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Moderating Role of Environment on the Relationship of Competitive Strategy and Firm Performance: Based on Machine Learning and Text Analysis



Abstract: - The impact of competitive strategy on firm performance has been a fundamental and important issue. However, there is a little research on moderating role of environment on the relationship, especially moderating role of different dimensions of environment. This study employs the technology of machine learning and text analysis to obtain the measure value of competitive strategy and environment. On this basis, the research empirically investigates the moderating effect of environmental dynamism, complexity and competitiveness on the relationship between competitive strategy and organizational performance. The results show that both types of competitive strategy can improve corporate performance, environmental characteristics have a significant impact on the causal relationship mentioned above, and there are differences in the moderating effects of different environmental dimensions. Some conclusions are inconsistent with the research of foreign scholars. The differences in conclusions reflect the impact of China's transitional economic environment on corporate competitive strategy decisions and result.

Keywords: cost leadership strategy, differentiation strategy, environment, moderating role, firm performance, machine learning method.

I. INTRODUCTION

Currently, the competition becomes increasingly intense and complicated. If the enterprise wants to obtain a sustainable competitive advantage, firms need implement clear strategy. The impact of competitive strategy on firm performance has been a fundamental and frontier issue in strategic management research. At present, the focus of the research has been shifted from the "whether influence or not" to "the way and mechanism of influence". Empirical studies have shown that there is positive and complex relation[1,2]. Scholars in contingency strategic management area show that the environment has a moderating effect on the relationship between competitive strategy and firm performance[3]. However, the related research abroad is based on mature environment, while one of the characteristics of Chinese economic transformation is the imperfect market environment[4,5]. So, in current market environment, how does the basic competitive strategy affect the performance? This is a meaningful topic.

In addition, the related research regards the environment as a dimension variable when the moderating role of environment is examined. The measurement of the single dimension of the environment limits the explanatory power of the environment to the different competitive strategies. Different dimensions of environment have different moderating effects, so it needs to be discussed in different dimensions. This study attempts to further expand in this respect. Based on Chinese transitional economic environment, this article mainly analyzes the relations between the cost leadership strategy, differentiation strategy and firm performance, as well as the moderating role of the environment dimensions of dynamic, complex and competitive. This study tries to reveal that how the competitive strategy of the firm under the economic environment of China affects the firm performance.

Technology of natural language processing provides an opportunity for measuring competitive strategies. Domestic and foreign literature studies have shown that financial statement texts contain a large amount of incremental information. Therefore, this article takes the financial reports of A-share listed companies in Chinese stock market as the research sample, and uses machine learning method to construct and measure indicators of competitive strategy and environmental characteristics.

II. LITERATURE REVIEW AND RESEARCH HYPOTHESIS

Porter proposed three basic competitive strategies and pointed out that the successful implementation of one of the strategies can gain a competitive advantage and bring a performance growth. The focus strategy applicate to a specific target market. So, the competitive strategy is limited to cost leadership strategy and differentiation strategy in this study. The empirical research of many scholars show that it can improve firm performance if firms make

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clear competitive strategies[6], but some results have showed that the competitive strategy is irrelevant or weakly relevant to firm performance. Some researchers find that competitive strategy does not directly affect the performance of a firm by examining the performance of Ghana's manufacturing companies, but it indirectly affects the performance of the business through a positive correlation of the manufacturing strategy.

In order to obtain a more scientific explanation, some scholars try to explore the mechanism between the two types by adding mediation variables. The main mediating variables were innovation[7], dynamic capabilities[8], manufacturing strategy[9]. Some scholars have suggested that competitive strategies work differently in different scenarios[10], and the moderating variables should be added to the simple bi-variate relationship model of competitive strategy and performance[11]. Regulating variables have defined the boundary conditions, affecting the strength or direction of the relationship. Regulating variables can be divided into external environment, industry characteristics and other environmental variables, as well as organizational structure, resources, culture and other organizational variables in two categories. Under different environmental characteristics and organizational conditions, the role of competition strategy and performance is different. In this study, only one of the most important contingency variables in strategic management was selected as regulatory variables to study the regulatory effect. It is environment.

As important contingency variable, the environment has attracted attention from scholars in the empirical research of the performance relationship of enterprise competition strategy[12]. In the study of the environment, some scholars use the concept of single dimension to research the moderating effect of environmental uncertainty. However, environment has multiple dimensions, and the effect of different dimension of environment on competitive strategic performance is different. It needs to be treated differently. With regard to the division of environmental dimensions, the relevant research is rich and the expression is complex and diverse, such as dynamics, stability, complexity, heterogeneity, looseness, hostility, competitiveness and so on. Among existing literatures, Dess & Beard classification is more classic and adopted by many scholars[13]. Dess & Beard divides environmental characteristics into three dimensions: dynamics, complexity, and competitiveness. The dynamics of the environment mainly focuses on the rate and instability of environmental change. The complexity refers to the quantity and nature of the environmental factors taken into account in the decision-making process. The competitiveness refers to the competitive strength, resource constraints and threats in the environment. In this study, we use this classification to examine the moderating effects of environmental dynamics, complexity and competitiveness.

Environmental dynamics is related to the rate of unpredictable changes in the corporate environment, which is derived from continuous changes. The dynamics of the business environment is manifested in many aspects, such as changes in politics, economy, technology, culture and competition, and so on. Under the conditions of globalization and information technology, the dynamic characteristics of the environment are more obvious. In high dynamic environments, frequent changes in consumer preferences and competitors' products require companies to innovate or the market occupation, so that consumers believe in the superiority of their new or existing products. In other words, the changing environment is suitable for the differentiation strategy to provide relevant or more attractive products[14]. The differentiation strategy is more innovative and adventurous, and these tendencies are more suitable for dynamic environments. On the contrary, cost leadership strategy is more suitable for a stable and predictable environment. In order to maintain low unit costs, large fixed asset investments may be required, and a stable environment minimizes investment risk. Unstable changes require too much modification of the product and process and will make the long-term accumulation of experience comes to naught, which is contrary to the requirements of cost leadership strategy. Therefore, we make the following assumptions:

H1a: In a high dynamic environment, the relationship between cost leadership strategy and firm performance will be weakened.

H1b: In a high dynamic environment, the relationship between the differentiation strategy and firm performance will be enhanced.

Environmental complexity refers to the diversification of customer needs and expectations in the market segment, the diversity of competition and technology[15]. Low complexity means that the factors that affect the company's operations are relatively simple and high complexity means that the company is in a diverse market and demand environment (such as diversified and globally operated companies) that increases the difficulty of making strategic decisions, but it also provides the opportunity to develop market segments and new markets for the company to support the company's product line expansion and extension, leaving a wide space for the company's innovation. The competitive advantage of the company which is in the complex environment lies in the differentiation and characteristics of the products and services provided. In a complex environment, economies of

scale, technological capability and first-mover advantage are of decisive significance for the company's strategic advantages. Therefore, differentiation strategy has better performance in a high complex environment, cost leadership strategy is more suitable for a low complex environment. So, we make the following assumptions.

H2a: In a high complex environment, the relationship between cost leadership strategy and firm performance will be weakened.

H2b: In a high complex environment, the relationship between the differentiation strategy and firm performance will be enhanced.

Environmental competitiveness refers to the extent of the threat to the enterprise caused by the versatility and intensity of competition, and the rise or fall of the major industries. There are two aspects of environmental competitiveness, one is the scarcity of resources required, and the second is the degree of competition. In a high competitive environment, the limitation of effective resources enables enterprises to only focus on improving operating efficiency to reduce costs without the need to monitor and produce consumer demand[16]. The low competitive environments provide the resources needed for innovation and differentiation. Therefore, the high competitive environment is more suitable for cost leadership strategy, while the competitive environment is suitable for the differentiation strategy.

Wu et al. examine the moderating role of environmental hostility by the sample from 32 industries in 30 countries based on the global economic recession[17]. Empirical results show that differential-oriented firms are less efficient than efficiency-oriented firms during periods of economic recession; differentiation does not necessarily increase profitability, the reason is the lack of market opportunities and excessive competition leads to the competitive advantage by differentiation cannot produce immediate benefits in a hostile environment. Of course, some scholars have the opposite view, the empirical study found that in a competitive environment, innovative adventure aggressive strategy possesses high performance; and in a relaxed environment, the conservative enterprise has a high performance. Innovative adventures are often associated with differentiation strategies, while conservatism is a feature of cost leadership strategies[18]. This study temporarily accepts the views of most scholars and puts forward the following assumptions.

H3a: In a high competitive environment, the relationship between cost leadership strategy and firm performance will be enhanced.

H3b: In a high competitive environment, the relationship between the differentiation strategy and firm performance will be weakened.

III. RESEARCH DESIGN

A. *Samples and Data Sources*

In this paper, the listed companies in the stock market from 2011 to 2021 are selected and the data are processed. Firstly, excluding abnormal samples with insolvency. Secondly, excluding samples with missing values of relevant variables. At last, we obtain 25667 data. To eliminate the effect of extreme values, the analysis is done at 1% and 99%. The text data of this paper comes from WinGo financial text data platform.

B. *Keyword Extraction and Variable Measurement*

To construct a vocabulary of competitive strategy, this article first sorts out the concepts of competitive strategy and extracts vocabulary that describes the characteristics of strategy. Porter's theory suggests that implementing a cost leadership strategy is mainly achieved through strict cost and expense control, the introduction of automated machinery and equipment to improve production efficiency, and other means. Implementing a differentiation strategy emphasizes the uniqueness and differentiation of products and services. Dess & Davis argue that companies typically achieve cost leadership strategies by controlling costs and expenses through operational efficiency, competitive pricing, raw material procurement, and innovative production processes. Enterprises implementing differentiation strategies pay more attention to new product research and development, brand positioning, and marketing technology innovation[1]. Dess & Davis analyzed and summarized 21 factors to measure the types of competitive strategy. Subsequently, most of the research's indicator set was based on the research and adjusted appropriately. Kim et al. obtain factors for the competition dimension of e-commerce companies based on 18 variables[19].

By reviewing existing classic literature on competitive strategy, this article summarizes the relevant vocabulary of competitive strategy and extracts text keywords. This article distributes the revised strategic vocabulary collection to two scholars and industry experts in the field of strategic research for review and feedback, ultimately

forming the vocabulary set of competitive strategy[20]. Among them, 11 key words characterize differentiation strategy and 13 key words characterize cost leadership strategy.

The design of the environmental characteristic scale is relatively mature. The measurement of the dynamism, complexity, and competitiveness of the environment in this article is based on the scale developed by Dess & Beard, and combined with the research of other scholars on concept definition and feature discussion, their respective feature keywords are extracted.

After determining the word set of competitive strategy and environment characteristic, this study expands the word set with similar words by employing the supervised machine learning method[21,22].

The statistical results of extracting keywords for competitive strategy and environmental characteristics are shown in Table 1.

Table 1: The Statistical Results of Extracting Keywords

Variable	Keywords
Low cost strategy (COST)	Cost control, budget management, cost management, lean management, comprehensive budget management, refined management, target cost, expense control, cost reduction and efficiency improvement, process control, utilization efficiency, process innovation, raw materials
Differentiation strategy(DIFF)	Brand promotion, brand management, corporate branding, marketing, brand marketing, product innovation, marketing innovation, exploring new products, high priced segmented markets, independent innovation, differentiation
Dynamics	Changes, frequency, updates, opponent actions, unpredictability, development changes
Complexity	Multiple markets, market differences, different products, different services, diverse demands, and diverse approaches
Competition	Resource acquisition, government regulation, suppliers, price competition

The value of variables in table is the one percent of the frequency of key words respectively, which is obtained by the technology of machine learning and text analysis.

Kim et al. and other scholars use corporate potential of growth to measure the business performance[19]. This research uses the index of the return on total assets (ROA) to measure enterprise performance.

C. Moderating Regression Model

The conceptual model of this study is based on the contingency theory, that is, the correlation is affected by the variable of the environmental characteristics. The nature and the level of the contingency variables, as well as the interaction between the contingency variables and main variables will have a complex impact on firm performance. Moderating Regression Analysis is suitable for verifying the hypothesis of contingency relationship. In this study, the method of moderated regression analysis is used to validate the hypothesis in the study[23]. The interactive data are processed centrally in this study to avoid the problem of collinearity in the regression equation.

IV. EMPIRICAL RESULTS

A. Correlation of Variables

The Correlation coefficients matrix of variables is shown in Table 2. It can be seen that there are different degrees of correlation among the dynamics, the complexity and the competition of the environment (maximum value is 0.576 and minimum value is 0.367). However, there is a non-shared variance from 66.82% to 86.53%, which means that the three dimensions of the environment tend to be independent of each other. In addition, from the results of regression analysis in Table 3, we can see that the moderating effect of environmental dynamism, complexity and competition on competitive aggression and performance is different.

Table 2: Correlation Coefficients Matrix of Variables

	COST	DIFF	Dynamics	Complexity	Competition	ROA
COST	1					
DIFF	0.126	1				
Dynamics	0.183*	0.417**	1			
Complexity	0.201	0.266*	0.367**	1		
Competition	-0.303	-0.415*	0.411**	0.576***	1	
ROA	0.355**	0.557***	0.290*	0.314	-0.283*	1

Note: *, ** and *** mean significance level: 10%, 5% and 1% respectively.

B. Results of Adjustment Effect Test

In Table 3, the model 1 is basic model, the model 2, 3, 4 is the model for adding the interaction effect. In all models, the index of F-value is greater than the critical level of 0.01 of four models, indicating that the overall significance of the model is great.

Model 2 shows the moderating effect of environmental dynamism. It can be seen from the results, the impact of the cross terms of dynamic environments and cost leadership strategy is negative (-0.340), but the coefficient is not significant. H1a failed to obtain full support. The impact on performance in the cross terms of environmental dynamics and the differentiation strategy is positive (0.196), and the coefficient is significant. The result indicates that the environmental dynamics has a significant positive moderating effect, and it means that H1b get supported.

Model 3 shows the moderating effect of environmental complexity. The results show that the impact on performance in the cross terms of environmental complexity and cost leadership strategy is positive (-0.340), but the coefficient is not significant. H2a failed to obtain full support; the impact on performance in the cross terms of environmental complexity and the differentiation strategy is negative (-0.339), and the coefficient is significant, which is contrary to the expectation of this study, so H2b is supported in reverse.

Model 4 shows the moderating effect of environmental competition. The results show that the impact on performance in the cross terms of environmental competition and cost leadership strategy is positive (0.362), and the coefficient is not significant. So H3a failed to obtain full support. The impact on performance in the cross terms of environmental competition and the differentiation strategy is negative (-0.127), and the coefficient is significant, which is contrary to the expectation of this study, so H3b is supported.

Table 3: The Basic Regression Model and Moderating Regression Model

Variable	Model 1	Model 2	Model 3	Model 4
COST	0.419(3.561)***	0.295(3.208)***	0.335(4.037)***	0.614(2.213)**
DIFF	0.502(7.716)***	0.457(4.993)***	0.507(5.996)***	0.527(5.239)***
Dynamics		0.238(0.750)		
COST × Dynamics		-0.340(-1.268)		
DIFF × Dynamics		0.196(1.755)*		
Complexity			0.379(1.007)	
COST × Complexity			-0.503(-0.816)	
DIFF × Complexity			-0.339(4.936)***	
Competition				-0.377(-6.291)***
COST × Competition				0.362(1.005)
DIFF × Competition				-0.127(-4.644)***
F	44.059***	32.671***	27.005***	31.783***
VIF		4.562	5.164	6.789

Note:(1) the dependent variable is the firm performance; (2) the model does not report the constant item

V. RESEARCH CONCLUSION AND MANAGEMENT IMPLICATIONS

A. The Impact of Competitive Strategy on Firm Performance

The empirical results show that the implementation of strategy can enhance the enterprise performance. Therefore, enterprises in the fierce competition must develop and implement a clear competitive strategy based on internal resources and external environment. Enterprises implementing cost leadership strategies should effectively control cost drivers, restructure their value chains, provide the business efficiency through learning and integration, thereby gaining cost advantages and improving corporate performance. Enterprises that implement differentiation strategies should research or develop sound distribution channels so that enterprises are different from their rivals in the brand image, technical characteristics, appearance characteristics, customer service, the distribution network and other aspects to obtain competitive advantages of differentiation.

B. The Moderating Role of Environmental Dynamics

H1a is supported. It means that environmental dynamics has a negative moderating effect on the relationship between cost leadership strategy and firm performance, but it is not significant. This shows that in a volatile environment, the competitive advantage created by low-cost competition is easy to be eroded and lost. Due to the rapid development and dissemination of information technology and network technology, the new technology is spread more widely and rapidly, and the product life cycle is greatly shortened. Rapidly changing product innovation and technological innovation make the existing resources of the enterprise inefficient, it may be the way of competition, the field changes. The executor of cost leadership strategy is mainly due to its emphasis on stability rather than change, and focus on the production process rather than product innovation in the research and development, therefore its effective resources can easily be eroded by the development of technology, contributing to the loss of competitive advantage. Porter also pointed out that a fatal drawback of low-cost is that technological change in the industry would lead to a breakthrough in the production process and technology, which made a large number of firms that have implemented a cost leadership strategy lose the advantages that have invested vast funds and high efficiency from the funds, and meanwhile provided opportunities for their rivals to enter the market with lower cost.

H1b is supported. It means that the firms of implementing differentiation strategy have better performance in a high dynamic environment. Differentiated strategy-oriented firms have the characteristics of innovation and change, and are mostly willing to accept high-risk, high-paying programs, and always take a bold and positive attitude to seize the opportunity to strengthen the organization to build a competitive advantage persistently in a dynamic environment. Rapid changes of the market and technology provide favorable conditions for companies to create differentiated benefits, which can make it easier to adapt to changes in the environment.

C. The Moderating Effect of Environmental Complexity

H2a is partly supported by the fact that the environmental complexity has a negative moderating effect on the relationship between cost leadership strategy and firm performance, but it is not significant. The conclusion is consistent with the expectation, which shows that in the simple environment, the cost leadership strategy can give full play to its competitive advantage.

H2b is supported. It means that the complexity of the environment has a negative moderating effect on the relationship between the differentiation strategy and firm performance. This shows that in a high dynamic environment, the company that uses a different strategic posture may get low performance, which is contrary to the author's expectations, and meanwhile is opposite with the results studied by other scholars. The difference in this result is a reflection of the differences in the competitive strategy of enterprises in different economic environments. The results of this study can be explained from the characteristics of China's transitional economy corporate strategic decisions.

The complexity of the environment weakens the judgment of decision making on environmental factors and decision outcomes, but also provides opportunities for the development of market segments and new markets. In the western market economic normative environment, the company would scan and predict markets prudently before implementing the differentiation strategy to minimize the adverse effects, which shows a "cautious and rational" competition behavior. However, in the current economic of China's transition period, there exists a large number of uncertain factors in the business environment due to the rule of law is not perfect, the credit system is not complete, the economic subject behavior is not standardized, and the enterprise regime is not perfect and so on, so that it is very difficult for enterprises to make accurate judgments on the external environment, and strategic decision and the implementation process of companies face greater risk. As a result, the strategic actions of differentiation of many enterprises may be a "risk" competitive behavior. Thus, many firms' differentiated strategic actions may be a "risky" competitive behavior. As a result, the risk-taking behavior of enterprises operating in high complex environments will be punished and associated with low firm performance[32].

D. The Moderating Effect of Environmental Competitiveness

H3a and H3b are partly supported. The conclusion is consistent with the expected hypothesis, and is consistent with study of Acquaaah Moses. The study the relationship on the competitive strategy, environmental characteristics and performance of the African Garner enterprise, finally obtaining the following conclusions: the strength of industrial competitiveness has a moderating effect on the relationship between cost leadership strategy and sales profit margin, as well as the relationship between the differentiation strategy and sales return rate. And cost

leadership strategy is more suitable for competitive industries, and differentiation strategy is more suitable for monopoly industries.

However, this study further finds that, even if the cost leadership strategy is adopted, the group performance of enterprises in a high competitive business group is significantly lower than the enterprises in a low competitive environment. This shows that the enterprises in the high competitive environment are mainly for survival, especially in the environment of fierce price competition. At the end of twentieth Century, the competitive behavior of household appliance industry in China confirm the results of this study. As Dess & Beard said environmental competitiveness means that there exists a high intensity of competition, a small number of market opportunities that can take advantage of and uncertainty of market and product, companies are affected direct by the forces and factors in the external environment, therefore survival is the primary objective of the enterprise.

In this study, we find that the environment does affect the performance of enterprise competitive strategy. It is the enterprises in a transitional economy that shows the environmental complexity, dynamics and competitiveness. However, it should be emphasized that Chinese firms in the transitional economy carry out business activities in a dynamic environment influenced by technological changes and fierce competition, the form of moderating effects that environmental characteristics on competitive strategy performance is different from the form in a mature market economy. It needs pay special attention in the empirical study. Due to facing more dynamic changes, more complexity and uncertainty, the effective management of Chinese enterprises in the turbulent environment presents more severe challenges and more urgent requirements. Therefore, it is a difficult problem that any enterprise must face up to the relationship scientifically.

In addition, using machine learning and text analysis methods to measure competitive strategy and environmental characteristics, the measurement method for these variables has been optimized, greatly avoiding information bias that may arise from relying on third-party databases.

VI. LIMITATIONS

Firstly, cross-section research design is adopted, but the competitive strategy, the implementation of competitive behavior and environmental changes needs to go through a certain period of time, the future study of the use of longitudinal design will be more conducive to further explore the relationship among these variables. Secondly, the control variables may have an impact on the model and the various assumptions. Subsequent studies can introduce relevant control variables in the analysis to obtain more detailed results.

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