Agent-based Modeling and Cultural Integration after Mergers and Acquisitions in State-Owned Enterprise

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Abstract. This study examines how state-owned enterprises respond to cultural integration challenges following mergers and acquisitions. We developed an agent-based simulation model using the NK fitness landscape to explore how managerial characteristics influence the effectiveness of cultural integration strategies. The model incorporates both managerial experience dependency and acculturation modes, drawing from prior research to capture the unique decision-making processes of SOEs. The study thoroughly examines the impact of organizational complexity and managerial characteristics on integration success. Findings reveal that excessive reliance on managerial experience hinders the development of newly merged organizations. Additionally, experience dependence has varying effects on acculturation modes, and organizational complexity plays a crucial role in shaping overall outcomes. This research offers managerial insights for post-merger cultural integration in state-owned enterprises and contributes a new perspective to the theoretical understanding of cultural integration in complex environments.

Keywords: Agent-Based Simulation, Complexity, Acculturation mode, State-owned enterprises.

1 Introduction

In recent years, Chinese enterprises have strengthened their positions in the global value chain through overseas mergers and acquisitions (M&As), acquiring strategic assets such as design, research and development, marketing, and services [1]. M&As bring significant shifts not only in operational frameworks but also in corporate culture, with post-merger integration (PMI) being a critical phase for managing these transitions. Among the many challenges in PMI, cultural integration is considered one of the most difficult aspects to navigate. Deloitte reports that 60% of Chinese M&As fail to realize their anticipated commercial value, with nearly two-thirds of these failures attributed to insufficient cultural integration [2]. Unresolved cultural conflicts during PMI can impede synergy realization, highlighting the importance of effective cultural alignment.

The rapid advancement of information technology has reshaped organizational interactions, compelling firms to adapt to external complexities and realign internal structures. Understanding how organizations respond to such complex environments requires sophisticated theoretical frameworks. One such framework is the theory of complex adaptive systems [3], which uses mathematical models and computational methods to analyze interdependencies and dynamic behaviors within organizations [4].

While previous research has explored cultural integration in M&As from various perspectives, most studies focus on individual-level interactions. For instance, Yamanoi modeled individual social networks between merged firms, examining the influence of cultural distance [5], while Albert employed agent-based modeling (ABM) to study cultural compatibility, with a focus on individual attributes such as age and work experience [6]. However, these approaches offer limited insights into corporate-level decision-making processes, particularly within the context of Chinese state-owned enterprises (SOEs). SOEs operate under unique organizational structures, which necessitate a multidimensional approach to understanding decision-making during cultural integration.

Cultural integration requires organizations to make interdependent strategic decisions, where the interactions between these decisions have a profound impact on overall performance. Companies strive for optimal cultural integration strategies, but these strategies are shaped by underlying dynamics, such as managerial decision-making and organizational complexity [7]. Therefore, a systematic approach is required to model and understand these interactions, especially in the context of SOEs, where managerial experience plays a key role.

Building on Berry's acculturation framework, Nahavandi proposed a corporate culture integration model, which includes four modes: integration, separation, assimilation, and marginalization [7, 8]. Marks and Mavis refined this model, replacing marginalization with a “reverse merger” concept that better reflects the complexities of cultural change during M&As [9]. As key players in China’s economy and pioneers in international M&A activities [10], SOEs have increasingly attracted academic attention. Scholars such as He and Liao have adapted acculturation modes to better fit Chinese enterprise structure, making them more applicable to their operational environments [11, 12]. However, understanding how acculturation modes affect the cultural integration of these enterprises, it is necessary to go beyond theoretical discussions and analyze them in conjunction with management characteristics.

To address these challenges, this study proposes a dynamic model tailored to the post-merger cultural environment of SOEs, using the NK model. The NK model is well-suited for representing complex and uncertain environments, capturing multiple variables and interactions [13].

In this study, we simulate the decision-making behaviors of managers (including subsystem managers and the headquarters CEO) , integrating the passive search of the NK model with the active activities of managers and explore how these behaviors influence the effectiveness of cultural integration strategies. Specifically, we focus on the role of managerial experience dependency—a key aspect of bounded rationality—and its impact on post-merger performance under different acculturation modes.

By analyzing these interactions, the NK model provides insights into how organizational decisions after M&As affect overall performance. Additionally, the study evaluates how SOE management characteristics shape the outcomes of cultural

integration strategies. The findings offer managerial insights for post-merger cultural integration in SOEs post-merger integration, combining active and passive search for more practical enterprise operations.

2 Establishing a search model

This section establishes an enhanced NK model to analyze the decision-making process of cultural integration in SOE. This model considers the acquiring company and the target company as subsystems within the new organization, linking their decision-making processes together. The foundation of integration is shaped by different acculturation modes, and the integration process is influenced by management capabilities and organizational characteristics.

2.1 NK Model in new organization

The NK structure highlights the interdependency among decisions. *N* represents the total number of decisions. *K* indicates how interdependent these decisions are. A higher *K* means decisions are more interconnected, affecting each other significantly. We assume that an organization needs to make choices for *N* decisions that are related to cultural integration. The 'decision combination' is shown as $d = d_1 d_2 ... d_N$ with each d_i either 0 or 1. The effect of each decision is affected not only by the choice (0 or 1) made concerning that decision, but also by the choices regarding other decisions. In the model, each decision *i* makes a contribution C_i to overall performance. C_i depends not only on d_i, but also on how other decisions d_j are resolved: $C_i = C_i (d_i , d_j)$. Overall performance associated with a combination is the average over the *N* contributions:

$$P_d = \frac{\sum_{i=1}^{N} C_i}{N} \tag{1}$$

There may be many situations in the decision combination after acquisition. In this article, we assume that the number of cultural decisions of the two subsystems is the same. That is to say, when faced with *N* decisions, the organization assigns *N/2* to each of the two subsystems separately. Furthermore, we assume that when decisions are combined together, the interaction within the two subsystems remains unchanged and operate in same patterns. The number of interactions within the subsystems is represented by K_{in}, and the number of interactions across subsystems is K_{bw}. The contribution of each decision (C_i) now potentially involves more decisions (d_i, d_j, d_k), reflecting new interactions. $C_i = C_i (d_i, d_j, d_k)$, and d_k represents cross subsystem interaction. When two companies merge, their decisions influence each other. The schematic diagram of the influence matrix is shown in Table 1. If the decision in column *j* affects the contribution of decision *i*, then the *(i, j) th* of *i* is marked as "x", otherwise it is empty. The upper left part represents the impact matrix of the acquiring company, the lower right part represents the impact matrix of the target company, the upper right part represents the impact of the acquiring company's decisions on the target company, and the lower left part represents the impact of the target company's decisions on the acquiring company.

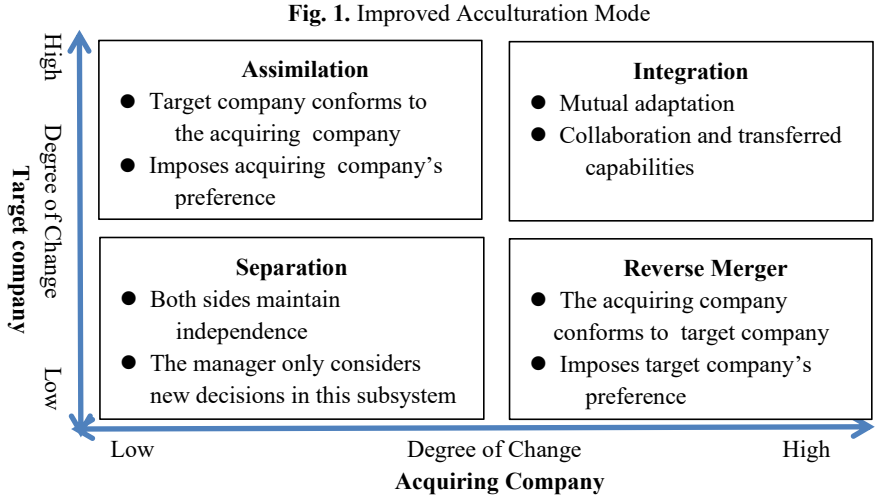
Table 1. Example of matrix for cultural integration

		Acquiring company				Target company			
		1	2	3	4	5	6	7	8
Detailed decision	1	x		x	x		x	x	
	2	x	x		x		x		x
	3	x		x	x			x	x
	4	x	x		x	x			x
	5		x		x	x	x		x
	6		x	x			x	x	x
	7		x			x		x	x
	8	x		x		x	x		x

2.2 Acculturation Mode

The research on cultural integration methods is mostly based on Berry's framework, and scholars continuously improve it by combining organization and environment. Figure 1 shows a model developed based on Berry's cultural framework to reflect organizational management and cross-cultural integration [8, 9]:

Fig. 1. Improved Acculturation Mode



This experiment explores the modes suitable for managers:
(1) The 'integration mode': encourages collaborative decision-making. In this mode, the manager of a subsystem will consult with the other party when making decisions, consider each other's latest decisions, and then submit the new combination to the CEO.
(2) The 'separation mode' may be regarded as refraining from any coordination. It corresponds to what Horling & Lesser [14] categorize as 'congregations' in terms of

rather loosely collaborating agents: the subsystems make their partial choices autonomously without ‘asking’ the other one. The two companies do not need to discuss their own decision combinations and can only use the initial decision of the other subsystem as a reference.
(3) In the ‘assimilation mode’, the culture of the acquiring company dominates, so manager in acquiring company has priority access to the target company's new combination, while manager in target company only needs to refer to the original decision.
(4) The process of ‘reverse merger mode' is opposite to that of assimilation mode. The culture of the acquiring company is subordinate to the target company.

2.3 Managers' experience dependency

Based on a certain amount of direct or indirect experience, humans can use a combination of induction and deduction to summarize causal relationships between elements [15]. Management team form cognition through deduction and inductive reasoning. Due to the limitations of bounded rationality [16], the dimensions of cognition formed by managers based on their own experience are much lower than those in the real organizational environment. Schoemaker discussed that decision makers tend to stick to past successful strategies, which simplifies the decision-making process but can easily lead to ignoring changes in the environment [17].
In this study, we will set up an experience dependency ratio (*POE*) to represent the degree to which managers rely on experience. The characteristic of the manager of the acquiring company are represented by POE_A, and the characteristic of the manager of the target company are represented by POE_T. A higher *POE* means that the manager trusts experience more and is unwilling to search for more decision combinations in the local NK of the subsystem. The CEO represents the person or department with decision-making power at the headquarters, and also has an experience dependency rate (POE_CEO), which plays a role in conjunction with the nature of the enterprise discussed below.

2.4 The nature of state-owned enterprises

State-owned enterprises are the backbone of China's economy. The corporate culture is imbued with traditional Chinese cultural characteristics, which emphasizes collectivism, concentration of power, and is surrounded by a strong political atmosphere [18]. Quantitative analysis of the degree of attention paid by state-owned enterprises to different acculturation modes is not common,but many literature points out that state-owned enterprises tend to pursue national interests and political goals, often focusing more on the interests of the acquiring party and resource integration, while ignoring the interests of the acquired party [19]. In this study, when the CEO discovers a conflict between the decision combination submitted by the subsystem and the decision based on experience, it is necessary to check whether the conflict item comes from the acquiring company or the target company. The CEO places more

emphasis on the new decisions of the acquiring company and neglects the plan from the target company. A high POE_{CEO} means that the CEO can compare more decisions based on past experience. If the conflict occurs in the acquiring company, the experience selection will be replaced by a new state; if the conflict item occurs in the target company, the CEO needs to stick to the initial experience selection.

2.5 Simulation Experiments

When two companies merge, the acculturation mode and interaction matrix will both affect the interaction of decision-making. Levinthal believes that the fewer interactions, the easier it is to find the optimal solution [20]. The new organization has two subsystems running, and we first need to analyze the impact of K (K_{in} and K_{bw}) under different acculturation modes. For a given initial environment, the computer will perform 100 searches on each combination and represent its performance with the average value. In the two subsystem models, we need to consider the interactions between internal and external factors. The multiple peaks caused by these interactions weaken the possibility of searching for "vertices".

Next, we will observe the impact of the experience dependency of subsystem managers on performance effectiveness in different modes. Existing research has shown that relying on experience for decision-making can achieve results quickly, but it is easy to overlook environmental changes. So we tested the long-term and short-term average performance and compared them.

Finally, after analyzing the complexity of the organization and the experience dependence of managers, the experiment also combined the nature of the enterprise with the CEO's experience dependence to analyze overall performance.

The search strategy for management characteristics is as follows:

(1) The managers of two subsystems (the acquiring company and the target company) confirm in the subsystems that the projects with the original configuration can be retained based on experience;

(2) Managers need to determine the decision combination of another subsystem based on different acculturation modes;

(3) Perform a local search for other N/2*(1-POE) decisions within the subsystem. The specific method is to observe the performance value of each decision in the N/2*(1-POE) items after individually changing it, based on the starting point, and select the maximum value as P' if P' >P, then use the decision configuration corresponding to P' as the new starting point to repeat the above search work until performance cannot be further improved;

(4) The manager submits the new decision combination to the CEO, then, CEO makes the final judgment based on experience and the nature of the enterprise.

3 Results

There are multiple types of randomness present in experiments: the randomness of the influence matrix and the performance contribution degree C_i of individual decisions in the generation process of performance landscape; the decision items determined by

managers and CEO based on experience have randomness; moreover, within the established performance landscape, the starting point of the search process is also random.

In order to eliminate the randomness mentioned above, this study randomly generated 100 performance landscapes under the same conditions, conducted 100 searches on each performance landscape, and took the normalized average performance value of all search activities as the performance value under this condition.

3.1 Organizational Complexity and Acculturation Modes

When the manager's dependence on experience is 0, it means that there is only passive search under the NK model in the subsystem; in state-owned enterprises, the CEO's dependence on experience is 0, which means that the organization provides equal opportunities for the decision-making combination submitted by the acquiring company and the target company. At this point, we observe the relationship between organizational complexity and acculturation modes. Taking N=8 as an example, the managers of each subsystem are responsible for N/2=4 decisions. The performance under different modes is shown in Table 2. $K_{in}+K_{bw}$ is the total K value corresponding to each decision after merging.

Table 2. Performance under the influence of organizational complexity & modes

K		Mode			
K_{in}	K_{bw}	Integration	Separation	Assimilation	Reverse Merger
0	0	1	1	1	1
0	1	0.973	0.844	0.948	0.953
0	2	0.935	0.822	0.929	0.927
0	3	0.930	0.814	0.892	0.900
0	4	0.908	0.807	0.880	0.888
1	0	0.971	0.982	0.970	0.974
1	1	0.953	0.845	0.922	0.923
1	2	0.926	0.774	0.893	0.902
1	3	0.912	0.724	0.877	0.902
1	4	0.882	0.765	0.869	0.881
2	0	0.942	0.943	0.945	0.935
2	1	0.937	0.805	0.916	0.907
2	2	0.900	0.764	0.891	0.890
2	3	0.892	0.720	0.872	0.871
2	4	0.877	0.718	0.858	0.861
3	0	0.918	0.921	0.917	0.905
3	1	0.896	0.802	0.896	0.889
3	2	0.894	0.729	0.880	0.874
3	3	0.883	0.705	0.848	0.857
3	4	0.850	0.699	0.833	0.834

Although the two subsystems are merged together, they will still be consistent with the conclusion of the NK model in an organization: the lower the K value, the easier it is to achieve higher performance. In addition, the performance of the separation mode is significantly lower than the other three modes. This is because the subsystem in the separation mode is completely indifferent to the decisions of another subsystem, making partial choices autonomously without "consulting" other managers; subsystems in integration mode communicate the latest decisions and make decisions accordingly; the assimilation and reverse merger modes involve managers in the "low position" not inquiring, while managers in the "high position" will inquire about the other party. It can be seen that communication is very important in actual mergers and acquisitions.

3.2 Experience Dependence on Managers

Due to the bounded rationality of managers, they are able to focus on some decisions (POE*N/2) rather than all of them (N/2). Managers who rely heavily on past experience are unwilling to change known focus decisions, regardless of whether the new choice is more in line with the post-merger environment. This means that the subsystem can search for local optimal values among N/2*(1-POE) decisions.
We observe the impact of experience dependence on the managers of the acquiring company and the target company separately.

Table 3. The influence of experience dependence and modes

POE		Mode			
POE_A	POE_T	Integration	Separation	Assimilation	Reverse Merger
		Performance in period 100			
0	0	0.946	0.846	0.924	0.930
0	0.5	0.895	0.825	0.886	0.885
0	1	0.849	0.807	0.847	0.838
0.5	0	0.893	0.822	0.894	0.881
0.5	0.5	0.830	0.773	0.822	0.838
0.5	1	0.780	0.768	0.753	0.762
1	0	0.849	0.842	0.845	0.823
1	0.5	0.752	0.741	0.768	0.772
1	1	0.682	0.701	0.666	0.679
		Performance in period 10			
0	0	0.875	0.828	0.914	0.914
0	0.5	0.857	0.817	0.872	0.865
0	1	0.828	0.813	0.829	0.825
0.5	0	0.856	0.821	0.868	0.865
0.5	0.5	0.831	0.789	0.826	0.822
0.5	1	0.766	0.751	0.759	0.744
1	0	0.827	0.831	0.830	0.827
1	0.5	0.745	0.765	0.769	0.754
1	1	0.669	0.676	0.672	0.659

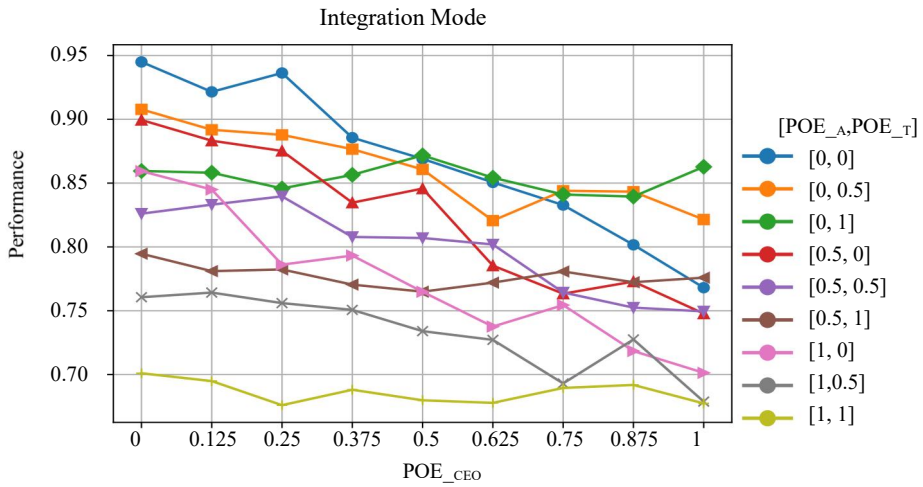
*Note: POE=0, 0.5 and 1 were chosen in the experiment to represent managers not constrained by inherent experience, managers partially constrained, and managers fully trusting experience. A or T represents the acquiring company and the target company. K_{in}=1, K_{bw}=1

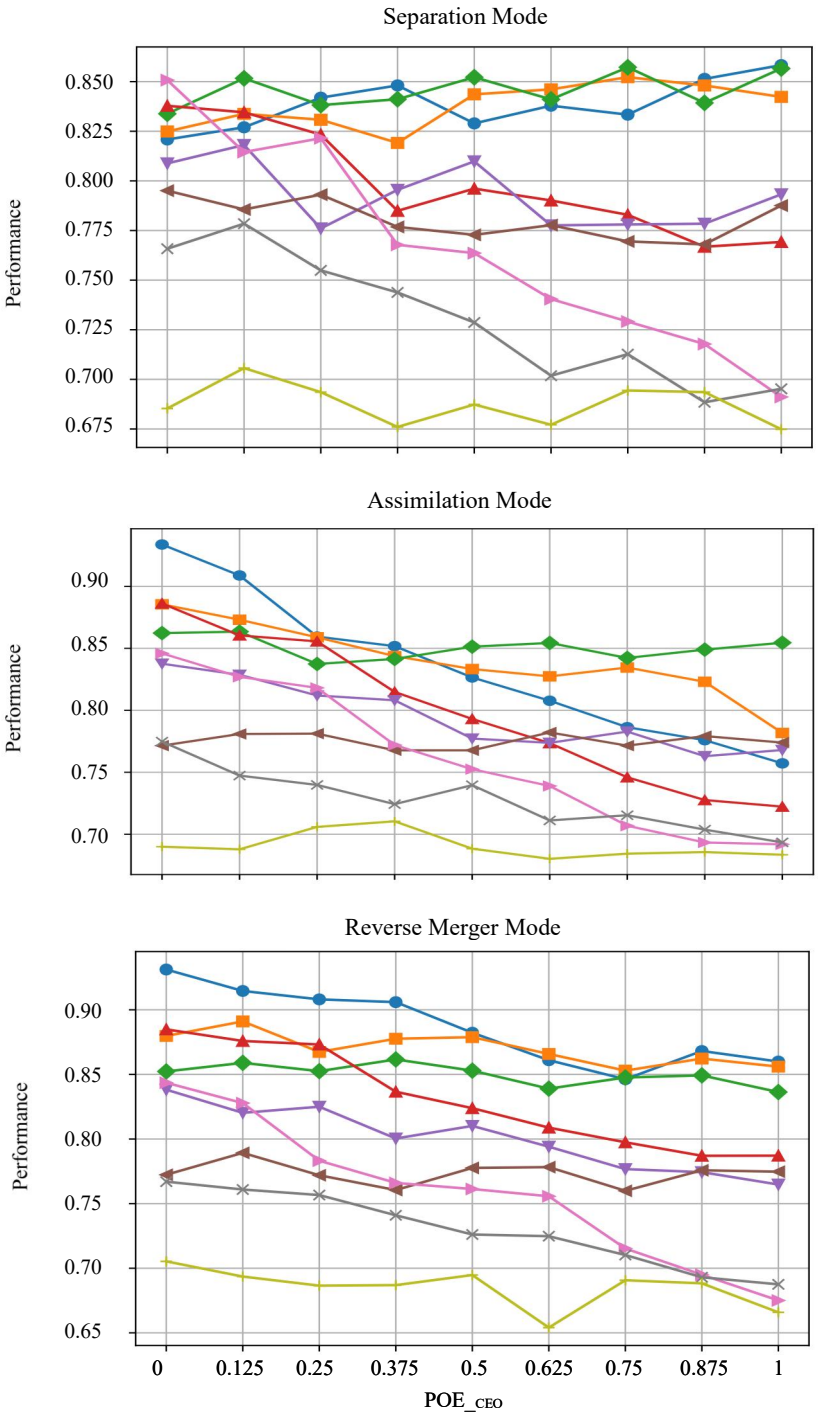
In the long run, managers' high dependence on experience is not conducive to decision-making after mergers and acquisitions. When the dependence on experience is low, the integration mode can simultaneously examine the decision interaction of two subsystems, so the performance is the highest among all modes. The operation way of assimilation mode and reverse merger mode is similar, with performance second only to integration one. In the separation mode, there is no interaction between managers of subsystems, resulting in the worst performance. As the dependence on experience increases, these differences gradually disappear.
In the short term, the conclusion regarding experience dependency is consistent, but the advantage of integration mode disappears first when dependency is low, leaving insufficient time for subsystems to search for local optimal solutions.

3.3 Experience Dependence and the Nature of SOEs

The experience of a CEO does not solely affect decision-making, but needs to be combined with the nature of state-owned enterprises to play a role. Due to bounded rationality, CEO also tends to focus on key items within decision clusters. State owned enterprises place greater emphasis on the interests of the acquiring company. When the CEO discovers that the decision-making state based on experience is inconsistent with that of the acquiring company, they will abandon the experience gained and adopt the acquiring company's plan; when the key decision state is inconsistent with the target company, they will choose the experience gained. We grouped the managers based on their experience dependency.

Fig. 2. The impact of experience dependence and nature (*Note: K_{in}=1, K_{bw}=1)




Separation Mode
Performance
0.850
0.825
0.800
0.775
0.750
0.725
0.700
0.675
Assimilation Mode
Performance
0.90
0.85
0.80
0.75
0.70
Reverse Merger Mode
Performance
0.90
0.85
0.80
0.75
0.70
0.65
0
0.125
0.25
0.375
0.5
0.625
0.75
0.875
1
POE_CEO

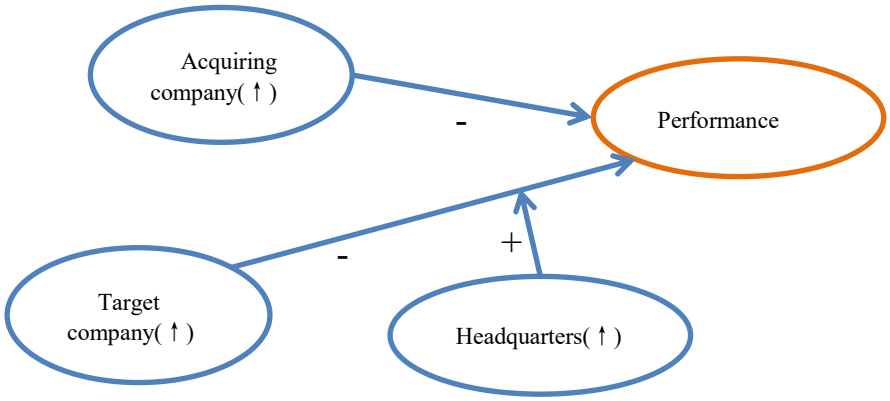
1) In the separation mode and reverse merger mode, as the CEO's experience dependence increases, it gradually concentrates on the classification of the acquiring company's experience dependence. This is because these two modes use the original target company decisions as the search basis, which is consistent with the high dependence of CEO on existing experience.
2) When the experience dependence of the target company's managers increases, the rate of performance decline decreases. When the dependence of the CEO increases, the impact of the nature of the enterprise on the target company is consistent with that of the manager.
3) When both the CEO and manager have a high dependence on experience, there is no significant difference between the four modes.
The separation mode has the worst performance, as managers lack the desire to communicate and make decisions with each other; the integration mode has universality and is more likely to achieve relatively good performance among the four modes; the assimilation mode can gain some benefits in state-owned enterprises, while being sensitive to the experience dependence of acquiring companies; the sensitivity of the reverse merger mode to the target company's experience dependence is weakened in state-owned enterprises.

4 Discussion

The most significant impact of the interaction between organizational complexity and acculturation modes is the separation mode, in which the two subsystems do not communicate with each other, so there is no active interaction from the management, and they rely more on NK passive search. This is consistent with the conclusion of the NK basic model, that is to say, the less interaction there is, the easier it is to achieve high performance.
The higher the dependence of managers and CEO on past experience, the more likely they are to limit the search for local optimal solutions. In the context of bounded rationality, excessive reliance on past experience is a typical phenomenon, especially in organizational or management decisions, which may lead decision-makers to overlook the complexity and uncertainty of current environmental changes due to excessive reliance on past successful experiences. The cognitive framework brought by past experience may limit the decision-maker's perspective, making it difficult for them to correctly identify new problems or challenges. But in SOEs, combining acculturation modes can make this situation more complicated.
When the experience dependence of two subsystems is very high, the post-merger organization has no direct impact on the choice of mode and the hiring of CEO with different abilities, and the variability of decision-making status is very low.
When the experience dependence of two subsystems is very low, an increase in the CEO's experience dependence will cause a decline in the performance of integration mode and assimilation mode, as the search of these two modes will make judgments after receiving new decisions from the subsystems. Similarly, the reverse merger mode is also affected by new decisions, but the nature of SOEs can help the mode selectively

abandon the new decisions of the target company, so the impact is relatively small. Meanwhile, the separation mode based on the original decision exhibits better stability. As the experience of subsystems and CEOs changes from low to high, the dependence on experience inevitably weakens overall performance. Figure 3 illustrates the impact mechanism of increased experience dependence on performance.

Fig. 3. the impact mechanism of increased experience dependence



At the same time, we have to admit that there are not many public cases of cultural integration after mergers and acquisitions of state-owned enterprises, and there are difficulties in extracting effective parameters that can be verified by combining simulation models. The specific acculturation modes and the experience dependence of management personnel do not always appear in the correct way, and when applied to this model, it requires internal cooperation within the company to provide real data for more effective integration.

5 Conclusion

This model takes state-owned enterprises as the background and uses an enhanced NK model to study the impact of management team experience dependence on cultural integration under different modes.

The less interaction between decisions, the easier it is to achieve better performance.

Managers rely on experience to make decisions, which can achieve performance requirements in a shorter period of time, but they are prone to overlook the changes brought about by the new environment.

The nature of state-owned enterprises has different compensatory effects on performance decline caused by experience dependence under different modes.

This study has certain significance for the cultural integration of state-owned enterprises after mergers and acquisitions, and can provide reference for different management structures. It contributes to the practical management and theoretical understanding of dynamic cultural integration after mergers and acquisitions of state-owned enterprises.

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