Transportation Research Part A 116 (2018) 350–360

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Transportation policy for high-speed rail competing with airlines

Yushi Tsunoda

Graduate School of Business Administration, Kobe University, 2-1, Rokkodai-cho, Nada-ku, Kobe 65708501, Japan

ARTICLE INFO

Keywords:
Air transportation
High-speed rail
Regulation
Bertrand competition

ABSTRACT

This study investigates the desirable transportation policy for a government seeking to regulate the competition between high-speed rail (HSR) and air transportation. To address this issue, we construct a game-theoretic model. A basic assumption underlying the model is that the airline maximizes its own profit whereas the HSR operator maximizes a weighted sum of profit and social welfare due to the government regulation. We assume a two-stage game in which the government sets the weight to maximize social welfare in the first stage and the HSR operator and the airline maximize their respective objective functions in the second stage. The central result from our model is that partial public regulation arises as a subgame perfect equilibrium unless the benefits to consumers from using the HSR are sufficiently large or sufficiently small compared to the benefits to consumers from using air transportation. The result provides a theoretical foundation for the public policies of joint investments by both governments and HSR operators in HSR networks in European and Asian countries. In addition, our results suggest that the optimal regulation by the government depends on the benefits for consumers using each mode of transport and the difference between the levels of benefits.

1. Introduction

Since the first modern high-speed rail (HSR) started to run between Tokyo and Osaka; in Japan in 1964, HSR networks have been constructed mainly in European and Asian countries. For a variety of reasons, such as substantial capital requirements or political circumstances, most HSR operators are owned by governments. Even in countries where HSR operators are owned by private companies, such as some European and Asian countries, the governments have often co-invested in the networks with these companies. In Japan, the central government, local governments, and private companies have co-invested in high-speed rail networks (i.e., the Shinkansen networks). In China, the government has planned the construction of an HSR network that is over 12,000 km is planed by the government in China, and the investment in this construction is about USD 300 billion.

Numerous previous studies have examined the economic consequences of HSR's entry into transportation markets. In particular, the effects of competition between HSR and air transportation on economic outcomes have commanded significant attention as an important issue in the transport literature from both theoretical and empirical viewpoints. Most previous theoretical studies that construct analytical models assume that both HSR operators and airlines maximize their own profits because they are private companies. However, some analytical studies (D'Alfonso et al., 2015; Yang and Zhang, 2012) focus on the fact that HSR operators are regulated by the government because of government ownership and co-investment. Hence, these studies assume that HSR operators maximize a weighted sum of their own profit and social welfare due to this regulation by the government. This assumption has been conventionally used in previous studies that discuss the welfare consequences of the partial privatization of a public firm in a mixed oligopoly market (Matsumura, 1998).

An important finding in Yang and Zhang (2012) is that both HSR fares and airfares decrease as the weight on social welfare in the

E-mail address: 143b012b@stu.kobe-u.ac.jp.

https://doi.org/10.1016/j.tra.2018.06.030
Received 2 June 2016; Received in revised form 19 March 2018; Accepted 21 June 2018

HSR operator's objective function increases. In addition, the authors show that HSR fares and airfares depend on the airport access time and the HSR's speed by analyzing a model that considers business and leisure passengers, price discrimination, and the flight schedule frequency decision. However, Yang and Zhang (2012) assume that the degree of the strictness of the government regulation, which is represented by the weight on social welfare in the HSR operator's objective function, is given exogenously.

This study investigates the optimal level of regulation determined by the government endogenously in an economic model. To address this issue, we construct a game-theoretic model. We assume a two-stage game, in which the government sets the weight to maximize social welfare in the first stage, and the HSR operator and the airline subsequently maximize their respective objective functions in the second stage. An important assumption underlying this model is that the airline maximizes its own profit whereas the HSR operator maximizes a weighted sum of profit and social welfare due to the government regulation. This assumption is consistent with both Yang and Zhang (2012) and D'Alfonso et al. (2015). Although this analysis is closely related to the analysis of Yang and Zhang (2012), the degree of the strictness of the regulation by the government is endogenously determined within the model constructed in this study. In this respect, this study clearly differs from Yang and Zhang (2012) and thus makes a significant contribution to the existing literature on transportation research.

The central result from our model is that a partial regulation by the government arises in a subgame perfect equilibrium unless the benefits for consumers using the HSR are sufficiently large or sufficiently small compared to the benefits for consumers using air transportation. The result provides a theoretical foundation for the public transportation policies of HSRs owned by governments and of joint investments by both governments and private companies in the HSR networks in European and Asian countries. The intuition behind this result is laid out as follows. The government strengthening the regulation on the HSR causes both airfares and HSR fares to decline. Because the decline in HSR fares is larger than the decline in airfares, the number of consumers using the HSR increases. Since each consumer has his own preferences over transport modes, it is undesirable for social welfare that all consumers who prefer air transportation use the HSR. Therefore, the government sets a partial regulation so that consumers continue to use air transportation. In addition, our results suggest that the optimal level of the government regulation depends on benefits for consumers using each transport mode and the difference between the levels of benefits. Specifically, when the difference between the benefits provided by each transport mode is small, the regulation is strengthened by the government as the consumers' benefits from the HSR increase, and the regulation is relaxed as the consumers' benefits from air transportation increase. On the other hand, when the difference between the benefits of the two transport modes is large, the regulation is strengthened as the benefits of air transportation increase, and the regulation is relaxed as the benefits of HSR increase. The intuition behind this results is laid out as follows. An increase in the benefits to consumers from using a specific transport mode makes the use of the transport mode more desirable for social welfare. Intuitively, it is desirable for the government to coordinate the regulation on the HSR in order to help the transport mode whose benefits are increased. When the difference between the benefits from each transport mode is small, such regulation coordination by the government occurs. On the other hand, when the difference between the benefits from each transport mode is large, it is socially desirable to maintain the transport mode whose benefits are not increased, rather than to help the other transport mode whose benefits are increased. This result follows because it is undesirable for the transport mode whose benefits are not increased to exit the market. Therefore, the government needs to carefully observe the benefits from each transport mode to consumers and the difference between the benefits of each transport mode to set an appropriate regulation. Furthermore, we extend the model to incorporate schedule frequency as an additional decision variable. Even in the extended model, we show that a partial regulation on the HSR by the government arises as a subgame perfect equilibrium, and that the optimal level of the regulation by the government depends on the benefits to consumers using each transport mode.

The remainder of the paper is organized as follows. Section 2 provides a review of the literature on the competition between HSR and air transportation. In Section 3, we delineate the assumptions underlying our model and solve the model to determine the transportation policy adopted by the government in the subgame perfect equilibrium. Section 4 extends the model so that schedule frequency is incorporated as an additional factor. Finally, Section 5 provides concluding remarks.

2. Literature review

A number of previous empirical studies have investigated the economic outcomes of the competition between HSR and air transportation (Behrens and Pels, 2012; Castillo-Manzano et al., 2015; Clewlow et al., 2014; Dobruszkes, 2011; Fu et al., 2011; Gonzalez-Savignat, 2004; Park and Ha, 2006; Roman et al., 2007, 2010). Gonzalez-Savignat (2004) analyzes model choices between the HSR and the airline using stated-preference methods. The study shows that HSR has a significant impact on the airline market and that this impact mainly depends on total travel time. Specifically, she shows that HSR's share decreases as HSR's travel time increases. By the using stated-preference method, Park and Ha (2006) point out that the opening of South Korea's HSR line significantly influenced the domestic airline market. Behrens and Pels (2012) estimate multinomial and mixed logit models with the use of revealed preference methods to examine the competition between HSR and air transportation in the London-Paris passenger market. Their result explains that travel time and frequency are the main determinants of travel behavior. Clewlow et al. (2014) analyze the impacts of HSR and low-cost carriers on European air transportation with the use of origin-destination (O-D) passenger traffic data. They show that reductions in HSRs' travel times have resulted in reductions in short-haul air travel, and the expansion of the low-cost carrier supply has led to a significant increase in total air traffic. Castillo-Manzano et al. (2015) show that the substitution rate between HSR and air transportation has changed dynamically using dynamic linear regression models. Fu et al. (2011) show that services between HSR and air transportation are significantly differentiated and that travel time and frequency affect the shares of each transport mode by estimating a travel demand model in Japan's intercity market with aggregate O-D data. Roman et al. (2007, 2010) estimate disaggregated mode choice models using mixed revealed and stated preference data collected from consumers. Their