Assessing the demand for rail transport: an empirical analysis for high-speed services in France

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Introduction:

High-speed rail services represent in 2018, 63 % of total rail traffic in France (in passenger.km), the other traffic being made under public service obligations (PSO). The French rail transport has been increasing for the last 5 years (about 1,9 % more for rail transport, and 5,5 % for specific high-speed rail transport). However, the competition has increased with other long distance transport modes; private car usage (including carpooling), air transport, coach transport have all known sustained growth of about 2,8 %, 11,2 % and 27,6 % since 2015. Therefore, these trends may confirm possible changes in passenger modal choices and behaviours for long distance transport.

In a soon to be liberalized rail domestic market, there is a crucial lack of knowledge on passengers' behaviours for all stakeholders except for the domestic incumbent operating those services in monopoly. Detailed knowledge on the demand-side of this market is yet essential, for public makers in order to prepare the opening of the market, as for potential new entrants in order to plan new services. Several studies already helped improve the knowledge on the demand for rail passenger services in Europe and in France [1]–[7]. For that purpose, various assessments of price elasticity of demand have been carried out, most of the time in order to analyse the ex ante or ex post impact of a new rail service on a given route, and notably in the case of new high-speed services. However, it is worth noting these demand-side estimates are either aggregated at national/regional level or limited to specific routes. This study proposes a first statistical analysis of the high-speed rail services performance and its underlying factors, based on the global database of all origin-destinations operated in the domestic French market.

This study aims at (1) identifying the main factors having an impact on the high-speed rail performance in France, in order to (2) isolate relevant clusters of O/D in regards to characteristics of routes and their context (modal competition, sociodemographics…). Finally, the study (3) proposes an estimation, per cluster of O/D, of the elasticities of rail demand to several explaining factors (price, journey time, revenue, modal competition…).

Assessing rail users elasticities is essential for several studies such as traffic forecast or analysis of the business models of rail undertakings. It can also be used for additional studies, such as the analysis of chained impacts for changes in global rail pricing schemes.

Methodology and results:

The prior condition for improving the common knowledge on this market lies on the collection of detailed and exhaustive data from the domestic incumbent, including traffic, revenues and indicators of quality of service for each route. The French transport regulatory body was provided with such powers in 2015 and has been collecting the needed data so far, for both rail and road transport. Consequently, ART was able to build an original database containing exhaustive information on the supply and the demand-side for each origin and destination (called O/D in the rest of this abstract) served by high-speed services and coach services in France in 2015 and 2016. For other modes of transport, ART used available online information.

Thanks to this original database, this paper proposes a first assessment of the key factors of demand for high-speed rail transport services per O/D in France. It leads to estimate spatial-varying elasticities notably according to variables capturing the degree of intermodal competition (relative intensity, pricing, duration for rail PSO services, carpooling, air transport, coach services), local characteristics (local attractiveness, congestion…) and demand characteristics (socioeconomics, demographics…). This analysis is based on cross-sectional data, gathered for 1 700 high-speed train O/D between 2015 and 2017).

The methodology used to assess the key factors of demand for high-speed rail transport services is divided into three main steps.

First, variables that impact mostly the demand for high-speed services are short-listed among all 170 variables gathered. This selection of explanatory variables is obtained through a supervised classification of the data [8], enabling to keep only the most relevant variables from our panel and to build composite variables relevant for econometric analysis.

The second step consists in defining clusters of O/D, empirically showing similar characteristics in terms of end-users demand for high-speed rail services. For that purpose, we use a partial least squares regression [9], [10] on previously selected variables. It enables to build a hierarchical classification and a clustering of all O/D, revealing homogeneous variances of rail traffic volume in a given context of rail service supply, intermodal competition and socio-demographic environment.

Finally, an econometric demand function for high-speed services is built thanks to a modal choice model [11], [12]. We use instrumental variables methods to correct the possible bias of endogeneity, using lagged values of rail fares observed per O/D. Price elasticities are then derived for each cluster of O/D. and along all branches of the classification built in the second step. We also test for the stability of these results in regards of other indicators of average rail fares per O/D, especially testing how the elasticity of the demand vary on last-minute prices.

Results show highly differentiated impacts of local characteristics on the demand for high-speed rail services per O/D. The classical variables of volumes of population, time of travel and average fares per O/D confirm (on cross-sectional data) their impact on the HST performance per O/D. We can also observe that the level of competition between rail and other long-distance transport, and especially coach services, appears as a significant factor to be considered for modelling the rail demand per O/D. Other variables such as road congestion, existence and proximity of air transport services and car usage also reveals themselves as secondary pertinent factors to differentiate the rail performance.

It is worth noting that these results also allow a comparison of high-speed rail demand behaviours between 16 homogeneous clusters of O/D, which has not been seen so far in previous studies in the French market. If the O/D connecting Paris stations are not surprisingly clearly distinguishable from all other O/D, three homogeneous sub-clusters can be isolated between these O/D regarding the relative generalized cost and time of travel in comparison with others modes: air transport, carpooling and coach transport. Other clusters also show the relative importance for shorter distance O/D of the density of car commuters, either as a positive factor on origin or destination to connect with rail transport or as a negative factor stressing potential competition for the O/D between road and rail usage.

Finally, various price-elasticities can be assessed for all clusters and along branches of the classification, reflecting different end-users reactions according to local conditions (e.g. intensity of air transport services in parallel of high-speed rail ones, propensity to travel …). Around the global elasticity assessed on the whole panel of -0,90, the fare-elasticity computed per clusters vary between very low values for clusters gathering O/D with weak or unattractive modal competition (elasticity of -0,1 or even non-significative elasticities), to high values of elasticities (above 1,3) for clusters of O/D having relative higher cost or time of transport or lower utility for rail transport in comparison with other modes. The results also show consistency in the estimates of elasticities using different variables of fares, and are also quite robust on average between 2016 estimations (-0,94) and 2017 (-0,90). This result could have been called into question since 2016 was a very specific year for French rail transport with important strikes which could have caused biases in the model. This result therefore strengthens the methodology used and the prospects for enhancing it on the subsequent years.

References:
A. O. Hortelano, A. F. Guzman, J. Preston, et J. M. Vassallo, « Price Elasticity of Demand on the High-Speed Rail Lines of Spain: Impact of the New Pricing Scheme », Transp. Res. Rec. J. Transp. Res. Board, vol. 2597, p. 90-98, janv. 2016.

M. Girault, « Mobilité comparée selon les différents modes de transport », Notes Synthèse Serv. Économique Stat., mai 1997.

Y Chopinet, « Modélisation des effets des grands projets: l'expérience de la SNCF », in Déplacements à longue distance. Mesures et analyses, Paris, 1998.

J. Calio et J.-C. Méteyer, « Le modèle multimodal de transport intérieur à longue distance du SES: MODEV », Notes Synthèse Serv. Économique Stat., no 136, p. 37–44, 2001.

A. Sauvant, « Le transport ferroviaire de voyageurs en France: enfin un bien normal? », Notes Synthèse SES, 2002.

INRETS, « Application du modèle MATISSE à l'étude multimodale des schémas directeurs pour le transport interrégional de voyageurs. », 1997.

T. Anselme et F. P. A. Combes, « Complex model structures versus fine disaggregation of travel demand: the specification of an urban mode choice model for the French urban area of Rouen », in European Transport Conference, Glasgow, United Kingdom, 2012

R. Genuer, J.-M. Poggi, et C. Tuleau-Malot, « Variable selection using random forests », Pattern Recognit. Lett., vol. 31, no 14, p. 2225–2236, 2010.

H. Wold, « Estimation of principal components and related models by iterative least squares », in Multivariate Analysis, Krishnaiah P.R., New York: Academic Press, 1966, p. 391-420.

M. Tenenhaus, La régression PLS: théorie et pratique. Editions technip, 1998.

J. de D. Ortúzar S. et L. G. Willumsen, Modelling Transport, Fourth edition. Chichester, West Sussex, United Kingdom: John Wiley & Sons, 2011.

P. Bonnel, « Prévoir la Demande de Transport », Presse ENPC Paris, févr. 2004.