Red Queen Competition through Innovations on a Digital Platform for Experience Goods

Zhen Zhu
China University of Geosciences, zhuzhen2008@gmail.com

Ping Wang
University of Maryland, pwang@umd.edu

Qiuyun Huang
China University of Geosciences, 995384884@qq.com

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Completed Research

Zhen Zhu
China University of Geosciences, Wuhan
zhuzhen@cug.edu.cn

Ping Wang
University of Maryland, College Park
pwang@umd.edu

Qiuyun Huang
China University of Geosciences, Wuhan
995384884@qq.com

Abstract

This study examines a dynamic process of competition, learning, and innovation, referred to as "Red Queen," on a digital platform for trading experience goods. Specifically, by analyzing the package tours sold by 114 travel agencies on the world's largest online travel platform – Trip.com, the study reveals initial evidence of Red Queen as a type of intra-platform competition and how it is played out by firms through continuous innovations. The findings suggest that the providers of experience goods, on a digital platform without intellectual property protection, should maintain appropriate innovation postures according to the type of innovations and level of rivalry in the markets. High performance may result from leading postures for incremental innovations, and from middle-of-the-road postures for radical innovations, especially in high-rivalry markets. These findings can help experience goods providers strategize what, how, and where to innovate in order to beat competition and improve performance on digital platforms.

Keywords

Digital platform, Red Queen, intra-platform competition, experience goods, innovation posture, travel.

"Now, here, you see, it takes all the running you can do, to keep in the same place."
– Red Queen said to Alice in Lewis Carroll's novel *Through the Looking-Glass*

Introduction

Digital technologies have helped expand substantially the scale and scope of business being conducted in numerous industries. Companies can now collaborate and compete across industry and national boundaries thanks to the incredible connectivity of digital technologies. Meanwhile, digital technologies make things programmable and embeddable (Yoo 2010), enabling multiple parties to make complementary products and then integrate them into a coherent solution for the customers. The foundational technology, product, or service enabled by digital technologies and modular product design is a *digital platform*, on which multiple players interact (de Reuver et al. 2018; Gawer and Cusumano 2014). As digital platform research grows, IS research has just begun to study how competition unfolds on digital platforms.

Competition is prevalent on digital platforms. Prior studies mainly examined *inter-platform* competition, yet *intra-platform* competition among the providers of similar products, perhaps the most common form of competition, has received scant attention (Tiwana 2015). Further, in the emerging stream of IS research on intra-platform competition, most studies examined "search goods," whose quality can be evaluated by inspection, neglecting "experience goods," such as dining and travel, whose quality can be evaluated only after consumption. Due to their large share in the economy and lack of intellectual property (IP) protection, experience goods and their providers' competition deserve sustained research.

Specifically, in this study, we examine the competition among travel agencies on the world's largest online platform for travel – Trip.com (China Knowledge 2018). There hundreds of travel agencies compete by constantly innovating their products in the markets where they operate, in order to stay in business and,

hopefully, ahead of their competitors. This form of competition has been labeled "Red Queen" (Barnett and Hansen 1996). How they innovate and where they compete are likely to shape their competition outcomes and performances. Therefore, we raise the overall research question: *How do innovations and market conditions affect the performance of experience goods providers on a digital platform?*

By analyzing the package tours from Shanghai to 15 international destinations sold by 114 China-based travel agencies on Trip.com in a 21-month period, we have found that the performance of a travel agency depended on the types of innovations it developed, its innovation position relative to the industry average (called "innovation posture"), and the level of rivalry in the markets where it operated. Specifically, a travel agency's better posture in incremental innovations led to higher performance, whereas its posture in radical innovations and performance had a bell-shaped relationship, which was sharpened by the rivalry in the markets. We contribute to the digital platform research with the initial evidence of Red Queen as a form of intra-platform competition for experience goods. The study can also help the providers of experience goods strategize what, how, and where to innovate in order to improve performance in Red Queen competition.

Theoretical Background and Hypothesis Development

This study is at the nexus of research on digital platforms, Red Queen competition, and experience goods.

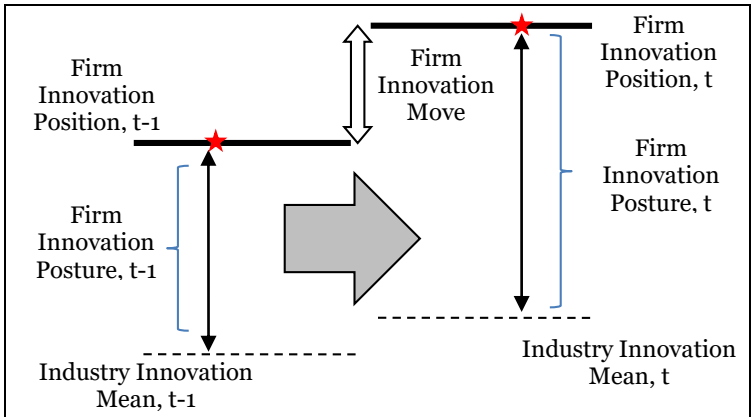
Digital Platforms

Platforms refer to products, services, or technologies that "serve as foundations upon which a larger number of firms can build further complementary innovations and potentially generate network effects" (Gawer and Cusumano 2014, p. 420). What is a "digital platform," however, is still open to debate (de Reuver et al. 2018). Between an extensible codebase (Tiwana et al. 2010) and ensembles of software, hardware, and organizational processes and standards (Tilson et al. 2012), we define a digital platform as *a technology, product, or service foundation enabled by digital technologies*. 3D printing, iPhone, and eBay, for instance, illustrate the digital platform as a foundational technology, product, or service, respectively.

Research has examined the access (Ghazawneh and Henfridsson 2015), structure (Zhu and lansiti 2019), and other aspects of digital platforms from the perspectives of the platform owners, users, and third-party participants. For example, dynamic capabilities are critical for platform owners to capture value (Helfat and Raubitschek 2018). User organizations need to take the opportunities afforded by digital platforms under the conditions set by their existing infrastructure (Rolland et al. 2018). Other participants, such as third-party app developers (Ghazawneh and Henfridsson 2015) or hosts on Airbnb (Wessel et al. 2017), compete, sometimes, with the platform owners (Foerderer et al. 2018), but more often, among themselves. Although intra-platform competition is prevalent on digital platforms, IS research has just begun to understand the phenomenon. Here we study a specific form of competition, "Red Queen," on a digital platform.

Red Queen Competition

As this paper's opening quote shows, the statement made by Red Queen in that famous novel was initially borrowed by evolutionary biologists to hypothesize that, in a continuously changing environment, organisms must constantly adapt and proliferate in order to compete with adapting and proliferating opposing organisms. This hypothesis was then borrowed to theorize inter-firm competition: a firm facing competition learns to gain competitive strength, which in turn prompts its competitors to learn and become stronger and prompting the



Note: Firm (represented by star) starts from an innovation position innovation at t-1 and then moves to the position at t, away from or toward the industry mean, changing its innovation posture.

Figure 1. Firm's Innovation Position, Move, and Posture, Adapted from (Mithas et al. 2013)

focal firm to learn again (Barnett and Hansen 1996). The learning involved in Red Queen competition may generate adaptation through innovation (Derfus et al. 2008). Similarly, competition on a digital platform may pressure vying firms to engage in learning and innovation as well.

Consequently, due to Red Queen competition, as Figure 1 illustrates, competitive advantage does not necessarily come from an organization's *position* of the innovations in its products or services. Rather, competitive advantage comes from the organization's *posture* in innovation relative to the industry's mean position, averaging the positions of other competitors in the industry. Over time, the focal firm's innovation posture and competitive strength change as a result of its own and competitors' innovation moves. Considering the reach and modularity of digital technologies enabling learning and innovation, we suspect that Red Queen competition may exist as a form of intra-form competition on digital platforms.

Experience Goods

To date, unfortunately, in the emerging research on intra-platform competition, most studies are focused on so-called "search goods," products and services whose quality can be evaluated by inspection, rather than "experience goods," such as dining, travel, and legal services, whose quality can be evaluated only after consumption (Nelson 1970). On one hand, the intellectual properties of the providers of experience goods are usually not protected. On the other hand, experience goods, based on interactions between the providers and customers, are extremely difficult to imitate. Therefore, both the prevalence of experience goods and their uncertain relationship with competition have prompted us to study the competition among experience goods providers on digital platforms.

Developing Hypotheses on Performance of Experience Goods Providers

Like any firm facing competition, the providers of experience goods may engage two modes of organizational learning: *exploitation* and *exploration* (March 1991). Exploitation builds on a firm's existing knowledge and facilitates *incremental* innovations in the products or processes (Benner and Tushman 2003). In contrast, exploration seeks new knowledge by departing from a firm's existing knowledge, likely leading to *radical* innovations (Dewar and Dutton 1986). In Red Queen competition, incremental and radical innovations, stemming from different modes of learning, may have differentiated effects on firm performance.

Effect of Incremental Innovation Posture on Performance

Based on learning from the changing demand in the markets where they operate, the providers of experience goods can update, improve, and adjust their existing products to better meet their customers' needs. A firm's incremental innovations must be compared with those of its competitors in Red Queen competition. If the focal firm increases its lead or reduces its lag from the industry's mean position, its improved innovation posture should help improve the firm's performance (Mithas et al. 2013). **H1:** *A firm's posture of incremental innovations positively affects the firm's performance.*

Effect of Radical Innovation Posture on Performance

In contrast, radical innovations entail developing products in new markets, thus requiring significantly more development and facing far more risks than incremental innovations (Clark et al. 1987). High risks and development costs do not necessarily bring high rewards in Red Queen competition on a transparent platform without IP protection. On one hand, firms with leading postures in new products, exposed to the scrutiny of their competitors, may attract competitors to imitate their new products (Giachetti et al. 2017). Also, the leading posture leads to fewer opportunities for learning (Barnett and Sorenson 2002) and less competitive pressure (Barnett and Mckendrick 2004), causing firms to lose sensitivity to market demands and risks. All of this hurts performance. In contrast, new products developed by firms lagging behind the competition in radical innovations are less likely to attract scrutiny or imitation and thus help boost firm performance. For example, top firms are the envy of the travel industry and their moves are being watched closely and imitated by others, whereas lagging firms' moves are neither monitored nor copied. Hence, **H2:** *A firm's posture of radical innovations has a bell-shaped relationship with the firm's performance, such that radical innovation posture affects performance positively up to a turning point, and, beyond that point, radical innovation posture affects performance negatively.*

Moderating Effect of Rivalry in Markets

Experience goods providers in the same market may have overlapping products. The more overlap, the higher level of rivalry in that market (Greve 2000). The level of rivalry in a market can have a moderating effect on the relationship between innovation posture and firm performance. For incremental innovations such as updated products, high level of rivalry in the market requires higher capabilities of learning and innovation (Barnett and Sorenson 2002), making it harder to achieve leading posture and performance. For example, in highly competitive travel destinations such as Japan and Hong Kong, travel products offered by different travel agencies are highly similar and differentiation is extremely difficult. **H3:** *Rivalry in the markets where a firm operates dampens the positive relationship between the firm's incremental innovation posture and performance, such that the higher level of rivalry in the markets, the weaker effects of incremental innovation posture on performance.*

For radical innovations such as new products, the more rivalry in the market, the more scrutiny of the industry leaders, and the more imitation of their new products, hurting the performance of the leaders further. This should be good news for the laggards as their new products are scrutinized and imitated by their competitors even less, making it easier for laggards to test new products and improve performances. **H4:** *Rivalry in the markets where a firm operates sharpens the bell-shaped relationship between the firm's radical innovation posture and performance, such that the higher level of rivalry in the markets, the stronger the effects of radical innovation posture on performance on both sides of the turning point.*

Methods

We collected a longitudinal dataset of travel agencies that offer outbound package tour products from Mainland China to international destinations on Trip.com (formerly Ctrip.com). Trip.com is a highly competitive and transparent platform for travel products. We choose outbound package tours because they remain the dominant form for Chinese outbound tourists, accounting for 58% of the overall Chinese outbound market in 2017. Further, firms authorized to sell outbound package tours have more resources to develop innovations than those not authorized to do so.

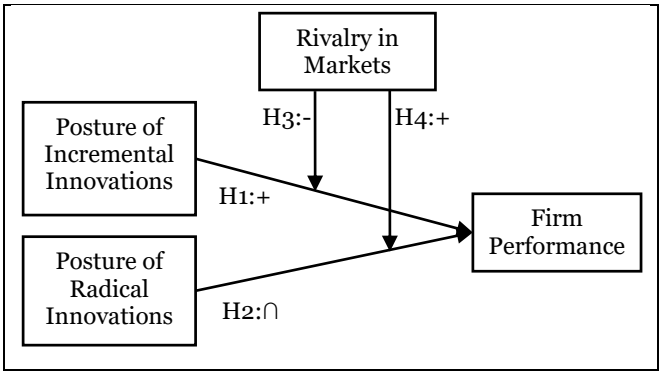


Figure 2. Research Model

We used two criteria to select the travel agencies on Trip.com to examine in this study. First, the firm must offer at least an outbound package tour departing from Shanghai for one of the top 15 destinations, including, ordered by market size, Japan, South Korea, Hong Kong, Taiwan, Europe, Singapore, Cambodia, Thailand, Maldives, Malaysia, Vietnam, United States, Canada, Australia & New Zealand, and Indonesia. According to China Tourism Academy, these 15 markets amounted to 96% of the total spending on outbound package tours in 2018. Further, Shanghai is the No. 1 departure city in China with more than 25% of sales in these 15 markets combined. Second, the firm must have updated its products (incremental innovations) or introduced new products (radical innovations) between March 2017 and November 2018 (21 months). This screening resulted in a sample of 114 travel agencies. Since outbound package tours are relatively expensive and thus purchased infrequently, their information does not change often on Trip.com. After observing such products for two months and consulting five sales managers at top travel agencies, we determined that it was appropriate to collect data from the product information pages on a monthly basis.

Measurement

Firm Performance Measured by Sales Volume (Dependent Variable)

We operationalized firm performance with the volume of sales: the monthly total number of customers who purchased the package tour products sold by a travel agency in our sample (*Sales*). Because each web page

shows the cumulative sales volume for a package tour, we calculated net sales volume for time *t* as the difference between the cumulative sale volume at *t* and that at *t-1*.

Innovation Postures Measured by Updated/New Product Postures (Independent Variables)

The travel agencies on the Trip.com platform engage innovations in two ways. On one hand, they develop incremental innovations by updating their existing products of package tours serving existing routes. On the other hand, they develop radical innovations by introducing new products of package tours serving new routes. Accordingly, we operationalized a firm's incremental innovation position with the proportion of updated products in the firm's portfolio of package tour products, and, similarly, a firm's radical innovation position as the proportion of new products in the firm's whole portfolio of package tour products. Regarding innovation posture, we followed Mithas et al. (2013) and calculated the difference between a firm's innovation position and the mean innovation position of all 114 firms as a proxy for industry mean. We calculated this difference for updated products (*UpdPosture*) and new products (*NewPosture*) to measure incremental innovation posture and radical innovation posture, respectively.

For the updated products in particular, not every update is considered an incremental innovation though. We compared the description of a product at *t-1* and that of the same product (with the same product ID) at *t* to determine whether the update is significant enough to be considered an incremental innovation. Specifically, we used TF-IDF (Term Frequency-Inverse Document Frequency) to vectorize the word frequency of product descriptions and then calculated the cosine similarity, which ranges from 0 to 1. The higher the cosine similarity, the smaller the change made to the product. We asked 12 sales managers at 10 top travel agencies in China to help evaluate the preliminary results of this text similarity analysis. They found that products with similarity scores over 0.9 were essentially the same product with only clerical updates. They had varied opinions about products with similarity scores between 0.8 and 0.9. Nevertheless, they agreed that cosine similarity scores below 0.8 indicated significant changes to the original product, thus we used 0.8 as the threshold to identify incremental innovations. Accordingly, the updated products with the same product ID and text-similarity under 0.8 were selected as incremental innovations. Products with similarity scores at or above 0.8 were considered the same product. For example, Table 1 compares two products with the same product ID sold by the same travel agency. Their cosine similarity is 0.65, within our range, thus the updated product was considered an incremental innovation.

March 2017	April 2017
Flow-viewing Tour · Japan Tokyo+Osaka+Kyoto+Hakone package tour 7 days 6 nights · A&C routes double ancient capitals; BD routes independent tours in Tokyo and Osaka. Labor Day immediate discount of ¥1000 for children without need for hotel bed! E route Disney or Private Owakudani. B&D routes Tokyo Osaka independent tours and stay in Okayama; Anime shrine parade; flower viewing	Flow-viewing Tour · Japan Tokyo+Osaka+Kyoto+Hakone package tour 7 days 6 nights · A&C routes double ancient capitals; B&D routes independent tours in Tokyo and Osaka. Parent-child Labor Day and Dragon Boat Festival immediate discount of ¥1000 for children without need for hotel bed! E route Disney or Private Owakudani and stay in brand new 5-star hotel. B&D routes Tokyo Osaka independent tours and stay in Okayama, free 4-star hotel experience for parent-child traveling together; Anime shrine parade; outlet shopping
Note: China Youth Travel Service, Product #8773408, translated from Chinese with original emphases	

Table 1. Comparison of Product Descriptions with the Same Product ID

Once we have identified the updated products, we calculated the percentage of updated products for every travel agency in our sample, *RUptPosition*, representing the incremental innovation position. To test H1, we then compared that percentage with the mean percentage in our sample to calculate *UpdPosture*, representing incremental innovation posture, for firm *i* at *t*:

$$UpdPosture_{i,t} = RUptPosition_{i,t} - AvgRUptPosition_t \quad (1)$$

where $RUptPosition_{i,t}$ is the position of updated products for firm *i* at *t*; and $AvgRUptPosition_t$ is the mean position of updated products at the sample level at *t*. *R* is the percentage of updated products.

Similarly, we also calculated the percentage of new products (i.e., package tours sold at *t* but not at *t-1*) for every travel agency in our sample, *RNewPosition*, representing the radical innovation position. To test H2, we then compared that percentage with the mean percentage in our sample to calculate *NewPosture*, representing radical innovation posture, for firm *i* at *t*:

$$NewPosture_{i,t} = RNewPosition_{i,t} - AvgRNewPosition_t \quad (2)$$

where $RNewPosition_{i,t}$ is the position of new products for firm i at t; and $AvgRNewPosition_t$ is the mean position of new products at the sample level at t. R is the percentage of new products.

Rivalry in Markets Measured by Competitive Density (Moderator)

To test H3 and H4, we followed Venkatraman and Lee (2004) and used market overlap density (*MODensity*) to measure the level of rivalry faced by competitors in each market. The market overlap density for market j at t is:

$$MODensity_{j,t} = \sum_{i} P_{ij,t} + \sum_{k \neq j} W_{kj,t} \left(\sum_{i} P_{ik,t} \right) \quad (3)$$

where $P_{ij,t}$ denotes the percentage of products that firm i offers on the market j at time t. Similarly, $P_{ik,t}$ the percentage of products that firm i offers on market k at t. $W_{kj,t}$ is the extent to which two markets overlap, calculated using the following overlap metric (Sohn 2001).

$$W_{kj,t} = \frac{\sum_i \alpha_{ik,t} \min(\alpha_{ik,t}, \alpha_{ij,t})}{\sum_i (\alpha_{ik,t})^2} \quad (4)$$

where $\alpha_{ik,t}$and $\alpha_{ij,t}$ are the numbers of products sold by firm i in market j and k, respectively.

Finally, we summed up the market overlap density of all 15 markets for each of the 114 travel agencies:

$$CompeteDensity_{i,t} = \sum_{j=1}^{15} \emptyset_{i,j,t} \times MODensity_{j,t} \quad (5)$$

where $CompeteDensity_{i,t}$ is the market overlap density for firm i in the overall marketplace (consisting of the markets for the 15 destinations) at t; $\emptyset_{i,j,t}$ is the percentage of products sold by firm i in market j at t.

Construct	Measure	Notation	Definition of Measure
Firm performance	Sales volume	*Sales*	Total number of customers who purchased the package tour products sold by a travel agency each month
Incremental innovation posture	Updated product posture	*UpdPosture*	Difference between a travel agency's percentage of updated products and the sample's mean percentage of updated products
Radical innovation posture	New product posture	*NewPosture*	Difference between a travel agency's percentage of new products and the sample's mean percentage of new products
Rivalry in Markets	Competitive density	*CompeteDensity*	Summation of market overlap density of the markets where each travel agency operated
Firm Age	Firm Age	*Age*	Number of years a travel agency existed in travel industry
Promotion	Promotion	*Promo*	Proportion of products with promotions in all products sold by a travel agency in the 15 markets
Withdrawal	Withdrawal	*Withdraw*	Proportion of products withdrawn each month in all the products sold by a travel agency in the 15 markets

Table 2. Summary of Constructs and Their Measures

Control Variables

We included three control variables. First, firm age (*Age*) is an important indicator for a firm's experience of learning and competition, which may help a firm perceive and predict market risks (Barnett and Sorenson 2002). Firm age is measured by the number of years a firm had existed in the travel industry up to the time of observation t. In addition, previous research has shown that when an organization's performance is below expectations, the organization will take competitive actions to change the existing

competitive position (Chen 2009). The competitive actions relevant to the travel industry include promotions and product withdrawals. A firm's promotion at *t* (*Promo*) is measured by the proportion of the firm's products with promotions in all products sold by the firm in the 15 markets on Trip.com. A firm's product withdrawal (*Withdraw*) is measured by the proportion of products the firm has withdrawn from the 15 markets each month in all products sold by the firm in the 15 markets.

Analytical Models

We developed a fixed-effects model to analyze the unbalanced longitudinal dataset (Jabr and Zheng 2014) because the result of the Sargan-Hansen test (169.970, p=0.00) suggests that a fixed-effects model is more appropriate than a random-effects model. Hence, our fixed-effects model is:

$$\ln(Sales_{i,t}) = \alpha_i + \beta_1 Age_{i,t} + \beta_2 Withdraw_{i,t} + \beta_3 Promo_{i,t} + \beta_4 UpdPosture_{i,t} + \beta_5 NewPosture^2{}_{i,t} + \beta_6 NewPosture_{i,t} + \beta_7 CompeteDensity_{i,t} + \beta_8 (UpdPosture \times CompeteDensity)_{i,t} + \beta_9 (NewPosture^2 \times CompeteDensity)_{i,t} + \beta_{10} (NewPosture \times CompeteDensity)_{i,t} + u_i + \varepsilon_{i,t} \quad (6)$$

where $\ln(Sales_{i,t})$ represents the logarithm of the dependent variable – sales volume of firm i at t; α_i is the intercept; $\beta_i (i = 1 \ldots 10)$ denote the coefficients for all variables; u_i is the firm-specific component of error.

Results

After removing unusual values (with a sales volume 10 times different from the previous period) and outliers (observations in the top and bottom 2.5%) in the dependent variable (*Sales*), we finalized the dataset containing 2,287 firm-month observations of the 114 travel agencies over the 21-month period. The firms in the sample are quite diverse in terms of ownership, industry status, age, and business scope.

Table 3 shows the descriptive statics of the variables in this study. We conducted a Wald test for heteroscedasticity (Greene 2000), which rejected the null hypothesis that the errors are homoscedastic ($\chi^2 = 94.66, p < 0.001$). We therefore controlled for homoscedasticity using robust standard errors (Jabr and Zheng 2014). Also, the variance inflation factors (VIF) for all independent variables were lower than 10 (mean=3.25), indicating multicollinearity was not a problem in our analysis (Hair et al. 2009).

Variables	Mean (S.D)	Max/Min	1	2	3	4	5	6
1. *Ln(Sales)*	5.85(2.29)	14.50/0	1					
2. *Age*	14.44(8.61)	36.95/0.10	0.04	1				
3. *Withdraw*	0.43(0.70)	11.00/0	-0.23*	0.06*	1			
4. *Promo*	0.17(0.28)	0/1	0.163*	-0.05*	0.01	1		
5. *NewPosture*	0.00(0.22)	0.76/-0.50	-0.21*	0.09*	0.06*	-0.04	1	
6. *UpdPosture*	0.00(0.12)	0.91/-0.14	0.23*	-0.01	-0.07*	0.18*	-0.16*	1
7. *CompeteDensity*	81.66(11.62)	111.39/48.60	-0.04	-0.02	-0.03	-0.08*	0.01	-0.10*

Table 3. Descriptive Statistics of Variables

As Table 4 shows, we followed the step-wise process by adding control variables first to the model (Model 1). We then added the independent variables, moderator, and their interaction terms step by step (Models 2-6). Finally, we ran a full model with all the main effects and moderation effects included (Model 7). Table 4 also shows the fixed-effects regression results for all variables with robust standard errors.

H1 is concerned with the effects of incremental innovation posture on performance. As shown in Model 2, the coefficient of updated product posture is positive and significant. However, the statistical significance of this effect became border-line in Models 3-5. Therefore, H1 is only marginally supported. H2 pertains to a bell-shaped relationship between radical innovation posture and performance. First, the quadratic term is significant and with a negative sign for the bell-shaped curve (Model 3). Second, the slopes are sufficiently steep: The slope at the low end of the X-range is positive and significant (p<0.01) and the slope at the high end is negative and significant (p<0.01). Third, Fieller's test shows that the turning point of the bell-shaped curve has a value of 0.01 within the turning point interval of [-0.376,0.150] (T-value=2.15, p<0.05). Therefore, the posture of new products demonstrates a bell-shaped relationship with sales volume, supporting H2. H3 for a negative moderation of the relationships between performance and incremental innovation posture by market rivalry is not supported as Model 5 shows a non-significant interaction term.

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
Constant	-3.048** (1.236)	-3.073** (1.360)	-2.922* (1.226)	-2.921* (1.249)	-3.066** (1.230)	-2.882* (1.223)	-2.905* (1.246)
Age	0.625*** (0.085)	0.627*** (0.085)	0.618*** (0.085)	0.619*** (0.085)	0.626*** (0.085)	0.612*** (0.084)	0.614*** (0.084)
Withdraw	-0.191*** (0.043)	-0.190*** (0.043)	-0.189*** (0.044)	-0.189*** (0.044)	-0.190*** (0.043)	-0.188*** (0.044)	-0.185*** (0.045)
Promo	0.175* (0.080)	0.166* (0.079)	0.158* (0.080)	0.157† (0.087)	0.165† (0.086)	0.169† (0.088)	0.159† (0.087)
UpdPosture		0.368* (0.187)	0.328† (0.196)	0.326† (0.197)	0.335† (0.185)		0.244 (0.192)
NewPosture			-0.000 (0.143)	-0.0005 (0.142)		-0.006 (0.147)	0.032 (0.149)
NewPosture²			-0.895* (0.364)	-0.895* (0.365)		-0.964** (0.370)	-1.001** (0.381)
CompeteDensity				-0.000 (0.003)	-0.000 (0.004)	0.000 (0.004)	0.000 (0.004)
*UpdPosture * CompeteDensity*					-0.009 (0.015)		-0.014 (0.015)
*NewPosture² * CompeteDensity*						-0.047* (0.025)	-0.066** (0.026)
*NewPosture * CompeteDensity*						0.011 (0.013)	0.012 (0.013)
R^2	0.168	0.170	0.173	0.173	0.170	0.184	0.186
$\triangle R^2$		0.002*	0.005*	0	0	0.011*	0.013*
No. of obs.	2287	2287	2287	2287	2287	2287	2287
Note: † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$							

Table 4. Results of Fixed-Effects Regression on Sales with Robust Standard Errors

H4 predicts that the level of rivalry in the markets sharpens the bell-shaped relationship between radical innovation posture and performance. To test this moderating effect, it is sufficient to check the significance of the coefficient of the second-order interaction term (Haans et al. 2016). Model 6 shows that the second-order interaction term for the quadratic form of new product posture and competitive density has a significant, negative coefficient, suggesting a stronger relationship between new product posture and performance on both sides of the turning point. To visualize this moderating effect, we plotted the results in Figure 3. The figure reveals that in the presence of high levels of rivalry, as indicated by competitive density, the bell-shaped curve, representing the curvilinear relationship between new product posture and sale volume, becomes steeper with the tuning point moving higher and to the right. Therefore, H4 is supported.

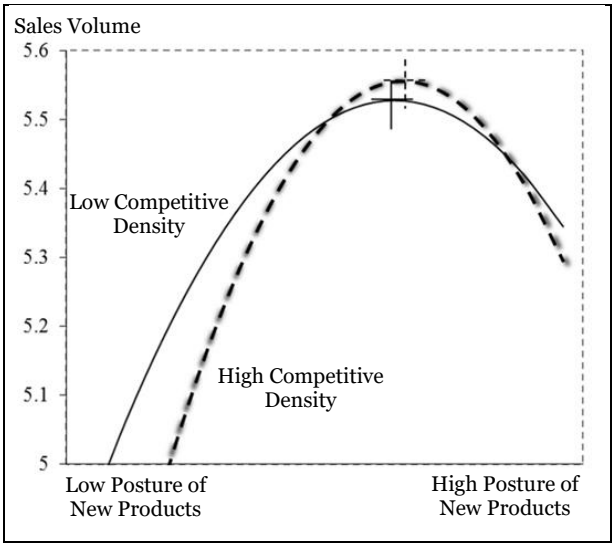


Figure 3. Moderation of Market Rivalry

Discussion

Theoretical Contributions

For digital platform research, this study makes contributions to the emerging stream of research on intra-platform competition. Foremost, the study reveals initial evidence that Red Queen is a type of intra-

platform competition. Further, the study also suggests that, on a digital platform for experience goods without much IP protection, Red Queen competition has nuanced effects on firm performance. Providers of experience goods must maintain appropriate innovation postures according to the types of innovations and level of rivalry in the markets. High performance may result from leading postures for incremental innovations regardless of the rivalry in the markets, and from middle-of-the-road postures for radical innovations, especially in high-rivalry markets.

Limitations and Future Research

The findings and contributions of the study are subject to at least four limitations. First, we used sample mean innovation posture as a proxy for the innovation postures of a firm's key, co-evolving competitors, as specified in the original literature on Red Queen competition (Barnett and Hansen 1996; Barnett and Sorenson 2002). Future research can properly identify a firm's key, co-evolving competitors and capture their innovation postures and moves. Second, we used cosine similarity to determine incremental innovation. Although we conducted sensitivity tests on the threshold, cosine similarity does not tell what exactly was innovated. More sophisticated text-mining methods should be in order to reveal the content of the innovations, of great practical value. Third, the algorithm Trip.com uses to determine new products is proprietary. Although the measure of radical innovation has face validity, for better replicability future research can develop a transparent measure. Lastly, firm performance was measured by the quantity of package tours sold. Data on the amount of sales and profit, if available, should be collected to measure performance more accurately.

Conclusion: What, How, and Where to Innovate on Digital Platforms

We conclude the paper with practical recommendations for the providers of experience goods competing on digital platforms. Without IP protection, firms need to not only constantly innovate to survive Red Queen competition, but also strategize what, how, and where to innovate in order to improve performance. First, they need to differentiate and balance between incremental and radical innovations, as the travel agencies at Trip.com need to determine what products to update and what new products to develop. Second, successful innovation strategies depend on the type of innovations. While better postures for incremental innovations may lead to better performance, middle-of-the-road postures for radical innovations may produce optimal results, especially in markets with a high level of rivalry. Lastly, these differentiated innovation strategies should be combined with business strategy so as to match the level of rivalry in the markets with the appropriate type and posture of innovations. These recommendations can also inform the owners of digital platforms as they continuously improve the design and governance of the platforms to foster learning, innovation, and competition.

Acknowledgements

Dr. Zhen Zhu thanks National Natural Science Foundation of China for financial support (Grant 71672183).

REFERENCES

Barnett, W.P., and Hansen, M.T. 1996. "The Red Queen in Organizational Evolution," *Strategic Management Journal* (17:S1), pp. 139-157.

Barnett, W.P., and Mckendrick, D.G. 2004. "Why Are Some Organizations More Competitive Than Others? Evidence from a Changing Global Market," *Administrative Science Quarterly* (49:4), pp. 535-571.

Barnett, W.P., and Sorenson, O. 2002. "The Red Queen in Organizational Creation and Development," *Industrial & Corporate Change* (11:2), pp. 289-325.

Benner, M.J., and Tushman, M.L. 2003. "Exploitation, Exploration, and Process Management: The Productivity Dilemma Revisited," *Academy of Management Review* (28:2), pp. 238-256.

Chen, M.J. 2009. "Competitive Dynamics Research: An Insider's Odyssey," *Asia Pacific Journal of Management* (26:1), pp. 5-25.

China Knowledge. 2018. "Ctrip Tops Global Travel Industry in Gmv Amid Tighter Margins." Retrieved February 20, 2020, from https://bit.ly/398ldjA.

Clark, K.B., Chew, W.B., Fujimoto, T., Meyer, J., and Scherer, F.M. 1987. "Product Development in the World Auto Industry," *Brookings Papers on Economic Activity* (1987:3), pp. 729-781.
de Reuver, M., Sørensen, C., and Basole, R.C. 2018. "The Digital Platform: A Research Agenda," *Journal of Information Technology* (33:2), 2018/06/01, pp. 124-135.
Derfus, P.J., Maggitti, P.G., Grimm, C.M., and Smith, K.G. 2008. "The Red Queen Effect: Competitive Actions and Firm Performance," *Academy of Management Journal* (51:1), pp. 61-80.
Dewar, R.D., and Dutton, J.E. 1986. "The Adoption of Radical and Incremental Innovations: An Empirical Analysis," *Management Science* (32:11), pp. 1422-1433.
Foerderer, J., Kude, T., Mithas, S., and Heinzl, A. 2018. "Does Platform Owner's Entry Crowd out Innovation? Evidence from Google Photos," *Information Systems Research* (29:2), pp. 444-460.
Gawer, A., and Cusumano, M.A. 2014. "Industry Platforms and Ecosystem Innovation," *Journal of Product Innovation Management* (31:3), pp. 417-433.
Ghazawneh, A., and Henfridsson, O. 2015. "A Paradigmatic Analysis of Digital Application Marketplaces," *Journal of Information Technology* (30:3), September 01, pp. 198-208.
Giachetti, C., Lampel, J., and Li Pira, S. 2017. "Red Queen Competitive Imitation in the UK Mobile Phone Industry," *Academy of Management Journal* (60:5), Oct, pp. 1882-1914.
Greene, W.H. 2000. *Econometric Analysis, 4th Ed*. Upper Saddle River, NJ.: Prentice-Hall.
Greve, H.R. 2000. "Market Niche Entry Decisions: Competition, Learning, and Strategy in Tokyo Banking, 1894-1936," *Academy of Management Journal* (43:5), pp. 816-836.
Haans, R.F.J., Pieters, C., and He, Z.L. 2016. "Thinking About U: Theorizing and Testing U- and Inverted U-Shaped Relationships in Strategy Research," *Strategic Management Journal* (37:7), Jul, pp. 1177-1195.
Hair, J., Anderson, R., Tatham, R., and Black, W. 2009. *Multivariate Data Analysis*. NJ: Prentice Hall.
Helfat, C.E., and Raubitschek, R.S. 2018. "Dynamic and Integrative Capabilities for Profiting from Innovation in Digital Platform-Based Ecosystems," *Research Policy* (47:8), pp. 1391-1399.
Jabr, W., and Zheng, E. 2014. "Know Yourself and Know Your Enemy: An Analysis of Firm Recommendations and Consumer Reviews in a Competitive Environment," *MIS Quarterly* (38:3), pp. 635-654.
March, J.G. 1991. "Exploration and Exploitation in Organizational Learning," *Organization Science* (2:1), pp. 71-87.
Mithas, S., Tafti, A., and Mitchell, W. 2013. "How a Firm's Competitive Environment and Digital Strategic Posture Influence Digital Business Strategy," *MIS Quarterly* (37:2), Jun, pp. 511-536.
Nelson, P. 1970. "Information and Consumer Behavior," *Journal of Political Economy* (78:2), pp. 311-329.
Rolland, K.H., Mathiassen, L., and Rai, A. 2018. "Managing Digital Platforms in User Organizations: The Interactions between Digital Options and Digital Debt," *Information Systems Research* (29:2), pp. 419-443.
Sohn, M.W. 2001. "Distance and Cosine Measures of Niche Overlap," *Social Networks* (23:2), May, pp. 141-165.
Tilson, D., Sorensen, C., and Lyytinen, K. 2012. "Change and Control Paradoxes in Mobile Infrastructure Innovation: The Android and iOS Mobile Operating Systems Cases," *2012 45th Hawaii International Conference on System Sciences*, pp. 1324-1333.
Tiwana, A. 2015. "Evolutionary Competition in Platform Ecosystems," *Information Systems Research* (26:2), Jun, pp. 266-281.
Tiwana, A., Konsynski, B., and Bush, A.A. 2010. "Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics," *Information Systems Research* (21:4), Dec, pp. 675-687.
Venkatraman, N., and Lee, C.H. 2004. "Preferential Linkage and Network Evolution: A Conceptual Model and Empirical Test in the U.S. Video Game Sector," *Academy of Management Journal* (47:6), pp. 876-892.
Wessel, M., Thies, F., and Benlian, A. 2017. "Competitive Positioning of Complementors on Digital Platforms: Evidence from the Sharing Economy," *38th International Conference on Information System*, Seoul, South Korea.
Yoo, Y. 2010. "Computing in Everyday Life: A Call for Research on Experiential Computing," *MIS Quarterly* (34:2), pp. 213-231.
Zhu, F., and Iansiti, M. 2019. "Why Some Platforms Thrive and Others Don't," *Harvard Business Review* (97:1), pp. 118-125.