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Environmental regulations, GHRM and green innovation of manufacturing enterprises: evidence from China

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The contradiction between the economy and the environment is becoming more and more prominent. Green innovation is significant for Chinese manufacturing enterprises considering environmental and economic performance. Based on motivation theory and motivation crowding theory, this study aims to explore the impact of environmental regulations on green innovation of Chinese manufacturing enterprises and the mediating role of green human resource management between environmental regulations and green innovation of enterprises. Using structural equation modeling and SPSS macro, the results of the empirical analysis of 127 manufacturing enterprises in Guangdong Province, China, show that command-controlled regulation, market-incentivized regulation, and voluntary regulation positively impact enterprises' green innovation, and green human resource management positively affects enterprises' green innovation. Green human resource management only mediates the relationship between voluntary environmental regulation and green innovation. The study systematically reveals the driving mechanism of green innovation in Chinese manufacturing enterprises and enriches the relevant research on green innovation in manufacturing enterprises.

KEYWORDS

green human resource management, green innovation, command-controlled regulation, market-incentivized regulation, voluntary regulation

1 Introduction

Chinese President Xi Jinping has repeatedly stressed that the manufacturing industry is the foundation of the real economy, and the real economy is the capital of China's development (Lee et al., 2023). For a long time, the development of China's manufacturing enterprises has mainly been at the cost of excessive consumption of resources and the sacrifice of the environment, resulting in irreversible consumption and destruction of the ecological environment (Elshaer et al., 2021). The 18th National Congress of the Communist Party of China put environmental civilization construction in a prominent position. It adhered to the overall strategy "Five in One" (economic, political, cultural, social, and ecological progress). The 19th National Congress of the Communist Party of China further proposed that the construction of ecological civilization was a major plan for the sustainable development of the Chinese nation and insisted on attaching equal importance to resource conservation and environmental environment protection (Shao

et al., 2022). Green innovation has the economic characteristics of improving production efficiency and enterprise competitiveness. It also has the social aspects of environmental protection, energy conservation, and emission reduction. It is a necessary way and means to solve the dilemma between economic development and environmental protection (Xie and Zhu, 2021).

In the process of enterprise growth, when an enterprise perceives its development to be threatened or challenged, it will motivate innovation to address the survival and development of enterprises (Cyert et al., 1963). These threats include the poor financial performance of the enterprise (Felin and Zenger, 2013) and the emergence of new customer demands or regulatory requirements from outside the enterprise (Horbach, 2008). In other words, environmental regulation may be a critical factor affecting enterprises to carry out green innovation. Previous research has shown two opposing views on the impact of environmental regulations (Horbach et al., 2012). One group of scholars believes that appropriate environmental regulations can stimulate enterprises to innovate to gain competitive advantages and form comparative advantages (Geng et al., 2021). The other group of scholars believes that environmental regulations will crowd out enterprises' technological innovation funds and increase the cost of pollution control (Broberg et al., 2013), resulting in an additional cost burden for enterprises to hinder technological innovation (Zhai, 2019). Both viewpoints are reasonable. Therefore, an in-depth understanding of the effect of environmental regulation dramatically affects the formulation of ecological regulation and is significant in understanding the internal mechanism of enterprises' green innovation.

At the same time, enterprises face the risk of failure in the implementation of green innovation (Oduro et al., 2021), insufficient funds for green projects (Wakeford et al., 2017), the negative impact of external knowledge (Liao and Long, 2018), the lack of enterprise risk-taking spirit (Aguilera-Caracuel and Ortiz-de-Mandojana, 2013), and the lack of understanding of green initiatives (Ebrahimi and Mirbargkar, 2017). Suppose enterprises only comply with environmental regulations to obtain environmental and ethical soundness, which may lead to passively carrying out green innovation. In that case, the green innovation activities will only last for a while (Xie and Zhu, 2021). Therefore, besides the external regulation driving, enterprises still need the internal drive to take the initiative in green innovation for their survival and long-term development. Green Human Resource Management (GHRM), a management practice consistent with environmental sustainability, has received considerable attention in recent years in response to global green development initiatives (NahapietGhoshal, 1998). From the theories of different fields of management (Mehrajunnisa et al., 2021), sociology (Yang et al., 2019), economics (Solovida and Latan, 2017) and psychology (SawangKivits, 2014), the current research results reflect some potential positive effects of GHRM at organizational level (such as environmental performance (Elshaer et al., 2021), financial arrangement (Umrani et al., 2020), social performance (Shah and Soomro, 2021; Napathorn, 2022)) and employee level (such as employee happiness (Saeed et al., 2019; Rubel et al., 2020), organizational citizenship behavior (Adebanjo et al., 2016; Chaudhary, 2020), green behavior (Peng et al., 2019; Vázquez-Brust et al., 2022)). Therefore, GHRM is likely an intrinsic driving force behind green innovation in the enterprise.

Therefore, this study takes China's manufacturing enterprises as the research object. First, starting from the external conditions of green innovation, we will research the influence of different environmental regulations on the green creation of enterprises. The second, creating from the internal needs of green innovation of enterprises, the research will be centered on exploring the reasons behind the variability of green innovation among enterprises that utilize GHRM. The potential contributions of this study are as follows. On the one hand, the study constructs the theory model of green innovation in manufacturing enterprises based on the theory of motivation and motivation crowding, systematically reveals the driving mechanism of green innovation in manufacturing enterprises of China, and enriches the related research of green innovation. On the other hand, it provides reform ideas for the government to make environmental regulations and guide manufacturing enterprises of China to carry out green innovation.

2 Theoretical framework and development of hypotheses

2.1 Theoretical basis

Motivation is an essential antecedent of behavior, including extrinsic and intrinsic motives. An extrinsic motive promotes behavior by contributing to financial goals, such as maximizing profits or shareholder wealth value. Intrinsically motivated actions are actions for which there is no reward but the behavior itself (Frey and Oberholzer-Gee, 1997). Frey and Jegen (2001) argue that one type of intrinsic motivation concerns feelings of moral obligations. If one is morally motivated, one acts out of a sense of duty, responsibility, or concern with the social good rather than out of self-interest (Frey and Jegen, 2001). For example, moral motivation, whose corresponding behavior reflects a kind of social responsibility and obligation rather than personal interests, is closely related to moral responsibility, which believes that the enterprise is responsible for avoiding the negative impact on society and the natural environment (Kraus et al., 2020).

In economics, under different identifiable conditions, the possibility of external intervention through monetary incentives or penalties crowding out intrinsic motivation is widely acknowledged at the theoretical level. However, some scholars have disputed this theory (Gubler et al., 2016). Empirical evidence exists for motivational crowding out and crowding in (Rode et al., 2015). The impact of pricing measures such as pollution charges on environmental ethics is problematic in the natural environment. Regarding ecological regulations, it is necessary to consider whether financial incentives crowd out the "psychological contract" of enterprises, and the government must also consider the possible negative impact on entrepreneurship, innovation, and creativity when implementing subsidy policies (Graafland, 2019). The crowding effect of motivation also indicates that the implementation of external conditions will also enhance intrinsic motivation (Frey and Jegen, 2001). Up to now, crowding out and crowding in effect generated by motivational crowding theory have been the main topics discussed by economists (Rode et al., 2015). From the perspective of motivation theory, this

study will also discuss the conditions under which the environmental regulations of external motivation produce a crowding out effect and crowding in effect on the green innovation of enterprises and the impact on the green innovation of enterprises.

2.2 Hypothesis development

2.2.1 Environmental regulations and enterprises' green innovation

Environmental regulations are social rules involving laws and regulations to oversee, manage, and penalize production processes to protect the environment and prevent pollution. To achieve this, the government implements environmental protection laws and regulations (Shi, 2012). In other words, environmental regulations can prevent the worst excesses, and the existence of regulation and enforcement is a vital deterrent. (Li and Wang, 2015). Environmental regulations can be classified as command-controlled, market-incentivized, or voluntary based on the object's initiative. (Zhao et al., 2009).

For command-controlled environmental regulation, the government enables the actor to bear the corresponding civil liability through its legal power (Wang and Shen, 2016). Suppose the cost of ecological damage compensation in enterprises' production process is higher than compliance costs. In that case, compliance is the best choice for enterprises with a maximum profit (Becker, 1968). Therefore, the government affects the environmental behavior of the enterprise through regulatory policies and has a deterrent effect on illegal enterprises. Based on compliance motivation, it encourages enterprises to slow down the pressure on green innovation by improving products or technology.

For market-incentivized environmental regulation, the government has encouraged enterprises to make green innovations and reduce environmental damage based on economic motivation by issuing trading licenses, using environmental taxes, and distributing environmental subsidies (Opatha and Arulrajah, 2014). That may produce a "Porter effect" and promote innovation in enterprises (Preacher and Hayes, 2008). When dealing with environmental challenges, enterprises may purchase carbon emission quotas directly on the market to meet their emission reduction constraints or engage in innovative activities to save energy and reduce emissions (TuShi, 2023). The study by Chai et al. (2022) shows that implementing a carbon emission trading policy can reduce CO₂ emissions in the places where the policy is implemented and promote the greenness of economic growth (Chai et al., 2022). Besides, environmental taxes can reduce the expenditure on research and development innovation (Dong and Zheng, 2022).

For voluntary environmental regulation, enterprises can control pollution or conduct environmental protection activities through voluntary commitments, including signing agreements and disclosing environmental information (Li and Wang, 2015). The study of Nie et al. (2020) shows that voluntary environmental regulation significantly positively affects green technology innovation regardless of time, industry, and regional factors (Nie et al., 2022). The study of Bu et al. (2020) also provides

evidence that the voluntary environmental certification of ISO14000 leads to more innovation input and output in sampled Chinese enterprises (Bu et al., 2020). Thus, we hypothesize:

Hypothesis 1: Environmental regulations positively affect enterprises' green innovation.

Hypothesis 1a: Command-controlled environmental regulation positively affects enterprises' green innovation.

Hypothesis 1b: Market-incentivized environmental regulation positively affects enterprises' green innovation.

Hypothesis 1c: Voluntary environmental regulation positively affects enterprises' green innovation.

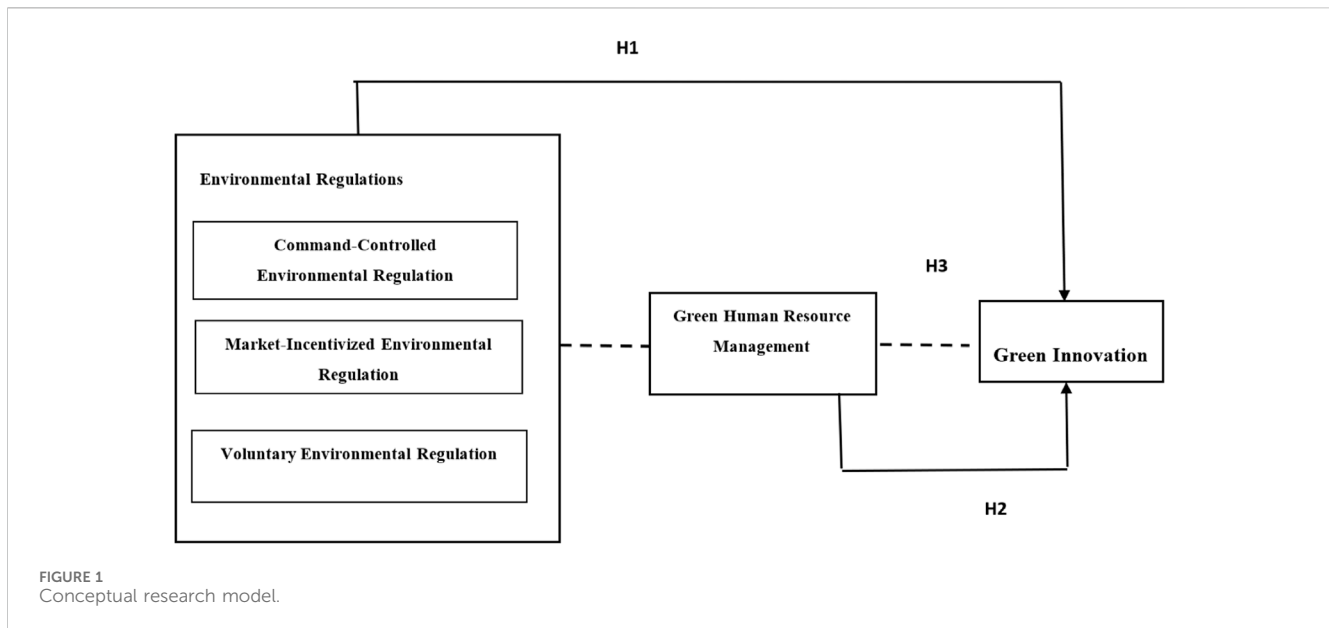
2.2.2 GHRM and enterprises' green innovation

The essential functions of human resource management usually revolve around the three major activities of human resource acquisition, human resource development, and human resource retention (Opatha and Arulrajah, 2014). Some scholars have focused on the relationship between human resource management and environmental performance (Renwick et al., 2013). They emphasized the importance of employees' green activities in the workplace. The combination of human resource management practices and environmental performance is called GHRM. GHRM can help enterprises align their business strategies with the environment and become critical to mitigating environmental problems (Renwick et al., 2013). Enterprises may benefit from a series of practices in GHRM. Firstly, GHRM emphasizes employees' green values in recruitment and selection to meet the requirements of green development (SawangKivits, 2014). Secondly, green training practices aim to improve employees' knowledge, skills, and capabilities, which are vital processes to encourage employees to engage in green activities (Al Kerdawy, 2019). Thirdly, promotion, evaluation, and rewards based on employees' green performance can motivate employees to participate in and contribute to green activities (Malik et al., 2020). These formal green human resource management practices and policies show enterprises' commitment to green development (Al Kerdawy, 2019) and may guide employees to act according to the organization's policies. These practices of GHRM complement and strengthen employees' understanding of the green development of enterprises and provide new opportunities for green innovation (Sobaih et al., 2020). Thus, we hypothesize:

Hypothesis 2: GHRM has a positive impact on enterprises' green innovation.

2.2.3 Mediating role of GHRM

Although the government is not a direct participant in the market economy, the effect of the government is the most direct. For pollution-intensive enterprises, command-controlled environmental regulation is a huge challenge. The incentive for compliance can help alleviate external pressure (Li and Wang, 2015). Enterprises need to find new alternatives and green innovations in



products and processes to meet the government's mandate of reducing emissions. In green innovation, enterprises rely on accumulating and transferring knowledge, which is often embedded in their human resources, prompting them to construct GHRM (Xie et al., 2022). Market-incentivized environmental regulation includes a series of incentives, such as carbon pilots, that allow enterprises to sell emissions permits above the standard to earn additional revenue to compensate for the cost of environmental regulation (Porter Michael and Linde, 1995), which can enable enterprises to generate momentum for green transformation. Voluntary environmental regulation in the context of voluntary supervision, such as the ISO 14001 environmental management system certification, is an essential indicator for enterprises to participate in national environmental patent applications and has a role in predicting innovative activities (Lim and Aseem, 2014). Enterprises need to invest in green human resources to obtain information, knowledge, and technology for green innovation when facing the pressure and opportunities ruled by environmental regulation (ZhouHong and Liu, 2013). Thus, we hypothesize:

Hypothesis 3: GHRM mediates the relationship between environmental regulations and enterprises' green innovation.

Hypothesis 3a: GHRM mediates the relationship between command-controlled environmental regulation and enterprises' green innovation.

Hypothesis 3b: GHRM mediates the relationship between market-incentivized environmental regulation and enterprises' green innovation.

Hypothesis 3c: GHRM mediates the relationship between voluntary environmental regulation and enterprises' green innovation.

Figure 1 displays the proposed conceptual research model.

3 Materials and method

3.1 Procedure and sample

This study aims to explore the impact of environmental regulation on manufacturing enterprises' green innovation and the mediating role of GHRM. Our research objectives are manufacturing enterprises in Guangdong Province because Guangdong Province is a large manufacturing province in China that is vital to China's economic development and manufacturing base globally. Regarding the scale of enterprises, we chose medium and large enterprises with more than 300 employees because these enterprises are more sensitive to environmental impact and have formalized human resource practices. Meanwhile, according to this standard, the sample size should be five to ten times the number of indicators (Hair et al., 2010), so we plan to distribute 200 questionnaires. Through the Guangdong Manufacturing Industry Association, we contacted 200 enterprises that agreed to accept the survey. The assistant general manager filled in the questionnaire with the general manager's approval. We promised that the data would only be for research and would be processed anonymously, and we would inform them of the research results. The electronic questionnaires were sent to the email address published by the assistant general managers. The data were obtained at two different times to reduce common-method bias (Podsakoff et al., 2003). At Time 1, participants provided the first part of questionnaires on control, independent, and mediating variables in December 2022. After filling them out, they returned them to us, and we printed out the resulting questionnaires and coded them with numbers. At Time 2, we contacted the same respondents again 1 month later and sent the second part of the questionnaires containing only the dependent variable. They returned them after filling them out. We also printed out the questionnaires and coded them with numbers. Then, we matched the first and second parts of the questionnaires with the codes. A total of 127 valid questionnaires were received. The average age of

enterprises was 6.7 years. There were 20 state-owned enterprises, accounting for 16%, 24 collective enterprises, accounting for 19%, and 70 private enterprises, accounting for 55%. There were 13 joint-venture enterprises, accounting for 10%.

3.2 Measures

All items in the English scales were translated into Chinese and then back-translated to ensure equivalence of meaning. The ratings were done using a five-point Likert-type scale. (1 = *strong disagree*, 5 = *strongly agree*).

3.2.1 Environmental regulations

We measured command-controlled environmental regulation, market-incentivized environmental regulation, and voluntary environmental regulation using items from the scales of Ma et al. (2011) (Ma et al., 2011). There were three items for command-controlled environmental regulation. The Cronbach alpha coefficient was determined to be 0.835. There were three items for market-incentivized environmental regulation. The Cronbach alpha coefficient was calculated to be 0.905. In addition, there were five items for voluntary environmental regulation. The Cronbach alpha coefficient for the test was 0.917.

3.2.2 GHRM

We measured GHRM using a five-item scale developed by Dumont et al. (Dumont et al., 2017). The Cronbach alpha was 0.943.

3.2.3 Green innovation

We further measured green innovation using Chiou et al.'s (2011) nine-item scale. Two scales are available: a five-item scale for measuring green process innovation and a four-item scale for measuring green productions (Chiou et al., 2011). The Cronbach alpha was 0.949 and 0.926, respectively. In the study, we wanted to obtain the innovation situation of the whole enterprise, so we combined these two dimensions to measure the average during operation. The Cronbach alpha was 0.965.

3.2.4 Control variable

According to prior research, technology innovation depends on whether enterprises have obtained heterogeneous resources and abilities (NahapietGhoshal, 1998). Social capital will affect the capacity and efficiency of resources obtained and utilized. Relationships with external organizations, such as customers and suppliers, can assist enterprises in diversifying risks and costs by developing compliant green products and processes. Therefore, the components of social capital are cognitive, structural, and relational capital, the control variables.

4 Data analysis and results

4.1 Common method deviation test

As Podsakoff et al. (2003) suggested, the questionnaires were obtained at two different times to prevent possible standard method deviations from the data (Podsakoff et al., 2003). At the same time,

the Harman single-factor test was used to test. There were five common factors with eigenvalues >1. The variance interpretation rate of the first factor was 48.73%, which was less than the standard 50% (Hair, 1998). In addition, we performed a latent method factor analysis, described in Podsakoff et al. (2003) (Podsakoff et al., 2003). We allowed all items to load on their theoretical constructs and a latent standard methods variance factor. The model fit remained essentially similar after including a common latent factor (model without common latent factor: $\chi^2/df = 1.753$, model with common latent factor: $\chi^2/df = 1.787$). The result suggested that standard method variance was not an issue in this study.

4.2 Confirmatory factor analyses

We conducted confirmatory factor analyses to assess the fit of our data to a measurement model. Model one was the proposed model of the five variables in the study (command-controlled regulation, market-incentivized regulation, voluntary regulation, GHRM, and green innovation). We compared the hypothesized 5-factor model to a series of nested 3-factor models and a 1-factor model. The fit indices indicated that our hypothesized 5-factor model fit the data best ($\chi^2/df = 1.753$, CFI = 0.941, TLI = 0.933, RMSEA = 0.077). The findings are displayed in Table 1. Thus, this analysis has supported the adequacy of the measures testing our hypothesized relationship. We also conducted tests on the convergent validities (CR and AVE) and the discriminant validities (MSV and ASV). Results in Table 2 show that the AVE of all constructs exceeded the benchmark of 0.50, CR exceeded 0.70, and the MSV and ASV of all constructs are smaller than the corresponding AVE (Hair et al., 2010). Based on the results, it can be inferred that the study has good convergent and discriminant validities.

4.3 Descriptive statistical analysis and correlation analysis

The study's descriptive and correlation analyses are presented in Table 3. Command-controlled environmental regulation was significantly and positively associated with green innovation ($r = 0.617$, $p < 0.01$). Market-incentivized environmental regulation was significantly and positively correlated with green innovation ($r = 0.715$, $p < 0.01$). Similarly, voluntary environmental regulation was significantly and positively correlated with green innovation ($r = 0.836$, $p < 0.01$). GHRM was also significantly and positively correlated with green innovation ($r = 0.851$, $p < 0.01$). These initial results seem to support our hypotheses.

4.4 Hypotheses testing

This study used structural equation modeling to conduct path analysis, and the results are presented in Figure 2 and Table 4. Command-controlled environmental regulation (0.386, $p < 0.001$), market-incentivized environmental regulation (0.142, $p < 0.05$), and voluntary environmental regulation (0.309, $p < 0.05$) all had a positive impact on green innovation. Hypothesis one was

TABLE 1 Comparison of measurement models for main variables in the study.

Model	χ^2	df	χ^2/df	CFI	RMSEA
Baseline model (five factors)	466.259	266.000	1.753	0.941	0.077
Model 1 (three factors: (Command-controlled environmental regulation, Market-incentivized environmental regulation and Voluntary environmental regulation were combined into one factor)	665.822	272.000	2.448	0.881	0.107
Model 2(One factor: Environmental regulation, Green Human Resources Management and Green innovation were combined into one factor)	865.205	275.000	3.146	0.635	0.131

supported, and GHRM (0.522, $p < 0.001$) positively affected green innovation. Hypothesis two was also supported.

To further test the mediating effect of hypothesis 3, we used the SPSS macro developed by Preacher and Hayes (2008) (Preacher and Hayes, 2004) proposed using the Bootstrap method. The effect is considered significant when the 95% confidence interval (CI) for the effect does not include zero. The summary of total, direct, and indirect effects and their confidence intervals are presented in Table 5. The direct effects of command-controlled environmental regulation, market-incentivized environmental regulation, and voluntary environmental regulation on green innovation were 0.219, 0.119, and 0.257, respectively. The 95% confidence intervals were [0.059, 0.379], [0.007, 0.231], [0.119, 0.395], all of which did not include zero, indicating that the direct effect was significant, and hypothesis one was again supported. However, the 95% confidence intervals for the indirect effects of command-controlled and market-inspired environmental regulations on green innovation through GHRM were [-0.021, 0.114] and [-0.034, 0.090], respectively, which included zero. Therefore, hypothesis 3a and 3b were not supported. The total effect of voluntary environmental regulation on green innovation was 0.466, with a 95% confidence interval of [0.337, 0.595], an indirect effect of 0.288, and a 95% confidence interval of [0.118, 0.360], excluding zero. Hypothesis 3c was thus supported.

5 Discussion and conclusion

This study extends the existing body of knowledge by examining the relationship between environmental regulations, GHRM, and green innovation. First, the three forms of environmental regulations have a considerable and positive influence on the green innovation of enterprises. This is generally consistent with previous research results (Wu et al., 2022). In China, environmental regulations are closely related to enterprises' environmental behaviors, and compulsory regulation is still the primary environmental management method.

The second, GHRM has a positive impact on green innovation. That is consistent with the results obtained in the study by Singh et al. (2020) (Singh et al., 2020) in 309 small and medium-sized manufacturing enterprises. GHRM is a brand-new business management concept based on the background of the new economic transition era. Green innovation requires the support of professional researchers and a large number of R&D funds to improve energy efficiency, which depends on GHRM's selection of relevant green technical talents, green training, and performance management, and a series of human resource management

practices, which plays an essential role in enhancing the enterprise's green innovation.

The third, voluntary environmental regulation can affect green innovation in enterprises directly and indirectly through GHRM. The study did not find evidence to support the idea that GHRM plays a mediating role in the relationship between command-controlled environmental regulation and green innovation. This suggests that while mandatory legal norms can motivate enterprises to comply with environmental regulations, they may not be as effective in promoting the intrinsic motivation of enterprises to adopt green management practices internally. The mediating role of GHRM in Market-incentivized environmental regulation on green innovation of enterprises was also not supported, which suggests that the government's green subsidies to enterprises only encourage enterprises to introduce new environmental protection technologies. Still, they need help to motivate them to research and develop green products and processes. Economic incentives will crowd out and will not have an impact on GHRM. When implementing voluntary environmental regulation policies, enterprises actively provide information and show moral responsibility for the environment. Voluntary environmental regulation is consistent with the intrinsic motivation of the enterprise, which has a promoting effect on GHRM, aligning its human resource management actions with the green development of the enterprise, thus promoting the enterprise's green innovation.

5.1 Theoretical contribution

The possible theoretical contributions of this study are as follows: First, it further proves the positive impact of environmental regulations on enterprises' green innovation at the theoretical level. Environmental regulations have enabled many enterprises in industrialized countries to reduce pollution and increase profits simultaneously, attributed to implementing different environmental regulation policies to protect the public's environmental rights and realize sustainable economic development. Although some scholars previously believed that environmental regulations might increase the burden of enterprises and lead to damage to enterprises' growth objectives, this study's results show that command-controlled environmental regulation, market-incentivized environmental regulation, and voluntary environmental regulation all have a positive impact on green innovation in the development of China's manufacturing enterprises.

The second, the empirical research of GHRM on enterprises' green innovation is added to the theory. This result is consistent with

TABLE 2 Factor loading estimates.

Constructs	Loadings	CR	AVE	MSV	ASV
Command-controlled environmental regulation		0.853	0.663	0.381	0.305
Indicator 1	0.757				
Indicator 2	0.961				
Indicator 3	0.701				
Green process innovation		0.905	0.761	0.511	0.432
Indicator 1	0.853				
Indicator 2	0.889				
Indicator 3	0.875				
Market-incentivized environmental regulation		0.921	0.700	0.699	0.534
Indicator 1	0.829				
Indicator 2	0.840				
Indicator 3	0.890				
Indicator 4	0.811				
Indicator 5	0.812				
Green human resource management		0.943	0.770	0.724	0.523
Indicator 1	0.855				
Indicator 2	0.934				
Indicator 3	0.921				
Indicator 4	0.864				
Indicator 5	0.808				
Green innovation		0.965	0.756	0.724	0.579
Green process innovation					
Indicatot 1	0.954				
Indicatot 2	0.877				
Indicatot 3	0.846				
Indicatot 4	0.889				
Indicatot 5	0.863				
Green products					
Indicator 1	0.874				
Indicator 2	0.830				
Indicator 3	0.854				
Indicator 4	0.834				

the results of (Yong et al., 2020). Human resources are the source of an enterprise’s competitive advantage and are a component of an enterprise’s human capital. GHRM plays a vital role in disseminating corporate environmental responsibility and green standards. The selection of employees with green values encourages them to improve their green innovation skills and develop the enterprise’s green innovation ability. The job description and responsibilities of employees are linked with environmental responsibility. The performance and promotion of

employees are based on their green contributions to the organization, which will motivate employees to achieve the enterprise’s green goals by completing green goals. These initiatives are essential to promote the continuity of green innovation. Therefore, GHRM provides the necessary knowledge, skills, methods, and attitudes for enterprises’ green innovation. Enterprises should strive to combine their green development goals with GHRM to support and promote green innovation in green processes and green production.

TABLE 3 Means, standard Deviations, and Correlations of the Variables (N = 127).

	M	SD	1	2	3	4	5	6	7
1.Structural capital	3.795	0.723							
2.Cognitive capital	3.635	0.622	.668**						
3.Relationship capital	3.761	0.728	.692**	.657**					
4.Command-controlled environmental regulation	3.974	0.557	.425**	.441**	.496**				
5.Market-incentivized environmental regulation	3.433	0.966	.506**	.332**	.450**	.536**			
6.Voluntary environmental regulation	3.403	0.995	.564**	.558**	.600**	.521**	.709**		
7.Green Human Resources Management	3.328	0.962	.609**	.543**	.592**	.529**	.652**	.815**	
8.Green innovation	3.504	0.91	.623**	.550**	.646**	.617**	.715**	.836**	.851**

Note: * $p < .05$. ** $p < .01$.

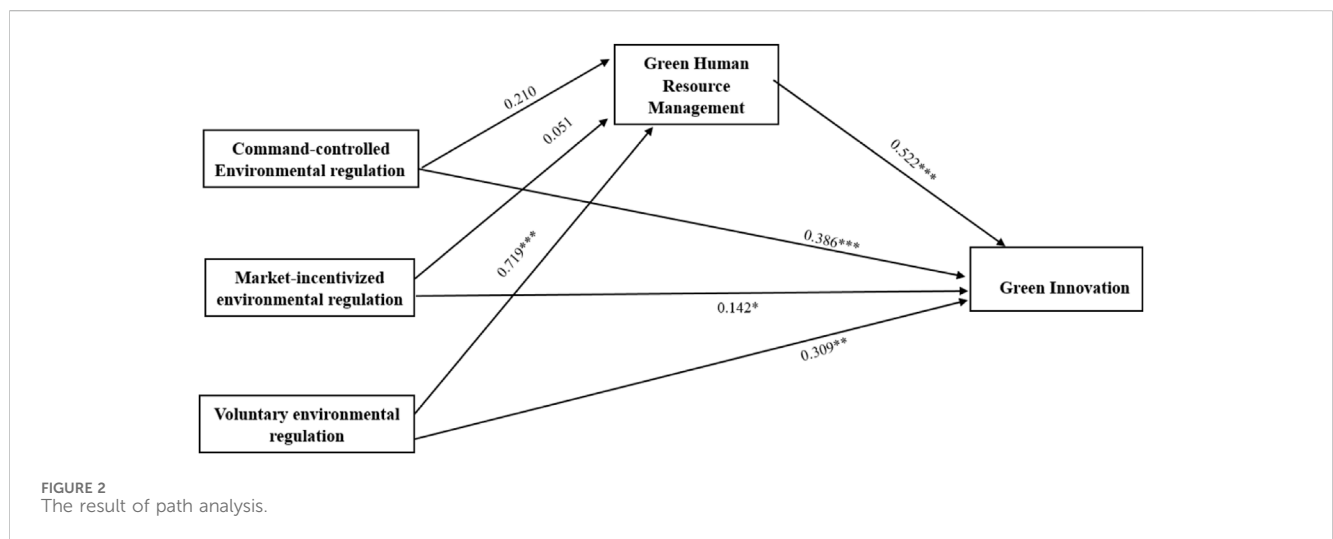


TABLE 4 The results of path coefficients.

	Estimates	S.E.	C.R.	p
Command-controlled environmental regulation → Green innovation	0.386	0.116	3.336	***
Market-incentivized environmental regulation → Green innovation	0.142	0.080	1.769	0.027
Voluntary environmental regulation → Green innovation	0.309	0.119	2.589	0.010
Green Human Resources Management → Green innovation	0.522	0.113	4.615	***

Note: * $p < 0.05$; ** $p < 0.01$; *** <0.001 . S.E., standard error; C.R. = critical ratio, p = Significant.

Finally, the internal mechanism of environmental regulations on the green innovation of enterprises is added. Although environmental regulations can encourage green innovation, their impact could be further maximized with additional support. It may even have a motivational crowding-out effect, dampening some enterprises' innovation enthusiasm. If market-incentive environmental regulation is unfair or not a positive way to provide information when implemented, external economic rewards hurt subsequent intrinsic motivation according to the theory of motivation crowding out, and it will not affect green

innovation through GHRM. That depends on whether the information is provided positively at the time of implementation of environmental regulation. Only when the supporting behaviors of environmental regulations are consistent with the internal mechanism of the enterprise will the moral motivation of the enterprise be encouraged, resulting in the crowding-in effect of motivation. Voluntary environmental regulation will strengthen the intrinsic moral motivation of the enterprise, which promotes the development of enterprises' GHRM and exerts the maximum effect on the green innovation of enterprises.

TABLE 5 Summary of total, direct and indirect effects.

	Effect	SE	95% CI
Command-controlled environmental regulation → Green Human Resources Management → Green innovation			
Total effect	0.271	0.090	(0.093, 0.448)
Direct effect	0.219	0.080	(0.059, 0.379)
Indirect effect	0.032	0.035	(-0.021, 0.114)
Market-incentivized environmental regulation → Green Human Resources Management → Green innovation			
Total effect	0.151	0.062	(0.018, 0.027)
Direct effect	0.119	0.057	(0.007, 0.231)
Indirect effect	0.034	0.031	(-0.034, 0.090)
Voluntary environmental regulation → Green Human Resources Management → Green innovation			
Total effect	0.466	0.066	(0.337, 0.595)
Direct effect	0.257	0.070	(0.119, 0.395)
Indirect effect	0.228	0.063	(0.118, 0.360)

5.2 Practical implications

1) At the government level, on the one hand, the intensity of environmental regulation policies should be improved. For command-controlled environmental regulation, it is necessary to strengthen the enforcement of command-controlled environmental regulation and build perfect environmental laws and regulations. At the same time, relevant laws and regulations can be effectively implemented and play a deterrent role for enterprises, especially for the heavy pollution enterprises in the manufacturing industry. For market-incentivized environment regulation, the government should further improve and strengthen, establish a fair evaluation system, promote enterprises to improve resource utilization efficiency, take into account efficiency and fairness, strengthen the fair service level when the government departments support enterprises to implement green behaviors and avoid crowd-out the intrinsic motivation to damage the real green innovation motivation. In terms of voluntary environmental regulation, the government should recognize and commend the sense of environmental moral responsibility of enterprises to encourage their moral motivation and increase the durability of green innovation.

On the other hand, the government should strengthen the guidance of the green development of enterprises. To promote sustainable green innovation of enterprises, environmental regulations alone cannot play a role to the maximum extent. The premise is that enterprises themselves should have the intrinsic motivation and sense of moral responsibility for green development to form a positive interaction between environmental regulations and enterprises' green innovation. The government can formulate a series of policies or laws to guide enterprises and provide appropriate training to improve and strengthen the awareness of green development of enterprises. If enterprises do not have a genuine desire to engage in green development, relying solely on external motivators may not be sufficient. In such cases, enterprises

may resort to "greenwashing" tactics, which involve using misleading claims and symbolism to give the impression that they are committed to the environment. However, such behavior is seen as a threat to "true" green and green innovation (Williams, 2024). Most countries have regulations to minimize the use of misleading claims, which is not conducive to enterprises' international competition. Sometimes, enterprises engage in greenwashing due to a lack of knowledge about environmental issues and laws rather than malice (Nemes et al., 2022). Therefore, the government should increase enterprises' understanding of environmental regulations and strengthen enterprises' sense of identity and mission for green development.

2) At the enterprise level, on the one hand, the goal is to improve the green development awareness and moral level of enterprise executives. The enterprises' green innovation comes not only from the pressure of external environmental regulations but also from the internal cognition level to filter and absorb external information. Suppose a manufacturing enterprise's top management is highly aware of environmental management. In that case, the enterprise will try to reduce the harmful effects of various manufacturing processes on the environment. Enterprises should cultivate managers' awareness of green development and morality level to create an atmosphere of moral responsibility for green innovation. Because of the responsibility of vigorously advocating and actively promoting, it can provide a continuous commitment to the enterprises' green innovation.

On the other hand, the goal is to improve GHRM construction. Under the existing green development background, environmental regulations put forward higher requirements for manufacturing enterprises, and GHRM is necessary for enterprises to improve their sensitivity to meet environmental changes. Through the internalization of the organization, GHRM can ensure value consistency between enterprises and employees and strengthen enterprises' commitment to green development. A series of structured and continuous GHRM practices indicate the expectations of the enterprise to employees and expect them to

behave in line with the enterprise's green policy. Improving employees' green capabilities enables the enterprise to provide greener processes and products by reducing waste and pollution in manufacturing and enhancing the durability of the enterprise's green innovation.

6 Limitations and directions for future research

This study has made several valuable contributions but still has some limitations. The samples in this study are concentrated in manufacturing enterprises in Guangdong Province, China, which may limit the generalizability of the result. Future studies need to adopt a larger sample size and classify the manufacturing industry by region. This study utilizes cross-sectional data; further research, including longitudinal studies, is necessary to confirm the validity of these findings.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary Material](#), further inquiries can be directed to the corresponding author.

Author contributions

YT: Writing—original draft. LL: Writing—review and editing. SW: Supervision, Writing—review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fenvs.2024.1308224/full#supplementary-material>

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