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The Relationship between Product Innovation and Online Sales: A Red Queen Competition Perspective

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Abstract: Competitions among online sellers on an e-commerce platforms has entered the era of "Red sea". The highly transparent feature reduces the costs of learning and imitation, which breeds vicious competition on markets and increases product similarity. Hence, online sellers have to promote product iteration and innovation to meet the changes of market demands. However, how to measure the product innovative of online sellers, as well as the relationship between the posture of product innovation and online sales in changing competitive environment have barely been empirically revealed. This study intends to theoretical analyze the relationship between the posture of two different types of product innovation and online sales grounded on the red queen competition theory. The expected results are: First, compared with the average level of the industry, the better the posture of updated product innovation is, the higher the online sales are. Second, compared with the average level of the industry, the relationship between the posture of new product innovation and online sales is inversely U-shaped. This study not only expands the research scope on organizational competition mechanism based on the red queen competition theory, but also provides essential ideas for online sellers to develop product innovation strategies in competitive environments.

Keywords: Product Innovation, Competitive Pressure, the Red Queen Competition Theory, E-commerce platform.

1. INTRODUCTION

In recent years, with the maturity of the e-commerce platform business model, the competition pressure of online sellers becomes increasingly intense, which contributes to the arrival of the era of e-commerce "red sea". The important way for online sellers to survive from the red sea is to update and iterate their products quickly[1], and this is one of the effective strategies for them to gain competitive advantages. However, the online sellers' product innovation behavior will intensify market competition, so that it will restrict their competitive behavior and performance. On the one hand, the highly transparent competitive environment enables online sellers to quickly acquaint with the new development of competitors, which could help them to reduce learning costs and promote product innovation. On the other hand, when the performance improvement is gained by an online seller through effective competitive behavior, the performance of its competitors will be reduced. Consequently, it will lead to the imitation and follow-up of competitors, and then it will inhibit the performance of the core online sellers. And this inhibiting effect is significantly stronger than the positive effect brought by competitive behavior, which forces the core online seller and its competitors into a cycle of action and performance[2]. Therefore, online sellers must constantly take effective actions to cope with the rapid changes in the market.

Since the mutual influence between online sellers' competitive behavior and industry development, the impact of online sellers product innovation on competitive advantage not only depends on the active level of their own behavior but also on the relative level that compared to the industry development. As is shown in the competitive relationship in the red queen competition theory, online sellers participating in the competition must constantly "run" to keep relatively static with competitors.

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Competitive actions have been regarded as the cornerstone of enterprise development and growth, and its positive impact on organizational performance has long been known in previous studies. However, in the context of e-commerce red sea competition, it has not been empirically revealed that how to measure the posture of innovation behavior of online sellers and the relationship between their behaviors surpassing competitors and online sales. Based on previous studies on competition mechanism revealed in the red queen competition theory, this study proposes that: when exploring how to break through the competitive pressure by product innovation, the development of online sellers must be placed in the context of industry evolution. Only by correctly considering the relationship between the posture of online sellers' product innovation and market pressure can we correctly understand the actual utility of online sellers' product innovation. Therefore, our research question is: under the competitive pressure on the platform, how can online sellers improve online sales through product innovation strategies?

2. LITERATURE REVIEW

The red queen competition theory is based on a quote from the Queen of Hearts in the movie *Alice in Wonderland*. She once said: "Running at your fastest speed just allows you to maintain your current position. To move forward, you must double your current speed[3]." Through integrating organizational learning theory and ecological theory, this theory describes the symbiotic evolution of competitive subjects and systems and the mechanism of competition constraints in organizations[4]. It also reveals how environmental changes affect the movement of subjects' important reference value: When an organization takes action to obtain a competitive advantage, it may trigger a reaction among competitors. Continuous competitive interactions between organizations and social comparison behavior develop and improve the industry's average level constantly, thereby forming a natural choice of "survival of the fittest" for the subjects that survive in the environment. In this scenario, the emergence of a company's competitive advantage relies on the behavior of matching and surpassing its competitors[4][5]. This means that, whether a company can obtain a competitive advantage depends not only on its absolute speed in a competitive environment but also on its relative speed in comparison with other competitors in the environment.

In previous studies, the research on the red queen competition theory focused mostly on the following aspects:

(1) Organizational competition is related to the time exposed to the competitive environment. Through empirical research, Barnett and others[6][7] found that recent competition experience can not only reduce the core organization's mortality rate but also significantly increase its performance growth rate. At the same time, it has a significant inhibitory effect on competitors' growth rate and birth rate. However, the long-term competitive experience will show the opposite effect.

(2) Organizational competitive behavior is linked to the experience that being exposed to the competitive environment. Levitt[8], Barnett[5], and others have pointed out that organizations often adopt solutions that are well-known in the past to deal with new problems, which may have a negative impact on the organization's adaptability. This is the "capacity trap" of the red queen competition theory.

(3) Individual competition will have an impact on the whole industry. Foscari's[9] research further characterizes the micro-processes of mutual learning between organizations and the causal competitive relationship. It found that the survival outcome of an organization is not only related to its own survival behavior, but also to the survival environment and its adaptability of the entire population system.

By analyzing previous studies, the red queen competition theory found that the behavior of another organization's search solution is caused by the improvement of one organization's performance. This is consistent with what has been discussed in our paper: under the pressure of competition, online sellers have to

make product innovation to gain more advantages. Therefore, the theory provides a theoretical basis for this paper. Admittedly, in previous research, competitive behavior has been regarded as the cornerstone of corporate development and growth, and its positive impact on organizational performance has long been known. For example, in the field of IT investment, Mithas[10] and others have discussed the impact of business investment deviations on business strategy and business performance based on the industry average level. Nevertheless, in the context of the e-commerce red sea competition, how to measure the posture of product innovation of online sellers, and the relationship between their posture of product innovation beyond competitors and online sales have scarcely been empirically revealed. In view of these research gaps, starting from the internal competition mechanism revealed by the red queen competition theory, this paper takes the changes in the market environment caused by inter-organizational competition into consideration and uses the industry average level as a benchmark, so as to explore the impact of the online seller's posture of product innovation near or far from industry benchmark on online sales.

3. RESEARCH MODEL AND HYPOTHESIS

3.1. Research model

Grounded on the red queen competition theory, online sellers on the e-commerce platform are subjects with organizational learning ability. In a competitive environment, when an online seller's performance is lower than its ideal level, its internal search learning mechanism will be triggered. Viewed from online sellers practice, the decision-making behavior of online sellers in product dimension can be divided into two types: the first one is updated product innovation, which is generally implemented by improving the existing product description and label; the second one is new product innovation, that is, showing the new product in the platform display box.

Therefore, from the perspective of the red queen competition theory, this paper discusses the relationship between the online seller's posture of product innovation and online sales compared with the average level of the industry. The research model is shown in the figure below:

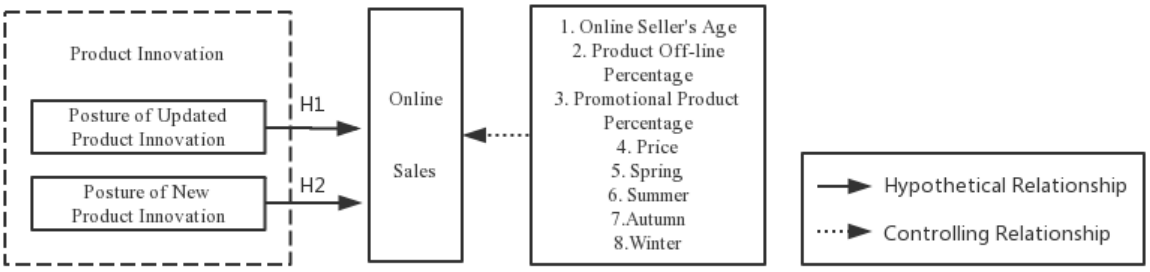

Figure 1. Research model

3.2. Research hypothesis

3.2.1. The relationship between the posture of updated product innovation and online sales

In this paper, the posture of updated product innovation of online sellers refers to the posture of the operation behavior of the online sellers to upgrade, innovate, cut down or make the product line more characteristic timely according to the change of market demand. It is the purposeful organization and management of product managers to increase user's stickiness or contribution. Updated product innovation is a kind of utilization innovation[11], which is usually confined to a specific and relatively narrow scope of knowledge, so both the learning cost and the market risk are low. This study proposes that compared with the average level of the industry, the online sales are in proportion to the posture of updated product innovation of the online seller itself. Three reasons are listed below:

(1) An updated product innovation is an easier way for the e-commerce platform to obtain the revenue

quickly and accurately[12]. Considering the updated product innovation on the platform as a change to the features, labels, services or copywriting of the existing products, online sellers can take advantage of the traffic dividend of the recommendation system of the platform to match user needs more accurately.

(2) The features of updated product innovation make online sellers more flexible to adapt to market needs. The updated product innovation on the e-commerce platform involves the description of product content instead of the change of product structure. The worst result of organizational learning maladjustment is the decline of product search traffic, and even such maladjustment behavior can be quickly reflected and adjusted in time. Therefore, the characteristics of high flexibility and low risk of updated product innovation give online sellers opportunity to adjust themselves, which facilitates it to adapt to the environment quickly and flexibly.

(3) The long-term exposure to the competitive environment is conducive to improving the competitive advantage of product. Empirical research shows that organizational learning and competition experience can enhance the ability of organizations to perceive and respond to the opportunities and threats, enable organizations to control the risks and costs of innovation activities more effectively, and improve their competitiveness. Especially on the e-commerce platform, the long-term sales and word-of-mouth accumulation will be conducive to consolidating the product's competitive advantage.

Therefore, hypothesis 1 is proposed as follows:

H1: Compared with the average level of the industry, the online seller’s posture of updated product innovation has a positive impact on online sales.

3.2.2. The relationship between the posture of new product innovation and online sales

In this paper, the new product innovation of online sellers is that the online sellers will put the brand new product introduction on the platform to sell. Different from updated product innovation, the new product innovation takes place at the beginning of the product life cycle[13]. It involves the uncertainty of the acceptability of new products in the market. From the perspective of the classification of innovation situation, the new product innovation of an organization belongs to "exploratory innovation". This study suggests that: the influences of new product innovation on online sales are related to the relative degree of new product innovation of online sellers to the average level of the industry.

New product innovation is an online seller's search and learning behavior to gain more competitive advantages. Its effect on online sales is manifested in the following two aspects: First, the high transparency of the e-commerce platform reduces the cost of sellers to obtain market demand, so the new product innovation can enable online sellers to better adapt to market demand and achieve the ideal online sales of themselves. Second, new product innovation is the search results based on organizational learning. The more product features change, the more likely it is to attract new users and increase online sales. Therefore, in comparison with the industry average level, the stronger the seller's new product innovation capacity is, the higher the online sales will be.

However, an increasing number of new product innovation does not always lead to increasing online sales, because exploratory innovation has the innate characteristics of high cost, high risk, and long cycle. From the perspective of the market, as the number of new products increases, the market demand overloads, which leads to the decline of online sales directly. Meanwhile, from the perspective of online sellers, the red queen competition theory holds that when the new organizational capacity exceeds the average level of the industry, the seller's output ratio of cost input will decline, and it is easy to fall into the "capacity trap", as well as lead to the decline of the seller's learning ability and the loss of competitive advantage.

Therefore, hypothesis 2 is proposed as follows:

H2: Compared to the industry average, the relationship between the online seller’s posture of new product innovation and online sales is inversely U-shaped.

4. RESEARCH DESIGN

4.1. Research setting

This paper selects the tourism e-commerce platform as a research sample because of its fierce competition, rapid evolution, and high information transparency. Specifically, a typical tourism e-commerce platform，Ctrip is chosen for the following two reasons: (1) It provides the online sellers' information on the product details page, which makes it possible to obtain the research data. (2) According to industry statistics, Ctrip has consistently ranked the top three in the online travel and vacation market over the past three years.

As China's largest tourism e-commerce platform, Ctrip's package tour product can be divided into domestic tours and outbound tours according to the geographic scope of the destination. The outbound tourism market is growing fast and competitive. Moreover, outbound package tour products are only allowed to be operated by online sellers with the qualification of international travel agencies, so the information about relevant travel agencies is reliable and comprehensive. Therefore, this paper selects the outbound package tour product in the Ctrip platform as the research object.

Furthermore, according to the "Major Data Report on Tourism Economy in the First Half of 2018" issued by the Ministry of Culture and Tourism Data Center, we select the most popular domestic outbound tourism city--"Shanghai" as the departure city, and select 15 popular destination cities for outbound tourism as our research's destination cities. And they make up 1*15 market segments.

4.2. Data collection

In this paper, the core task of data collection is to transform the data of Ctrip outbound package tour products into the data at the seller level. Accordingly, the data collection will be carried out through the following four stages: Firstly, constructing the outbound package tour product database; secondly, determining the list of the online sellers; thirdly, preprocessing data; fourthly, constructing the data set at the seller level. In the end, 114 sellers are included in the scope of the study. The observation period is from March 1, 2017 to December 1, 2018, and the invalid routes and repeated key fields have been cleared.

4.3. The measurement of variables

4.3.1. Dependent variable

In this paper, the total number of tourists (Count) of the online seller's current package tour product is taken as the dependent variable, which reflects the seller's current online sales. Monitoring the long-term data, we found that the statistics of the number of Ctrip outbound package tour products are calculated in a cumulative way. Therefore, the number of people traveling on a package tour product in the period t equals to the cumulative number of people traveling on the package tour product in the period t minus the cumulative number of people traveling on the package tour product in the period t-1.

4.3.2. Independent variables

(1) Posture of updated product innovation

The updated product innovation refers to the package tour product updated and changed by the seller in the period t compared with the period t-1. The total number of package tour products provided by online sellers is different. In order to reduce such data differences, this paper calculates the ratio of seller's product updated innovation in the total number of package tour products in the period t before calculating the posture of updated product innovation of online sellers.

In this paper, the method of text similarity is used to calculate the posture of updated product innovation. Text similarity, a method of text mining, refers to the similarity between two texts. The first step is to obtain the package tour product with the same ID of the period t and the period t-1 in the product database of this study and make statistics of the text data containing key fields to form word bags. In the following step, TF-IDF (Term Frequency—Inverse Document Frequency) is used to vectorize the word frequency of each circuit. Finally, the

text-similarity of the package tour product in the period t is calculated by the law of cosines. The value of text-similarity is between 0 and 1, and the higher the value is, the smaller the change of the same product ID in the product description of two phases is. Through observation, we found when the text-similarity in this study is above 0.8, the package tour product changes little in the description. Therefore, the package tour product with text similarity between 0 and 0.8 is selected as the package tour product that is updated.

In this paper, the average of updated product innovation ratio of all sellers in the study samples is regarded as the industry average level in the period t. And the difference between the updated product innovation ratio of each seller and the average level of the industry is the posture of updated product innovation.

(2) Posture of new product innovation

New product innovation refers to the package tour product that is newly put on sale by the online seller. The total number of package tour products provided by sellers is different. In order to reduce such data differences, before calculating the posture of new product innovation, the ratio of new product innovation in the total package tour product of the period t is calculated. In this paper, the average of new product innovation ratio of all sellers in the study sample is regarded as the industry average level in the period t. Then the difference between the new product innovation ratio of each seller and the average level of the industry is the posture of new product innovation.

4.3.3. Control variable

Referring to the study of Barnett about the red queen competition theory[13], the online seller's age (Age) is included as the control variable in this paper. In addition, previous studies have shown that when the performance is lower than the organization's expectation, the organization will take actions such as promotion or removal of products to change the existing competitive position. Based on this, this paper controls other factors affecting performance at the level of organizational behavior, including product off-line percentage (Off-line), the promotional product percentage (Prom) and the product price (Price).

At the same time, due to the long period of data collection, we select the seasonal factors as dummy variables: spring (Spri) is (1,0,0,0), summer (Summ) is (0,1,0,0), autumn (Autu) is (0,0,1,0), and winter (Wint) is (0,0,0,1). Considering the "dummy variable trap", we only add spring, summer and autumn into the model.

4.4. Econometric model

According to the research hypothesis, this paper adopts the econometric model of the unbalanced panel to analyze the impact of the posture of new product innovation and the posture of updated product innovation on organizational performance respectively, and then constructs the following two econometric models:

Model 1: The impact of organization's posture of updated product innovation on online sales.

$$\mathrm{InCount}_{it} = \alpha_0 + \beta_1 Age_{i,t} + \beta_2 Off\_Shelf_{i,t} + \beta_3 Prom_{i,t} + \beta_4 Price_{i,t} + \beta_5 Spri_{i,t} + \beta_6 Summ_{i,t} + \beta_7 Autu_{i,t} + \beta_8 Update_{i,t} + \mu_i + \varepsilon_{i,t} \quad (1)$$

Model 2: The impact of organization's posture of new product innovation on online sales.

$$\mathrm{InCount}_{it} = \alpha_0 + \beta_1 Age_{i,t} + \beta_2 Off\_Shelf_{i,t} + \beta_3 Prom_{i,t} + \beta_4 Price_{i,t} + \beta_5 Spri_{i,t} + \beta_6 Summ_{i,t} + \beta_7 Autu_{i,t} + \beta_8 (New)^2{}_{i,t} + \beta_9 New_{i,t} + \mu_i + \varepsilon_{i,t} \quad (2)$$

Where, $\alpha_0$is the intercept term;β_i (i = 1⋯9) represents the regression coefficient of the model; ε_i is the disturbing term that changes with individuals and time, and captures other factors that may cause changes in dependent variables that are not considered. And μ_i captures individual heterogeneity cannot be seen that does not change with time.

5. EXPECTED RESULTS

Our research sample in this paper contains 114 individuals (n=114) and accumulates 21 periods of data (T=21), which can be considered as short panel data. In choosing the model estimation method, the fixed effect

is preferred in this paper. Since the independent variable studied in this paper, the posture of updated product innovation and the posture of new product innovation are variables that change with time, this paper finally determines to use the method of fixed effect and clustering robust standard error to make a model estimation.

5.1. The impact of the posture of updated product innovation on online sales

We expected that at the 0.05 significance level, β_1, $\beta_3$will have a positive influence, while β_2, $\beta_4$will have a negative influence. This means: (1) The longer the online seller stays on the e-commerce platform, the more market experience it will get and the more competitive the organization becomes; (2) The more promotional products in the period t is, the higher the online sales are; (3) The more off-line products in the period t is, the lower the online sales are; (4) The lower the product price in the period t is, the higher the online sales is. And seasonal factors also have significant impacts on online sales. These are consistent with previous relevant studies and objective facts, which can prove that the control variables selected in this paper are reasonable.

After the seller's posture of updated product innovation is included, we expect that at the 0.05 significance level, β_8 will have a positive influence. The results can indicate that: compared to the industry average level, the higher the posture of updated product innovation in the period t is, the better the online sales will be, which can support hypothesis 1.

5.2. The impact of the posture of new product innovation on online sales

After adding the posture of new product innovation, we expect that at the 0.05 significance level,$\beta_8$and$\beta_9$are all significant negative, which indicates that there is an inverted U-shaped relationship between the posture of new product innovation and online sales: the total number of tourists in the seller's package tour product increases at first and then decreases with the strengthening of the posture of new product innovation. A more detailed analysis is: on the left side of the axis of symmetry, the relationship between the posture of new product innovation and online sales is positive, and the slope gradually slows down. In other words, the better the posture of new product innovation (the closer to the industry average level) is, the better the online sales will be, but the contribution of the posture of new product innovation to online sales will decrease as it approaches the industry average level. On the right side of the axis of symmetry, the relationship between the posture of new product innovation and online sales is negative, and the slope gradually steepens.That is to say, the better the posture of new product innovation (the further away from the industry average level) is, the worse the online sales will be, and the negative impact of the posture of new product innovation on online sales will be intensified with the deviation from the industry average level. This can support hypothesis 2.

6. EXPECTED CONTRIBUTION

The expected contributions of this study can be summarized as follows:

(1) Grounded on the red queen competition theory, this paper will expand the research on the competition mechanism of organizations, which reveals the relationship between individual competition behavior and industry average level. Through this study, we hold that the emergence of online sellers competitive advantage is not only relevant to the self-learning and improvement of the organization, but also depending on the relativity with the industry average level and the adaptability with the industry environment. To some extent, this extends the practicability of the red queen competition theory in competition mechanism and provides a new idea and foothold for the follow-up research.

(2) The research will examine the behavioral paths of online sellers on the platform to achieve online sales by launching different types of product innovation. In this paper, package tour product is taken as the research object, and the following conclusions are found: As a kind of low-risk utilization innovation, the posture of

updated product innovation has a positive linear relationship with online sales; As a kind of exploratory innovation with high cost and risk, the posture of new product innovation improves online sales to the greatest extent when catching up and maintaining at the average level of the industry.

(3) Our research can provide important practical guidance for online sellers to deal with the pressure of competition through product innovation. This study offers an important idea for online sellers to develop product innovation strategies and improve market competitive environments.

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