Self-organizing type, Innovation Path and Enterprise Performance: Mechanism and Empirical Analysis

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Abstract
To measure the relationship between Self-organizing type, innovation path and firm performance, the study uses a structural equation model and a confirmatory factor analysis method to conduct empirical tests on the basis of in-depth interviews with electronic information enterprises in the Pearl River Delta. The research shows that the higher the degree of synergistic self-organization, the better the enterprise performance. The higher the degree of collaborative self-organization, the more enterprises are inclined to choose the independent innovation path, and the influence of collaborative self-organization on the independent innovation path is obviously higher than the positive influence on the imitation innovation path. Additionally, eventually, the more inclined the enterprise is to choose the independent innovation path, the better the enterprise performance will be, while the imitative innovation path has no significant impact on the enterprise performance. Simultaneously, by building a model and survey data, it is found that the imitative innovation path can promote the independent innovation path, it shows that the incremental imitative innovation path also plays a certain role in promoting the improvement of enterprise performance.

Keywords-*Collaborative Self-organization; Innovation Path; Enterprise Performance*

1. INTRODUCTION

J.A Schumpeter (1912) put forward the economics of innovation, pointing out that "innovation is an engine of organizational economic development"[1]. With the increasingly prominent status of the knowledge economy, especially under the situation of global economic development slowing since the COVID-19 epidemic, the circular economy theory of self-organization system and its sustainable development has become the focus of academic circles at home and abroad. At present, the world is experiencing a new round of technological change and industrial update critical period, such as cloud computing, artificial intelligence and the Internet of things technology innovation emerging endlessly, the enterprise profit model and industrial agglomeration process have had a profound effect, new industries, new energy have become the core factors that affect economic development. Enterprises constantly seek self-organizing forms suitable for their own development to improve corporate performance and expect to win the first opportunity in the fierce market competition. Enterprise organization is a complex system, and it is difficult to describe the operational laws of the enterprise system through several variables. Only through field investigation and research can the agglomeration law among enterprises be revealed. This research idea is to establish the production activities of enterprises on the basis of self-organization theory, using competition or collaborative cooperation strategy. In order to adapt to the external environment, enterprises must constantly conduct innovation and organizational reform.

2. LITERATURE REVIEW AND THEORETICAL ASSUMPTIONS

2.1. Self-organization type and firm performance

First, according to H. Haken, a German theoretical physicist, from the perspective of the evolution of organizations, they can be divided into two types: other organizations and self-organizations [2]. If a system relies on external instructions to form an organization, it is an other organization. If there is no external instruction, the internal elements of the system in accordance with a tacit understanding of some rules, each to do their job and coordinated automatic formation of an orderly

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structure, is self-organization. Self-organization includes two types, competitive self-organization and cooperative self-organization. Competitive self-organization refers to an uncertain and dynamic unbalanced process in which two or more elements or individuals hinder or restrict each other and oppose, exclude, or compete with each other for their own " economic interests ". The second type of self-organization is collaborative self-organization, which means that elements or subsystems cooperate, learn from and support each other to achieve the overall goal of the organizational system and form a virtuous cycle of growth [3].

The new idea of co-opetition was first proposed in 1995 by Barry J. Nalebuff, which is a management professor at Yale, and Adam M. Brandenburger, which is a professor of business administration at Harvard [4]. They believe that enterprise production is a complex linear game system, and a non-zero-sum game that can reach win-win. The business activities of enterprise organizations should not only perform competition but also cooperate. In fact, individual enterprises in an enterprise organization have the behavior of competition and cooperation, referred to as the phenomenon of competition and cooperation. They are often interwoven together, which is the inherent root of the nonlinearity and spontaneity of the complex system organization.

Competitive self-organization adheres to the market demand as the guidance and stimulates the internal potential of enterprises through competition. To survive, individual enterprises constantly conduct independent innovation, improve production technology and develop new products. Under the circumstance of limited resource factors, enterprises often choose the innovation path of independent r&d(research and development) to win in the cruel market, which intensifies the degree of competition among enterprises. In other words, the result of the zero-sum game is that the winning side tends to increase corporate performance. When the competition between enterprises is orderly, the overall benefit of the enterprise is better, and the continuous profit. However, once excessive competition occurs, it will cause disastrous losses to the entire industry chain. The internal coordination mechanism will be broken, which may lead to the decline in innovation ability, profit, enterprise scale and product market share, thus affecting the cultural system and performance of the entire enterprise organization. Therefore, the hypothesis is proposed:

H1: Competitive self-organization is positively correlated with enterprise performance;

H2: Collaborative self-organization is positively correlated with enterprise performance.

2.2.Self-organization type and innovation path

According to the early marketing theory, innovation generally refers to the transformation of original products, innovative design methods and improvement of technological processes, as well as the upgrading and updating of sales channels, and the adoption of new business strategies and competitive means, to occupy the product market. Joseph Schumpeter (1921), an American economist, proposed the theory of creative destruction, which explained the real root of economic development-innovation [5], emphasized the importance of production technology and method reform, greatly enriched the connotation of innovation. Additionally, Joseph Schumpeter explained the concept of innovation from the perspective of a macroeconomy, and connected innovation and innovation management closely with the current external economic development, extending the connotation of innovation from product innovation to the production process and enterprise management organization. Simultaneously, some scholars have put forward a broader concept from the perspective of enterprise innovation network system, believing that innovation is multi-dimensional, including innovation subject, innovation objects and external support systems [6]. The innovation path refers to the enterprises to improve the enterprise performance, the use of their accumulated experience and knowledge base, and strive to achieve the expected goals of technological innovation and management innovation. Innovation path is a complex system with the characteristics of multi-dimension, multi-layer, and externality. According to the degree of originality of knowledge or the degree of technology introduction and absorption, innovation path can be divided into independent innovation path and an imitative innovation path. The independent innovation path belongs to an innovative path of original product r&d, continuous innovation of production processes and sublimation of management. The system organization relies on existing resources to construct new intellectual property rights. The imitation innovation refers to a path to improve enterprise performance or increase knowledge and skills in a short time through imitation after actively introducing the technologies of other organizations based on existing external knowledge and digesting and absorbing them [7]. With to the relationship between self-organization and the innovation path, different schools have drawn different conclusions. Have put forward by some scholars, the path of innovation type can directly affect the enterprise decision-making effect, and the imitation innovation path will drive enterprise organization coordinated self-organizing behavior; through the specialized division of labor have a complementary effect between the organization, prompting behavior, synergy, the production behavior of r&d and sales together, which establishes a relationship of competition and causes products to have a more competitive advantage. Thus, the industrial cluster has been expanded [8]. Both the independent innovation path and the imitative innovation path are a form of self-organization for the continuous development and self-expansion of enterprises. It can be

said that the choice of self-organization type and innovation path is cross-influenced and complement each other. Therefore, the following hypothesis is proposed:

H3: Competitive self-organization is positively correlated with the independent innovation path;

H4: Competitive self-organization is negatively correlated with the imitative innovation path.

Collaborative self-organization is a development mode with less dissipation and greater benefit than competitive self-organization, which is characterized by the linear orderly and stable state of individuals in an organization through association, cooperation and mutual learning, aiming at maximizing resources. Collaborative self-organization covers two aspects: from the perspective of the process, collaboration is a way of life opposite to the competition. Enterprises are mainly established on the basis of mutual cooperation and require competition and cooperation among various elements of the system to maintain the overall optimization of the system organization. From the perspective of this effect, synergy means less friction among members of the system organization, clearer service objectives and stronger profitability. The premise of successful collaboration is that organizational elements are interrelated and interact with each other in the process of product creation, which is a long-term positive feedback mechanism. Therefore, the following hypothesis is proposed:

H5: Collaborative self-organization is positively correlated with the independent innovation path;

H6: Collaborative self-organization is positively correlated with the imitative innovation path.

2.3. Innovation path and enterprise performance

By selecting appropriate innovation paths, enterprise organizations constantly improve production technology and process flow, improve product performance, reduce unit product r&d cost, constantly meet customer personalized needs, create more customer transfer value, gain stronger competitiveness in the market, to promote the development of the entire industrial cluster. Simultaneously, the independent innovation of enterprises covers a series of economic activities, including not only the technological patent invention, but also production method improvement, the technological process innovation, marketing strategies and other activities, which ultimately achieve corporate profits, promote the continuous optimization of financial indicators, and enhance the sustainable development ability of enterprises. Therefore, the products of independent innovation are not only endowed with value, but also endowed unique patents, as well as the value carriers for the exchange of market subjects. Through independent r&d, enterprise organizations constantly improve the value of products and service quality, gain market competitive advantages, to achieve profits. Therefore, the following hypothesis is proposed:

H7: Independent innovation path is positively correlated with firm performance.

Imitative innovation, also known as imported innovation, refers to the enterprise organization according to its own scale and strength, constantly learn knowledge and management experience from neighboring enterprises, in order to realize the improvement of production technology and product and service quality. The specific implementation path of enterprises is to introduce advanced equipment or purchase technology developed by other enterprises, and actively accept knowledge spillover, digestion and absorption, and even realize technology catch-up. In early start-up of Huawei company, for example, lack of financial support, not only less qualified r&d team, in this case can only learn to imitate the foreign technology of homogeneous product enterprise, fully incremental innovation again after digestion and absorption, can be said to be a very practical and efficient mode of imitation innovation, reduce the early high investment risk. Later, when Huawei's r&d strength developed to a certain extent, it actively worked with universities and other scientific research institutions at home and abroad to jointly develop product technologies, jointly set up laboratories, and formed strategic alliances with world-class enterprises with strong technologies to promote technological development. At the same time, accelerate the learning of management methods and organizational structure of world-class technology giants, implement standardized management, so as to achieve leapfrog development of enterprise performance. Finally, the innovation ecosystem with close combination of industry, university and research has been actively constructed to realize the sublimation of self-research value. Therefore, the following hypothesis is proposed:

H8: Imitative innovation path is positively correlated with enterprise performance.

Based on the above assumptions, the theoretical model of this paper is shown in Figure I.

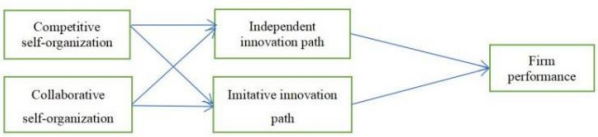

Figure 1. Model of relationships between variables

3. RESEARCH METHODS

3.1. Scale design

Since the organization theory was put forward, it has exerted an important influence in the fields of natural science and sociology, and is an important methodology to explore the law of industrial cluster development. However, few scholars study self-organization theory from the perspective of scale. Therefore, this study explains the evolution process of self-organization from the perspective of marketing. The variables related to this paper include collaborative self-organization, independent innovation path, and imitative innovation paths, and firm performance, which are also illustrated by the likert scale. To ensure the effectiveness of the measurement tool, a maturity scale widely used today will be used in this paper. The two variables of synergistic self-organization and enterprise performance are both adopted in the scale developed by Ramani and Ku-Mar [9]. The collaborative self-organization scale mainly contains 6 items, while the enterprise performance scale includes 12 items, which are mainly based on three dimensions of financial performance, r&d performance and management performance, and each dimension has 3-5 items. It should be noted in particular that the scale of corporate performance in this study mainly refers to the steps and practices commonly used in marketing, that is, the interviewees are more inclined to corporate executives, to improve the accuracy of the answers. According to existing studies, this method can effectively improve the interview effect, and the conclusions obtained are highly consistent with the expected goals [10]. The scale of independent innovation paths and imitative innovation paths are derived from the scale developed by He and Wong [11]. And moderately modified according to the actual situation. The scale of independent innovation path and imitative innovation path have 5 items, respectively. For the improved scale, the consistency test coefficient of the independent innovation path is 0.827, and that of the imitative innovation path is 0.759, indicating good overall validity.

3.2. Data collection

At present, there are not many applications of synergetic self-organization scale in the industrial economy. Therefore, to ensure the scientific nature and effectiveness of this study, questionnaires were distributed to on-the-job MBA students in colleges and universities in advance, and a small sample of pre-survey was carried out, and good results were achieved. Then, the core factors in the synergy self-organization scale are discovered, that is, the variance of the collected data is explained by the least Factor to the maximum extent. For this purpose, this paper adopts the Exploratory Factor Analysis (EFA method). In the case of multiple influence factors, to intercept effective data, it is necessary to set the characteristic root value greater than 1. Simultaneously, the orthogonal rotation method is used to conduct factor analysis. The results showed that the KMO (Kaiser-Meyer-Olkin) test statistic value was 0.81, and the SPSS test result also indicated that Bartlett's sphere test was passed ($P < 0.001$). This study has four characteristic roots with values greater than 1, in other words, these factors explain 63.5% of the total variance. The formal survey was conducted by entrusts third-party research company to obtain data and randomly sampling. Senior executives of the investigated enterprises were interviewed. The designed questions were completed in the form of face-to-face interview. To ensure the authenticity and universality of the data sources, online questionnaires and paper questions and answers are also used to collect data. In accordance with the scientific principle, the managers of relevant enterprises must fill carefully according to the research objectives, to improve the accuracy of data and strive to reduce the overall sample error. A total of 187 questionnaires were sent out and 150 were collected in this survey. Simultaneously, the collected questionnaires were optimized, that is, after 15 invalid questionnaires with incorrect filling, incomplete filling and inobjective filling were removed, 135 valid questionnaires remained. The questionnaire recovery rate was 80% and the effective rate was 72%.

3.3. Sample characteristics

The main research object of this study is the managers of electronic information enterprises in the pearl River Delta. The industries surveyed included ERP software development companies, chip manufacturing enterprises, upstream and downstream suppliers and other high-tech enterprises, and the specific geographical scope was mainly from Guangzhou, Shenzhen and Dongguan. Located in the core area of Guangzhou-Shenzhen Science and Technology Innovation Corridor, these three cities are the concentration places of the electronic information industry in the Pearl River Delta, with good industrial clusters and complete industrial supply chains, which are relatively representative. The interviewees work in various departments and participate in various management departments of the enterprise. They have a good understanding of corporate policies, production processes, external policies and organizational structure; and have a clear understanding of the purpose of this study. From the length of service of the respondents, under the background of rapid development in the Internet era of big data, high and new technology enterprise management younger, more dynamic and innovative spirit, the length of service of the selected respondents mostly between 3 and 10 years, the life of the staff of experienced, dynamic understand more deeply on the development of the industry, Besides, he was loyal to the enterprise and can give feasible suggestions and implementation plans. In terms of age, most of the interviewees are over 30 years old, and this

age group is the middle and senior managers of enterprises, who can develop or implement the development strategic plans of enterprises. Finally, from the perspective of educational background, 99% of the interviewees have a bachelor's degree or above; and have rich practical experience in the industry, high professional quality level and strong sensitivity to data, so they can provide objective evaluation opinions. The number of employees of enterprises is between 50 and 2000, and both the size and nature of enterprises are typical. These samples met the requirements of the study. Additionally, the enterprise has been established for a relatively long time, has rich experience, and is mainly a joint-stock company, flexible mechanism, in line with the pearl River Delta industrial development strategy. In this study, the efficiency of the questionnaire was relatively high after the questionnaire was collected and evaluated by the factor test.

4. DATA ANALYSIS AND MODEL TESTING

4.1. Scale reliability and validity test

After sorting out the survey data and processing the data with SPSS 24 software, it can be seen from the operation results that the correlation coefficient between each variable and the common factor, namely, a factor load, is greater than 0.5. The coefficient values(χ^2 / df) of collaborative self-organization, independent innovation path, imitator innovation path, and internal consistency of enterprise performance are 0.815, 0.829, 0.798, 0.813, values are all greater than 0.7, indicating that the scale has high reliability.

To ensure the accuracy and validity of sample data, the evaluation method proposed by Anderson and Gerbing (1988) was adopted. After optimized fitting with the structural equation model, the validity of the scale was tested. In this study, AMOS 24 software was used for factor analysis of scale data (See Table I). AVE (Average Variance Extracted) and Construct Reliability were adopted as the concrete criteria. As can be seen from the data in the table, the correlation coefficients or factor loadings of common factors in the scale are higher than 0.50, indicating good aggregation validity. According to theoretical deduction and actual measurement, if the correlation coefficient between two indicators with the same potential characteristics is less than 0.70, it indicates that the scale has good discriminative validity. As shown in Table 1, the maximum correlation coefficient between each construct is only 0.615, which is lower than the requirement of 0.70. Additionally, according to the research results of fornell et al., when the square root of the AVE value of these latent variables that cannot be directly measured is greater than the correlation coefficient of each construct, it indicates that the scale has good discriminative validity.

TABLE 1. Descriptive statistics, Pearson correlation coefficient, AVE square root

Variable	The mean	The standard deviation	1	2	3	4
1.Competitive self-organization	3.6148	0.59652	0.68			
2.Collaborative self-organization	3.7235	0.58721	0.73			
3.Independent innovation path	3.7502	0.75032	0.468**	0.68		
4.Mimicry innovation path	3.8986	0.71246	0.451**	0.615**	0.66	
5.Enterprise performance	3.7013	0.59068	0.613**	0.592**	0.574**	0.56

Note:1.**.There was a significant correlation at 0.01 level (bilateral). 2. The square root of AVE is on the diagonal.

4.2. Structural equation model testing

Meier (1976) proposed that fitting degree analysis should be conducted using the structural equations before scale validity measurement. In this study, AMOS24.0 software was used to describe the overall framework of the report, and the path map of the structural equation model was obtained. Then, relevant indicators were used to evaluate the model. Generally speaking, the coefficient matrix or covariance matrix formed between variables can be measured using the structural fit index. If the value (χ^2 / df) is less than 3, the fit index NFI is greater than 0.9, indicating that the fitting degree of the variable relationship matrix in the overall model constructed in this study is high with the actual data relationship matrix. If we want to reflect the suitability of the model and actual data in a more concise way, we can use the index of reduced fit degree to test. In other words, on the premise of ensuring a reasonable number of model variables and samples, the more concise the hypothesis model is, the more predictive validity it has. In other words, it passed the AMOS test. If the PNFI of the model is assumed to be higher than 0.5, the PGFI is also greater than 0.5, suggesting that the simplified fit of the model is reasonable. Value-added fitting degree measures the degree of fitting between the hypothetical model and the actual data; and can describe the degree of difference in the covariance matrix between variables in reality. If CFI is greater than 0.9, it indicates that the value-added fitting degree of this model is good.As there are many measurement items designed in this study, only the path analysis of the following indicators is selected, as shown in Table 2. Table 2 shows that the overall model fitting index of AMOS output is consistent with the actual data, which meets the requirements of this study.

TABLE 2. Analysis of the fitting degree of structural equation model

Indicators	Absolute fit				Simplicity fit		Value added fit	
	χ^2 / df	*GFI*	*SRMR*	*RSMEA*	*PNFI*	*PGFI*	*NFI*	*CFI*
Standard	<3	>0.9	<0.08	>0.06	>0.5	>0.5	>0.9	>0.9
Results of the analysis	1.89	0.97	0.07	0.061	0.80	0.85	0.96	0.952

Order to further optimize the model, AMOS24.0 was used to calculate the data again. The running results of the model show that the fitting effect of the model is more ideal after the degree of freedom of the model is optimized. It is worth mentioning that there may be a correlation between the independent innovation path and the imitative innovation path, but the positive and

negative directions of the relationship cannot be determined. Therefore, this study adopts the exploratory validation function of models in AMOS to construct four competitive models, and finally captures some important characteristics, namely, imitative innovation paths also have a significant positive impact on autonomous innovation paths, which is called H-Unidentified hypothesis (HU). After model exploration and modification, the fitting degree of the model is significantly improved, and all the indexes agree with the research objectives.

To save space, some steps are omitted in this study, and the optimal model is presented directly after modification and model exploration. χ^2 = 225.8, DF =165, absolute fitting index (χ^2 / df) = 1.256, value less than 2. The square root of the approximation error RMSEA = 0.061, less than 0.08, indicating that the model has a high degree of fitting and is consistent with the actual data.IFI =0.942, TLI = 0.917, CFI = 0.952, all greater than 0.9, indicating better fitting degree of the model. The optimized model architecture is shown in Figure 2. The solid line indicates that the above assumptions H1, H2, H3, H4, H5, H6; and H7, have been verified, while the dashed line indicates that H8 has not been verified, while HU has passed the exploratory test, and the running results also show that there is a positive influence relationship.

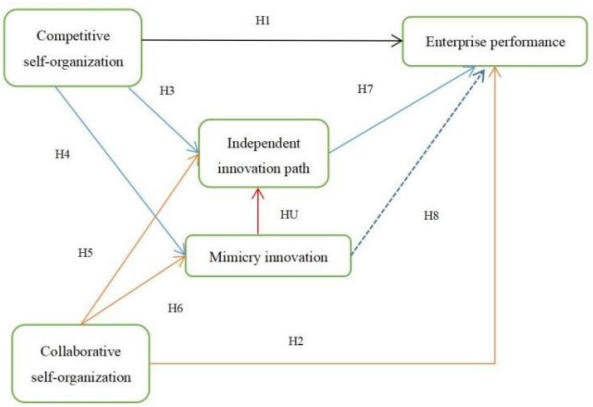

Figure 2. Model diagram of verification results

In order to accurately measure and deal with the relationship between variables, structural equation model is used to test the collected data, and the results are shown in Table 3.

TABLE 3. Path analysis results of the structural equation model

	The path	*Estimate*	*S. E.*	*P*	*T*	Significant level	Normalized regression coefficient
H1	Competitive self-organization→Enterprise performance	0.515	0.205	0.007	2.608	Significant	0.548
H2	Collaborative self-organization→Enterprise performance	0.595	0.231	0.006	2.618	Significant	0.566
H3	Competitive self-organization→Independent innovation path	0.845	0.267	0.005	3.456	Significant	0.676
H4	Competitive self-organization→Imitation innovation path	0.769	0.282	0.008	2.571	Significant	0.469
H5	Collaborative self-organization→Independent innovation path	0.867	0.251	0.003	3.471	Significant	0.682
H6	Collaborative self-organization→Imitation innovation path	0.751	0.235	0.004	2.563	Significant	0.469
H7	Independent innovation path→Enterprise performance	0.459	0.154	0.003	2.879	Significant	0.528
HU	Imitation innovation path→Independent innovation path	0.568	0.213	0.002	2.856	significant	0.430
H8	Imitation innovation path→Enterprise performance	-0.065	0.162	0.689	-0.391	Non-significant	-0.090

In this study, the P values of H1, H2, H3, H4, H5, H6, H7 and HU are all less than 0.05, which has been proved. It is noteworthy that in the linear correlation analysis of H8, the significance level between variables is significantly higher than 0.05, and the fitting degree of path analysis indicates that H8The hypothesis is not true. Additionally, the positive relationship between collaborative self-organization and autonomous innovation path (β= 0.682, t= 3.471, P < 0.001) is greater than that between collaborative self-organization and imitative innovation path (β= 0.469, t=2.563, P= 0.009).

5. CONCLUSION AND MANAGEMENT ENLIGHTENMENT

Firstly, competitive self-organization, collaborative self-organization, and firm performance have a significant positive relationship. The competition is one of the most basic behavior characteristics of enterprise organization, is also an important driving force of innovation, simultaneously, the coordinated ability stronger enterprises generally have the adaptive, self-development and self-adjusted the corrective function, through the exchange with the outside material, information and energy, promote the orderly development of the entire system organization, to improve business performance and economic scale. Therefore, it also indicates that although emerging economies like China are experiencing great development in economy, network data and institutional environment, competitiveness and collaborative self-organization have a significant impact on enterprise performance, which is consistent with the actual situation.

Secondly, collaborative self-organization can significantly promote the independent innovation path and imitative innovation pathway. Simultaneously, it was also found that the degree of positive impact of collaborative self-organization on independent

innovation paths is significantly higher than that of the imitative innovation path, and the degree of impact of collaborative self-organization on different innovation paths is also different. Therefore, it is a meaningful supplement to the existing research results. According to the principle of cooperative self-organization theory, the competition between individual organizations is not a zero-sum game behavior, but a multi-win behavior established in a certain competitive state. Despite a complex and changeable external environment, individual organizations, especially high-tech electronic enterprises, cannot gain a place in the fierce market system by themselves. Therefore, organizations must cooperate with each other, choose the innovation path of competition and cooperation, let the innovation elements flow freely; and promote the value maximization of network node organization members.

Thirdly, from the perspective of the impact of the innovation path on firm performance, autonomous innovation path has a significant positive impact on firm performance, while the reverse imitative innovation path has no significant impact on firm performance. In the scenario independent innovation model, individual enterprises invest many human and material resources and obtain high-quality resources to the maximum extent through the competition mechanism; and obtain the dominant position in the market by the survival of the fittest. However, imitative innovation path is difficult to obtain breakthrough technology in a short time and may be annexed at any time. When enterprises implement the imitative innovation path, they tend to be complacent, and the technology will stagnate, with high uncertainty, and they always face huge business risks. Therefore, from the perspective of sustainable development strategies, imitative innovation path is negatively correlated with enterprise performance.

Fourth, after data inspection and calculation, it is found that the imitative innovation path has a positive impact on the independent innovation path, which confirms that the independent innovation path and the imitative innovation path can coexist. Independent innovation path and imitative innovation paths can be integrated, complement each other, and promote the development of enterprise performance together. Therefore, an enterprise organization should adopt two innovation path modes. Simultaneously, advocate balanced-development, change from the previous competition and unbalanced development state, not only to joint r&d; but also to encourage independent r&d, to ensure the advancement of products, to shape the core capabilities of the enterprise organization.

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