Journal of Air Transport Management xxx (2017) 1–10

Contents lists available at ScienceDirect

Journal of Air Transport Management

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

Air and high-speed rail transport integration on profits and welfare: Effects of air-rail connecting time

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ARTICLE INFO

Article history:
Available online xxx

Keywords:
Air transport
High-speed rail
Integration
Connecting time
Welfare

ABSTRACT

Air-rail integration has become a popular idea to relieve airport congestion and environmental impact of transport industry, especially amid the fast expansion of high-speed rail network around the world. This study examines the circumstances under which air-rail integration can be better justified, by focusing on the effects of reducing air-rail connecting time on transport operators' profits, consumer surplus, and social welfare. We show that while consumers always benefit from less air-rail connecting time (an integrated hub with seamless transfer between air and rail services is always preferred by passengers), operators of the two modes, air transport and high-speed rail, won't have an incentive to integrate unless the cost of integration is sufficiently low. Nonetheless, reducing air-rail connecting time enhances total surplus when the hub airport suffers from a certain degree of capacity constraint and the cost of air-rail integration is not too high.

1. Introduction

The first modern high-speed rail (HSR) went into operation in Japan between Tokyo and Osaka in 1964 with a maximum speed of 210 km/h (Givoni and Dobruszkes, 2013). After 17 years, HSR was introduced to Europe where France inaugurated regular HSR service between Paris and Lyon at a top speed of 270 km/h (Cheng, 2010). In 1988, Italy launched HSR service connecting Rome and Milan, followed by HSR services in Germany connecting Hannover and Würzburg in 1991 and in Spain connecting Seville and Madrid in 1992. Since then, HSR has expanded to other adjacent European countries, such as Belgium, the Netherlands, and the United Kingdom. As a result, the trans-European high-speed passenger rail network started to take shape (Givoni, 2005).

Japan remained as the only country operating HSR service outside Europe until the 2000s, when a number of countries in East Asia started HSR services. South Korea launched its HSR service in 2004 (between Seoul and Daejeon), followed by Taiwan three years later (between Taipei and Kaohsiung). However, the most remarkable and astonishing development occurred recently in China (Fu et al., 2012; Givoni et al., 2012). Currently, the daily ridership of China's fast-expanding HSR network exceeds 1.3 million.[1] According to the updated "Medium-to-Long-Term Railway Network Plan" covering the period 2016–2025 with an outlook to 2030, China's HSR network will by 2025 reach a total of 38,000 km, including eight north-south and eight east-west trunk lines. By 2020, 192 cities of prefectural-level in China will be connected by HSR lines (Fu et al., 2015).

Table 1 shows the HSR networks of some major countries according to the latest statistics from International Union of Railways (UIC, 2014). As of September 2014, the worldwide HSR lines under operation were 22,954 km, of which 66% was in Asia (with China taking the lion's share) and 32% in Europe; 12,754 km were under construction and 18,841 km were in both short-term and medium-to-long-term plans (UIC, 2014). By 2025, the length of HSR lines worldwide is expected to reach 54,550 km, thus more than doubling the 2014 level, of which Asia will account for 57% and Europe 39% (UIC, 2014).

Air transport and HSR have traditionally been regarded as competitors. Table 2 contains some examples about air transport and HSR competition in city-pair markets. Note that even for much longer distance such as the Wuhan-Guangzhou route, air transport is still affected following the entry of HSR. However, as pointed out by (Givoni and Banister, 2006), there is large potential for air and

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[1] See http://www.cnn.com/2013/04/11/travel/china-high-speed-rail/.

http://dx.doi.org/10.1016/j.jairtraman.2017.06.008
0969-6997/

Table 1
High-speed rail networks of major countries (in kilometers).

	Country	In Operation	Under Construction	Planned	Total
Asia	China	11,132	7571	3777	22,480
	Japan	2664	779	179	3622
	Turkey	688	469	1758	2915
	South Korea	412	247	49	708
	Taiwan-China	345	9	–	354
Europe	Spain	2515	1308	1702	5525
	France	2036	757	2407	5200
	Germany	1352	466	324	2142
	Italy	923	125	221	1269
	Belgium	209	–	–	209
	The Netherlands	120	–	–	120
	United Kingdom	113	–	543	656
	Austria	48	201	–	249
Other high speed systems	USA	362	–	777	1139
	Morocco	–	200	480	680

Source: UIC (2014).

Table 2
Examples of air transport and HSR competition.

Route	Year of HSR entry	Distance	Impacts
Paris-Lyon	1981	427 km	Air share fell from 31% in 1981 to 7% in 1984 (European Commission, 1998).
Madrid-Seville	1992	470 km	Air share fell from 40% in 1991 to 13% in 1994 (European Commission, 1998).
London-Paris	1994	492 km	Airlines lost 56% passengers (Givoni and Dobruszkes, 2013).
London-Brussels	1994	373 km	Airlines lost 58% passengers (Givoni and Dobruszkes, 2013).
Frankfurt-Cologne	2002	177 km	Air services were suspended.
Seoul-Busan	2004	223 km	Air share fell from 42% in 2004 to 17% in 2008 (Givoni and Dobruszkes, 2013).
Taipei-Kaohsiung	2007	345 km	Air share fell from 24% to 13% following the HSR entry (Cheng, 2010). All flights were suspended in 2012.
Wuhan-Guangzhou	2009	1069 km	Airlines' daily frequency was reduced from 32 to 17 in 2010 (Fu et al., 2012).

HSR transport to cooperate and integrate, especially in regions where the hub-and-spoke network strategy is widely adopted by airlines. Several leading airports in Europe witness air-rail alliances for which railway services are used as additional spokes of airlines to free up airport slots and enlarge airports' catchment areas. AIRail service, which was launched in 2001 in Germany, is one example of dedicated air-rail alliances formed among a hub airport (Frankfurt), airlines (e.g., Lufthansa) and HSR (Deutsch Bahn). Due to the increasing concerns about airport congestion and climate change, air and rail transport integration has been proposed as a possible solution to offer immediate congestion relief, release runway capacity, save air traffic control resources, reduce the negative environmental impacts of transport, and improve ground access to airports (e.g., Cokasova, 2006; Givoni and Banister, 2006; Miyoshi and Givoni, 2013).

Although air-rail integration has been proposed, and practiced in some markets, for over a decade, air and rail are still not fully integrated in many parts of the world (e.g., Chen and Lin, 2016; Givoni, 2016). As initially the main reason for the construction of many HSR lines was to increase route capacity for inter-city travel rather than to integrate with air transport (Givoni, 2006), airports were not planned as a through station in the railway network. Nowadays despite the potential benefits of air-rail integration, the major obstacle is the lack of railway infrastructure at the airport. In other words, an important condition for airline and railway integration to take place is the co-location of airport and railway station.

Givoni and Banister (2006) analyze the potential of airline and railway integration at London Heathrow Airport and show that an HSR station at Heathrow airport would free 10% of Heathrow's capacity and provide Heathrow with a similar level of capacity as the third runway. In planning the High-Speed 2 project, which will connect London and Birmingham in Phase 1 and extend from Birmingham to Manchester and Leeds in Phase 2, the option of connecting Heathrow airport was widely discussed. Largely due to technical reasons, including Heathrow as a through station on the emerging UK HSR network was considered too costly, thus not feasible (Givoni, 2016). The option to serve the airport is either through a station near the airport (not at the airport) or via a spur to the airport from the main HSR line. However, both options to connect Heathrow were excluded from Phases 1 and 2 of the High Speed 2 scheme. Although the notion of airline and railway integration was suggested in 2005 (Givoni, 2005; Givoni and Banister, 2006), air and rail transport have still been largely disintegrated after 10 years, despite the fast expansion of HSR network around the world (Givoni, 2016).[2]

Our study aims to examine the circumstances under which air-rail integration can be better justified, by focusing on the effects of reducing air-rail connecting time on social welfare, consumer surplus and transport operators' profits. Economic analysis of air transport and HSR interaction has largely focused on the competition aspect of the two modes (see Adler et al., 2010; Behrens and Pels, 2012; D'Alfonso et al., 2015; Givoni and Dobruszkes, 2013; Jiang and Zhang, 2016; Yang and Zhang, 2012). The work on the cooperation aspect started to emerge recently. For instance, Jiang and Zhang (2014) showed that cooperation between airline and HSR reduces traffic in markets where prior modal competition occurs, but may increase traffic in other markets of the network. Xia

[2] It appears that now there is a movement towards co-location of airport and HSR stations in Asia. For example, Korea's Incheon International Airport was integrated into Korean HSR (KTX) network in 2014. In China, both Zhengzhou (Xinzheng International) and Chengdu (Shuangliu International) airports were respectively added a through station of HSR network in 2016. Chen and Lin (2016) discuss ways to further strengthen the air-rail integration at Shanghai's Hongqiao International Airport where the airport and HSR station are already co-located.