Analyzing competition between High Speed Rail and Bus mode using market entry game analysis

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Abstract

The introduction of High Speed Rail (HSR) changes the dynamics of the passenger transport therefore understanding the market scenario after the entry of the HSR is of utmost importance. In this study, a market entry game is analysed in the context of High Speed Rail competing with the bus mode on the Bangalore-Mysore corridor. The game is modelled as an extensive form game whose outcome will determine the strategies of the players in the competitive scenario. A discrete choice model is constructed using revealed and stated preference data to compute the modal share in the hypothetical scenario. Utilities in terms of profit for each mode is calculated using assumed cost functions for different strategies of the mode operators. These utilities are then used to form the basis for the extensive form game for the market entry.

The extensive form game (with and without perfect information) is analyzed by computing the sub game perfect Nash equilibrium of the game which determines best strategies for each player under different demand scenarios. This study therefore provides a scientific tool for policy makers to analyze best strategies for players under different demand scenarios thereby aiding in decision making.

Keywords: HSR; Discrete Choice Model; Mode Choice; Game Theory; Extensive Form Game; Nash Equilibrium; Inter-modal Competition

1. Introduction

High speed rail (HSR) system has been globally proven to be an efficient transportation mode to fulfill the demand gap for faster intercity movement of passenger traffic. Thus, in order to cater to the ever increasing passenger traffic
and demand for better services, the Government of India is exploring the option of introducing HSR system as a sustainable mode of transportation.

The Indian Railways' vision 2020 envisages the following on High Speed Corridors: “India is the only country among the major nations of the world which do not have a high speed rail corridor. In order to escalate the speed of the corridors Indian Railway will follow a two-step approach. Based on the feasibility of the passenger corridors, speed will be raised to either 160-200 kmph using conventional technology or up to 350 kmph by building state-of-the-art high-speed corridors through on PPP mode in partnerships with the State Governments. By 2020, at least four corridors of 2000 km would be developed and planning for 8 other corridors would be in different stages of progress." High Speed Rail Corporation of India Limited (HSRC) has been formed on the directions of Ministry of Railways, Government of India, for development and implementation of high speed rail projects. HSRC mentions the railway budget speech 2012-2013 which states the issue of capital intensiveness and innovative funding mechanism to make this project a reality. Ministry of Railways, Railway Board has decided to carry out the prefeasibility study for Diamond Quadrilateral Network of High Speed Rail connecting four major metro and growth centers of the country i.e. New Delhi – Mumbai – Chennai – Kolkata – New Delhi. High-speed corridors have been proposed and are under prefeasibility studies. Six corridors have already been identified for technical studies on setting up of HSR as shown in Table 1.

<table>
<thead>
<tr>
<th>High-Speed Corridor</th>
<th>Route</th>
<th>Stations</th>
<th>Speed (kmph)</th>
<th>Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Howrah-Haldia</td>
<td>Howrah-Haldia</td>
<td>TBD</td>
<td>250-300</td>
<td>135</td>
</tr>
<tr>
<td>Delhi-Patna</td>
<td>Delhi-Agra-Kanpur-Lucknow-Varanasi-Patna</td>
<td>TBD</td>
<td>200-350</td>
<td>991</td>
</tr>
<tr>
<td>Delhi-Amritsar</td>
<td>Delhi-Chandigarh-Amritsar</td>
<td>TBD</td>
<td>TBD</td>
<td>450</td>
</tr>
<tr>
<td>Hyderabad-Chennai</td>
<td>Hyderabad-Dornakal-Vijayawada-Chennai</td>
<td>TBD</td>
<td>TBD</td>
<td>664</td>
</tr>
<tr>
<td>Pune-Mumbai-Ahmedabad</td>
<td>Pune-Mumbai-Ahmedabad</td>
<td>7</td>
<td>300-350</td>
<td>650</td>
</tr>
<tr>
<td>Chennai-Bangalore-Coimbatore-Ernakulam</td>
<td>Chennai-Bangalore-Coimbatore-Ernakulam</td>
<td>TBD</td>
<td>350</td>
<td>649</td>
</tr>
</tbody>
</table>

While there is a considerable amount of studies on HSR in developed nations especially the European countries, very little is available for the developing nation’s scenario.. Roman et.al (2007) analysed the potential competition of the high-speed train with the air transport between Madrid and Barcelona. They developed a disaggregate demand model using mixed RP/SP data and obtained different willingness to pay measures for improving service quality. Demand responses to various policy scenarios that consider the potential competition between high-speed train and air transport were examined and concluded that the HST market share would not exceed 35%. This implied that low modal share and generally low rate of return on HST projects, cast doubts on the competition that HSTs can exert in markets characterized by high frequency air services. Shyr and Hung (2010) estimated the modal shares using discrete choice modelling by conducting revealed preference and stated preference survey and stated that if Taiwan High speed rail continues to increase its service frequency and lower its promotion prices, the chances of airline market to compete with HSR is very slim. They incorporate co-operative game theory to study the coalition structures between the airlines predicting that to maintain profitability, airlines would have to unify as an alliance and cut their daily flights by 50%. For given payoff values, Shapley value is computed in order to solve the profit distribution problem. Raturi et al. (2013) incorporated a game theoretic approach to investigate the competition between HSR and bus system for Bangalore-Mysore corridor. Value of time approach was used to compute the modal share in the hypothetical scenario. They used hypothetical data to illustrate the importance of sunk cost and different strategies in the decision of HSR to enter or stay out of the market. They modelled the competition scenario as an extensive form game and the sub-game perfect Nash equilibrium was found out by backward induction.
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