Economic evaluation of the High Speed Rail

Executive summary

The purpose of this paper is to answer the normative question of whether investing in the construction of High Speed Rail (HSR) infrastructure in a standard medium-distance corridor, like the Stockholm-Gothenburg in Sweden, is socially desirable. We analyze the expected economic effects of the construction of a HSR infrastructure in an intercity corridor, where people commute or travel for business or leisure or other purposes, and where bus companies, airlines and rail operators compete between them, and with cars, for passenger-trips. HSR services reduce rail travel time, changing the modal split in the corridor. In situations with capacity constraints in the conventional rail network and airports, additional benefits may be derived from the construction of new lines through the release of capacity for freight and other types of services in the case of rail, and for other destinations in the case of airports.

The resources allocated to the HSR infrastructure and services are significant. Construction costs exceed those corresponding to any other transport alternative, and these costs include a significant environmental impact. The rest of the costs are distributed during the life of the project: rolling stock, energy, maintenance, labor and the environmental costs associated to the provision of services. Moreover, investment costs are paid by the taxpayers, in many cases in a significant proportion, as HSR is constructed and the services provided by the public sector. Nevertheless, although the investment in dedicated high speed infrastructure is an expensive option for the improvement of rail transport, the point is not about the amount of HSR investment costs. The relevant issue is whether the society is willing to pay for this investment. The question is whether the social benefits of HSR investment are worth its costs.

The paper analyzes the main direct and indirect benefits of a new HSR line, discussing which benefits we should concentrate our attention on, and which others are not expected to be relevant in answering the question of whether the investment is socially desirable. We present a basic model for the economic evaluation of three HSR lines: the Madrid-Seville, in operation since 1992, the Madrid-Barcelona, fully in service since 2008 though operating between Madrid and Zaragoza since 2003, and the

Stockholm-Gothenburg project. The distance between the cities is around 500 km. This is a standard medium-length line where the HSR develops its full potential. In this paper we conduct a cost-benefit analysis of the HSR lines for Madrid-Barcelona, Madrid-Seville and Stockholm-Gothenburg. The first one has been running for a couple of years and the second one since 1992, so we can evaluate their performance and increase our understanding of the potential social profitability of similar lines, like the Stockholm-Gothenburg where the investment decision has not been taken so far.

The results obtained in the economic evaluation of the HSR Madrid-Seville and Madrid-Barcelona may possibly rest on some inaccuracy affecting cost or demand figures but it reflects, several undisputable facts: demand is extremely low in the first full year of operation (2.8 million passenger-trips and 5.5 million respectively). Only half of this demand travels the whole length of the line. The majority of passengers were already traveling by conventional rail, or by air where the time benefits of diversion are modest. The massive fixed costs of the line require a substantially higher volume of demand to justify the investment. The population in the cities of Madrid, Barcelona and Seville is 3.3, 1.6 and 0.7 million respectively (their metropolitan areas double these figures).

We do not try to estimate a new figure for the economic profitability of the HSR project in Sweden. The main reason is the lack of data. Moreover, we are unable to comment on the results obtained in previous evaluations as the demand data supporting the calculus of the social surplus are not disclosed in these studies. What we do here is to start with some basic supply data on investment costs, some ranges on acquisition of rolling stock and operation and maintenance in Europe; and, on the demand side, we rest on the estimation of values of time and modal split with and without the project reported in previous studies.

Instead of the calculus of the net present value (NPV), we invert the process and estimate the minimum demand volume compatible with a positive NPV, given a set of explicit assumptions on costs and demand. Then, we change the values of the main parameters to cover other less realistic cases to obtain the corresponding demand thresholds within a wide range of circumstances. We focus on the Stockholm-Gothenburg, and only accounting for the direct benefits.

Evidence from other studies and the results of the two Spanish lines evaluated in this paper show that benefits deriving from the reduction of congestion and accidents are less than 5% of total benefits and, in the case of Sweden, the prediction of changes in modal split with the project show that car passenger-trips shifting to HSR are less than 3% of the total passenger-trips in the first year of operation. Once we obtain the minimum demand thresholds needed for a positive NPV under these assumptions, we conduct a sensitivity analysis with the introduction of freight benefits reported in previous studies. A discussion of the potential environmental benefits is also carried out.

In the cases where the demand-income elasticity is assumed to be the value estimated for Sweden, labor costs grow proportionally with income and half of the passenger-trips travel the whole length of the line, the demand thresholds for a NPV equal to zero go from 17 to 25 million of passenger-trips in the first year operation. There are other more favorable scenarios where the required demand levels for the first year of operation could be lower but the underlying assumptions are then somewhat unrealistic. The released capacity for freight transport has been argued to be one of the benefits of the construction of HSR infrastructure in Sweden. To conclude the simulations, we recalculate the minimum demand volumes compatible with a positive NPV including the alleged benefits derived from the release of capacity for freight transport. The results do not show any dramatic change with respect to the demand thresholds.

The investment in HSR infrastructure is one of the feasible `do something´ alternatives to deal with transport-capacity problems in passenger intercity corridors. It is not the only one but the economic case for this option is more likely when there are capacity constraints in the conventional rail network, roads and airports and the release of capacity generates additional benefits for freight, long-haul flights and other side effects of the marginal capacity that avoid major investments. Another potential benefit of HSR investment is the reduction of environmental externalities, though this depends on the volume of demand deviated from less environmentally friendly transport modes and whether the demand is high enough to compensate the negative externalities during construction, the barrier effect, noise and visual intrusion. The problem is that, according with the predictions, 72% of HSR passenger-trips in the Stockholm-Gothenburg line come from already existing railway and 21% from generated demand; therefore, the reduction in environmental externalities from traffic diversion might be insignificant.

The economic evaluation of long-lived infrastructure requires a careful construction of the contrafactual and there are many assumptions that might seriously bias the results. This is the case of transport pricing during the lifespan of the project. Pricing policy needs to be explicitly treated. We need to consider how the alternative transport modes are going to be charged. For example, the government could charge air and road transport below social marginal cost and then justify a massive rail investment as a second-best policy to change the modal split, or it could optimally price all transport modes and then evaluate the optimal way to expand capacity. The final result may be quite different.

There is a dynamic aspect worth considering. Socially profitable or not, once the HSR infrastructure is built the costs are sunk, and this irreversibility affects more than half of the total costs (even higher for low density lines). Once the line is built, the marginal cost of additional traffic is quite low compared with the *ex ante* marginal cost. Prices much lower than total average costs are common in many HSR lines around the world, fostering demand and the expansion of a network in regions or countries where there were better transport solutions for their accessibility and mobility needs.

There is considerable pressure on governments to built new high speed lines as if the investment were a kind of `now or never´ decision. This does not seem to be the case with this technology. The construction of HSR infrastructure is irreversible and there is uncertainty associated with costs and demand. In these conditions the question of the right moment to invest is critical as the investment can be postponed in most cases. Hence, the optimal timing of the investment should be addressed even in the case of a positive NPV.