THE INFLUENCE EFFECT AND MECHANISM OF ENVIRONMENTAL REGULATION ON RURAL INDUSTIAL INTERGRATION—EMPIRICAL ANALYSIS BASED ON SURVEY DATA FROM EIGHT PROVINCES IN CHINA

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Abstract. Achieving good governance of the rural environment and promoting the integration of rural industries are crucial tasks in implementing China's rural revitalization strategy, and serving as an important basis for achieving high-quality development in agriculture and rural areas. This paper uses survey data from 3727 households in eight provinces to construct a Logit model to empirically analyze the impact and mechanisms of environmental regulations on rural industrial integration. The results show that: Overall, environmental regulations significantly increase the probability of farmers participating in industrial integration, but their effects vary among different types of farmers. They can significantly increase the probability of farmers with higher education levels, middle-to-low income farmers, and non-stable employment farmers participating in industrial integration, while having no significant impact on farmers with lower education levels, high-income farmers, and stable employment farmers; Hometown identity, improved living conditions, and local employment all play significant positive moderating roles in the influence of environmental regulations on the development of rural industrial integration.
Keywords: *environmental regulation, rural industrial integration, heterogeneity, hometown identity*

Introduction

Rural environmental governance is a crucial component of the rural revitalization strategy and also serves as the foundation and prerequisite for advancing rural industrial development. The Central Document No.1 issued on February 3, 2024, titled "Opinions of the CPC Central Committee and the State Council on Learning from and Effectively Promoting the Comprehensive Revitalization of Rural Areas by Drawing on the Experience of the 'Model Village and Ten Thousand Villages Improvement' Project," clarifies that "starting with rural environmental improvement, expanding from point to area, and iterating upgrades, 20 years of sustained effort have created thousands of beautiful villages." The document emphasizes making the comprehensive revitalization of rural areas a key task in this new era and new journey, focusing on agriculture, rural areas, and farmers. This is the seventh time revitalization has been included in the Central Document No.1, following a series of specialized documents such as the "Three-Year Action Plan for Rural Human Settlements Improvement (2018-2020)," the "Guiding Opinions on Promoting the Revitalization of Rural Industries," and the "Five-Year Action Plan for Improving Rural Human Settlements (2021-2025)." This highlights the firm commitment of the central leadership to improve the rural environment and promote the prosperity of rural industries.

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The 2025 No. 1 Central Document outlines key policies for integrating rural environmental improvement with industrial development. It deep integration of agriculture, culture, and tourism to foster diversified rural economic growth. In this context, how to grasp the regularities of rural environmental governance and the integration of rural industries, and explore effective approaches that balance the resolution of ecological environment governance and industrial integration in rural areas, thereby promoting a "win-win" situation for rural environmental governance and rural industry development, has become an urgent issue that needs to be addressed by governments at all levels and the academic community.

Environmental regulations not only generate ecological effects but also socioeconomic impacts, a conclusion widely recognized by both the government and academia (Porter and Linde, 1995; Erdogan, 2014; Bowser, 2020; Xiao et al., 2024). Existing research on the socioeconomic effects of environmental regulations primarily examines their relationship with economic growth (Zhang and Li, 2021; Wang et al., 2019; Li et al., 2020), technological progress (Calel and Dechezleprêtre, 2016; Song and Bi, 2022; Li et al., 2024), income distribution (Qin and Qi, 2019; Xiao et al., 2024), employment (Hafstead and Williams, 2018; Kai et al., 2021; Qin et al., 2018), and industrial development (Juan and Zhong, 2022; Peng et al., 2023; Xu and Ma et al., 2023; Wang and He, 2022). Studies focusing on the relationship between environmental regulations and industrial development mainly concentrate on two aspects: one is exploring the relationship between environmental regulations and industrial structure. Fan and Xiao (2024) conducted an empirical analysis of the direct and indirect effects of environmental regulations on industrial structure optimization, concluding that environmental regulations have an "inverted U" -shaped impact, promoting first and then inhibiting industrial structure adjustment (Fan and Xiao, 2024). Xu and Ma (2023) studied the heterogeneity of the impact of environmental regulations on industrial transformation from the perspectives of rationalization and upgrading of industries, examining the coupling effect of digital economy and environmental regulations on industrial transformation (Xu and Ma, 2023). Zheng et al. (2021) investigated the relationship and influencing factors of the coordination between environmental regulations and industrial structure upgrading in city clusters (Zheng et al., 2021). Zeng et al. (2021) used balanced panel data from 30 provinces between 2004 and 2018 to empirically examine the agricultural structural adjustment effects brought about by environmental regulations (Zeng et al., 2021). Hu et al. (2020) studied the pathways and mechanisms by which environmental regulations influence industrial structure adjustment (Hu et al., 2020). Secondly, they explored the relationship between environmental regulations and industrial agglomeration and relocation. Research in this area has yet to reach a consensus. Qin and Liao (2015) found that the intensity of environmental regulations has a significant positive impact on industrial agglomeration (Qin and Liao, 2015). Guan (2019) discovered that environmental regulations have a threshold effect on the agglomeration of manufacturing industries (Guan, 2019). Hao et al. (2021) argued that environmental regulations do not reduce the level of urban industrial agglomeration but only slow down the net inflow of enterprises initially (Hao et al., 2021). Wang and He (2022) found that industrial agglomeration can enhance the promoting effect of environmental regulations on green innovation efficiency (Wang and He, 2022).

Research on the integration of agricultural industries and its influencing factors at the micro level has been a focal point for scholars in recent years. However, such studies

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remain relatively scattered. Some scholars, based on micro survey data, have analyzed the mechanisms of farmer responses to the integration of primary, secondary, and tertiary sectors in rural areas. They found that factors such as farmer age, policy awareness, years of agricultural production experience, market price fluctuations (Liu et al., 2019), land transfer, technological progress, environmental quality, human capital, inclusive finance, and entrepreneurial spirit all significantly influence farmers' participation in industrial integration (Zhang and Zhou, 2021; Juan and Zhong, 2022). Systematic research on how environmental regulations affect rural industrial integration is still scarce.

Previous studies have provided valuable references for this paper. However, most of these studies focus on the macro level, using national or city-level data to examine the impact of environmental regulations on industrial development. Due to factors such as data availability, few studies have explored the industrial integration effects of environmental regulations at the micro level, using village-level survey data. Literature that discusses the mechanisms by which rural environmental governance influences the integration of rural industries is even rarer. Based on this, this paper aims to use micro-level survey data at the village level to systematically study the impact and heterogeneity of environmental regulations on the integration of rural industries. By analyzing their mechanisms of influence, it seeks to provide theoretical support for the formulation and optimization of future policies on environmental regulations and industrial integration.

Materials and methods

Data sources

The data used in this paper comes from a sampling survey conducted by the research team from July to September 2023 across 3727 households in eight provinces: Hunan, Hubei, Jiangxi, Guangxi, Chongqing, Sichuan, and Jiangxi. The survey was carried out at two levels: first, at the household level, where familiar household heads or primary caregivers were selected to complete questionnaires on family economic conditions, family member situations, participation in environmental governance, and involvement in industrial organization; second, at the village level, where village chiefs or party branch secretaries were chosen for face-to-face questionnaires on the status of village environmental governance, the work of village officials, and the development of the village economy. The surveyed households came from 287 villages across 135 counties in the eight provinces. By matching village questionnaires with household questionnaires and removing samples with significant information loss, a total of 3727 valid samples were obtained, which are representative.

Model

Considering that the explained variable is a binary variable, this paper constructs the following Logit model for empirical analysis:

$$\mathrm{logit}[P(〚\mathrm{chyrh}〛\_t = 1)] = \alpha + \beta\, 〚\mathrm{hujgzt}〛\_(t-1) + \theta X\_t + \varepsilon \qquad \text{(Eq.1)}$$

In the formula, chyrh is the rural industrial integration variable, hujgzt is the core explanatory X variable, that is, the environmental regulation variable, which represents a series of control variables. α, β and θ are the estimated coefficients, and ε represents the random disturbance term.

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Variables and their descriptive statistics

Dependent variable

The variable "Rural Industry Integration" (chyrh) is primarily measured by the degree of interest linkage between the surveyed farming households and other agricultural production and operation entities (Qi et al., 2021). The questionnaire includes questions such as: "Has your family joined cooperatives like supply and marketing cooperatives, specialized cooperatives, contract farming, or industrial chains?" "Does your family engage in production and business activities that combine planting, breeding, or other industries?" "Does your family participate in new agricultural forms such as leisure agriculture or picking of specialty agricultural products?" "Has your family achieved mutual integration and connectivity between agriculture and other industries in their production and business activities?" If any of these questions are answered with "yes," it indicates that the household is involved in rural industry integration; otherwise, it is considered not to be involved.

Explanatory variables

This paper defines the explanatory variable as environmental regulation (hujgzt). Given that large-scale and widespread rural environmental improvements in China officially began in 2018, and considering the lag effect of environmental regulations, especially their impact on industrial integration, the survey questionnaire includes the question "Has your family participated in the special rural environmental improvement campaign?" If the answer is "Yes," and the response to "When did your family start participating in the environmental improvement efforts?" is "One year ago or earlier, continuing until now," it is considered that the village implemented a special environmental regulation last year. Otherwise, it is not considered to have implemented a special environmental regulation. This aims to examine the impact of ongoing environmental regulations from the previous period on current industrial integration and development.

Control variables

Previous studies have found that household head characteristics, family characteristics, and village characteristics have significant impacts on rural industrial integration. Therefore, this paper sets up a series of control variables at the levels of household head, family, and village. The definitions and descriptive statistics of all variables are shown in *Table 1*.

Results

Benchmark regression

Table 2 reports the benchmark regression results of environmental regulation on the integration of agricultural industries. For ease of comparison, the Logit model was used for estimation, followed by the Probit model for verification. Columns (1)-(2) and (3)-(4) report the estimation results of the Logit model and the Probit model, respectively. The comparison shows that, regardless of whether control variables are included, the estimated coefficients of the Logit model and the Probit model are consistent in direction and significance. This indicates that the estimation results are relatively robust to some

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extent. From the perspective of the significance of the core explanatory variable "hujgzt," its estimated coefficient is positive and has passed the 1% significance level test, indicating that environmental regulation significantly increases the probability of farmers participating in rural industry integration, thereby promoting the integrated development of rural industries. Regarding household characteristic variables, the impact of agricultural production and improved conditions on the integrated development of rural industries is positively significant, suggesting that compared to households not engaged in agricultural production, those engaged in agricultural production will have a higher probability of participating in rural industry integration; households with improved living conditions also have a greater probability of participating in household industry integration. The estimated coefficient of the support burden is negatively significant, indicating that households with heavier support burdens have a lower probability of participating in rural industry integration. This suggests that from the perspective of household head characteristic variables, education and local employment have a positive impact on rural industry integration. Higher levels of education lead to a higher probability of households participating in rural industry integration. In addition, relatively speaking, households where the head of household is employed locally have a higher probability of participating in rural industrial integration compared to those who are employed elsewhere. From the perspective of village characteristics, village governance and the capabilities of village officials significantly positively influence rural industrial integration, indicating that better village governance and stronger capabilities of village officials will significantly promote the integration of rural industries.

Heterogeneity analysis

The impact of environmental regulations on farmers' participation in the integration of rural industries may vary due to individual heterogeneity. Therefore, it is necessary to further examine the differences in how environmental regulations affect different groups with distinct characteristics in their participation in the integration of rural industries. Existing research suggests that individuals may exhibit group heterogeneity in the influence of environmental regulations on farmers' participation in industrial integration due to differences in education levels, income levels, and employment status. To this end, first, groups should be formed based on education level, dividing samples with primary school or lower education levels into one group, considered as farmers with lower education levels, and those with junior high school or higher education levels into another group, considered as farmers with higher education levels, to investigate whether the impact of environmental regulations on farmers' participation in industrial integration varies due to differences in education level. Second, groups should be formed based on income level, dividing all samples into three equal parts according to annual income levels from low to high, sequentially defining them as farmers with lower income levels, middle-income levels, and higher-income levels, to examine whether the impact of environmental regulations on farmers' participation in industrial integration varies due to differences in income levels. Third, groups should be formed based on employment status, dividing samples that have achieved stable employment into one group, considered as stable employment groups, and those that have not achieved stable employment into another group, considered as non-stable employment groups, to investigate whether the impact of environmental regulations on farmers' participation in industrial integration varies due to differences in the employment status of household heads.

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Table 1. *Variable definition and descriptive statistics*

Variable name	Variable symbol	Variable-definition	Mean	Standard error	Least value	Crest value
Industry amalgamation	*chyrh*	Participation in industrial integration = 1, non-participation in industrial integration = 0	0.3427	0.4746	0	1
Environmental regulation	*hujgz*	Environmental regulation = 1, no environmental regulation = 0	0.8256	0.3795	0	1
Home recognition	*jiaxrt*	Are you willing to live in a town if conditions permit? No = 1, yes = 0	0.4531	0.4978	0	1
Land is idle	*tudix*	Whether your land is idle or not, yes = 1, no = 0	0.2108	0.4079	0	1
Agricultural production	*noysc*	Whether the family is engaged in agricultural production, yes = 1, no = 0	0.5027	0.5001	0	1
Living conditions improved	*shtji*	Whether the family has access to flush toilets and clean water sources	0.7108	0.4534	0	1
Member health	*healt*	Whether there is an unhealthy adult in the family, yes = 1, no = 0	0.9536	0.2101	0	1
Support burden	*shany*	The proportion of the elderly over 60 years old and minors in the total population of a family	0.4753	0.2533	0	1
Gender of the head of household	*hdged*	Householder gender, male = 1, female = 0	0.6547	0.4755	0	1
Age of the head of household	*hdage*	Age of the head of household	46.2103	10.5987	18	65
Age squared	*hdag2*	The square of the age of the head of household	2433.1231	1534.3060	324	4225
Householder education	*hdedu*	Number of years of education of the head of household	9.6395	3.6984	0	20
Local employment	*bdjye*	The employment place is in the village/out of the town within the county = 1, out of the county/out of the province = 0	0.6477	0.4777	0	1
Stable employment	*wedjy*	Have you been continuously employed in the past 6 months, or have you not been unemployed or out of work or changed jobs? Yes = 1, No = 0	0.6291	0.4831	0	1
Village governance effect	*cunzl*	How do you think the overall effect of your village governance is? Very poor = 1, relatively poor 2, general 3, better 4, very good 5	3.5631	0.7852	1	5
Ability of cadres	*cungb*	How is the overall working ability of the village cadres in your village? Very poor = 1, relatively poor = 2, average = 3, better = 4, very good = 5	3.6357	0.7981	1	5

Table 3 reports the impact of environmental regulations on the participation of different characteristic groups in industrial integration. The results show that there is significant group heterogeneity in the influence of environmental regulations on farmers' participation in industrial integration. In terms of educational level differences, the impact of environmental regulations on higher education levels is positively significant, while it is not significant for lower education levels. This indicates that, relatively speaking, environmental regulations only significantly increase the probability of higher education levels participating in industrial integration, and the effect of promoting lower education levels to participate in industrial integration has yet to be effectively demonstrated. Generally, under environmental regulations, higher education levels have significantly stronger risk awareness, policy awareness, and value recognition regarding industrial integration compared to lower education levels, which may further enhance their willingness to participate in industrial integration. From the perspective of household income level differences, the impact of environmental regulations on lower-income and middle-income households participating in industrial integration is positively significant, while the impact on higher-income households is negatively insignificant. This suggests that environmental regulations significantly increase the probability of middle and low-

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income households participating in rural industrial integration, but fail to promote the participation of higher-income groups in industrial integration. The possible reason is that, with the further advancement of environmental regulations, middle-and low-income households are constrained to varying degrees by their own production capacity, factor endowments, and technological levels in preventing pollution of farmland and agricultural products and developing green agriculture. Therefore, they choose to participate in industrial integration, which not only alleviates constraints on their capabilities, factors, and technology but also enhances the added value and income of their products. From the perspective of employment differences, environmental regulations have a positive and significant impact on the participation of households that have not achieved stable employment in industrial integration, while having no significant impact on those who have achieved stable employment. This indicates that environmental regulations significantly increase the probability of unstable employment households participating in industrial integration. It suggests that environmental regulations play a significant positive role in promoting employment for idle, unemployed, and job-seeking households.

Table 2. *Results of the benchmark regression*

	*logit*1 **(1)**	*logit*2 **(2)**	*probit*1 **(3)**	*probit*2 **(4)**
hujgz	0.7224***	0.3217***	0.4337***	0.1811***
	(0.0985)	(0.1151)	(0.0576)	(0.0661)
jiaxrt		0.0308		0.0186
		(0.0785)		(0.0470)
tudix		0.0449		0.0213
		(0.0969)		(0.0573)
noysc		1.2091***		0.7229***
		(0.0797)		(0.0469)
shtji		0.1547*		0.0970*
		(0.0894)		(0.0528)
healt		-0.2773		-0.1561
		(0.1716)		(0.1039)
shany		-0.5243***		-0.3143***
		(0.1545)		(0.0920)
hdged		0.0825		0.0462
		(0.0808)		(0.0481)
hdage		-0.0034		0.0028
		(0.0028)		(0.0075)
*hdag*2		0.0001		0.0001
		(0.0001)		（0.0001）
hdedu		0.0455***		0.0266***
		(0.0126)		(0.0075)
bdjye		0.2067**		0.1156**
		(0.0828)		(0.0490)
wedjy		0.1222		0.0657
		(0.0816)		(0.0485)
cunzl		0.4941***		0.2906***
		(0.0702)		(0.0413)
cungb		0.3546***		0.2083***
		(0.0651)		(0.0379)
_cons	-1.2611***	-5.3003***	-0.7696***	-3.0915***
	(0.0916)	(0.4618)	(0.0531)	(0.2688)
N	3727	3727	3727	3727

The standard error of robustness is in brackets, * p < 0.1, ** p < 0.05, *** p < 0.01

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Table 3. *Heterogeneity analysis of environmental regulation on rural industrial integration*

	Lower education group	Higher education group	Lower income group	Middle income group	Higher income group	Stable employment group	The unstable employment group
hujgz	0.4764	0.3235***	0.5709***	0.4734**	-0.0204	0.2261	0.4342**
	(0.3815)	(0.1223)	(0.2187)	(0.1920)	(0.2009)	(0.1565)	(0.1695)
jiaxrt	-0.2138	0.0654	-0.0780	0.0993	0.0784	0.0356	0.0457
	(0.2628)	(0.0827)	(0.1420)	(0.1316)	(0.1414)	(0.0992)	(0.1305)
tudix	0.2978	-0.0328	-0.1654	0.2253	0.0585	0.0646	0.0185
	(0.2711)	(0.1042)	(0.1737)	(0.1681)	(0.1667)	(0.1183)	(0.1702)
noysc	0.9015***	1.2281***	1.0008***	1.0315***	1.5415***	1.2784***	1.0710***
	(0.2617)	(0.0831)	(0.1431)	(0.1361)	(0.1385)	(0.1005)	(0.1323)
shtji	0.0528	0.1963**	0.2474	0.0070	0.2576	0.0630	0.3138**
	(0.2602)	(0.0958)	(0.1520)	(0.1408)	(0.1865)	(0.1153)	(0.1449)
healt	0.0536	-0.3718*	-0.3585	-0.1662	-0.1057	-0.3665	-0.3010
	(0.3759)	(0.1944)	(0.2525)	(0.2872)	(0.4156)	(0.2668)	(0.2236)
shany	0.2648	-0.6742***	-0.6872***	-0.8400***	0.0550	-0.7358***	-0.0773
	(0.4915)	(0.1605)	(0.2655)	(0.2652)	(0.2915)	(0.1920)	(0.2703)
hdged	0.4616*	0.0226	0.2257	0.0859	-0.0204	0.0158	0.1765
	(0.2627)	(0.0859)	(0.1454)	(0.1373)	(0.1427)	(0.1024)	(0.1344)
hdage	-0.0498	-0.0090	-0.0036	0.0164	-0.0165	0.0065	-0.0122
	(0.0452)	(0.0140)	(0.0223)	(0.0233)	(0.0242)	(0.0173)	(0.0187)
*hdag*2	0.0005	0.0002	0.0001	-0.0001	0.0002	0.0001	0.0001
	(0.0004)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0002)
hdedu			0.0306	0.0519**	0.0601***	0.0644***	0.0160
			(0.0226)	(0.0216)	(0.0226)	(0.0157)	(0.0213)
bdjye	0.8872***	0.1396	-0.0312	0.3807***	0.2914*	0.2244**	0.1782
	(0.3098)	(0.0870)	(0.1482)	(0.1409)	(0.1512)	(0.1060)	(0.1352)
wedjy	0.4740*	0.1275	0.0957	0.1331	0.1886		
	(0.2648)	(0.0865)	(0.1456)	(0.1330)	(0.1558)		
cunzl	0.9129***	0.4455***	0.5691***	0.4403***	0.5074***	0.5416***	0.4154***
	(0.2126)	(0.0742)	(0.1284)	(0.1168)	(0.1243)	(0.0894)	(0.1132)
cungb	0.4555***	0.3559***	0.4053***	0.4337***	0.2393**	0.3872***	0.3053***
	(0.1699)	(0.0701)	(0.1235)	(0.1068)	(0.1140)	(0.0815)	(0.1088)
_cons	-7.2203***	-4.2679***	-5.4694***	-5.9546***	-5.1855***	-5.7670***	-4.4046***
	(1.7424)	(0.4512)	(0.7979)	(0.8346)	(0.8226)	(0.6200)	(0.7164)
N	392	3335	1242	1243	1242	2338	1389

The standard error of robustness is in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01

Mechanism analysis

The above analysis examines the impact of environmental regulations on farmers' participation in industrial integration and their group heterogeneity. A deeper question is, through what channels or pathways might environmental regulations influence rural industrial integration? Therefore, it is necessary to further analyze the mechanisms by which environmental regulations affect rural industrial integration. On one hand, environmental regulations may influence farmers' sense of identity and attachment to their hometowns, thereby affecting their participation in industrial integration. environmental regulations will promote the exploration of functions such as ecological conservation and leisure experiences in rural areas. Farmers can shift from selling

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products alone to selling scenery and experiences, transforming the ecological advantages of rural areas into economic benefits, thus increasing their sense of identity with their hometowns and enhancing their enthusiasm for participating in agricultural industrial integration. For this purpose, an interaction term between environmental regulations and farmers' sense of identity (huj_jiaxrt) is introduced to examine the role of family identity in the impact of environmental regulations on rural industrial integration. On the other hand, the "Three-Year Action Plan for Rural Human Settlements" prioritizes the construction and renovation of household sanitary toilets and ensuring villagers' safe and normal water use. environmental regulations may improve farmers' living conditions, including toilet and water usage, thereby enhancing their satisfaction with life and influencing their participation in rural industrial integration. Therefore, an interaction term between environmental regulations and improvements in farmers' living conditions (huj_shtji) is introduced to examine the role of improved living and hygiene conditions in the impact of environmental regulations on rural industrial integration. In addition, environmental regulations promote the improvement of the rural environment, attracting more talent to return home for employment and entrepreneurship, thereby facilitating local employment and entrepreneurship among farmers, which in turn encourages more households to participate in industrial integration. Therefore, the interaction term between environmental regulations and local employment (huj_bdjye) is introduced to examine the role of local employment in the impact of environmental regulations on rural industrial integration. As shown in *Table 4* models (1)–(4), the interaction terms hju_jiaxrt, hju_shtji, and hju_bdjye are all positive and have passed the significance level test. This indicates that hometown identity, improved living hygiene conditions, and local employment all play a significant positive moderating role in the impact of environmental regulations on rural industrial integration, serving as effective pathways to enhance the positive effects of environmental regulations on industrial integration.

Table 4. *Mechanism analysis*

	(1)	(2)	(3)	(4) c4
hujgz	0.1955** (0.0985)	0.4735** (0.1986)	0.3421* (0.1992)	0.2933* (0.1591)
jiaxrt	0.4070* (0.2160)			0.3945* (0.2166)
shtji		0.3456 (0.2233)		0.3275 (0.2224)
bdjye			0.2329* (0.1253)	0.1836* (0.0944)
huj _ jiaxrt	0.5087** (0.2289)			0.4918** (0.2300)
huj _ shtji		0.2297* (0.1114)		0.2075* (0.1008)
huj _ bdjye			0.1306*** (0.0412)	0.1671* (0.0870)
Other control variables	control	control	control	control
_cons	-5.0867*** (0.4696)	-5.4228*** (0.4834)	-5.3321*** (0.4654)	-5.2305*** (0.4948)
N	3727	3727	3727	3727

The standard error of robustness is shown in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01

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Robustness test

To test whether the above results are robust, we further use "the effectiveness of rural environmental improvement" as a core explanatory variable to estimate its impact on farmers' participation in agricultural industry integration, using it as a proxy for environmental regulation. In the questionnaire, respondents were asked, "How do you think the environmental improvement in your village is?" Those who answered "good" or "very good" were set to 1, while those who answered "average" or "poor" were set to 0; this measure reflects the effectiveness of rural environmental improvement. The model was re-estimated, and the results are shown in *Table 5*. A comparison reveals that the main estimation results in *Tables 2* and *4* are similar, indicating that the findings of this paper are robust.

Table 5. *Robustness test*

	(1) Benchmark regression	(2) Mechanism model 1	(3) Mechanism model 2	(4) Mechanism model 3	(5) Ultimate model 4
hujgz	0.2363*	0.1669**	0.3873*	0.3733*	0.3074*
	(0.1295)	(0.0632)	(0.2163)	(0.2085)	(0.1924)
jiaxrt	0.0314	0.4733*			0.4820*
	(0.0784)	(0.2467)			(0.2499)
shtji	0.1604*		0.3666		0.3622
	(0.0895)		(0.2512)		(0.2520)
bdjye	0.2086**			0.3921	0.4395*
	(0.0828)			(0.2600)	(0.2618)
huj _ jiaxrt		0.5639**			0.5730**
		(0.2578)			(0.2611)
huj _ shtji			0.2376*		0.2309*
			(0.1267)		(0.1178)
huj _ bdjye				0.2059*	0.2571*
				(0.1034)	(0.1053)
Other control variables	control	control	control	control	control
_cons	-5.2628***	-5.0272***	-5.3944***	-5.3932***	-5.3130***
	(0.4631)	(0.4735)	(0.4922)	(0.4982)	(0.5376)
N	3727	3727	3727	3727	3727

The standard error of robustness is in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01

Discussion

The research findings demonstrate that environmental regulations significantly positively influence rural industrial integration, with heterogeneous impacts across different types of farming households. This aligns with findings from the study (Bin et al., 2023) on environmental regulations' effects on manufacturing-service industry integration and the research (An et al., 2025) on environmental regulations and industrial upgrading, confirming their positive role in promoting industrial integration and upgrading. However, the study (Yin et al., 2025) highlighted geographical heterogeneity in environmental regulations' impact on agricultural green development. Regional disparities in agricultural resource conservation, environmental protection technology adoption, big data applications in ecological conservation, and regional analysis in policy evaluation reports all indicate significant variations in implementation effectiveness and impact intensity. Given the concentrated research scope in this study, future

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investigations should expand survey coverage and regional comparisons. By analyzing environmental regulations across different regions and their effects on rural industrial integration, we can develop region-specific strategies to enhance implementation efficiency and optimize environmental policies. These insights provide valuable guidance for further research in this field.

Conclusion

This paper utilizes survey data from 3727 households across 8 provinces to construct a binary Logit model for empirical analysis of the impact of environmental regulation on rural industrial integration. It further explores the mechanisms by which hometown identity, improved living conditions, and local employment influence rural industrial integration under the impact of environmental regulation. The main conclusions and insights obtained are as follows:

First, environmental regulations in rural areas have a significant positive impact on the integration of rural industries, significantly increasing the probability of farmers participating in such integration. However, the effects vary among different types of farmers. Environmental regulations can notably enhance the likelihood of higher-educated farmers, middle-and low-income farmers, and those with unstable employment to participate in agricultural industry integration. In contrast, they have less significant effects on lower-educated farmers, high-income farmers, and those with stable employment.

Second, the improvement of hometown identity, living and health conditions and local employment have played a significant positive regulatory role in the influence of environmental regulation on the integration of rural industries. The three further strengthen the promoting effect of environmental regulation on the integration of rural industries, which is a positive way to improve the industrial integration effect of environmental regulation.

This study is conducive to re-examining the role of environmental regulation in rural economic development. For the rural revitalization strategy, which aims at industrial revitalization, the smooth implementation of rural environmental improvement policies has promoted the integration and development of rural industries. Therefore, it is particularly necessary to comprehensively, continuously, and deeply advance rural environmental improvement. At the same time, during the process of rural environmental governance, it is essential to scientifically and fully integrate the characteristics and trends of local rural economic development. Policies for environmental governance should be differentiated based on differences in farmers' education levels, income levels, and employment status. A multi-dimensional and comprehensive interest linkage mechanism should be constructed to ensure that different groups of farmers can benefit from environmental regulation. This will actively guide and promote various types of farmers to participate in agricultural industry integration, achieving income growth.

This study further reveals the intrinsic effectiveness of hometown identity, improved living hygiene conditions, and local employment in environmental regulation on the integration of rural industries. Driven by hometown identity, improved living hygiene conditions, and nearby employment opportunities, environmental regulation will have a positive promoting effect on agricultural industry integration (Zhang and Zhou, 2021; Zheng et al., 2021). Therefore, how to further cultivate and enhance farmers' hometown identity, improve rural living hygiene conditions, attract talent to return for employment

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and entrepreneurship, and promote local employment and entrepreneurship among farmers, will be a crucial aspect in more effectively enhancing the industrial development effects of environmental regulation. To this end, on one hand, it is necessary to explore and inherit the unique festivals, folk customs, social etiquette, and other material and spiritual wealth of villages, awakening villagers' attachment to their homeland and home, and strengthening their sense of hometown identity and attachment. On the other hand, efforts should be increased in the intensity and depth of rural human settlement environment improvement, accelerating the construction of beautiful countryside, promoting the flow of more elements such as talent, capital, and technology to rural areas, encouraging and guiding social forces, villagers, and enterprises to actively participate in rural environmental governance and the integration of rural industries, forming a diversified participation pattern of government, society, enterprises, and the public in rural environmental governance. Using a beautiful ecological environment to foster new rural business forms, striving to transform the "aesthetic value" of villages into the "output value" of villagers, and promoting the coordinated and efficient development of rural environmental governance and rural industries.

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