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Forecasting demand for high speed rail

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ABSTRACT

It is sometimes argued that standard state-of-practice logit-based models cannot forecast the demand for substantially reduced travel times, for instance due to High Speed Rail (HSR). The present paper investigates this issue by reviewing the literature on travel time elasticities for long distance rail travel and comparing these with elasticities observed when new HSR lines have opened. This paper also validates the Swedish long distance model, Sampers, and its forecast demand for a proposed new HSR, using aggregate data revealing how the air–rail modal split varies with the difference in generalized travel time between rail and air. The Sampers long distance model is also compared to a newly developed model applying Box–Cox transformations. The paper contributes to the empirical literature on long distance travel, long distance elasticities and HSR passenger demand forecasts. Results indicate that the Sampers model is indeed able to predict the demand for HSR reasonably well. The new non-linear model has even better model fit and also slightly higher elasticities.

1. Introduction

Long distance travel stands for a disproportionately large share of person kilometers traveled compared to its share of trip making. Worldwide there are great hopes that High Speed Rail (HSR) may help to alleviate the heavy load of traffic in road and air corridors and improve interregional accessibility. There is a wide political backing for investments in HSR in many countries and the European Union is considering increasing the financial funding for HSR projects (European Commission, 2010). However, HSR requires substantial investments. The economic rationale for allocating public money to construction of new HSR tracks is highly dependent on the present volume of rail travel, generation of new rail trips, and the extent to which air and car trips would be diverted to rail.

A common argument is that state-of-practice forecast models tend to underpredict demand when travel times are substantially reduced for instance due to HSR, and specifically that such models predict too small a diversion of trips from air to rail. There have so far not been many studies trying to validate forecast models in this respect, which is the purpose of the present study. Flyvbjerg et al. (2005) analyze, however, the accuracy of demand forecasts, finding that they systematically have overestimated traffic volumes of rail investments. Moreover, Flyvbjerg et al. find that forecasts have not improved over time, although estimation and forecasting techniques have. According to their findings the demand for road investments is not overestimated as much as for rail investments, indicating that the overestimation of demand for rail investments is not primarily due to unreliable forecast models, but to strong political pressure.

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Table 1
Rail elasticities in the literature.

Study	Elasticity	Comment
Model-based studies		
Román et al. (2010)	−0.4 (Madrid–Barcelona) −0.6 (Madrid–Zaragoza)	Cross-section RP/SP data. Spanish HSR corridors. In-vehicle travel time elasticity.
Cabanne (2003)[a]	0.3/0.45 −0.16 (air cross-elasticity)	Time series data models. Rail accessibility elasticity. French HSR corridor.
de Bok et al. (2010)	−0.6 (business) −0.5 (commute) −0.3 (other)	Average distance elasticity. Portugal. Cross-section RP data.
Rohr et al. (2010)	−0.9 (business) −0.4 (private)	Average distance elasticity. UK. Cross-section RP data.
Dargay (2010)	−0.49 to −3.04	Aggregate time series, UK. Different purposes and trip length segments.
Empirical studies		
Nash (2010)	−1.6 (Paris–Lyon, phase 1) −1.1 (Paris–Lyon, phase 2)	HSR line 1981–1983. In-vehicle travel time elasticity.
Sánchez-Borràs (2010)	−1.3 (Madrid–Barcelona)[b]	HSR line 2008. In-vehicle travel time elasticity.
Sánchez-Borràs (2010)	−1.2 (Madrid–Sevilla)[b]	HSR line 1992. In-vehicle travel time elasticity.

[a] These elasticities refer to rail accessibility and not in-vehicle travel time, implying positive own elasticity.
[b] Computed by the author based on data reported in the reference given.

The purpose of this paper is to investigate whether state-of-practice forecasting models can predict the demand for HSR. First, model-based long distance elasticities in the literature are compared with elasticities observed when new HSR lines have been introduced. Then the paper briefly describes the Swedish long distance model that is part of the national transport model package Sampers (Beser and Algers, 2002), studies its elasticities and demand forecast for a suggested HSR service, and validates the forecast against previous literature and aggregate Swedish data. The Sampers long distance model has been in use for some ten years and is one of the most comprehensive state-of-practice long distance models in the world presently in use for appraisal. The response of the Sampers long distance model is also compared to the response of a newly developed model applying Box–Cox transformations on time and cost parameters. The paper contributes to the empirical literature on long distance travel elasticities and HSR passenger demand forecasts.

There are reasons to believe that long distance models are less reliable than models for regional travel. First, the vast majority of forecasting models deal with regional travel, although the interest in HSR has triggered the development of long distance models in many countries (e.g. Ben-Akiva et al., 2010; de Bok et al., 2010; Outwater et al., 2010; Rohr et al., 2010). When developing long distance models the same modeling techniques are used as have traditionally been used for regional travel although long distance travel seems to be more heterogeneous. Second, non-linearity in travel time sensitivity makes long distance modeling complex. Gaudry (2008) demonstrates that mode choice logit models assuming linear sensitivity underestimate the cross-elasticity in HSR line forecasts. Daly (2010) reveals a large amount of evidence of non-linear time and cost sensitivity in previous research. Third, since long distance travel is less frequent and less evenly distributed in the population, data collection is more difficult. For instance, a long reporting period used to increase the chance that the respondent can report at least one journey induces underreporting of trips due to forgetfulness (Armoogum and Madre, 1997; Axhausen et al., 1997).

Section 2 reviews evidence of elasticities for HSR investments in the literature. Evidence of cross-elasticities of long distance travel is virtually non-existent, and this section therefore concentrates on own elasticities. Besides, cross-elasticities are less meaningful to compare between situations since they tend to be highly dependent on specific market conditions. Section 3 describes the Sampers long distance model. The section also reports the implied average elasticities and cross-elasticities of this model, which are compared to the previous evidence.

The Sampers long distance model has been used to forecast the demand for a proposed new HSR service of about 500 km, connecting the country's two largest cities: Stockholm and Gothenburg. In this corridor there is already a fast train in service, called X2000, with a travel time of 3 h and 5 min operating on upgraded conventional tracks. With the new track the travel time is supposed to decrease to 2 h and 14 min[1]. Section 4 describes the forecast demand response to the suggested HSR service and compares it with international evidence. Since cross-elasticities are rare in the literature and difficult to compare across different contexts, Section 5 validates the forecast effect on air–rail mode split against aggregate traffic count data and corresponding generalized travel time difference between air and rail in different relations. Section 6 concludes.

2. Elasticities and air–rail split in the literature

The literature on rail travel time elasticities and cross-elasticities for long distance travel is fairly limited. Long distance models, which can produce elasticities, are few, but examples are de Bok et al. (2010), Cabanne (2003), de Rohr et al. (2010)

[1] The cost is assessed to €10–€15 billion.