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Chinese Travelers' Perceptions towards Demand Based Pricing Strategies of the High Speed Rail: A Conjoint Analysis Approach

聯合分析法研究內地旅客關於高速鐵路按需定價策略之看法

(Project No: 2020.A6.150.20A)

Final Report

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Executive summary

Abstract of the research

The introduction of High Speed Rail in Hong Kong is an important development in terms of keeping Hong Kong's status as a transport hub. High Speed Rail service opened in September 2018 and the estimated forecast of daily passengers are around 80,000. This initiative, which took more than 18 years to build, connects Hong Kong to China's network of high-speed railways. At this time, passengers taking the train from Hong Kong can connect to 44 destinations in China (High Speed Rail, 2019). After being in development for less than 10 years, the Chinese high-speed railway (CRH) became the largest high-speed railway network in the world (Xinhuanet, 2016). Since the Beijing-Tianjin railway—the first high-speed railway line in China which only has a length of 120 km—began to operate in 2008, the CHSR experienced intensive development (Xinhuanet, 2016). Railway systems have many competitive advantages compared with other types of transportation, especially in city pairs of short-to-medium distances. The complexity of railway networks permits multi-leg routes and an increased choice of route arrangements.

Taking High Speed Rail as an example, the purpose of this study is to examine Chinese travelers' perceptions towards demand based pricing strategies. More specifically, this research intends to identify the trade-off effects between fares and fare restrictions to identify the relative importance of different types of railway ticket rate fences by mainland Chinese travelers and Hong Kong residents. Using conjoint analysis, this study identifies price, departure time, and booking requirement as the three most important rate fences in passengers' decision making and also provides guidelines on passengers' preferences of each attribute level through the partial utility scores. Furthermore, this study examines the effect of socio-demographic and travel characteristics on the perceived attribute importance. The findings of this study help Chinese rail high-speed company gain a better understanding of passengers' perceptions and preferences so that they can design more efficient rate fence combinations.

研究摘要

在香港引入高鐵是保持香港的交通樞紐地位的一個重要發展。高鐵服務於 2018 年 9 月開通，估計預測每天的乘客約為 80,000 人。這一舉措耗時超過 18 年，將香港與中國內地的高速鐵路網絡連接起來。此時，從香港乘坐火車的乘客可以連接到中國內地的 44 個目的地（High Speed Rail, 2019）。在發展了不到 10 年後，中國高速鐵路（CRH）成為世界上最大的高速鐵路網（新華網，2016）。自 2008 年京津鐵路--中國第一條長度僅為 120 公里的高速鐵路開始運營以來，中國高速

鐵路經歷了快速的發展（新華網，2016）。與其他類型的運輸方式相比，鐵路系統有許多競爭優勢，特別是在中短距離的城市間。鐵路網絡的複雜性允許多條線路和更多的線路安排選擇。

本研究以高速鐵路為例，旨在探討中國旅客對按需定價策略之看法。更具體而言，此項研究旨在確定票價和票價限制之間的權衡效果，以確定對於內地旅客和香港居民來說不同類型的鐵路票價圍欄的相對重要性。通過聯合分析，本研究將價格、發車時間和訂票要求確定為乘客決策中最重要的三個票價圍欄，並根據效用得分為乘客對各屬性水平的偏好提供指導。此外，本研究還考察了社會人口學和旅行特徵對感知屬性重要性的影響。本研究的結果有助於中國鐵路高速公司更好地瞭解乘客的感知和偏好，從而設計出更有效的票價圍欄組合。

Summary on policy implications and recommendations

Investigating how Chinese travelers and Hong Kong residents value different rate fences is an important endeavor. Understanding the perceptions and preferences of these travelers for ticket pricing policies will allow Hong Kong and Chinese governments to assess their current ticket pricing policies, consider rate fences as a competitive tool, and seek opportunities to improve existing products and services. It is clear that High Speed Rail service will continue to expand to other destinations in mainland China and rail travel is a primary way of travel in China. In this respect, understanding customer perceptions on railway rate fences will contribute to the development and viability of the High Speed Rail service in Hong Kong and mainland China. The findings of this study have five important policy implications and recommendations.

1) CRH should design railway rate fences according to the importance of the attributes.

CRH needs to carefully consider the three most important attributes (i.e., ticket price, departure time, and booking requirement), as improper design of these attributes may dissuade passengers from making ticket purchases. CRH can justify price levels by offering conditions of departure time and booking requirements that are attractive to passengers. CRH could implement a non-refundable ticket policy to protect company interests while having a limited influence on passengers' decision making. Furthermore, HK and CN passengers have preference differences, and therefore CRH could devise rate fence combinations differently for mainland Chinese and Hong Kong passengers.

2) CRH should pay attention to passengers' socio-demographic profiles and travel characteristics and design rate fences accordingly.

This study provides useful information by comparing the importance value relative to passengers' socio-demographic profiles and CRH travel behaviors and by investigating the effects of gender, age, education, city of residence, monthly household income, and familiarity with rate fences on the attribute importance. The results show that for most segments, price was consistently the most important attribute, followed by departure time and booking requirement, and the refund conditions was the least important. But some exceptions and statistical differences exist. Therefore, CHR are suggested to pay attention to passengers' segments and design rate fences accordingly.

3) CRH should design efficient rate fence combinations according to passengers' preference of each attribute level.

This study provides guidelines on passengers' preferences of each attribute level through the partial utility scores. The results showed that the most preferred rate fence combination was to depart at lunchtime, to book on the day of travel, to offer a 30% discount on tickets, and to offer customers a full refund when canceling their ticket. The partial utility scores were found to be slightly different between CN and HK passengers. By understanding the difference, CRH can offer a modest price that requires CN passengers to book three days in advance, to attract passengers and simultaneously protect the company's interests. Based on our results, this combination of rate fences may not work for HK passengers.

4) CRH can use conjoint analysis, a powerful tool, to determine the utility score and importance value of rail rate fences.

In reality, passengers make their purchasing decisions on the implicit utility attached to each attribute. The conventional approach that assesses each attribute separately is flawed, as it does not capture the trade-off effects between the various attributes and passengers' decision making. Conjoint analysis helps to solve this problem by placing passengers in a more realistic scenario where passengers are presented with bundled attributes, thus implicitly revealing and measuring their hidden needs. This method is also helpful in assessing the utility of the current rate fences in use.

5) CRH should ensure that passengers who are very familiar with rate fences are not dissuaded by unfavorable fencing conditions and that they are not taking advantage of reduced fares.

The study revealed that passengers who were more familiar with rail rate fences paid more attention to departure time and booking requirement, whereas they paid less attention to refund conditions and ticket price. This finding suggests that as passengers become more familiar with rail rate fences, they become less price sensitive. In other words, they are more willing to pay a higher price for their preferred fencing conditions. CRH should therefore ensure that passengers of high familiarity degree are not dissuaded by unfavorable fencing conditions and that they are not taking advantage of reduced fares, to achieve optimal rate fence combinations.

政策含義和建議摘要

調查中國內地旅客和香港居民如何評價不同的票價圍欄是一項重要的工作。瞭解這些旅客對車票定價政策的看法和偏好，將有助於香港和中國內地政府評估他們目前的車票定價政策，考慮將票價圍欄作為一種競爭工具，並尋求改善現有產品和服務的機會。很明顯，高鐵服務將繼續擴展到中國內地的其他目的地，鐵路旅行是中國的主要旅行方式。因此，瞭解旅客對鐵路票價圍欄的看法將有助於香港和中國內地的高鐵服務的發展和可行性。本研究結果有五個重要的政策含義和建議。

1）中國高速鐵路應根據屬性的重要性來設計鐵路票價圍欄。

中國高速鐵路需要仔細考慮三個最重要的屬性（即票價、發車時間和訂票要求），因為這些屬性的設計不當可能會打消乘客的購票念頭。中國高速鐵路可以通過提供對乘客有吸引力的出發時間和訂票要求的條件來解釋價格水平。中國高速鐵路可以實施不退票政策來保護公司利益，同時這對乘客的決策影響是有限的。此外，香港和中國內地的乘客有偏好上的差異，因此中國高速鐵路可以為中國內地和香港的乘客設計不同的票價圍欄組合。

2）中國高速鐵路應關注乘客的社會人口狀況和旅行特點，並據此設計票價圍欄。

本研究通過比較乘客的社會人口狀況和中國高速鐵路的旅行行為的相應重要性，以及調查性別、年齡、教育、居住城市、家庭月收入和對票價圍欄的熟悉程度對屬性重要性的影響，提供了有用的信息。結果顯示，對於大多數群體來說，價格始終是最重要的屬性，其次是出發時間和訂票要求，而退款條件是最不重要的。但也存在一些例外情況和統計差異。因此，建議中國高速鐵路關注乘客的細分市場並設計相應的票價圍欄。

3）中國高速鐵路應根據乘客對各屬性水平的偏好，設計有效的票價圍欄組合。

本研究通過部分效用分值為乘客對各屬性水平的偏好提供了指導。結果顯示，最受歡迎的票價圍欄組合是在午餐時間出發，在旅行當天預訂，提供 30%的票價折扣，以及在取消車票時為顧客提供全額退款。研究發現，中國和香港乘客的部分效用得分略有不同。通過瞭解這些差異，中國高速鐵路可以提供一個適度的價格並要求中國內地乘客提前三天預訂，以吸引乘客並同時保護公司的利益。根據我們的結果，這種票價圍欄的組合可能對香港乘客不起作用。

4）中國高速鐵路可以利用聯合分析這一強大的工具來確定鐵路票價圍欄的效用分數和重要性值。

在現實中，乘客是根據每個屬性的隱含效用做出購買決定的。單獨評估每個屬性的傳統方法是有缺陷的，因為它忽略了各種屬性和乘客決策之間的權衡效應。聯合分析法有助於解決這個問題，它將乘客置於一個更現實的場景中，即乘客被呈現出捆綁的屬性，從而隱含地揭示和測量他們的隱藏需求。這種方法也有助於評估目前正在使用的票價圍欄的效用。

5) 中國高速鐵路應確保非常熟悉票價圍欄的乘客不會被不利的圍欄條件所勸阻，也不會購買到降低的票價。

研究顯示，對鐵路票價圍欄比較熟悉的乘客更關注出發時間和訂票要求，而對退票條件和票價的關注度較低。這一髮現表明，隨著乘客對鐵路票價圍欄越來越熟悉，他們對價格的敏感度也越來越低。換句話說，他們更願意為自己喜歡的圍欄條件支付更高的價格。因此，CRH 應該確保熟悉程度高的乘客不會被不利的圍欄條件所勸阻，同時也不會購買到降低的票價，以實現最佳的票價圍欄組合。

1 Introduction

Rate fences, also known as rate restrictions or terms and conditions, refer to "logical, rational rules or restrictions that are designed to allow customers to segment themselves into appropriate rate categories based on their needs, behavior, or willingness to pay" (Hanks, Cross, and Noland 1992, 21). This customer segmentation strategy can help service providers justify price discrimination among different segments, thereby avoiding selling products or services at low prices to customers who are willing to pay more. Rate fences have been adopted in many service industries, including hospitality (hotels and restaurants) and air and rail travel. Examples of common rate fences used in service industries include the class of travel (business/economy), seat location in a theater or stadium, advance purchase, and minimum length of stay (Wirtz and Kimes 2007). It is in the best interests of service providers that rate fences are well designed so that they are perceived fair and acceptable by customers (Denizci Guillet, Law, and Qu 2014). In other words, it is fundamental for businesses to understand customer perceptions and preferences with regard to rate fences.

Rate fences are commonly used in the rail travel industry. Typical rate fences adopted by rail companies, such as SNCF (France), SBB (Switzerland), ICE (Germany), and Comboios de Portugal (Portugal), include time conditions (referring to departure and arrival time), booking requirements (referring to how many days in advance a ticket is purchased), and refund rules (referring to the refund amount a passenger will receive if a reservation is canceled). Despite the widespread use of these strategies, no prior studies have investigated how rail passengers perceive different types of rate fences. To fill this gap in the literature, this study aimed to investigate the perceived importance of and preference for various rail rate fences by rail passengers.

Past research has mainly focused on the application of revenue management practices in Western countries, with little attention paid to the mindset and preferences of Chinese travelers (e.g., Kimes and Wirtz 2002; Choi and Mattila 2009). This study focuses on China Railway High-Speed (CRH), the largest high-speed passenger railway network in the world (Lawrence, Bullock, and Liu 2019). Since the network began operating in 2008, CRH has experienced extensive development, including the opening of 25,162 km of high-speed lines, resulting in the network carrying over seven billion passengers over the last 10 years, equating to 1.7 billion passengers per year by the end of 2017 (Lawrence et al. 2019). Hong Kong was added to China's high-speed railway network in 2018. Passengers taking the CRH from Hong Kong can travel to 58 destinations in China (High Speed Rail 2021). The introduction of high-speed rail in Hong Kong is an important development in terms of maintaining Hong Kong's status as a transport hub.

Given the widespread use of CRH, we deemed it essential to assess the ways in which mainland Chinese passengers and Hong Kong passengers value different rate fences. The conjoint approach, a powerful method to analyze passenger preferences in a joint way, was used in this study. In addition, based on the results of conjoint analysis, this study further examined whether there are any differences in the relative importance of different types of railway ticket rate fences for Chinese travelers and Hong Kong residents with different socio-demographic and travel characteristics. Furthermore, although familiarity with pricing practices has been found to be influential in customers' fairness perceptions, which are central to customers' acceptance of pricing practices (Wirtz and Kimes 2007), the ways in which different types of rate fences are affected by the degree of customer familiarity remains unclear. As a result, this study also examined the role of familiarity in the perceived importance of various rail rate fences.

It is expected that the findings of this study will aid the Hong Kong and Chinese governments in assessing their current railway pricing policies by using rate fences as a competitive tool to formulate better pricing practices, and seek opportunities to improve existing products and services. In addition to the industrial implications, this study contributes to the research on rate fences by providing insights into the perceptions and preferences of Chinese high-speed rail passengers, an important demographic that has been underexplored in previous studies.

2 Objectives of the study

The specific objectives of this study were as follows:

(1) To identify the relative importance of different types of railway ticket rate fences by Mainland Chinese and Hong Kong travelers.
(2) To determine the preferred railway ticket rate fences by the Chinese travelers and Hong Kong residents.
(3) To investigate whether there are any differences in the relative importance of different types of railway ticket rate fences for Chinese travelers and Hong Kong residents with different sociodemographic and travel characteristics.
(4) To provide pricing and rate restriction recommendations to government bodies in China.

3 Background of research

3.1 Railway revenue management

Kimes (1989) defined revenue management as allocating the right type of capacity to the right customer at the right price. Revenue management is applicable when an industry has the following characteristics: (1) capacity is relatively fixed; (2) demand

can be segmented; (3) inventory is perishable; (4) the product can be sold in advance; and (5) sales costs are low but production costs are high. These five characteristics need to be simultaneously present. The rail travel industry features these characteristics as having inflexible capacity of rail seats and fluctuating passenger demand, being unable to save unsold railway ticket as inventory, selling tickets in advance, and holding marginal cost of running railway business as compared with the capital investment of building the railway network. Responding to the managerial concern that an efficient information system is necessary for the effective use of revenue management, Kimes (1989) also suggested that information about booking patterns, demand patterns, and the effects of price changes should be collected in the information system.

Kimes and Chase (1998) categorized different service industries into four groups with two interrelated strategic levers: fixed or variable prices and predictable or unpredictable duration. In practice, industries in Quadrant 2 (variable price and predictable duration) have the best outcomes with regard to the application of revenue management techniques. The researchers suggested that industries in the other three quadrants wishing to improve their revenue performance should first redesign their service/product to match Quadrant 2 and then apply revenue management strategies. CRH, with its fixed price and predictable duration characteristics, is currently located in Quadrant 1. To move to Quadrant 2, the CRH must first change its pricing mechanism from fixed to dynamic pricing. Once this change has taken place, other revenue management strategies can be applied.

Demand-based pricing is a popular dynamic pricing strategy used in many industries (Kimes and Wirtz 2003). This strategy is based on capitalizing on the different characteristics of various customer segments, such as price sensitivity and individual product requirements. Using demand-based pricing strategies, a product could be sold to low price-sensitive customers at a higher price and to high price-sensitive customers at a lower price. When this strategy is appropriately designed and applied, making full use of all resources, profit is maximized. The successful application of demand-based pricing requires the help of rate fences. When more conditions and restrictions are attached to a low price point, price-sensitive customers often sacrifice flexibility to qualify for the cheaper price. Alternatively, customers without price sensitivity and more requirements would be able purchase the product or service at a higher price.

Demand-based pricing and rate fences have been applied by rail companies in many countries (Table 1). Take SNCF as an example, it offers one of the most comprehensive ticket purchasing systems, applying a large number of rate fences. The rate fences

include time conditions (referring to departure and arrival times), booking requirements (referring to how many days in advance a ticket is purchased), refund rules (referring to the refund amount a passenger would receive if a reservation is canceled), travel class (referring to different types of train class, such as first class and second class), ticket type (referring to different types of high-speed train ticket), number and/or duration of change (referring to the number and/or duration of changing from one train to another), and facilities on the train (referring the special or premium facilities provided on the train). At the same time, several additional conditions are also applied. For example, SNCF offers special prices for seniors, children, group bookings, and members of their loyalty scheme. Overall, time conditions, booking requirement, refund rules, travel class, number/duration of change, and ticket type are the most common rate fences. Currently, CRH only applies travel class as a rate fence and passenger age as well as special group as an additional condition. CRH offers three classes of travel: business, first, and second class. CRH takes passenger age into consideration, with the fare for children's tickets being reduced by 50% relative to adult fares. Also, passengers from special groups (i.e., disabled military and students traveling between institutions city and home city) are provided with discounted fare.

Table 1 Rate fence application by various international passenger rail transport providers

Rate fences	France/ SNCF TGV	Swiss/ SBB	Germany/ ICE	Portugal/ Comboios de Portugal	Spain/ Renfe AVE	U.K./ National Rail	China/ CHR
Time conditions	X	X	X	X	X	X	
Booking requirement	X	X	X	X	X	X	
Refund conditions	X	X	X	X	X	X	
Travel class (e.g., 1st/2nd class)	X	X	X	X	X	X	X
Number/duration of change	X	X	X	X	X	X	
Ticket type (e.g., weekend pass, regional ticket)	X	X	X	X	X	X	
Group discount	X	X	X	X	X	X	
Passenger age	X	X	X	X	X	X	X
Membership of the loyalty scheme	X	X	X			X	

Facilities on the train (e.g., with electric sockets)	X	
Special group (e.g., disabled military)		X

3.2 Role of familiarity with rate fences

Previous research has suggested that the degree of familiarity with pricing practices is a significant variable in customer fairness perception, a key determinant of customers' responses to pricing policies (Heo and Lee 2010; Wirtz and Kimes 2007). According to Kimes (1994), customers perceived pricing practices in the airline industry more favorably than similar pricing strategies in the hotel industry, as these practices were more common among airlines at the time. The same survey was conducted again in 2002, when such pricing practices had become more common in the hotel industry, and no difference was found in fairness perceptions between the two industries (Kimes and Noone 2002). This finding implies that increased familiarity with pricing practices improves customers' perceptions of fairness. Wirtz and Kimes (2007) examined the moderating role of familiarity with pricing practices in the effects of framing (whether a price is presented as a discount or surcharge) and fencing conditions on customers' perceptions of fairness. In their study, customers with a higher degree of familiarity were more capable of differentiating products with different rate fencing conditions (for example, price differences between weekday and weekend train tickets). These customers were more likely to compare the price they paid for products or services subject to similar fencing conditions, thereby perceiving the price as fair and acceptable. The positive impact of increased familiarity on customers' fairness perception was further supported by Suklabaidya and Singh's (2017) study of hotel pricing and Tang, Repetti, and Raab's (2019) study of pricing in restaurants.

Drawing from the conclusion of Wirtz and Kimes (2007), it is reasonable to assume that rail passengers who are more familiar with rail rate fences have a better understanding of how various rate fences differentiate the railway tickets they purchase at different prices. Therefore, they may be less price-sensitive and pay more attention to the rate fences other than price (e.g., time condition) in making purchasing decisions. In contrast, passengers who are less familiar with rail rate fences may be more price-sensitive because they are less capable of distinguishing their tickets from other tickets in different fencing conditions. Such passengers being less familiar with rail rate fences may therefore attach more importance to ticket price than other rate fences when making purchasing decisions. Given that no prior studies have explored the effect of

familiarity on the perceived importance of different types of rate fences, this study addresses this gap by assessing the ways in which Chinese passengers perceive rail rate fences based on their familiarity levels.

3.3 Utility, preference, and conjoint approach

Utility is the conceptual basis for measuring consumer demand in economic theory. Utility is normally considered to be subjective and therefore specific to each individual. According to Lancaster's (1971) model of consumer behavior, the theory of brand preferences stipulates that products are valued for their attributes, rather than their prices. Lancaster (1971) also noted that differentiated products are simply different bundles of attributes. Before making their final purchasing decision, consumers rely on judgments, impressions, and evaluations of all competing products. During this process, customers incorporate information about the product's various attributes to formulate an overall impression. This process is known as information integration theory (Louviere 1988), and conjoint analysis was established based on this process. Following the theories of information integration and utility, a customer will ultimately choose products that possess the highest level of utility.

The conjoint analysis method uses a set of techniques to measure customer preferences and purchase decisions of multi-attribute products (Fischer 1975). When deciding between different products, customers consider all of the relevant attributes and evaluate the importance of each one (Lehmann and O'Shaughnessy 1974). Hwang and Yoon (1981) claimed that because it may be impossible for one product to fulfill all attribute requirements, customers must select products that possess the highest possible number of favorable attributes, thereby simultaneously giving up other attributes. Consequently, it is not sufficient for researchers to simply examine and combine customer preferences for single attributes. Indeed, testing products with joint attributes will yield more robust results. According to Green and Srinivasan (1990), conjoint analysis is the most appropriate method to assess how customers make trade-offs between different products, by examining the joint effect of various product attributes. As we aimed to investigate how CRH passengers decide between various rail rate fences and the importance that passengers attach to each attribute level, we deemed conjoint analysis to be the most appropriate methodology for our study. The conceptual map of this study is presented in Figure 1.

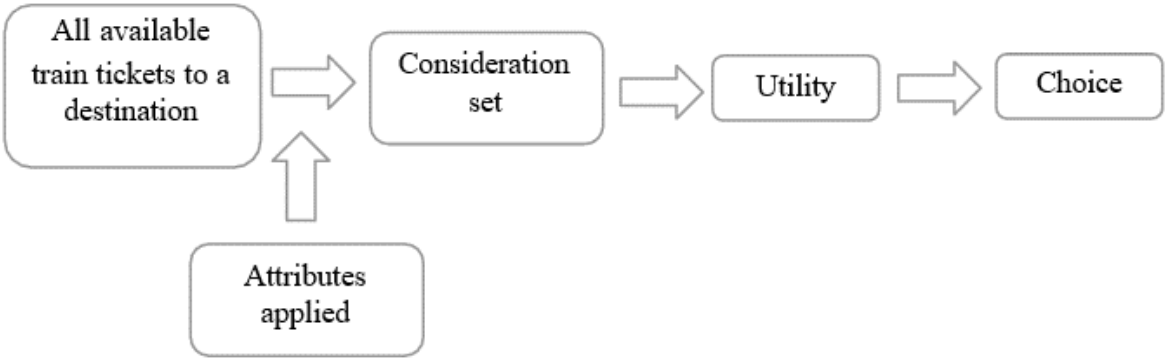


Fig. 1 Conceptual map of the key constructs

The basic model in this study is:

$$y = b1(\text{ticket price}) + b2(\text{time condition}) + b3(\text{booking requirement}) + b4(\text{refund rules}) + \text{constant} + \varepsilon,$$

where y = respondent's preference for the rate fence combinations; b = beta weights (utilities) for the attributes; constant = the regression constant; and ε = an error term.

4 Research methodology

4.1 Questionnaire design

The study aims to evaluate the application of revenue management in CRH, as well as the passenger preferences for different rate fences. We used a questionnaire as the instrument for data collection, after which we used conjoint analysis as the main method to investigate railway passengers' preferences regarding rail rate fences. Following Van der Pol and Ryan (1996), three steps were followed to execute the conjoint analysis: (1) determine the attributes; (2) assign related attribute levels; and (3) compile the profiles of the attributes. These steps are detailed below.

Due to the lack of studies identifying rate fences applied in the rail travel industry, the rate fence attributes were selected from successful practices in different countries. As such, we adopted the following four attributes: (1) price, which refers to the amount of money passengers pay for tickets; (2) time conditions, which refers to the departure time of the train; (3) booking requirements, which refers to how many days in advance passengers need to book their tickets; and (4) refund conditions, identifying whether passengers are eligible for a refund when canceling their reservation.

The set of ticket prices was determined based on the price of a second class ticket on CRH services between Hong Kong and Guangzhou, which is RMB215 (equivalent to

approximately USD33). As this study aimed to examine the preferences of customers in both the Hong Kong and mainland Chinese markets, we selected Hong Kong as the departure station and Guangzhou as the destination station. We chose Guangzhou because it is a major urban center, and because of its distance from Hong Kong—travelers are more likely to use CRH services rather than regional Hong Kong transport (MTR) or flight options to reach this destination. As CRH tags a second class ticket that is not subject to any rules or conditions at the price of RMB215, this price was set as the highest in the questionnaire. Two additional price options were 15% and 30% lower than the highest price. Based on their work in the US, Della Bitta, Monroe, and McGinnis (1981) recommended a price threshold level of 15% and a discount saturation point of 20% to 30%. In other words, Della Bitta et al. (1981) recommendation suggests that a discount level of 15% would trigger a purchase intention reaction, and a discount of more than 30% would be a waste for the seller. Marshall and Leng (2002) examined the discount saturation of service products in Singapore, and their findings were consistent with those of Della Bitta et al. (1981) (20% to 30%).

The levels of time conditions were identified based on the observed demand curve of Chinese passengers. According to the official CRH website, time conditions can be divided into five ranges: early morning, morning, lunchtime, afternoon, and evening. However, if five time ranges were used in the questionnaire, 25 combinations would be generated for respondents to rank, which would be excessive. According to Wei, Shi, and Xu's (2019) estimation of the time-varying demand of CRH ticket booking, the demand in the early morning and evening is lower than the demand at other time. Therefore, we only used three time ranges: morning, lunchtime, and afternoon.

Although tickets are normally available for purchase 30 days in advance, passengers can sometimes buy tickets on the day of travel, depending on availability. However, many ticket agents (for example, Travel China Guide and China Ticket Online) suggest booking tickets as early as possible to avoid disappointment, especially for travel during peak three seasons or on popular routes. Therefore, for this study, booking requirements contained three levels: zero days in advance, three days in advance, and 10 days in advance.

With regard to refund conditions, CRH bases refund amounts on how many days before the departure date passengers cancel their reservation. To simplify the ranking process for our respondents, we adopted two levels of refund conditions: fully refundable and non-refundable. The selected attributes and their corresponding levels are listed in Table 2.

Drawing from these attributes and their levels, the total number of possible combinations of attributes should be 3*3*3*2 = 54, a number that could be challenging for respondents to rank. Therefore, a fractional factorial design that presents a fraction of all possible combinations was applied. An orthogonal array, the most commonly used technique in a fractional factorial design, was used to decrease the number of combinations to a more manageable level "without sacrificing the predicting power contained in the original design" (Ding, Geschke, and Lewis 1991, 9). An orthogonal array is an experimental design that only considers the main effects among the variables while neglecting the interactions (Ding et al. 1991). Through the conjoint model of SPSS 26.0, 12 combinations were generated in this study.

Table 2 Attributes and attribute levels included in this study

Attribute	Attribute level	Reference
Price	(1) Current price	Della Bitta, Monroe, and McGinnis (1981); Marshall and Leng (2002)
	(2) 15% lower than current price	
	(3) 30% lower than current price	
Departure Time	(1) Morning	Observed demand curve; Wei, Shi, and Xu (2019)
	(2) Lunchtime	
	(3) Afternoon	
Booking Requirement	(1) zero day in advance	
	(2) three days in advance	
	(3) 10 days in advance	
Refund Conditions	(1) Fully refundable	
	(2) Non-refundable	

The questionnaire consisted of three sections. The first section tested respondents' familiarity with the railway company's rate fences, including six scale items adapted from Wirtz and Kimes (2007). The second section presented the generated 12 combinations of the four attributes in a scenario format. The respondents were asked to imagine that they were booking a CRH ticket for their trip from Hong Kong to Guangzhou and that they were able to find 12 options on the CRH website. Following the instruction, respondents ranked the 12 combinations from the most preferred to the least preferred. In the final section, we collected respondents' socio-demographic information and CRH travel characteristics. The socio-demographic information included gender, age, education level, city of residence, and household income. The CRH travel characteristics involved ascertaining respondents' familiarity with railway

rate fences, experience of taking CRH, preferred travel time on CRH service, average trip duration by using CRH services, number of annual trips on CRH services, number of days of advance booking, and travel purpose on CRH services. The questionnaire was firstly designed in English, and then translated into one traditional Chinese version and one simplified Chinese version using the back-to-back translation method to ensure content validity. The questionnaire was pilot-tested to minimize potential misunderstandings produced by translation.

4.2 Sampling

CRH operates services in both mainland China and Hong Kong. It has been operated in mainland China since 2008, and has connected Hong Kong with mainland China since 2018. As such, this study targeted actual and potential passengers in both markets as respondents. Actual CRH users refer to those who had used CRH services in the past three years whereas potential CRH users refer to those who hadn't used CRH services in the past three years but intended to use the CRH within the next 2-3 years. To obtain a comparable number of mainland Chinese (CN) passengers and Hong Kong (HK) passengers, a quota-sampling method was used. The quota selection criteria included gender and age. The respondents were asked a screening question to ensure that they were at least 18 years old. Besides, we included screening questions to differentiate actual CRH users from potential CRH users. If the respondent was not an actual CRH user, we asked whether the person intended to use the CRH within the next 2-3 years. If the answer was yes, then the respondent was allowed to proceed with the survey. Furthermore, to minimize generalizability issues that could arise due to the large population of mainland China, we stipulated that CN respondents must live in a first-tier or second-tier city, and their average annual household income was greater than RMB30,000 (equivalent to USD4,625). Following Orme's (1998, 65) assertion that "sample sizes for conjoint studies generally range from about 150 to 1,200 respondents," we collected a total of 1211 questionnaires. More specifically, respondents consisted of 300 CN actual passengers, 300 CN potential passengers, 310 HK actual passengers and 301 HK potential passengers. They were recruited from online panels via the marketing research companies company Idiaoyan and Dynata, respectively. The data collection was carried out in November 2020 for CN respondents and in January 2021 for HK respondents.

5 Research findings

5.1 Socio-demographic profiles and railway travel characteristics

Table 3 shows the respondents' socio-demographic profiles and rail travel characteristics. The distributions of respondents' gender and age were fairly even:

49.6% male and 50.4% female, and about one quarter in each of the following age groups: 18 to 30, 31 to 40, 41 to 50, and over 50-years-old. Nearly 44.8% of respondents had a Bachelor's degree or above, 28.6% had a sub-degree or equivalent, and 26.7% had a high school education or below. In terms of city of residence, around half of the CN respondents resided in a second-tier city (30.7%) or first-tier city (18.8%), and the HK respondents were from the New Territories (20.6%), Hong Kong Island (15.0%), and Kowloon (14.9%). Because of the large disparity in average household income between CN and HK residents, the income question used different scales. Of the 600 CN respondents, the majority reported a monthly household income of between RMB7,500 (equivalent to USD1,155) and RMB15,000 (equivalent to USD2,310), representing 22.5% of the total. Of the 611 HK respondents, the majority had a monthly household income of between HKD40,000 (equivalent to USD5,153) and HKD60,000 (equivalent to USD7,730), which accounted for 17.4% of the total.

37.8% of respondents reported that they were very unfamiliar with railway rate fences, 24.9% reported moderately familiar, and 37.2% reported very familiar. 63.9% of respondents stated that they were inexperienced in taking CRH, 13.7% stated experienced, and 22.4% stated very experienced. In terms of preferred travel time, 61.8% of respondents reported traveling on weekends. The average trip duration for most respondents was 2–3 days (33.9%) and 4–5 days (19.4%). Approximately 26.0% of respondents used CRH services more than three times a year, and the rest used CRH services up to three times a year (74.0%). When asked about the number of days in advance respondents booked their trips, 25.5% responded that they booked 1–3 days in advance, 15.4% booked 4–6 days in advance, 11.9% booked 1 week in advance, and 10.1% booked more than 1 week in advance. Those who booked on the day of departure represented just 5.6% of all respondents. With regard to the purpose of travel on CRH services, about half of the respondents typically traveled for holidays or day trips (45.7%), followed by social or family reasons (34.1%) such as visiting friends and relatives, and business reasons (28.5%). Those who traveled for personal business represented 16.3% of all respondents, followed by sports or entertainment (11.7%), shopping (10.7%), commuting (10.2%), and education (3.4%).

Table 3 Respondents' socio-demographic profiles and CRH travel characteristics

Variables	Percent
Gender	
Male	49.6
Female	50.4
Age	
18–30	24.9
31–40	24.6
41–50	25.5
51 and above	25.0
Education	
High school or below	26.7
Sub-degree or equivalent	28.6
Bachelor's degree or above	44.8
City of residence	
1st tier city (CN)	18.8
2nd tier city (CN)	30.7
Kowloon (HK)	14.9
HK Island (HK)	15.0
New Territories (HK)	20.6
Monthly household income	
CN respondents	
< RMB7,500	18.7
RMB7,500–15,000	22.5
> RMB15,000	8.3
HK respondents	
< HKD40,000	16.7
HKD40,000–60,000	17.4
>HKD60,000	16.4
Familiarity with railway rate fences	
Very unfamiliar	37.8%
Moderately familiar	24.9%
Very familiar	37.2%
Experience of taking CRH	
Inexperienced	63.9%
Experienced	13.7%
Very experienced	22.4%

Preferred travel time on CRH services	
Weekend	61.8
Weekday	12.5
All days of the week	25.7
Average trip duration by using CRH services	
1 day	7.0
2-3 days	33.9
4-5 days	19.4
More than 5 days	8.1
Number of annual trips on CRH services	
3 times or fewer	74.0
More than 3 times	26.0
Number of days of advance booking	
Day of travel (0 days in advance)	5.6
1–3 days in advance	25.5
4–6 days in advance	15.4
One week in advance	11.9
More than one week in advance	10.1
Primary travel purpose of using CRH services	
Business	28.5
Commuting	10.2
Personal business	16.3
Social	34.1
Sports or entertainment	11.7
Holidays or day trips	45.7
Education	3.4
Shopping	10.7

5.2 Conjoint analysis results

The conjoint model in SPSS 26.0 was used to analyze the collected data, which generated partial utility scores and relative importance. Utility represents the overall preference for a product, whereas partial utility scores, also known as part-worths, represent the preference of each specific attribute level (Hair et al. 1998, 392). A higher partial utility score, either positive or negative, corresponds to a greater impact on overall utility (Hair et al. 1998, 420). Relative importance is computed based on the range of utility scores and measures how important the attribute is to the overall preference. A greater range indicates that certain attributes have a stronger influence respondents' overall preference (Denizci, Guillet and Xu, 2013).

5.2.1 Partial utility score

The partial utility scores of each attribute level are presented in Table 4. Both CN and HK respondents attached the highest level of preference to lunchtime departures, booking their tickets on the day of travel, fully refundable tickets, and tickets sold at a 30% discount. In this case, the utility of the most preferred combination was 7.447. The computation is shown as follows:

$$.367 + .377 + .566 + 1.326 + 4.811 \text{ (constant)} = 7.447$$

Figure 2 compares the partial utility scores of the level of each attribute between CN and HK actual passengers while figure 3 compares the partial utility scores of the level of each attribute between CN and HK potential passengers (i.e., CN actual passengers vs. HK actual passengers and CN potential passengers vs. HK potential passengers). As shown in the Figure 2, CN actual passengers reported higher scores than HK actual passengers for afternoon departures, a booking requirement of zero day and three days in advance, fully refundable tickets, and tickets sold at 15% and 30% discount. Conversely, HK actual passengers assigned higher scores than CN actual passengers to morning and lunchtime departures, a booking requirement of 10 days in advance, non-refundable tickets, and full price tickets. As shown in the Figure 3, CN potential passengers reported higher scores than HK potential passengers for lunchtime departures, a booking requirement of zero day and three days in advance, fully refundable tickets, and tickets sold at 15% and 30% discount. Conversely, HK potential passengers assigned higher scores than CN potential passengers to morning and afternoon departures, a booking requirement of 10 days in advance, non-refundable tickets, and full price tickets. These results well address the second objective of the study, revealing the preferred railway ticket rate fences by the CN and HK travelers.

Table 4 Partial utility scores of each attribute level for CN and HK respondents

Attribute	Attribute level	CN actual passenger (N=300)		CN potential passenger (N=300)		HK actual passenger (N=310)		HK potential passenger (N=301)		All respondents (N=1211)	
		Utility	SE	Utility	SE	Utility	SE	Utility	SE	Utility	SE
Departure time	Morning	0.131	0.454	0.152	0.45	0.216	0.113	0.256	0.001	0.189	0.195
	Lunchtime	**0.270**	0.454	**0.430**	0.45	**0.459**	0.113	**0.305**	0.001	**0.367**	0.195
	Afternoon	-0.401	0.454	-0.582	0.45	-0.675	0.113	-0.56	0.001	-0.556	0.195
Booking requirement	0 day in advance	**0.479**	0.454	**0.489**	0.45	**0.337**	0.113	**0.204**	0.001	**0.377**	0.195
	3 days in advance	0.254	0.454	0.188	0.45	-0.147	0.113	-0.089	0.001	0.050	0.195
	10 days in advance	-0.733	0.454	-0.677	0.45	-0.189	0.113	-0.115	0.001	-0.426	0.195
	Fully refundable	**0.842**	0.341	**0.808**	0.337	**0.284**	0.085	**0.343**	0.000	**0.566**	0.146

Refund conditions	Non-refundable	-0.842	0.341	-0.808	0.337	-0.284	0.085	-0.343	0.000	-0.566	0.146
Price	Full price	-1.278	0.454	-1.283	0.45	-1.043	0.113	-1.204	0.001	-1.201	0.195
	15% off	-0.107	0.454	-0.113	0.45	-0.11	0.113	-0.172	0.001	-0.125	0.195
	30% off	**1.384**	0.454	**1.397**	0.45	**1.153**	0.113	**1.375**	0.001	**1.326**	0.195
(Constant)		4.719	0.341	4.731	0.337	4.905	0.085	4.886	0.000	4.811	0.146

Note: The highest utility score of each attribute is shown in bold.

Fig. 2 Partial utility scores of CN and HK actual passengers

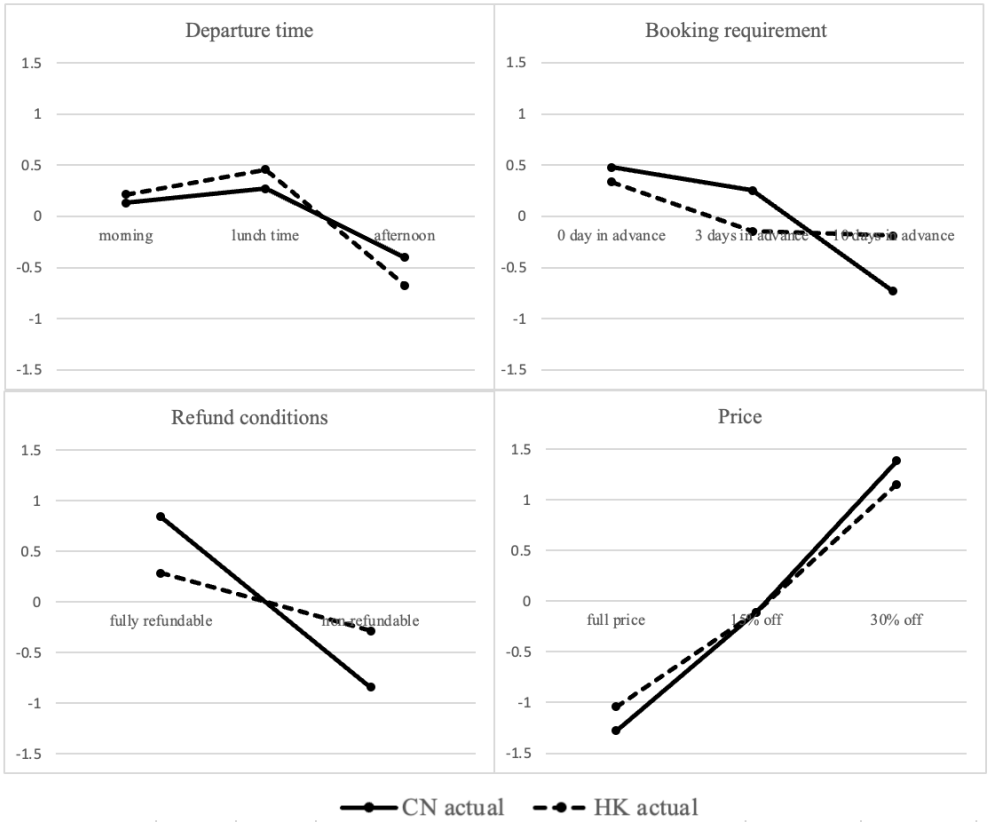
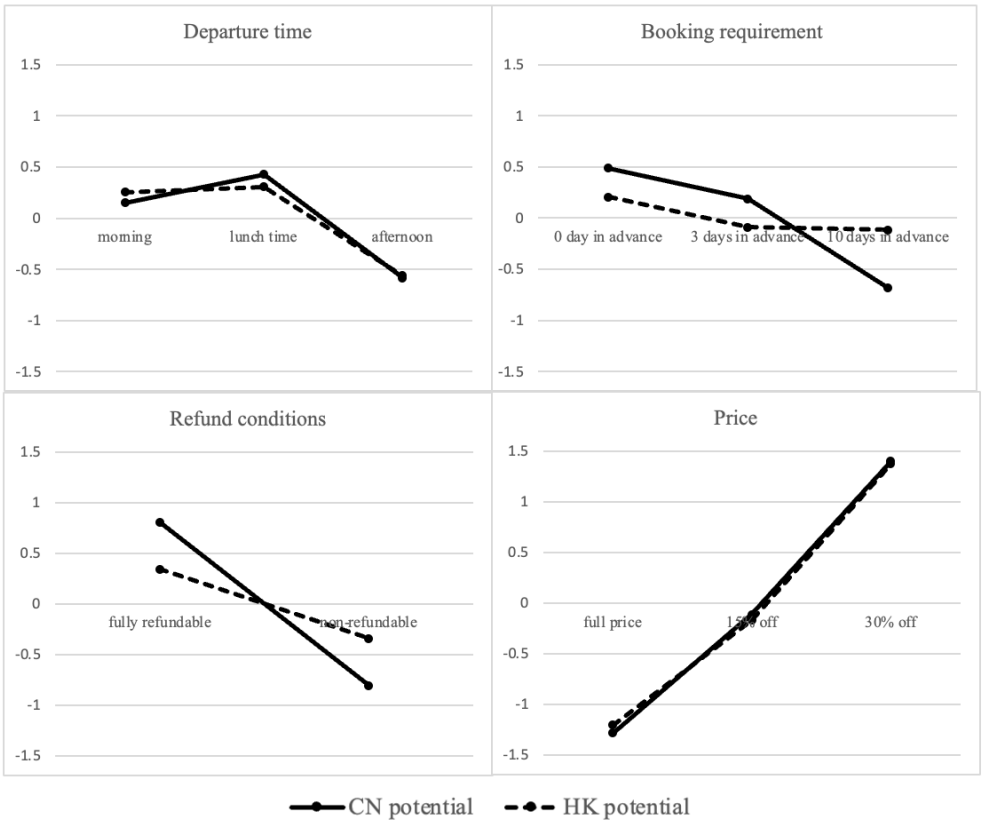


Fig. 3 Partial utility scores of CN and HK potential passengers



5.2.2 Importance value

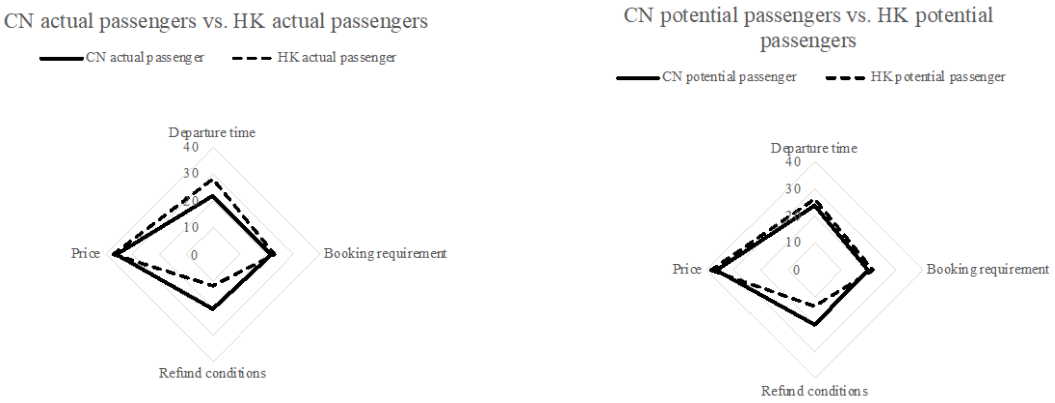
Table 5 describes the overall average importance of the four attributes tested, which addresses the first research objective. Overall, price had the highest average importance value (37.02%), followed by departure time (25.06%), booking requirement (21.54%), and refund conditions (16.38%). Based on these findings, price, departure time, and booking requirement were somewhat more important than refund conditions. Although both CN and HK respondents attached the highest importance to price, the importance of the other three attributes was inconsistent among the four groups (i.e., CN actual, CN potential, HK actual, and HK potential passengers). As Figure 4 shows, in the comparison between CN actual passengers and HK actual passengers, as well as the comparison between CN potential passengers and HK potential passengers, the large discrepancies appeared in departure time and refund conditions. Departure time played a more significant role in HK respondents' overall decision than that of CN respondents, whereas refund conditions were more influential to CN respondents' choice than that of their HK counterparts.

Table 5 Average importance score (%) of each attribute

Attribute	CN actual passenger (N=300)	CN potential passenger (N=300)	HK actual passenger (N=310)	HK potential passenger (N=301)	All respondents (N=1211)
Departure time	21.78	23.85	28.14	26.37	25.06
Booking requirement	21.74	19.78	22.92	21.68	21.54
Refund conditions	20.49	20.09	11.72	13.39	16.38
Price	**36.00**	**36.28**	**37.22**	**38.57**	**37.02**

Note: All figures are percentages.

Fig. 4 Average importance of each attribute



Note: All figures are percentages.

5.2.3 Differences in the average attribute importance among socio-demographic and travel characteristics groups

Tables 6 and 7 display the average attribute importance based on respondents' socio-demographic profiles and CRH travel characteristics, respectively. The tables show no large differences in attribute importance across the groups. Not surprisingly, price was the most important consideration for most socio-demographic and travel groups, followed by departure time, booking requirement, and refund conditions. Differences were found among respondents whose travel purposes were commuting, personal business, and sports or entertainment as they attached the highest importance to departure time.

Table 6 Average importance score (%) of each attribute by respondents' demographic profiles

Variables	Departure time	Booking requirement	Refund conditions	Price
Gender				
Male	26.92	22.53	14.86	**35.70**
Female	24.25	21.49	15.19	**39.07**
Age				
18-30	25.99	21.77	14.60	**37.64**
31-40	26.38	22.64	16.26	**34.73**
41-50	25.28	21.99	15.46	**37.28**
51 and above	24.68	21.63	13.78	**39.90**
Education				
High school or below	24.89	20.98	15.86	**38.27**
Sub-degree or equivalent	23.95	21.89	17.33	**36.83**
Bachelor's degree or above	27.03	22.68	13.05	**37.24**
City of residence				
1st tier city (CN)	23.95	21.98	18.70	**35.36**
2nd tier city (CN)	23.04	20.75	18.61	**37.61**
Kowloon (HK)	25.23	22.43	12.24	**40.10**
HK Island (HK)	31.60	25.29	10.36	**32.75**
New Territories (HK)	26.71	21.18	11.72	**40.39**
Monthly household income				
CN respondents				
< RMB7,500	22.22	21.36	18.54	**37.87**
RMB7,500-15,000	23.45	21.42	19.37	**35.76**

> RMB15,000	25.81	20.36	16.90	**36.94**
HK respondents				
< HKD40,000	24.46	21.71	12.74	**41.09**
HKD40,000-60,000	29.89	23.34	10.13	**36.63**
>HKD60,000	28.76	23.25	11.60	**36.39**

Note: The attribute with highest relative importance score for each demographic variable is shown in bold.

Table 7 Average importance score (%) of each attribute by respondents' CRH travel characteristics

Variables	Departure time	Booking requirement	Refund conditions	Price
Familiarity with railway rate fences				
Very unfamiliar	22.39	19.78	17.03	**40.80**
Moderately familiar	26.40	21.22	14.17	**38.20**
Very familiar	28.27	24.78	13.55	**33.40**
Experience of taking CHSR				
Inexperienced	25.34	21.29	15.07	**38.30**
Experienced	25.48	23.90	14.55	**36.07**
Very experienced	26.32	22.87	15.18	**35.63**
Usual travel time during a week				
Weekend	24.36	21.62	16.42	**37.60**
Weekday	30.63	25.96	9.88	**33.53**
All day of the week	26.07	21.00	14.16	**38.77**
Travel length for taking CHSR				
1 day	23.40	22.66	14.62	**39.33**
2-3 days	26.81	22.72	13.90	**36.57**
4-5 days	27.64	22.59	13.48	**36.29**
6-7 days	23.74	25.70	13.09	**37.47**
More than 1 week	23.32	22.48	19.20	**35.00**
Annual frequency of taking CHSR				
3 times or below	24.78	20.93	15.81	**38.48**
more than 3 times	25.96	23.82	16.20	**34.02**
Days to book CHSR ticket in advance				
Same day as departure (0 days in advance)	26.38	28.07	11.39	**34.17**
1-3 days in advance	27.03	23.85	13.71	**35.41**
4-6 days in advance	26.48	22.78	14.10	**36.64**

One week in advance	26.65	19.30	15.38	**38.68**
More than one week in advance	23.88	22.26	14.02	**39.84**
Travel purpose				
Business	27.24	24.78	14.08	**33.91**
Commuting	**30.71**	25.99	13.54	29.76
Personal business	**30.18**	26.27	13.47	30.08
Social	26.18	23.04	14.34	**36.44**
Sports or entertainment	**29.96**	27.84	12.98	29.22
Holiday or day trips	25.76	22.24	14.15	**37.84**
Education	25.85	25.14	16.56	**32.45**
Shopping	27.68	21.96	12.58	**37.78**

Note: The attribute with the highest relative importance score for each CRH travel variable is shown in bold.

Furthermore, statistical analysis was conducted to identify the significant differences in attribute importance among different socio-demographic (i.e., gender, age, education, city of residence, and monthly household income) and travel characteristic (i.e., familiarity with railway rate fences) groups. According to the results of the Kolmogorov–Smirnov test, the attribute importance was not normally distributed based on socio-demographic and travel characteristics groups. Therefore, the Kruskal-Wallis test, a non-parametric alternative to the one-way ANOVA, and Mann–Whitney *U* test, a non-parametric alternative to the independent samples *t*-test (Green, Salkind, and Akey. 1999), were performed to identify the significant differences in attribute importance among different groups. These tests were conducted in 9 types of respondents, including all passengers, CN passengers, HK passengers, actual passengers, potential passengers, CN actual passengers, CN potential passengers, HK actual passengers, and HK potential passengers. Significance values were adjusted by the Bonferroni correction to control for Type I errors. The results with statistically significant differences are shown in Table 8. As non-parametric tests, the Kruskal-Wallis tests and the Mann–Whitney *U* tests are based on median scores, thus the reported results are the median scores of each group's attribute importance. These findings answer whether there are any differences in the relative importance of different types of railway ticket rate fences for Chinese travelers and Hong Kong residents with different sociodemographic and travel characteristic, addressing the third objective of the study.

First, gender plays an important role in the attribute importance of departure time, refund conditions, and price. Notably, male in all types of respondents except CN

potential and HK actual passengers paid more attention to departure time than female counterparts. CN female, potential female, and CN potential female attached higher importance in price than male counterparts. Second, the effect of age on attribute importance is mainly reflected in departure time, refund conditions, and price. Specifically, HK respondents aged 51 and above emphasized the importance of price while CN respondents aged 51 and above downplayed refund conditions. Third, education does not impact the respondents of CN, CN actual, CN potential, and HK actual but exerts more influence on respondents of HK, potential and HK potential. Respondents with higher level of education valued more on booking requirement and valued less on price. Fourth, city of residence influences the respondents of HK, CN potential, and HK potential. Notably, for HK respondents, passengers from HK Island paid more attention to departure time and booking requirement whereas passengers from Kowloon and New Territories paid more attention to price. Fifth, monthly household income only impacts the attribute importance of departure time among respondents of HK, CN potential, and HK potential. Respondents with higher income attached higher importance on departure time than respondents with lower income.

To test the effect of familiarity on attribute importance, the respondents were categorized into very unfamiliar, moderately familiar, and very familiar groups based on their familiarity ratings. We first computed the individual mean score of the 6-item familiarity ratings. Respondents whose mean score was below 3.5 were considered "very unfamiliar", respondents whose mean score was equal or above 3.5 and below 4.5 were categorized as "moderately familiar", and respondents whose mean score was above 4.5 were categorized as "very familiar". Results show that familiarity has a substantial effect on attribute importance across 9 types of respondents. Notably, for all respondents, significant differences appear among groups with different level of familiarity for all the attributes. Respondents who were very familiar with railway rate fences paid more attention to departure time (24.18%) and booking requirement (21.89%) than those who were less familiar. Respondents in the very unfamiliar group attached more importance to price (35.79%) and refund conditions (13.04%) than their counterparts in the higher familiarity groups.

In summary, with these findings, we examined the effects of gender, age, education, city of residence, monthly household income, and familiarity with railway rate fences on attribute importance and revealed that the effect valence varies depending on the type of rate fence applied and the type of respondents investigated.

Table 8 Findings of Kruskal – Wallis tests and Mann – Whitney U tests based on respondents' demographic profiles and travel characteristics

Gender				
Respondents	Departure time	Booking requirement	Refund conditions	Price
All	U = 162118.00, P = 0.000 Male (Md = 23.48%) > Female (Md = 19.05%)	/	/	U = 201235.00, P = 0.003 Male (Md = 31.15%) < Female (Md = 34.29%)
CN	U = 39273.00, p = 0.007 Male (Md = 21.83%) > Female (Md = 17.92%)	/	/	U = 39498.00, p = 0.010 Male (Md = 30.54%) < Female (Md = 33.67%)
HK	U = 41197.00, P = 0.012 Male (Md = 25.43%) > Female (Md = 22.03%)	/	U = 52169.00, P = 0.011 Male (Md = 31.60%) < Female (Md = 34.80%)	/
Actual	U = 40980.00, p = 0.011 Male (Md = 23.84%) > Female (Md = 21.65%)	/	/	/
Potential	U = 39883.00, P = 0.013 Male (Md = 22.78%) > Female (Md = 18.48%)	/	/	U = 50376.50 p = 0.014 Male (Md = 30.37%) < Female (Md = 35.85%)
CN Actual	U = 9675.50, P = 0.037 Male (Md = 21.85%) > Female (Md = 17.92%)	/	/	/
CN Potential	/	/	U = 9904.00, P = 0.007 Male (Md =	U = 9904.00, P = 0.034 Male (Md =

			19.37%) > Female (Md = 12.34%)	29.23%) < Female (Md = 31.81%)
HK Actual	/	/	/	/
HK Potential	U = 9831.00 P = 0.049 Male (Md = 25.14%) > Female (Md = 19.07%)	/	U = 12995.50 P = 0.026 Male (Md = 7.55%) < Female (Md = 9.67%)	/

Age				
Respondents	Departure time	Booking requirement	Refund conditions	Price
All	/	/	/	$\chi2(3) = 10.076$ p = 0.018 31-40 (Md = 30.72%) to 51 and above (Md = 34.81%, U = -89.357, p = 0.010)
CN	/	/	$\chi2(3) = 9.967$, p = 0.019 51 and above (Md = 13.06%) < 31-40 (Md = 20.00%, U = 61.637, p = 0.012)	/
HK	/	/	/	$\chi2(3) = 11.407$ p = 0.010 31-40 (Md = 30.52%) to 51 and above (Md = 41.56%, U = -59.666, p = 0.020) 41-50 (Md = 30.77%) to 51 and above (Md = 41.56%, U = -

				56.353, p = 0.029)
Actual	/	/	/	/
Potential	/	/	/	/
CN Actual	$\chi2(3) = 11.669$, p = 0.009 41-50 (Md = 17.39%) < 31-40 (Md = 23.52%, U = 39.493, p = 0.032). 18-30 (Md = 17.91%) < 31-40 (Md = 23.52%, U = -37.480, p = 0.049)	/	/	/
CN Potential	/	/	$\chi2(3) = 14.821$, p = 0.002 51 and above (Md = 11.68%) < 31-40 (Md = 23.83%, U = 50.107, p = 0.002). 18-30 (Md = 13.03%) < 31-40 (Md = 23.83%, U = -41.820, p = 0.018). 41-50 (Md = 13.03%) < 31-40 (Md = 23.83%, U = 37.593, p = 0.047)	/

HK Actual	/	/	/	$\chi2(3) = 10.248$, $p = 0.017$ 41-50 (Md = 30.36%) < 51 and above (Md = 41.76%, U = -40.003, p = 0.033). 31-40 (Md = 26.86%) < 51 and above (Md = 41.76%, U = -39.798, p = 0.034)
HK Potential	/	/	/	/

Education				
Respondents	Departure time	Booking requirement	Refund conditions	Price
All	$\chi2(2) = 9.951$, $p = 0.007$ sub-degree or equivalent (Md = 19.06%) to bachelor's degree or above (Md = 23.09%, U = -77.566, p = 0.017) high school or below (Md = 21.57%) to bachelor's degree or above (Md = 23.09%, U = -60.501, p = 0.042)	/	$\chi2(2) = 21.633$, $p = 0.000$ Bachelor's degree or above (Md = 9.10%) to sub-degree or equivalent (Md = 13.05%, U = 111.092, p = 0.000)	/
CN	/	/	/	/

HK	/	$\chi2(2) = 7.593$, $p = 0.022$ high school or below (Md = 17.02%) to bachelor's degree or above (Md = 21.89%, U = -49.729, p = 0.022)	/	$\chi2(2) = 8.662$, $p = 0.013$ sub-degree or equivalent (Md = 31.74%) to high school or below (Md = 40.79%, U = -59.890, p = 0.025) bachelor's degree or above (Md = 31.74%) to high school or below (Md = 40.79%, U = 49.163, p = 0.024)
Actual	/	/	$\chi2(2) = 7.30$, $p = 0.026$ bachelor… (Md = 9.10%) to sub-degree… (Md = 14.73%, U = 46.342, p = 0.022).	/
Potential	$\chi2(2) = 6.727$, $p = 0.035$ high school or below (Md = 19.05%) to bachelor's degree or above (Md = 23.57%, U = -44.191, p = 0.033)	$\chi2(2) = 6.052$, $p = 0.049$ high school or below (Md = 17.92%) to bachelor's degree or above (Md = 21.83%, U = -42.367, p = 0.044)	$\chi2(2) = 16.579$, $p = 0.000$ bachelor's degree or above (Md = 9.09%) to high school or below (Md = 11.68%, U = 42.311, p = 0.044) Bachelor… (Md = 9.09%) to sub-degree… (Md = 13.04%, U = 71.522, p = 0.000)	/
CN Actual	/	/	/	/
CN Potential	/	/	/	/

HK Actual	/	/	/	/
HK Potential	/	$\chi2(2) = 11.647$, $p = 0.003$ high school or below (Md = 14.79%) to bachelor's degree or above (Md = 21.88%, U = -41.555, p = 0.004) high school or below (Md = 14.79%) to sub-degree or diploma/certificate (Md = 22.00%, U = -43.275, p = 0.013)	/	$\chi2(2) = 14.190$, $p = 0.001$ sub-degree or diploma/certificate (Md = 31.47%) to high school or below (Md = 50.68%, U = 50.101, p = 0.003) bachelor's degree or above (Md = 32.02%) to high school or below (Md = 50.68%, U = 44.530, p = 0.002)

City of residence				
Respondents	Departure time	Booking requirement	Refund conditions	Price
CN	/	/	/	/
HK	$\chi2(2) = 13.953$, $p = 0.001$ Kowloon (Md = 21.00%) to Hong Kong Island (Md = 28.40%, U = -63.821, p = 0.002)	$\chi2(2) = 9.977$, $p = 0.007$ New Territories (Md = 22.50%) to Hong Kong Island (Md = 28.40%, U = 54.368, p = 0.005)	/	$\chi2(2) = 16.617$, $p = 0.000$ Hong Kong Island (Md = 27.07%) to Kowloon (Md = 34.78%, U = 61.657, p = 0.003) Hong Kong Island (Md =27.07%) to New Territories (Md = 36.46%, U = -64.967, p = 0.000)
CN Actual	/	/	/	/

CN Potential	U = 7309.50, p = 0.032 1st tier (Md = 21.83%) to 2nd tier (Md = 18.47%)	/	/	/
HK Actual	/	/	/	/
HK Potential	$\chi2(2) = 7.533$, p = 0.023 Kowloon (Md = 17.65%) to Hong Kong Island (Md = 25.69%, U = -36.558, p = 0.023)	/	/	/

Monthly household income				
Respondents	Departure time	Booking requirement	Refund conditions	Price
CN	/	/	/	/
HK	$\chi2(2) = 11.842$, p = 0.003 < HKD40,000 (Md = 19.05%) to > HKD60,000 (Md = 25.55%, U = -47.784, p = 0.020) < HKD40,000 (Md = 19.05%) to HKD40,000 - 60,000 (Md = 24.20%, U = -55.564, p = 0.004)	/	/	/
CN Actual	/	/	/	/
CN Potential	$\chi2(2) = 12.035$, p = 0.002 < RMB75,00 (Md = 19.05%) to >	/	/	/

	RMB15,000 (Md = 35.27%, U = -76.038, p = 0.002) RMB75,00 - 15,000 (Md = 18.48%) to > RMB15,000 (Md = 35.27%, U = -73.582, p = 0.003)			
HK Actual	/	/	/	/
HK Potential	$\chi2(2) = 8.069$, p = 0.018 < HKD40,000 (Md = 18.18%) to HKD40,000 - 60,000 (Md = 24.18%, U = -31.353, p = 0.022)	/	/	/

Familiarity with railway rate fences				
Respondents	Departure time	Booking requirement	Refund conditions	Price
All	$\chi2(2) = 32.361$, p = 0.000 Very unfamiliar (Md = 18.18%) to Moderately familiar (Md = 21.85%, U = -85.476, p = 0.003) Very unfamiliar (Md = 18.18%) to Very familiar (Md = 24.18%, U = -130.322, p =	$\chi2(2) = 30.958$, p = 0.000 Very unfamiliar (Md = 17.26%) to Very familiar (Md = 24.18%, U = -128.104, p = 0.000) Moderately familiar (Md = 19.05%) to Very familiar (Md = 21.89%, U = -	$\chi2(2) = 12.578$, p = 0.002 Very familiar (Md = 9.11%) to Very unfamiliar (Md = 13.04%, U = 74.442, p = 0.004) Moderately familiar (Md = 10.73%) to Very unfamiliar (Md = 13.04%, U = 74.672, p = 0.017)	$\chi2(2) = 32.421$, p = 0.000 Very familiar (Md = 29.45%) to Very unfamiliar (Md = 35.79%, U = 131.004 p = 0.000) Moderately familiar (Md = 33.33%) to Very unfamiliar (Md = 35.79%, U = -82.907, p = 0.004)

	0.000)	80.309, p = 0.006)		
CN	$\chi2(2) = 14.263$, p = 0.001 Very unfamiliar (Md = 17.64%) to Very familiar (Md = 21.88%, U = -51.089, p = 0.007) Very unfamiliar (Md = 17.64%) to Moderately familiar (Md = 21.83%, U = -56.021, p = 0.005)	/	/	$\chi2(2) = 12.117$, p = 0.002 Moderately familiar (Md = 28.84%) to Very unfamiliar (Md = 34.31%, U = 53.651, p = 0.008) Very familiar (Md = 30.77%) to Very unfamiliar (Md = 34.31%, U = 44.874, p = 0.023)
HK	$\chi2(2) = 11.918$, p = 0.003 Very unfamiliar (Md = 21.83%) to Very familiar (Md = 26.18%, U = -54.898, p = 0.005)	$\chi2(2) = 27.319$, p = 0.000 Very unfamiliar (Md = 17.15%) to Very familiar (Md = 23.69%, U = -84.190, p = 0.000) Moderately familiar (Md = 19.05%) to Very familiar (Md = 23.69%, U = -62.083, p = 0.001)	/	$\chi2(2) = 32.234$, p = 0.000 Very familiar (Md = 27.43%) to Very unfamiliar (Md = 40.02%, U = 85.283, p = 0.000) Very familiar (Md = 27.43%) to Moderately familiar (Md = 43.71%, U = 76.817, p = 0.000)
Actual	$\chi2(2) = 20.938$, p = 0.000 Very unfamiliar (Md = 16.75%) to Very familiar (Md	$\chi2(2) = 9.475$, p = 0.009 Very unfamiliar (Md = 16.95%) to Very familiar (Md	/	$\chi2(2) = 15.564$, p = 0.000 Very familiar (Md = 29.94%) to Very unfamiliar (Md =

	= 23.87%, U = -83.506, p = 0.000)	= 21.83%, U = -53.784, p = 0.010)		36.38%, U = 68.285, p = 0.001)
Potential	$\chi2(2) = 13.440$, p = 0.001 Very unfamiliar (Md = 19.05%) to Moderately familiar (Md = 22.15%, U = -44.025, p = 0.027) Very unfamiliar (Md = 19.05%) to Very familiar (Md = 25.36%, U = -60.693, p = 0.004)	$\chi2(2) = 19.318$, p = 0.000 Very unfamiliar (Md = 17.38%) to Very familiar (Md = 25.00%, U = -83.099, p = 0.000) Moderately familiar (Md = 19.52%) to Very familiar (Md = 25.00%, U = -61.716, p = 0.012)	$\chi2(2) = 14.539$, p = 0.001 Very familiar (Md = 8.58%) to Very unfamiliar (Md = 13.05%, U = 58.896, p = 0.005) Moderately familiar (Md = 9.10%) to Very unfamiliar (Md = 13.05%, U = 50.217, p = 0.008)	$\chi2(2) = 18.336$, p = 0.000 Very familiar (Md = 27.09%) to Moderately familiar (Md = 32.20%, U = 54.297, p = 0.034) Very familiar (Md = 27.09%) to Very unfamiliar (Md = 34.89%, U = 80.674, p = 0.000)
CN Actual	$\chi2(2) = 13.314$, p = 0.001 Very unfamiliar (Md = 14.60%) to Very familiar (Md = 22.26%, U = -44.674, p = 0.001)	/	/	$\chi2(2) = 8.366$, p = 0.015 Very familiar (Md = 30.54%) to Very unfamiliar (Md = 36.38%, U = 35.345, p = 0.012)
CN Potential	$\chi2(2) = 9.618$, p = 0.008 Very unfamiliar (Md = 18.48%) to Moderately familiar (Md = 25.98%, U = -37.254, p = 0.006)	/	/	$\chi2(2) = 10.608$, p = 0.005 Moderately familiar (Md = 25.00%) to Very unfamiliar (Md = 33.98%, U = 38.800, p = 0.004)
HK Actual	/	$\chi2(2) = 9.003$, p = 0.011 Very unfamiliar (Md = 17.34%) to Very familiar (Md	/	/

		= 23.01%, U = -35.203, p = 0.037)		
HK Potential	/	$\chi2(2) = 17.741$, p = 0.000 Very unfamiliar (Md = 17.15%) to Very familiar (Md = 25.32%, U = -48.718, p = 0.000) Moderately familiar (Md = 19.90%) to Very familiar (Md = 25.32%, U = -36.300, p = 0.012)	/	$\chi2(2) = 27.330$, p = 0.000 Very familiar (Md = 26.84%) to Moderately familiar (Md = 50.70%, U = 55.392, p = 0.000) Very familiar (Md = 26.84%) to Very unfamiliar (Md = 40.02%, U = 54.945, p = 0.000)

6 Policy implications and recommendations

CRH has experienced intensive development since it first began operating in 2008, becoming the primary mode of transport in China (Lawrence et al. 2019). As rate fences are commonly used in the rail travel industry to balance passengers' and companies' interests, understanding passengers' perceptions and preferences of the different rate fences is essential in helping CRH design more efficient rate fence combinations. However, no previous research or industry articles have clearly indicated how CRH passengers value the various rate fences. This study has made the first attempt to address this gap in the literature by using conjoint analysis to identify the trade-off effects among different rate fences, and to determine the relative importance of the different types of rail rate fences to mainland Chinese and Hong Kong passengers. The findings of this study have several important implications.

First, CRH should design railway rate fences according to the importance of the attributes. The study results indicate that for Chinese passengers, ticket price, departure time, and booking requirement are the three most important attributes when booking CRH tickets (Table 5). This finding suggests that CRH needs to carefully consider these three attributes, as improper design of these attributes may dissuade passengers from making ticket purchases. CRH can justify price levels by offering conditions of departure time and booking requirements that are attractive to passengers. Comparatively, Chinese passengers gave the refund conditions category the lowest

importance score. This finding suggests that CRH could implement a non-refundable ticket policy to protect company interests while having a limited influence on passengers' decision making. A closer look at the comparison between CN and HK passengers reveals that HK passengers (both actual and potential) concerned more about departure time but paid less attention to refund conditions than CN passengers (both actual and potential). A plausible explanation for the disparity of departure time is that HK residents hold higher time commitment than CN residents. HK residents are used to make advanced appointment for their daily activities, such as going to restaurants, visiting doctors, and participating in events. If they wish to change the original appointment, typically they will be moved to the end of the waiting list and queue up again. HK residents are therefore more accustomed to consider time conditions when consumption, so as the purchase of railway ticket. Comparatively, in less occasions should CN residents make early appointment in their daily life, and the appointment change is often easy. The lower average income in CN than in HK could help explain why CN passengers are more concerned about the eligibility of receiving refund if cancelling their booking. These preference differences suggest that CRH could devise rate fence combinations differently for mainland Chinese and Hong Kong passengers.

Second, CRH should pay attention to passengers' socio-demographic profiles and travel characteristics and design rate fences accordingly. This study provides useful information by comparing the importance value relative to passengers' socio-demographic profiles and CRH travel behaviors (Table 6 and Table 7) and by investigating the effects of gender, age, education, city of residence, monthly household income, and familiarity with rate fences on the attribute importance (Table 8). The results show that for most segments based on socio-demographic profiles and CRH travel behaviors, price was consistently the most important attribute, followed by departure time and booking requirement, and the refund conditions was the least important. It is interesting to note that passengers whose travel purposes were commuting, personal business, and sports or entertainment attached the highest importance to departure time rather than to ticket price. A possible reason is that passengers traveling for work or an event have the top concern of arriving on time, thus valuing departure time more importantly and being less price sensitive. We would therefore suggest that CHR pay attention to passengers' travel purposes and design rate fences accordingly. For instance, for passengers who travel for commuting, personal business, and sports or entertainment reasons, CHR could set a higher price for high-speed trains departing at their preferred time.

Third, CRH should design efficient rate fence combinations according to passengers' preference of each attribute level. This study provides guidelines on passengers' preferences of each attribute level through the partial utility scores. The results showed that the most preferred rate fence combination was to depart at lunchtime, to book on the day of travel, to offer a 30% discount on tickets, and to offer customers a full refund when canceling their ticket (Table 4). The partial utility scores were found to be slightly different between CN and HK passengers (both actual and potential). For instance, the average partial utility score of the booking requirement of three days in advance was positive for CN passengers but negative for HK passengers, meaning that this restriction was preferred by CN groups but disliked by HK groups. By understanding this difference, CRH can offer a modest price that requires CN passengers to book three days in advance, to attract passengers and simultaneously protect the company's interests. Based on our results, this combination of rate fences may not work for HK passengers.

Fourth, CRH can use conjoint analysis, a powerful tool, to determine the utility score and importance value of rail rate fences. This study demonstrates the benefits of conjoint analysis as a powerful tool to determine the utility score and importance value of rail rate fences. In reality, passengers make their purchasing decisions on the implicit utility attached to each attribute. The conventional approach that assesses each attribute separately is flawed, as it does not capture the trade-off effects between the various attributes and passengers' decision making. Conjoint analysis helps to solve this problem by placing passengers in a more realistic scenario where passengers are presented with bundled attributes, thus implicitly revealing and measuring their hidden needs. This method is also helpful in assessing the utility of the current rate fences in use.

Fifth, CRH should ensure that passengers who are very familiar with rate fences are not dissuaded by unfavorable fencing conditions and that they are not taking advantage of reduced fares. Consistent with previous studies (e.g., Wirtz and Kimes 2007), this study examined the effect of familiarity on passengers' responses to rate fences. The results revealed that passengers who were more familiar with rail rate fences paid more attention to departure time and booking requirement, whereas they paid less attention to refund conditions and ticket price (Table 8). A possible explanation for the observed differences is that passengers who are more familiar with rail rate fences had a better understanding of the various rate fences, prompting them to focus not solely on price and refund but also on other rate fences when making purchasing decision. In contrast, passengers who were less familiar with rail rate fences were less capable of

differentiating their purchasing decisions through the various rate fences in place. These passengers were therefore more likely to rely on price difference in their purchasing decisions. As the refund conditions category was the least important factor in passengers' overall purchasing decisions, we were not surprised that no significant differences existed in the respondents of CN, HK, actual, CN actual, CN potential, HK actual, and HK potential among passengers with different levels of familiarity. This finding suggests that as passengers become more familiar with rail rate fences, they become less price sensitive. In other words, they are more willing to pay a higher price for their preferred fencing conditions. CRH should therefore ensure that passengers of high familiarity degree are not dissuaded by unfavorable fencing conditions and that they are not taking advantage of reduced fares, to achieve optimal rate fence combinations.

Despite the useful findings, this study was not without limitations. First, for CN passengers, this study only included those who lived in first and second tier cities. Future studies could include passengers from other CN areas, particularly given that the CRH network is expanding regional links and will connect almost all medium-size cities by 2025 (Lawrence et al. 2019, 12). Residents of such cities will therefore comprise an increasing proportion of CRH passengers. A study that takes into account the potential differences in socio-demographic background between the participants in this study and residents of other areas would likely provide empirically interesting results. Furthermore, this study selected attributes and attribute levels based on popular industry practices. Some rate fences, such as travel class and loyal member booking, were not included in this study. Future studies could conduct first-hand research, such as preliminary interviews or surveys, to determine the relevant attributes and attribute levels. Whether the results can be generalized to longer distance services remain to be seen.

7 Details of the public dissemination held

Based on the research findings, the article named "Chinese travelers' perceptions of demand-based pricing strategies of high-speed rail: a conjoint analysis approach" was published in the refereed academic journal called "Journal of Revenue and Pricing Management" in 2021. In the acknowledgements, we stated that the work described in the article was supported by a Grant funded by the Public Policy Research Funding Scheme from the Policy Innovation and Co-ordination Office (PICO) of the Hong Kong Special Administrative Region, China (Project Number: 2020.A6.150.20A).

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8 Conclusion

CRH has experienced intensive development since it first began operating in 2008, becoming the primary mode of transport in China (Lawrence et al. 2019). The introduction of High Speed Rail in Hong Kong is an important development in terms of keeping Hong Kong's status as a transport hub. High Speed Rail service opened in September 2018 and the estimated forecast of daily passengers are around 80,000. This initiative, which took more than 18 years to build, connects Hong Kong to China's network of high-speed railways. As rate fences are commonly used in the rail travel industry to balance passengers' and companies' interests, understanding passengers' perceptions and preferences of the different rate fences is paramount in helping CRH design more efficient and optimized rate fence combinations.

Using conjoint analysis, this study identifies price, departure time, and booking requirement as the three most important rate fences in passengers' decision making. Examining the partial utility scores of each attribute level, this study finds that both CN and HK respondents attached the highest level of preference to lunchtime departures, booking their tickets on the day of travel, fully refundable tickets, and tickets sold at a 30% discount. Furthermore, this study investigates the effects of gender, age, education, city of residence, monthly household income, and familiarity with rate fences on the perceived importance and reveals that the effect valence varies depending on the type of rate fence applied and the type of respondents investigated. The findings of this study help Chinese rail high-speed company gain better understanding of passengers' perceptions and preferences so that they can design more efficient rate fence combinations for different customer segments with different socio-demographic backgrounds and travel characteristics.

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