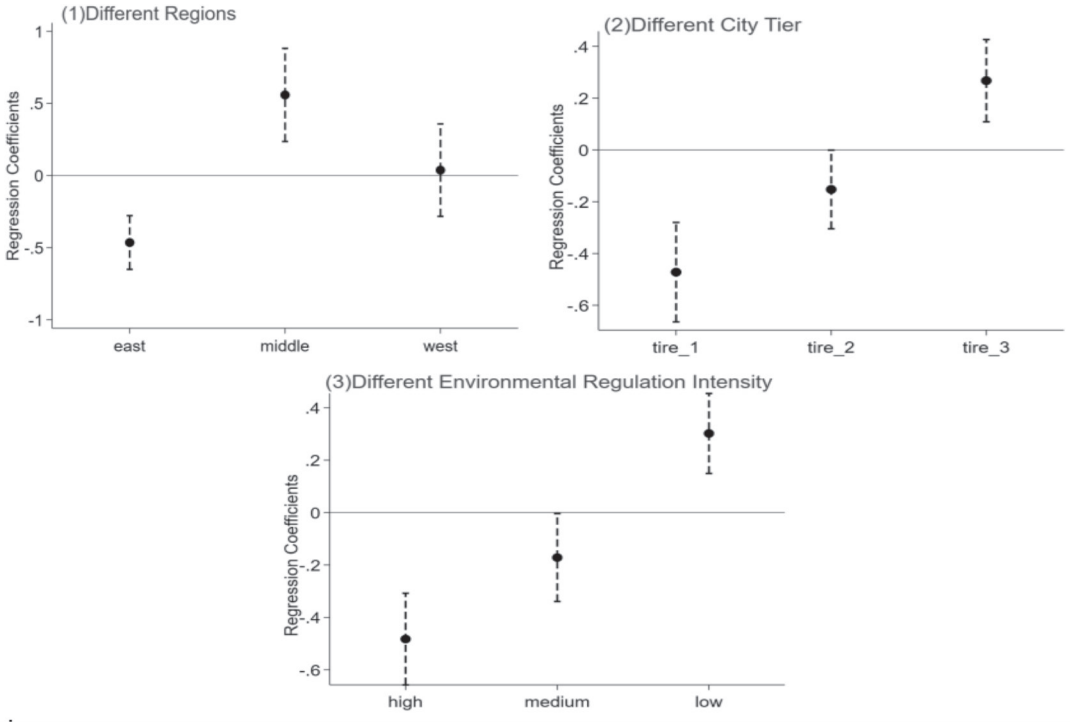

Fig 5. The results of Heterogeneity Analysis.

positively influence FDI [19]. This is attributed to the fact that the stringency of environmental regulation is positively correlated with the costs of FDI. The more stringent the environmental regulation, the less conducive to FDI, and vice versa. In some instances, weaker regulations may even enhance regional environmental and technological standards, thereby attracting foreign investment and stimulating an increase in FDI. To some degree, the stringency of environmental regulation reflects the extent of governmental commitment to enforcing environmental information disclosure policies. The effectiveness of the implementation of the information disclosure policy not only depends on the object of the policy implementation, but also depends on the implementation strength of the government to a large extent, confirming hypothesis H2.

Conclusions

FDI serves as a pivotal catalyst for China's economic expansion, and plays a pivotal role in national construction and economic development. Over an extended period, FDI has played a significant role in China's economic landscape, particularly in the optimization of its industrial structure, the facilitation of industrial upgrading, and the bolstering of innovation capabilities. As a leading destination for global investment, China continues to be a key player in the international investment arena. Chinese government's long-term policy and practice of combining 'bringing in' and 'going out' has also provided optimistic growth space and a cultivation environment for foreign investment and its own development. China's economic progression is intricately linked to the influx and augmentation of FDI. The institution of a sustainable development paradigm establishes a robust groundwork for the reciprocal benefits arising from this relationship.

Nonetheless, economic development should not be predicated on environmental degradation or the disruption of ecological equilibrium. Environmental issues have received widespread attention from the public and academics as important problems that need to be solved in today's society in China. Confronted with the escalating tensions between economic advancement and environmental degradation in China, the state has enacted a suite of environmental regulatory measures. These policies are designed to cultivate a conducive and sustainable arena for economic prosperity, alongside a balanced ecological milieu. At the same time, previous scholarly work has extensively investigated and assessed the impact of various environmental regulations enacted by the Chinese government. However, the body of literature that scrutinizes the influence and efficacy of these environmental policies on international investment, specifically through the lens of environmental regulatory information disclosure's effect on FDI inflows, remains scarce. On the one hand, this is related to the fact that information flows as an important unobservable factor is difficult to be captured and recognized. On the other hand, the endogeneity problem caused by information flow can also cause great trouble for the relevant causal inference. The policy of 'Environmental Information Disclosure Measures (Trial)' was implemented by the central government in 2007, however, as a 'natural' exogenous shock, this study lays the foundational groundwork necessary to ascertain the influence of information disclosure mechanisms on the influx of FDI.

Utilizing panel data from 265 cities across China spanning from 2004 to 2021, this study constructs a quasi-natural experimental framework predicated on the introduction of environmental information disclosure policies. It employs the PSM-DID approach to empirically assess the net effect of environmental information disclosure on FDI. The findings are as follows: Firstly, environmental information disclosure is found to significantly impede FDI inflows, with a notable temporal lag in the effectiveness of the policy. Secondly, in the eastern cities, environmental information disclosure exerts a markedly suppressive impact on FDI, whereas, in the central cities, it significantly stimulates FDI inflows; the impact in the western region is not statistically significant. Thirdly, for first-tier and second-tier cities, environmental information disclosure is observed to deter FDI inflows, whereas it enhances FDI in other city cities. This suggests that the higher of the city tier, the more pronounced the deterrent effect of environmental information disclosure on FDI. Lastly, the influence of environmental information disclosure on FDI is contingent upon the degree of environmental regulation in the city, with cities under stringent environmental regulations experiencing reduced FDI inflows due to the disclosure, while those with low environmental regulations may increase the FDI inflows.

The conclusions of this paper show that the introduction of foreign investment and environmental protection are contradictory, so when the government is dealing with the relationship between them, on the one hand, we should focus on the long-term goal of the regional economic development, actively and effectively implement the implementation of environmental regulations, and strive to seek a balance between environmental governance and the introduction of foreign investment, so as to promote the optimization of environmental protection and foreign investment complementary to each other. On the other hand, the government, in the implementation of environmental regulatory policies, should not fall into the "one size fits all" misunderstanding, implement different environmental information disclosure policies according to different urban economic development levels and geographical locations, encourage the attraction and introduction of clean foreign direct investment, and raise the entry threshold for polluting foreign direct investment, and ultimately realize the win-win situation for both local economic interests and environmental interests.

As an innovative environmental policy, the environmental information disclosure measures are integral to ensuring the robust and systematic progression of China's economic landscape. Although this study offers an exhaustive analysis of the repercussions that environmental disclosures have on the influx of foreign capital, there are the following shortcomings: On the one hand, the empirical evidence presented is drawn exclusively from panel data encompassing Chinese urban areas, which is not focused on micro enterprises. Plus, the establishment of the system is not only for foreign enterprises; its impact on local enterprises should not be ignored, and the exit and entry of enterprises in the market will change the original market structure, which will be an important factor for foreign enterprises to make decisions. On the other hand, as of 2018, more than 90 countries and regions around the world have formulated relevant policies and regulations on government information disclosure, and 20 countries have established pollutant data disclosure systems. This paper only empirically analyzes the situation in China, without analyzing the situation in other countries, and fails to compare and analyze China with other countries. Limited to the complexity of the problem and the acquisition of data, these will be one of the directions of future research on environmental information disclosure measures.

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Conflict of Interest

The authors declare no conflict of interest.

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