Spatial Agglomeration of Foreign Direct Investment and Green Productivity in African Industry: A Policy Dilemma Between Leverage and Ecological Trap

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Outline

Context and Problem Motivation

- African states have made FDI attraction a strategic lever for economic and social development, due to its capacity to transfer capital, technology, and knowledge (UNCTAD, 2023; AfDB, 2024).
- FDI can also lead to pollution transfer and negative environmental externalities, particularly in extractive and industrial sectors (Cao and Trans, 2025).

The Core Research Dilemma

how to maximize the benefits of FDI for green industrialization without falling into an ecological trap?

FDI Stock Dynamics in Africa

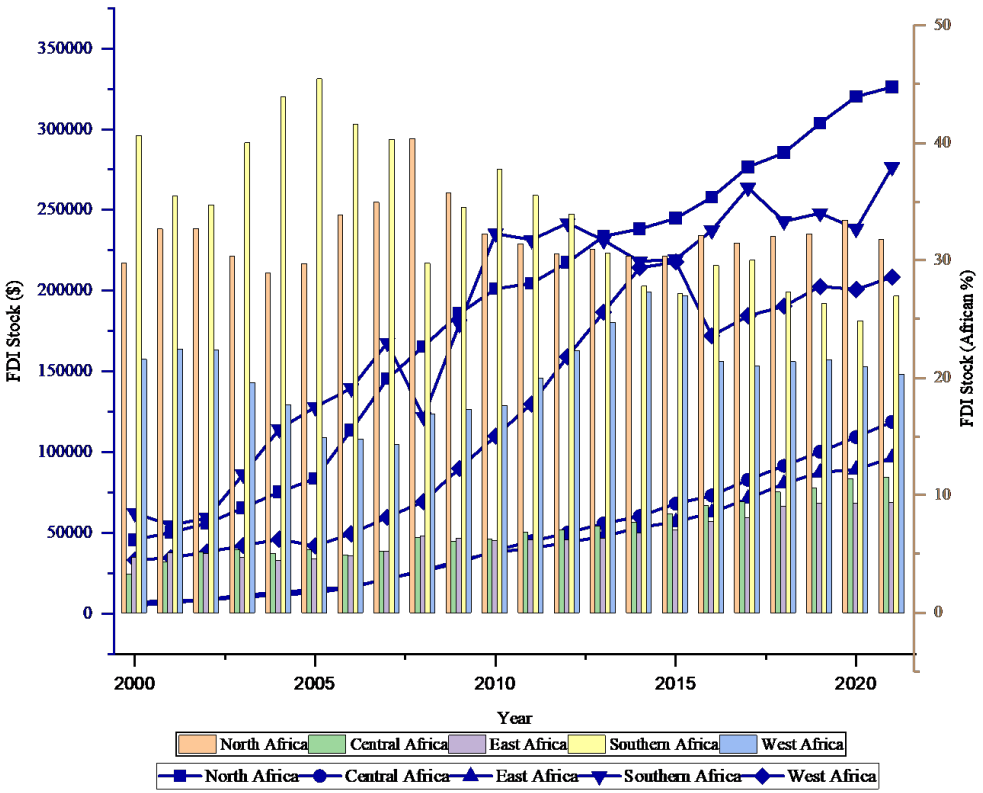

Figure 1. Dynamics of FDI stock in Africa, 2000–2021.

FDI Stok by origins

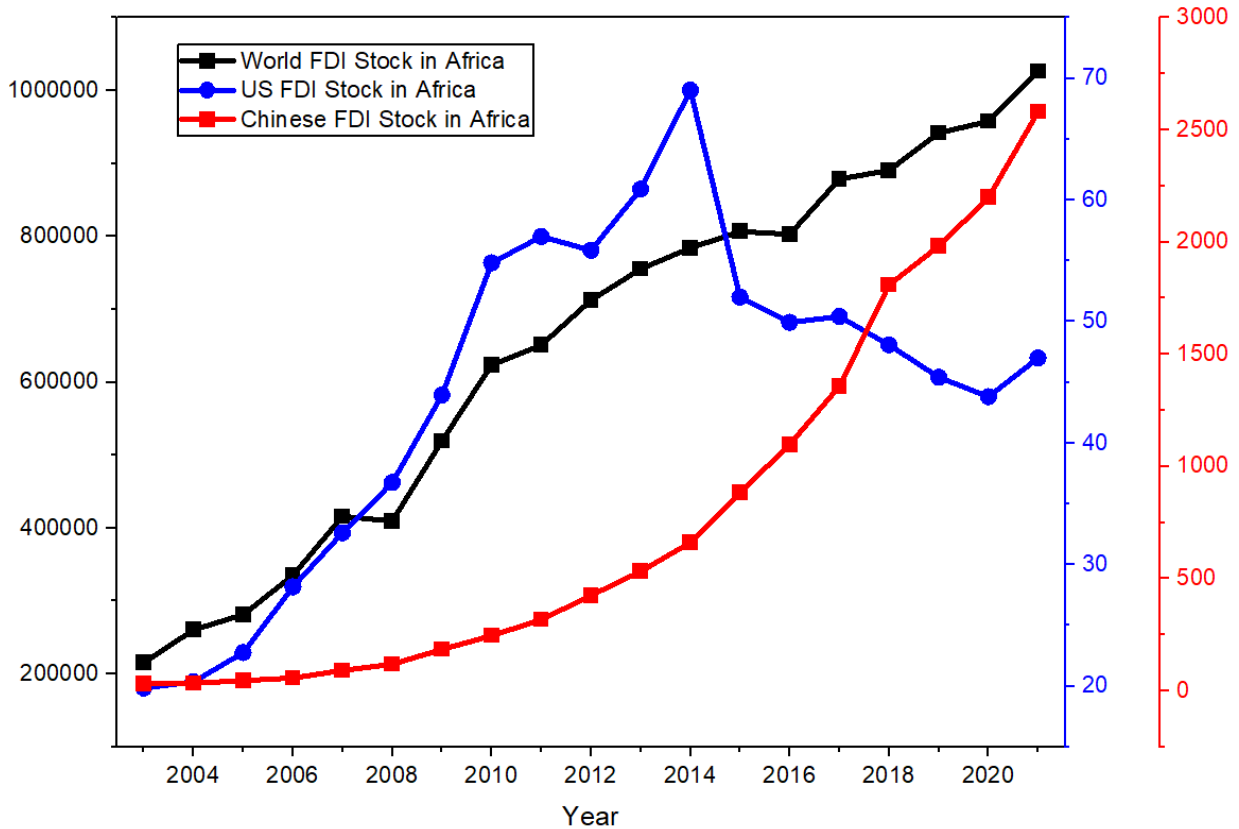

Figure 2. Evolution of FDI stock in Africa by origins from 2002 to 2021.

CO2 emission in africa by sectors

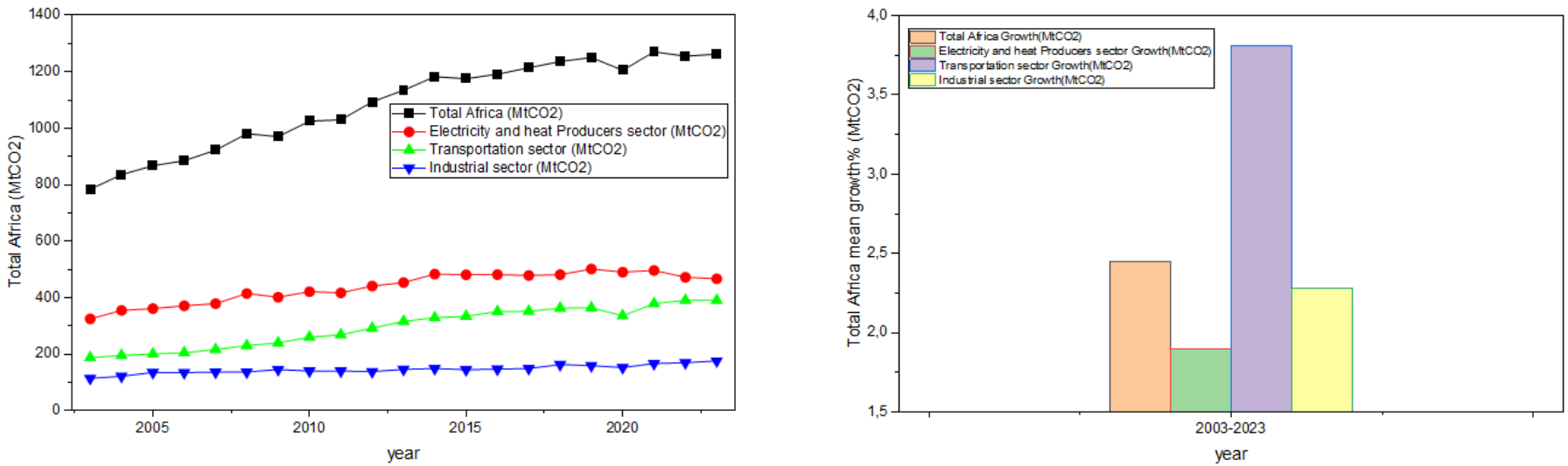

Figure 3. Dynamics and mean growth of CO2 emission in Africa by sectors (2003–2023).

Literature Review

What the Literature Knows

- New Economic Geography (Krugman, 1991): Agglomeration FDI generates productivity spillovers (Porter, Jacobs, MAR externalities).
- FDI and environment: Pollution Halo (Birdsall and Wheeler, 1993) vs. Pollution Haven (Copeland and Taylor, 1995) hypotheses.

Contribution

Key Gaps (What We Still Don't Know)

- Few studies distinguish FDI origin (global vs. Chinese) and host manufacturing development.
- Limited focus on spatial agglomeration of FDI in Africa.
- Scarce evidence on green productivity outcomes.

Our Contributions

This paper fills these gaps by combining spatial FDI agglomeration measures, green TFP (GML index), and heterogeneity analysis (origin + development level) on recent African panel data.

Research Questions and Hypothesis

Central Research Question

1. What is the overall impact of FDI spatial agglomeration on green productivity in the African manufacturing sector?
2. How does this impact vary depending on the origin of FDI (global vs. Chinese) and the host countries' level of manufacturing development?

Working Hypothesis

We hypothesise that the impact of FDI agglomeration on green productivity varies along these two dimensions.

Methodology: Measuring Green Total Factor Productivity

Green TFP Measurement Framework

Green total factor productivity (GTFP) is computed using the **Global Malmquist–Luenberger (GML) index** proposed by Oh (2010). Each African country is modelled using:

- **Inputs**: manufacturing labor, capital stock, and energy consumption
- **Desirable output**: manufacturing value added
- **Undesirable output**: CO2 emissions per unit of manufacturing value added

The production frontier is constructed using **Data Envelopment Analysis (DEA)**.

Methodology: Main Explanatory Variable

FDI Spatial Agglomeration Measure

Inspired by the work of Yu and al (2021), FDI agglomeration is computed as follows:

$$FDIA = \frac{\frac{FDI_i}{\sum_{i=1}^{n} FDI_i}}{\frac{AR_i}{\sum_{i=1}^{n} AR_i}} \quad (1)$$

Where $FDIA$ denotes the degree of FDI agglomeration, FDI_i is the FDI stock per active labour force in country i, AR_i represents land area, and n is the total number of countries.

Methodology: K-means Clustering

Grouping of countries by K-means method

this study employs the K-means clustering algorithm to classify 32 African countries into distinct groups based on their manufacturing value added(MVA). The K-means algorithm minimizes the within-cluster sum of squares (WCSS):

$$J = \sum_{k=1}^{K} \sum_{i \in C_k} \|X_i - \mu_k\|^2 \tag{2}$$

- C_k: set of countries in cluster k.
- μ_k: centroid of cluster k, i.e., mean of all X_i in C_k.
- $\|\cdot\|^2$: squared Euclidean distance.

Methodology: Two-Step System GMM Estimation

Dynamic Panel Model Specification

Following Guo et al. (2024), the empirical model is specified as:

$$GTFPCH_{it} = \alpha_0 + \alpha_1 GTFPCH_{it-1} + \alpha_2 FDIA_{it} + \alpha_3 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

- $GTFPCH_{it-1}$ captures the dynamic persistence of green productivity.
- X_{it} is the set of controle variables.
- α denotes the parameters to be estimated.
- μ_i controls for unobserved country-specific effects.
- λ_t captures time-specific shocks common to all countries.
- ε_{it} is the idiosyncratic error term.

World FDI Vs Chinese FDI Agglomeration

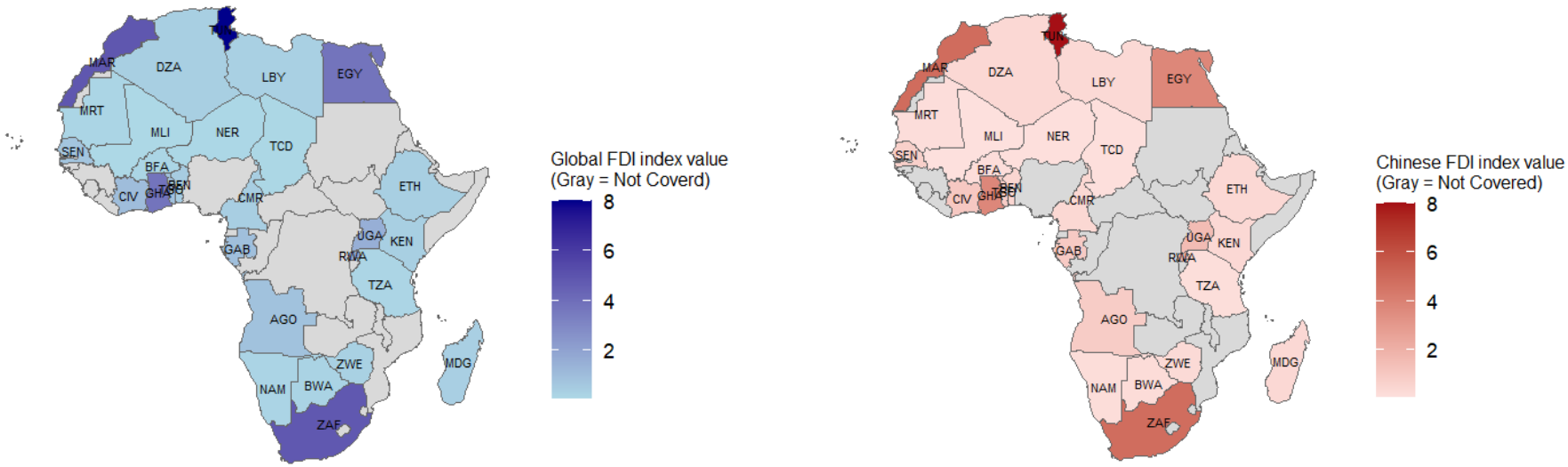

Figure 4. World and Chinese FDI Agglomeration Index (2008–2021).

Green TFP Dynamics in Africa

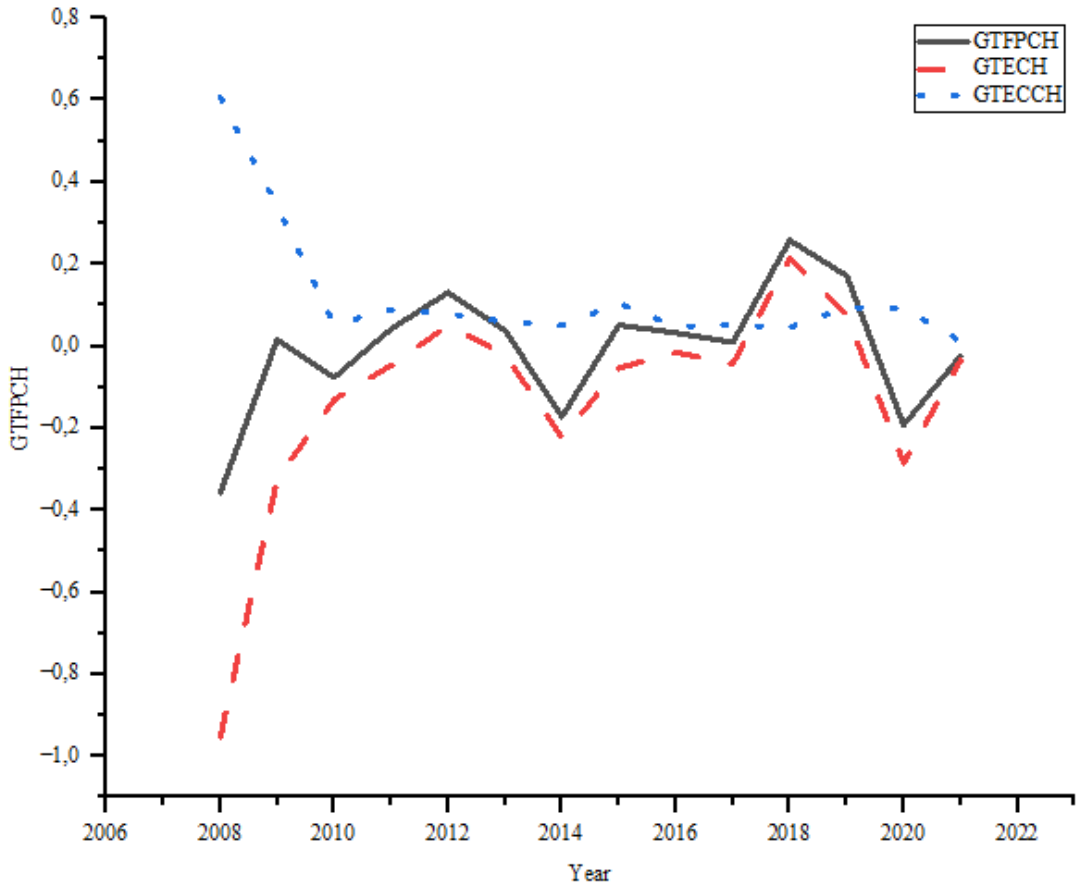

Figure 5. Evolution of GTFP and its components in Africa from 2008 to 2021.

Green TFP Dynamics in Africa

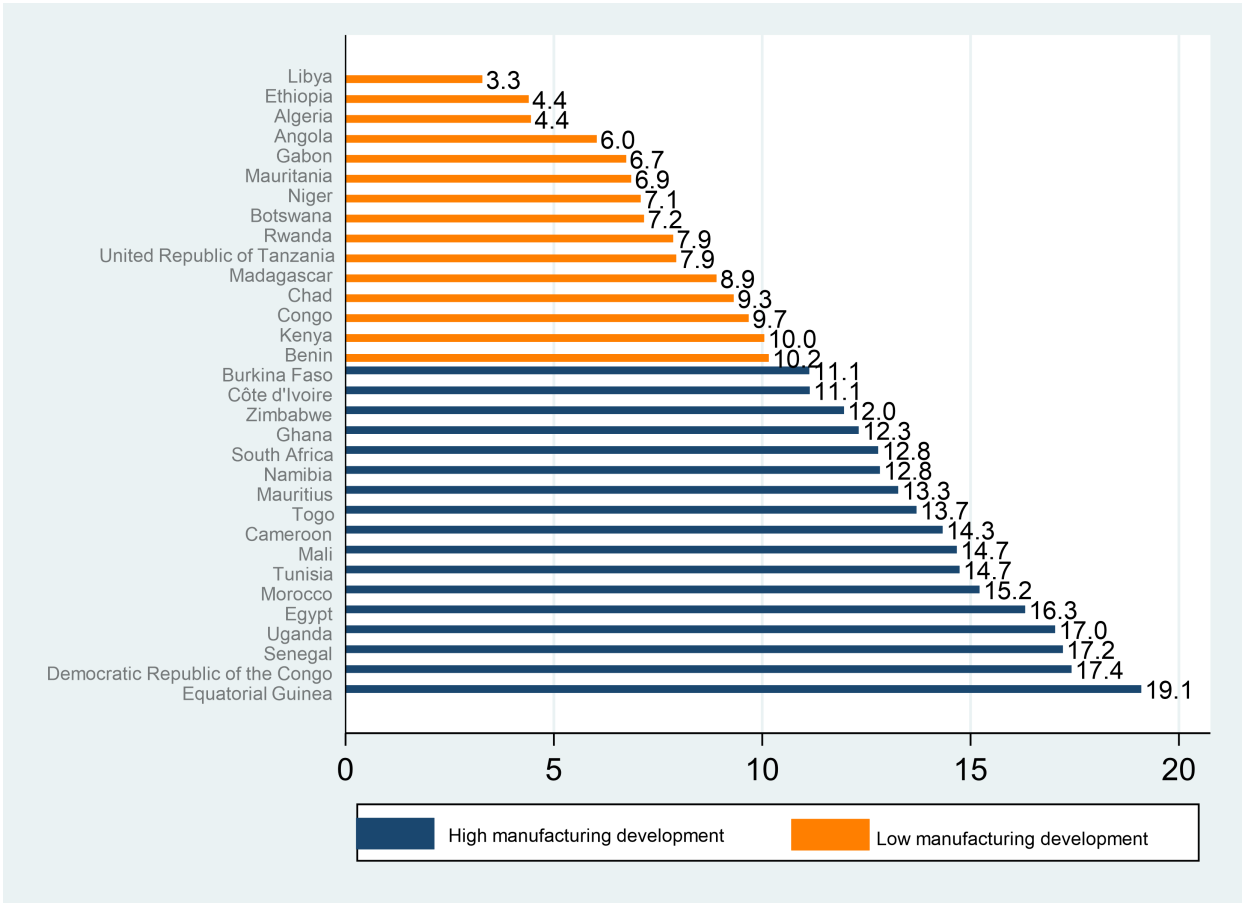

Figure 6. Country groups obtained using the K-means clustering method

Table 7: Africa's dynamic panel results

Variable name	Agglomeration of global FDI			Agglomeration of Chinese FDI			Agglomeration of FDI from other countries		
	GTFPCH	GEFFCH	GTECH	GTFPCH	GEFFCH	GTECH	GTFPCH	GEFFCH	GTECH
GTFPCH (-1)	-0.809**	-	-	-0.391***	-	-	-1.387*	-	-
	(0.033)	-	-	(0.000)	-	-	(0.083)	-	-
GEFFCH (-1)	-	-0.533**	-	-	-0.462**	-	-	-0.008*	-
	-	(0.044)	-	-	(0.014)	-	-	(0.964)	-
GTECH (-1)	-	-	0.635**	-	-	0.451***	-	-	0.596*
	-	-	(0.023)	-	-	(0.000)	-	-	(0.056)
W_FDIA	0.019*	0.012**	-0.010*	-	-	-	-	-	-
	(0.051)	(0.040)	(0.090)	-	-	-	-	-	-
C_FDIA	-	-	-	0.004***	0.005**	0.001**	-	-	-
	-	-	-	(0.000)	(0.050)	(0.017)	-	-	-
O_FDIA	-	-	-	-	-		0.038*	0.004*	-0.004
	-	-	-	-	-		(0.078)	(0.090)	(0.714)
ELECT	0.011	0.006	0.006	0.072	-0.066	0.000	-0.252	-0.002	0.008
	(0.776)	(0.771)	(0.384)	(0.155)	(0.160)	(0.949)	(0.237)	(0.714)	(0.566)
ENERG	0.018	0.020	0.039	-0.695	-0.246	0.236**	0.715	-0.014	0.131
	(0.822)	(0.691)	(0.539)	(0.167)	(0.302)	(0.047)	(0.361)	(0.654)	(0.719)
PSVA	-1.526*	-0.880*	0.859*	-4.171***	-4.681***	0.383***	0.243	-0.654	0.617**
	(0.099)	(0.093)	(0.058)	(0.000)	(0.000)	(0.000)	(0.827)	(0.152)	(0.032)
TRAD	0.049***	0.027***	-0.006	0.023***	0.025**	-0.002***	0.068**	0.003	-0.001
	(0.000)	(0.001)	(0.220)	(0.000)	(0.067)	(0.009)	(0.018)	(0.445)	(0.852)
HDI	0.629	0.706	-2.152	1.016	19.824***	0.693	18.229	2.414	-1.400**
	(0.916)	(0.845)	(0.131)	(0.723)	(0.000)	(0.442)	(0.234)	(0.213)	(0.092)
Constant	-5.644**	-3.551**	1.452	-6.487	-9.481***	-1.344	0.783	-1.791	-0.138
	(0.034	(0.028)	(0.160)	(0.331)	(0.003)	(0.299)	(0.920)	(0.172)	(0.970)
Groups	32	32	32	32	32	32	32	32	32
Instruments	16	16	12	14	13	14	12	15	10
AR(1)	-0.38	-0.73	-1.55	-1.31	-0.64	-1.98	-2.21	-2.09	-1.41
	(0.706)	(0.465)	(0.121)	(0.190)	(0.523)	(0.048)	(0.027)	(0.037)	(0.158)
AR(2)	-1.64	-1.59	0.89	-1.09	-1.43	0.77	-1.44	-0.19	0.82
	(0.101)	(0.112)	(0.373)	(0.275)	(0.152)	(0.441)	(0.149)	(0.851)	(0.410)
Sargan	0.70	1.77	2.73	0.34	0.16	0.84	0.18	0.80	3.97
	(1.000)	(0.987)	(0.604)	(0.999)	(0.999)	(0.991)	(0.996)	(0.997)	(0.137)
Hansen	6.04	7.40	3.63	5.52	2.39	5.02	2.11	7.00	3.91
	(0.642)	(0.495)	(0.459)	(0.479)	(0.793)	(0.542)	(0.715)	(0.429	(0.141)

Table 8: Results for low manufacturing development group

Variable name	Agglomeration of global FDI			Agglomeration of Chinese FDI			Agglomeration of FDI from other countries		
	GTFPCH	GEFFCH	GTECH	GTFPCH	GEFFCH	GTECH	GTFPCH	GEFFCH	GTECH
GTFPCH (-1)	0.375	-	-	0.862***	-	-	0.487	-	-
	(0.408)	-	-	(0.000)	-	-	(0.127)	-	-
GEFFCH (-1)	-	0.376*	-	-	0.255	-	-	0.373**	-
	-	(0.056)	-	-	(0.101)	-	-	(0.038)	-
GTECH (-1)	-	-	0.327**	-	-	0.296***	-	-	0.390**
	-	-	(0.022)	-	-	(0.009)	-	-	(0.039)
W_FDIA	0.028	0.017	0.020	-	-	-	-	-	-
	(0.763)	(0.810)	(0.285)	-	-	-	-	-	-
C_FDIA	-	-	-	0.089**	0.140**	-0.052	-	-	-
	-	-	-	(0.038)	(0.030)	(0.342)	-	-	-
O_FDIA	-	-	-	-	-	-	0.030	0.003	0.017
	-	-	-	-	-	-	(0.721)	(0.966)	(0.391)
ELECT	0.008*	0.007**	-0.001	0.006**	0.010*	-0.008	0.007**	0.007**	-0.001
	(0.082)	(0.040)	(0.440)	(0.020)	(0.066)	(0.419)	(0.014)	(0.048)	(0.508)
ENERG	0.089	0.095	-0.026*	0.022	0.076	-0.104**	0.084	0.100	-0.017
	(0.344)	(0.161)	(0.077)	(0.558)	(0.388)	(0.033)	(0.144)	(0.140)	(0.243)
PSVA	0.043	0.021	-0.007	-0.054	0.009	-0.017	-0.002	0.025	-0.002
	(0.657)	(0.745)	(0.721)	(0.201)	(0.889)	(0.764)	(0.959)	(0.702)	(0.892)
TRAD	0.002	0.003	-0.001	0.005*	0.004	-0.006**	0.004	0.003	-0.001*
	(0.699)	(0.410)	(0.112)	(0.094)	(0.424)	(0.043)	(0.212)	(0.400)	(0.051)
HDI	-1.131	-1.067	0.205	-1.680*	-1.387	1.303	-1.406***	-1.052	0.128
	(0.420)	(0.133)	(0.528)	(0.014)	(0.120)	(0.354)	(0.006)	(0.163)	(0.486)
Constant	-0.604	-0.746	0.235	-0.135	-0.819	0.950**	-.554	-0.772	0.161
	(0.395)	(0.210)	(0.128)	(0.727)	(0.274)	(0.014)	(0.206)	(0.194)	(0.258)
Groups	15	15	15	15	15	15	15	15	15
Instruments	10	12	12	12	12	10	12	12	13
AR(1)	-1.65	-2.11	-1.68	-2.15	-2.01	-1.69	-2.00	-2.13	-1.62
	(0.100)	(0.035)	(0.092)	(0.032)	(0.044)	(0.091)	(0.046)	(0.033)	(0.106)
AR(2)	0.59	1.02	1.10	1.14	0.76	0.90	0.91	1.06	1.16
	(0.558)	(0.309)	(0.270)	(0.255)	(0.446)	(0.367)	(0.362)	(0.289)	(0.245)
Sargan	0.60	0.76	6.00	0.06	1.84	8.72	1.04	0.88	7.04
	(0.740)	(0.944)	(0.200)	(1.000)	(0.765)	(0.013)	(0.904)	(0.927)	(0.218)
Hansen	1.46	0.97	4.00	0.50	3.03	1.38	2.28	1.14	5.79
	(0.481)	(0.914)	(0.406)	(0.973)	(0.553)	(0.501)	(0.685)	(0.887)	(0.327)

Table 9: Results for high manufacturing development group

Variable name	Agglomeration of global FDI			Agglomeration of Chinese FDI			Agglomeration of FDI from other countries		
	GTFPCH	GEFFCH	GTECH	GTFPCH	GEFFCH	GTECH	GTFPCH	GEFFCH	GTECH
GTFPCH (-1)	0.360*	-	-	0.214***	-	-	0.397**	-	-
	(0.059)	-	-	(0.008)	-	-	(0.043)	-	-
GEFFCH (-1)	-	-0.106	-	-	-0.106	-	-	0.106	-
	-	(0.637)	-	-	(0.492)	-	-	(0.716)	-
GTECH (-1)	-	-	0.364	-	-	0.474***	-	-	-0.587
	-	-	(0.512)	-	-	(0.000)	-	-	(0.428)
W_FDIA	-0.009*	-0.004*	-0.016	-	-		-	-	
	(0.052)	(0.069)	(0.245)	-	-		-	-	
C_FDIA	-	-		-0.000	0.000	0.001*	-	-	
	-	-		(0.598)	(0.288)	(0.073)	-	-	
O_FDIA	-	-		-			-0.013**	-0.010*	-0.003
	-	-		-			(0.037)	(0.063)	(0.439)
ELECT	-0.007	-0.004	-0.119	-0.012	-0.002	-0.010	-0.006	0.001	0.044
	(0.353)	(0.241)	(0.468)	(0.167)	(0.525)	(0.758)	(0.485)	(0.742)	(0.467)
ENERG	0.003	0.074	-1.226	-0.002	0.013**	-0.130	0.005	0.030	-1.826
	(0.697)	(0.762)	(0.401)	(0.918)	(0.013)	(0.634)	(0.621)	(0.167)	(0.324)
PSVA	-0.015	0.040	-0.459	-0.056	0.012	-0.124	-0.007	0.095	-1.328**
	(0.870)	(0.713)	(0.457)	(0.499)	(0.801)	(0.815)	(0.942)	(0.464)	(0.039)
TRAD	0.001	-0.001	-0.004	-0.001	-0.003*	-0.006***	0.002	-0.001	-0.012
	(0.550)	(0.562)	(0.780)	(0.905)	(0.054)	(0.004)	(0.382)	(0.640)	(0.131)
HDI	1.991**	1.691**	-5.408	2.254***	1.133	-0.640	1.945*	1.207*	-24.393
	(0.038)	(0.037)	(0.544)	(0.004)	(0.105)	(0.486)	(0.053)	(0.094)	(0.154)
Constant	-0.563	-0.561	20.931	-0.198	-0.375	2.333	-0.734	-0.844	21.438
	(0.277)	(0.311)	(0.439)	(0.683)	(0.120)	(0.577)	(0.204)	(0.138)	(0.346)
Groups		17	17	17	17	17	17	17	17
Instruments		14	15	9	13	15	9	12	15
AR(1)	-2.18	-1.56	-0.23	-2.43	-1.92	-1.71	-2.19	-1.65	-0.57
	(0.029)	(0.119)	(0.818)	(0.015)	(0.054)	(0.088)	(0.028)	(0.099)	(0.565)
AR(2)	0.55	-0.40	0.01	0.29	-0.49	-0.88	0.60	0.18	0.33
	(0.580)	(0.689)	(0.994)	(0.770)	(0.623)	(0.380)	(0.547)	(0.859)	(0.740)
Sargan	0.39	1.60	0.44	0.48	1.07	1.52	0.36	1.15	0.32
	(0.533)	(0.952)	(0.999)	(0.490)	(0.956)	(0.982)	(0.549)	(0.887)	(1.000)
Hansen	0.47	5.20	4.61	1.29	3.03	5.41	0.41	1.73	4.23
	(0.492)	(0.518)	(0.595)	(0.256)	(0.696)	(0.610)	(0.522)	(0.784)	(0.754)

Conclusion and Policy Recommendations

Policy Implications

- Establish a national FDI evaluation committee implementing mandatory scoring that integrates environmental criteria and FDI origin.
- Develop special industrial zones with low manufacturing development, offering progressive tax exemptions tied to the adoption of green technologies and local linkages.
- Introduce a progressive carbon tax on emissions in FDI clusters, with full reinvestment in local green funds.

Key References

1. Birdsall, N., & Wheeler, D. (1993). Trade policy and industrial pollution in Latin America: where are the pollution havens? *The Journal of Environment & Development*, 2(1), 137–149.
2. Copeland, B. R., & Taylor, M. S. (1995). Trade and the environment: a partial synthesis. *American Journal of Agricultural Economics*, 77(3), 765–771.
3. Krugman, P. (1991). Increasing Returns and Economic Geography. *Journal of Political Economy*, 99(3), 483–499.
4. Yu, D., Li, X., Yu, J., & Li, H. (2021). The impact of the spatial agglomeration of foreign direct investment on green total factor productivity of Chinese cities. *Journal of Environmental Management*, 290, 112666.

Thank You for Your Attention

Questions and Discussions Welcome

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