



# Air-rail cooperation: Partnership level, market structure and welfare implications



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## ARTICLE INFO

### Article history:

Received 7 December 2015

Revised 13 January 2017

Accepted 13 January 2017

Available online 26 April 2017

### Keywords:

Airline

Rail

Cooperation

Domestic partnership

International partnership

## ABSTRACT

We build a theoretical model to study different air-rail cooperation scenarios. We investigate two possible air-rail partnerships between a rail operator and either a domestic airline or a foreign airline. When a partnership is formed, an investment to improve the air-rail connecting service is allowed at a cost before the service is launched. We find that the cooperation level, the equilibrium partnership scenarios when air-rail cooperation is exclusive or non-exclusive, as well as the comparisons of social welfare under different partnership scenarios, all depend on the pre-investment quality of air-rail service compared with the quality of air-air service. We further apply our model to the real-life case of Strasbourg-Paris-Dubai market, showing that other factors, such as price sensitivity of demand, horizontal differentiation between air and rail, and asymmetries in partnership investment costs, also affect cooperation level.

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## 1. Introduction

In recent years, high-speed rail (HSR) has become a major competitor and substitute for air transport (Yang and Zhang, 2012; Jiang and Zhang, 2016; Jiang and Li, 2016). On short-haul routes, airlines usually lose ground to HSR, being either forced out of the market totally or into big cutbacks (e.g., Park and Ha, 2006; Barrón et al., 2009; Dobruszkes, 2011; Fu et al., 2012; 2014; Wan et al., 2016). However, air transport has incomparable advantages in long-distance travel and extensive networks. Due to this difference in advantages as well as the hub-and-spoke network adopted by most major airlines, HSR can complement air transport by connecting between airports and nearby cities, and hence the potential for air-rail cooperation exists. Under hub-and-spoke operation, passengers complete one journey from the origin airport to the destination airport by taking two flights ("legs") connecting at a hub airport. With HSR, however, both these legs need not be air flights: on legs where HSR service is comparable with flights in terms of (total) journey time and cost, HSR service may be used in combination with a flight in one journey.<sup>1</sup> Such air-rail cooperation may be viewed as a special type of "code sharing" – i.e., two airlines cooperate to offer a hub-and-spoke operation with each offering one leg of a trip (and the non-operating

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<sup>1</sup> In fact, the air-rail cooperation is not confined to high-speed rail. There are also cases of such intermodal partnerships in countries without real HSR, such as US and Canada.

carrier is allowed to put its code on the operating airline's flight number) – which is common in the airline industry (e.g., Oum et al., 1996; Brueckner, 2001; Ito and Lee, 2007; Gayle, 2008).

There are several driving forces behind the formation of air-rail cooperation. First, some short-haul flights are unprofitable to operate but indispensable for the airlines' network. Substituting these flights with train trips allows the airlines to maintain their networks and, at the same time, focus on operating the more profitable long-distance flights (Givoni and Banister, 2006). Second, it is possible that some hub airports are under serious capacity constraint. By forming intermodal cooperation, the airlines can divert part of the short-haul traffic to the rail (Givoni and Banister, 2006; Janic, 2011; Jiang and Zhang, 2014). Third, policy makers are in favor of intermodal cooperation because it is generally believed that substituting air traffic with rail traffic can alleviate the impacts on the environment (D'Alfonso et al., 2015, 2016). Fourth, due to freedom of the air, foreign airlines are usually excluded from, or seriously constrained in, domestic routes. With the help of air-rail cooperation, these airlines can significantly increase their market presence and avoid being undercut by the powerful national airlines (Chiambaretto and Decker, 2012). Besides, as suggested by Chiambaretto (2015) with a two-dimension framework of resource dependence and power balance, foreign airlines should proactively redesign their market boundaries to find new partners, i.e., to substitute the traditional airline alliance with air-rail intermodal cooperation, so as to avoid being undercut by the powerful national airlines. Airlines are usually the initiators of such cooperation schemes, but in some cases both the airline and the rail operator, at times even the hub airport, are actively involved in the partnership (e.g., the AIRail case in Germany).<sup>2</sup>

To the best of our knowledge, only recently, researchers have shifted their focuses from modal substitutability to modal complementarity. Analytical papers investigating modal complementarity between air and rail include Socorro and Viecens (2013), Jiang and Zhang (2014), Avenali et al. (2016), and Xia and Zhang (2016; 2017). Those studies focus on effects of air-rail cooperation in a hub-and-spoke network with capacity constraints and adopt the hidden assumption that there is only one type of cooperation. With the exception of Avenali et al. (2016), none of these papers explicitly considers the role of sunk costs that the airline and the rail operator bear to ensure compatibility between transport services. However, in reality there is substantial diversity among the existing air-rail cooperation cases.<sup>3</sup> This paper focuses on two interesting aspects of this diversity that have not yet been extensively explored. On the one hand, the rail operator might cooperate with different types of airlines. Some cooperation cases are between domestic airlines and rail operators, such as in China, Portugal, Switzerland, and USA; while other cases involve foreign airlines, such as in Italy and Spain. In countries like France, Germany, UK, as well as Canada, both situations exist simultaneously. On the other hand, the levels of cooperation in different cases can be diverse. Some cooperation is basic and nothing more than an emergency back-up strategy for extreme cases. For example, there is a re-protection agreement between Air Canada and VIA Rail, which will only be triggered under major delay or cancellation disruptions from the air sector. Some cooperation is very advanced with features like integrated ticketing, dedicated carriage, coordinated scheduling, and baggage push. The most renowned example of such high cooperation level is the AIRail service provided by Lufthansa and Deutsche Bahn at Frankfurt Airport. More partnerships have a cooperation level that is in between these two extremes. In particular, for these services, ticketing is usually integrated, but baggage push and dedicated train compartments are seldom available. Such cases abound across Europe and Asia (in Taiwan, as well as Mainland China). More interestingly, some anecdotes seem to imply a relationship between these two aspects and, in most cases, evidence shows that domestic airlines obtain higher cooperation levels with HSR compared to foreign airlines. So, are these two aspects really linked to each other? Under what conditions will a domestic/international air-rail partnership exist? Which type of air-rail cooperation is more desirable from a social welfare perspective? Although some papers have qualitatively analyzed the nature and the implications of air-rail intermodal agreements (Chiambaretto and Decker, 2012; European Commission, 2006), our paper is the first attempt to answer these questions analytically.

The contribution of this paper is mainly two-fold. On the one hand, it is the first theoretical paper to discuss the variety of air-rail partnerships. With the growing popularity of this intermodal arrangement around the world, due to reasons such as airport capacity constraint and environmental concerns, it would be of great benefit to the academia as well as the transport industry to better understand its mechanism. As a newly emerged but rapidly developing phenomenon, a large number of air-rail partnerships were formed in the past few years, which largely explains why there are not yet many existing studies on this topic. On the other hand, with a thorough welfare analysis, this paper also provides the conditions of and comparisons among various types of air-rail partnership scenarios, leading to potential policy developments. Whenever regulators find it necessary to have a careful investigation on the air-rail cooperation, possibly due to potential anti-trust issues (e.g., Jiang and Zhang, 2014), they might find this study useful as it offers a base to distinguish different types of such intermodal partnerships. Furthermore, with a real-life case study, we confirm the strengths as well as point out the weaknesses of our model in real-world application, building a more solid foundation for its future usage.

The paper is organized as follows. Section 2 sets up the basic model while Section 3 derives four different partnership scenarios and their respective equilibrium cooperation levels, profits as well as social welfare. Section 4 compares cooperation levels and social welfares across different scenarios and analyzes equilibrium market structure. Section 5 offers a numerical example based on real life data and Section 6 contains concluding remarks.

<sup>2</sup> As noted by Chiambaretto and Decker (2012), "the rail operator typically charges the airline for the transport services, and the airline then determines whether, and how, to reflect this cost in the price of the entire trip".

<sup>3</sup> Please see Appendix A for a summary of the existing cases of air-rail cooperation.

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