Cooperation between High Speed Trains and airlines

in an air network structure

Ó. Álvarez-San Jaime, P. Cantos-Sánchez,
R. Moner-Colonques and J. J. Sempere-Monerris

(Universitat de València)

The growth of high speed rail (HSR) networks has brought major changes in the supply of interurban transportation. Some authors have pointed out that the intermodal competition between air and HSR transportation is far more complicated than just pure competition between substitute services. The distinctive elements of our analysis are the consideration of: i) network demand complementarities, ii) access charges for the use of the infrastructure that are endogenous, and iii) the presence of alliances between transport operators. A number of interesting policy relevant questions arise: How do rail access fees and railway prices affect air transport in a hub-and-spoke network? Do rail access fees influence differently local and international air prices? How can these results change when an alliance between HST and an international airline is set?

There are papers that have studied intermodal competition between air transport and HSR (see Ivaldi and Vibes (2008), Adler et al. (2010), Álvarez et al. (2015)). Socorro and Viecens (2013) also consider a similar network, showing that integration on complementary legs is welfare improving. Jiang and Zhang (2014) consider cooperation involving both the leg where modes compete as well as the legs in which modes complement each other.

There exists an extensive literature on bundling incorporating the feature that the goods in the bundle are valuable when consumed together. In the air sector, there are some papers that have incorporated this element assuming that there are connecting passengers, who purchase a bundle composed of several complementary flights (Hendricks et al., 1997, 1999; Brueckner and Spiller 1991; Brueckner 2001; Flores and Moner, 2011).

To analyze these effects we propose a hub-spoke structure, as presented in Figure 1. There are three airports, two of them (A and H) are national. A is local airport, H is a hub airport and B is located elsewhere. Note that there will be two types of routes, a domestic or local one that connects A and H, and an international route connecting H and B. In the local route there is competition with train services that offers its service between A and H. In the international route there is competition between two airlines.
Therefore there are three markets whose demands follow from maximization of utility maximization of a representative user. In a first step, we assume that HST and Airline 1 set an alliance and undertake mixed bundling pricing strategies. The demand equations will be denoted by the following group of passengers:

- By train from A to H (\(q_t\))
- By air from A to H (\(q_a\))
- HB market flying with airline 1 (\(q_{i1}\))
- HB market flying with airline 2 (\(q_{i2}\))
- AB market travelling by the alliance between rail and airline 1 (\(q_{t1}\))
- AB market travelling by rail and airline 2 (\(q_{t2}\))
- AB market travelling by air and airline 1 (\(q_{a1}\))
- AB market travelling by air and airline 2 (\(q_{a2}\))

And we can specify the profit maximization problem of transportation operators:

\[
\pi_s = (p_t - c_t - 2f_t) (q_t + q_{t1} + q_{t2}) + (p_{i1} - c_{i1} - (f_H + f_B)) (q_{i1} + q_{a1} + q_{a2}) + (s_{i1} - c_{i1} - c_t - 2f_t - f_H - f_B) q_{t1}
\]

\[
\pi_a = (p_a - c_a - (f_A + f_H)) (q_a + q_{a1} + q_{a2})
\]

\[
\pi_{i2} = (p_{i2} - c_{i2} - (f_H + f_B)) (q_{i2} + q_{t1} + q_{a1} + q_{a2})
\]

where \(p_t, p_a, p_{i1} \) and \(p_{i2} \) are respectively the train price, the local air price, the price set by airline 1 and the price set by airline 2. And \(s_{i1} \) is the price paid to purchase the bundle of the two complementary services offered by the alliance \(s \) between HST and the international airline 1, lower case \(c_j \) (\(j=t, a, ia\)) denotes the corresponding marginal cost for train, local and international airline respectively, and \(f \) denotes the per-passenger infrastructure fees set by the rail manager \(f_t \) and by airports \(f_{A}, f_{H} \) and \(f_B \) (where only the latter is exogenous in the model).

Once the second stage competition in prices is characterized access infrastructure fees are set under various regimes. As long as the infrastructure remains public the manager will follow marginal cost pricing. Under privatization, managers maximize profits expressions given by:

\[
B_t = (2f_t - 2t_t) (q_t + q_{t1} + q_{t2})
\]

\[
B_A = (f_A - t_A) (q_{a} + q_{a1} + q_{a2})
\]
\[ B = \left( 2f_H^H - 2t_A^A \right) \left( q_{a1} + q_{a2} \right) + \left( f_H^H - t_A^A \right) \left( q_a + q_i + q_t + q_i^1 + q_i^2 + q_t^1 + q_t^2 \right) \]

where \( t \) and \( t_A \) stand for the marginal costs related with train and air infrastructure services, respectively.

The scenarios considered are the following: i) no alliance is promoted, ii) alliance between HST and airline 1 is produced, iii) alliance between local and airline 1 is produced. Results in terms of prices, infrastructure fees, traffic levels, profits for operators and infrastructure owners, consumer surplus and social welfare will be provided.