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ORIGINAL RESEARCH

The Influence of Decision-Making Logic on Employees' Innovative Behaviour: The Mediating Role of Positive Error Orientation and the Moderating Role of Environmental Dynamics

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Purpose: The derivation of employees' innovative behaviour is a complex multi-stage process influenced by decision logic. However, previous research on the relationship between the two has not been comprehensive without considering the individual level of employees, and the mechanism of action between the two is still unclear. Based on the behavioral decision theory, the broaden-and-build theory of positive emotions and triadic reciprocal determinism. This study investigates the mediating effects of positive error orientation between decision-making logic and employees' innovative behavior, and the moderating effects of environmental dynamics between decision-making logic and employees' innovative behavior, focusing on the individual level.

Methods: The questionnaire data was obtained from 403 employees randomly selected from 100 companies in Nanchang, China, in various industries such as manufacturing, transportation, storage and postal services, trade, and wholesale and retail trade. Hypotheses were tested using structural equation modeling.

Results: Effectual logic had a significantly positive impact on employees' innovative behavior. The direct effect of causal logic on employees' innovative behavior was not significant, but the total effect was significantly positive. Positive error orientation played a mediating role between both types of decision-making logic and employees' innovative behavior. Moreover, environmental dynamics played a negative moderating role between effectual logic and employees' innovative behavior.

Originality/Value: This study expands the application of behavioral decision theory, the broaden-and-build theory of positive emotions and triadic reciprocal determinism in employees' innovative behaviour, enriches the research on the mediating and moderating mechanism between employees' decision-making logic and innovative behaviour, and provides a new research perspective and empirical support for subsequent related research.

Practical Implications: The results of this study provide practical suggestions for promoting employees' innovative behaviour. For example, employees need to cultivate logical thinking, train their decision-making ability, form a positive error orientation, and objectively assess the external environment.

Keywords: causal logic, effectual logic, error orientation, innovative behavior, environmental dynamics

Introduction

Employee innovation is the source of enterprise innovation. In today's fast-paced society, companies are increasingly prioritizing innovation to enhance their competitive edge, compelling employees to cultivate cutting-edge perspectives and capabilities. Innovation is not only the key for employees to establish themselves in the enterprise, but also an inexhaustible driving force for their career development.

Employees' innovative behavior (identify problems and propose ideas, gather resources and develop implementation plans, as well as transform ideas into products) is often closely related to the decision-making logic they adopt. Decision-

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making logic refers to an individual's tendencies when making decisions. Decision-making logic include both causal logic (based on predictability and clear goals) and effectual logic (action logic, emphasizing the discovery or creation of opportunities through action). It's crucial to note that different decision-making logics can lead to varying impacts on employees' innovative behavior.[1] In the context of unpredictable reality, employees are often faced with many unknowns and mistakes, so the choice of decision-making logic is especially important.[2]

Most prior research of decision-making logic and employees' innovative behavior has focused on the enterprise level, whereas relatively few studies have adopted the individual level of employees.[3,4] How does the decision-making logic of employees affect their innovative behavior? Is there any other factor affecting the relationship between the two? Which decision-making logic is more conducive to employees' innovative behavior in a dynamic and unpredictable environment? These still needs further research. Based on existing literature, positive error orientation (the positive tendency of individuals to deviate from standards or goals in their actions) may be an important factor affecting the relationship between decision-making logic and employees' innovative behaviour. In employee innovation activities, they often face various risks and errors. According to behavioral decision theory, human cognition is limited. Information asymmetry and individual bounded rationality make it difficult for employees to rely on their own knowledge and ability to prevent errors.[5] The broaden-and-build theory of positive emotions suggests that positive emotions make people's thinking more flexible. If individuals take a positive approach to errors, they will analyze and summarize errors after they occur, leading to the formation of a positive error orientation. This is beneficial for promoting innovative behavior among employees.[6–8] The formation of employee positive error orientation depends to some extent on decision-making logic, but whether positive error orientation mediates the relationship between decision-making logic and employees' innovative behavior remains to be confirmed. In addition, according to triadic interactive determinism, the environment can have an impact on people's thinking and behaviour. Environmental dynamics (unpredictable changes in market demand and technological development over time) not only bring potential risks, but may also affect employees' decision-making logic and innovative behavior. There is still a lot of controversy over whether the goal oriented causal logic and the flexibility based effectual logic are still effective in dynamic environments.[9]

Unlike previous studies, this study is based on behavioral decision theory, broaden-and-build theory of positive emotions and triadic reciprocal determinism, introduced two key variables, namely positive error orientation and environmental dynamics, to deeply analyze the mechanism of decision-making logic on employees' innovative behavior. This study investigated 403 employees of enterprises in Nanchang City, and used structural equation modeling to analyze the relationship between decision-making logic, positive error orientation, environmental dynamics, and employee innovation behavior. At the same time, the bootstrap method is used to test the mediating effect of positive error orientation between decision-making logic and employee innovation behavior, and the moderating effect of environmental dynamics between decision-making logic and employees' innovative behavior. Its findings should offer insights on how employees can promote innovative behavior. This study makes the following contributions. First, from the individual level of employees, studying the impact mechanism of employee decision-making logic on employees' innovative behavior compensates for the shortcomings of previous studies that only considered decision-making logic and employees' innovative behavior at the organizational level. Secondly, based on relevant theories, it introduces positive error orientation as a mediating variable and environmental dynamics as a moderating variable, helping to enrich the research on the mediating and moderating mechanisms between decision-making logic and employees' innovative behavior.

The following parts are organized as follows. In the second part, a literature review of decision logic, positive error orientation, environmental dynamics, and employee innovation behavior is presented. In addition, we develop the relevant research hypotheses. In the 3rd part, the research design and the method of collecting data are shown. Then, in the 4th Part, we analysed the data. Then, the study discusses the results, implications and limitations in the 5th part. Finally, we summarized the research and drew conclusions in the 6th part.

Literature Review and Research Hypotheses

Decision-Making Logic and Employees' Innovative Behavior

Decision-making logic can be divided into causal and effectual logic. Causal logic holds that both market and opportunity exist objectively, and it is vital for individuals to maintain rational decision-making when facing uncertainty and risk.[10]

Conversely, effectual logic holds that decision-makers can choose strategic partners willing to cooperate on the basis of existing available resources and within the maximum loss range they can bear. Decision-makers can constantly use trial and error and iterative feedback in management practices and environmental interactions, and use emergency flexibility to adapt to environmental changes.

Causal logic focuses on rational decision-making and is premised on the belief that rigorous analysis and calculations are necessary to achieve the best outcomes and maximize benefits. Ettlie et al[11] contend that causal logic is conducive to trust within the organization, and that well-planned decision-making activities are key to innovation. Relatedly, Brinckmann et al[12] propose that causal logic entails specific plans and goals that help to improve team cohesion and, thus, companies' ability to innovate. Using causal logic arguably increases the likelihood of promoting employee innovation through identification of new opportunities.[13]

By contrast, decision-makers who embrace effectual logic have limited rationality. In the absence of specific planning and goals, they pay more attention to strengthening cooperation with external parties and achieving maximum satisfaction through various methods. Chandler et al[14] propose that effective decisions should be based on what one is willing to give up and that individuals should be optimistic about accepting the loss of invested resources. Meanwhile, Harms et al[15] assert that the innovation environment is very complex and highlight the difficulty of conducting market evaluation of new products. Taking effective logical decisions would be more beneficial. Osiyevskyy et al[16] propose that effectual logic entails using existing methods without setting specific goals, and pursuing continuous experimentation and flexibility. Kristinsson et al[17] argue that the principles of effectual logic help employees to improve inertia and promote innovative behavior. Effectual logic guides individuals to face challenges, maintain beliefs in creation and change, and control risks through interactions between themselves and the environment. By adhering to effectual logic, employees will explore new opportunities through ongoing trial and error and feedback, which is conducive to promoting innovative behavior.[18] Based on the above literature, this study proposes the following hypotheses:

H1-a: Causal logic has a significantly positive impact on employees' innovative behavior.

H1-b: Effectual logic has a significantly positive impact on employees' innovative behavior.

Decision-Making Logic and Positive Error Orientation

According to behavioral decision theory, human cognition is limited. Even if decision-makers fully understand and grasp information about the decision environment, they can only try to understand some of the various options.[19] Given their bounded rationality, employees are inevitably prone to various errors and risks in the process of innovating, often deviating from standards and goals. This individual tendency to deviate from standards or goals is called error orientation.[20] Yin et al[21] contend that error orientation refers to an individual's emotional, cognitive, and behavioral orientation after an error occurs.

Different decision-making logics affect people's error orientation in different ways. Olson et al[22] assert that causal logic is conducive to the formation of a stable internal trust environment, which can promote information sharing and employee communication. When errors occur, employees trust one another sufficiently to share details and exchange information on error causes and solutions, which promotes the formation of a positive error orientation. When employees adopt effectual logic, each individual can maximize all available resources to achieve satisfactory results because there are no strict restrictions.[23] Effectual logic emphasizes timely action and encourages trial and error to the greatest extent possible with limited resources and risks.[24] Effectual logic not only helps the organization to create a relaxed and active environment but also encourages employees not to avoid mistakes. It is, thus, conducive to the formation of a positive error orientation among employees. Based on the above research, this study proposes the following hypotheses:

H2-a: Causal logic has a significantly positive effect on positive error orientation.

H2-b: Effectual logic has a significantly positive effect on positive error orientation.

Positive Error Orientation and Employees' Innovative Behavior

As the main actors in enterprise innovation, employees often make various mistakes in the innovation process. Differences in individual psychology and environment shape whether employees have a positive or negative error orientation. Individuals with a positive error orientation see the benefits and opportunities when errors occur. According to the broaden-and-build theory,[25] positive emotions can broaden people's thinking and improve their ability to act. When individuals feel positive emotions, their thinking is more focused and flexible, enabling them to focus on refining and analyzing the information obtained.

The influence of error orientation on individuals' attitude to error extends to innovative behavior.[26] Gao[27] contends that employees' positive error orientation promotes the realization of innovative behavior. Employees with a positive error orientation are usually able to solve errors in correct and effective ways.[28] Miao[29] proposes that a positive error orientation can mobilize employees' trial and error enthusiasm and initiative, which is conducive to engaging in innovative behavior. With a positive error orientation, employees will take the initiative to conduct in-depth study of errors, reflect on what they find, and explore unknown areas. Du et al[30] point out that a positive error orientation can guide employees to undertake more innovative behavior. Error communication, which is promoted by positive error orientation, can help employees to find the root cause of errors and identify effective ways to solve them, thereby realizing the collision of ideas and generating innovative behavior.[31] Ma et al[32] verified a strong positive correlation between positive error orientation and employees' innovative behavior. Su et al[33] contend that a positive error orientation helps employees to remain calm when encountering errors in their work. Positive error orientation also helps to improve the creativity and flexibility of employees' thinking, which is conducive to innovative behavior. Based on the above research, this study proposes the following hypothesis:

H3: Positive error orientation has a significantly positive impact on employees' innovative behavior.

The Mediating Role of Positive Error Orientation

Decision-making logic offers the possibility of developing a positive error orientation among employees. Employees with a positive error orientation will adopt positive attitudes toward work errors, which will not only reduce the negative impact of errors but also provide sufficient conditions for employees' innovative behavior.[34]

Because causal logic guides decisions according to predictable and clear goals, it is conducive to conveying an attractive goal-oriented vision to employees. Therefore, causal logic can somewhat stimulate employees' confidence.[35] Confidence helps employees to have a positive attitude toward errors and encourages them to constantly take risks, accumulate experience of errors, and form knowledge reserves for innovation. Kilduff et al[36] point out that causal logic can stimulate competition among employees, thereby increasing their enthusiasm. High enthusiasm is conducive to employees forming a strong sense of responsibility, which leads to them taking seriously possible errors in work, and helps to promote employees' learning and innovation. Ding et al[37] contend that causal logic is conducive to improving the cohesion of decision-making teams, and can guide the formation of employees' positive error orientation.

Effectual logic emphasizes the discovery or creation of opportunities through action to achieve satisfactory results. It can give full play to the autonomy and initiative of employees, enabling them to experience a high level of trust and a strong sense of accomplishment. This is conducive for employees to explore new methods and engage in trial and error.[38] According to Hubner et al,[39] effectual logic encourages teamwork among employees. This promotes communication and collaboration when employees face errors. Effectual logic enables employees to think and learn independently, stimulates a challenging spirit and willingness to learn, and helps employees to have a positive attitude toward errors. It can not only encourage employees to jointly analyze the causes of and devise solutions to errors but also enable them to refine and analyze the information obtained around them, thus enabling employees to generate more innovative ideas and engage more in innovative behavior.[40]

This study contends that positive error orientation plays a mediating role between decision-making logics and employees' innovative behavior. Specifically, it proposes that the impact of decision-making logic on employees' innovative behavior occurs indirectly via positive error orientation. Therefore, this study proposes the following hypotheses:

H4-a: Positive error orientation mediates between causal logic and employees' innovative behavior.

H4-b: Positive error orientation mediates between effectual logic and employees' innovative behavior.

The Moderating Role of Environmental Dynamics

Environmental dynamics are the unpredictable changes in market demand and technological development over time.[41] Zahra et al[42] point out that environmental dynamics have three characteristics: dynamic, competitive, and heterogeneous. Relatedly, Simerly et al[43] assert that environmental dynamics result from a combination of several factors and involve a continuous process from stability to change.

According to Albert Bandura's triadic interactive determinism, there is a dynamic interaction between subject, behavior, and environment, and the latter affects people's thinking and behavior. Environmental dynamics can influence the effect of decision-making logic on innovative behavior.[44] In a rapidly changing and unpredictable environment, decision-makers always face considerable information-processing problems.[45] Planning based on causal logic often fails to adapt sufficiently quickly to market changes and can easily lead to deviations from expectations. At the same time, employees' innovative behavior is hindered by the difficulty of setting specific goals and detailed plans.[46] Cui et al[47] point out that although causal logic is appropriate in conditions of sufficient information and a predictable future, it may not achieve the desired effect in uncertain situations. Yu et al[48] propose that environmental dynamics set boundary conditions for causal logic and effectual logic. As a decision-making method developed for uncertain environments, effectual logic is often more advantageous than causal logic in a highly dynamic environment.[49] Effectual logic not only promotes continuous experimentation and error learning under the constraints of unpredictable situations and bounded rationality but is also based on the heuristic logic of repeated cycles of thinking, decision, and action.[50] The adoption of effectual logic can break current resource constraints, ensure plans are flexibly adjusted, and promote employee innovation. Based on the above research, this study proposes the following hypotheses:

H5-a: Environmental dynamics moderate the effect of causal logic on employees' innovative behavior.

H5-b: Environmental dynamics moderate the effect of effectual logic and employees' innovative behavior.

The study's theoretical framework is shown in Figure 1.

Method

Participants and Procedure

Participants were recruited from core development enterprises in Nanchang, Jiangxi Province, China. Given the complex actual situation of enterprises in Nanchang City, with a wide distribution of employees and significant differences in level. To ensure that the samples can better represent the overall characteristics, this survey adopted the method of classified sampling to collect samples from different industries, such as manufacturing, transportation, warehousing and

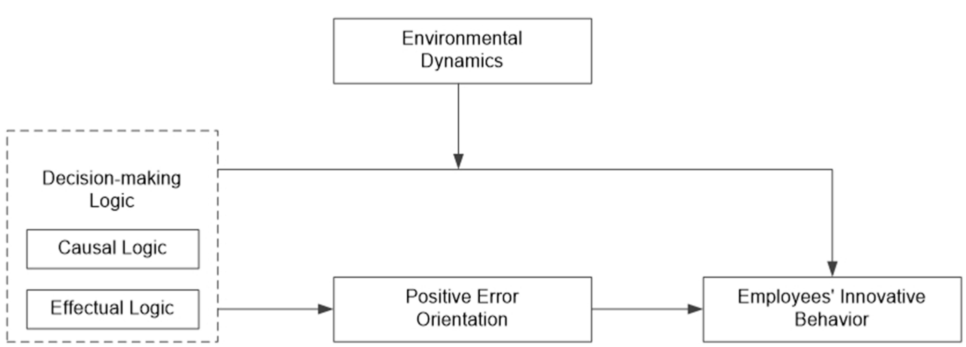

Figure 1 Research model.

postal services, trade, wholesale and retail (a total of 100 enterprises were selected), based on industry types, to reduce the sampling error and the effect of variability at each sampling level.[51] We contacted the human resources department of the companies surveyed and explained the purpose of the research. After obtaining their consent, several employees of the enterprises were selected to be interviewed with the aim of optimizing the questionnaire structure and thus improving the quality and the credibility of the research. A simple random sampling method was then used to select 5 employees from each company as respondents. The finalized questionnaire was distributed through a combination of online and offline methods in April 2022. A total of 450 questionnaires were collected, of which 403 were found to be valid, representing an effective response rate of 89.56%.

The descriptive statistics of the sample are as follows. Regarding gender distribution, the respective proportions of male and female participants were 42.18% and 57.82%. As regards age distribution, 18.11% of participants were aged under 25 years old, 35.24% were aged 25–30, 36.97% were aged 31–40, 7.94% were aged 41–50, and 1.74% were aged over 50. The majority of participants had a bachelor's degree or higher (67.49%), while 32.51% had a lower education level. Regarding the position of participants, 34.49% were grassroots managers, 32.01% were ordinary employees, and 2.98% were senior managers. Finally, regarding industry type, 22.83% were in trade, wholesale, and retail; 22.08% were in manufacturing; 16.87% were in transportation, storage, and post; and 38.22% were in other industries.

Measures

Decision-Making Logic

Referring to the decision-making logic scale developed by Gabrielsson and Politis,[52] this study selected six items to clearly reflect the characteristics of and differences between causal logic and effectual logic. Sample items include "I prefer predetermined goals and strive to achieve these goals"; and "I prefer flexible goals and can change the business direction according to the results". All items were scored on a five-point Likert scale from 1 ("strongly disagree") to 5 ("strongly agree").

Positive Error Orientation

Referring to the Error Orientation Scale devised by Rybowiak et al,[53] 12 items were selected covering four dimensions of positive error orientation: error competence, error learning, error thinking, and error communication. Sample items include "When I know something is wrong, I immediately know how to correct it"; "Mistakes help me improve my work"; "After I make mistakes, I think about the reasons for my mistakes"; and "If I cannot correct my mistakes myself, I will ask my colleagues for help".

Employees' Innovative Behavior

Based on the situation of Chinese enterprises, this study refers to the eight-item employees' innovative behavior scale devised by Zhang et al.[54] Sample items include "I often look for opportunities to improve working methods and workflows"; and "I often try to use new methods to solve problems in my work".

Environmental Dynamics

This study refers to four items from Xie[55] to measure both the technical and market aspects of environmental dynamics. Sample items include "The upgrading of technology can promote new products and new services"; and "The enterprise is in an industry with a high degree of market volatility".

Control Variables

To increase the reliability of the research, the following control variables were included: gender (female = 1, male = 2); age (under 25 years = 1, 25–30 years = 2, 31–40 years = 3, 41–50 years = 4, over 50 years = 5); position (ordinary staff = 1, grassroots manager = 2, middle manager = 3, senior manager = 4); education level (high school and below = 1, college = 2, undergraduate = 3, master = 4, doctorate = 5); and working years (under 3 years = 1, 3–8 years = 2, over 8 years = 3).

Data Analysis

SPSS 24.0 and Amos 24.0 were used for data processing. Firstly, SPSS 24.0 was used to conduct reliability and validity tests, while homologous bias was checked using the latent error variable control method. Secondly, SPSS 24.0 was used for descriptive statistics and Pearson correlation analysis. Next, Amos 24.0 and SPSS PROCESS macro was used to test the study hypotheses.[56] In addition, bootstrapping was used to test for mediating and moderating effects.

Reliability and Validity Testing

This study uses Cronbach's α values to test the questionnaire's reliability. As reported in Table 1, the Cronbach's α value was 0.968 for the overall questionnaire, 0.858 for the decision-making logic scale, 0.912 for the positive error orientation scale, 0.903 for the employees' innovative behavior scale, and 0.828 for the environmental dynamics scale. Since the Cronbach's α values of each scale and the corresponding subscales all exceed 0.7, the questionnaire has good reliability.

The accuracy and validity of the questionnaire were tested in SPSS using the KMO (Kaiser-Meyer-Olkin) and Bartlett's sphericity test. As Table 2 reports, the KMO value was 0.975 for the decision-making logic scale, 0.949 for the positive error orientation scale, 0.927 for the employees' innovative behavior scale, and 0.810 for the environmental dynamics scale. The *p*-values of Bartlett's sphericity test were also statistically significant. Together, the KMO values for the main variables were all greater than 0.8 and the p-values were all less than 0.1, indicating that the questionnaire met the requirements for high content validity.

Table 1 Reliability Test Results

Scale	Subscale	Number of Items	Cronbach's α of Subscales	Cronbach's α of Scales	Cronbach's α of Overall Questionnaire
Decision-making Logic	Causal logic	3	0.791	0.858	0.968
	Effectual logic	3	0.786		
Positive Error Orientation	Error competency	2	0.714	0.912	
	Error learning	3	0.781		
	Error thinking	4	0.812		
	Error communication	3	0.765		
Employees' Innovative Behavior		8	0.903	0.903	
Environmental dynamics	Technical dynamics	2	0.714	0.828	
	Market dynamics	2	0.709		

Table 2 Validity Test Results

Scale	Subscale	KMO value of Subscales	KMO value of Scale	Bartlett's Sphericity Test		
				Approx. Chi-Square	*df*	*p*-value
Decision-making Logic	Causal logic	0.699	0.975	947.675	15	0.000
	Effectual logic	0.700				
Positive Error Orientation	Error competency	0.500	0.949	2456.602	66	0.000
	Error learning	0.679				
	Error thinking	0.801				
	Error communication	0.693				
Employees' Innovative Behavior			0.927	1628.946	28	0.000
Environmental dynamics	Technical dynamics	0.500	0.810	568.711	6	0.000
	Market dynamics	0.500				

Common Variance Analysis

Given the low sensitivity of Harman's single-factor test, this study uses the latent error variable control method to check for homologous bias.[57] A six-factor model is constructed by adding a method bias latent variable to the study's five-factor model. For the six-factor model, CMIN/DF = 1.908, CFI = 0.958, TLI = 0.949, IFI = 0.958, and RMSEA = 0.048. Compared with the five-factor model, the added values of CFI, TLI, and IFI are less than 0.05, and RMSEA only decreases by 0.011 (<0.05), indicating that the five-factor model does not have serious homologous deviation. Detailed results of the multi-factor model tests are presented in Table 3.

Results

Descriptive Analysis and Correlations

Table 4 shows that the mean score for each variable is above the mid-point of the five-point scale. Table 5 shows the correlation between the main variables. It can be found that there is a significant positive correlation between causal logic, effectual logic, positive error orientation, employees' innovative behavior and environmental dynamics ($p < 0.01$).

Model Fit Analysis

This study used structural equation modeling (SEM) to analyze the relationship between decision-making logic, positive error orientation and employees' innovative behavior. Table 6 reports the model fit indices values. The main indices values were all acceptable (CFI, IFI, and TLI > 0.9, CMIN/DF < 5, RMSEA < 0.08), indicating the model fitted the data well.

Table 3 Multi-Factor Model Test Results

Model	CMIN/DF	CFI	TLI	IFI	RMSEA
Five-factor model	2.386	0.930	0.922	0.930	0.059
Four-factor model	2.483	0.924	0.917	0.925	0.061
Single-factor model	2.592	0.918	0.911	0.918	0.063

Notes: Five-factor model: causal logic, effectual logic, positive error orientation, employees' innovative behavior, and environmental dynamics. Four-factor model: causal logic + effectual logic, positive error orientation, employees' innovative behavior, and environmental dynamics. Single-factor model: causal logic + effectual logic +positive error orientation + employees' innovative behavior+ environmental dynamics.

Abbreviations: CMIN, Chi-square value; DF, Degree of Freedom measures the number of independent values that can diverge without obstructing any limitations in the model; CMIN/DF, discrepancy divided by degree of freedom; CFI, Comparative Fit Index; TLI, Tucker-Lewis coefficient; IFI, Incremental Fit Index; RMSEA, Root Mean Square Error of Approximation.

Table 4 Descriptive Statistics

Variable	Dimension	Mean	SD	Overall Mean	Overall SD
Decision-making Logic	Causal logic	4.037	0.748	3.965	0.709
	Effectual logic	3.893	0.805		
Positive Error Orientation	Error competency	4.037	0.782	4.011	0.662
	Error learning	4.026	0.750		
	Error thinking	4.047	0.702		
	Error communication	3.931	0.784		
Employees' Innovative Behavior				3.985	0.695
Environmental Dynamics	Technical dynamics	3.934	0.737	3.954	0.759
	Market dynamics	3.956	0.725		

Abbreviation: SD, Standard Deviation.

Table 5 Correlations

Variable	1	2	3	4	5
1.Causal logic	1.000				
2.Effectual logic	0.611***	1.000			
3.Positive Error Orientation	0.778***	0.709***	1.000		
4.Employees' Innovative Behavior	0.749***	0.720***	0.878***	1.000	
5.Environmental Dynamics	0.742***	0.732***	0.815***	0.873***	1.000

Note: ***p<0.001.

Table 6 Model Fit Indices Values

Indicator	Evaluation Criterion	Model Results	Fitting
CMIN/DF	≤3.0	2.633	Ideal
RMSEA	≤0.08	0.064	Ideal
IFI	≥0.90	0.927	Ideal
TLI	≥0.90	0.919	Ideal
CFI	≥0.90	0.927	Ideal
NFI	≥0.90	0.888	Slightly below ideal
RFI	≥0.90	0.876	Slightly below ideal
GFI	≥0.50	0.858	Ideal
PNFI	≥0.50	0.801	Ideal
PCFI	≥0.50	0.836	Ideal

Abbreviations: CMIN, Chi-square value; DF, Degree of Freedom measures the number of independent values that can diverge without obstructing any limitations in the model; CMIN/DF, discrepancy divided by degree of freedom; RMSEA, Root Mean Square Error of Approximation; IFI, Incremental Fit Index; TLI, Tucker-Lewis coefficient; CFI, Comparative Fit Index; NFI, Normed Fit Index; RFI, Relative Fit Index; GFI, Goodness of Fit Index; PNFI, Parsimony Normed Fixed Index; PCFI, Parsimony Comparative Fix Index.

Testing Path Coefficients

The standardized path coefficients of model are shown in Figure 2 and reported in Table 7. First, the direct effect of causal logic on employees' innovative behavior was not significant (path coefficient = 0.088, p>0.1), indicating that H1-a was not supported. This unexpected result might be explained by the rapid changes and unpredictability of the dynamic environment: unable to grasp all the information under bounded rationality, it is difficult for employees to set specific goals and make detailed plans by applying causal logic. In turn, employees' innovative behavior is hindered.

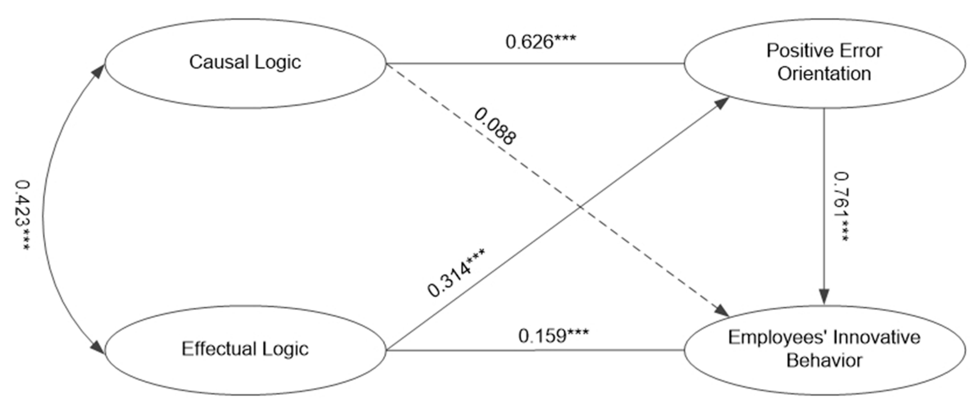

Figure 2 Standardized path coefficient graph of SEM.
Note: ***p<0.001.

Table 7 Model Parameter Estimation Results

Variable	Standardized Path Coefficients	SE	CR	*p*-value
Causal Logic ➔ Employees' Innovative Behavior	0.088	0.090	1.036	0.300
Effectual Logic ➔ Employees' Innovative Behavior	0.159	0.059	2.365	0.018
Causal Logic ➔ Positive Error Orientation	0.626	0.114	6.280	0.000
Effectual Logic ➔ Positive Error Orientation	0.314	0.088	3.398	0.000
Positive Error Orientation ➔ Employees' Innovative Behavior	0.761	0.078	9.004	0.000

Abbreviations: SE, Standard Error; CR, Construct Reliability.

Second, the direct effect of effectual logic on employees' innovative behavior was significant (path coefficient = 0.159, $p<0.05$). Effectual logic positively influences employees' innovative behaviour, the stronger the effectual logic, the more likely employees' innovative behaviour will increase, which indicating support for H1-b. Effectual logic promotes continuous trial and error and flexibility. By applying effectual logic, employees can break current resource constraints and flexibly adjust plans, thereby increasing the likelihood of innovative behavior.

Third, causal logic had a significantly positive effect on positive error orientation (path coefficient = 0.626, $p<0.01$), indicating support for H2-a. Causal logic can promote information sharing and personnel communication while also stimulating employees' trust. Under the influence of causal logic, employees communicate with one another about the causes of and solutions to errors, thereby forming a positive error orientation.

Fourth, effectual logic also had a significantly positive impact on positive error orientation (path coefficient = 0.314, $p<0.01$), indicating that H2-b was supported. Effectual logic encourages employees not to avoid mistakes and to act in a timely manner. Under the influence of effectual logic, employees can constantly trial and error, and face errors with a good attitude, thus contributing to the formation of positive error orientation.

Fifth, positive error orientation had a significantly positive effect on employees' innovative behavior (path coefficient = 0.761, $p<0.01$), indicating that H3 was supported. According to the broaden-and-build theory, positive emotions help to enhance creativity and flexible thinking. Employees with a positive error orientation communicate, learn, and think about the causes of and solutions to errors, which is conducive to promoting innovative behavior.

Mediating Effects of Positive Error Orientation

This study used the bootstrap method to test the mediating effects of positive error orientation, using 5000 iterations and a 95% confidence interval (CI). Where the 95% CI does not include zero, this indicates that the effect is significant. The bias-corrected bootstrap test results are reported in Table 8.

Focusing first on the total effect results, the total effect of causal logic on employees' innovative behavior was 0.564 (95% CI = [0.376, 0.709]), indicating a significantly positive impact. Likewise, the total effect of effectual logic on employees' innovative behavior was significantly positive (0.398, 95% CI = [0.245, 0.575]).

Considering next the indirect effect test results, the indirect effect of causal logic on employees' innovative behavior via positive error orientation was 0.239 with a 95% CI of [0.340, 0.622]. This indicates that positive error orientation played

Table 8 Mediation Testing Results

Mediator Variable	Independent Variable	Effect Classification	Effect value	SE	Lower (BC)	Upper (BC)
Positive Error Orientation	Causal Logic	Indirect	0.476***	0.072	0.340	0.622
		Direct	0.088	0.094	−0.107	0.264
		Total	0.564***	0.087	0.376	0.709
	Effectual Logic	Indirect	0.239***	0.061	0.121	0.363
		Direct	0.159***	0.083	0.013	0.331
		Total	0.398***	0.085	0.245	0.575

Note: ***p<0.001.
Abbreviation: SE, Standard Error.

Table 9 Moderation Testing Results

Interaction Items	Coefficient	Boot Mean	Boot SE	Boot LLCI	Boot ULCI
C*E	−0.011	0.012	0.010	−0.031	0.007
E*E	−0.025	0.026	0.011	−0.049	−0.007

Abbreviations: C*E, causal logic* environmental dynamics; E*E, effectual logic* environmental dynamics; SE, Bootstrap Standard Error; LLCI, lower level of confidence interval; ULCI, upper level of confidence interval.

a significant mediating role between causal logic and employees' innovative behavior, thus supporting H4-a. Causal logic can significantly promote employees' innovative behavior by enhancing the formation of positive error orientation.

Furthermore, the indirect effect of effectual logic on employees' innovative behavior via positive error orientation was 0.476 with a 95% CI of [0.121, 0.363]. This indicates that positive error orientation played a significant mediating role between effectual logic and employees' innovative behavior, thus supporting H4-b. Effectual logic can also significantly promote employees' innovative behavior by enhancing the formation of positive error orientation.

Moderating Effects of Environmental Dynamics

Including gender, age, education level, position, and working years as control variables, this study tested the moderating effects of environmental dynamics using PROCESS Model 5. Relevant results are shown in Table 9. The bootstrap test results show that:

First, the interaction coefficient between environmental dynamics and causal logic was 0.011 with a 95% CI of [−0.031, 0.007]. As the CI contains zero and the R^2 change is 0.0002 (p>0.1), environmental dynamics did not significantly moderate the effect of causal logic on employees' innovative behavior. Therefore, H5-a was not supported.

Second, the interaction coefficient between environmental dynamics and effectual logic was −0.025 with a 95% CI of [−0.049, −0.007]. The CI does not contain zero and the R^2 change is 0.0013 (p<0.1), indicating a significant effect. Since the sign of the interaction coefficient was opposite to the sign of the effectual logic coefficient (0.201, p<0.01), the results indicate that environmental dynamics significantly negatively moderated the effect of effectual logic on employees' innovative behavior, thus supporting H5-b.

Figure 3 shows the simple slopes used to further verify the moderating effect of environmental dynamics on the link between effectual logic and employees' innovative behavior. The slope for low environmental dynamics (M−1SD) is

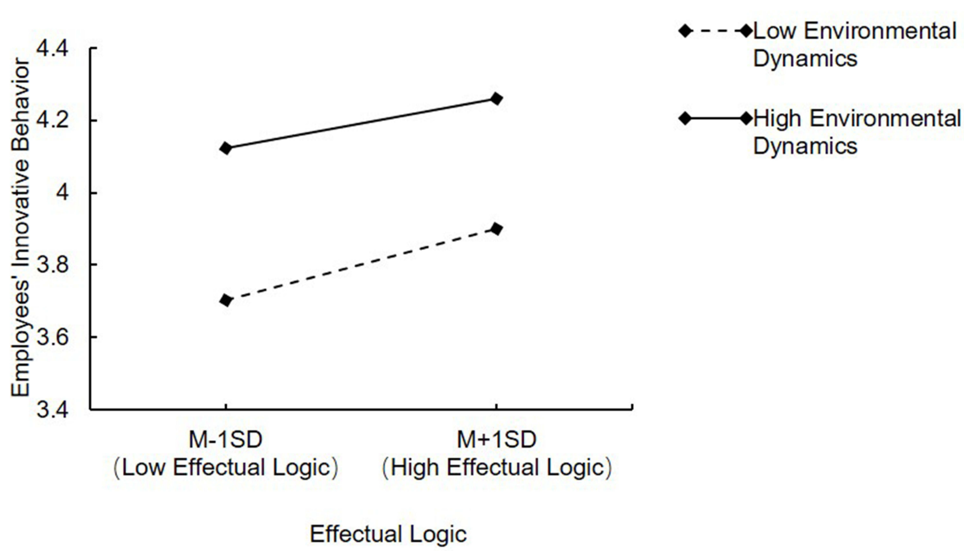

Figure 3 Simple slope diagram.

higher than that for high environmental dynamics (M+1SD), meaning that effectual logic had a stronger effect on employees' innovative behavior under low environmental dynamics than under high environmental dynamics.

Discussion

This study used SEM to examine the relationships between decision-making logic, positive error orientation, and employees' innovative behavior, and applied bias-corrected bootstrapping to test the mediating role of positive error orientation between decision-making logic and innovative behavior. It also used PROCESS Model 5 to test whether environmental dynamics moderate the effects of decision-making logic on employees' innovative behavior. Based on the results of hypothesis testing, this study draws the following conclusions.

First, the direct effect of causal logic on employees' innovative behavior was not significant but the total effect was significantly positive; by contrast, the direct and total effects of effectual logic on employees' innovative behavior were significantly positive.[58] The effect of causal logic on innovation is limited by the innovation environment, such that highly volatile conditions may weaken the direct effect of causal logic on employees' innovative behavior.[46,59] Conversely, the flexibility principle of effectual logic allows employees to constantly adjust their plans and try to improve, which is more conducive to generating innovative behavior.[60]

Second, positive error orientation has a positive effect on employees' innovative behaviour and plays a mediating role between decision-making logic and employees' innovative behaviour. According to the broaden-and-build theory of positive emotions, positive emotions help employees to develop a positive error orientation and to approach errors with the right attitude and behaviour. Under a positive error orientation, employees reflect on the reasons for their mistakes, communicate with each other and look for new solutions and opportunities. This motivates employees to engage in innovative behaviour.[61] This is consistent with the research of scholars such as Chen[62] and Su et al.[33] In addition, decision-making logic can help employees form a positive error orientation through various aspects (such as enhancing team cohesion, promoting internal trust, guiding individuals to face challenges, constantly trying and making mistakes, etc.), thereby promoting employees' innovative behaviour.[22,24]

Third, environmental dynamics did not significantly moderate the effect of causal logic on employees' innovative behavior but did have a significantly negative moderating effect on the impact of effectual logic on employees' innovative behavior. According to behavioural decision theory and triadic reciprocal determinism, people's cognition is limited, and the environment will influence people's behavioural decision. Rapid changes in the environment make employees more inclined to choose effectual rather than causal logic. This further expands the research of scholars such as Yu et al[48] and Su et al.[49] However, with the high unknown risks and unpredictable future outcomes that characterize dynamic environments, employees may not have the requisite cognitive level and ability to apply effectual logic, leading to a tendency to make conservative decisions. Thus, a turbulent environment will weaken the impact of effectual logic on employees' innovative behavior.[63,64] Conversely, amid a relatively stable external environment and predictable future outcomes, employees are more inclined to deviate from prevailing thinking and actively engage in innovation. Therefore, low environmental dynamics will strengthen the impact of effectual logic on employees' innovative behavior.[65]

Theoretical Implications

This study analyses the mechanism by which decision-making logic affects employees' innovative behaviour from an individual perspective, which enriches the relevant research on decision-making logic and employees' innovative behaviour. Decision-making logic is closely related to employees' innovative behaviour. However, previous studies have only analysed the relationship between decision-making logic and employees' innovative behaviour at the organisational level, neglecting the changes in employees' individual decision-making logic.[18,66] In the actual innovation process, employees' own decision-making logic is also important. This study draws on existing research in the academic community, sorts out the relevant theories and foundations of decision-making logic and employees' innovative behaviour, and summarises the forms of influence of two decision-making logic methods (causal logic and effectual logic) on employees' innovative behaviour. In addition, the relationship between the two was further explored to provide a theoretical basis for future research from the perspective of individual employees.

Based on behavioral decision theory and broaden-and-build theory of positive emotions, this study introduces the mediating variable of positive error orientation, enriches the research on the mediating mechanism between decision-making logic and employees' innovative behaviour, and provides new research perspectives and empirical support for subsequent related research. First, this study extends the research contexts of behavioural decision theory and broaden-and-build theory of positive emotions to employee decision-making logic and innovation contexts, further expanding the application contexts of both theories and providing a new research perspective for exploring employee decision-making logic and innovative behaviour. Second, this study introduces the key variable of positive error orientation and thoroughly analyses the mediating role of positive error orientation between decision-making logic and employees' innovative behaviour. It is found that decision-making logic can promote the formation of employees' positive error orientation and thus promote employees' innovative behaviour. This not only enriches the research on the mediating mechanism between decision-making logic and employees' innovative behaviour, but also provides a theoretical basis and empirical support for future related research.

Based on the triadic reciprocal determinism, this study introduces the moderating variable of environmental dynamics, which enriches the research on the moderating mechanism between decision logic and employees' innovative behaviour. This study combines previous studies and examines the relationship between the environment, employees' decision-making logic and innovative behaviour based on the theory of triadic reciprocal determinism, which further deepens the understanding of triadic reciprocal determinism.[67] In addition, this study analysed the moderating effect of environmental dynamics on decision-making logic and employees' innovative behaviour, which extends the research on the relationship between environmental dynamics regulating decision-making logic and employees' innovative behaviour at the individual level of employees.[48,49] This provides a basis and literature support for future research on the moderating mechanism between employees' decision-making logic and innovative behaviour.

Practical Implications

This study can provide some practical suggestions for promoting employees' innovative behavior.

We found that decision-making logic plays a vital role in innovative behavior, and the choice of causal logic and effectual logic affects the effect of innovation. The bounded rationality of individual employees means they lack sufficient knowledge and experience to make effective judgments and decisions under high environmental dynamics. Therefore, employees should undertake regular training to cultivate their decision-making ability in the innovation process. For example, learning theoretical knowledge about decision-making, listening to the experiences of predecessors or colleagues, participating in training to improve decision-making skills, constantly summarising and reflecting. Employees also need to improve their work skills and knowledge reserves. For example, conducting regular business knowledge learning, seeking experience from industry experts, and combining big data to improve business skills. To reduce the impact of the inability to make effective decisions due to the limitations of bounded rationality.[68]

Employees' positive error orientation can contribute to their innovative behaviour. Positive error orientation plays an important mediating role between decision-making logic and employees' innovative behaviour. In practice, innovation activities inevitably involve risks and errors. A positive error orientation can not only help employees to accumulate experience in communication and learning but also enhance their ability to deal with errors, thereby promoting employees' innovative behavior. Therefore, employees should seek to improve their tolerance for errors and handle them with a positive, healthy attitude. For example, rather than being accustomed to avoiding or ignoring mistakes, employees need to become more aware of how to face them courageously.[69] When errors cannot be resolved, actively seek help from supervisors or colleagues, share experiences of error handling, and strive to reduce the negative impact of errors. At the same time, targeted training can be provided to improve one's own error handling skills. Clear recognition of one's own error orientation, cultivation of positive emotions, constant reflection on the causes of errors, acquisition of knowledge from errors and continuous learning to improve one's ability to deal with errors.[70]

Environmental dynamics will affect the impact of decision-making logic on employees' innovative behavior. In a highly dynamic environment, goal-oriented causal logic may no longer apply whereas effectual logic, based on trial and error and flexibility, has unique advantages. In turbulent external environments, information is often difficult to obtain, outdated or inaccurate. Therefore, employees need to closely monitor the dynamic changes in the external environment, objectively assess the degree of turbulence in the external environment, and dynamically adjust and balance the two decision logics.[71] At work, for instance, employees need to follow industry news, pay attention to relevant policy, and obtain up-to-date information from various channels, including the Internet, newspapers, and people who work in the same industry, in order to increase the likelihood of identifying new opportunities. In addition, employees need to integrate the collected information and make objective evaluations, flexibly using two decision-making logic methods. When environmental dynamics are relatively low, employees can adopt causal logic to improve team cohesion and adopt effectual logic to improve their enthusiasm. Conversely, when environmental dynamics are relatively high, employees should choose effectual logic and make rational decisions to deal with risks and uncertainties.

Limitations and Future Research

Although this paper enriches research on the mediating and moderating mechanisms between decision-making logics and employees' innovative behavior, it has two main limitations.

First, besides positive error orientation and environmental dynamics, employees' innovative behavior is potentially affected by other factors such as employee characteristics and organizational management. Future research should comprehensively consider these factors to enrich the research model. Second, the data obtained in this study are cross-sectional data. However, the two variables of employees' decision-making logic and positive error orientation may change dynamically due to the external environment and corporate goals. Future research can choose the way of follow-up survey to reveal the dynamic change process of employee decision-making logic and positive error orientation.

Conclusion

Effectual logic had a significantly positive impact on employees' innovative behavior. The direct effect of causal logic on employees' innovative behavior was not significant, but the total effect was significantly positive. Positive error orientation played a mediating role between both types of decision-making logic and employees' innovative behavior. Moreover, environmental dynamics played a negative moderating role between effectual logic and employees' innovative behavior. The results of this study not only enrich the research on the mediating and moderating mechanisms between individual decision-making logic and employees' innovative behavior, but also provide reference opinions for promoting employees' innovative behavior, helping employees respond to complex environmental changes with more appropriate decision-making logic and positive error orientation in the innovation process.

Ethics Statement

This study was approved by the Ethics Committee of the School of Economics and Management at East China Jiaotong University. All participants provided written informed consent to participate.

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Disclosure

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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