

Efficiency and spatial equity impacts of high-speed rail extensions in urban areas

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ABSTRACT

Urban areas benefit from significant improvements in accessibility when a new high speed rail (HSR) project is built. These improvements, which are due mainly to a rise in efficiency, produce locational advantages and increase the attractiveness of these cities, thereby possibly enhancing their competitiveness and economic growth. However, there may be equity issues at stake, as the main accessibility benefits are primarily concentrated in urban areas with a HSR station, whereas other locations obtain only limited benefits.

HSR extensions may contribute to an increase in spatial imbalance and lead to more polarized patterns of spatial development. Procedures for assessing the spatial impacts of HSR must therefore follow a two-fold approach which addresses issues of both efficiency and equity. This analysis can be made by jointly assessing both the magnitude and distribution of the accessibility improvements deriving from a HSR project.

This paper describes an assessment methodology for HSR projects which follows this twofold approach. The procedure uses spatial impact analysis techniques and is based on the computation of accessibility indicators, supported by a Geographical Information System (GIS). Efficiency impacts are assessed in terms of the improvements in accessibility resulting from the HSR project, with a focus on major urban areas; and spatial equity implications are derived from changes in the distribution of accessibility values among these urban agglomerations.

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Introduction

The opening of a HSR station brings enhanced accessibility and fosters changes in the configuration of the land-use system of the urban area near the station and its immediate surroundings (Blum, Haynes, & Karlsson, 1997; Ureña, Menerault, & Garmendia, 2009; van den Berg & Pol, 1998). The spatial organization changes to take advantage of the increased attractiveness of the newly-connected location, in a dynamic process where involving simultaneous and multilevel impacts in the economic, social and environmental spheres (Banister & Berechman, 2003; Vickerman & Ullied, 2009).

The motivation for the implementation of a new HSR service in a city strongly influences the impacts it has (Campos & de Rus, 2009; Garmendia, Ureña, & Coronado, *in press*). These motivations, if considered in terms of the *accessibility* problem the HSR is intended to solve, can be broadly classified into two categories (Blum et al., 1997). On the one hand, the HSR service may be intended primarily to improve long distance and international connections, thus acting as a substitute for, or in combination with, air travel (Givoni, 2006; Román, Espino, & Martín, 2010). On the other hand, the HSR may be designed to promote high interregional accessibility by linking

together cities in an “integrated corridor economy” (Blum et al., 1997; Martínez & Givoni, 2009; Ureña, Garmendia, Coronado, Vickerman, & Romero, 2010; Ureña et al., 2009). These two categories are derived from the work of Blum et al. (1997), in which HSR stations which provide good connexion with airports are differentiated from those which are primarily designed to improve regional travel (train/car).

Furthermore, travel patterns in cities outside the HSR corridor may also change in response to the new HSR service (Garmendia et al., *in press*; López, Gutiérrez, & Gómez, 2008; Ureña et al., 2009, 2010). For these cities, the nearest HSR station may function as an interchange node to connect to the HSR network. Hence cities located outside the HSR corridor may also obtain accessibility benefits, whereas cities with their own HSR station may be transformed into new regional “core locations”.

The above considerations refer mainly to the magnitude of the effects of HSR extensions. These improvements are frequently referred to as *efficiency* impacts (Bröcker, Korzhenevych, & Schürmann, 2010; Gutiérrez, Monzón, & Piñero, 1998) and are mainly related with accessibility benefits. There is another complementary – and frequently conflicting – approach, which refers to the spatial distribution of these effects, i.e. to *equity* considerations (Hay, 1993). Traditionally, assessment methodologies have not addressed the conflict between the objectives of efficiency and equity (López &

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Monzón, 2010; Martínez & Givoni, 2009). Efficiency objectives in isolation would lead to a HSR network whose aim is to provide an efficient link between major economic activity centres. However, this strategy would have a negative impact on equity, as it would lead to more polarized patterns of spatial development: richer cities are likely to gain more, while disadvantaged cities would end up in a comparatively worse situation (Martin, 1997; Martínez & Givoni, 2009; Puga, 2002).

These equity considerations, related with concepts such as cohesion, polycentricity and peripherality, are gaining ground in European transport and regional policy documents (Bröcker et al., 2010; EC, 1999; Peters, 2003; Vickerman, Spiekermann, & Wegener, 1999). It is therefore increasingly being claimed that the design of a HSR network may need to be modified to ensure that both an acceptable degree of equity is retained, while maximizing economic growth (Bröcker et al., 2010; Button, 1993; López & Monzón, 2010). This design will require changes in local and regional secondary transport networks in order to improve the connection of cities without a HSR station to the HSR service (EC, 1999).

Accessibility analysis is increasingly being used as a support tool when planning HSR extensions (Bröcker et al., 2010; Gutiérrez, 2001; Gutiérrez, González, & Gómez, 1996), given its proven capacity to address both efficiency and equity issues (López et al., 2008; Martín, Gutiérrez, & Román, 2004). Accessibility measures are capable of gauging the achievement of efficiency objectives, as they make it possible to assess improvements in network efficiency (Gutiérrez et al., 1998). They can also determine how transport and development impacts are distributed across geographical areas and population groups, thus combining the objectives of compatibility and equity (Talen, 1998; Talen & Anselin, 1996).

In this context, the present paper contributes to the existing literature by proposing a methodology to assess both the equity and efficiency implications of HSR projects. The structure of the paper is as follows: the section after this introduction defines various general concepts of efficiency and equity, and outlines current attempts to measure equity impacts through accessibility analysis. The third section describes the proposed methodology, which is subsequently applied in a fourth section to a case study of a HSR extension in Spain. The fifth and final section contains the discussion and recommendations for future research directions.

Efficiency, equity and accessibility analysis

Efficiency impacts of HSR

From the perspective of a transport system, the opening of a HSR section obviously leads to an improvement in accessibility, – i.e. improved efficiency in the global network (Bröcker et al., 2010; Gutiérrez et al., 1998). In addition, at a strategic level, the opening of a new HSR link can significantly affect demand on competitive and complementary links and transport modes, thereby changing interconnections and the resulting patterns of network usage and performance (Adler, Pels, & Nash, 2010; Campos & de Rus, 2009; Givoni, 2006; Martin, 1997; Román et al., 2010).

These effects on the performance of the transport network as a whole are termed “network effects” (Laird, Nellthorp, & Mackie, 2005), and are thus related to issues such as “network efficiency”, (Gutiérrez et al., 1998; López & Monzón, 2010). We will use the term “efficiency” in this research work to describe the accessibility benefits conferred by a new transport infrastructure. This is a commonly accepted approach in accessibility papers (see e.g. Bröcker et al., 2010; Gutiérrez et al., 1998; López & Monzón, 2010), and was first used in the early work of Domanski (1979).

From a wider perspective, the implications of the accessibility benefits brought by HSR have been comprehensively addressed in the transport planning literature. When HSR first arrives in an urban area it triggers a dynamic process which transforms the land-use and economic activity patterns of the core city and its surroundings. However, the conclusions of recent studies show that support for investment in HSR infrastructure cannot be based only on expectations of benefits to economic development (Givoni, 2006). Other considerations apply if HSR impacts are approached solely from the standpoint of regional development (see e.g.; Kobayashi & Okumura, 1997; Martin, 1997; Martínez & Givoni, 2009; Vickerman & Uljed, 2009; Vickerman et al., 1999).

Although this issue is subject to debate (Givoni, 2006; Pol, 2003; Puga, 2002; Vickerman & Uljed, 2009), it has been argued that this improved connectivity may be transformed into increased competitiveness for firms located in these core cities connected to the HSR network. These cities can benefit from the effects of agglomeration to attract economic activity, enlarge their market areas and help accelerate the growth and development of regional economies (Martin, 1997). It has been suggested that these effects depend predominantly on the manner in which the urban actors react to the new opportunities offered by improved accessibility (Kobayashi & Okumura, 1997; Pol, 2003). It is therefore necessary to design a strategy for integrating HSR into the city (van den Berg & Pol, 1998) which takes into account the effects on the quality of the living environment.

Despite the complexity of the relationship between improved connectivity and economic growth, good accessibility is deemed to be a necessary condition in order to improve a city’s competitiveness (van Winden, van der Berg, & Pol, 2007). In a context of transition to the information society, core cities face the challenge of becoming the nodal points of worldwide networks. Thus “HSR can be a great opportunity to renew and/or strengthen the urban economy, to change the modal split in favour of the more environmentally-friendly modalities, and to improve the image of the inner city and its urban region” (Pol, 2003). International transport connections – in terms of access to international airports and HSR connections – are therefore a key element in this shift, as they provide city economies with expanded opportunities for “face-to-face communication for knowledge production” (Kobayashi & Okumura, 1997).

The above considerations apply mainly to major core cities connected to the HSR network. The picture is different for intermediate cities and low-density regions without a HSR station, but geographically located near a HSR corridor. The debate as to the

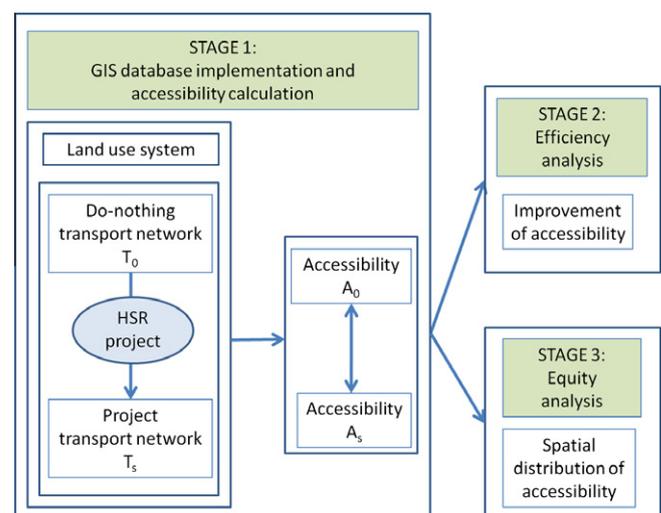


Fig. 1. Outline of the methodology.

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