Environmental Regulation, Foreign Direct Investment and China's High-Quality Economic Development

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Environmental regulation, foreign direct investment and China's high-quality economic development

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Abstract

As China's economy shifts from a rapid development stage to a high-quality development stage, it is important to know how different FDI characteristics affect high-quality economic development. Furthermore, under the constraints of environmental regulations, will these impacts change? The dual-fixed spatial Durbin model and panel data of 30 provinces in inland China from 2005 to 2018 were used for analysis. This study finds that (1) under the constraints of environmental regulations, the scale of FDI, export orientation, and technology spillover capacity have a significant positive impact on China's high-quality economic development, but without the constraints of environmental regulations, only the technological spillover capability of FDI has such a significant positive impact. (2) FDI with strong technology spillover capabilities not only promotes local development but also plays a significant role in promoting high-quality economic development in surrounding areas through spillover effects. (3) Compared with secondary industry, tertiary industry plays a stronger role in promoting the high-quality development of China's economy. (4) The areas with high quality economic development are concentrated in the eastern coastal cities. The outdated economic and scientific research and technology in the central and western regions means that they lack the ability to learn advanced technologies from FDI.

Keywords: Environmental regulation; Foreign direct investment; High-quality economic development; Spatial Durbin model (SDM)

1.Introduction

Since the 1980s, China’s economy has experienced momentous change; China has rapidly improved the comprehensive strength of its economy and become an important part of the world economy (Yuan et al., 2017). As shown in Figure 1, in 2020, China’s annual GDP exceeded the 100 trillion yuan mark, reaching 101.59 trillion yuan; its economy grew 2.3% compared to 2019; and per capita GDP reached 72,447 yuan. China's overall economic strength is stronger, and its position as the world's second largest economy will also become more stable (Xie et al., 2020). However, to spur the rapid development of its economy, China initially adopted the "extensive" type of

development, and this has led to serious damage to China’s ecological environment (Li et al., 2021). But economic development should also consider environmental protection (Liu et al., 2020). The development of China's economy is now advancing from rapid development to high-quality development: while developing in "quantity", China needs to now focus on "quality" to move toward high-quality economic development(Wang, 2018) .

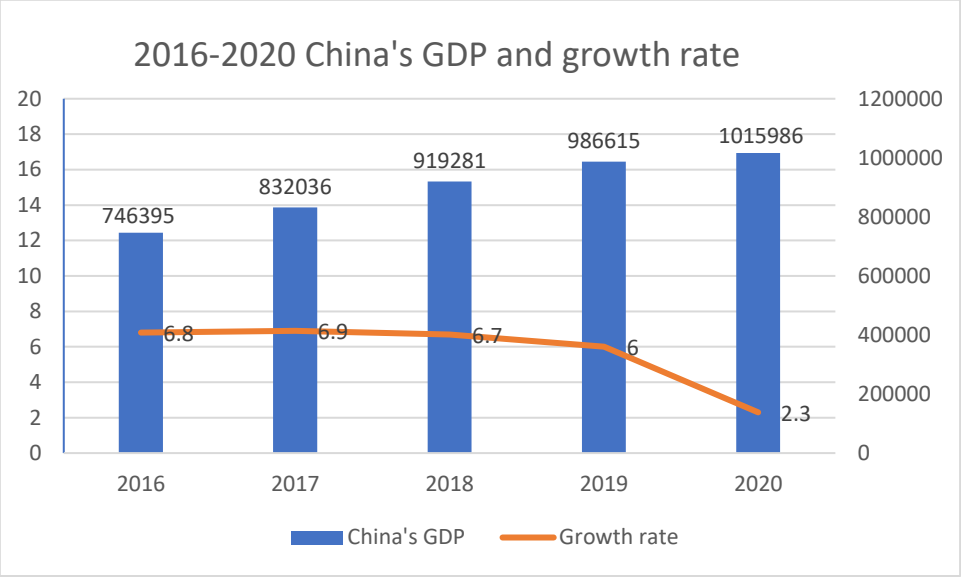

Fig.1. 2016-2020 China's GDP and growth rate

China is implementing a peaceful development policy of "bringing in" and "going out" and conducting cultural and political exchanges with countries worldwide. The year 2021 is also the first year of China’s 14th Five-Year Plan. China’s foreign policy welcomes cultural and technological exchanges between countries, and it will only open the door increasingly wider to serve all countries worldwide. This includes providing a broader space for enterprises to develop in China.

FDI drove China's early economic development and brought in advanced technology and capital, which greatly promoted China’s early economic development (Zafar et al., 2020) . Whether FDI also causes damage to the environment of foreign-invested countries has been a subject of controversy in academic circles, and two opposing hypotheses have formed: the "pollution paradise" or the "pollution halo"(Feng et al., 2019a; Li et al., 2017). The pollution paradise hypothesis argues that strict environmental regulations in the home country encourage some companies to establish themselves in developing countries with looser regulations to seek greater benefits. Therefore, although foreign businessmen bring capital to developing countries and promote their economic growth, they also cause environmental pollution(Tian et al., 2019; Demena and Afesorgbor, 2020; Wang and Chen, 2014). The pollution halo hypothesis argues that FDI improves the environmental quality of the host country

through technology spillover effects, ameliorates the issues caused by poor production technology in developing countries, and mitigates the environmental pollution caused by production (Zhang and Zhou, 2016) . Therefore, it is still undetermined whether FDI can promote China's development at its current stage, and this question remains worth exploring. However, at present, low-quality FDI will not significantly promote China's development(Li et al.). and to achieve the high-quality transformation of its economy, China should introduce high-quality FDI (Hu and Xu, 2020).

In China's economic development, the use of FDI has shifted from managing scale to an emphasis on managing both quantity and quality (Tian et al., 2019). At present, there is less research on the quality of FDI. Moreover, the state is now advocating economic transformation. At present, China is facing severe pressure to reduce environmental pollution and carbon emissions. The government has gradually increased the attention given to ecological and environmental issues and continuously improved the intensity of its environmental regulation, which may also change the magnitude and direction of FDI toward high economic quality. The empirical analysis provided here can help China take better advantage of foreign capital and introduce high-quality foreign capital to boost its economic transition.

2.Literature review

Protecting the ecological environment and developing the economy are not necessarily opposed, but their relationship is both tense and strong. To achieve sustainable economic development, China began to transform its economy to focus on high-quality development. There is currently no uniform standard for measuring high-quality development. Zhou et al.(2020) and Jahanger(2021) used total factor productivity to represent high-quality economic development, while (Chen and Chen, 2018) used labor productivity. Although such indicators are reasonable, high-quality economic development not only encompasses economic development but also affects the ecological environment, scientific and technological innovation and other areas. Therefore, a single indicator cannot accurately express high-quality economic development, and as a result, scholars began to use multiple indicators to measure high-quality economic development. For example,(Wang et al., 2021)constructed 24 secondary indicators for comprehensive evaluation from 4 aspects: economic vitality, development potential, urban-rural synergy, and ecological strength. Chen et al.(2020)and Du et al.(2020)choose economy, ecology and society as the first-level indicators and find corresponding headset measurement indicators to measure high-quality economic development; Sun et al.(2021) selected relevant indicators capturing the four aspects of the economy, innovation, green initiatives, and standard of living to provide a comprehensive measure of high-quality economic development.

What impact has the massive inflow of foreign capital had on China's development?

At present, there are two main views on its impact: the "pollution halo effect" and the "pollution paradise effect". Shahbaz et al.(2015) found that FDI pollutes the local environment, and that although the funds brought in can promote local development, such development is "unhealthy"; Cheng et al.(2020)a analyzed the data of 256 prefecture-level cities in China and found that FDI intensified urban pollution. Although different stages of urban development have different impacts, they are generally detrimental to urban development; Acharyya(2009) found that FDI facilitates economic growth in the early stage, but in the long run, it is not good for local development and will cause serious environmental damage, confirming the "pollution paradise" hypothesis; Chen et al.(2021) found through empirical research that FDI can improve China's carbon dioxide emission efficiency and environmental efficiency; Khan et al.(2021) found in their research that FDI brings financial support to promote not only local economic development but also the structural upgrading of the financial industry, confirming the "pollution halo" hypothesis.

High-quality FDI can greatly promote China's economic development at this stage. China has thus begun to seek high-quality FDI. Jahanger(2021) observed that when studying the overall relationship between the quality of FDI and economic development, the result is not obvious, but when the analysis is carried out by region, findings show that different qualities of FDI have different results for different regions, and this result is significant. Bai and Lv(2017) found that different qualities of FDI affect high-quality economic development in a disparate manner. Javorcik and Spatareanu(2010) and Saggikamal et al.(also observe that high-quality FDI can bring in more advanced technology and be more conducive to economic growth. (Liu and Ren, 2020) studied the impact of the quantity and quality of FDI on economic growth.

Although Foreign investment drives China's economic development on the one hand, it also aggravates China's environmental destruction and resource depletion on the other. By implementing stricter environmental regulation, China can screen and restrict foreign investment, thereby enhancing its quality and facilitating high-quality economic development overall. In their empirical research, Yu and Li(2020) found that strict environmental regulations can prevent China from becoming a "pollution paradise" for foreign-funded enterprises, Li et al.(2021)f found through an empirical study of cities in the Yangtze River Basin that strict environmental policies were conducive to their economic development. Feng et al.(2019a) found through empirical research that neither environmental regulations nor FDI along can notably facilitate urban innovation, but their interaction can.

Generally, the current research on FDI mainly concentrates on the causal correlation between FDI and economic development and does not consider FDI quality. However, as China's economy has begun to shift to high-quality development, the introduction of FDI no longer simply pursues "quantity" but has shifted to focus on its

"quality". How do the different quality characteristics change FDI's impact on China's development? There are few related studies addressing this question at present, and the lack of relevant research is not conducive to the implementation of meaningful policies. Therefore, this article conducts research considering four aspects of FDI: its export orientation, scale, technology spillover capacity, and degree of pollution.

To achieve high-quality economic development and strengthen environmental protection, China made its environmental regulations more stringent, and the entry of FDI will inevitably be restricted and guided by environmental policies. Through a literature summary and data analysis, Chen et al.(2020) found that reasonable environmental regulations will can screen FDI and benefit China's economic development Therefore, under strict environmental regulation, what impact will FDI's export orientation, scale, technology spillover, and pollution level have on high-quality economic development? This is also a question that requires study.

The innovations of this article are as follows. First, this article defines four aspects of FDI to capture its quality: export orientation, scale, technology spillover capacity, and pollution. Then, considering the coordination and spatial relevance of economic development in China, the spatial Durbin model (SDM) is applied to research. Second, an analysis of heterogeneity is used to further explore whether there are regional differences in the impact of each FDI characteristic on high-quality economic development. Third, this article studies the impact of FDI on high-quality economic development under the constraints of environmental regulations to analyze the important role of environmental regulations.

3.Study design

3.1.Variable selection and description

3.1.1. Dependent variable

The measurement of high-quality economic development must be comprehensive and include many aspects, such as the economy, ecological environment, and social harmony. Therefore, this research starts with the "Five Development Concepts" proposed by Xi Jinping in 2015. The research of Hu and Xu(2020)and others used the five aspects "innovation, coordination, green, open, sharing" to comprehensively evaluate high-quality economic development; they determined corresponding measurement indicators for these five major development concepts and evaluated them using the improved entropy method. Table 1 shows the high-quality index system for the development of the Chinese economy.

Table 1

Multiple-index system of high-quality economic development

Variable name	Measurement index	Measurement standard	Indicator direction
Innovation Development	patent application	Number of patent applications by regional industrial enterprises/number of patent applications by national industrial enterprises	+
	R&D expenditure	R&D expenditure/regional financial expenditure	+
Coordinated development	Regional coordinated development	Regional per capita GDP/ national per capita GDP	+
	Coordinated development of urban and rural areas	Disposable income per capita in urban areas/disposable income per capita in rural areas	+
	Industry coordinated development	GDP of tertiary industry/GDP of region	+
Green Development	Sulfur dioxide emission reduction contribution rate	(SO2 emissions of the current year-SO2 emissions of the previous year) / SO2 emissions of the last year	-
	Contribution rate of industrial wastewater emission reduction	(Industrial wastewater discharge volume of the current year-Industrial wastewater discharge volume of the previous year)/Last year industrial wastewater discharge volume	-
Open Development	Foreign trade dependence	Total value of imports and exports/GDP of region	+
Shared development	Highway facilities	Highway mileage/total population	+
	Medical Facilities	Health Expenditure Government Financial Expenditure/GDP of region	+
	educational facility	Education expenditure/GDP of region	+

The comprehensive evaluation method includes two approaches: subjective assignment and objective assignment,. Subjective assignment depends on subjective judgment and lacks objectivity; in comparison, the objective value assignment used by the entropy weight method compensates for such shortcomings by using the principle of information entropy to evaluate the weight of each characteristic within the total index. By referring to the methods of He and Sheng(2020) et al.和 Yang and Sun(2015) time variables were added in this paper, which increased the accuracy of the obtained information entropy. The specific calculation steps are as follows:

(1) Select index: Set r years, n provinces and cities, m indicators, $X_{\theta ij}$ is the value of index J for province I in year θ.

(2) Standardize indicators: Since there are multiple indicators in the measurement system, and different indicators have different dimensions and units, standardization must be carried out prior to applying the entropy weight method. Standardize positive indicators:

$$X'_{\theta ij} = \left(X_{\theta ij} - X_{min}\right) / \left(X_{max} - X_{min}\right),$$

Standardize negative indicators:

$$X'_{\theta ij} = \left(X_{max} - X_{\theta ij}\right) / \left(X_{max} - X_{min}\right)$$

(3) Determine index weights:

$$Y_{\theta ij} = X'_{\theta ij} / \sum_{\theta} \sum_{i} X'_{\theta ij},$$

(4) Calculate the entropy value of the JTH index:

$$e_j = -k \sum_{\theta} \sum_{i} Y_{ij} \ln(Y_{\theta ij}), \text{ k>0}, \text{ k=ln(rn)}$$

(5) Calculate the information utility value of index j :$g_j = 1 - e_j$

(6) Calculate the weight of each index:

$$w_j = g_j / \sum_{j} g_j$$

(7) Calculate the comprehensive score of the urbanization level of each province:

$$H_{\theta i} = \sum_{j} (w_j X'_{\theta ij})$$

Table 2 shows the economic high-quality development indexes of 30 provinces in mainland China in 2005, 2010, 2015 and 2018. To visually observe the change in each year, the high-quality economic development chart shown in Figure 2 was drawn using MATLAB 2020a.

Table 2

High quality economic development indicators in Major Years

Provinces	**2005**	**2010**	**2015**	**2018**
Beijing	0.539059	0.537907	0.444804	0.447864
Tianjin	0.33935	0.297803	0.291432	0.281376
Hebei	0.111553	0.131709	0.158884	0.17186
Shanxi	0.097259	0.128039	0.161762	0.161583
Inner Mongolia	0.089991	0.126288	0.147008	0.166639
Liaoning	0.187383	0.184865	0.180333	0.20447
Jilin	0.11887	0.129942	0.140619	0.148124
Heilongjiang	0.114052	0.150015	0.158129	0.157966
Shanghai	0.409703	0.408509	0.390932	0.389232
Jiangsu	0.338181	0.406413	0.430411	0.438102

Zhejiang	0.296214	0.350152	0.366637	0.365565
Anhui	0.11749	0.158607	0.2268	0.236241
Fujian	0.199313	0.221846	0.240563	0.253817
Jiangxi	0.093596	0.130141	0.163387	0.197001
Shandong	0.238245	0.279489	0.291182	0.290709
Henan	0.092805	0.131206	0.172227	0.188984
Hubei	0.142972	0.185875	0.202425	0.221086
Hunan	0.101916	0.157662	0.177139	0.200526
Guangdong	0.497033	0.480724	0.431086	0.507141
Guangxi	0.08067	0.110604	0.145364	0.158643
Hainan	0.098304	0.133987	0.168748	0.174963
Chongqing	0.14584	0.14896	0.223741	0.230655
Sichuan	0.138362	0.152135	0.196546	0.209379
Guizhou	0.079562	0.140233	0.166416	0.167551
Yunnan	0.102779	0.133861	0.16438	0.177051
Shanxi	0.288252	0.31333	0.338455	0.352736
Gansu	0.096939	0.136233	0.178221	0.181914
Qinghai	0.103996	0.157488	0.199934	0.225018
Ningxia	0.09229	0.12602	0.153863	0.168249
Sinkiang	0.14146	0.178932	0.205823	0.199616

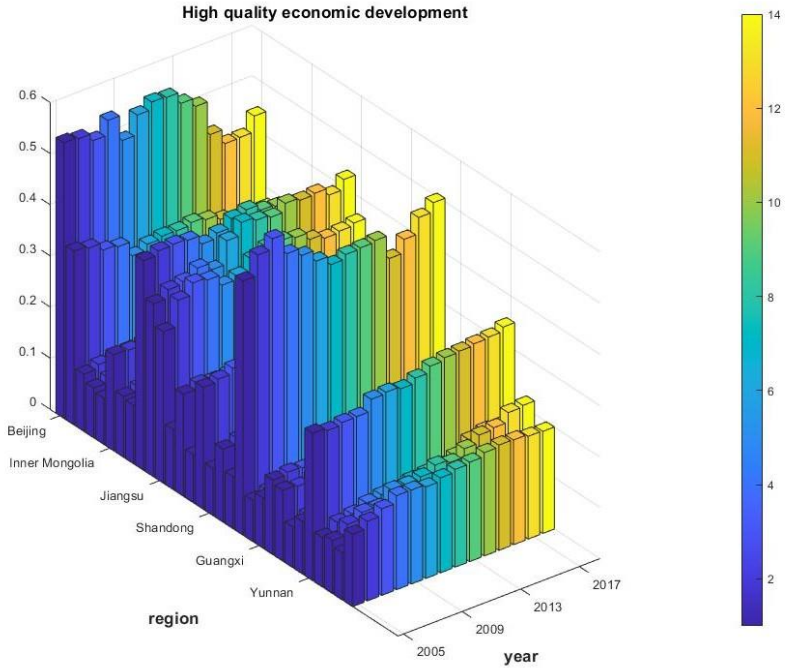

Fig.2. Measurement of high-quality economic development indicators

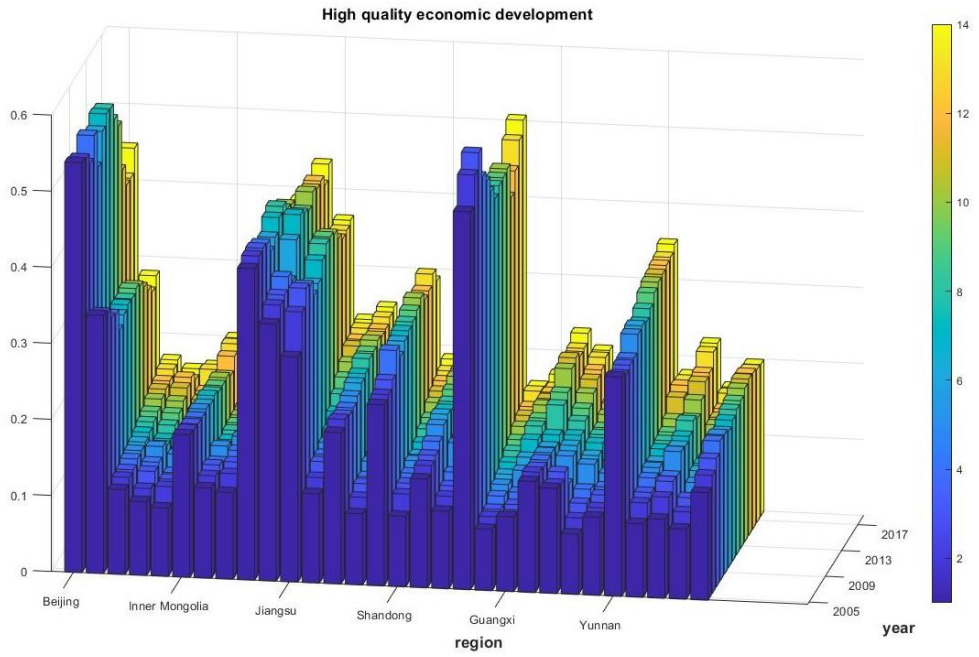

Fig.3. Measurement of high-quality economic development indicators

3.1.2. Selection and measurement of FDI quality

The quality of FDI is the most important explanatory variable in this study. This article draws on the ideas and construction methods of Lei et al.(2021)and (Hu and Xu, 2020) and considers the availability of data for the four aspects of FDI: export orientation, actual scale, technology spillover capacity, and pollution level. The descriptions of the data are as follows:

Export orientation of FDI (export): FDI with a strong export orientation holds a position in the international market through its internal advantages and can introduce advanced technology to the host country during the investment process. This gives the host country the opportunity to enter new export areas, thereby promoting the high-quality development of China's economy. This article uses the proportion of foreign-invested industrial enterprises' total exports to the total exports from all regional operations to measure the export orientation of FDI.

The actual scale of FDI (pscale): The actual scale of FDI represents the economic strength of foreign companies. Foreign companies with high economic power will bring more technology and capital to the host country. They will have sufficient funds for technological upgrades and environmental protection; it is easier to take positive measures when subject to strict environmental regulations(Lei et al., 2021)； However, the larger the actual scale of FDI is, the more likely that it will lead to the distortion of internal information and bureaucratic management. When the scale of enterprises increases, the benefits from economies of scale decline, and if there are no strict environmental regulations, companies will often ignore environmental protection; thus,

large scale FDI is not conducive to the high-quality development of China's economy(Hu and Xu, 2020). This research uses the average investment amount of foreign-invested enterprises (total investment by foreign-invested enterprises/number of foreign-invested enterprises) to represent scale.

Technology spillover capability of FDI (technology-sp): When foreign companies invest, in addition to other resources, they bring technology resources to the host country and allow the host country to learn advanced technology. In this study, the ratio of the actual use of foreign capital to total fixed investment in the region is selected to represent technology spillover capacity.

Pollution degree of FDI (pollution): Although FDI generally promotes the development of the host country, it can also cause certain environmental problems and thereby inhibit development. Therefore, the pollution level of FDI is an important component of its quality. At present, there are no relevant data on the pollution by foreign-invested enterprises. This article uses the pollutant (sulfur dioxide, smoke, dust, dust) emissions per unit of GDP, and multiplies this by the main business income of FDI industrial enterprises to measure the pollution degree of FDI(Lei et al., 2021).

3.1.3. Selection and measurement of environmental regulations

There is currently no uniform definition for the measurement of environmental regulations (er). Feng et al.(2019b) used the utilization rate and removal rate of China's five major pollutants to perform a weighted linear summation to express environmental regulations; Wang et al.(2021)comprehensively considered the emission data of three industrial pollutants to measure environmental regulations. This article considers the approach of Feng et al. It is impossible to comprehensively cover the intensity of environmental regulations because the government's investment in environmental regulations is reflected not only in the abovementioned aspects but also in others, and the study by Xiaowen Wang and others is not reasonable because it only captures pollutant emissions. The proportion of industrial pollution source treatment investment to regional GDP is used here to express environmental regulations.

3.1.4. Selection and measurement of control variables

Domestic investment in fixed assets (investment): this article takes it as one of the control variables studied and characterizes it with (regional total investment-foreign investment)/regional GDP.

Industrial structure (structure):Dong et al.(2020) found through empirical research that the upgrading of industrial structure is advantageous for economic growth. Therefore, industrial structure is taken as an important control variable in this study and is defined by the GDP from secondary industry and that from tertiary industry/regional GDP, represented by structure2 and structure3, respectively (Feng et al., 2019a; Dong

et al., 2020).

Government expenditure (expenditure): To promote economic growth, the government generally offers certain incentive policies, which tend to be in the form of fiscal expenditure. When Qi and Yue(2020)s studied the relationship between fiscal expenditure and economic development, they found that faster economic development usually indicated a larger scale of total fiscal expenditure; there is a positive correlation between the two. Zhang et al.(2020) also pointed out that fiscal expenditure can promote economic growth. Therefore, this article regards government fiscal expenditure as a control variable, expressed as local government fiscal expenditure/regional GDP.

Population growth rate (population). Does population growth promote or inhibit economic growth? This question has always been a concern of economists and demographers. Furuoka(2013) found that economic growth is driven by population, and rapid population growth can stimulate economic development; Liu and Yuan(2020) found that the effect of negative population growth on economic growth in the short term is not obvious and that the economy can still grow; however, in the long term, negative population growth is not conducive to economic growth. Therefore, the population growth rate is regarded as a control variable.

3.1.5. Data Sources

In view of the availability of data, this article uses the data of 30 provinces in China from 2005 to 2018 (excluding the data of Tibet, Taiwan and Hong Kong), and the data related to currency have been converted to the base period. The original data come from the "China Statistical Yearbook", "China Environmental Statistics Yearbook" and "China Science and Technology Statistical Yearbook".

3.2.Method

3.2.1 Spatial autocorrelation test

The study selects the global Moran’s index and the local Moran’s scatter plot to test the spatial autocorrelation. The global Moran's index formula is as follows:

$$I = \frac{n}{S_0} \times \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\ (y_i - \bar{y}\ )(y_j - \bar{y}\ )}{\sum_{i=1}^{n}(y_i - \bar{y}\ )^2}$$

whereS_0=$\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$is the total number of space units; y_i and y_j represent the attribute values of the i-th spatial unit and the j-th spatial unit, respectively; $\bar{y}$ is the mean value of all spatial unit attribute values,w_{ij} is the value of the spatial weight matrix.

Table 4 shows the Moran's I value and its Z test results for high-quality economic

development from 2005 to 2018. As shown in the table, the Moran's I values are positive and fluctuate slightly at approximately 0.30. The Z test results are all significant. The results show that the 30 provinces in China (except Tibet) show a certain agglomeration trend, mainly because China's cities are developing relatively quickly, and all provinces and cities are developing vigorously.

Table 3
Global Moran's I

Year	*High-quality economic development*				
	Moran's I	E(I)	Sd(I)	Z	p-value*
2005	0.318	-0.034	0.082	4.311	0.000
2006	0.317	-0.034	0.082	4.306	0.000
2007	0.304	-0.034	0.081	4.149	0.000
2008	0.309	-0.034	0.082	4.186	0.000
2009	0.302	-0.034	0.082	4.104	0.000
2010	0.310	-0.034	0.082	4.19	0.000
2011	0.319	-0.034	0.082	4.296	0.000
2012	0.315	-0.034	0.082	4.233	0.000
2013	0.307	-0.034	0.083	4.121	0.000
2014	0.298	-0.034	0.083	4.004	0.000
2015	0.291	-0.034	0.084	3.895	0.000
2016	0.282	-0.034	0.083	3.797	0.000
2017	0.278	-0.034	0.083	3.747	0.000
2018	0.272	-0.034	0.083	3.704	0.000

The global Moran's index only shows whether there is spatial agglomeration, but the specific place and type cannot be displayed. Therefore, the local Moran's index is used to further analyze the specific locations where spatial agglomeration occurs. The local Moran's scatter plots calculated for 2005, 2010, 2015 and 2018 are shown in the figure below, and the local Moran's indexes are 0.318, 0.310, 0.291 and 0.272, respectively. The degree of agglomeration in the various provinces has slightly decreased, and most of provinces are concentrated in the first and third quadrants with obvious characteristics of either "high-high agglomeration" or "low-low agglomeration".

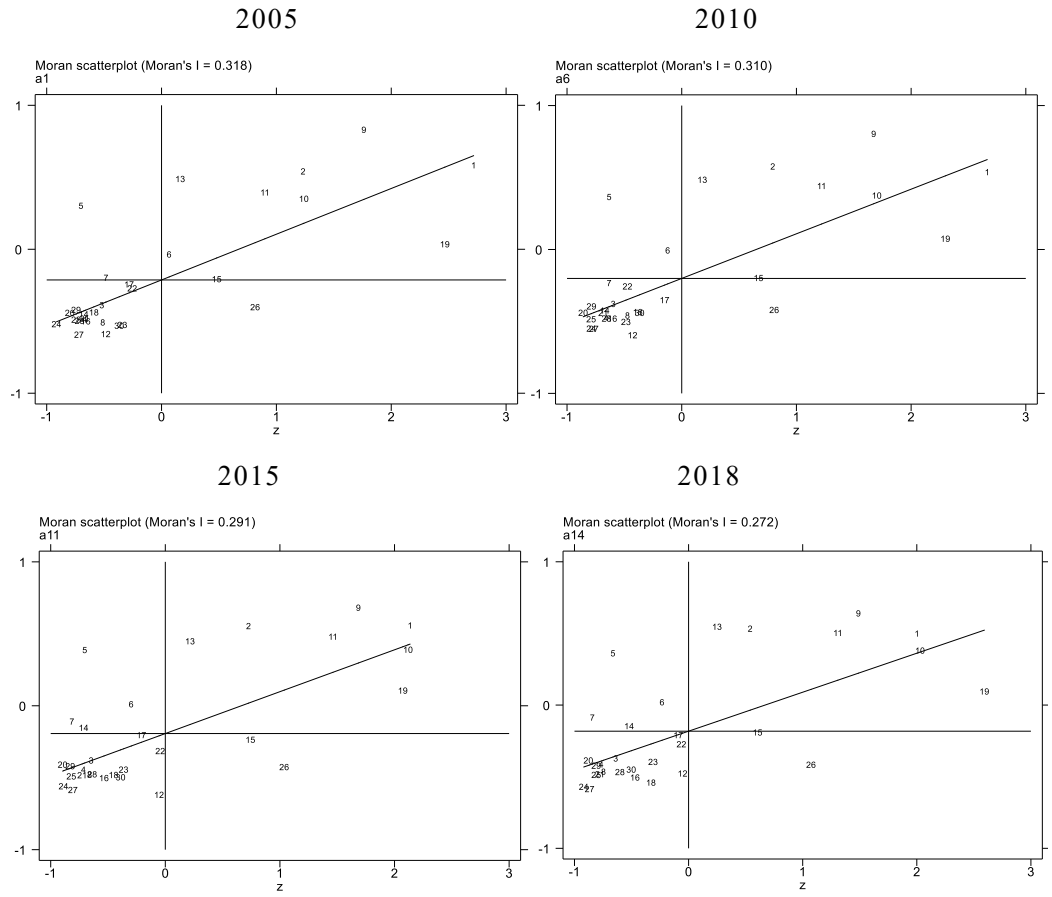

Fig.4. Local Moran graph

3.2.2. Model setting

From the results of the global Moran index, we can see that there is obvious spatial autocorrelation between the variables in this article. Therefore, this article establishes three spatial models for research:

SLM:

$$development = \beta_0 + \beta_1 fdi_{it} + \beta_2 contrali_{it} + \rho W development + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

SEM：

$$development = \beta_0 + \beta_1 fdi_{it} + \beta_2 contrali_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

$$\varepsilon_{it} = \lambda_t \sum_{j=1}^{n} w_{ij}\, \varepsilon_{jt} + \varphi_{it} \quad (3)$$

SDM:

$$development = \beta_0 + \beta_1 fdi_{it} + \beta_2 contrali_{it} + \beta_3 W_{it} fdi_{it} + \beta_4 W_{it} contrali_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

In addition, the cross-term of environmental regulation and FDI is added to the model.

SLM:

$$development = \beta_0 + \beta_1 fdi_{it} * er_{it} + \beta_2 contrali_{it} + \rho W development + \mu_i + \lambda_t + \varepsilon_{it} \quad (5)$$

SEM：

$$development = \beta_0 + \beta_1 fdi_{it} * er_{it} + \beta_2 contrali_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (6)$$

$$\varepsilon_{it} = \lambda_t \sum_{j=1}^{n} w_{ij}\, \varepsilon_{jt} + \varphi_{it} \quad (7)$$

SDM:

$$development = \beta_0 + \beta_1 fdi_{it} * er_{it} + \beta_2 contrali_{it} + \beta_3 W_{it} fdi_{it} * er_{it} + \beta_4 W_{it} contrali_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (8)$$

where β_0 represents the constant term, $\beta_{1,2}$ represent the coefficients of the independent variable; $\beta_{3,4}$ represent the spatial lag coefficient of the independent variable; ρ represents the spatial autoregressive coefficient; λ_t represents the time fixed effect;μ_i represents the space fixed effect.

3.2.3. Spatial weight matrix

This article studies high-quality economic development. Therefore, this research utilizes the economic distance weight matrix for the regression analysis.

$$w_{ij} = \begin{cases} 1/|x_i - x_j| & i \neq j \\ 0 & i = j \end{cases}$$

where x_i and x_j are the GDP per capita of i or j ,respectively, and$|x_i - x_j|$ represents the economic gap between the two provinces. The smaller this value is, the more similar the economic level of the two provinces is, the closer the economic distance is, and the greater the spatial weight of the two provinces.

4. Empirical results

4.1Model selection

Before performing spatial regression, it is necessary to determine the selected spatial model. Therefore, this article first conducts an LM test to determine whether to choose a nonspatial model, SEM or SLM. The values of LM_spatial_error and LM_spatial_lag are 139.329 and 28.415, respectively, which pass the significance test

at the 1% level; the Robust_LM_spatial_error and Robust_LM_spatial_lag values are 114.163 and 3.248, respectively, which pass the significance test at the 1% and 10% levels, respectively, so the LM test rejects the null hypothesis that there is a spatial lag or spatial error test.

Next, this article uses the Wald test and LR test to determine whether the SDM will degenerate into SLM or SEM. Both the Wald_spatial_lag value and the chi2(7) value for LR_spatial_lag of 39.39 and 28.87, respectively, pass the significance test at the 1% level; the Wald_spatial_error and LR_spatial_error are chi2 (7), and the values of 34.45 and 28.84 also pass the significance test at the 1% level. Therefore, the SDM is selected.

The Hausman test results show that fixed effects should be selected. Next, to test whether a time fixed model, individual fixed model or double fixed model should be used, a joint significance test was conducted. The results show that the LR_BOTH_IND and LR_BOTH_TIME values are 31.07 and 662.25, respectively, and pass the significance test. Therefore, the SDM of bidirectional fixed effects was ultimately selected for this paper.

4.2.Analysis of empirical results

Table 4 (1) ~ (4) are the actual scale, export orientation, technology spillover capacity and pollution degree of FDI, respectively. Table 5 shows that the regression results for the average scale, export orientation, and pollution degree of FDI are not significant. This may be due to the fact that the quality of China's current FDI has not yet reached a level that can have a significant impact on the high-quality development of China's economy (Hu and Xu, 2020). However, the estimated coefficients of the SDM cannot directly reflect the influence of the explanatory variable change on the explained variable; therefore, this paper further decomposes the direct and indirect effects of the SDM to analyze the spillover effects between regions (see Table 5).

Table 4

Spatial Durbin model estimation results

Variable	*High-quality economic development*			
	(1)	(2)	(3)	(4)
investment	0.044***	0.046***	0.044***	0.044***
	(5.79)	(5.97)	(5.87)	(5.77)
expend	-0.032	-0.022	-0.055	-0.038
	(-0.86)	(-0.57)	(-1.49)	(-1.01)
population	0.004***	0.004***	0.005***	0.005***
	(3.30)	(3.46)	(3.95)	(3.67)
structure2	0.161***	0.136***	0.126**	0.148***

	(3.18)	(2.59)	(2.47)	(2.86)
structure3	0.225***	0.184***	0.195***	0.207***
	(3.49)	(2.68)	(3.00)	(3.13)
pscale	-0.018			
	(-0.62)			
export		-0.013		
		(1.49)		
tech-sp			0.218***	
			(2.94)	
pollution				0.000
				(0.84)
*W*investment*	0.153***	0.148***	0.139***	0.151***
	(5.69)	(5.36)	(5.18)	(5.44)
*W*expend*	-0.048	-0.068	-0.119	-0.037
	(-0.42)	(-0.59)	(-1.05)	(-0.32)
*W*population*	-0.003	-0.001	-0.000	-0.001
	(-0.68)	(-0.31)	(-0.07)	(-0.26)
*W*structure2*	0.201	0.157	0.058	0.152
	(1.55)	(1.19)	(0.45)	(1.13)
*W*structure3*	0.165	0.123	0.047	0.114
	(0.98)	(0.70)	(0.28)	(0.66)
*W*pscale*	-0.126			
	(-1.31)			
*W*export*		-0.016		
		(-0.62)		
*W*tech-sp*			0.531*	
			(1.86)	
*W*pollution*				-0.000
				(-0.04)
sigma2_e	0.000***	0.000***	0.000***	0.000***
	(14.34)	(14.34)	(14.44)	(14.39)
Spatial rho	0.346***	0.347***	0.315***	0.342***
	(3.95)	(3.94)	(3.53)	(3.86)
N	420	420	420	420
R^2	0.4855	0.4978	0.5149	0.4949

t statistics in parentheses

*** p < 0.01. ** p < 0.05. * p < 0.1

Without the influence of environmental regulations, The technology spillover capability of FDI (tech-sp) in model (3) significantly promotes the high-quality development of the local economy, indicating that although many of China's technologies have reached world-class levels, there are still many others that can take advantage of spillovers. Technology in China is lagging behind that in other countries,

and enterprises with stronger FDI technology spillover ability can bring more technology and learning opportunities to China. China can improve its technology level through learning and imitation. The technological spillover capacity of FDI can also affect the areas surrounding the FDI site through the spillover effect so that production technology in surrounding areas can also be improved, thereby improving the development level.

In terms of the decomposition effect of the control variables, the regression results of each variable are basically consistent with expectations. The direct and indirect effects of fixed asset investment (investment) are both significantly positive, indicating that an increase in fixed asset investment not only helps the accumulation of the material foundations needed for the economic and social development of the region but also benefits surrounding areas through information exchange and knowledge sharing. FDI always promotes high-quality economic development in neighboring areas. The direct and indirect impact coefficients of government fiscal expenditures (expend) are both negative and not significant, which may be due to current problems in the management of fiscal expenditures. To obtain more support from the central government, there is competition between regions. The direct effect of the population growth rate (population) is significantly positive at the 1% level, while the indirect effect is not significant, indicating that China has reasonably controlled its population structure through family planning policies and that population growth at this stage can provide the needed talent for high-quality economic development. The direct effects of the industrial structure for secondary (structure2) and tertiary industry (structure3) are both significantly positive at the 1% level, but the coefficient of tertiary industry is larger than that of secondary industry, indicating that China's industrial structure is relatively reasonable at this stage and can promote local high-quality economic development, but that tertiary industry plays a greater role in this. Therefore, China can focus on the development of tertiary industry while ensuring a reasonable industrial structure.

Table 5

Spatial effect decomposition result

Variable	*High-quality economic development*			
	(1)	(2)	(3)	(4)
LR_Direct				
investment	0.053***	0.055***	0.051***	0.053***
	(6.86)	(6.94)	(6.79)	(6.71)
expend	-0.030	-0.021	-0.058	-0.036
	(-0.80)	(-0.54)	(-1.53)	(-0.93)
population	0.004***	0.004***	0.005***	0.005***
	(3.18)	(3.37)	(3.95)	(3.61)
structure2	0.176***	0.148***	0.132**	0.160***
	(3.35)	(2.73)	(2.49)	(2.95)
structure3	0.242***	0.197***	0.204***	0.221***

	(3.50)	(2.74)	(2.96)	(3.12)
pscale	-0.024			
	(-0.76)			
export		0.013		
		(1.37)		
tech-sp			0.251***	
			(3.15)	
pollution				0.000
				(0.84)
LR_Indirect				
investment	0.249***	0.242***	0.216***	0.244***
	(5.47)	(5.08)	(5.12)	(5.09)
expend	-0.068	-0.095	-0.177	-0.053
	(-0.40)	(-0.55)	(-1.07)	(-0.31)
population	-0.001	0.001	0.002	0.001
	(-0.25)	(0.15)	(0.41)	(0.21)
structure2	0.386*	0.308	0.142	0.306
	(1.83)	(1.43)	(0.73)	(1.40)
structure3	0.379	0.295	0.169	0.291
	(1.35)	(1.02)	(0.66)	(1.02)
pscale	-0.200			
	(-1.24)			
export		-0.018		
		(-0.47)		
tech-sp			0.846**	
			(2.02)	
pollution				0.000
				(0.01)
LR_Total				
investment	0.306***	0.300***	0.269***	0.298***
	(6.11)	(5.92)	(6.03)	(5.86)
expend	-0.133	-0.150	-0.268	-0.124
	(-0.76)	(-0.86)	(-1.57)	(-0.71)
population	0.003	0.005	0.007	0.006
	(0.50)	(0.92)	(1.30)	(1.02)
structure2	0.555**	0.448*	0.265	0.454*
	(2.37)	(1.87)	(1.20)	(1.88)
structure3	0.597**	0.469	0.351	0.485
	(1.98)	(1.50)	(1.25)	(1.58)
pscale	-0.204			
	(-1.16)			
export		-0.001		
		(-0.02)		
tech-sp			1.144**	
			(2.38)	
pollution				0.000
				(0.29)

441 t statistics in parentheses

442 *** p < 0.01. ** p < 0.05. * p < 0.1

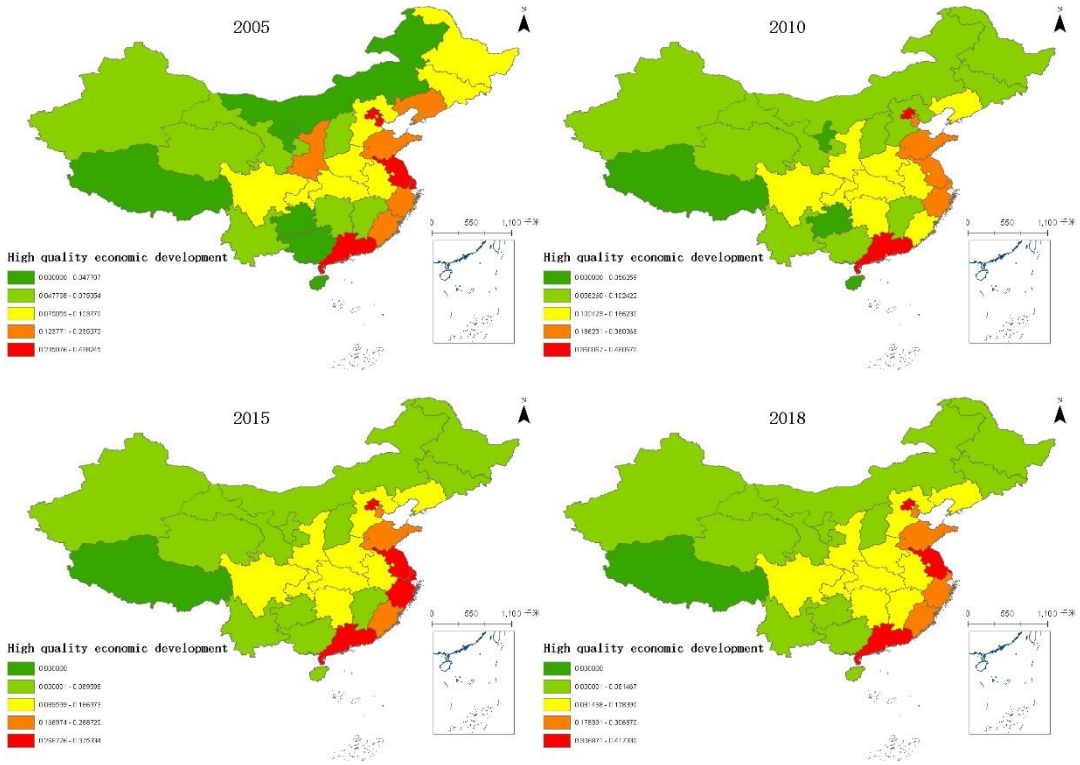

Fig.5. Regional distribution map of high-quality economic development

Figure 5 is a map showing the distribution of high-quality economic development regions in 2005, 2010, 2015, and 2018 drawn by ArcGIS 10.7. As shown in Figure 4, the top five provinces are Guangdong, Beijing, Jiangsu, Shanghai and Tianjin, all of which include eastern coastal cities with relatively developed economies. Therefore, there are obvious differences between China's east and west in terms of high-quality economic development. So, this article divides China's 30 provinces into two parts: the eastern coastal cities and the central and western inland regions (Peng and Li, 2015). The eastern coastal cities include 11 provinces: Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. The corresponding regression results are shown in Table 6 and Table 7.

Table 6

Decomposition results of spatial effects in the eastern coastal area

Variable	*High-quality economic development*			
	(1)	(2)	(3)	(4)
LR_Direct				
investment	0.082***	0.083***	0.096***	0.086***
	(3.58)	(3.72)	(4.26)	(3.87)
expend	-0.425***	-0.487***	-0.415***	-0.374***
	(-3.26)	(-3.62)	(-3.16)	(-2.76)
population	0.008***	0.008***	0.008***	0.007***
	(3.45)	(3.38)	(3.24)	(2.94)
structure2	-0.104	-0.165	-0.063	-0.120

	(-0.56)	(-0.89)	(-0.33)	(-0.66)
structure3	0.152	0.066	0.211	0.187
	(0.89)	(0.37)	(1.16)	(1.10)
pscale	-0.041			
	(-0.66)			
export		0.044*		
		(1.75)		
tech-sp			0.269*	
			(1.87)	
pollution				0.000
				(0.35)
LR_Indirect				
investment	0.360***	0.282***	0.305***	0.328***
	(5.20)	(4.24)	(4.67)	(5.07)
expend	-0.101	-0.241	-0.161	0.042
	(-0.33)	(-0.77)	(-0.53)	(0.13)
population	-0.005	-0.001	-0.001	-0.004
	(-0.74)	(-0.19)	(-0.13)	(-0.66)
structure2	-0.526	-0.415	-0.322	-0.154
	(-1.00)	(-0.81)	(-0.65)	(-0.30)
structure3	-0.445	-0.549	-0.515	-0.280
	(-1.04)	(-1.21)	(-1.21)	(-0.66)
pscale	0.130			
	(1.08)			
export		0.081		
		(1.63)		
tech-sp			0.147	
			(0.44)	
pollution				-0.000*
				(-1.81)
LR_Total				
investment	0.442***	0.364***	0.401***	0.414***
	(6.02)	(5.18)	(5.86)	(5.97)
expend	-0.525*	-0.728**	-0.576*	-0.332
	(-1.72)	(-2.28)	(-1.92)	(-0.98)
population	0.004	0.007	0.007	0.003
	(0.61)	(1.18)	(1.18)	(0.48)
structure2	-0.630	-0.579	-0.384	-0.274
	(-1.03)	(-0.98)	(-0.66)	(-0.45)
structure3	-0.292	-0.483	-0.303	-0.093
	(-0.60)	(-0.97)	(-0.65)	(-0.19)
pscale	0.089			
	(0.60)			
export		0.125*		
		(1.93)		
tech-sp			0.416	
			(1.05)	
pollution				-0.000
				(-1.47)

458 t statistics in parentheses

459 *** p < 0.01. ** p < 0.05. * p < 0.1

For the eastern coastal areas, the direct and indirect effects of the actual scale of FDI (pscale) are still insignificant, while the direct effects of FDI's export orientation (export) and technology spillover capabilities (tech-sp) are significantly positive, indicating that the economically more developed eastern coastal cities are able to seize the potential of FDI. Advanced technology and the opportunity to enter the international market will promote the high-quality economic development of the region. However, the direct effect of fiscal expenditure (expend) is significantly negative. This is because China, unlike other developed countries, needs to consider not only modern economic construction but also more comprehensive goals. This has led to problems in China's fiscal system and in the eastern coastal areas. Because not all fiscal expenditures are used for economic construction, they may not be conducive to the high-quality economic development of eastern coastal cities.

For the central and western inland regions, the direct effect of the actual scale of FDI is significantly positive, indicating that although the large scale of FDI may cause certain damage to the environment, for the central and western inland regions, with their low economic development levels, the capital and technology brought by foreign-funded enterprises can promote high-quality economic development. The total effect of FDI's export orientation (export) and technology spillover capacity (tech-sp) is significantly negative, indicating that for the economically less advanced central and western inland regions, the entry requirements for FDI could be reduced to develop the economy. However, because the economy and technology in these regions are outdated, they cannot absorb the advanced technology brought by FDI and seize the opportunity to enter the international market, and thus the environmental damage caused is greater than the economic benefits. The direct effect of fiscal expenditure (expend) is significantly positive, indicating that for the economically developing central and western inland regions, fiscal expenditures by the state bring funds for infrastructure construction and thus promote regional development and high-quality economic development. The direct effects of the secondary (structure2) and tertiary industrial structures (structure3) are significantly positive. This is because the economic development of the eastern coastal areas is better, and its industrial structure has entered the stage of rationalization, which has a certain promotion effect on economic development. However, due their the high economic level, the promotion effect in the eastern coastal areas is not significant. For the central and western inland areas, the economic benefits brought by secondary and tertiary industry are relatively large, although there are certain areas with a more developed industrial structure. Aside from such disparities, the promotion effect on the economy is still more significant.

Table 7

Decomposition Results of Spatial Effects in the Midwestern Inland

Variable	*High-quality economic development*			
	(1)	(2)	(3)	(4)
LR_Direct				
investment	0.009*	0.007*	0.009**	0.009*
	(1.91)	(1.65)	(1.97)	(1.77)
expend	0.078***	0.067***	0.068***	0.090***
	(3.00)	(2.91)	(2.79)	(3.39)
population	0.007***	0.007***	0.006***	0.007***
	(7.58)	(8.25)	(7.12)	(7.65)
structure2	0.070**	0.075***	0.083***	0.095***
	(2.28)	(2.69)	(2.76)	(3.07)
structure3	0.115***	0.114***	0.124***	0.110***
	(2.86)	(3.15)	(3.19)	(2.72)
pscale	0.054***			
	(2.59)			
export		-0.012**		
		(-2.27)		
Tech-sp			-0.065	
			(-0.50)	
pollution				0.000
				(0.96)
LR_Indirect				
investment	0.005	-0.014	-0.006	0.005
	(0.34)	(-1.14)	(-0.42)	(0.36)
expend	0.100	0.010	0.111	0.195**
	(1.04)	(0.13)	(1.29)	(1.99)
population	-0.001	0.000	-0.002	-0.001
	(-0.46)	(0.03)	(-0.78)	(-0.56)
structure2	0.034	-0.033	-0.085	0.017
	(0.41)	(-0.51)	(-1.13)	(0.22)
structure3	-0.070	-0.045	-0.117	-0.081
	(-0.72)	(-0.61)	(-1.39)	(-0.84)
pscale	-0.118			
	(-1.64)			
export		-0.088***		
		(-6.22)		
techspillover			-0.944***	
			(-3.98)	
pollution				-0.001**
				(-2.31)
LR_Total				
investment	0.014	-0.007	0.003	0.014
	(0.80)	(-0.51)	(0.20)	(0.79)
expend	0.178	0.078	0.178*	0.285**
	(1.56)	(0.85)	(1.76)	(2.44)
population	0.006*	0.007***	0.005*	0.006*
	(1.89)	(3.14)	(1.73)	(1.86)
structure2	0.104	0.042	-0.002	0.112
	(1.03)	(0.53)	(-0.02)	(1.13)

structure3	0.046	0.069	0.007	0.030
	(0.37)	(0.71)	(0.06)	(0.24)
pscale	-0.063			
	(-0.78)			
export		-0.100***		
		(-6.42)		
tech-sp			-1.009***	
			(-3.89)	
pollution				-0.001*
				(-1.87)

t statistics in parentheses

*** p < 0.01. ** p < 0.05. * p < 0.1

Despite the impact of the 2019 novel coronavirus pneumonia epidemic, the amount of foreign investment absorbed by China in 2021 reached a new high, with an increase of 30.3% over the same period in 2019. A large amount of foreign capital inflow is bound to be constrained by China's environmental regulations and policies. Therefore, this article adds the interaction item of FDI quality and environmental regulation to the above research to study whether the impact of different aspects of FDI on high-quality economic development under the influence of environmental regulation will change.

Table 8

Regression results of spatial Durbin model with environmental regulation added

Variable	*High-quality economic development*			
	(5)	(6)	(7)	(8)
investment	0.045***	0.049***	0.047***	0.045***
	(6.00)	(6.37)	(6.22)	(5.95)
expend	-0.049	-0.034	-0.058	-0.016
	(-1.32)	(-0.88)	(-1.50)	(-0.40)
population	0.005***	0.004***	0.005***	0.004***
	(3.91)	(3.33)	(3.67)	(3.61)
structure2	0.142***	0.156***	0.144***	0.178***
	(2.84)	(3.06)	(2.73)	(3.43)
structure3	0.223***	0.219***	0.223***	0.249***
	(3.49)	(3.38)	(3.37)	(3.78)
er pscale*	0.000**			
	(2.49)			
*er*export*		7.214***		
		(2.74)		
er tech-sp*			95.401***	
			(3.29)	
*er*pollution*				0.033
				(1.30)
*W*investment*	0.153***	0.145***	0.145***	0.160***
	(5.67)	(5.37)	(5.43)	(5.91)
*W*expend*	-0.021	-0.020	-0.103	0.171

	(-0.19)	(-0.16)	(-0.81)	(1.23)
*W*population*	-0.002	-0.001	-0.002	-0.002
	(-0.43)	(-0.41)	(-0.48)	(-0.45)
*W*structure2*	0.176	0.182	0.082	0.297**
	(1.39)	(1.36)	(0.60)	(2.14)
*W*structure3*	0.085	0.125	0.062	0.178
	(0.51)	(0.74)	(0.37)	(1.05)
*W*er* pscale*	-0.000			
	(-1.00)			
*W*er*export*		-16.386		
		(-1.43)		
*W*er* tech-sp*			26.200	
			(0.21)	
*W*er*pollution*				-0.279***
				(-2.81)
Spatial rho	0.358***	0.360***	0.346***	0.371***
	(4.11)	(4.14)	(3.96)	(4.27)
sigma2_e	0.000***	0.000***	0.000***	0.000***
	(14.27)	(14.27)	(14.34)	(14.24)
N	420	420	420	420
R-sq	0.4867	0.4968	0.5042	0.4753

t statistics in parentheses

*** p < 0.01. ** p < 0.05. * p < 0.1

Models (5)~(8) in Table 8 show how the average scale of FDI, the export orientation of FDI, the technological spillover capacity of FDI, and the degree of pollution from FDI influence high-quality economic development under the constraints of environmental regulations. It can be seen from the table that the regression results of each control variable did not change significantly, but the impact of average scale and export orientation of FDI on high-quality economic development has changed. The results show that although the quality of China's FDI is not high at this stage, environmental regulatory policies can implement reasonable policy subsidies and restrictions on foreign-funded enterprises to supervise and guide the promotion of high-quality economic development. For further analysis, spatial effect decomposition is also carried out on the SDM (see Table 9).

Models (5) to (8) in Table 9 are the results of the spatial effect decomposition of the spatial Durbin model in Table 8. The direct effect of the actual scale of FDI is significantly positive at the 5% level, indicating that although a series of issues such as environmental protection may be ignored when the actual scale of FDI is large, environmental regulations will constrain these companies. While pursuing their interests, they must also take into account environmental protection and technological upgrading, but such policies have not played a significant role in promoting neighboring areas. The reason is that current environmental regulatory policies are based on the development of the focal region and there is economic competition between regions, so

the formulation of environmental regulations and policies does not take into account the high-quality economic development of other regions. The direct effect of FDI's export orientation is significantly positive at the 5% level, indicating that under the constraints of environmental regulations and policies, export-oriented FDI can bring more advanced technologies and opportunities for China to enter the international market. The direct effect of FDI's technology spillover capacity is still significantly positive at the 1% level, but the indirect effect has become insignificant, indicating that there is currently competition between regions. Competition leads to the implementation of environmental regulatory policies in various regions to promote local high-quality economic development, but these do not care about the high-quality economic development of neighboring areas. The direct development of the pollution level of FDI is not significant, but the indirect effect is significantly negative at the 5% level, indicating that the implementation of environmental regulatory policies in a region will pressure foreign-funded enterprises to transfer pollution to neighboring regions, which is not conducive to high-quality economic development in neighboring areas.

Table 9

Increase the spatial effect decomposition results of environmental regulations

Variable	*High-quality economic development*			
	(1)	(2)	(3)	(4)
LR_Direct				
investment	0.056***	0.058***	0.056***	0.056***
	(6.66)	(7.01)	(6.90)	(6.72)
expend	-0.054	-0.039	-0.067*	-0.008
	(-1.41)	(-0.94)	(-1.67)	(-0.19)
population	0.005***	0.004***	0.005***	0.005***
	(3.98)	(3.39)	(3.74)	(3.66)
structure2	0.154***	0.168***	0.149***	0.198***
	(2.94)	(3.13)	(2.69)	(3.59)
structure3	0.232***	0.230***	0.230***	0.264***
	(3.43)	(3.34)	(3.30)	(3.76)
pscale	0.000**			
	(2.16)			
export		6.631**		
		(2.33)		
tech-sp			101.467***	
			(3.20)	
pollution				0.019
				(0.72)
LR_Indirect				
investment	0.257***	0.246***	0.240***	0.272***
	(5.47)	(5.41)	(5.54)	(5.61)
expend	-0.068	-0.063	-0.195	0.242
	(-0.43)	(-0.35)	(-1.09)	(1.18)

population	0.001	0.000	0.000	0.001
	(0.13)	(0.08)	(0.03)	(0.09)
structure2	0.343*	0.358*	0.191	0.555**
	(1.73)	(1.70)	(0.91)	(2.43)
structure3	0.247	0.306	0.204	0.414
	(0.97)	(1.18)	(0.82)	(1.53)
pscale	-0.000			
	(-0.68)			
export		-19.082		
		(-1.03)		
tech-sp			107.865	
			(0.54)	
pollution				-0.399**
				(-2.39)
LR_Total				
investment	0.312***	0.304***	0.296***	0.328***
	(6.12)	(6.17)	(6.31)	(6.23)
expend	-0.121	-0.101	-0.262	0.234
	(-0.69)	(-0.49)	(-1.30)	(1.01)
population	0.006	0.005	0.005	0.005
	(0.95)	(0.78)	(0.82)	(0.83)
structure2	0.497**	0.526**	0.340	0.753***
	(2.14)	(2.13)	(1.37)	(2.83)
structure3	0.479	0.536*	0.434	0.678**
	(1.59)	(1.75)	(1.46)	(2.12)
pscale	-0.000			
	(-0.34)			
export		-12.452		
		(-0.63)		
tech-sp			209.333	
			(0.96)	
pollution				-0.380**
				(-2.17)

t statistics in parentheses

*** p < 0.01. ** p < 0.05. * p < 0.1

4.3.Robustness test

In the above, the proportion of industrial pollution source treatment investment and regional GDP are used to represent environmental regulations. This article considers that the formulation of environmental regulation policies allows enterprises to carry out technological innovations and stops their polluting behaviors. When the government implements strict regulatory policies, companies will see an increased cost of technological innovation or equipment renewal to meet pollutant emission standards. Therefore, the proportion of industrial pollution control investment across the number of companies can be used to represent environmental regulations. The results are consistent with the direction and significance of the variables in the original regression, so the test results are robust.

Table 10

Robustness test (Replace core explanatory variables)

variable	Explained variable（development）			
	(1)	(2)	(3)	(4)
investment	0.0454***	0.0490***	0.0459***	0.0450***
	(0.00757)	(0.00773)	(0.00756)	(0.00761)
expend	-0.0492	-0.0246	-0.0673*	-0.0339
	(0.0373)	(0.0377)	(0.0392)	(0.0378)
population	0.00484***	0.00411***	0.00449***	0.00436***
	(0.00124)	(0.00124)	(0.00123)	(0.00125)
structure2	0.142***	0.153***	0.131**	0.162***
	(0.0499)	(0.0506)	(0.0525)	(0.0513)
structure3	0.223***	0.217***	0.211***	0.227***
	(0.0640)	(0.0648)	(0.0660)	(0.0653)
Er pscale*	5.935**			
	(2.380)			
*Er*export*		1.868*		
		(1.004)		
*Er*tech-sp*			40.99***	
			(13.18)	
*Er*pollution*				0.00807
				(0.00895)
*W*investment*	0.153***	0.151***	0.141***	0.157***
	(0.0269)	(0.0271)	(0.0272)	(0.0275)
*W*expend*	-0.0208	-0.0288	-0.140	0.00870
	(0.111)	(0.116)	(0.134)	(0.118)
*W*population*	-0.00154	-0.000665	-0.00160	-0.00120
	(0.00357)	(0.00357)	(0.00355)	(0.00358)
*W*structure2*	0.176	0.203	0.0672	0.205
	(0.127)	(0.131)	(0.138)	(0.134)
*W*structure3*	0.0848	0.150	0.0528	0.150
	(0.168)	(0.169)	(0.168)	(0.171)
*W*Er* pscale*	-11.17			
	(11.12)			
*W*Er*export*		-7.548*		
		(4.117)		
*W*Er*tech-sp*			31.59	
			(59.64)	
*W*Er*pollution*				-0.0414
				(0.0307)
Spatial rho	0.358***	0.362***	0.335***	0.356***
	(0.0872)	(0.0872)	(0.0885)	(0.0877)
N	420	420	420	420
R-sq	0.4970	0.4921	0.5130	0.4879

t statistics in parentheses

*** p < 0.01. ** p < 0.05. * p < 0.1

5.Conclusion and policy suggestions

Due to the COVID-19 epidemic in 2020, the economies and trade of countries worldwide have been greatly impacted, but China has successfully responded to the impact of the epidemic, realizing the use of foreign capital to grow against the worldwide declining trend and surpassing the United States to become the country with the largest foreign capital inflow. China has become a "stabilizer" and "safe haven" for multinational investment and has made important contributions to stabilizing the world economy. However, FDI is a "double-edged sword" for China's development. It has not only promoted the rapid development of China's economy but also brought environmental pollution. As China's economy shifts from rapid development to high-quality development, what different effects will different aspects of FDI have on high-quality economic development? Furthermore, because the entry of foreign capital into China will inevitably be restricted by China's environmental regulations and policies, will this influence change under the constraints of environmental regulations? This article examines four aspects of FDI: export orientation, actual scale, technology spillover capacity and pollution degree and explore its impact on the high-quality development of China's economy. Subsequently, the impact of the four dimensions of FDI on the high-quality development of China's economy under the influence of environmental regulations is studied.

Through the empirical research, this paper finds that (1) under the constraints of environmental regulations, the actual scale, export orientation, and technology spillover capacity of FDI have a significant positive impact on the high-quality development of China's economy. Without the constraints of environmental regulations, only the technological spillover capability of FDI has a significant positive impact on high-quality economic development. This shows that environmental regulatory policies can not only restrict FDI but also guide foreign-funded enterprises to significantly promote China's high-quality economic development. (2) FDI with strong technology spillover capabilities not only promotes local development but also plays a significant role in promoting high-quality economic development in surrounding areas through spillover effects. (3) Compared with secondary industry, tertiary industry plays a stronger role in promoting the high-quality development of China's economy, indicating that China needs to promote the "rationalization" of its industrial structure toward "advanced" industries and promote informatization and high-tech industry development. (4) The areas with high economic development quality concentrate on the eastern coastal cities. The development of the central and western regions is far behind that in these areas. Examining the subregions, it can be seen that due to the outdated economic and scientific research technology in the central and western regions, they have insufficient ability to learn the advanced technology brought by FDI. (5) Under the influence of the

environmental regulations and policies implemented in this region, foreign-funded enterprises will be under pressure to transfer pollution to neighboring regions, which is not conducive to their high-quality economic development.

Based on the results of the empirical analysis, corresponding policy recommendations are now proposed for China's economic development:

First, environmental regulatory policies should be further optimized and improved. China's high-quality economic development must not only achieve steady economic growth but also incorporate the improvement of high-tech levels and the protection of the environment. The government can implement certain preferential policies to encourage local enterprises and foreign-invested enterprises to engage in technological innovation, increase the enforcement of environmental regulations, impose severe penalties on enterprises that damage the environment, further supervise and guide enterprises' "green development", and promote China's high-quality economic development.

Second, China should focus its use of foreign capital on obtaining financial assistance to access advanced foreign technology and promoting the technological upgrading of Chinese enterprises. To achieve high-quality economic development, China must adjust the source structure of FDI, avoid the transfer of highly polluting, highly energy-consuming outdated industries from developed countries to China, and follow the content of the "Foreign Investment Law of the People's Republic of China" implemented in 2020. The entry of FDI must be strictly screened and reasonably guided to introduce high-quality FDI.

Third, China must actively coordinate competition between regions. To achieve rapid economic growth and strong performance indicators, regional governments will engage in a "race to the bottom" that prioritizes economic development but causes damage to resources and the environment. Therefore, the central government should actively guide local governments and formulate reasonable performance indicators, appropriately reduce economic indicators, add the environment and education to performance evaluation indicators, and develop a coordination mechanism for regional interests to effectively organize and promote "competition for the best" among regions.

Fourth, China's industrial structure should be further upgraded and optimized. Optimizing and upgrading the industrial structure can not only promote economic growth but also affect whether China can overcome the "middle income trap" and better respond to international competition. In the past ten years, China has made reasonable adjustments and upgrades to its industrial structure, and its economic quality has been continuously improved, but problems still exist with its industrial structure. China has further upgraded and optimized its industrial structure while ensuring the development of basic industries. China should strengthen the development of high-tech industries, accelerate the development of modern industries, and promote the coordinated

development of industries to achieve high-quality economic development.

Fifth, China should coordinate the development of the eastern coastal areas and the central and western inland areas while ensuring the steady development of the eastern coastal areas. The central and western regions should be guided according to the "Guiding Opinions on Promoting the Development of the Western Region in the New Era to Form a New Pattern". China should support the coordinated development of its eastern and western regions to achieve the high-quality development of its overall economy.

Declarations

- Ethics approval

Not applicable

- Consent to participate

Not applicable

- Consent for publish

Not applicable

- Authors' contributions

HCY: data curation, formal analysis, writing – original draft, writing – review & editing.

HW: data curation, formal analysis.

WL: project administration, funding acquisition, conceptualization, supervision.

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- Competing interests

The authors declare that they have no competing interests.

- Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to relative requirements of financially supporting projects but are available from the corresponding author on reasonable request.

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