Research on Competitive Ticket Pricing of China's High Speed Rail——A Case Study of Beijing - Shanghai High - speed Railway

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Abstract: With the rapid development of China high-speed railway, High-speed rail will bring new changes to the passenger transport market, especially in the long-distance passenger transport, High-speed rail and civil aviation will have more intense competition. From the perspective of raising the price of high-speed rail, increase revenue, enhance the competitiveness, this article analyzes competition range; at the same time，taking "Beijing – Shanghai" high - speed rail as an example, using three methods "average cost pricing、break-Even Analysis、balance of supply and demand", this article studies the pricing strategy of high iron discount and makes corresponding recommendations.

1. Introduction

With the rapid construction of China's high-speed rail, the road network coverage area gradually expanded, high-speed rail lines have overlapped with most of the domestic civil aviation routes , the flow of air traffic inevitably has made the competition between the high-speed railway line and the civil aviation route in medium long-distance and long-distance. Especially affected by weather conditions and high delay rate of flights to Beijing in recent years, making a lot of price insensitive business people began to pay attention to high-speed rail. Although the speed of the high-speed rail is less than the aircraft, but the high-speed rail with its high standard rate and more convenient waiting experience gradually undertook the part of medium long-distance passenger transport.

Under the high-speed passenger monopoly market of high-speed rail and aviation in the medium long-distance transport line, with the increase in the distance, the competitiveness of high-speed rail line on the civil aviation gradually weaken, the share of passenger transport gradually decreased .However, air travel occupied vast of the passenger market in the long-distance transport, high-speed rail almost lost competitiveness.

Designing high-speed rail competitive fares and taking a flexible discount price, not only can improve the attendance of high-speed rail and compete in the transport market, but also can format a reasonable market relationship between supply and demand.

2. Competitive Analysis of High-speed Rail and Aviation

According to the transportation distance of high-speed railway, this paper analyzes the competitive range between the high-speed railway and civil aviation from the comparison of travel time and fare. High-speed railway and civil aviation line-related data from Shanghai, as shown in Table 1.

Table 1 Data Comparison Table of High-speed Railway and Civil Aviation in Some Sections

Sections	High-speed Railway Distance (km)	High-speed Railway Economy-class Ticket Fare （yuan）	Running Time (h)	Travel Time by High-speed Train （h）	Airline Economy-class Discount Price （yuan）	Flight Time (h)	Travel Time by Civil Airplane （h）
shanghai-nanjing	301	134.5	1.88	2.38	200	1.10	3.10
shanghai-anqing	568	238	4.28	4.78	275	1.67	3.67
shanghai-wuhan	823	256	5.87	6.37	400	2.10	4.10
shanghai-changsha	1083	478	5.70	6.2	400	1.92	3.92
shanghai-xiamen	1104	462	6.58	7.08	450	2.00	4.00
shanghai-qingdao	1308	518	7.12	7.62	485	1.58	3.58
shanghai-beijing	1318	553	5.65	6.15	490	2.33	4.33
shanghai-xi'an	1509	669.5	7.13	7.63	560	2.75	4.75
shanghai-shenzhen	1605	568	11.55	12.05	510	2.58	4.58
shanghai-guangzhou	1790	793	6.85	7.35	555	2.33	4.33
shanghai-chengdu	1985	606	14.38	14.88	810	3.42	5.42
shanghai-changchun	2194	869	11.18	11.68	660	2.83	4.83

In the table1,the fare of civil aviation is the discounted fare of economy class, which is compared with fare of the second class of high-speed rail, because there are few discounts for high-speed rail lines, furthermore ,the aviation discount is more powerful and the civil aviation has a discount of between 1.5 percent and 7 percent, therefore, the data in the table is the discounted ticket prices of the various ticketing websites, combined with the corresponding construction fee (50 yuan for domestic routes) . In addition, because the civil aviation needs passengers ahead of time to the airport terminal and check-in procedures, so the table "take the time required for civil aviation" corresponding to the flight time on the basis of plus 2 hours, and high-speed rail security inspection process is relatively simple and fast, the table "take the time required for high-speed rail" only on the basis of running time plus 0.5 hours.
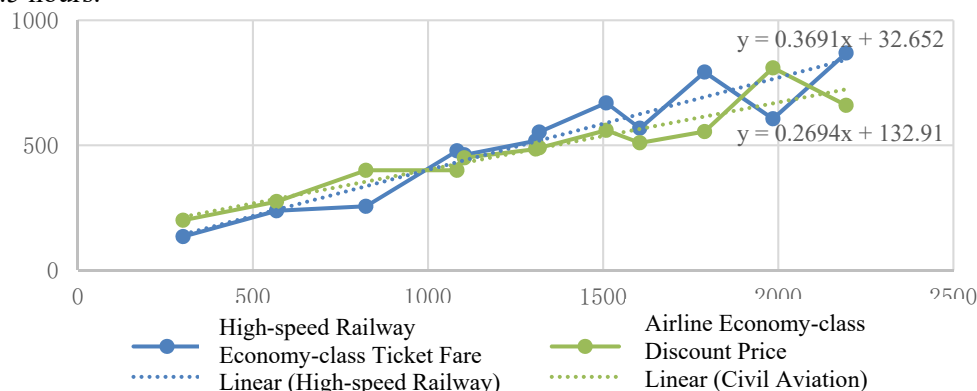

Figure 1 Comparison of Price between High-speed Railway and Civil Aviation

From Figure 1, the intersection point of high-speed rail and civil aviation at the same distance can be obtained through the trend line. From y=0.3691x+32.652 and y=0.2694x+132.91(x: transport distance, y: transport fares), we can see that when the high-speed rail transport distance at 1005.60km, it is the same as the civil aviation discount price, meanwhile, at this time it is the most intense competition, but in this point, the time required to take a civil aviation is 2 hours faster than the time required to take the high-speed rail. If hail-speed rail want to share more passengers, it must take the fare adjustment strategy and use the price to improve the competitive advantage.

Analysis can be drawn to Shanghai as a starting point, for example, in the 300km-500km high-speed rail transport distance, High-speed rail not only has an advantage in price, but also takes less time than civil aviation; in 500km-1005.6km, High-speed rail and civil aviation compete the most fiercely; in the 1005.6km-1600km high-speed rail transport distance, the price of high-speed rail and civil aviation is not much difference, the passenger traffic time is slightly lower than the high-speed rail, high-speed rail competition at a disadvantage; in 1600km-2000km of high-speed rail transport distance, civil aviation has an absolute advantage in the price and time.

Therefore, the high-speed railway should improve competitiveness in the fares of long-distance passenger transport (500km-1600km) and adopt a more flexible pricing strategy. Civil aviation fare mechanism has experienced a long time precipitation and learned from the civil aviation fare mechanism, launched a certain percentage of discount fares, so it can effectively improve the high-speed rail market competitiveness and increase market share.

3. Design Case Study of Beijing-Shanghai high-speed Rail Fares

In order to discuss the price of high-speed rail ticket under the market conditions, this paper chooses the Beijing-Shanghai transport corridor as the example research object, and validates the rationality and feasibility of the competitive ticket price.

From the Beijing South Railway Station to the Shanghai Hongqiao station high-speed railway, according to the different routes, there are 1318 km, 1451 km of two running lines, with 5 to 5.5 hours or so. In the non-special holiday period, about 38 trains per day on average, all the trains in the day can transport about 38,152 passengers. There are 9 airlines selling the route of the ticket from Beijing Capital Airport to Shanghai Hongqiao Airport flights, the route about 1200 km, with 2 hours and 25 minutes. In the non-special holiday period, about 95 flights per day on average, all the flights in the day can be transported Approximate 19,000 passengers.

Table 2 Transport Differences Comparison Table of High-speed Railway and Civil Aviation from Beijing-Shanghai

Beijing-Shanghai Transportation	Running Time (h)	Departure and Arrival time	Passenger Capacity（person）	Frequencies of Train or Fight Everyday	Price of Economy-class (yuan)	The Section Average Passenger Occupancy（person/day）
High-speed Railway	5-5.5	06:44-19:00	1004	38	553	38152
Civil Aviation	2.2	06:25-21:40	159-301	95	1290	19000

Without considering the full load rate, in terms of passengers transport,the number of passengers in high-speed rail is bigger than civil aviation, on sale ticket number, high-speed Rail has obvious advantages;Considering the time and waiting time to the station or airport or waiting time, civil aviation can be flat with the high-speed rail, therefore, using discount tickets to increase sales can improve the overall efficiency, the high-speed rail has more room for adjustment. However, because of the current section of high-speed rail fares and fares discount strategy, the advantage has not been well played.

Due to the different arrival time of passengers when traveling by rail or aviation requirements,although the morning and evening flights for civil aviation sell a large number of discounts, but the high-speed rail in the "Beijing - Shanghai" section passengers choose to start early in the morning. According to the number of votes on the 12306 website statistics, the attendance rate of the cold time period is between 30% and 50%. Therefore, this paper proposes in the non-special statutory holidays and non-weekends, selling discount tickets at 11: 00-14: 00 and 16: 00-18: 00, only in this way can increase attendance and revenue.

According to the relevant literature data, off-peak fares at around 550 yuan of demand elasticity value is 3.05.According to the fare level of the full price of 550 yuan,the attendance increased by 0.55% when decreasing one yuan per ticket,"Beijing - Shanghai" high-speed rail capacity of 825, the sale price of 100 yuan and 50 yuan discount Price, through the calculation can be found that the sale of

these two discount tickets can be increased attendance to 95.63%, compared to the income situation of 50% attendance, the strategy can be the proceeds from 228,113 yuan to 40,661 yuan,earnings can increase to78%.

According to the needs to properly adjust fares, with the aim of maximum increase attendance, it can get the train fill up with people..In the above-mentioned "Beijing-Shanghai" section of the high-speed rail second-class floating fare adjustment, for example, non-peak period to reduce the fare can drive more traffic, resulting in positive growth income. Since the marginal cost of each ticket sold is very small, it is almost negligible, and the reduction in ticket sales revenue to a certain extent can make up for operating costs. The appropriate price fluctuations can be based on consumer demand for different consumer groups to develop, according to market demand for flexible adjustment, it can do their best to attract passengers.

3.1 Ticket Pricing based on Average Cost Pricing
According to the literature survey, the cost of the Beijing-Shanghai high-speed railway is 0.3239 yuan/person km, in view of the data from a few years ago, considering the current rate of social prices, the value is 0.35 yuan/person in this paper. In accordance with the relevant policies and regulations of the country, the financial internal benchmark rate of return is 6% in the economic evaluation index of railway construction projects, so it is priced according to the rate of return of at least 6%. According to the average cost pricing method, the calculation of income under different standards from the Beijing South Railway Station to Shanghai Hongqiao station high-speed rail fare as shown in Table 3.

Table 3 High-speed Railway Ticket Price of Beijing-Shanghai Section based on Income Situation

Yield Rate	0	6%	10%	15%	20%	25%
Ticket Price(yuan/person)	436.9	463.11	480.59	502.43	524.28	546.12

Through the statistics, the current Beijing-Shanghai high-speed rail attendance ranges from 40% to70% in non-peak period; the attendance of weekend and statutory holidays rate ranges from 90% to 100%. According to the average cost pricing method, the calculation of the attendance rate under different circumstances from Beijing South Railway Station to Shanghai Hongqiao station high-speed rail fare as shown in Table 4.

Table 4 High-speed Railway Ticket Price of Beijing-Shanghai Section based on Attendance Situation

Attendance Rate	90%	80%	70%	60%	50%
Ticket Price(yuan/person)	440.74	528.79	557.26	595.22	648.36

According to the method of reverse analysis of the second-class ticket pricing 553 yuan of Beijing South Railway Station to Shanghai Hongqiao station high-speed rail, the pricing yield is 27% and the occupancy rate can reach 70%. According to the survey, removing the hot day trips, the other nearly seven percent of the attendance rate in the 50% is up and down, so the line should be a reasonable way to reduce fares, improve competitiveness, compete for market sources and get greater income.

3.2 Column Fare Analysis of Break-even Analysis Model
According to the above analysis based on the average cost of several prices, now we use break-even Analysis model to discuss the reasonable fares applicable to Beijing - Shanghai high-speed railway.

The analysis model of the profit and loss of the train is mainly through the analysis relationship between the total revenue of Beijing-Shanghai high-speed railway passenger and the total cost of the operation, judging the operation of the train profit and loss situation. According to the Beijing-Shanghai high-speed railway statistics to establish break-even analysis, as shown in Figure 2.
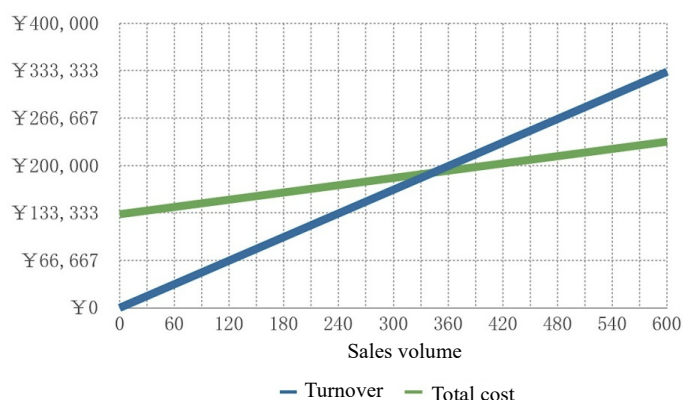
Figure 2 The Break-even Analysis chart of the Cost and Sales of Beijing-Shanghai High-speed Railway

In Figure 2, the break-even point is the number of units sold when the revenue is equal to the cost. Break-even point is the sales of 343 when the corresponding point, according to the number of capacity of 825 people, that is, when the fare is 553 yuan and the attendance is 42%, it can achieve break-even.

Comparing the price of 10%, 15% and 20% of the income in Table 3 and the price of attendance of 80% in Table 4, because of the analysis which is about the fare reduction strategy, so we need to deduct the price which is higher than the sum of $ 553 Earnings and below 6% of the price.

According to the relevant literature data, the value at the price of 550 yuan in the non-peak demand elasticity is 3.05, that is, each dollar price will increase 0.55%, according to the calculation of the attendance and income as shown in Table 5.

Table 5 Design Price Comparison Table of Beijing-Shanghai High-speed Railway

Price（yuan）	Attendance Improvement（%）	Revenue Improvement（yuan）
529	13.2	47708.1
524	15.95	56989.35
502	28.05	95131.58
481	39.6	127442.7

According to the above analysis, the break-even point in the current price of 553 yuan is 343, that attendance of 42% can be balanced; Similarly, the use of break-even method, the attendance fares of 529 yuan in the break-even point is 366, that attendance of 44% can be balanced; plus 20% of the proceeds of the fare 524 yuan in break-even point is 372, that attendance of 45% can be balanced; plus 15% of the proceeds of the fare of 502 yuan in break-even point is 396, that attendance of 48% can be balanced; plus 10% of the proceeds of the fare 481 yuan in break-even point is 423, that attendance rate of 51% can be balanced.

According to the analysis of current attendance rate, attendance of 100%in the hottest period is slightly lower than other time ; for the attendance of 30%-50%,in this floating time period, appropriate price discount strategy can effectively share of the popular passenger flow, capturing the market for the transport of passengers can reach the purpose of competing.

3.3 Analysis of Price Elasticity of Supply and Demand Equilibrium Analysis Model
Reference to the Beijing-Shanghai line data, we can make a simple regression analysis of the Beijing-Shanghai high-speed railway fares and passenger relations, as shown in Figure 3.
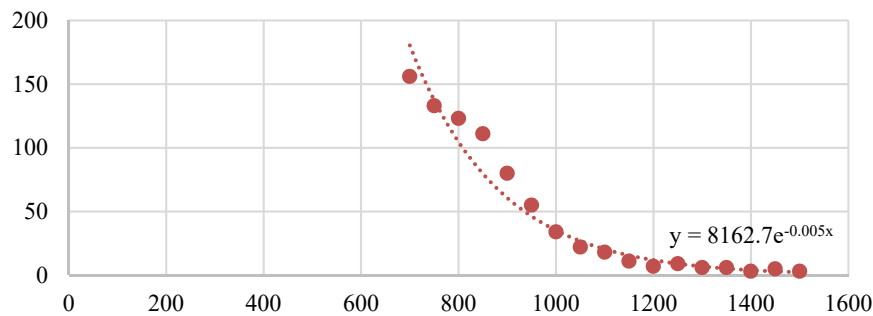
Figure 3 Regression Analysis for Ticket Price and Passenger Volume of Beijing-Shanghai
High-speed Railway

According to the regression analysis curve above, we can see that the relationship between Beijing-Shanghai high-speed railway fares and passenger traffic is $Q=8162.7e^{0.005P}$. In the Beijing-Shanghai high-speed rail passenger demand curve desirable, we can choose any two points, find the elastic coefficient between the two points: E_d. For example, select points (750, 191.97) and points (1300, 12.27), we can conclude that $E_d=-3.28$. At the same time, we can conclude that $Q=22603246+30137.92P$, in the case of $W=P×Q$ that is, $W=22603246P-30137.92P^2$, as shown in figure 4.
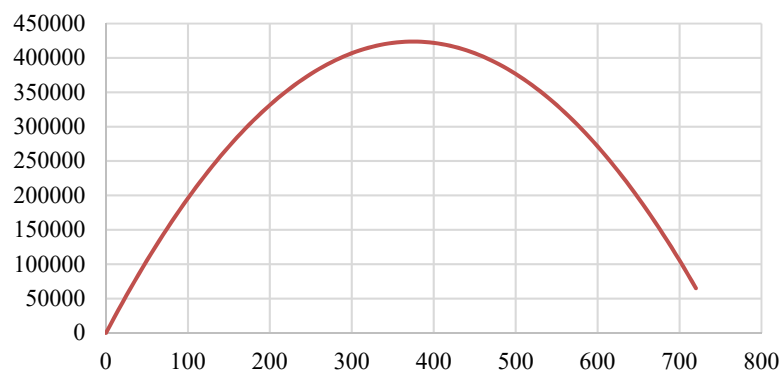

Figure 4 Function Diagram for Ticket Price and Income of Beijing-Shanghai High-speed Railway

From the formula, according to the supply and demand balance theory model, when the Beijing-Shanghai section of the high-speed rail ticket pricing of 375,reaching the largest return (4238072000 yuan). So the price below the point is not desirable, higher than the price of the point, the more close to 375, the greater income.

4. Conclusion and Suggestion

According to the inquiry of booking site, the current discount ticket fare from Beijing Capital airport flying to Shanghai Hongqiao is between 500-700 yuan (plus 50 yuan after the airport construction costs) before 8:00am and after 10:00am; The remaining flights of the ticket price between 800-1000 yuan, the full price of the ticket for the 1240 yuan. Comparison of aviation prices, the current high-speed rail prices regardless of booking time and frequency, the price is 553 yuan (second seat).

This paper suggests that the attendance rate of 100% or even frequency of difficult to get a ticket, high-speed rail ticket fare can be properly improved. For other non-hot flights, it is recommended to reduce the fare, such as non-hot times in the case of 50% attendance, the 553 yuan down to 502 yuan can increase the attendance rate to 78%, earnings growth of 95131.58 yuan. Combined with the price floating strategy, you can design 30-20 days before the sale price of 481 yuan for the fixed (100) discount tickets, discount tickets to be added to make up the difference in the fare difference.

Comparing the actual high-speed rail second-class fare from Beijing West Railway Station to Shanghai Hongqiao, through the average cost pricing method, the minimum income in the case of 6% of the actual fare is less than the actual fare of 90 yuan; Fare of attendance of 50% is more than the actual fare of 95 yuan. It can be seen that the current high-speed rail fares have enough floating space and it can develop a reasonable strategy to increase. When the floating fare to meet the needs of different groups of passengers in the market, it can increase the consumer surplus and attract more high-speed rail transport needs. With the development of transport demands, the economies of scale of high-speed railway can move the supply line to the right, because of the average cost declining, so it can fundamentally improve the high-speed railway transport capacity; supply capacity can meet the requirement of increased demand, the cut of long run average cost for freight rate provide a reliable guarantee, meanwhile, it reversely drives the growth in demand, so as to promote the entire high-speed rail transport network to achieve the best economies of scale and get the maximum benefit.

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