Analysis of service differentiation and purchase pricing strategies based on game theory

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Abstract. This paper uses game theory to analyse how tourist attractions can increase revenue through differentiated services and purchase pricing strategies in peak seasons, and attract tourists through strategies in low seasons, so as to balance the flow of tourists and avoid excessive gaps between peak and low flow times. The study constructs a revenue matrix and a dynamic game model to explore tourists' decisions to purchase VIP services, corporate pricing strategies and market acceptance of differentiated services. Secondly, game theory is used to analyse why firms choose to adopt second-tier price discrimination in order to gain higher profits. The analysis shows that the introduction of differentiated service products can attract tourists and increase revenue. Meanwhile, differentiation game theory helps enterprises dynamically adjust their service strategies according to market demand to maximise long-term revenue and benefits. The study also points out that optimising pricing strategies is crucial to attract different consumer groups.

1 Introduction

In many domestic tourist attractions, revenues are low in the off-season, while in the peak season, due to the large number of passengers, the service is difficult to keep up, which leads to a negative impact on revenues. How to effectively improve the service quality of scenic spots in the peak season to ensure revenue has become an urgent problem [1]. Currently, there are still fewer studies on improving the negative impacts of services in the peak season of scenic spots due to high flow of people through purchase pricing and service differentiation strategies. Most of the existing research focuses on marketing strategies and scenic area infrastructure improvements, while there is a relative lack of exploration on how to optimize visitor experience and increase scenic area revenue through pricing and service differentiation [2, 3].

This research gap highlights the need to further explore effective pricing models and service strategies to better cope with the challenges of tourist surges in peak seasons and low revenue in off-season, so as to enhance the overall operational efficiency of scenic spots. In recent years, there has been a gradual increase in research on pricing and service strategies for tourist attractions. Pan et al. showed thatpersonalised travel has become mainstream [4]. This paper explores the application of dynamic pricing-based strategies and finds that this approach can effectively balance the distribution of passenger flows between peak and off-

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season, thereby reducing the pressure on scenic area services. Shen et al. proposed the importance of differentiated services to improve tourist satisfaction, and their study showed that by providing diversified service options, the needs of different types of tourists can be satisfied, which will in turn increase the repeat rate of tourists [5-7]. In addition, this paper examines the effects of using time-sharing pricing strategies during peak seasons, and concludes that time-sharing pricing not only enhances the revenue of scenic spots, but also improves the tourists' experience to a certain extent [8, 9].

2 Gambling model

2.1 Model construction

The following dynamic game will be used to analyse the acceptance of differentiated services by tourists. Place the figure as close as possible after the point where it is first referenced in the text. The main body of the game is Scenic area managers, which provide differentiated services, such as VIP access, special guided tours, and customised experiences. The goal is to increase revenue and tourist satisfaction through differentiated services.And tourists who can choose to accept or not to accept the differentiated services provided by the scenic area and make decisions according to their own experience and price.At stage 1, the scenic spot chooses whether to provide differentiated services or not, as well as setting the price (p) . (A1) is the scenic spot provides differentiated services at a price (p). (A0) is the scenic spot does not provide differentiated services.

At stage 2, the tourist observes the decision of the scenic spot and chooses whether to accept the service or not.If the scenic spot chooses (A1) to provide the service, the tourist can choose (B1) accept and pay the price (p), or (B0)not accept the service.The benefit function is each participant has their own benefit function based on their choices.

2.2 Analysis process

The revenue of the scenic spot depends on whether the tourist accepts the service or not. If the tourist accepts, the scenic spot's revenue is the price of the service (p) , and if not the revenue is zero. Assume that the cost of the service provided by the scenic spot is(c). If the tourist chooses (B1) to accept, the scenic gain is $\pi = p - c$. If tourists choose (B0) not to accept, the benefit to the scenic spot is $\pi = 0$. The benefits to tourists depend on whether they accept the service or not. If they accept, tourists receive utility(u) from the service, but pay a price (p). If choice (B1) Accept, the tourists' benefits are $\pi = u + p$. If choice (B0) is not accepted, the tourists' gains are $\pi = 0$.

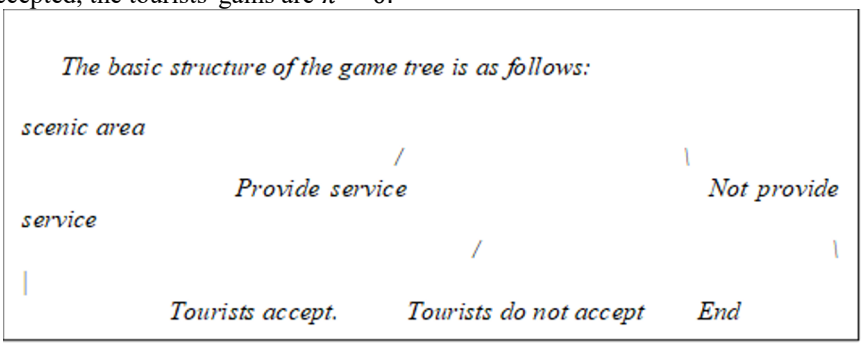

Fig. 1. Game tree

Subgame Perfect Nash Equilibrium (SPNE) is that this paper can use “backward induction” to solve the Subgame Perfect Nash Equilibrium (SPNE) of this dynamic game. This is a commonly used analytical method in dynamic games. From Reverse induction steps, at stage 2 (Tourist's decision). If the scenic spot offers a service (A1) , tourists will decide whether to accept it or non- based on utility (u) and price (p). The tourist accepts the service on the condition that $(u - p > 0)$. If (p)exceeds (u) , the tourist does not accept (Figure 1).

At stage 1 (Decision Making at the Scenic Area), The scenic spot chooses the optimal strategy based on the tourists' responses. The objective of the attraction is to maximise the revenue by providing the service. The scenic spot chooses to provide the service only if $(p - c > 0)$ and the tourist accepts the service.The final equilibrium strategy is that if $(u > p)$ and $(p - c > 0)$, the scenic spot offers a differentiated service and tourists accept it. If $(u < p)$ and $(p - c < 0)$, the scenic spot does not provide the service or the tourist does not accept it. The Normal Form Representation (NFR) is that for dynamic games, a payoff matrix can also be constructed to represent the payoffs of the participants. Suppose there are two states: the scenic spot provides differentiated services (A1) and does not provide services (A0), and tourists can choose to accept (B1) or not accept (B0).

3 Pricing strategy analysis

Equations should be centred and should be numbered with the number on the right-hand side. Using game theory to analyse whether firms can increase earnings by adopting secondary price discrimination strategies [10]. Secondary price discrimination (also known as quantity price discrimination) means that firms set different prices according to the quantity of purchases made by consumers. For example, consumers who buy in large quantities enjoy a lower unit price, while those who buy in small quantities pay a higher unit price.In the framework of game theory, the firm's goal is to maximise profits by inducing consumers to choose the optimal consumption option according to their needs through this pricing strategy. This paper can use the reverse inducement game (Stackelberg game) model to analyse whether firms can increase their revenue through secondary price discrimination.

3.1 Preliminary work

Participants are the main players in the game are businesses and consumers. Firms are as the first mover in the game, set different price packages (e.g. quantity discounts). Consumers are as followers of the game, they choose price packages according to their demand for goods.The strategic space for businesses is that firms can create different pricing packages that offer different discounts for different quantities of items. For example, purchases of 1-10 items are priced at P1 and purchases of more than 10 items are priced at p2 $(p2 < p1)$.The consumer's strategy space is that consumers choose the optimal quantity from different price packages based on their needs and budget. consumers will choose the quantity to buy based on their willingness to pay (i.e., the demand curve). From firm's revenue function, A firm's revenue is equal to price times volume minus cost. Assuming constant marginal cost, the firm's objective is to increase total sales volume and thus profits through price discrimination In a game theoretic framework, whether a firm can increase its revenue by adopting secondary price discrimination depends on the following key conditions. First, Demand heterogeneity exists in the market: firms can better extract consumer surplus through price discrimination if there are large differences in demand among consumers. For example, consumers with high demand will choose high quantity packages and consumers with low demand will choose low quantity packages but pay higher prices. Second, low or decreasing marginal cost: If a firm's marginal cost is low (or even decreasing), the firm's profits are able

to rise with volume growth when it increases volume through secondary price discrimination. And then, Inducibility of consumer choice: Firms need to ensure that their price structure is sufficiently clear to allow consumers to spontaneously choose the option that is in the firm's interest when making rational decisions (i.e., high-demanding consumers buy more, and low-demanding consumers pay a higher unit price).

3.2 Analysis process

Assuming that consumers know the prices of different quantities, they will choose the package that maximises their utility when faced with different prices. Firms, as first movers, need to anticipate consumers' decisions and design a set of price combinations such that high-demand consumers are willing to buy more, while allowing low-demand consumers to still choose the appropriate quantity. High-demand consumers who buy large quantities of goods and enjoy lower unit prices can increase the firm's sales. Low-demand consumers who choose small quantities of goods, even though they pay a higher unit price, have lower total expenditures and the firm profits through higher profit margins. The Nash equilibrium is that the firm designs its secondary price discrimination strategy to achieve a Nash equilibrium in which each consumer makes a decision that is optimal for him or her when faced with a price package, while the firm maximises profits through differential pricing. If the firm's pricing strategy is sound, consumers do not deviate from their optimal choices and the firm maximises revenue by increasing total sales or profitability.

3.3 Results of service differentiation issue

For dynamic games, a payoff matrix can also be constructed to represent the payoffs of the participants (table 1). Suppose there are two states: the scenic spot provides differentiated services (A1) and does not provide services (A0), and tourists can choose to accept (B1)or not accept (B0).

Table 1. Normal Form Representation (NFR)

	Acceptance of service(B1)	Non-acceptance of services(B0)
Provision of services(A1)	(p-c，u-p)	（-c，0）
No services provided (A0)	(0，0)	(0，0)

If the attraction chooses to provide the service (A1) and the tourist accepts (B1), the benefits are $(p-c)$ to the attraction and $(u-p)$ to the tourist.If the attraction provides the service (A1) and the tourist does not accept (B0), the attraction loses the cost of providing the service and there is no gain to the tourist. If the scenic spot does not provide the service (A0), no matter whether the tourists accept it or not, the revenue of both parties is 0. Through the dynamic game, tourism enterprises can dynamically adjust their differentiation strategies; the number of products with differentiated services should be increased in peak seasons, and can be reduced moderately in low seasons, so as to maximise their long-term returns by adapting to changes in market demand. This approach takes into account not only the current competitive environment but also future market evolution, which helps to develop a more sustainable competitive strategy. In addition, the annual pass tickets set up by theme parks such as Disney's Universal Studios also have a positive impact on their revenues. In the following this passage will use the basic game model to analyze why firms behave in a manner of secondary price discrimination.

4 Conclusion

In the framework of game theory, second-order price discrimination is a way for firms to maximise revenue by developing different pricing strategies and offering differentiated products or services to different groups of consumers. At the heart of this strategy lies the ability to exploit the diversity of market demand and the firm's ability to accurately predict consumer preferences and behaviour. Through a well-designed pricing scheme, a firm is able to increase sales and profitability by allowing consumers to make optimal choices based on their needs and ability to pay. For example, airlines often price air tickets with second-order price discrimination based on factors such as time of purchase, seat type, and additional services to attract customers with different spending power. With the combination of dynamic and static game theory, firms can not only optimise their pricing strategies, but also better respond to competitors' market reactions. In particular, dynamic game theory can reveal long-term competitive dynamics and optimal decision paths by analysing the strategic interactions of participants over time. Future research can further explore more complex multi-participant games and non-linear pricing strategies, expanding the depth of game theory's application in economics and marketing, and providing richer theoretical support for practical operations.

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