frontiers | Frontiers in Environmental Science

TYPE Original Research
PUBLISHED 29 August 2022
DOI 10.3389/fenvs.2022.982994

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Environmental Economics and Management, a section of the journal Frontiers in Environmental Science

RECEIVED 30 June 2022
ACCEPTED 02 August 2022
PUBLISHED 29 August 2022

CITATION
Dong H, Wang B, Li J, Li Z, Li F and Wang C (2022), Circular economy implementation and business performance: The mediating role of environmental performance in the Chinese energy production enterprises. *Front. Environ. Sci.* 10:982994. doi: 10.3389/fenvs.2022.982994

Circular economy implementation and business performance: The mediating role of environmental performance in the Chinese energy production enterprises

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This study proposes a model to explain the effect of circular economy implementation on business performance in the Chinese energy production enterprises. Moreover, it analyzes the mediating role of environmental performance in explaining the influence mechanism. Our study used data from the Chinese energy production enterprises, which included 295 firms. We applied the methodological approach, partial least square structural equation modeling (PLS-SEM), to test the hypothetical model. The results show that circular economy implementation have a positive on business performance, and environmental performance plays a part of the intermediary role in the circular economy implementation affecting business performance. Finally, some promising avenues for future research and implications for managers and policymakers are suggested based on these findings.

KEYWORDS

circular economy implementation, enterprise performance, China, PLS-SEM, energy production enterprises

1 Introduction

Companies are increasingly becoming aware of adapting to "Green Transformation and Digital Transformation" challenges through their activities, strategies, and routines (Alhawari et al., 2021). Firms have begun to optimize and improve their resource' efficiency through environmental policy tools to ensure business continuity (Awan and Sroufe, 2020). Thus, circular economy implementation are gaining popularity due to a changing and turbulent environment (Awan and Sroufe, 2022). The cyclic economy refers to the transformation of the traditional linear growth economy relying on resource consumption into the development economy relying on ecological resource circulation in the whole process of resource input, enterprise production, product consumption and waste in the large system of human, natural

resources and science and technology (Awan et al., 2021a; Montag et al., 2021). Circular economy develops economy on the basis of material circulation, regeneration and utilization, which is an economic development model based on resource recovery and recycling (Korhonen et al., 2018). The principle is the reduce (RDC), reuse (RUC), and recycle (RCC) (Kabirifar et al., 2020). The basic characteristics of its production are low consumption, low emission and high efficiency (Howard et al., 2019).

However, our literature review indicates no consensus on the relationship between circular economy implementation and business performance (Homrich et al., 2018; Prieto-Sandoval et al., 2018; Atif et al., 2021). Some studies argue that circular economy implementation positively affect a firm through reduced costs and increased flexibility (Jain et al., 2020). The more a firm is equipped with these resources and the more effectively it can use them, the more likely it is to develop a more complex and advantageous strategy (Tukker, 2015). However, There are also researchers who extract key points from the lessons of failure, such as Luttenberger (2020) studies the phenomenon of municipal waste in Croatia and calls for an accelerated pace of circular economy.

From the existing literature, the existing results have the following shortcomings: first, the lack of systematic attention to the success strategy of business performance in the context of green economy. Although researchers have begun to pay attention to the impact of the implementation of circular economy on business performance, they are limited to a certain type of resources and few studies systematically explore the motivation of enterprise performance. Second, there is a lack of analysis on the mechanism of environmental performance on business performance. Although existing studies have paid attention to the role of dynamic capabilities and resource-based capabilities on enterprise performance, there is less attention to business performance in the context of green economy, and even less quantitative research on Chinese energy production enterprises. Third, the action path of circular economy on enterprise performance is not clear, and the "black box" of its specific process has not been opened yet.

In view of this, this study establishes a theoretical model to explore the implementation mechanism and firm performance of circular economy in enterprises, and verifies the theoretical model using partial least square structural equation (PLS-SEM) method based on data collected from 295 Chinese energy production enterprises.

2 Theoretical analysis and research hypothesis

2.1 Circular economy implementation (CEI)

In this study, circular economy implementation (CEIM) is defined as a series of activities for enterprises to adjust and optimize production process, material use, waste disposal and other aspects in accordance with the 3R principle (reduction (RDC), reuse (RUC) and recycle (RCC)) (Nechifor et al., 2020). Specifically, reduction requires enterprises to reduce resource and energy consumption as much as possible by reducing working hours, improving equipment efficiency and optimizing production processes (Saidani et al., 2019; Wang et al., 2022a; Wang et al., 2022c). Reuse requires enterprises to reuse packaging materials, raw materials and production auxiliary spare parts as much as possible (Geng et al., 2012). Resource recycling requires enterprises to collect and sort out the waste as far as possible in the process of production and operation, and use it in the new production process through necessary means of treatment (Bilal et al., 2020). These three principles cover the environmental protection activities in the whole process of enterprise production from raw material acquisition, manufacturing and processing, distribution and distribution to collection and recovery, and can completely reflect the main content of enterprise circular economy implementation (Panchal et al., 2021).

2.2 Environmental performance (EP)

Referring to the research of Wood (1991) and Ilinitch et al. (1998), this study divides environmental performance into four dimensions, including internal environmental management (IEM), external stake-holders relationship (ESR), laws and regulations compliance (LRC) and natural environment impact (NEI) (Kristensen and Mosgaard, 2020). Specifically, internal environmental protection management reflects the specific situation of the enterprise carrying out environmental protection related work inside. The relationship with external stakeholders reflects the extent to which an enterprise meets external requirements in environmental protection (Wang et al., 2022b). Compliance with laws and regulations reflects the extent to which an enterprise complies with policies, laws, industry norms and enterprise systems related to environmental protection (Wang et al., 2022d). The impact on the natural environment reflects the degree of negative impact on the natural environment in the production and operation of enterprises. Combined with the contents of each dimension, environmental performance is defined as the degree to which an enterprise successfully manages its internal environmental activities, maintains a good relationship with external stakeholders, complies with environmental laws and regulations and reduces the negative environmental impact of production and operation.

2.3 Business performance (BP)

Business performance (BP) is a complex and multi-dimensional concept. It usually contains two main aspects:

market performance and financial performance (Venkatraman and Ramanujam, 1986). Specifically, market performance reflects the extent to which an enterprise increases sales, expands market share and improves market position (Kristal et al., 2010). Financial performance reflects the extent to which an enterprise effectively uses its assets and investments to create benefits. In order to ensure the comparability of research results, this study uses return on assets (ROA), return on investment (ROI) and return on sales (ROS) to measure the financial performance of enterprises. This study uses the subjective evaluation of enterprise performance by enterprise managers as the measurement standard of enterprise performance. This subjective evaluation method has been widely used in academic research and proved to be effective.

2.4 Research hypothesis

According to the theory of natural resources, the implementation of circular economy can directly promote the improvement of environmental performance (Hart, 1995). Specifically, enterprises' reduction practices can help reduce the negative impact of their production operations on the natural environment. At the same time, through recycling and resource-related activities, enterprises can use resources more efficiently and reduce environmental pressure. All these activities can simultaneously help enterprises improve the actual effect of their environmental protection activities, establish a good relationship with environmental protection stakeholders, improve compliance with laws and regulations, and ultimately improve the overall environmental performance of enterprises (Yong, 2007). Therefore, it is hypothesized:

Hypothesis **(H1).** RDC has a positive effect on EP.

Hypothesis **(H2).** RUC has a positive effect on EP.

Hypothesis **(H3).** RCC has a positive effect on EP.

The theory of natural resource basis points out that enterprises' circular economy implementation can also promote their success in market competition (Jowsey, 2007). For example, the reduction operation of enterprises can help reduce the cost of purchasing raw materials, production and operation costs and waste treatment costs (Jasch, 2003). The reuse and resource recycling practices of enterprises can help them make full use of the economic value of resources, so as to improve the financial performance of enterprises (He et al., 2020). At the same time, these measures can also form a synergy to help enterprises better meet the market and the public's increasingly strong demand for environmental protection, so as to expand market share and improve market position. Therefore, it is hypothesized:

Hypothesis **(H4).** RDC has a positive effect on BP.

Hypothesis **(H5).** RUC has a positive effect on BP.

Hypothesis **(H6).** RCC has a positive effect on BP.

According to the theory of ecological modernization, the efforts of enterprises in environmental protection should not be regarded as a burden (Park et al., 2010), but as an important measure to help enterprises succeed. For example, efficient internal environmental protection management mechanism can help enterprises improve the performance of environmental protection activities and save costs (Zhu et al., 2012); A good relationship with external stakeholders can help enterprises better shoulder social responsibilities and get more investment and support (Jänicke, 2008); Strict compliance with laws and regulations related to environmental protection can help enterprises avoid penalties and reduce related costs; Effectively reducing the negative impact on the natural environment can help enterprises save the cost and expense of waste disposal. At the same time, the above factors can also jointly help enterprises to establish a good public image, attract consumers with environmental preferences, expand market share, and finally consolidate the dominant position in the market competition. Therefore, it is hypothesized:

Hypothesis **(H7).** EP has a positive effect on BP.

2.5 The mediating role of environmental performance

The improvement of environmental performance will cause the enterprise to bear additional costs, which may lead to the decline of operating performance in the current year. However, in the long run, the improvement of environmental performance can reduce the production and operation costs of enterprises, such as the reduction of carbon emissions and the recycling of materials. It can also meet the needs of consumers' green concept, improve the corporate image, and reduce the long-term risks related to environmental pollution liability, rising energy prices, and the increase in waste and waste use. Therefore, improving environmental performance can help enterprises reduce operating costs, resist market risks and improve operating performance in the long run. Therefore, it is hypothesized:

Hypothesis **(H8).** EP strengthens the CEI's positive effect on BP.

H8a. : EP strengthens the RDC's positive effect on BP.

H8b. : EP strengthens the RUC's positive effect on BP.

H8c. : EP strengthens the RCC's positive effect on BP.

2.6 Framework construction

In order to research the relationship of the above three main concepts, this study based on the natural resource base theory (NRBV) and ecological modernization theory (EMT) has established the theoretical model (Figure 1), tested the CEI for EP and the influence of BP, and examined the relationship

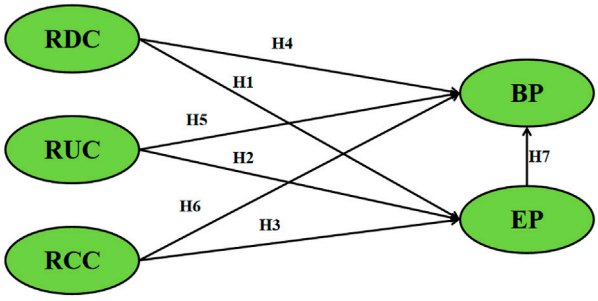

FIGURE 1
Research model.

between the two types of performance. To be specific, the natural resource Based theory integrates environmental protection considerations into the traditional Resources Base View (RBV), which requires enterprises to consider the constraints of the natural environment when allocating Resources, which can help enterprises fundamentally and effectively cope with environmental challenges and ultimately obtain sustainable competitive advantages (Dong et al., 2022a). The theory of ecological modernization overturns the traditional idea that environmental protection activities and business efficiency are zero-sum choices, and holds that environmental protection performance and business performance complement and promote each other (Dong et al., 2022b).

3 Methodology

3.1 Sample

In order to avoid the systematic differences in environmental protection in different industries affecting the scientific nature and extensibility of the research, all the data in this study were collected from Chinese energy production and consumption enterprises. With the assistance of a professional management consulting institution, 400 manufacturing enterprises were randomly selected from its database to send survey invitations, and 350 enterprises with clear intention to participate in the survey were given questionnaires. Through multi-wave large-scale questionnaire survey, 295 questionnaires were collected for 21 research variables (see Table 1) and three characteristic variables in the measurement tool, with a response rate of 84.3%. The surveyed enterprises cover 14 business categories, with different sizes and forms of ownership, which is highly representative. In order to test the non-response bias of the data, this study arranged all valid data according to the sequence of collection time and divided them into three groups equally. Then, chi-square test ($p < 0.001$) was used to compare the group of the first reply and the group of the last reply and found that there was no non-response bias.

TABLE 1 Distribution of sample characteristics (295).

Characteristics	Samples	Percent (%)
Industry Characteristics		
Energy production	195	66.1
Energy consumption	100	33.9
Business Nature		
Wholly State-Owned Enterprises	72	24.4
Sino-foreign joint ventures	32	10.9
Private enterprises	191	64.7
Enterprise size characteristics		
<50	115	39.0
50–99	61	20.7
100–499	58	19.7
500–999	50	16.9
>1000	11	3.7

3.2Survey design

A questionnaire was designed, including 1) demographic characteristics; 2) evaluation of BP predictors; and 3) evaluation of EP implications. Each construct was measured using a validated research instrument developed by previous studies (modified to fit the research context) and based on the literature review findings and the theoretical foundation. A seven-point Likert scale was used to overcome measurement errors. The Likert scale ranges from "strongly disagree" (i.e., 1) to "strongly agree" (i.e., 7). Table 2 describes the used survey items.

3.3 Data analysis technique

Potential biases were considered in the survey, protocol design, and data analysis. Several approaches (e.g. direct contact by phone and assurance to share the results) were adopted to ensure the highest response rate and avoid a non-response bias (Frohlich and Westbrook, 2002). To test the research model and answer our research questions, PLS-SEM were used for the analyzes. This technique has been adopted because this process gives better results in the analysis of this type of exploratory study. This process can also analyze those data that are not normally distributed (Hair et al., 2012). This technique does not impose any sample restriction to conduct the survey.

4 Analysis Result

4.1 Measurement models: constructs validity and reliability

The reflective constructs were validated by testing internal consistency, composite reliability, convergent, and discriminant

TABLE 2 Items used to measure each survey construct, loadings, and VIF.

Construct	Items	Loadings	VIF
Business performance (BP), adapted from Vickery et al. (2003) and Nahm et al. (2004)	BP1: Our company's sales revenue	0.814	2.024
	BP2: Our company's market share	0.858	2.362
	BP3: Customer satisfaction in our company	0.850	2.071
	BP4: Our company's rate of return on investment	0.798	1.633
Environmental performance (EP), adapted from Jasch (2000)	EP1: Our company with environmental laws and regulations	0.757	1.665
	EP2: Our company's relationship with other stakeholders in environmental protection	0.719	1.599
	EP3: The efficiency of our company's environmental department	0.789	1.696
	EP4: The emission level of air pollutants in our company	0.715	1.568
	EP5: The discharge level of solid pollutants in our company	0.757	1.591
Recycle (RCC), adapted from de Souza Junior et al. (2020)	RCC1: Our company recycles waste products from consumers	0.800	1.756
	RCC2: Our company collects waste during production	0.835	1.979
	RCC3: Our company reprocesses the waste products recovered	0.813	1.763
	RCC4: Our company uses waste products after reprocessing in production	0.805	1.654
Reduce (RDC), adapted from Djoutsa Wamba et al. (2020)	RDC1: Our company is committed to reducing the production time per unit of product	0.842	2.308
	RDC2: Our company is committed to reducing employees' working hours	0.874	2.951
	RDC3: Our company is committed to reducing energy consumption	0.873	2.528
	RDC4: Our company is committed to reducing the consumption of raw materials	0.765	1.474
Reuse (RUC), adapted from Pini et al. (2019)	RUC1: Our company reuses packaging materials	0.887	3.417
	RUC2: Our company reuses equipment and consumables	0.895	3.557
	RUC3: Our company reuses raw materials to produce similar products	0.915	3.813
	RUC4: Our company reuses production scraps	0.877	3.006

TABLE 3 Construct consistency, reliability, convergent and discriminant validity squared value of the AVE reported on the main diagonal of the correlation matrix.

Constructs	Composite Reliability	Cronbach's Alpha	Average variance extracted	BP	EP	RCC	RDC	RUC
BP	0.899	0.850	0.690	**0.830**	0.678	0.640	0.647	0.730
EP	0.864	0.802	0.559	0.561**	**0.748**	0.604	0.561	0.605
RCC	0.877	0.830	0.662	0.538**	0.496**	**0.813**	0.506	0.502
RDC	0.905	0.860	0.705	0.563**	0.469**	0.431**	**0.840**	0.658
RUC	0.941	0.916	0.798	0.651**	0.518**	0.437**	0.585**	**0.893**

BP, Business performance; EP, Environmental performance; RCC, Recycle; RDC, Reduce; RUC, Reuse; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$, Bold diagonal entries are square root of AVEs, Heterotrait-Montrait ratios (HTMT)(Underlined) are below 0.85.

validity (Table 3 and Figure 2). To verify the internal consistency and composite reliability of the constructs, we verified that the value of Cronbach s alpha and composite reliability indices exceeded 0.7 (Hair et al., 2011). This condition was valid for all the constructs. To test convergent validity, we verified that the average variance extracted (AVE) index was greater than 0.5. The lowest observed value (0.559) was substantially higher than this threshold. The discriminant validity of the reflective constructs was tested in three ways (Fornell and Larcker, 1981). The variance inflation factor (VIF) was used to examine the collinearity of the measurement model. As presented in Table 2, all VIF values are lower than the threshold of 5 (Hair et al., 2019), showing that collinearity among indicators is not an issue. This study assesses discriminant validity using the Heterotrait-Monotrait (HTMT) ratio of correlations. As shown in Table 3, all HTMT values are below 0.85. Referring to Henseler et al. (2015), the results support the discriminant validity of the constructs. In sum, the robustness of measurement

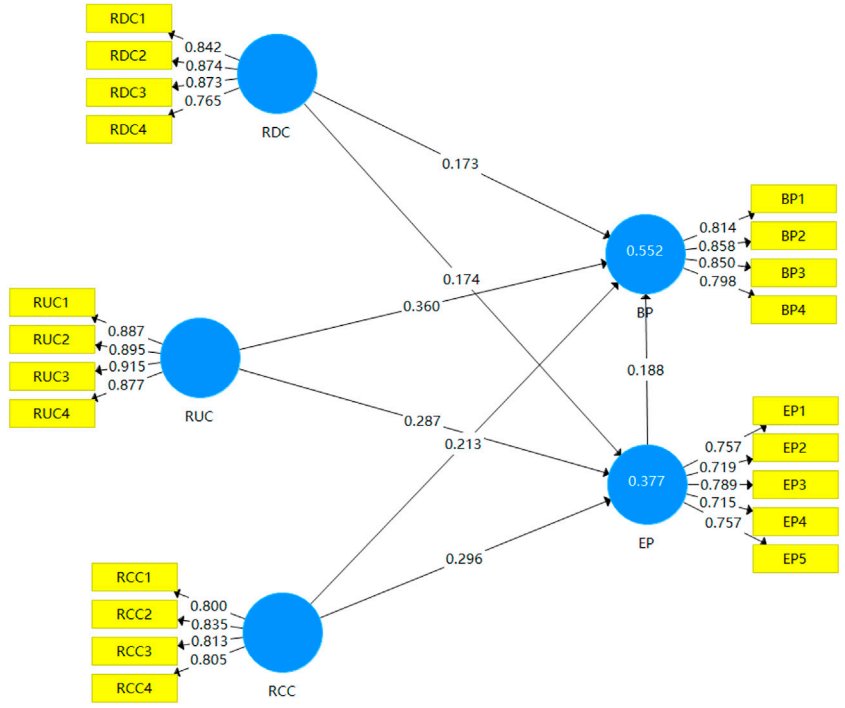

FIGURE 2
Measurement model assessment.

TABLE 4 Results of hypothesis testing.

Hypothesis	Effect Main effects in the research model	Path	Path coefficient	95% confidence interval	t-statistics	*p*-value	Decision
H1	Direct	RDC -> EP	0.174	[0.053; 0.292]	2.821	0.005**	Accept
H2	Direct	RUC -> EP	0.287	[0.150; 0.423]	4.237	0.000***	Accept
H3	Direct	RCC -> EP	0.296	[0.162; 0.440]	4.078	0.000***	Accept
H4	Direct	RDC -> BP	0.173	[0.054; 0.297]	2.724	0.006**	Accept
H5	Direct	RUC -> BP	0.360	[0.213; 0.512]	4.664	0.000***	Accept
H6	Direct	RCC -> BP	0.213	[0.086; 0.353]	3.083	0.002**	Accept
H7	Direct	EP -> BP	0.188	[0.075; 0.300]	3.310	0.001**	Accept
	Post-hoc tests for the mediation of EP						
H8a	Indirect	RDC -> EP -> BP	0.033	[0.007; 0.067]	2.038	0.042*	Accept
H8c	Indirect	RCC -> EP -> BP	0.055	[0.018; 0.105]	2.479	0.013*	Accept
H8b	Indirect	RUC -> EP -> BP	0.054	[0.017; 0.104]	2.449	0.014*	Accept

SRMR composite model = 0.062

R^2_{BP} = 0.552; Q^2_{BP} = 0.367

R^2_{EP} = 0.377; Q^2_{EP} = 0.206

5000 bootstrap samples

*** = $p < 0.001$; ** = $p < 0.01$; * = $p < 0.05$; NS = $p > 0.05$.

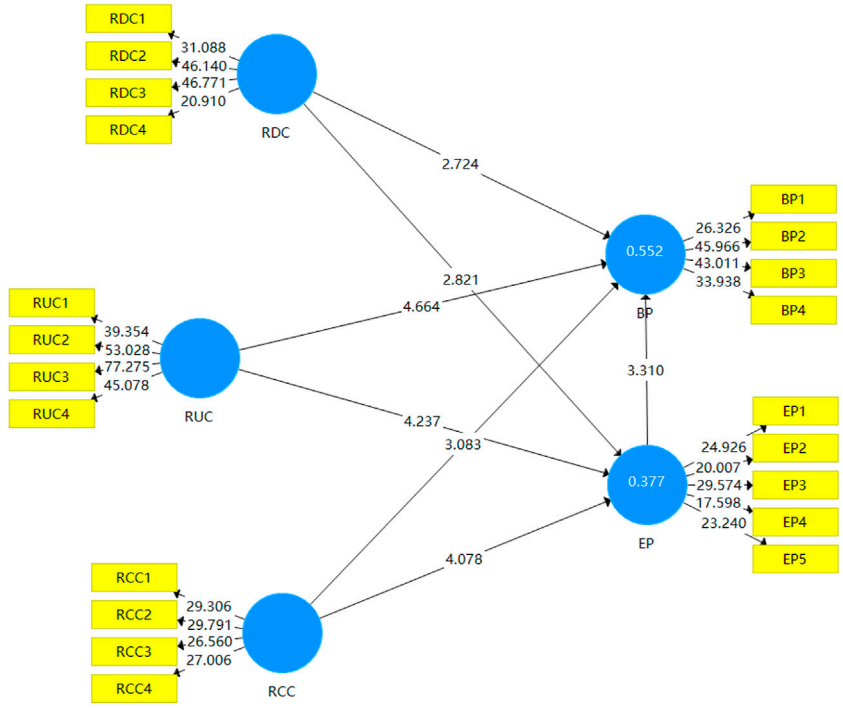

FIGURE 3
Structural model assessment.

model was sound and appropriate for further structural equation modelling analyses.

4.2 Structural model: hypotheses testing

Table 4 shows the results of the structural model from the PLS analysis, including standardized path coefficients with two-tailed t-tests for the hypotheses and the posthoc tests for testing the mediation effect of EP.

The results partially confirm the hypotheses proposed by the research model (Figure 3). The path analysis confirms that RDC (*H1: β = 0.174, p < 0.01*), RUC (*H2: β = 0.287, p < 0.001*), and RCC (*H3: β = 0.296, p < 0.001*) all positively impact EP. RDC (*H4: β = 0.173, p < 0.01*), RUC (*H5: β = 0.360, p < 0.001*), RCC (*H6: β = 0.213, p < 0.01*), and (*H7: β = 0.188, p < 0.01*) all positively impact BP. All the post-hoc test for the indirect effect is statistically significant for the path are significant. The study assessed the model's predictive power on the endogenous constructs using the coefficient of determination (R^2). The results showed that the R-square value for construct EP was 0.377 (R^2 adjusted = 0.371), BP was 0.552 (R^2 adjusted = 0.546). The R-square values for all two dependent variables were greater than 0.25 or 25% (Cohen, 1988), EP (37.7%) and BP (54.6%) were substantially explained by its predictors. Furthermore, the predictive relevance (Q^2) of the endogenous latent variables were assured, as the EP and BP were 0.206 (SSO = 1475, SSE = 1171.316) and 0.367 (SSO = 1180, SSE = 746.479) respectively, which were all larger than zero (Hair et al., 2019). These values can be considered as the predictive accuracy of the models between moderate and strong (Hair et al., 2019). The analysis of the composite-based standardized root mean square residual (SRMR) yielded a value of 0.062, below the 0.10 threshold, which confirms the robustness of the model (Henseler et al., 2015).

5 Conclusion

In this study, the empirical analysis method of structural equation modeling is introduced pioneering, and the circular economy practice of Chinese enterprises is systematically studied, which builds a theoretical basis and provides a research tool for the future research in related fields. Based on the empirical analysis results, this study finds that: 1) the implementation mechanism of circular economy is consistent with the 3R principle of circular economy, which mainly includes three main parts: reduction, reuse and resource recovery; 2) The implementation of circular economy of enterprises is effective, and has positive, direct and significant impact on their environmental performance and business performance; 3) An enterprise's environmental

performance also has a positive, direct and significant impact on its business performance.

6 Discussion and implications

6.1 Discussion of the analysis results

Drawing on natural resource base theory and ecological modernization theory, this study proposes a research model in which EP mediates the impact of CEI on BP and also examines the relationship between the two performances. Therefore, we propose research hypotheses including seven direct effects, namely RDC on BP, RUC on EP, RCC on EP, RDC on BP, RUC on BP, RCC on BP, and EP on BP. Likewise, we assume that RUC, RDC and RCC have three indirect effects on BP through EP.

At the same time, all the assumptions in the theoretical model are fully supported by the statistical analysis results: it is assumed that the path coefficients of H1-H3 are 0.174, 0.287, and 0.296. The *p*-value is significant. This shows that the implementation of circular economy is an important factor to promote the improvement of enterprise environmental performance. This finding responds to the doubts about the actual effects of circular economy and proves that circular economy (Diemer et al., 2022), as a national environmental protection strategy, is not only effective at the regional and other macro levels, but also can play a practical role at the micro level of enterprise management (Horn and Proksch, 2022).

It is assumed that the path coefficients of H4-H6 are 0.173, 0.360 and 0.213 respectively, with significant *p*-value, indicating that the implementation of circular economy is an important factor to promote the improvement of business performance of enterprises. This finding proves that the implementation of circular economy will not cause too much economic burden for enterprises. Through scientific planning, careful organization and efficient implementation, circular economy can help enterprises build good public relations, cultivate competitive advantages, expand market share, expand financing channels, and ultimately achieve business success (Alhawari et al., 2021; Awan et al., 2021b; Awan and Sroufe, 2022).

The path coefficient of hypothesis seven is 0.188 ($p < 0.01$, t = 3.310), which indicates that the environmental protection activities of enterprises are no longer negative behaviors that have to be carried out in order to meet laws and regulations, but positive elements that can promote the business performance of enterprises. This finding overturns the traditional notion that enterprises must make a zero-sum choice between environmental performance and business performance. Based on quantitative statistical analysis, it proves that efficient environmental activities can effectively help enterprises to become good corporate citizens, fully fulfill their social responsibilities and establish a competitive advantage in the market with equal emphasis on ecology and business.

6.2 Implications

The results of this study have important reference and guiding significance for the circular economy practice of Energy production and consumption enterprises in China. First of all, this study explains in detail the levels and specific contents of the operation mechanism of circular economy, which can not only deepen the understanding of circular economy for enterprise managers, but also provide specific suggestions for the actual operation and management of enterprises. Secondly, this study eliminates the doubts of enterprises about whether circular economy is effective and points out that the implementation of circular economy is not only an important means to improve the environmental performance of enterprises, but also a promotion factor to help enterprises achieve business success. Thirdly, this study points out that enterprise environmental protection activities are not a burden of business activities, and enterprise managers do not have to make zero-sum decisions between environmental protection and profit, and environmental protection and business success can be achieved at the same time. However, it should be noted that the implementation of environmental protection activities often requires a large amount of human, material and financial resources, and requires continuous investment and efforts to highlight the effectiveness, especially in the initial stage, may have a great impact on the profitability of enterprises, which puts forward higher requirements for enterprise management. In the actual business decisions, on the one hand, enterprise managers should have firm confidence, correctly understand the implementation mechanism and cost input of environmental protection activities, can support environmental protection activities from top to bottom, and create an enterprise atmosphere in which all staff pay attention to environmental protection and understand environmental protection; On the other hand, a variety of measures should be taken at the same time, through the establishment of rules and regulations, optimize the operation process, improve the quality of employees, comprehensively improve the management level of environmental protection activities, reasonably reduce the implementation cost, to ensure that environmental protection measures can be organically combined with enterprises' production and operation practices, and promote each other.

6.3 Limitations and future research

Although the theoretical model and hypothesis have been verified, there are still some deficiencies in this study. First of all, this study only collected one set of data in each interviewed enterprise. Due to the lack of verification and comparison, this data collection method may not be objective and complete enough to reflect complex organizational behaviors. Secondly, the data collected in this study only reflect the specific situation of enterprises at the time of interview, which can only provide "close-up" information and cannot reflect the consistent changes

of enterprises in a period of time. In order to make up for the above deficiencies, follow-up research can select multiple interviewees with different management levels and business backgrounds from the surveyed enterprises for data collection, so as to improve the representativeness and objectivity of data. In addition, long-term follow-up research can be conducted on the surveyed enterprises to grasp the ins and outs of enterprise behavior, so as to strengthen the accuracy and persuasiveness of research results. At the same time, in order to expand the field of vision and deepen the understanding, further research from the following aspects to analyze the implementation of enterprise circular economy: first, the research scope to expand, with different pollution level and industry, this paper compares and analyzes the characteristics of the industry to understand the implementation of circular economy in different industries, and targeted implementation suggestion is given. Secondly, we disassemble and explore the lower-level relationships among the concepts in the theoretical model of this study, so as to have a deeper understanding of the implementation mechanism and influence of circular economy.

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 authors.

Ethics statement

Ethics review and approval/written informed consent was not required as per local legislation and institutional requirements.

Author contributions

Methodology and software, HD and ZWL; formal analysis, HD and FJL; resources and data curation, HD and BW; investigation, JZL; writing-original draft preparation, HD and CJW; writing-review and editing, HD; supervision and project administration, HD; All authors have read and agreed to the published version of the manuscript.

Funding

This research was funded by the Internal scientific research project of Shaanxi Land Engineering Construction Group in 2019: Development and application of land engineering digital scientific research management information system (DJNY2021-16).

Conflict of interest

HD, BW, JZL, ZWL, FJL, and CJW are employed by Shaanxi Provincial Land Engineering Construction GroupCo., Ltd.

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